NFPA® 1
Fire Code Handbook

EIGHTH EDITION

Edited by

Kristin C. Bigda, P.E.

Principal Fire Protection Engineer
National Fire Protection Association

With the complete text of the 2018 edition of NFPA® *1, Fire Code*

NATIONAL FIRE PROTECTION ASSOCIATION
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A Guide to Using the *NFPA® 1 Fire Code Handbook*

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176 Chapter 10 • General Safety Requirements

Exhibit 10.7

Stair sign placement.

Exhibit 10.8

Stairway identification sign with tactile floor level designator.

Exhibit 10.7 illustrates the placement required to ensure that the sign is readily visible, whether the door leaf is open or closed.

The indication of the direction to the level of exit discharge can be extremely useful to occupants of a building, especially if the occupants are below the level of exit discharge. The natural tendency of occupants is to attempt egress by traveling downward in a stair; this is counterproductive where the exit discharge is located on an upper level. Also, many buildings have multiple levels of entrance, which create confusion with respect to travel direction in a given stair.

The requirements of 10.11.3 are not exempted for existing buildings, because it is feasible and cost effective to install signs providing the required information. Because stair enclosures are usually not as aesthetically well finished as occupied portions of a building, the requirement for the signage (other than for the tactile floor level designator) is often met by stenciling the information directly onto the walls.

The provision of 10.11.3.1.13 was revised for the 2009 edition of the *Code*. In prior editions, roof access or lack of roof access was required to be designated by a sign. In many cases, roof access was provided for emergency responders only, and a sign reading "Roof Access" was misleading to building occupants. The current provision requires that only the lack of roof access be designated by a sign.

The provision of 10.11.3.1.7 was new to the 2015 edition of the *Code*. It replaced a provision that required the signage to be located approximately 60 in. (1525 mm) above the floor landing. The *Code* user now has a definitive height range for placement of the sign above the floor landing. Other criteria were moved or combined for clarification.

The provision of 10.11.3.1.16 is needed so that signs installed prior to 2009, when subitems (L) through (O) were added, are not unfairly reclassified as noncompliant.

The provision of 10.11.3.1.8 was revised for the 2018 edition of the *Code* to add the words "from within the stair enclosure," because misinterpretations were being made that occupants must be able to see the sign before entering the exit stair enclosure.

Exhibit 10.8 shows a stairway identification sign with the information required by 10.11.3.1. The element reading *Level 2* was provided for compliance with 10.11.3.1.2, which requires that the signage indicate the floor level, and for compliance with 10.11.3.1.10, which requires that the floor level designation also be tactile in accordance with ICC/ANSI A117.1, *Accessible and Usable Buildings and Facilities*. The minimum 5 in. (125 mm) high floor level number — the large *2* in this case — that was provided for compliance with 10.11.3.1.14 cannot serve as the tactile floor level designation because ICC/ANSI A117.1 limits raised characters to being not more than 2 in. (51 mm) in height. Further, the floor level designation is provided in braille below the tactile element, because ICC/ANSI A117.1 requires that raised letters be duplicated in braille.

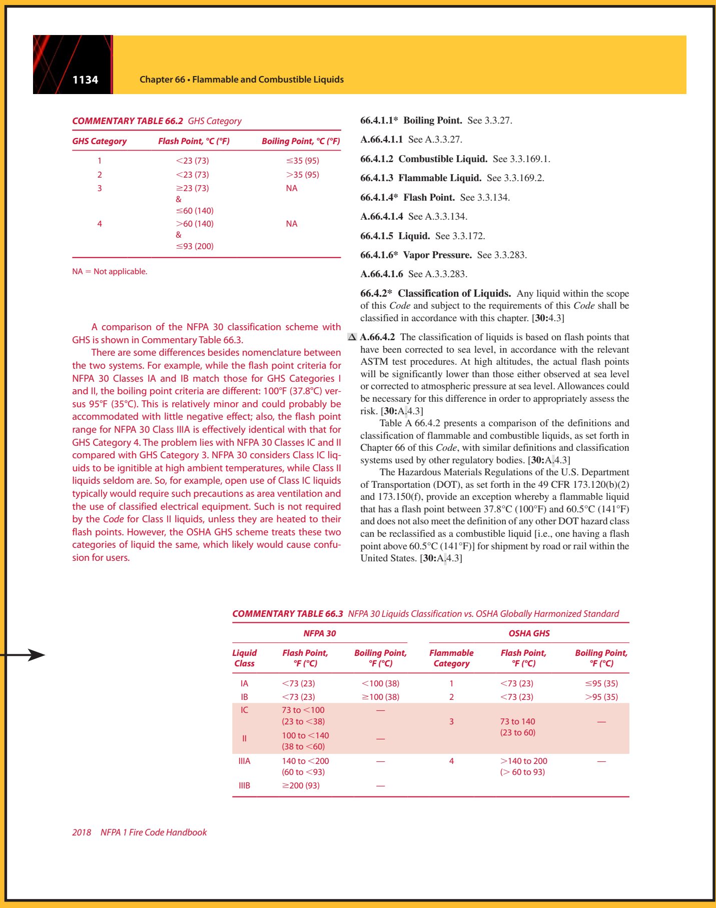
Δ **10.11.3.2** Wherever an enclosed stair requires travel in an upward direction to reach the level of exit discharge, special signs with directional indicators showing the direction to the level of exit discharge shall be provided at each floor level landing from which upward direction of travel is required, unless otherwise provided in 10.11.3.2.1 and 10.11.3.2.2, and both of the following also shall apply:

(1) Such signage shall comply with 14.14.8.1 and 14.14.8.2.
(2) Such signage shall be visible when the door leaf is in the open or closed position.

[***101:***7.2.2.5.4.2]

2018 NFPA 1 Fire Code Handbook

Commentary exhibits, including both illustrations and photographs, are set off in red frames.



1134 Chapter 66 • Flammable and Combustible Liquids

COMMENTARY TABLE 66.2 *GHS Category*

GHS Category	Flash Point, °C (°F)	Boiling Point, °C (°F)
1	<23 (73)	≤35 (95)
2	<23 (73)	>35 (95)
3	≥23 (73) & ≤60 (140)	NA
4	>60 (140) & ≤93 (200)	NA

NA = Not applicable.

A comparison of the NFPA 30 classification scheme with GHS is shown in Commentary Table 66.3.

There are some differences besides nomenclature between the two systems. For example, while the flash point criteria for NFPA 30 Classes IA and IB match those for GHS Categories I and II, the boiling point criteria are different: 100°F (37.8°C) versus 95°F (35°C). This is relatively minor and could probably be accommodated with little negative effect; also, the flash point range for NFPA 30 Class IIIA is effectively identical with that for GHS Category 4. The problem lies with NFPA 30 Classes IC and II compared with GHS Category 3. NFPA 30 considers Class IC liquids to be ignitible at high ambient temperatures, while Class II liquids seldom are. So, for example, open use of Class IC liquids typically would require such precautions as area ventilation and the use of classified electrical equipment. Such is not required by the *Code* for Class II liquids, unless they are heated to their flash points. However, the OSHA GHS scheme treats these two categories of liquid the same, which likely would cause confusion for users.

66.4.1.1* Boiling Point. See 3.3.27.

A.66.4.1.1 See A.3.3.27.

66.4.1.2 Combustible Liquid. See 3.3.169.1.

66.4.1.3 Flammable Liquid. See 3.3.169.2.

66.4.1.4* Flash Point. See 3.3.134.

A.66.4.1.4 See A.3.3.134.

66.4.1.5 Liquid. See 3.3.172.

66.4.1.6* Vapor Pressure. See 3.3.283.

A.66.4.1.6 See A.3.3.283.

66.4.2* Classification of Liquids. Any liquid within the scope of this *Code* and subject to the requirements of this *Code* shall be classified in accordance with this chapter. [**30:**4.3]

Δ **A.66.4.2** The classification of liquids is based on flash points that have been corrected to sea level, in accordance with the relevant ASTM test procedures. At high altitudes, the actual flash points will be significantly lower than those either observed at sea level or corrected to atmospheric pressure at sea level. Allowances could be necessary for this difference in order to appropriately assess the risk. [**30:**A.4.3]

Table A 66.4.2 presents a comparison of the definitions and classification of flammable and combustible liquids, as set forth in Chapter 66 of this *Code*, with similar definitions and classification systems used by other regulatory bodies. [**30:**A.4.3]

The Hazardous Materials Regulations of the U.S. Department of Transportation (DOT), as set forth in the 49 CFR 173.120(b)(2) and 173.150(f), provide an exception whereby a flammable liquid that has a flash point between 37.8°C (100°F) and 60.5°C (141°F) and does not also meet the definition of any other DOT hazard class can be reclassified as a combustible liquid [i.e., one having a flash point above 60.5°C (141°F)] for shipment by road or rail within the United States. [**30:**A.4.3]

COMMENTARY TABLE 66.3 *NFPA 30 Liquids Classification vs. OSHA Globally Harmonized Standard*

NFPA 30			OSHA GHS		
Liquid Class	Flash Point, °F (°C)	Boiling Point, °F (°C)	Flammable Category	Flash Point, °F (°C)	Boiling Point, °F (°C)
IA	<73 (23)	<100 (38)	1	<73 (23)	≤95 (35)
IB	<73 (23)	≥100 (38)	2	<73 (23)	>95 (35)
IC	73 to <100 (23 to <38)	—	3	73 to 140 (23 to 60)	—
II	100 to <140 (38 to <60)	—			
IIIA	140 to <200 (60 to <93)	—	4	>140 to 200 (> 60 to 93)	—
IIIB	≥200 (93)	—			

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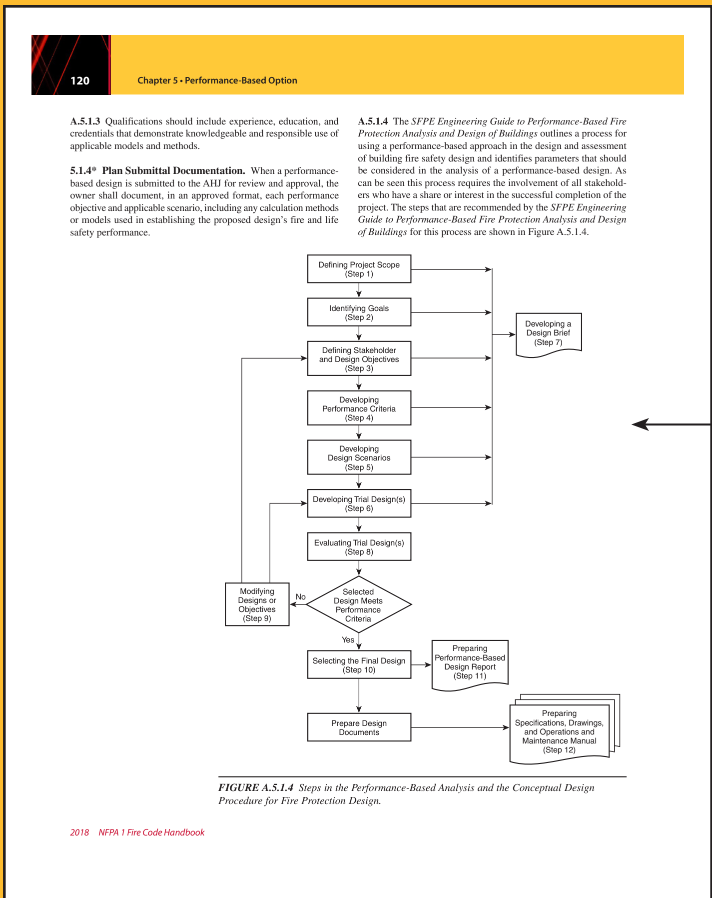
Commentary tables are printed in red to distinguish them from the *Code* tables.



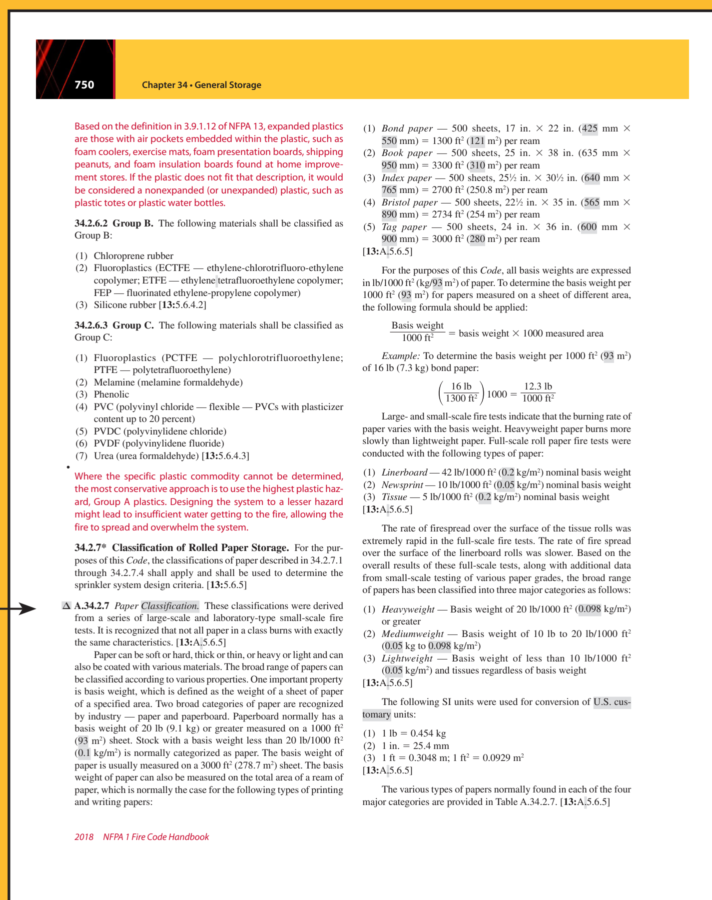
A.5.1.3 Qualifications should include experience, education, and credentials that demonstrate knowledgeable and responsible use of applicable models and methods.

5.1.4* Plan Submittal Documentation. When a performance-based design is submitted to the AHJ for review and approval, the owner shall document, in an approved format, each performance objective and applicable scenario, including any calculation methods or models used in establishing the proposed design's fire and life safety performance.

A.5.1.4 The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* outlines a process for using a performance-based approach in the design and assessment of building fire safety design and identifies parameters that should be considered in the analysis of a performance-based design. As can be seen this process requires the involvement of all stakeholders who have a share or interest in the successful completion of the project. The steps that are recommended by the *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* for this process are shown in Figure A.5.1.4.

FIGURE A.5.1.4 Steps in the Performance-Based Analysis and the Conceptual Design Procedure for Fire Protection Design.

Code figures and tables are printed in black.



Based on the definition in 3.9.1.12 of NFPA 13, expanded plastics are those with air pockets embedded within the plastic, such as foam coolers, exercise mats, foam presentation boards, shipping peanuts, and foam insulation boards found at home improvement stores. If the plastic does not fit that description, it would be considered a nonexpanded (or unexpanded) plastic, such as plastic totes or plastic water bottles.

34.2.6.2 Group B. The following materials shall be classified as Group B:

(1) Chloroprene rubber
(2) Fluoroplastics (ECTFE — ethylene-chlorotrifluoro-ethylene copolymer; ETFE — ethylene tetrafluoroethylene copolymer; FEP — fluorinated ethylene-propylene copolymer)
(3) Silicone rubber [**13:**5.6.4.2]

34.2.6.3 Group C. The following materials shall be classified as Group C:

(1) Fluoroplastics (PCTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene)
(2) Melamine (melamine formaldehyde)
(3) Phenolic
(4) PVC (polyvinyl chloride — flexible — PVCs with plasticizer content up to 20 percent)
(5) PVDC (polyvinylidene chloride)
(6) PVDF (polyvinylidene fluoride)
(7) Urea (urea formaldehyde) [**13:**5.6.4.3]

Where the specific plastic commodity cannot be determined, the most conservative approach is to use the highest plastic hazard, Group A plastics. Designing the system to a lesser hazard might lead to insufficient water getting to the fire, allowing the fire to spread and overwhelm the system.

34.2.7* Classification of Rolled Paper Storage. For the purposes of this *Code*, the classifications of paper described in 34.2.7.1 through 34.2.7.4 shall apply and shall be used to determine the sprinkler system design criteria. [**13:**5.6.5]

Δ **A.34.2.7** *Paper Classification.* These classifications were derived from a series of large-scale and laboratory-type small-scale fire tests. It is recognized that not all paper in a class burns with exactly the same characteristics. [**13:**A.5.6.5]

Paper can be soft or hard, thick or thin, or heavy or light and can also be coated with various materials. The broad range of papers can be classified according to various properties. One important property is basis weight, which is defined as the weight of a sheet of paper of a specified area. Two broad categories of paper are recognized by industry — paper and paperboard. Paperboard normally has a basis weight of 20 lb (9.1 kg) or greater measured on a 1000 ft² (93 m²) sheet. Stock with a basis weight less than 20 lb/1000 ft² (0.1 kg/m²) is normally categorized as paper. The basis weight of paper is usually measured on a 3000 ft² (278.7 m²) sheet. The basis weight of paper can also be measured on the total area of a ream of paper, which is normally the case for the following types of printing and writing papers:

(1) *Bond paper* — 500 sheets, 17 in. × 22 in. (425 mm × 550 mm) = 1300 ft² (121 m²) per ream
(2) *Book paper* — 500 sheets, 25 in. × 38 in. (635 mm × 950 mm) = 3300 ft² (310 m²) per ream
(3) *Index paper* — 500 sheets, 25½ in. × 30½ in. (640 mm × 765 mm) = 2700 ft² (250.8 m²) per ream
(4) *Bristol paper* — 500 sheets, 22½ in. × 35 in. (565 mm × 890 mm) = 2734 ft² (254 m²) per ream
(5) *Tag paper* — 500 sheets, 24 in. × 36 in. (600 mm × 900 mm) = 3000 ft² (280 m²) per ream

[**13:**A.5.6.5]

For the purposes of this *Code*, all basis weights are expressed in lb/1000 ft² (kg/93 m²) of paper. To determine the basis weight per 1000 ft² (93 m²) for papers measured on a sheet of different area, the following formula should be applied:

$$\frac{\text{Basis weight}}{1000\ \text{ft}^2} = \text{basis weight} \times 1000\ \text{measured area}$$

Example: To determine the basis weight per 1000 ft² (93 m²) of 16 lb (7.3 kg) bond paper:

$$\left(\frac{16\ \text{lb}}{1300\ \text{ft}^2}\right)1000 = \frac{12.3\ \text{lb}}{1000\ \text{ft}^2}$$

Large- and small-scale fire tests indicate that the burning rate of paper varies with the basis weight. Heavyweight paper burns more slowly than lightweight paper. Full-scale roll paper fire tests were conducted with the following types of paper:

(1) *Linerboard* — 42 lb/1000 ft² (0.2 kg/m²) nominal basis weight
(2) *Newsprint* — 10 lb/1000 ft² (0.05 kg/m²) nominal basis weight
(3) *Tissue* — 5 lb/1000 ft² (0.2 kg/m²) nominal basis weight

[**13:**A.5.6.5]

The rate of firespread over the surface of the tissue rolls was extremely rapid in the full-scale fire tests. The rate of fire spread over the surface of the linerboard rolls was slower. Based on the overall results of these full-scale tests, along with additional data from small-scale testing of various paper grades, the broad range of papers has been classified into three major categories as follows:

(1) *Heavyweight* — Basis weight of 20 lb/1000 ft² (0.098 kg/m²) or greater
(2) *Mediumweight* — Basis weight of 10 lb to 20 lb/1000 ft² (0.05 kg to 0.098 kg/m²)
(3) *Lightweight* — Basis weight of less than 10 lb/1000 ft² (0.05 kg/m²) and tissues regardless of basis weight

[**13:**A.5.6.5]

The following SI units were used for conversion of U.S. customary units:

(1) 1 lb = 0.454 kg
(2) 1 in. = 25.4 mm
(3) 1 ft = 0.3048 m; 1 ft² = 0.0929 m²

[**13:**A.5.6.5]

The various types of papers normally found in each of the four major categories are provided in Table A.34.2.7. [**13:**A.5.6.5]

Specific icons and shading within *Code* text indicate where text has changed from the previous edition.

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off the worker's view of the exterior doors. The placement of temporary directional signs that point to exits throughout the building is important, as well as the rearrangement of such signs as the building interior changes during construction.

16.1.4 Fire department access roads provided in accordance with 18.2.3 shall be provided at the start of a project and shall be maintained throughout construction.

Fire department access roads are required throughout the construction process. The minimum 20 ft (6.1 m) of required clear width must be maintained at all times for access to the building and the building site. Maintenance of fire department access roads should be a key component of the fire protection plan (where required; see 16.1.2) and fire safety program (see 16.3.1).

Large construction sites might require two or more fire department access roads to be provided for access to within 150 ft (46 m) of all exterior first floor walls. (See 7.5.5.7 of NFPA 241.)

16.1.5 Permanent fire department access road markings shall not be required until the building is complete or occupied for use.

Signs marking the fire department access road might be required, in accordance with 18.2.3.5. Permanent signs are not required until after construction is completed. Temporary signs might be required to ensure that fire department access roads are kept clear during construction, alteration, or demolition operations. (Also see 7.5.5.6 of NFPA 241.)

16.2 Processes and Hazards

This section covers specific operations that represent likely ignition sources and lists specific combustible, flammable, or explosive materials that are generated or used in the course of construction. If not handled correctly, these materials can cause a disastrous situation.

16.2.1 Temporary Heating Equipment.

16.2.1.1* Temporary heating equipment shall be listed. [**241:**5.2.1]

A.16.2.1.1 Examples of relevant test standards include, but are not limited to, the following:

(1) UL 647, *Standard for Unvented Kerosene-Fired Room Heaters and Portable Heaters*
(2) ANSI/UL 1278, *Standard for Moveable and Wall- or Ceiling-Hung Electric Room Heaters*

[**241:**A.5.2.1]

16.2.1.2 Temporary heating equipment shall be installed in accordance with its listing, including clearance to combustible material, equipment, or construction. [**241:**5.2.2]

16.2.1.3 Temporary heating equipment shall be installed, used, and maintained in accordance with the manufacturer's instructions, except as otherwise provided in 16.2.1.4. [**241:**5.2.3]

16.2.1.4 Where instructions, as addressed in 16.2.1.3, are not available, temporary heating equipment shall be used in accordance with recognized safe practices. [**241:**5.2.4]

16.2.1.5 Temporary heating equipment shall be situated so that it is secured. [**241:**5.2.5]

Paragraph 16.2.1.5 requires temporary heating devices to be secured to prevent them from being tipped over or accidentally moved. Any associated tanks should also be secured. Heaters that tip over or are easily moved can come into contact with combustible materials or spilled fuel. Special care should be taken with the movement of cylinders and the connection of hoses to heating appliances. (See Chapter 69 for requirements pertaining to liquefied petroleum gas and liquefied natural gas.)

16.2.1.6 Only personnel familiar with the operation of the temporary heating equipment shall be allowed to operate such devices. [**241:**5.2.6]

16.2.1.7* Temporary heating equipment, where utilized, shall be monitored for safe operation and maintained by properly trained personnel. [**241:**5.2.7]

A.16.2.1.7 Misuse of temporary heating devices has resulted in numerous fires and millions of dollars in property loss. Temporary heating equipment, while operating, should be visually inspected every hour to ensure that combustibles have not blown or fallen over near the temporary heating device. During windy periods, it might be necessary to reduce the interval between inspections. Any object near the temporary heating device that is hot to the touch should be moved, or the temporary heating device should be relocated. The visual inspection also should ensure that the appliance is operating properly. Any appliance that is not operating properly should be turned off until repairs have been made. [**241:**A.5.2.7]

Where plastic films are used for temporary enclosures, they must comply with Test Method 2 of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*. Plastic film used for temporary enclosure of buildings should be adequately fastened to ensure that it does not rip off and get blown against a heater or other heat-producing device. Storage of combustible construction materials should be kept a safe distance from any heating appliance.

16.2.1.8 Temporary heating equipment and devices noted to be damaged or considered to be a potential safety hazard shall not be used. [**241:**5.2.8]

16.2.1.9 Temporary heating equipment using exposed radiant heating wires shall not be used. [**241:**5.2.9]

16.2.1.10 Temporary electrical heating equipment shall be equipped with tip-over protection and overheat cutoffs. [**241:**5.2.10]

Δ **16.2.1.11** Chimney or vent connectors, where required from direct-fired heaters, shall be maintained at least 18 in. (460 mm) from combustibles and shall be installed in accordance with NFPA 211. [**241:**5.2.11]

Mandatory *Code* text is printed in black.

Nonmandatory Annex A material is printed in black and follows the *Code* text it references.

Compliance with this *Code* can be achieved in more than one way, as indicated in 1.4.4. A building either complies with the *Code's* prescriptive requirements or achieves equivalency through documentation of AHJ-approved alternatives or modifications. If an alternate approach to compliance is implemented, and the AHJ has judged that the alternative provides equivalency, the building is considered *Code* compliant. Compliance achieved by means of equivalency differs from a waiver that permits continued use of a noncompliant building, which should never be permitted. Documentation of equivalencies should be maintained by both the building owner and the AHJ for the life of the building. In addition, such documentation should specify whether changes to the building, such as removal of an otherwise nonrequired smoke detection system, will render the equivalency void.

1.4.5 Each application for an equivalent, alternative, or modified fire protection feature shall be filed with the AHJ and shall be accompanied by such evidence, letters, statements, results of tests, or other supporting information as required to justify the request. The AHJ shall keep a record of actions on such applications, and a signed copy of the AHJ's decision shall be provided for the applicant.

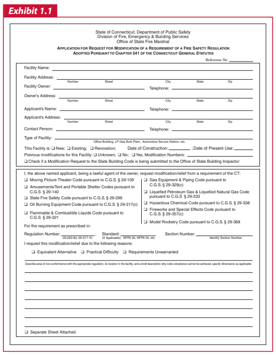
An applicant filing a request for an equivalency, alternative, or modification should be provided with a form by the AHJ. Exhibit 1.1 shows the first page of one such form for requesting a modification to a *Code* requirement. The form ensures that each applicant provides the AHJ with the appropriate information in an acceptable manner.

The AHJ should also require information, as necessary, to assist in determining whether the alternative level of protection is equivalent to the intent of this *Code*. The information required might include testing data, listing or labeling reports, engineering reports, and other supporting details that allow the AHJ to make an informed decision. The information must be maintained in an appropriate file so that a record on which the decision was based is available. This information is also important if the applicant files an appeal on the AHJ's decision to the Board of Appeals, as outlined in Section 1.10.

Δ **1.4.6 Approval.** The AHJ shall approve such equivalent, alternative, or modified construction systems, materials, or methods of design when it is substantiated that the standards of this *Code* are at least equaled. If, in the opinion of the AHJ, the standards of this *Code* are not equaled by the alternative requested, approval for permanent work shall be refused. Consideration shall be given to test or prototype installations.

The AHJ has the discretionary authority to approve or refuse an equivalency, alternatives, or modifications. However, that approval or refusal needs to be based on the ability of the applicant to justify that the equivalent level of life safety and protection has been provided.

Exhibit 1.1



Sample application form for an equivalency, alteration, or modification. (Courtesy of State of Connecticut, Department of Public Safety)

1.4.7 Tests.

1.4.7.1 Whenever evidence of compliance with the requirements of this *Code* is insufficient or evidence that any material or method of construction does not conform to the requirements of this *Code*, or to substantiate claims for alternative construction systems, materials, or methods of construction, the AHJ shall be permitted to require tests for proof of compliance to be made by an approved agency at the expense of the owner or his/her agent.

1.4.7.2 Test methods shall be as specified by this *Code* for the material in question. If appropriate test methods are not specified in this *Code*, the AHJ is authorized to accept an applicable test procedure from another recognized source.

The question of "What is an appropriate test?" is one that needs careful consideration by the AHJ. If an incorrect type of test is submitted to the AHJ or if the AHJ specifies an incorrect test method, the code specified level of safety may not be achieved. If there is a question about the appropriate test method to be used, the AHJ should consult subject experts and testing laboratories with expertise in the area.

1.4.7.3 Copies of the results of all such tests shall be retained in accordance with Section 1.11.

Commentary is printed in red to distinguish it from *Code* text.

948 Chapter 50 • Commercial Cooking

Simultaneous operation provides for common actuation of all fire suppression systems protecting the hazards in the single hazard area. The goal of this requirement is to cover all the components of the cooking operation to suppress a fire.

Arguments have been made against the simultaneous operation approach, especially with respect to chemical systems, which provide a limited supply of extinguishing agent. Some believe it is safer to discharge the chemical only in the areas where the fire is burning. If the fire then spreads to other areas, some remaining chemical is still available. When chemical is prematurely discharged, dry chemical tends to be carried out of the system by fan action, while wet chemical tends to drain out of the system; therefore, if a fire subsequently spreads, no agent remains to extinguish the spreading fire.

The concern regarding premature discharge of extinguishing agent led to the sequential or separate component fire suppression approach as an alternative to simultaneous discharge. This approach is especially effective and practical in the case of a manifold exhaust system in a large restaurant or when manifolding multiple types of restaurant exhaust systems in a food court of a shopping mall. In either case, simultaneous actuation of all systems is messy and expensive, especially in the case of a food court, where a real or an accidental discharge in one restaurant can result in multiple lawsuits from the affected restaurants due to premature actuation of adjacent fire protection systems.

NFPA 17 contains requirements for fixed pipe extinguishing systems using dry chemical agents for protection of restaurant hood, duct, and cooking appliance systems. Additionally, NFPA 17A contains requirements for fixed pipe extinguishing systems using wet chemical agents for protection of cooking equipment.

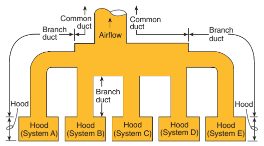
Alternative designs to simultaneous discharge are found in the annexes of NFPA 17 and NFPA 17A. These alternative systems segment the total manifold exhaust in different ways, all of which provide some backup protection in the common duct areas that permits some of the hoods or restaurants to continue operating while shutting down those that have experienced fire or those without a backup system in their common duct. These systems are a necessity for common design solutions for food courts with manifold exhaust systems and can be economical in large restaurants with multiple hoods on manifold exhaust systems. Exhibit 50.6 through Exhibit 50.9 illustrate various system configurations.

Example 1

A fire is detected by System A; its hood and branch duct are operated. Simultaneously, Systems B, C, D, and E are also actuated. All fuel or power to all protected appliances served by the common exhaust duct is shut off.

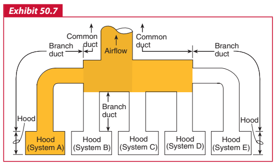
Upon operation of the common exhaust duct systems, the fuel or power to all protected appliances served by the common exhaust duct is shut off. The cooking appliance, hood, and branch duct systems provide protection in accordance with NFPA 17 and NFPA 17A. (See Exhibit 50.6.)

Exhibit 50.6



Simultaneous operation of all systems.

Exhibit 50.7



Simultaneous operation of a single cooking appliance, hood, or branch duct system and the system protecting the common duct.

Example 2

System 1, protecting the entire common exhaust duct, is separate from Systems A, B, C, D, and E. A fire is detected in System A. System A and System 1 operate simultaneously. Shutdown of all appliances protected by Systems A, B, C, D, and E is in accordance with NFPA 17. (See Exhibit 50.7.)

Example 3

System E also provides protection for the entire common exhaust duct. A fire is detected in System C. System C and System E operate simultaneously. Shutdown of all appliances protected by Systems A, B, C, D, and E is in accordance with NFPA 17. (See Exhibit 50.8.)

Example 4

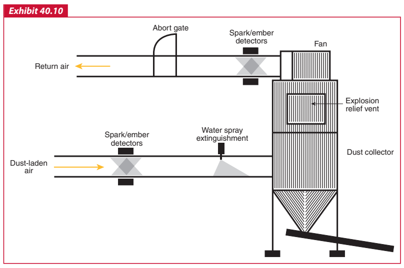
System E also provides protection for the entire common exhaust duct. A fire detected in System E will result in the actuation of System E only. Shutdown of all appliances protected by Systems A, B, C, D, and E is in accordance with NFPA 17. (See Exhibit 50.9.)

2018 NFPA 1 Fire Code Handbook

Examples help illustrate how the *Code* is applied in real-world situations.

794 Chapter 40 • Dust Explosion and Fire Prevention

Exhibit 40.10



Basic spark detection and extinguishment system for a single air-material separator.

Case Studies illustrate the importance of implementing NFPA 1 requirements.

Case Study

On February 7, 2008, a series of sugar dust explosions at the Imperial Sugar Company manufacturing facility in Port Wentworth, Georgia, resulted in 14 worker fatalities. In addition to the 14 fatalities, 36 workers were treated for serious burns and injuries, some of which caused permanent, life altering conditions. The explosions and subsequent fires destroyed the sugar packing buildings, palletizer room, and silos and severely damaged the bulk train car loading area and parts of the sugar refining process areas. The Imperial Sugar manufacturing facility housed a refinery for converting raw cane sugar into granulated sugar. Through a system of conveyors and elevators, the raw sugar was transported from grain silos to sugar processing machines, and the final sugar products were stored in buildings surrounding the silos.

In its investigation report released in September 2009, the U.S. Chemical Safety Board (CSB) found that an initial dust explosion originated in the enclosed steel belt conveyor located below the sugar silos where high concentrations of sugar dust had accumulated inside the enclosure. The initial explosion stirred up sugar dust that had built up on the floors and other surfaces, causing a chain reaction of additional dust explosions through the buildings. Fires resulting from the explosions destroyed the packing buildings, silos, and palletizer building and severely damaged parts of the refinery and sugar loading area.

Many contributing factors to the explosions were identified, including the following:

- Equipment that was not designed or maintained to minimize the release of sugar and sugar dust into the work area
- Inadequate housekeeping practices, which resulted in accumulations of combustible sugar and sugar dust on the floors and other elevated surfaces throughout the packing buildings
- Accumulation of airborne combustible sugar dust above the maximum explosible concentration
- Inadequate evacuation plans

The investigation conducted by the CSB highlighted many safety concerns regarding buildings where dust explosions are a risk and resulted in a list of recommendations to ensure that buildings at risk for dust explosions reduce that risk and even prevent such explosions from occurring. Additional information on the Imperial Sugar Company explosion and fire, as well as the CSB investigation report, in its entirety, can be found online at http://www.csb.gov/investigations/detail.aspx?SID=6.

Exhibit CS40.1

(Courtesy of the U.S. Chemical Safety Board)

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Contents

Preface

The 2018 edition of NFPA 1, *Fire Code*, contains updated requirements from text extracted from other NFPA codes and standards. Because the *Code* relies so heavily on extracted text from other documents, the *Code* has the advantage of reflecting the technical knowledge and expertise of the many committees responsible for the codes and standards from which the text is extracted. This *Code* is intended to provide local and state jurisdictions with an effective fire code. This edition of the handbook is based on the 2018 edition of NFPA 1. The *Code* consists of 75 chapters (13 of which are reserved for future topics). The 2018 edition contains a new Chapter 35 (formerly reserved) on Animal Housing Facilities, a new Chapter 38 (formerly reserved) on Marijuana Growing, Processing, or Extraction Facilities, and a new Chapter 55 (formerly reserved) on Cleaning and Purging of Flammable Gas Piping Systems.

The editors developed new explanatory material in this handbook, and revised commentary from the previous edition, which relied on the expertise of NFPA technical committees, many independent subject matter specialists, and NFPA technical staff. Much of the commentary text clarifies the *Code* requirements as well as the annex material in the various codes and standards from which the requirements were extracted. The *Code* has changed significantly since the first issuance in 1925 of NFPA 1L, *Fire Prevention Bureau Ordinance*. That first edition provided fire departments with regulations for establishing a fire prevention bureau and a means for staffing the bureau. NFPA 1L also defined the bureau's powers and duties. With the *Ordinance* in place, a fire department was responsible for enforcing all laws and ordinances covering the prevention of fires, the storage and use of explosives and flammables, the installation and maintenance of fire alarm systems and fire-extinguishing equipment, the maintenance and regulation of fire escapes, and the means and adequacy of exits in case of fire. The fire department was also given responsibility for the investigation of the cause, origin, and circumstances of fires. NFPA 1L remained as an NFPA document until 1973.

NFPA 1, *Fire Prevention Code*, was developed as a result of NFPA members' requests for a document that would cover all aspects of fire protection and prevention and support the adoption and utilization of other NFPA codes and standards. The NFPA Board of Directors requested that staff initiate work in 1971 to develop such a document. The result of that work was then given to a newly formed technical committee that assumed responsibility for the draft and processed the proposed *Code* following the NFPA Regulations Governing Committee Projects. The first edition of NFPA 1, *Fire Prevention Code*, was adopted and published in 1975.

The original 1975 *Code* served as a guide for the development of a local fire prevention code. The appendixes could be incorporated into the local code as desired by the local officials. Appendix A listed NFPA codes and standards that were suitable for inclusion in a fire prevention code and a recommendation that the codes and standards be adopted in their entirety as a supplement to the code text of NFPA 1.

In the late 1980s, the Fire Marshals Association of North America (FMANA), now known as the International Fire Marshals Association (IFMA), undertook the task of developing a more self-contained code. FMANA added administrative sections, extracted text from many of those codes and standards that fire inspectors would need to use in the field, and incorporated appropriate NFPA codes and standards by reference. That draft was submitted as a proposal to the NFPA Technical Committee on Fire Prevention Code.

The committee examined changes affecting the built environment and used input from FMANA to change the scope and content of the *Code* to provide a comprehensive document for the protection of life and property. A special task group on hazardous materials examined technological changes in the use, handling, and storage of flammable and combustible materials. In chapters in which extracted hazardous materials requirements appeared, greater emphasis was placed on protection of life and property from chemical products made and used in industry. This major rewrite resulted in the 1992 edition of NFPA 1, *Fire Prevention Code.*

NFPA and the Western Fire Chiefs Association (WFCA) subsequently formed an alliance to jointly develop a comprehensive fire code. NFPA and WFCA appointed an Ad Hoc Task Group of ten fire code enforcement officials to review the provisions of the *Uniform Fire Code* (UFC) and NFPA 1 to identify requirements to be included in the draft of the new code in accordance with the agreement between the organizations. Over the course of nine months, the Ad Hoc Task Group volunteered hundreds of hours of time and expertise to create the draft, which evolved into the 2003 edition of NFPA 1, *Uniform Fire Code*. The title of NFPA 1 remained *Uniform Fire Code* until the 2009 edition, which was renamed NFPA 1, *Fire Code*.

The 2018 edition of the handbook provides discussions of the provisions of NFPA 1, *Fire Code*. The commentary is not a substitute for the actual requirements in the *Code* or in the text of the many codes and standards that are incorporated by reference in this *Code*. NFPA's other code handbooks are also valuable sources of information on requirements in this *Code*.

Kristin C. Bigda, P.E.
Principal Fire Protection Engineer

Acknowledgments

The editor thanks and acknowledges the contributions of the following individuals who have contributed to commentary in this edition of the Handbook or to commentary for previous editions of the handbook, which remains in place in this edition, or on which revised commentary was based.

NFPA staff who contributed to this edition of the handbook include the following:

- Allan Fraser (Chapter 16)
- Thomas McGowan (Chapter 17)
- Steven Sawyer (Chapter 18)
- Barry Chase, Senior Fire Alarm Engineer (Chapter 21, Section 42.10)
- Lawrence Russell, Principal Chemical and Marine Specialist (Chapter 28)
- Val Boutin, Fire Protection Engineer (Chapter 32)
- Susan Bershad, Chemical Engineer (Chapter 40, Chapter 63)
- Laura Moreno, Engineer (Chapter 41)
- Eric Nette, Engineer (Chapter 51)
- Robert Benedetti, *retired* (Chapter 43 and Chapter 60)

NFPA staff who contributed to previous editions of the handbook: Michele Steinberg, Division Manager, Wildland Fire Protection.

Outside authors who contributed to this edition of the handbook include the following:

- Tony Apfelbeck, Fire Marshal/Building Official/Division Chief, Altamonte Springs, FL (Chapters 1, 15, and 18)
- Kelly Nicolello, UL, LLC, Fort Worth, TX (Chapter 52)

Outside authors who contributed to previous editions of the handbook include the following:

- Scott Adams, Assistant Fire Chief/District Fire Marshal, Park City, UT
- Tony Apfelbeck, Fire Marshal/Building Official/Division Chief, Altamonte Springs, FL
- Shane Clary, Bay Alarm Company, Pacheco, CA
- Ed Comeau, writer-tech.com, Belchertown, MA
- Bradford T. Cronin, Strategic Code Solutions, Kingston, MA
- Tom DeMint, Fire Chief, Poudre Fire Authority, CO
- Ryan Depew, Depew Services, MA
- Ron Farr, Underwriters Laboratories Inc. (retired) and State Fire Marshal (retired), MI
- Robert Fash, Deputy Fire Marshal, Las Vegas Fire & Rescue, Las Vegas, NV
- Dan Hodge, North Haines Fire Department, Rapid City, SD
- Robert James, Underwriters Laboratories Inc., Chicago, IL
- Richard Kraus, API/Petroleum Safety Consultants, Falls Church, VA
- R.T. Leicht, Delaware State Fire Marshal's Office, Wilmington, DE
- Michael Madden, AMEC Environment & Infrastructure, San Diego, CA
- Chris Schiehl, NBC Universal Studios, Universal City, CA
- Richard Schiehl, R.B. Schiehl & Associates, Palm Desert, CA
- Catherine Stashak, Office of the Illinois State Fire Marshal, Chicago, IL
- Steven Younis, Steven E. Younis PE, Inc., Franklin, MA.

Editors of other NFPA handbooks and annotated standards, portions of which are incorporated in this handbook, include: Gregory Harrington, Matthew Klaus, Chad Duffy, Richard Roux, Christopher Coache, Robert Benedetti, Janna Shapiro, Jacqueline Wilmot, Barry Chase, and Eric Nette. The editors of the previous editions of this handbook, Gregory Harrington, Carl Peterson, Steven Sawyer, and Martha Curtis, provided a solid foundation on which to build.

Our Product Manager, Debra Rose, and our Production Editors, Tracy Gaudet and Ken Ritchie, supervised the development and production of this handbook.

Many other individuals supported the development of this handbook. They include members of the NFPA Building Fire Protection Department, namely, Division Manager Robert E. Solomon, P.E., and Val Boutin. A special thank you goes to Val, a Fire Protection Engineer, who contributed significantly to the review of edits, commentary placement, and review of the document pages.

About the Editor

Kristin C. Bigda, P.E., Principal Fire Protection Engineer in the Building Fire Protection and Life Safety Department at NFPA. She serves as Staff Liaison to the Fire Code Technical Committee, Fire Doors and Windows Technical Committee, as well as several safety to life and building code technical committees responsible for the development of NFPA *101*® and *NFPA 5000*®. Kristin is the editor of the NFPA 80 Handbook. Prior to joining the NFPA staff in 2007, Kristin attended Worcester Polytechnic Institute where she received degrees of Bachelor of Science in Civil Engineering and Master of Science in Fire Protection Engineering. Kristin is also a registered professional engineer in the discipline of fire protection in the Commonwealth of Massachusetts.

Introduction

NFPA® 1, *Fire Code,* and Commentary

This handbook includes the complete text of the 2018 edition of NFPA 1, *Fire Code,* which comprises 75 chapters of requirements. The handbook contains requirements in Chapters 1 through 75, followed by seven supporting annexes (three of which are adoptable by jurisdictions).

The Technical Committee on Fire Code prepared the mandatory provisions found in Chapters 1 through 75 within the framework of NFPA's consensus codes- and standards-making system. Many of the requirements in this *Code* have been extracted from other NFPA codes and standards, and others come from the former NFPA 1, *Uniform Fire Code,* to provide a comprehensive fire code. Because these provisions are designed to be suitable for adoption into law, the text is concise, without extended explanation.

The Technical Committee on Fire Code also developed the annexes of the *Code* within NFPA's codes- and standards-making system. The annex material is designed to assist users in interpreting the mandatory *Code* provisions. It is not considered part of the requirements of the *Code*; this material is advisory or informational. Annexes D, E, and F are written in mandatory language so they can be adopted by a jurisdiction where needed. An asterisk (*) following a *Code* paragraph number indicates that advisory annex material pertaining to that paragraph appears in Annex A. For the reader's convenience, in this handbook, Annex A material has been repositioned to appear immediately following its corresponding *Code* text.

The explanatory commentary in this handbook was prepared by the handbook editors, with the assistance of those individuals mentioned in the acknowledgments, and is intended to provide the reader with an understanding of the provisions of the *Code* and to serve as a resource and reference for implementing the provisions of or enforcing the *Code*. The commentary is not a substitute for the actual wording of the *Code* or the text of the many codes and standards that are incorporated by reference. The commentary immediately follows the *Code* text it discusses and is set in red type for easy identification.

The explanatory material in this handbook is influenced heavily by the various codes and standards from which the requirements of NFPA 1, *Fire Code,* were extracted and, where available, by other NFPA handbooks on specific codes and standards. For the full content of such handbooks, the reader is referred to the following publications:

Nette, Eric, P.E., ed., *LP-Gas Code Handbook,* 2017 edition, NFPA, Quincy, MA.

Benedetti, Robert, CSP, P.E., and Janna Shapiro, eds., *Flammable and Combustible Liquids Code Handbook,* 2018 edition, NFPA, Quincy, MA.

Bigda, Kristin C., P.E., and Gregory E. Harrington, P.E., eds., *Life Safety Code® Handbook,* 2018 edition, NFPA, Quincy, MA.

Chase, Barry, ed., *Standard for Portable Fire Extinguishers Handbook,* 2010 edition, NFPA, Quincy, MA.

Duffy, Chad R. W., ed., *Stationary Fire Pumps Handbook,* 2016 edition, NFPA, Quincy, MA.

Klaus, Matthew J., ed., *Automatic Sprinkler Systems Handbook,* 2016 edition, NFPA, Quincy, MA.

Hart, Jonathan R., and Matthew J. Klaus, eds., *Water-Based Fire Protection Systems Handbook,* 2017 edition, NFPA, Quincy, MA.
Coache, Christopher D., and Richard J. Roux, eds., *National Fire Alarm and Signaling Code® Handbook,* 2016 edition, NFPA, Quincy, MA.
Solomon, Robert E., P.E., and Gregory E. Harrington, P.E., eds., *Building Construction and Safety Code® Handbook*, 2003 edition, NFPA, Quincy, MA.
Wilmot, Jacqueline R., ed., *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations Handbook,* 2017 edition, NFPA, Quincy, MA.

NFPA 1 Summary of Technical Changes: 2015 to 2018

This table provides an overview of major code changes from the 2015 edition to the 2018 edition of NFPA 1, *Fire Code*. Changes to extracted documents are not included in the table, nor are purely editorial and formatting changes. For more information about the reason(s) for each change, visit www.nfpa.org/1. The first revision (FR) numbers, second revision (SR) numbers, and CAM (certified amending motion) numbers given in the third column of this table are for reference to the official documentation of the technical committee's actions.

Section Number	***Comments***	***FR/SR Reference***
Chapter 1 Administration		
1.3.2.2 **A.1.3.2.2**	Revised text provides users with another compliance strategy for items not addressed by the *Code*. The text clarifies the intent that, for occupancies or hazards not specifically regulated by NFPA 1 or its referenced standards, performance-based design approach is an option. New annex text supports the text added to 1.3.2.2	**FR-95**
1.4.1.1 Compliance with Subsequent Editions of Referenced Publications. **1.4.1.1.1** **1.4.1.1.2** **A.1.4.1.1** **A.1.4.1.1.1** **A.1.4.1.1.2**	New paragraphs permit the use of newer editions of the codes and standards than those referenced by the adopted edition of NFPA 1. Where the adoption of NFPA 1 is delayed and newer editions of the referenced publications are available, the new paragraphs specifically give the AHJ the authority to utilize those newer publications. Where newer editions of referenced publications are used, the entire edition must be referenced, because the new paragraphs do not permit picking specific sections from multiple editions of a referenced publication unless technical documentation is submitted and approved by the AHJ via equivalency. New annex section provides additional information on the application of the new *Code* section.	**FR-114**
1.4.5	This subsection has been revised to include equivalent and modified fire protection features that may be approved by the AHJ. The addition of the terms *equivalent* and *modified* ensures that an applicant attempting to utilize these approaches has to meet the same application criteria as for an "alternative."	**FR-6**
1.4.6 Approval	This subsection has been revised to include equivalent and modified fire protection features that may be approved by the AHJ. The addition of the terms *equivalent* and *modified* ensures that an applicant attempting to utilize these approaches has to meet the same application criteria as for an "alternative."	**FR-7**
1.7.2 Minimum Qualifications to Enforce this *Code* **1.7.2.1** **1.7.2.2** **1.7.2.3** **1.7.2.4**	New subsection and paragraphs mandate the required minimum qualifications and competencies as referenced in NFPA 1031 and NFPA 1037 for individuals enforcing the *Code*. If AHJs choose to modify those minimum qualifications and competencies, they can do so at time of adoption. However, the model provisions in the fire code should expect that fire inspectors, plans examiners, and fire marshals are technically competent to perform their job functions.	**FR-115**

Section Number	Comments	FR/SR Reference
A.1.7.7.1	The newly promulgated NFPA 1730 provides a national standard as to how risk assessment and fire protection resources should be allocated in order to accomplish the purpose of the fire code. As a model code, NFPA 1 should specify compliance with the NFPA national standard in this area. If a local jurisdiction chooses to delete it, they have that option during the adoption process.	
1.10.5.6	Current paragraph 1.10.1.1.2 states that the board shall consist of five or seven members. Based on the current language, either 100 percent or 71 percent of the members would have to be in attendance. A quorum of 100 percent is unrealistic, and the typical standard for establishing a quorum is at least 50%. This *Code* change establishes 50 percent as the quorum.	**FR-9**
Table 1.12.8(a) Permit Requirements	The permitting requirements added to Table 1.12.8(a) coordinate with new provisions for mobile cooking operations in Chapter 50, energy storage systems in Chapter 52, and marijuana processing and extraction facilities in new Chapter 38.	**FR-10, SR-66**
1.14.5	This change updates the subsection to reference approved construction documents rather than plans. NFPA 1 uses the terms *construction documents* and *shop drawings*. Previous editions of the *Code* used the term *plans,* which was not inclusive of everything that the revised term catches.	**SR-67**
1.14.6 A.1.14.6	This revision requires that plans and design documents be prepared by a registered design professional. Certain scopes of design work warrant and/or require individuals who prepare such plans to demonstrate that they have specific qualifications to practice that ensure the quality and safety of the design. Annex A text provides guidance to the AHJ as to when the documents should be prepared by such a design professional.	**FR-117**
1.16.4.2 1.16.4.3	The new paragraphs clarify an unintended consequence of existing text that appeared to require a $250 fine when a jurisdiction has not otherwise adopted a separate fee schedule. Requiring a $100 penalty per day for each violation provides a reasonable penalty amount and necessary guidance for how to apply the penalty (per day, per violation.) The text clarifies that the intent is for a jurisdiction to adopt the model code and have a violation provision that could then be applied without having to adopt a separate fees schedule.	**FR-118, SR-11**
1.17 Permit Fees A.1.17	New section provides a basic authorization for the AHJ to adopt a fee schedule. New Annex A text provides direction on how to establish service levels and how fees/revenues should be allocated to cover the cost of services provided under this *Code*.	**FR-116**
Chapter 2 Referenced Publications		
2.1.1 Compliance with Subsequent Editions of the Referenced Publications 2.1.1.1 2.1.1.2 A.2.1.1 A.2.1.1.1 A.2.1.1.2	New subsection permits the use of newer editions of the codes and standards than those referenced by the adopted edition of NFPA 1. Where the adoption of NFPA 1 is delayed and newer editions of the referenced publications are available, the new subsection specifically gives the AHJ the authority to utilize those newer publications. Where newer editions of referenced publications are used, the entire edition must be referenced, because the new text does not permit picking specific sections from multiple editions of a referenced publication unless technical documentation is submitted to and approved by the AHJ via equivalency. New Annex A material provides additional information on the application of the new *Code* requirements.	**FR-119**

Section Number	*Comments*	*FR/SR Reference*
Chapter 3 Definitions		
3.3.20 Barricade (Explosives or Fireworks)	New definitions have been added to Chapter 3 from NFPA 1124, which has been reissued, for terms used within NFPA 1.	**FR-138**
3.3.20.1 *Artificial Barricade*		
3.3.20.2 *Natural Barricade*		
3.3.42 Chemical Fume Hood	New definition added in conjunction with new Chapter 38 on marijuana growing, processing, and extraction facilities supports the application of requirements in that chapter. This definition is extracted from NFPA 45.	**SR-85**
3.3.84 Deficiency	New definitions extracted from NFPA 25 coordinate with the new provisions from 13.1.9.	**FR-136**
3.3.84.1 *Critical Deficiency*		
3.3.84.2 *Noncritical Deficiency*		
3.3.86 Desolventizing	New definition added in conjunction with new Chapter 38 on marijuana growing, processing, and extraction facilities supports the application of requirements in that chapter.	**SR-85**
3.3.111 Extraction Room (Marijuana)	New definition added in conjunction with new Chapter 38 on marijuana growing, processing, and extraction facilities supports the application of requirements in that chapter.	**SR-85**
3.3.112.1 Animal Housing Facility	New definition has been added to clarify the application of new Chapter 35 for animal housing facilities.	**CAM 1-5**
3.3.130 Fireworks	New definitions have been added to Chapter 3 from NFPA 1124, which has been reissued, for terms used within NFPA 1.	**FR-139**
3.3.130.1 *Display Fireworks*		
A.3.3.130 Fireworks		
A.3.3.130.1 Display Fireworks		
3.3.176 Marijuana Extraction Equipment	New definition added in conjunction with new Chapter 38 on marijuana growing, processing, and extraction facilities supports the application of requirements in that chapter.	**SR-85**
3.3.177 Marijuana Extraction Facility	New definition added in conjunction with new Chapter 38 on marijuana growing, processing, and extraction facilities supports the application of requirements in that chapter.	**SR-85**
3.3.185 Miscella	New definition added in conjunction with new Chapter 38 on marijuana growing, processing, and extraction facilities supports the application of requirements in that chapter.	**SR-85**
3.3.187 Mobile or Temporary Cooking	New definition and annex language support the application of new provisions in Section 50.7 for mobile and temporary cooking operations.	**FR-143**
A.3.3.187 Mobile or Temporary Cooking		
3.3.191 Observation	New definition added in conjunction with new Chapter 38 on marijuana growing, processing, and extraction facilities supports the application of requirements in that chapter.	**SR-85**
3.3.192.12 *High-Risk Occupancy*	New definition extracted from NFPA 1730 and added to Chapter 3 coordinates with new provisions of 10.2.7 on minimum fire prevention inspection frequencies for existing occupancies.	**FR-122**
A.3.3.192.12 High-Risk Occupancy		
3.3.192.18 *Low-Risk Occupancy*	New definition extracted from NFPA 1730 and added to Chapter 3 coordinates with new provisions of 10.2.7 on minimum fire prevention inspection frequencies for existing occupancies.	**FR-123**
A.3.3.192.18 Low-Risk Occupancy		

Section Number	Comments	FR/SR Reference
3.3.192.21 ***Moderate-Risk Occupancy*** **A.3.3.192.21 Moderate-Risk Occupancy**	New definition extracted from NFPA 1730 and added to Chapter 3 coordinates with new provisions of 10.2.7 on minimum fire prevention inspection frequencies for existing occupancies.	**FR-124**
3.3.231 Rubberized Asphalt Melter (Melter)	New definition supports the application of new 16.7.3 on rubberized asphalt melters for roof deck systems.	**FR-141**
3.3.232 Rural	New definition provides direction to the AHJ as to what is a "rural" environment and what is a "suburban" environment. Specific exceptions are provided in Chapter 18 for structures that fall within those definitions. Without clear criteria, the AHJ is left with no guidance as to when the exceptions should apply. See also new definition of *suburb or suburban*.	**SR-68**
3.3.265 Suburb or Suburban **A.3.3.265 Suburb or Suburban**	New definition provides direction to the AHJ as to what is a "rural" environment and what is a "suburban" environment. Specific exceptions are provided in Chapter 18 for structures that fall within those definitions. Without clear criteria, the AHJ is left with no guidance as to when the exceptions should apply. See also new definition of *rural*.	**SR-69**
3.3.274 Transfilling **A.3.3.274 Transfilling**	New definition added in conjunction with new Chapter 38 on marijuana growing, processing, and extraction facilities supports the application of requirements in that chapter.	**SR-85**
Chapter 10 General Safety Requirements		
10.2.7 Minimum Fire Prevention Inspection Frequencies for Existing Occupancies **10.2.7.1** **10.2.7.2** **10.2.7.3** **10.2.7.4**	New subsection extracted from NFPA 1730 addresses the minimum fire prevention inspection frequencies for existing occupancies. To ensure that existing occupancies comply with the fire prevention code, a fire prevention inspection is required as part of the standard of care as specified in NFPA 1730. This new text incorporates that standard of care into NFPA 1.	**FR-121**
10.10.10 Discontinuance **A.10.10.10**	Bonfires in densely populated urban areas can create nuisance issues to neighboring properties where smoke from the bonfires is wind driven into other homes and businesses. The AHJ should have the authority to have the fire discontinued until more appropriate and safer conditions are available. The new Annex A text provides additional clarity as to what constitutes a potential hazardous condition under this subsection as well as also confirming that these determinations will need to be made on a case-by-case basis.	**SR-14**
A.10.11.1	New A.10.11.1 provides guidance on alternative means for identifying the locations of new and existing buildings	**FR-163**
10.11.1.2	The new text provides a minimum height and width for address numbers to ensure a reasonable level of visibility to emergency responders. The current 10.11.1.1 states that addresses shall be plainly legible and visible. However, this created a source for conflict and differences of opinion. The 4 in. minimum is a reasonable standard.	**FR-15**

Section Number	Comments	FR/SR Reference
10.11.1.3 **A.10.11.1.3**	New text that addresses the proper programing of telecommunications equipment to convey correct address information in the event of an E911 call is imperative. Incorrect information can result in a delayed response to a fire, EMS, or other emergency. The code should require the owners/occupants to ensure that their chain in the E911 communication is correct and maintained.	**FR-125**
10.11.1.4 **10.11.1.5**	New text requires that the assignment of addresses to buildings be in accordance with a method approved by the AHJ. Assignment of addressing buildings and changes of addresses to existing buildings can create significant difficulties to emergency responders if a consistent approach is not utilized. Maintaining a current addressing methodology is becoming increasingly important as addressing databases, such as GIS, are being used in new technology application during a response.	**FR-17**
10.11.1.6	The existing language in 10.11.1 did not provide any provision for the addressing of individual suites in a multiple tenant environment. A shopping center could have one single address, displayed at the street in accordance with 10.11.1.1, but numerous suites could go unidentified but be in compliance with the current provision of NFPA 1. The new text helps to reduce the potential for delays in response times of emergency responders when trying to locate a particular suite within a multi-suite complex.	**FR-16**
10.19.1	Revision clarifies that the structures required to comply with the provisions of 10.19.1.1 through 10.19.1.4 should be those that exceed either the threshold for height or area.	**FR-126**
Chapter 11 Building Services		
11.1.4.1	The existing code language required relocatable power taps to be listed but did not specify the standard to be used. The change to this paragraph adds references to specific standards for listing, which clarifies which relocatable power taps are suitable for specific occupancies and uses.	**SR-15**
11.5.2.3 **(1)** **(2)** **(3)** **(4)** **(5)**	Revised text references UL 647, *Standard for Safety for Unvented Kerosene-Fired Room Heaters and Portable Heaters*, which provides requirements for unvented kerosene-fired room heaters, including requirements for automatic primary safety controls or for inherent construction that prevents abnormal discharge of fuel at the burner in case of ignition failure or premature flame extinguishment. This change adds the specific UL standard to be used for the certification and listing of kerosene heaters.	**FR-128**
11.9.3 **11.9.3.1**	This revision modifies the size of emergency command center rooms from a minimum of 96 ft^2 (8.9 m^2) to 200 ft^2 (19 m^2). New 11.9.3.1 provides an exemption for existing emergency command center rooms so that they are not inadvertently required to be expanded in size to meet the new provisions of 11.9.3.	**FR-2, SR-16**
11.10.2	Requirements for two-way radio communication enhancement systems are now located in NFPA 1221.	**FR-108**
11.12.2.1.1 Rapid Shutdown Marking through 11.12.2.2.2.3.4 Minimizing Obstructions in Pathways	New text incorporates the provisions for PV system marking requirements and extracts text from *NFPA 70*.	**FR-129**

Section Number	Comments	FR/SR Reference
11.12.3.2 Vegetation Management Plan	Revised text provides flexibility for the AHJ to enforce provisions appropriate to the scale of a project. For example, it would be overly restrictive to assume a project would import gravel to cover a 500 acre photovoltaic power plant, and it would be environmentally insensitive to do so. Revised text provides AHJs with the resource and guidance to properly evaluate large-scale ground-mount PV installations and also addresses the environmental aspect of large installations.	**FR-132**
Chapter 12 Features of Fire Protection		
12.3.3 Maintenance of Fire-Resistive Construction, Draft-Stop Partitions, and Roof Coverings **12.3.3.3**	Revised text requires visual inspections of fire-resistance rated assemblies in high-rise buildings every 3 years, revised from 5 years. Waiting 5 years to do an inspection, with the various changes that occur with respect to tenant improvements and facility upgrades could result in this critical fire protection feature being compromised for an unacceptable period of time.	**FR-1**
A.12.3.3	The new text added to A.12.3.3 provides useful information to assist with the periodic inspection and maintenance process for firestop systems.	**FR-160**
Chapter 13 Fire Protection Systems		
13.1.9	Revision permits AHJ to approve the time for corrections of deficiencies. The definitions for *deficiency*, *critical deficiency*, and *noncritical deficiency* have been added to Chapter 3 to support the application of 13.1.9.	**FR-135**
13.1.10	Existing 13.1.10 was deleted to eliminate a conflict with 13.3.3.6.5.2, which requires impairments to water-based fire protection systems to comply with NFPA 25. Also, 13.7.1.4.3 requires fire alarm system impairment procedures to comply with NFPA 72.	**FR-110**
13.1.3 Integrated Fire Protection and Life Safety System Test **A.13.1.3**	When fire protection and life safety systems are integrated with other building systems, they should be tested end-to-end. Referencing NFPA 4 provides guidance since no other document addresses end-to-end testing of integrated systems. New text is extracted from NFPA *101*.	**FR-134**
A.13.2.2.2(3)	New Annex A text provides guidance on determining building height.	**FR-111**
Chapter 16 Safeguarding Construction, Alteration, and Demolition Operations		
16.7 Tar Kettles and Rubberized Asphalt Melters through 16.7.3.10.3	New section on rubberized asphalt melters distinguishes the differences between safe use of torches or tar kettles and rubberized asphalt melters on roof decks. Both operations need safeguards against the potential for fire, but with different constraints. The new text, which separates out rubberized asphalt melters for use on roof decks, brings with it recognition of fire safety as a part of that process. Rubberized asphalt melters operate and perform differently from tar kettles. It is important to note that the fuel used to provide indirect heating to the rubberized asphalt melter is diesel, so there are temperature controls inherent in melters in part due to the need to maintain the roofing material at 350°F to 380°F. Overheating into the temperature range of ordinary combustibles makes the rubberized asphalt product unsuitable for roof deck application. Because of the lower application temperature on noncombustible roof decks, the opportunity for fire with this method is greatly decreased compared to tar kettles and torches.	

Section Number	Comments	FR/SR Reference
	The new text for rubberized asphalt melters is consistent with the intent of the code while providing important differentiations from the more hazardous operations involving open flames and tar kettles.	
Chapter 18 Fire Department Access and Water Supply		
18.1.3.1 Fire Apparatus Access **18.1.3.2 Fire Hydrant Systems**	"AHJ" is the proper term for the regulatory body within NFPA codes and standards that is empowered to enforce the code. The term "AHJ" is utilized throughout the remainder of Chapter 18. The fire department might or might not be the AHJ.	**FR-20**
18.2.3.2.1.1	Section 13.3 points the user to the appropriate section in NFPA 1 that addresses sprinkler options.	**FR-22**
18.2.3.3 **A.18.2.3.3**	New Annex A text addresses questions that frequently come up regarding how an AHJ should determine when multiple fire apparatus roads are required under this paragraph. This annex material provides guidance to the common situations of flood, rail traffic, and congestion.	**FR-21**
18.2.3.4 Traffic Signal Pre-emption	Traffic signal pre-emption improves response times and provides for safer fire fighter responses by halting conflicting traffic movements. When fire department units are equipped with such devices, newly installed traffic signals should also be equipped to ensure that the new intersections don't increase response times or contribute to a dangerous response condition.	**FR-140**
A.18.2.3.5.1.1 **18.2.3.5.1.1.1** **A.18.2.3.5.1.1.1** **18.2.3.5.1.1.2** **18.2.3.5.1.3.1** **18.2.3.5.1.2.2** **A.18.2.3.5.2** **18.2.3.5.6.3**	Revisions to these paragraphs and associated Annex A material on specifications of fire department access roads intend to provide flexibility to the AHJ to evaluate and approve reduced access road widths where conditions warrant.	**FR-152, SR-18**
18.2.3.5.6.1	This revision clarifies the permitted gradient for a fire department access road. The revised text reminds users that the gradient cannot exceed the limitations of the apparatus and must also be approved by the AHJ.	**SR-19**
18.2.4.2.6 **18.2.4.2.6.1** **18.2.4.2.6.2**	New paragraph provides required standards with which electric gate systems and gates intended for automatic operation must comply. Maintenance of the gate system in the same condition as it was installed is imperative to ensure the long-term safe operation of the gate. Otherwise, gate components could fail or be disabled, and there would be no mechanism for the AHJ to address repairs or safety.	**FR-154, SR-20, SR-21**
Chapter 19 Combustible Waste and Refuse		
19.2.1.4 Rubbish Within Dumpsters **19.2.1.4.1** **19.2.1.4.2** **(1)** **(2)** **(3)**	Revision is editorial in nature. The paragraphs have been rewritten to comply with the formatting of exceptions within NFPA codes and standards.	**FR-3**

Section Number	Comments	FR/SR Reference
Chapter 27 Manufactured Home and Recreational Vehicle Sites		
27.1.2	Referenced publication title has been updated.	**FR-52**
Chapter 29 Parking Garages		
29.1.3	New text provides a pointer to NFPA 2 for the storage of self-propelled vehicles powered by GH_2 or LH_2.	**FR-103**
Chapter 30 Motor Fuel Dispensing Facilities and Repair Garages		
30.1.1.1	NFPA 2 contains two chapters on hydrogen fueling facilities. In lieu of extracting two chapters' worth of material, a simple reference to NFPA 2 points the user to those requirements.	**FR-99**
30.2.1.1	NFPA 2 contains a chapter on repair garages servicing hydrogen-fueled vehicles. In lieu of extracting an entire chapter's worth of material, a simple reference to NFPA 2 points the user to those requirements. Furthermore, requirements for repair garages servicing self-propelled vehicles powered by GH_2 or LH_2 are contained only in NFPA 2 and nowhere else. Previous text in NFPA 52 has been removed.	**FR-100**
Chapter 31 Forest Products and Biomass Feedstocks		
Chapter 31 Forest Products and Biomass Feedstocks	The modification of the chapter title is to provide for material covered by new 31.3.10 addressing biomass feedstock utilized at biomass to ethanol industrial facilities.	**SR-60**
31.1 General	This revision adds biomass feedstock as an item that must comply with Chapter 31 and NFPA 664 for consistency with new 31.3.10.	**SR-61**
31.3.1.1 **(1)** **(2)** **(3)** **(4)** **(5)** **(6)**	This revision adds the outside storage of biomass feedstocks as being included in the application of Chapter 31. This revision is necessary to correlate with the addition of new 31.3.10.	**SR-62**
31.3.10 Outside Storage of Biomass Feedstock through 31.3.10.12	This new subsection provides requirements for the safe storage of biomass feedstock at biomass to ethanol manufacturing facilities. Previous general requirements for the storage of agricultural products was not sufficient for these types of operations. The storage arrangement dimensions are based upon current operations after shorter separation distances were found to be insufficient to retard fire spread. The requirements for securing the site in an approved manner and for the provision of lightning protection is in recognition of the two main causes of fires in this type of storage, arson and lightning strikes.	**SR-64**
Chapter 34 General Storage		
34.10.3.1 **34.10.4 Outside Storage at Pallet Manufacturing and Pallet Recycling Facilities through 34.10.4.12**	This change adds a new paragraph (34.10.3.1) and a new subsection (34.10.4) to the *Code*. Subsection 34.10.4 addresses the outdoor storage of wood and wood composite pallets or listed pallets equivalent to wood on the same site as a pallet manufacturing or pallet recycling facility. Outdoor pallet storage areas for manufacturing and recyclers of pallets were not adequately addressed by the requirements previously in NFPA 1 because pallets are not idle nor managed in an idle fashion at these types of facilities. Pallet manufacturers and recyclers have intimate knowledge of their pallet inventory, which is considered an asset. The storage areas are fluid environments where pallets are being moved and replaced on a daily basis.	**FR-159, SR-71, SR-73**

Section Number	*Comments*	*FR/SR Reference*
	The outdoor storage area of pallet manufacturing and recycling facilities is an active management environment. Because personnel are a constant presence within the storage area, fire hazards can be identified and reported and immediate corrective action taken. Storage yards are organized by pallet type and into recycle streams for high operational efficiency, kept sufficiently free of waste and debris, and perimeters are well maintained. The intent of the new subsection is to reduce the likelihood of fire at pallet manufacturing and recycling facilities through best practices. In the event that a fire does occur, measures are described that will mitigate the spread of fire to adjoining structures and properties through the establishment of pallet pile spacing between buildings and property lines.	
Chapter 35 Animal Housing Facilities		
Chapter 35 Animal Housing Facilities **35.1 General** **35.2 Permits**	This revision adds a new Chapter 35, which references NFPA 150 for animal housing facilities. A definition of *animal housing facility* has also been added to Chapter 3.	**CAM 1-4**
Chapter 38 Marijuana Growing, Processing, or Extraction Facilities		
Chapter 38 Marijuana Growing, Processing, or Extraction Facilities	New Chapter 38 provides safety requirements for marijuana growing, processing, and extraction facilities. The Committee provided language for a new chapter as a Committee Input during the First Draft stage. After the First Draft meeting a task group was formed consisting of both Technical Committee members and industry experts who volunteered their time over the year to further develop and refine the chapter. This new chapter is a direct result of requests from the industry for guidance in the *Code* on the requirements necessary to protect marijuana growing, processing, and extraction facilities. Several hazards make these facilities unique (e.g., use of hazardous materials as solvents, fumigation, special systems and equipment, staff training, transfilling LPG), and this new chapter focuses on those hazards while pointing users to other sections in the *Code* for provisions that can be applied generically (fire protection systems, means of egress, occupancy classification, hazardous materials.)	**SR-84**
Chapter 40 Dust Explosion and Fire Prevention		
40.1 Application **40.1.1** **40.2 Permits**	This revision replaces requirements in Chapter 40 that were extracted from NFPA 654 with the equivalent provisions from NFPA 652. NFPA 652 provides the basic principles of and requirements for identifying and managing the fire and explosion hazards of combustible dusts and particulate solids. NFPA 652 is now the umbrella standard that governs the series of other standards related to dust and explosion hazards.	**FR-142, SR-23**
40.7.1.4	A key portion of the new standard NFPA 652, *Standard on the Fundamentals of Combustible Dust*, is Chapter 7 and its requirement for existing operations to perform a dust hazards analysis to evaluate fire, deflagration, and explosion hazards and provide recommendations to manage those hazards. This is an important step to address in existing facilities that may or may not have been established utilizing appropriate dust hazard safety precautions.	**FR-102**

Section Number	Comments	FR/SR Reference
Chapter 41 Welding, Cutting, and Other Hot Work		
41.1.4	NFPA 51A has been withdrawn and incorporated into NFPA 55.	**FR-105**
Chapter 45 Combustible Fibers		
45.1.3	This new text clarifies the application of Chapter 45 with regard to the new subsection added to Chapter 31 (31.3.10) on the outside storage of biomass feedstocks.	**SR-63**
Chapter 50 Commercial Cooking		
50.1.1	Revision addresses new text on temporary and mobile cooking equipment in 50.7.1.	**FR-104**
50.7 Mobile and Temporary Cooking Operations	New Section 50.7 provides requirements for mobile and temporary cooking operations to provide guidance on these type of operations after recent events involving such operations along with a lack of regulation for the increasing number of temporary and mobile cooking units. There was no one place to find all the requirements for mobile and temporary cooking operations. The requirements include common provisions for operation (e.g., permits, portable fire extinguishers, training, fire department access) appropriate to NFPA 1. The remaining text brings together requirements from NFPA 96 and NFPA 58 to address specifics on cooking equipment, LP-Gas systems, storage, leak detection, installation and use of containers, and vehicle maintenance and protection. A definition of *mobile or temporary cooking* was added to Chapter 3 to assist in the application of this new section	**FR-98, SR-29, SR-26, SR-27, SR-25, SR-28, SR-24**
Chapter 52 Energy Storage Systems		
Chapter 52 Energy Storage Systems **52.1 General through 52.3**	Chapter 52 has been both updated and also completely rewritten in sections to appropriately address both recognized battery technologies as well as new technologies and applications of energy storage systems. The title of the chapter has been updated to Energy Storage Systems, which more accurately reflects the chapter being inclusive of both battery technologies as well as other energy storage technologies.	**SR-65**
Chapter 53 Mechanical Refrigeration		
53.2.3.1.1 Alarm Threshold	This change correlates NFPA 1 with ANSI/IIAR 2-2014, which revises the detection threshold for ammonia alarms to 25 ppm.	**FR-150**
53.2.3.3.3	This change correlates NFPA 1 with ANSI/IIAR 2-2014, which revises the detection threshold for activation of ventilation systems in ammonia machinery rooms to 150 ppm ($^1/_2$ IDLH). This is a fraction of the 160,000 ppm LFL for ammonia.	**FR-151**
53.3.3 Decommissioning of Ammonia Refrigeration Systems	This revision adds a reference to ANSI/IIAR 8, which is a new standard that provides regulations for the decommissioning of closed-circuit ammonia refrigeration systems.	**FR-147**
Chapter 55 Cleaning and Purging of Flammable Gas Piping Systems		
Chapter 55 Cleaning and Purging of Flammable Gas Piping Systems **55.1 Application**	This revision adds a reference to NFPA 56 for cleaning and purging activities for new and existing flammable gas piping applications. Inclusion of NFPA 56 as a referenced document in NFPA 1 provides AHJs and owners with clear direction to ensure compliance with NFPA standards on the hazard.	**SR-22**

Section Number	Comments	FR/SR Reference
Chapter 61 Aerosol Products		
A.61.1.1.1	The new Annex A text clarifies the application of Chapter 60 and Chapter 61 to aerosol products in storage and mercantile occupancies.	**FR-106**
Chapter 63 Compressed Gases and Cryogenic Fluids		
63.9.1 General **63.9.2 Permits** **63.9.2.1** **63.9.2.2** **63.9.2.3**	This revision adds requirements for insulated liquid carbon dioxide systems. Specifically, 63.9.2 addresses the permitting requirements for these systems and applications. 63.9.3 through 63.9.14.3.4 are new to the 2018 edition of the *Code* and have been added as part of this revision. The text is extracted from NFPA 55.	**SR-31**
Chapter 65 Explosives, Fireworks, and Model Rocketry		
A.65.1.1	This new Annex A text clarifies the scope and application of Chapter 65. The text is related to 1.3.2.2, which notes consumer fireworks sale and use as being one of the conditions where the AHJ needs to turn to other resources.	**FR-96**
65.2.2	This revision adds back into the *Code* a reference to NFPA 1124, which has been reissued.	**FR-97**
65.5.1	This revision adds back into the *Code* a reference to NFPA 1124, which has been reissued.	**FR-107**
Annex F Fire Fighter Breathing-Air Replenishment Systems		
Annex F Fire Fighter Breathing-Air Replenishment Systems **F.1 General**	New Annex F provides guidance for those jurisdictions using fire fighter air replenishment systems. The systems are not mandated by the *Code*; rather, the annex is provided solely to assist those AHJs needing to enforce such requirements.	**SR-59**

1

Administration

Chapter 1 addresses the administrative and enforcement requirements of NFPA 1. It covers the scope, purpose, and application of the *Code* within the adopting jurisdiction's legal enforcement boundaries. The authority to enforce the *Code*, enforcement power given to the authority having jurisdiction (AHJ), permitting requirements, liability, and qualifications of individuals practicing contracting are also covered. The importance of Chapter 1 is critical to the AHJ; the powers specified in this chapter are the basis for enforcing all other chapters and references contained in this *Code*. Frequently, when a legal challenge arises to the AHJ during attempts to enforce the *Code*, a failure by the AHJ to comply properly with the administrative procedures of the *Code* is almost always one of the accusations. A failure of the AHJ to comply with the administrative provisions has the potential to invalidate any needed enforcement action.

While Chapter 1 provides comprehensive provisions and direction on how the *Code* should be administered and enforced, these administrative procedures and requirements are frequently customized by the jurisdiction as part of the code adoption process. To ensure that unintended conflicts are not created, the adopting AHJ should consult other state or local ordinance, laws, and administrative rules that affect this chapter before adopting this *Code*.

If the AHJ adopts its own local administrative provisions as part of a Chapter 1 revision, the AHJ should ensure that all topics specified in Chapter 1 are covered in the locally adopted administrative provisions. If topics are deleted without appropriate replacement, the deletion may result in the AHJ being unable to enforce the *Code* appropriately or to enforce a reasonable level of safety.

1.1 Scope

1.1.1 The scope includes, but is not limited to, the following:

(1) Inspection of permanent and temporary buildings, processes, equipment, systems, and other fire and related life safety situations
(2) Investigation of fires, explosions, hazardous materials incidents, and other related emergency incidents
(3) Review of construction plans, drawings, and specifications for life safety systems, fire protection systems, access, water supplies, processes, hazardous materials, and other fire and life safety issues
(4) Fire and life safety education of fire brigades, employees, responsible parties, and the general public
(5) Existing occupancies and conditions, the design and construction of new buildings, remodeling of existing buildings, and additions to existing buildings
(6) Design, installation, alteration, modification, construction, maintenance, repairs, servicing, and testing of fire protection systems and equipment
(7) Installation, use, storage, and handling of medical gas systems
(8) Access requirements for fire department operations
(9) Hazards from outside fires in vegetation, trash, building debris, and other materials
(10) Regulation and control of special events including, but not limited to, assemblage of people, exhibits, trade shows, amusement parks, haunted houses, outdoor events, and other similar special temporary and permanent occupancies
(11) Interior finish, decorations, furnishings, and other combustibles that contribute to fire spread, fire load, and smoke production
(12) Storage, use, processing, handling, and on-site transportation of flammable and combustible gases, liquids, and solids
(13) Storage, use, processing, handling, and on-site transportation of hazardous materials
(14) Control of emergency operations and scenes
(15) Conditions affecting fire fighter safety
(16) Arrangement, design, construction, and alteration of new and existing means of egress

While it is intuitive to owners, occupants, contractors, design professionals, and the public that the *Code* is intended to protect occupants of the building, it is not always understood by these stakeholders that the *Code* is intended to protect fire fighters. There are many specific NFPA 1 *Fire Code* provisions in place to address fire fighter safety. Many of the provisions to protect occupants, such as fire sprinkler protection, also protect fire fighters.

1.1.2 Title. The title of this *Code* shall be NFPA 1, *Fire Code*, of the National Fire Protection Association (NFPA).

1.2* Purpose

The purpose of this *Code* is to prescribe minimum requirements necessary to establish a reasonable level of fire and life safety and property protection from the hazards created by fire, explosion, and dangerous conditions.

Provisions of NFPA 1 represent the minimum levels of protection needed to provide life safety from fire to building occupants, property protection, and enhanced emergency responder safety. Building owners, tenants, and design professionals should carefully consider whether additional safeguards might be needed based on their specific loss tolerability. For example, meeting the requirements of NFPA 1 alone might not provide sufficient protection from fire to a highly valued risk, such as rare artwork that might be destroyed by exposure to smoke. Such determination needs to be made based on a complete risk assessment of the property. The protection requirements of this *Code* can always be supplemented, but they should never be reduced.

A.1.2 Consideration for life safety could include occupants, fire department personnel, fire brigade members, employees, responsible parties, and the general public.

1.3 Application

1.3.1 This *Code* shall apply to both new and existing conditions.

The *Code* addresses requirements for both new and existing conditions. It recognizes that, in most cases, existing conditions or structures are unable to meet the requirements for new structures, occupancies, or conditions without considerable hardship and that sometimes only minimal gains in safety might be achieved. The *Code* also recognizes that a minimum level of fire and life safety must be provided for all structures and conditions. The requirements for existing buildings are intended to be reasonable and limit the resulting disruption and financial impact, while still providing a minimum, acceptable level of fire and life safety.

In some cases, requirements for existing buildings or conditions are less restrictive than those for new buildings or conditions because it is sometimes impractical to apply the requirements for new construction to an existing situation. In other cases, however, the requirements for new and existing occupancies or conditions might be identical. It is the intent of the *Code* that its requirements apply to existing buildings and that conditions are applied retroactively unless specifically stated otherwise to provide a minimum, reasonable level of protection to all buildings.

Frequently, AHJs are approached by an owner or a tenant to questions that an existing code compliance issue is "grandfathered in" with approval because the violation existed for a long time or that the violation existed before adoption of the *Code*. It is important to note that there is no grandfathering of existing violations. As indicated above, the *Code* will differentiate between new and existing conditions within the text when such differentiation is appropriate.

1.3.2* Referenced Standards.

A.1.3.2 This *Code* is partially composed of limited text references extracted from other NFPA codes and standards in an effort to bring together information useful during field inspections.

With respect to hazardous materials, provisions in Chapters 60, 61, 63, 65, 66, and 69, are partial extracts of materials from NFPA standards referenced in each of these chapters. These extracts are included in NFPA 1 to assist users of the document by providing ready access to provisions that could be routinely referenced by fire code enforcers. However, through their adoption by reference in NFPA 1, the NFPA standards identified in these chapters apply in their entirety.

1.3.2.1 Details regarding processes, methods, specifications, equipment testing and maintenance, design standards, performance, installation, or other pertinent criteria contained in those codes and standards listed in Chapter 2 of this *Code* shall be considered a part of this *Code*.

The codes and standards referenced in Chapter 2 are mandatory requirements of this *Code* and should be enforced as part of this *Code* to the extent they are referenced. In certain instances, this *Code* references the complete code or standard; in other instances, a specific section of the code or standard is referenced. All references to the codes and standards listed in Chapter 2 should be taken in the context of the *Code* requirements of Chapters 1 through 75.

1.3.2.2* Where no applicable codes, standards, or requirements are set forth in this *Code* or contained within other laws, codes, regulations, ordinances, or bylaws adopted by the authority having jurisdiction (AHJ), compliance with applicable codes and standards of NFPA or other nationally recognized standards, as are approved, or approved performance-based options in accordance with Chapter 5, shall be deemed as prima facie evidence of compliance with the intent of this *Code*.

NFPA publishes about 300 codes and standards that can assist the AHJ with topics not addressed by this *Code* specifically and offer guidance in determining equivalent levels of protection, as provided in Section 1.4. Even if an NFPA code or standard is not referenced in Chapter 2, or if the NFPA document is a guide or recommended practice, the AHJ can use such NFPA documents for guidance to determine evidence of compliance with the intent of this *Code*. Where no NFPA code or standard exists to address a particular situation, the AHJ can use any nationally recognized standard for guidance, including industry standards from organizations such as the American Petroleum Institute (API), FM Global, ASTM International (ASTM), Underwriters Laboratories (UL), or the Compressed Gas Association (CGA).

N **A.1.3.2.2** This section provides a basis for regulating an occupancy or hazard not specifically regulated by NFPA 1 or its referenced standards (e.g., retail sales and associated storage of consumer fireworks; wind turbines; amusement structures not defined as special amusement buildings, such as outdoor roller coasters and water slides). The AHJ has the authority to use any available resource and its own discretion to develop an appropriate protection scheme, including use of the provisions of Chapter 1, Administration; Chapter 4, Goals and Objectives; Chapter 5, Performance-Based Option; or other nationally recognized standards as indicated in 1.3.2.2 to regulate such occupancies or hazards.

1.3.2.3 Nothing herein shall diminish the authority of the AHJ to determine compliance with codes or standards for those activities or installations within the AHJ's responsibility.

1.3.2.4 Retroactivity of Referenced Standards to Existing Conditions. Unless otherwise specified by 1.3.2.4.1 through 1.3.2.4.3, the current provisions of the referenced standards shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of this *Code*.

1.3.2.4.1 Where specified by a reference standard for existing occupancies, conditions, or systems, the provisions of the referenced standards shall be retroactive.

1.3.2.4.2 Facilities, equipment, structures, and installations, installed in accordance with a reference standard, shall be maintained in accordance with the edition of the standard in effect at the time of installation.

1.3.2.4.3 In those cases where the AHJ determines that the existing situation constitutes an imminent danger, the AHJ shall be permitted to apply retroactively any portions of the current referenced standards deemed appropriate.

The intent of 1.3.2.4 is to clarify the application of referenced codes and standards to existing conditions. For example, it is not the *Code's* intent to require that a sprinkler system installed when the building was constructed be brought up to the latest edition of NFPA 13, *Standard for the Installation of Sprinkler Systems,* every time that standard is updated, unless the AHJ determines that the existing installation is no longer adequate for the hazard or that an imminent danger exists, as described in 1.3.2.4.3.

1.3.3 Conflicts.

1.3.3.1 When a requirement differs between this *Code* and a referenced document, the requirement of this *Code* shall apply.

NFPA codes and standards are updated periodically. The editions of the codes and standards referenced in Chapter 2 are the current editions available when this *Code* was issued on August 17, 2017, and became effective on September 6, 2017.

With the adoption of the 2018 edition of NFPA 1 by a jurisdiction, the specific editions of the various codes and standards referenced in Chapter 2 are the enforceable editions of those codes and standards, unless the adopting legislation specifies that a different edition be used. For example, this *Code* references the 2016 edition of NFPA 13. However, the AHJ's adoption process for NFPA 1 might require a more current edition of NFPA 13. If a different edition of a referenced code or standard is specified, the text of the most recent edition might differ from extracted text in this edition of the *Code*. The AHJ should be aware of this during the code adoption process.

There might be instances where NFPA 1 contains requirements beyond those addressed in the referenced codes and standards. In such instances, where the requirements in the *Code* differ from those of the referenced code or standard, the requirements in this *Code* take precedence.

1.3.3.2 When a conflict between a general requirement and a specific requirement occurs, the specific requirement shall apply.

Examples of a general requirement versus a specific requirement can be found in Section 10.9 and 60.5.1.5.1. Section 10.9 has a general provision dealing with smoking, while 60.5.1.5.1 contains specific requirements on how to address smoking in areas where hazardous materials are used, stored, or handled. In this case, the specific requirements of 60.5.1.5.1 apply.

1.3.4 Multiple Occupancies. Where two or more classes of occupancy occur in the same building or structure and are so intermingled that separate safeguards are impractical, means of egress facilities, construction, protection, and other safeguards shall comply with the most restrictive fire safety requirements of the occupancies involved.

See 6.1.14 for additional guidance on multiple occupancies. An example of a multiple occupancy in which the uses are mixed (intermingled) might be a school (educational occupancy) with an auditorium (assembly occupancy) within it. If the classrooms and auditorium are not separated and share exit access components, the most restrictive requirements of the occupancies involved apply throughout the building. Each requirement for each occupancy involved must be evaluated individually; it should not be assumed that all requirements for one occupancy are more restrictive than requirements for another.

Δ **1.3.5 Vehicles and Vessels.** Vehicles, vessels, or other similar conveyances, when in fixed locations and occupied as buildings, as described by Section 11.6 of NFPA *101* shall be treated as buildings and comply with this *Code*.

Conversions such as railroad cars converted to dining or drinking establishments, ships or barges converted to hotels or restaurants, or transportation trailers used for storage or mercantile sales are not uncommon. Where these vehicles, vessels, or other mobile structures are in a fixed location and occupied as a building, the *Code* intends that they be regulated as a building. Although these vehicles and vessels are existing structures, the AHJ may require that they be reviewed for code compliance as new buildings under the provision of this *Code* unless specifically exempted from such application in the *Code*. In cases where it is unclear whether a vehicle or vessel is being used as a building, the AHJ should determine whether the vehicle or vessel meets the criteria described in 1.3.5 and Section 11.6 of NFPA *101*®, *Life Safety Code*®, or whether it is regulated by another agency, such as the U.S. Coast Guard or U.S. Department of Transportation. If the vehicle or vessel does not meet the criteria of 1.3.5 and Section 11.6 of NFPA *101*, it should be exempt from the requirements of this *Code*.

1.3.6 Buildings.

1.3.6.1 Buildings permitted for construction after the adoption of this *Code* shall comply with the provisions stated herein for new buildings.

1.3.6.2* Buildings in existence or permitted for construction prior to the adoption of this *Code* shall comply with the provisions stated herein or referenced for existing buildings *(see 10.3.2)*.

A.1.3.6.2 A limited but reasonable time should be allowed for compliance with any part of this *Code* for existing buildings, commensurate with the magnitude of expenditure, disruption of services, and degree of hazard. Occupied existing buildings should comply with 10.3.3.

The term *existing building* is defined in 3.3.29.5 as "a building erected or officially authorized prior to the effective date of the adoption of this edition of the *Code* by the agency or jurisdiction." Existing installations, such as fire alarm systems, sprinkler systems, and electrical installations, are not required to be brought into compliance with the latest edition of the applicable code or standard unless the AHJ determines that not doing so creates an imminent danger. See 1.3.2.4.3.

Existing buildings that do not comply with the *Code* are required to be brought into compliance. Based on the number and extent of the violations, a reasonable time should be given to correct the violations. When determining reasonable time, the AHJ should evaluate the degree of hazard with respect to fire and life safety, magnitude of work required, and, to a lesser extent, expenditure and disruption to the building occupants. The cost of correcting *Code* deficiencies should not be the only or the final basis for determining the time allowed for compliance. It is worth restating that the *Code* represents the minimum level of protection required for a reasonable level of fire and life safety — it does not represent the ultimate protection package.

1.3.6.3 Repairs, renovations, alterations, reconstruction, change of occupancy, and additions to buildings shall conform to this *Code*, NFPA *101*, and the building code.

In jurisdictions where a building code has been adopted, the building code, in addition to NFPA *101*, should be used to determine requirements for repairs, renovations, alterations, reconstruction, additions, and changes of occupancy classification. Where a building code has not been adopted, NFPA *101* should be used as the basis for fire and life safety provisions.

1.3.6.4 Newly introduced equipment, materials, and operations regulated by this *Code* shall comply with the requirements for new construction or processes.

1.3.7 Severability. If any provision of this *Code* or the application thereof to any person or circumstance is held invalid, the remainder of the *Code* and the application of such provision to other persons or circumstances shall not be affected thereby.

1.4 Equivalencies, Alternatives, and Modifications

Section 1.4 provides limited latitude to the AHJ in applying the *Code* to new and existing buildings. The AHJ should determine the granting of equivalencies, alternatives, or modifications by reviewing technical data provided with the applications for such requests. Chapter 5 provides a method or system to assist the AHJ in reviewing these requests. However, such requests do not need to be limited to the performance-based options outlined in Chapter 5. If a request is granted, the equivalency, alternative, or modification must provide at least the same level of protection as the original *Code* requirement and meet the goals and objectives of this *Code*.

NFPA 1 recognizes that in some situations applying its requirements to existing situations might not be practical. In such cases, the AHJ is permitted to modify the *Code* requirements. However, a reasonable degree of safety must be provided.

1.4.1 Equivalencies. Nothing in this *Code* is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety to those prescribed by this *Code*, provided technical documentation is submitted to the AHJ to demonstrate equivalency and the system, method, or device is approved for the intended purpose.

N **1.4.1.1* Compliance with Subsequent Editions of Referenced Publications.** The AHJ shall be authorized to accept subsequent editions of publications referenced in this *Code* as evidence of compliance with the specified edition. When the AHJ accepts compliance with a subsequent edition of a referenced publication, compliance with subsequent edition shall be considered evidence of compliance with this *Code's* specified edition.

N **A.1.4.1.1** New editions of referenced publications incorporate advances in knowledge, best practices, and technology. Therefore, if an owner or contractor provides compliance with a new edition of a referenced publication that is specified by this *Code*, the AHJ should accept the new edition as evidence of full compliance with the *Code*.

For various reasons, jurisdictions may not be able to adopt the most recent edition of this *Code* when it is published. Frequently, these delays involve many years between adoptions resulting in editions of referenced standards that are no longer the most current. This section of the *Code* anticipates the problems that AHJs confront on a recurring basis. Rather than a designer or contractor being forced to use an older edition of a standard just because it is the edition referenced in this *Code*, the AHJ is authorized to approve designs using subsequent editions of the standards referenced in Chapter 2.

For example, this *Code* references the 2016 edition of NFPA 13 in Chapter 2. In some jurisdictions, this *Code* will likely be in effect well beyond the date NFPA produces the 2019 edition of NFPA 13. Once the 2019 edition of NFPA 13 is published, subparagraph 1.4.1.1 of this *Code* would authorize the AHJ to accept the 2019 edition of NFPA 13 as clear evidence of compliance with the 2016 edition of NFPA 13 referenced in Chapter 2. See 1.4.1.1.1.

N **1.4.1.1.1*** Compliance with subsequent editions of reference publications shall be achieved by complying with the entire subsequent edition of the referenced publication.

N **A.1.4.1.1.1** The intent of 1.4.1.1 and 1.4.1.1.1 is that an AHJ should approve the use of subsequent editions of referenced publications only when the entire new edition of the referenced standard is used. This paragraph is not intended to permit the use of "cherry-picking" specific sections of one edition of a referenced standard but to use the entire subsequent edition of the referenced standard.

Designers and contractors may approach AHJs for approval to use a section in a future edition of a code or standard that will add design flexibility. Although permitted under subparagraph 1.4.1.1.2, the AHJ should be cautious about granting approvals that "cherry pick" certain sections of subsequent codes or standards. Frequently, modifications to codes and standards from one edition to another are not made as stand-alone changes. They are parts of a package that, to provide the appropriate protection, must be applied in their entirety. Other sections of the code or standard may also have been modified at the same time as the section the AHJ is being asked to approve. A.1.4.1.1.1 informs AHJs that when they approve for use subsequent editions of a code or standard, and not a current edition, the new edition should be used in its entirety.

N **1.4.1.1.2*** Compliance with individual specific sections contained in subsequent editions of referenced publications, and not the entire reference publication, shall only be approved by the AHJ through technical documentation submitted in compliance with 1.4.1 or 1.4.2.

N **A.1.4.1.1.2** In circumstances where the AHJ is requested to use a specific section in a subsequent edition of a referenced publication and not the entire subsequent edition, the AHJ should require technical documentation submitted in compliance with 1.4.1 or 1.4.2. Before approving the use of specific sections of subsequent editions of referenced documents and not the entire edition of the subsequent edition, the AHJ should ensure that other changes did not occur to the subsequent edition that might affect the overall level of fire and life safety protection.

1.4.2 Alternatives. The specific requirements of this *Code* shall be permitted to be altered by the AHJ to allow alternative methods that will secure equivalent fire safety, but in no case shall the alternative afford less fire safety than, in the judgment of the AHJ, that which would be provided by compliance with the provisions contained in this *Code*.

Paragraph 1.4.2 allows the AHJ flexibility in dealing with existing buildings, including those that are deemed historic. Also see 4.5.2 and Section 20.17.

Historic buildings might have numerous *Code* deficiencies, such as open stairs (unprotected vertical openings) or highly combustible interior finishes. Rather than waiving requirements, the AHJ might require that a facility attain a level of safety equivalent to that required by the *Code*. For example, the use of sprinkler systems, smoke detection systems, voice alarm systems for staged evacuation, smoke control systems, or other features and systems might be required to overcome the existing deficiencies. Such an approach might be applied when bringing the building into strict compliance with the *Code* would destroy its historic fabric or character. Alternate approaches might increase safety to a level well above what existed in the building.

Before an inspection takes place, records should be reviewed carefully to determine whether equivalencies or alternate levels of protection have already been approved. It is important to note that the alternate level of protection must be at least equal to that specified by the *Code*; waivers are not permitted.

1.4.3 Modifications. The AHJ is authorized to modify any of the provisions of this *Code* upon application in writing by the owner, a lessee, or a duly authorized representative where there are practical difficulties in the way of carrying out the provisions of the *Code*, provided that the intent of the *Code* shall be complied with, public safety secured, and substantial justice done.

1.4.4 Buildings with equivalency, alternatives, or modifications approved by the AHJ shall be considered as conforming with this *Code*.

Compliance with this *Code* can be achieved in more than one way, as indicated in 1.4.4. A building either complies with the *Code's* prescriptive requirements or achieves equivalency through documentation of AHJ-approved alternatives or modifications. If an alternate approach to compliance is implemented, and the AHJ has judged that the alternative provides equivalency, the building is considered *Code* compliant. Compliance achieved by means of equivalency differs from a waiver that permits continued use of a noncompliant building, which should never be permitted. Documentation of equivalencies should be maintained by both the building owner and the AHJ for the life of the building. In addition, such documentation should specify whether changes to the building, such as removal of an otherwise nonrequired smoke detection system, will render the equivalency void.

1.4.5 Each application for an equivalent, alternative, or modified fire protection feature shall be filed with the AHJ and shall be accompanied by such evidence, letters, statements, results of tests, or other supporting information as required to justify the request. The AHJ shall keep a record of actions on such applications, and a signed copy of the AHJ's decision shall be provided for the applicant.

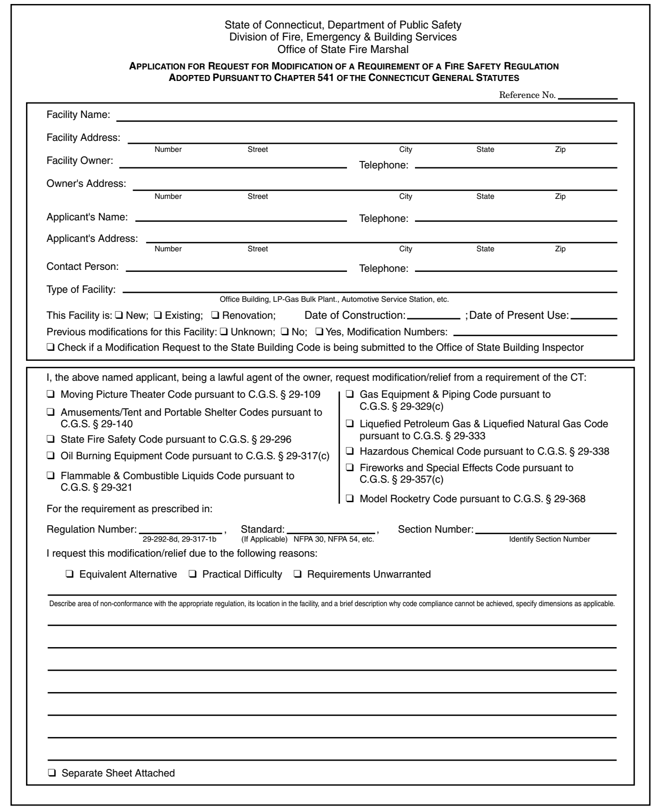
An applicant filing a request for an equivalency, alternative, or modification should be provided with a form by the AHJ. Exhibit 1.1 shows the first page of one such form for requesting a modification to a *Code* requirement. The form ensures that each applicant provides the AHJ with the appropriate information in an acceptable manner.

The AHJ should also require information, as necessary, to assist in determining whether the alternative level of protection is equivalent to the intent of this *Code*. The information required might include testing data, listing or labeling reports, engineering reports, and other supporting details that allow the AHJ to make an informed decision. The information must be maintained in an appropriate file so that a record on which the decision was based is available. This information is also important if the applicant files an appeal on the AHJ's decision to the Board of Appeals, as outlined in Section 1.10.

Δ **1.4.6 Approval.** The AHJ shall approve such equivalent, alternative, or modified construction systems, materials, or methods of design when it is substantiated that the standards of this *Code* are at least equaled. If, in the opinion of the AHJ, the standards of this *Code* are not equaled by the alternative requested, approval for permanent work shall be refused. Consideration shall be given to test or prototype installations.

The AHJ has the discretionary authority to approve or refuse an equivalency, alternatives, or modifications. However, that approval or refusal needs to be based on the ability of the applicant to justify that the equivalent level of life safety and protection has been provided.

Exhibit 1.1



State of Connecticut, Department of Public Safety
Division of Fire, Emergency & Building Services
Office of State Fire Marshal

APPLICATION FOR REQUEST FOR MODIFICATION OF A REQUIREMENT OF A FIRE SAFETY REGULATION
ADOPTED PURSUANT TO CHAPTER 541 OF THE CONNECTICUT GENERAL STATUTES

Reference No. ______

Facility Name: ______
Facility Address: ______ (Number, Street, City, State, Zip)
Facility Owner: ______ Telephone: ______
Owner's Address: ______ (Number, Street, City, State, Zip)
Applicant's Name: ______ Telephone: ______
Applicant's Address: ______ (Number, Street, City, State, Zip)
Contact Person: ______ Telephone: ______
Type of Facility: ______ (Office Building, LP-Gas Bulk Plant., Automotive Service Station, etc.)
This Facility is: ❑ New; ❑ Existing; ❑ Renovation; Date of Construction: ______ ; Date of Present Use: ______
Previous modifications for this Facility: ❑ Unknown; ❑ No; ❑ Yes, Modification Numbers: ______
❑ Check if a Modification Request to the State Building Code is being submitted to the Office of State Building Inspector

I, the above named applicant, being a lawful agent of the owner, request modification/relief from a requirement of the CT:
- ❑ Moving Picture Theater Code pursuant to C.G.S. § 29-109
- ❑ Amusements/Tent and Portable Shelter Codes pursuant to C.G.S. § 29-140
- ❑ State Fire Safety Code pursuant to C.G.S. § 29-296
- ❑ Oil Burning Equipment Code pursuant to C.G.S. § 29-317(c)
- ❑ Flammable & Combustible Liquids Code pursuant to C.G.S. § 29-321
- ❑ Gas Equipment & Piping Code pursuant to C.G.S. § 29-329(c)
- ❑ Liquefied Petroleum Gas & Liquefied Natural Gas Code pursuant to C.G.S. § 29-333
- ❑ Hazardous Chemical Code pursuant to C.G.S. § 29-338
- ❑ Fireworks and Special Effects Code pursuant to C.G.S. § 29-357(c)
- ❑ Model Rocketry Code pursuant to C.G.S. § 29-368

For the requirement as prescribed in:
Regulation Number: ______ (29-292-8d, 29-317-1b), Standard: ______ (If Applicable) (NFPA 30, NFPA 54, etc.), Section Number: ______ (Identify Section Number)
I request this modification/relief due to the following reasons:
❑ Equivalent Alternative ❑ Practical Difficulty ❑ Requirements Unwarranted

Describe area of non-conformance with the appropriate regulation, its location in the facility, and a brief description why code compliance cannot be achieved, specify dimensions as applicable.

❑ Separate Sheet Attached

Sample application form for an equivalency, alteration, or modification. (Courtesy of State of Connecticut, Department of Public Safety)

1.4.7 Tests.

1.4.7.1 Whenever evidence of compliance with the requirements of this *Code* is insufficient or evidence that any material or method of construction does not conform to the requirements of this *Code*, or to substantiate claims for alternative construction systems, materials, or methods of construction, the AHJ shall be permitted to require tests for proof of compliance to be made by an approved agency at the expense of the owner or his/her agent.

1.4.7.2 Test methods shall be as specified by this *Code* for the material in question. If appropriate test methods are not specified in this *Code*, the AHJ is authorized to accept an applicable test procedure from another recognized source.

The question of "What is an appropriate test?" is one that needs careful consideration by the AHJ. If an incorrect type of test is submitted to the AHJ or if the AHJ specifies an incorrect test method, the code specified level of safety may not be achieved. If there is a question about the appropriate test method to be used, the AHJ should consult subject experts and testing laboratories with expertise in the area.

1.4.7.3 Copies of the results of all such tests shall be retained in accordance with Section 1.11.

1.5 Units

1.5.1 International System of Units. Metric units of measurement in this *Code* are in accordance with the modernized metric system known as the International System of Units (SI).

1.5.2 Primary and Equivalent Values. If a value for a measurement as given in this *Code* is followed by an equivalent value in other units, the first stated value shall be regarded as the requirement. A given equivalent value could be approximate.

1.6 Enforcement

This *Code* shall be administered and enforced by the AHJ designated by the governing authority. *(See Annex C for sample wording for enabling legislation.)*

NFPA 1 might be enforced by different agencies in different jurisdictions. Depending how the *Code* is adopted, enforcement responsibilities might be divided between state and local agencies or between different agencies at either the state or local level. If the enforcement responsibility is divided, each agency must be aware of the portions of NFPA 1 for which it has enforcement responsibility and must understand the source of its authority to enforce those portions.

The agency needs to confirm their ability to legally adopt and enforce this *Code* with the proper legal procedures to use during a code adoption process. Frequently, an individual or company contesting the need to comply with this *Code* will challenge the agency's authority to adopt this *Code* and the mechanism used to adopt this *Code*. If the *Code* was not legally or properly adopted, the ability to enforce this *Code* will be brought into question and may not be upheld.

1.7 Authority

1.7.1 Administration. The provisions of this *Code* shall apply without restriction, unless specifically exempted.

The governing authority might choose to supplement or alter the *Code*. The authority might, for example, mandate that specific annex material be adopted or that certain sections of the *Code* cannot apply within the jurisdiction. Annexes are provided for informational purposes only and are not part of the requirements of this *Code*. However, two annexes in NFPA 1 are adoptable: Annex D, Hazardous Materials Management Plans and Hazardous Materials Inventory Statements; and Annex E, Fire Fighter Safety Building Marking System. Governing authorities choosing to adopt either or both of these annexes must include them by name in the ordinance adopting this *Code*. The annexes then become an enforceable part of the *Code*. See Annex C for a sample ordinance to adopt NFPA 1.

1.7.2* Minimum Qualifications to Enforce this *Code*. The AHJ shall establish minimum qualifications for all persons assigned the responsibility of enforcing this *Code*.

Δ **A.1.7.2** For additional information on qualifications of code enforcement personnel, see NFPA 1031, NFPA 1033, NFPA 1035 and NFPA 1037.

N **1.7.2.1** Fire inspectors and plans examiners shall meet the minimum professional qualifications established in NFPA 1031.

NFPA 1031, *Standard for Professional Qualifications for Fire Inspector and Plan Examiner*, provides a list of job performance requirements with matching knowledge areas and skills that a fire inspector or plans examiner should possess when performing specific job functions. NFPA 1031 has three levels of progression for fire inspectors and two plans examiners. The *Code* requires that fire inspectors and plans examiners be assigned only to roles that match their NFPA 1031 fire inspector or plans examiner levels.

The primary method to ensure that fire inspectors and plans examiners are trained appropriately to their job functions is via an accredited certification program. ProBoard and IFSAC, International Fire Service Accreditation Congress, are two examples of such fire service accrediting bodies that evaluate fire service certifying entities. Certifying entities will then provide certification to NFPA 1031 for fire inspectors and plans examiners.

N **1.7.2.2** The AHJ shall be authorized to approve alternative qualifications for personnel conducting fire inspections and plan examination if the AHJ determines the individual possesses the knowledge, skills, and abilities to perform the job performance requirements of the position.

N **1.7.2.3** Fire marshals shall meet the minimum professional qualifications established in NFPA 1037.

NFPA 1037, *Standard on Fire Marshal Professional Qualifications*, specifies minimum job performance requirements, knowledge, and skills expected of a fire marshal. Before placing an individual in the position of a fire marshal, NFPA 1037 requires that the agency must ensure that the individual meets the requirements of NFPA 1031.

N **1.7.2.4** The AHJ shall be authorized to approve alternative qualifications for personnel performing the position of fire marshal if the AHJ determines the individual possesses the knowledge, skills, and abilities to perform the job performance requirements of the position.

1.7.3 Interpretations.

1.7.3.1 The AHJ is authorized to render interpretations of this *Code* and to make and enforce rules and supplemental regulations in order to carry out the application and intent of its provisions.

The AHJ is authorized to clarify or supplement *Code* requirements based on its interpretation for ease of use and enforcement. The granting of this authority includes the power to adopt rules, polices, and regulations to effectively implement the intent of this *Code*. Because AHJs are charged with enforcing this *Code*, they must also provide interpretations of its intent and application. AHJs requiring assistance in determining the application or intent of a requirement might consider contacting other area AHJs or NFPA technical staff for assistance.

1.7.3.2 Such interpretations, rules, and regulations shall be in conformance with the intent and purpose of this *Code* and shall be available to the public during normal business hours.

1.7.4 Enforcement Assistance. Police and other enforcement agencies shall have authority to render necessary assistance in the enforcement of this *Code* when requested to do so by the AHJ.

The enforcement power given to the AHJ varies. Assistance from another agency, such as a police department, building department, or public works department, might be required when carrying out the responsibilities assigned by the *Code*. The AHJ should maintain a close working relationship with other enforcement agencies whose assistance is needed to enforce the *Code* properly.

If regular assistance is needed, having the same person(s) from the assisting enforcement agency work with the AHJ each time enables that person(s) to become familiar with the issues and provide better continuity and support. At times, personnel from other enforcement agencies might be assigned to the office of the AHJ.

1.7.5 Delegation of Authority. The AHJ shall be permitted to delegate to other qualified individuals such powers as necessary for the administration and enforcement of this *Code*.

The AHJ might have staff assigned to assist with enforcement duties. Staff members might have specific or specialized assignments, such as plan review or flammable and combustible liquid inspection responsibilities, or they could perform a variety of duties. In either case, the organizational structure should be clear. In addition, AHJ designated staff members might be assigned to roles outside of the traditional fire prevention bureau, such as to fire department operations units in fire stations. Staff members and others should be able to identify a clear chain of command to the AHJ, the duties and responsibilities of the various command and staff positions, and the procedures for all staff to follow. This information should be provided as part of staff training, and a written copy should be available for reference and review as needed.

1.7.6 Reliance on Other Enforcement Officials.

1.7.6.1* The AHJ shall be authorized to rely on plan reviews, inspections, opinions, and approvals rendered by other enforcement officials in determining compliance with this *Code*.

Δ **A.1.7.6.1** The AHJ enforcing NFPA 1 may not have the technical expertise, required certifications, licensure, or legal authority to enforce all of the provisions and subject matter contained therein. As an example, Chapter 11 contains references to codes and standards that regulate specific building subsystems. These subsystems could be regulated by electrical, mechanical, plumbing, or other specialty enforcement officials with technical expertise or legal authority in the specific area of the subsystem. This paragraph authorizes the AHJ enforcing NFPA 1 to rely on the opinion and authority of these specialty enforcement officials in order to determine compliance.

The AHJ for NFPA 1 should have an understanding with other AHJs, such as building, mechanical, plumbing, and electrical codes, on issues that may cross over each other's scope of authority. As an example, systems such as medical gas and liquefied petroleum gas might be regulated by multiple codes or authorities. Developing an understanding as to scope of plans review and inspections for those systems that might be jointly regulated will go a long way to ensuring quality customer service and that hazards are not missed by multiple AHJs.

1.7.6.2 When the AHJ relies on inspections, plan reviews, opinions, and approvals rendered by other enforcement officials in determining compliance with this *Code*, the other enforcement officials shall be deemed to be acting as agents under their own authority and not as agents of the AHJ enforcing this *Code*.

The provisions of paragraph 1.7.6 clarify that the AHJ responsible for its enforcement likely has neither the authority nor the expertise to enforce the plumbing, mechanical, or electrical code, among others, as referenced by other sections of this *Code*. The AHJ can rely on the approvals of other applicable enforcement officials to determine compliance with such other codes.

1.7.7 Inspection.

1.7.7.1* The AHJ shall be authorized to inspect, at all reasonable times, any building or premises for dangerous or hazardous conditions or materials as set forth in this *Code*.

N **A.1.7.7.1** New construction and existing occupancy inspection services should comply with NFPA 1730.

1.7.7.2 The AHJ shall have authority to order any person(s) to remove or remedy such dangerous or hazardous condition or material. Any person(s) failing to comply with such order shall be in violation of this *Code*.

If a dangerous or hazardous condition is found during an inspection, the AHJ is required to order the owner to correct the violation. Owners who fail to correct or abate such deficiencies are in violation of the *Code*. See Section 1.16 and Section 10.2.

1.7.7.3 To the full extent permitted by law, any AHJ engaged in fire prevention and inspection work shall be authorized at all reasonable times to enter and examine any building, structure, marine vessel, vehicle, or premises for the purpose of making fire safety inspections.

The phrase *all reasonable times,* which is used in subparagraph 1.7.7.3, usually corresponds to the operating or business hours of a building or property. In most cases, performing a fire inspection at midnight in a business occupancy that is open from 8 a.m. to 5 p.m. is not reasonable. However, it may be reasonable to conduct an inspection of a bar or nightclub at midnight. AHJs should confer with their jurisdiction's legal counsel for further guidance.

1.7.7.4 Before entering, the AHJ shall obtain the consent of the occupant thereof or obtain a court warrant authorizing entry for the purpose of inspection except in those instances where an emergency exists.

The ability to perform an inspection is an important part of a jurisdiction's fire and life safety program. To perform an inspection, the inspector needs to obtain permission from the property owner, as stated in 1.7.7.4. In some jurisdictions, an occupant can allow entry for the inspection. In many jurisdictions, the AHJ can apply for and receive an administrative warrant to perform inspections if entry is not granted. In jurisdictions where an administrative warrant is not available, the acquisition of a search warrant might be required. The inspector should be familiar with state and local laws regarding the right to enter property and the appropriate procedures to take when consent is not granted.

Basic search and seizure guidelines require that the person granting permission for an inspection has control over the area(s) to be entered. In most cases, determining who has the authority to allow access to an occupancy or an area for inspection is relatively easy. However, in multi-tenant arrangements, such as apartments with more than one tenant in a single dwelling unit, determining the right of an individual to grant inspection access to all areas is more difficult. In the case of multiple tenants, any tenant can allow access to common spaces, such as the living room, kitchen, and bathroom (if they share the bathroom). However, bedroom areas are usually under the separate control of each tenant, and each can allow access only to his or her own bedroom. Another important factor is the age of the person granting permission. Minors do not have the authority to grant permission to enter or inspect a premises.

The AHJ needs to exercise caution when entering a property without permission or a warrant on the grounds that an emergency exists. The AHJ's determination of the presence of an emergency may be subject to challenge and overturned if the evidence for such a determination is not deemed reasonable by a court. If the AHJ has any uncertainty about their legal authority to conduct an inspection, the AHJ should confer with their jurisdiction's legal counsel for guidance before conducting the inspection.

1.7.7.5 As used in 1.7.7.4, emergency shall mean circumstances that the AHJ knows, or has reason to believe, exist and that can constitute imminent danger.

An example of the application of 1.7.7.5 would be where the AHJ or the fire department sees smoke coming from an apartment window. In such a situation, the owner or occupant's permission would not be required to enter the premises and extinguish the fire. In fact, according to 1.7.8, 1.8.2, and 1.8.3, any person(s) interfering with the duties of those involved would be in violation of this *Code*. Other examples of emergencies could include situations such as reports of a gas leak, a building that is potentially structurally unsafe, improper storage of hazardous materials, fire protection systems that are out of service, or locked means of egress. If challenged whether a search was legal under this section, the burden will be on the AHJ to demonstrate that the information the AHJ had met the standard of an emergency.

1.7.7.6 Persons authorized to enter and inspect buildings, structures, marine vessels, vehicles, and premises as herein set forth shall be identified by credentials issued by the governing authority.

Identification credentials for a fire code inspector might include a photo identification card that carries the inspector's name, title, and affiliation, as well as the name and address of the issuing agency. The photo should show the inspector's face and should be current. For example, if the inspector has a beard or mustache, the card photo should not show him as clean-shaven. The printing on the card should be legible in poor lighting conditions and large enough for those with poor eyesight to read easily.

The AHJ should willingly demonstrate to any member of the public their proper credentials if questioned.

1.7.8 Where conditions exist and are deemed hazardous to life or property by the AHJ, the AHJ shall have the authority to summarily abate such hazardous conditions that are in violation of this *Code*.

Abatement of a hazard means to correct the hazard. Whether the hazard exists on public or private property, the AHJ has the authority to correct that condition when the condition is hazardous to life or property. The AHJ needs to use discretion in exercising this authority. The more imminent the danger, the greater the justification exists for the AHJ to take abatement action.

See Section 1.16 for requirements on serving notice of violations and penalties.

1.7.9 Interference with Enforcement. Persons shall not interfere or cause conditions that would interfere with an AHJ carrying out any duties or functions prescribed by this *Code*.

1.7.10 Impersonation. Persons shall not use a badge, uniform, or other credentials to impersonate the AHJ.

1.7.11 Investigation.

A complete investigation of the origin, cause, and circumstances of fire incidents assists the AHJ in determining the fire and life safety risks in its jurisdiction and can help in planning fire prevention activities. In addition, professionally conducted fire investigations to ascertain the origins and causes of fires are necessary to determine if a crime has been committed. Fire investigators should follow NFPA 921, *Guide for Fire and Explosion Investigations,* when conducting fire investigations. Individuals assigned the role of a fire investigator should also meet the professional qualification standards contained in NFPA 1033, *Standard for Professional Qualifications for Fire Investigator.*

1.7.11.1 Authority. The AHJ shall have the authority to investigate the cause, origin, and circumstances of any fire, explosion, release of hazardous materials, or other hazardous condition.

1.7.11.2 Evidence. The AHJ shall have the authority to take custody of all physical evidence relating to the cause of the fire, explosion, release of hazardous materials, or other hazardous condition.

With regards to the application of 1.7.11.1 and 1.7.11.2, the AHJ should ensure that they have a legal right to search a property and/or take physical evidence under their state laws and federal limitations.

1.7.11.3 Limiting Access. The AHJ shall have the authority to limit access to emergencies or other similar situations.

1.7.11.4 Trade Secret. Information that could be related to trade secrets or processes shall not be made part of the public record except as could be directed by a court of law.

Freedom of information laws and local legal counsel should be consulted for guidance about the proper handling of records, reports, and other documents that might involve proprietary industry information. State freedom of information laws may supersede this provision.

1.7.12 Plans and Specifications.

The review of plans by an AHJ ensures compliance with the *Code*. In jurisdictions where other departments or AHJs also review plans, the requirements of 1.7.12 provide for an additional review by the AHJ responsible to enforce this *Code* and referenced standards. Cooperation among the fire official, the building official, and other code officials is key to the success of any code enforcement program. With good cooperation and coordination from plan review up to and including final approval, both the jurisdiction and the community benefit by ensuring compliance with all applicable codes and standards.

1.7.12.1 The AHJ shall have the authority to require plans and specifications to ensure compliance with applicable codes and standards.

The AHJ is granted broad discretionary power to determine when and what plans and specifications are required to be reviewed. Usually, the requirement to submit plans and specifications is tied to the permit approval process.

1.7.12.2 Plans shall be submitted to the AHJ prior to construction unless otherwise permitted by 1.7.12.4.

1.7.12.3 The construction documents for each phase shall be complete in themselves, so that review and inspection can properly be made. Preliminary plans of the total building shall be submitted with the construction documents, and with sufficient detail, so that proper evaluation can be made. Areas and items not included in the phase to be permitted shall be shown as not included. [**5000:**1.7.6.3.3.3]

1.7.12.4 The AHJ is authorized to exempt detached one- and two-family dwellings and accessory structures from the submittal of plans.

Frequently, one- and two-family dwelling plans are reviewed and approved for compliance with an adopted building code by the building department. In this circumstance, the AHJ may determine that there is limited value for the AHJ enforcing this *Code* to conduct an additional review. However, the AHJ should ensure that fire department access and water supply provisions have been addressed adequately because those topics are typically not addressed in a building code. It is important to note that even if a one- or two-family dwelling is exempt from a plan review for the architectural design, the AHJ would still be warranted in requiring a plan review for a fire sprinkler system design. Exemption from permit requirements is covered under 1.7.12.9.

1.7.12.5 Plans shall be submitted to the AHJ prior to the change of occupancy of any existing building.

In some cases, a change of occupancy classification might not involve physical alterations to the building. For example, an open retail space (mercantile occupancy) might be converted to a travel agency (business occupancy) with no construction required except for the replacement of fixtures and furnishings. In such a case, notification must be provided to the AHJ so that compliance with the *Code* requirements applicable to the new occupancy can be verified. In most cases, this will also require that the building's or lease space's occupancy classification be clearly stated on its certificate of occupancy; changes to the building's or lease space's occupancy classification should render the certificate of occupancy invalid.

1.7.12.6 Plans shall be submitted to the AHJ prior to the alteration of the means of egress or fire protection systems of any existing building.

1.7.12.7 Plans shall be submitted to the AHJ for other conditions as deemed necessary by the AHJ to determine compliance with the applicable codes and standards.

1.7.12.8 The AHJ shall be authorized to require permits for conditions listed in 1.7.12.2, 1.7.12.5, and 1.7.12.6, unless otherwise permitted by 1.7.12.9.

1.7.12.9 The AHJ is authorized to exempt detached one- and two-family dwellings and accessory structures from the permit requirement of 1.7.12.8.

See commentary to 1.7.12.4.

1.7.12.10 No construction work shall proceed until the AHJ has reviewed the plans for compliance with the applicable codes and standards and the applicable permits have been issued.

Construction work on buildings and the installation or modification of fire protection systems must not commence until plans are approved and the appropriate permits are issued by the AHJ. Contractors who start work without permits do so at their own risk and are in violation of the *Code*. Many jurisdictions discourage work without a permit by adopting a permit fee schedule that provides a penalty of double or triple the normal permit fee for work occurring without a permit. Other regulatory methods to discourage work without a permit are to provide disciplinary action to contractors in jurisdictions that require certificates of fitness or licenses. Some jurisdictions provide contractors with flexibility by issuing permit types that allow for early start of work before the full permit is issued. These permits only allow work to occur up to the point of the fire inspection and at the contractor's risk.

1.7.13 Inspection of Construction and Installation.

1.7.13.1 The AHJ shall be notified by the person performing the work when the installation is ready for a required inspection.

Persons performing work subject to inspection should be notified how much lead time is required for scheduling inspections. For example, it might be reasonable to require inspections to be scheduled at least 24 hours in advance. Requiring inspections to be scheduled two weeks in advance is probably unreasonable and not conducive to beneficial relationships between the AHJ and the development community.

1.7.13.2 Whenever any installation subject to inspection prior to use is covered or concealed without having first been inspected, the AHJ shall have the authority to require that such work be exposed for inspection.

At times, an inspector might discover that items subject to inspection are intentionally or unintentionally covered or concealed. To confirm that an installation of wiring, ductwork, or other similar building system was made in accordance with the appropriate standards or prior approvals, the AHJ can require that the area be exposed for inspection. The installer should notify the AHJ, in advance and when work is visible, that an installation is in need of an inspection. The AHJ should establish guidelines for the inspections types that are required for each permit type and the notification time frames.

1.7.13.3 When any construction or installation work is being performed in violation of the plans and specifications as approved by the AHJ, a written notice shall be issued to the responsible party to stop work on that portion of the work that is in violation.

1.7.13.4 The notice shall state the nature of the violation, and no work shall be continued on that portion until the violation has been corrected.

During the construction or the installation of systems or equipment, the work performed might be found to differ from the approved plans or specifications. The change might be necessary because of unexpected features or conditions in a building or an area. If changes are noted during an inspection, the AHJ can issue a stop work order to suspend the work until proper corrective action or approval has been obtained. See Exhibit 1.2 for an example of a form that an AHJ can use to issue a stop work order. (See 1.7.15 for details on stop work orders.)

If approval for modification of the approved plans or specifications, or both, has not been obtained, the stop work order protects the building owner, the community, and the AHJ from problems that could result from the unapproved work.

Exhibit 1.2

LEGAL NOTICE

Date ________________

WHEREAS, VIOLATIONS OF { Article ________, Section ________ of the Zoning Ordinance / Article ________, Section ________ of the Building Code / Article ________, Section ________ of the ____________ Code } have been found on these premises, IT IS HEREBY ORDERED in accordance with the above Code that all persons cease, desist from, and

STOP WORK

at once pertaining to construction, alterations or repairs on these premises known as________________________________

All persons acting contrary to this order or removing or mutilating this notice are liable to arrest unless such action is aurhorized by the Department.

____
CODE OFFICIAL

Sample form for a stop work order.

The inspector can allow work to resume when the appropriate approvals, the corrections, or an explanation for the variation from the approved plans or specifications is obtained.

A stop work order issued under this section should be reserved only for circumstances where there is a significant divergence from the plans. In most other cases, the AHJ can issue a rejection on an inspection and direct the contractor to correct the plans to match the field conditions or to correct the field condition to match the plans.

1.7.14 Certificate of Occupancy. When the building code requires a certificate of occupancy, the certificate of occupancy shall not be issued until approved by the AHJ for fire code enforcement.

The building code typically empowers the building official to issue a certificate of occupancy once the use is determined to be compliant with the approved plans and the adopted building code. The issuance of a certificate of occupancy is usually the final authorization for the start of the building's intended use by the occupants and public. In most jurisdictions, that authorization involves final approved inspections by building, mechanical, plumbing, and electrical inspectors. The AHJ for fire code enforcement should have the same standing as the other trade inspectors for co-approval.

1.7.15 Stop Work Order. The AHJ shall have the authority to order an operation, construction, or use stopped when any of the following conditions exists:

(1) Work is being done contrary to provision of this *Code*.
(2) Work is occurring without a permit required by Section 1.12.
(3) An imminent danger has been created.

The AHJ has the authority to order the cessation of work where any of the conditions cited under 1.7.15 are encountered. The most serious of these relates to the creation of *imminent danger,* which is defined in 3.3.159 as "a condition or practice in an occupancy or structure that poses a danger that could reasonably be expected to cause death, serious physical harm, or serious property loss." An example of imminent danger might be unauthorized handling of explosives by untrained personnel without proper precautions. The AHJ might reasonably expect that such activity has a relatively high probability of causing death, serious physical harm, or serious property loss. The issuance of a stop work order in such a case would be most appropriate. In addition, if work is occurring without a permit or if the work is contrary to the code, the AHJ can issue a stop work order. Similar language is cited in 1.17.13.3 that allows a stop work order to be issued when conditions in the field do not match the plans.

1.7.16 Imminent Dangers and Evacuation.

1.7.16.1 When, in the opinion of the AHJ, an imminent danger exists, the AHJ shall be authorized to order the occupants to vacate, or temporarily close for use or occupancy, a building, the right-of-way, sidewalks, streets, or adjacent buildings or nearby areas.

1.7.16.2 The AHJ shall be authorized to employ the necessary resources to perform the required work in order to mitigate the imminent danger.

1.7.16.3 Costs incurred by the AHJ in the performance of emergency work shall be the responsibility of the property owner or other responsible party creating such imminent danger.

The AHJ might evacuate a building or an area, or stop a use or an operation, when danger is imminent. One common reason for evacuation, other than fire or a similar emergency, is overcrowding.

Care should be taken when evacuating an overcrowded building, especially where alcohol is served and occupants might become disorderly or even violent. The inspector should be certain that he or she has the appropriate authority to order the evacuation under the specific circumstances present. The inspector should also be careful to follow all department guidelines before initiating the evacuation. As a safety precaution for the inspector and the evacuees, adequate police presence should be in place before an evacuation begins.

1.7.17 Standby and Fire Watch Personnel.

1.7.17.1 The AHJ shall have the authority to require standby fire personnel or an approved fire watch when potentially hazardous conditions or a reduction in a life safety feature exist due to the type of performance, display, exhibit, occupancy, contest, or activity; an impairment to a fire protection feature; or the number of persons present.

1.7.17.2 The owner, agent, or lessee shall employ one or more qualified persons, as required and approved, to be on duty.

The term *qualified persons,* as used in 1.7.17.2, is left to the discretion of the AHJ. The term *fire personnel* also includes emergency medical service (EMS) personnel who may be required as part of a standby for an activity that may generate a need for EMS services for participants or spectators. Depending on the circumstances, qualified persons might be building personnel, security personnel, emergency medical technicians, paramedics, fire inspectors, or fire fighters. The number of qualified persons is also subject to determination of the AHJ.

1.7.17.2.1 The cost of standby fire personnel shall be at no cost to the AHJ.

The building owner or building owner's representative is responsible for the cost of standby and fire watch personnel. In determining the cost to provide such services, the AHJ may include salaries, benefits, equipment use, overhead to plan and manage the standby, and any other costs that are created to the jurisdiction as a result of the standby. In cases of anticipated events where the jurisdiction will provided the standby personnel, the jurisdiction may consider collecting the estimated cost of the standby fire personnel at the time the permit or other authorization is provided for the activity requiring standby fire personnel.

1.7.17.3* Such standby fire personnel or fire watch personnel shall be subject to the AHJ's orders at all times and shall be identifiable and remain on duty during the times such places are open to the public, when such activity is being conducted, or as required by the AHJ.

A.1.7.17.3 Before each performance or the start of such activity, such individuals should inspect the required fire appliances provided to see that they are properly located and in good working order, and should keep diligent watch for fires during the time such place is open to the public or such activity is being conducted and take prompt measures for extinguishment of fires that can occur.

Standby fire personnel are subject to the orders of the AHJ and should not serve other unrelated functions unless specifically permitted by the AHJ. They should be readily identifiable and available during the times specified by the AHJ. These times could be short term, such as during a performance, or long term, such as while a sprinkler system is impaired or out of service.

1.7.18 Public Fire Education.

1.7.18.1 The AHJ shall have the authority to develop and implement a public fire safety education program as deemed necessary for the general welfare with respect to the potential fire hazards within the jurisdiction.

Public fire and life safety education programs should be a major part of any fire prevention program. Community outreach, education, and awareness programs should start as early as possible in preschool and/or elementary school and continue through high school. Adult programs should also be available to increase fire and life safety awareness in the community. A review of the community's fire records can help to identify high-risk problems or areas in the community that require extra fire and life safety efforts.

Fire education programs in schools should be a year-round endeavor and not merely a special program conducted during an annual Fire Prevention Week. School systems can incorporate fire safety programs into their existing curricula. The fire prevention authority can help by advising schools on the proper training of presenters and by identifying appropriate materials to reinforce the fire safety message. NFPA's *Learn Not to Burn*® and *Remembering When*™ programs provide training and materials needed for such a fire safety effort.

The media can be a useful partner in fire safety awareness initiatives for adults and children. Television and radio stations might run public safety messages free of charge as part of their licensing requirements. In addition, many cable companies offer public access as part of their contract to provide service to the community. These programs are excellent opportunities to provide fire safety education messages on a regular basis. The fire department, police department, and other public service agencies can pool their resources to use these public access avenues more effectively. Collaboration relieves a single agency from the burden of providing a complete program every week and gives the audience a broader spectrum of programming to maintain their interest.

There are situations where education of a specific segment of the public is a required activity under the *Code*, for example, in crowd management training programs, assembly occupancies, and emergency action plans.

1.7.18.2 The AHJ shall have the authority to ensure duly authorized public fire safety education programs or public fire safety messages are disseminated to the general public.

1.8 Duties and Powers of the Incident Commander

1.8.1 Authority. The incident commander conducting operations in connection with the extinguishment and control of any fire, explosion, hazardous materials incident, natural disaster, rescue, and/or other emergency shall have authority to direct all operations of fire extinguishment, mitigation of a hazardous materials incident, natural disaster, rescue, and/or control and to take necessary precautions to save life, protect property, and prevent further injury or damage.

The incident commander of an emergency operation must have the authority to do what is necessary to mitigate a hazard. Paragraph 1.8.1 gives the incident commander broad authority to perform the duties required. As such, state statutes, local ordinances, and department policies related to the duties and powers of an incident commander should also be considered when determining the scope of an incident commander's duties and powers.

1.8.2 Controlling Scene. During any emergency described in 1.8.1, including the investigation of the cause of such emergency, the incident commander or authorized representative shall be permitted to control or prohibit the approach to the scene of such emergency by any vehicle, vessel, or person.

Paragraph 1.8.2 authorizes the incident commander to prevent people from entering the scene of an emergency and to evacuate areas in a danger zone. Areas in a danger zone include areas in the path of a fire and downwind of a hazardous materials spill or release.

1.8.3 Obstruction of Operations. Persons shall not obstruct the operations of the fire department or disobey any command of the incident commander or authorized representative or any part thereof, or any order of a police officer assisting the fire department.

State statutes should also be consulted because those documents typically contain provisions that make the obstruction of fire department operations a criminal offense.

1.8.4 Scene Barrier. The incident commander or authorized representative in charge of an emergency scene shall have the authority to establish barriers to control access in the vicinity of such emergency and to place, or cause to be placed, ropes, guards, barricades, or other obstructions across any street or alley to delineate such emergency scene barrier.

During emergency operations, the incident commander should establish safe areas and keep the public within those areas. Physical barriers, barrier tape, or other means appropriate for the situation and the duration of the emergency can accomplish the requirement of 1.8.4. Exhibit 1.3 shows an example of barrier tape blocking access to a fire scene.

Some emergency scenes are more controllable than others. For example, controlling access to an incident on a limited-access highway is less complicated than controlling access to a fire in a downtown area close to traffic and pedestrians. At all emergencies, the incident commander should ensure that the area controlled is large enough for adequate expansion of the emergency, as warranted. The area should be large enough to accommodate the personnel and equipment required for mitigation of the incident, as well as to ensure the public's safety.

Exhibit 1.3

Barrier tape blocking access to a fire scene. (©Rodehi, Dreamstime .com)

Reducing the size of the area under control is easier than increasing it. Special provisions for the media should be in place, including a system for providing the media with special passes and access to specific areas when necessary and appropriate.

1.8.5 Persons, except as authorized by the incident commander in charge of the emergency, shall not be permitted to cross barriers established in accordance with 1.8.4.

1.9 Liability

While the provision of Section 1.9 provides appropriate liability protections to the AHJ professionally and personally, the AHJ should check with the jurisdiction's legal counsel for any additional liability laws. If the AHJ is involved in litigation, Section 1.9 should be brought to the attention of the AHJ's legal counsel.

1.9.1 The AHJ, and other individuals charged by the AHJ, or the incident commander of emergency operations, charged with the enforcement of this *Code* or any other official duties, acting in good faith and without malice in the discharge of their duties, shall not thereby be rendered personally liable for any damage that could accrue to persons or property as a result of any act or by reason of any act or omission in the discharge of their duties.

Subsection 1.9.1 addresses a situation in which a plaintiff may attempt to hold an AHJ personally liable for damages. As long as the AHJ is acting in good faith and without malice in their official actions, the intent of this section is to shield the AHJ from any personal liability associated with their official job function.

1.9.2 The fire department and AHJ, acting in good faith and without malice in the discharge of the organizations' public duty, shall not thereby be rendered liable for any damage that could accrue to persons or property as a result of any act or by reason of any act or omission in the discharge of such duties.

Subsection 1.9.2 addresses a situation in which a plaintiff may attempt to hold an AHJ or the fire department professionally liable for damages. As long as the AHJ or the fire department is acting in good faith and without malice in their official actions, the intent of this section is to shield the AHJ and fire department from professional liability associated with their official job function.

1.9.3 Any suit brought against the AHJ, the incident commander, or such individuals because of such act or omission performed in the enforcement of any provision of such codes or other pertinent laws or ordinances implemented through the enforcement of this *Code* or enforced by the code enforcement agency shall be defended by this jurisdiction until final termination of such proceedings, and any judgment resulting therefrom shall be assumed by this jurisdiction.

1.9.4 This *Code* shall not be construed to relieve from or lessen the responsibility of any person owning, operating, or controlling any building or structure for any damages to persons or property caused by defects, nor shall the code enforcement agency or its parent jurisdiction be held as assuming any such liability by reason of the inspections authorized by this *Code* or any permits or certificates issued under this *Code*.

1.10 Fire Code Board of Appeals

The AHJ should consult state statutes and local ordinances for additional guidance that may further direct the AHJ as to the composition, authority, and function of the Fire Code Board of Appeals.

1.10.1 Establishment of Fire Code Board of Appeals. A Board of Appeals shall be established to rule on matters relating to the fire code and its enforcement.

1.10.1.1 Membership.

1.10.1.1.1 The members of the Board of Appeals shall be appointed by the governing body of the jurisdiction.

1.10.1.1.2 The Board of Appeals shall consist of five or seven principal members and one ex officio member representative of the AHJ. Each principal member shall be permitted to have an alternate with similar experience to serve in his or her stead when necessary.

1.10.1.1.2.1 The jurisdiction governing body shall have the authority to appoint alternates who shall serve when a principal member is unable to fulfill their obligations. Alternates shall have the full authority and responsibility of principal members when serving in place of a principal member.

The purpose of appointing alternates is to assist in ensuring that a quorum is reached for meetings. For local boards, it can sometimes be a challenge to assemble board members in a timely manner to meet and reach decisions. If principal members are unavailable, alternate members can step in to ensure the quorum is reached and the meeting can proceed.

1.10.1.1.3 Members and alternate members shall be appointed based on their education, experience, and knowledge.

1.10.1.1.4 Members and alternates shall be appointed to a 3-year term.

1.10.1.1.5 Members and alternates shall be composed of individuals experienced in the following fields or professions:

(1) Engineering or architectural design
(2) General contracting
(3) Fire protection contracting
(4) Fire department operations or fire code enforcement
(5) Building code enforcement
(6) Legal
(7) General public

1.10.1.1.5.1 Members and alternates shall not be employees, agents, or officers of the jurisdiction.

1.10.1.1.5.2 Members and alternates shall be residents of the jurisdiction.

1.10.1.1.5.3 No more than one member shall represent the same field or provision listed in 1.10.1.1.5.

Diversity in the Board of Appeals membership is important to ensure a fair and impartial hearing. To achieve fairness, no more than one member of the same profession should be appointed to the board, except as an alternate. A range of professional representation ensures issues that come before the board are analyzed effectively and quality, evidence-based decisions are reached.

1.10.1.1.6 The representative of the AHJ shall be an ex officio member and shall be entitled to participate in all discussions. The ex officio member shall not be entitled to a vote.

1.10.1.1.7 No member of the Board of Appeals shall sit in judgment on any case in which the member holds a direct or indirect property or financial interest in the case.

If a board member, the company a board member represents, or that company's constituent or customer has applied to the board for an appeal, the board member should recuse himself or herself from all discussions and findings of the board in relation to that appeal.

1.10.1.1.8 The board shall select one of its members to serve as chair and one member to serve as vice chair.

1.10.2 Rules and Procedures of the Board of Appeals. The Board of Appeals shall have the authority to establish rules and regulations for conducting its business that are consistent with the provisions of this *Code*.

1.10.3 Authority of the Board of Appeals.

1.10.3.1 The Board of Appeals shall provide for the reasonable interpretation of the provisions of this *Code* and issue rulings on appeals of the decisions of the AHJ.

The Board of Appeals is charged with ensuring that the intent of the *Code* and public safety are met. The board is not permitted to grant variances or waivers that allow noncompliance with the *Code*. (See 1.10.3.4.) Board of Appeals members should receive training on the limitations of their authority, intent of the code, and the process to be used in rendering a decision.

1.10.3.2 The ruling of the Board of Appeals shall be consistent with the letter of the *Code* or when involving issues of clarity, ensuring that the intent of the *Code* is met with due consideration for public safety and fire fighter safety.

1.10.3.3 The Board of Appeals shall have the authority to grant alternatives or modifications through procedures outlined in Section 1.4 of the *Code*.

It is important to differentiate alternatives and modifications from waivers. Alternatives and modifications allow for differing approaches than what the prescriptive provisions of this *Code* may require while still providing for an equivalent level of property and life safety protection. The granting of a waiver would allow a petitioner to the board to disregard the protection provisions of the *Code* and is not allowed under 1.10.3.4.

1.10.3.4 The Board of Appeals shall not have the authority to waive the requirements of the *Code*.

The Board of Appeals is prohibited from waiving any requirement of the *Code*. AHJs and board members should be careful to ensure that a waiver is not being misrepresented as an alternative or modification. Any alternatives or modifications must be proven to ensure the intent of the *Code* is met for property protection, building safety, and fire fighter safety.

If a waiver request is submitted to the Board of Appeals, the request should be dismissed by the board's legal counsel without the board considering the request. When an appeal is rejected by the board's legal counsel, the applicant should be informed in writing by the board legal counsel that the appeal has been rejected as the board has no jurisdiction to rule on waivers.

1.10.3.5 The Board of Appeals decisions shall not be precedent setting.

Previous rulings by a board are not intended to set a precedent for future rulings. Each appeal should be made based on the circumstances relating to each individual appeal.

1.10.4 Means of Appeals.

1.10.4.1 Any person with standing shall be permitted to appeal a decision of the AHJ to the Board of Appeals when it is claimed that any one or more of the following conditions exist:

(1) The true intent of the *Code* has been incorrectly interpreted.
(2) The provisions of the *Code* do not fully apply.
(3) A decision is unreasonable or arbitrary as it applies to alternatives or new materials.

The board must review each application before accepting an appeal to determine whether one of the conditions in 1.10.4.1 exists. Where none of the conditions exist, the application for a hearing should be rejected, and the applicant must be sent a letter stating why the application was rejected. The letter should outline what further action, if any, the applicant can take within the appeals process of the jurisdiction.

1.10.4.2 An appeal shall be submitted to the AHJ in writing within 30 calendar days of notification of violation. The appeal shall outline all of the following:

(1) The *Code* provision(s) from which relief is sought
(2) A statement indicating which provisions of 1.10.4.1 apply
(3) Justification as to the applicability of the provision(s) cited in 1.10.4.1
(4) A requested remedy
(5) Justification for the requested remedy stating specifically how the *Code* is complied with, public safety is secured, and fire fighter safety is secured

If the application is insufficient, it should be rejected by the board legal counsel and the applicant should be notified of such reasons for rejection. Incomplete or deficient appeal applications that do not meet the criteria of 1.10.4.2 should not be allowed to reach the board for a hearing.

The appeals process should not be allowed to be used as a tactic to delay the correction of violations. Typically, the property owner or tenant is given a period of time to abate a violation found during an inspection. The expectation is that work will commence as soon as practicable after the violations are reported to the owner or tenant. If the owner or tenant disagrees with the AHJ or its representative, an appeal must be made in a timely manner so that the issue can be resolved and the appropriate correction made. Any notice of violation should carry a prominent notice with wording that states: "If you intend to appeal any of the findings of this inspection or the need for corrective action, that appeal must be filed with (name of agency) within 30 days of the date of this inspection, as shown above."

1.10.4.3* Documentation supporting an appeal shall be submitted to the AHJ at least 7 calendar days prior to the Board of Appeals hearing.

A.1.10.4.3 No additional information should be submitted to review by the Board of Appeals without the information submitted to the AHJ for their review prior to the hearing date. Additional information submitted after the filing of the appeal to the Board and AHJ should be made available to the Board and AHJ in a time frame that permits adequate review before the hearing date.

To ensure a fair review of the appeal, the AHJ should have access to all documentation that will be presented to support the appeal. This disclosure will provide the AHJ with an opportunity to review the evidence and supporting documents and then develop a recommendation to the board. Neither the AHJ nor the board should be surprised with new evidence presented at the board hearing that has not been either available to the AHJ or part of the informational package presented to the board.

1.10.5 Meetings and Records.

1.10.5.1 Meetings of the Board of Appeals shall be held at the call of the chair, at such other times as the board determines, and within 30 calendar days of the filing of a notice of appeal.

The number of appeals received by the jurisdiction determines how often the board needs to meet. The importance of a timely hearing prevents unnecessary added expense due to a delay in the projects of appellants.

An initial hearing must be held not more than 30 days after submittal of the appeal. This limit does not mean a judgment must be issued at that time; the board might require additional information to make a decision. The *Code* does not specifically address timely notification of the board's decision. Generally, the board's written decision should be sent to all affected parties as soon as possible after it rules on the appeal and the AHJ is notified.

1.10.5.2 All hearings before the Board of Appeals shall be open to the public.

All meetings must be open to the public. The rules and regulations for conducting business should define the procedures for allowing the public to speak or to be given copies of the material under discussion. The procedures for many Board of Appeals is that only the individuals with some significant connection to the case (standing) are be permitted to speak. The board can set time limits on speakers, even at public hearings. In addition, copies of correspondence submitted to the board, while they must be available for public inspection, do not have to be provided to members of the public attending the meeting. If interested parties want to obtain copies of relevant documents, they can be obtained or purchased according to the local regulations governing public-record documents. The local legal counsel should be consulted for information on open meeting law requirements.

1.10.5.3 The Board of Appeals shall keep minutes of its proceedings showing the vote of each member on every question or, if the member is absent or fails to vote, these actions shall be recorded.

1.10.5.4 The Board of Appeals shall keep records of its examinations and other official actions.

1.10.5.5 Minutes and records of the Board of Appeals shall be public record.

1.10.5.6 A quorum shall consist of not less than a simple majority of appointed members or alternates.

1.10.5.7 In varying the application of any provision of this *Code*, or in modifying an order of the AHJ, a two-thirds vote of the quorum shall be required.

When the Board of Appeals is requested to modify an order of the AHJ or to vary the application of the *Code*, the board is required to obtain a two-thirds super majority of the quorum. This super majority requirement ensures that a consensus exists within the board that public safety, fire fighter safety, and property protection is secured by the board's action to vary the application of the *Code* or modifying an order of the AHJ. If the board cannot obtain a two-thirds majority vote, then the motion fails, and the AHJ's order is upheld.

1.10.6 Decisions.

1.10.6.1 Every decision of the Board of Appeals shall be entered in the minutes of the board meeting.

1.10.6.2 A decision of the Board of Appeals to modify an order of the AHJ shall be in writing and shall specify the manner in which such modification is made, the conditions upon which it is made, the reasons therefore, and justification linked to specific code sections.

Frequently, board decisions are rendered with conditions tied to the decision. These conditions are often key components in establishing life safety, fire fighter safety, and property protection. Therefore, it is imperative that these conditions are captured as part of the board decision.

As part of the board's decision, the board must present the evidence it is using to justify its decisions. Those decisions must provide for life safety, fire fighter safety, and property protection that is equivalent to the levels of safety the *Code* provides.

1.10.6.3 Every decision shall be promptly filed in the office of the AHJ and shall be open for public inspection.

1.10.6.4 A certified copy shall be sent by mail or delivered in person to the appellant, and a copy shall be publicly posted in the office of the AHJ for 2 weeks after filing.

1.10.6.5 The decision of the Board of Appeals shall be final, subject to such remedy as any aggrieved party might have through legal, equity, or other avenues of appeal or petition.

1.10.6.6 If a decision of the Board of Appeals reverses or modifies a refusal, order, or disallowance of the AHJ, or varies the application of any provision of this *Code*, the AHJ shall take action immediately in accordance with such decision.

An order of the Board of Appeals is binding on the AHJ. Therefore, the AHJ needs to take the appropriate action to implement the order from the board with due diligence.

1.11 Records and Reports

1.11.1 A record of examinations, approvals, equivalencies, and alternates shall be maintained by the AHJ and shall be available for public inspection during business hours in accordance with applicable laws.

All examinations, approvals, equivalencies, and alternatives granted are part of a permanent record for the property or event in question and should be maintained as part of the applicable file. Equivalencies granted should also be retained on file as a reference for future inspections. These records should be maintained in accordance with local and state requirements. (See 1.11.2.)

State and local freedom of information laws may require that certain records be made available to the public. These laws also may require or allow some information to remain confidential. Two sets of files might need to be maintained. Files should indicate whether or not the contents are open to the public.

Most freedom of information laws state that the information must be made available to the public. This requirement does not mean it must be immediately available or available without charge. AHJs should consult applicable local ordinances and state statutes for specific guidance on this issue.

The AHJ should make available formal request for information forms to anyone requesting specific files. The form should include the requester's name, address, phone number, and the information requested. If the copies are not free of charge, the amount of the fee should be made clear before the copies are produced. If only a review of the files is requested, such review should be by appointment, and reviewers should not be left unsupervised in order to protect files from theft or destruction. The AHJ should consult applicable local ordinance and state statutes for guidance because some laws prohibit the AHJ from asking for the requestor's contact information and otherwise limit the AHJ's discretion on how public records can be distributed.

1.11.2 The AHJ shall keep a record of all fire prevention inspections, including the date of such inspections and a summary of any violations found to exist, the date of the services of notices, and a record of the final disposition of all violations.

These types of records allow the AHJ and property owner to reconstruct the history of a property. The historical records become important when disputes arise about approval for a condition in the field or if a fire occurs at the property. The AHJ can also use this data as part of a community risk assessment to assist in determining where prevention or other resources should be committed in the community.

1.11.3 Emergency Response Records.

1.11.3.1 The fire department shall keep a record of fire and other emergency responses occurring within its jurisdiction and of facts concerning the same, including statistics as to the extent and damage caused by such fires or emergencies.

Fire department incident records provide statistics needed to determine the community's level of risk and plan for risk reduction. These records, along with the records of fire inspections, provide an important overview of the fire and life safety problems in the community, identify target areas for correction, and assist in determining where to allocate resources.

1.11.3.2 The fire department shall report its incident record data, collected in accordance with 1.11.3, to the recognized state agency responsible for collecting such data.

Fire department incident record data must be reported to the state agency that is responsible for collecting such data. State data collection and analysis allows for state data to be analyzed for trends and resource allocations statewide. This data can also be presented to policymakers at the state level so that the scope of the fire department response demands are understood. This state data can then be submitted to the National Fire Incident Report System (NFIRS) where national fire problems and trends are analyzed and problems are identified. Actions can then be taken on a national level.

1.11.4 All records required to be kept shall be maintained until their usefulness has been served or as required by law.

State or local freedom of information laws and records retention laws may mandate the types of records needed and the length of time those records need to be maintained. The jurisdiction's legal counsel can offer guidance on requirements for records retention.

1.12 Permits and Approvals

1.12.1 The AHJ shall be authorized to establish and issue permits, certificates, and approvals pertaining to conditions, operations, or materials hazardous to life or property pursuant to Section 1.12.

The AHJ must know where and what activities are occurring in its jurisdiction that could affect fire and life safety. By requiring permits and approvals, the AHJ can ensure that the activities or operations are performed safely. Table 1.12.8(a) through Table 1.12.8(d) outline many of the permits and approvals that can be issued by the AHJ. Based on local experience, the AHJ can also require that permits be obtained to conduct other hazardous operations not included in Table 1.12.8(a) through Table 1.12.8(d). The AHJ should review the tables during the adoption of this *Code* to determine which permits are required and to modify them accordingly.

In some jurisdictions, the AHJ may allow the permitting of some of these activities through other departments in the jurisdiction. As an example, the AHJ may allow all permits for new construction to be applied for and issued at the building department, sometimes called a "One Stop Shop." In these circumstances, the AHJ still maintains the permit, plan review, and inspection authority granted in this *Code*.

1.12.2 Applications for permits shall be made to the AHJ on forms provided by the jurisdiction and shall include the applicant's answers in full to inquiries set forth on such forms.

The jurisdiction should have an application form for permits (see Exhibit 1.4), as well as an information sheet to explain how to fill out the form. The information sheet should identify all of the information that must be provided. See 1.12.6.13 for more information.

1.12.2.1 Applications for permits shall be accompanied by such data as required by the AHJ and fees as required by the jurisdiction.

See Section 1.17 for fees.

1.12.2.2 The AHJ shall review all applications submitted and issue permits as required.

1.12.2.3 If an application for a permit is rejected by the AHJ, the applicant shall be advised of the reasons for such rejection.

Exhibit 1.4

STATE OF CONNECTICUT
DEPARTMENT OF EMERGENCY SERVICES AND PUBLIC PROTECTION
Fire and Explosion Investigation Unit

Attn: Special Licensing and Firearms Unit
1111 Country Club Road
Middletown, Connecticut 06457-2389

APPLICATION FOR PERMIT TO DISPLAY FIREWORKS OR SPECIAL EFFECTS

1. Application and Proof of Financial Responsibility Form, DPS-884-C, must be completed and submitted to the Special Licensing and Firearms Unit (SLFU), **Attention:** SLFU, Fireworks and Special Effects Licensing, at least fifteen (**15) days** prior to the date of the display.
2. The fee of $100.00 is payable to the ***"Treasurer, State of Connecticut".***
3. A copy of United States Coast Guard Marine Permit (not application) is required for fireworks fired from a barge.
4. Type or print legibly. ***Forms will be returned if they are incomplete or illegible.***

Type of Permit: ☐ **Fireworks** ☐ **Special Effects**

For Fireworks displays, please submit a diagram of the display site indicating the discharge site, location of the spectator viewing area(s), buildings, highways, nearby utilities, trees and any overhead obstructions, compass heading indicating north, the date the diagram was produced and who produced the diagram. **This application will not be reviewed without this required documentation.**

Name of applicant (sponsoring organization):			
Address (number, street, city, state and zip code):			
Name of authorized agent (last, first and middle initial):			
Address of authorized agent (number, street, city, state and zip code):			
Email address of authorized agent:			
Telephone number of authorized agent:		Fax number of authorized agent:	
Exact location of display:			
Date of display:	Time of display:	Rain date:	Time of display:

For **SPECIAL EFFECTS** displays, please submit a diagram of the display site indicating the location and type of devices to be used, location of the audience, a list of all special effects and type of detonation mechanism(s) to be used. Also, include distances and measurements of the display area including audience location as well as between the effects and equipment/fixtures used.
Note: This application will not be reviewed without this required documentation.

Name of show:	
Company name:	
Company address (number, street, city, state and zip code):	
Company telephone number:	Company fax number:

Number and type of fireworks/special effects to be fired: **Please be specific about the type, size and amount to be fired.** (use additional paper if required)

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STATE OF CONNECTICUT
DEPARTMENT OF EMERGENCY SERVICES AND PUBLIC PROTECTION

Name(s) of technician(s) who will fire the display:

Type of certificate:

Connecticut Competency Certificate number:

Address of technician: (number, street, city, state and zip code)

This application has been reviewed and is ☐ Approved ☐ Denied Dated:____________

Print name of Chief of Police or First Selectperson Signature of Chief of Police or First Selectperson

Reason for Denial:____________

This application has been reviewed and is ☐ Approved ☐ Denied Dated:____________

Print name of Fire Chief Signature of Fire Chief

Reason for Denial:

***Pursuant to Connecticut General Statutes Section 29-357(b) (1), a compliance check shall be completed by the local Fire Marshal.**

Compliance check of proposed fireworks/special effects display conducted by:

Print name of person conducting compliance check Signature of person conducting compliance check

☐ Compliant ☐ Non-Compliant, if non-compliant, explain: (use additional paper if necessary)

Fire and Explosion Investigation Unit Use Only

Incident number: ____________ Date received: ____________ Date of entry: ____________

Check number: ____________ Amount: ____________ Permit number: ____________

Reviewed by: ____________ ____________
Print name of Investigator and Badge Number Signature of Investigator

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Sample permit application. (Courtesy of State of Connecticut, Department of Public Safety)

The reasons for rejections should be detailed sufficiently so that the applicant can understand what actions are required to resubmit the permit application and potentially receive approval. See Section 1.16 for requirements on serving notice of violations and penalties.

1.12.2.4 Permits for activities requiring evidence of financial responsibility by the jurisdiction shall not be issued unless proof of required financial responsibility is furnished.

1.12.3 Conditions of Approval.

1.12.3.1 Any conditions of the initial approval by the AHJ of a use, occupancy, permit, or construction shall remain with the use, occupancy, permit, or construction unless modified by the AHJ.

1.12.3.2 The AHJ shall be permitted to require conditions of approval be memorialized via recording in the public records, as part of the plat, permit, or other method as approved by the AHJ.

Certain situations will require the AHJ to attach conditions to the approval of a use, occupancy, permit, or construction. Such conditions must remain with the use, occupancy, permit, or construction for the duration of the approval. Examples of such conditions include easements, cross access, occupancy constraints, future limitations on construction, future obligations of the owner, and other site configurations.

1.12.4 Approvals by Other AHJs.

1.12.4.1 The AHJ shall have the authority to require evidence to show that other regulatory agencies having jurisdiction over the design, construction, alteration, repair, equipment, maintenance, process, and relocation of structures have issued appropriate approvals.

Permit activities regulated under this *Code* may also be regulated by other government bodies. One example is the installation of underground petroleum storage tanks. In many jurisdictions, a separate environmental protection agency may be charged with responsibility to review the environmental factors of petroleum storage tank installations. The AHJ for this *Code* may wish to withhold fire code permit approval until confirmation is received that an approval from the environmental permitting body has also been received. See 1.12.6.3 for further requirements to receive approvals from other agencies.

1.12.4.2 The AHJ shall not be held responsible for enforcement of the regulations of such other regulatory agencies unless specifically mandated to enforce those agencies' regulations.

1.12.5 Misrepresentation.

1.12.5.1 Any attempt to misrepresent or otherwise deliberately or knowingly design; install; service; maintain; operate; sell; represent for sale; falsify records, reports, or applications; or other related activity in violation of the requirements prescribed by this *Code* shall be a violation of this *Code*.

1.12.5.2 Such violations shall be cause for immediate suspension or revocation of any related approvals, certificates, or permits issued by this jurisdiction.

1.12.5.3 Such violations shall be subject to any other criminal or civil penalties as available by the laws of this jurisdiction.

In many cases, intentionally providing false or fraudulent information to mislead the AHJ is a criminal offense. In these circumstances, the AHJ should consult with law enforcement to determine if a crime has been committed.

1.12.6 Permits.

1.12.6.1 A permit shall be predicated upon compliance with the requirements of this *Code* and shall constitute written authority issued by the AHJ to maintain, store, use, or handle materials; to conduct processes that could produce conditions hazardous to life or property; or to install equipment used in connection with such activities.

1.12.6.2 Any permit issued under this *Code* shall not take the place of any other approval, certificate, license, or permit required by other regulations or laws of this jurisdiction.

1.12.6.3 Where additional permits, approvals, certificates, or licenses are required by other agencies, approval shall be obtained from those other agencies.

There are times when other regulatory agencies or laws require permits that are similar to those required by this *Code*. In such cases, the applicant must obtain those permits before work can begin. If the AHJ has contact with such agencies, it can help to prevent conflicts on permit approvals. The other permits or approvals might be required before a permit is issued under this *Code*. See 1.12.4 for additional details on approvals by other AHJs.

1.12.6.4 The AHJ shall have the authority to require an inspection prior to the issuance of a permit.

Many required permits are for operations or functions that require an inspection before the permitted activity can take place. Such preliminary inspections ensure compliance with the *Code* and allow the AHJ to review the proposed site or activity before approving the permit application. The preliminary inspection assists the AHJ in making an informed decision on the approval of the application and is useful in determining if additional safeguards are required. Any violations should be corrected before final approval for the permit is issued.

1.12.6.5 A permit issued under this *Code* shall continue until revoked or for the period of time designated on the permit.

The permit expiration date depends largely on the type of work or activity performed. Many permits are issued for periods less than 1 week or for a specific date range, such as those permitting bonfires, traveling amusement shows or carnivals, cutting and welding operations, exhibits, and trade shows. Modifications to, and installation of, fire protection systems might require a 90- or

180-day permit. Still other permits, such as those granted for dust explosion prevention, flammable and combustible liquids, and LP-Gas installations, might require an annual permit. The length of time for which the permit is valid should be based on the time necessary to complete the activity, with adequate time for setup and removal of equipment, as needed.

For construction-related permits, the AHJ should also consider the length of time of building permits issued under the jurisdiction's building code and use a similar time frame. In most cases, model building codes specify that a permit is good for 180 days and may continue beyond that time if active construction is occurring.

1.12.6.6 The permit shall be issued to one person or business only and for the location or purpose described in the permit.

A permit is issued to a particular person or business and is not permitted to be transferred without approval from the AHJ. Transfer of the permit to others, or alteration of the permit, is grounds for revocation of the permit.

1.12.6.7 Any change that affects any of the conditions of the permit shall require a new or amended permit.

If, during the execution of the permit, the conditions of the permit or approval need to be altered, or the field conditions are different than anticipated, the AHJ should be asked to amend the permit or issue a new one.

1.12.6.8 The AHJ shall have the authority to grant an extension of the permit time period upon presentation by the permittee of a satisfactory reason for failure to start or complete the work or activity authorized by the permit.

While work designated on the permit is in progress, certain problems might prevent or hinder completion of the permitted work or activity within the time allotted on the permit. The applicant should provide the AHJ with a written statement outlining the reasons for any failure to complete the permitted work on time, along with a new projected completion date. After review, the AHJ can grant an extension of the permit expiration date.

1.12.6.9 A copy of the permit shall be posted or otherwise readily accessible at each place of operation and shall be subject to inspection as specified by the AHJ.

Depending on the type of activity for which the permit is issued, the permit should be either displayed at the site or carried by the permit holder. Posted permits are generally issued for activities such as the installation of fire alarm and sprinkler systems.

When a permit is issued, the applicant agrees to the inspections required by the granting authority, even if those inspections exceed those required in 1.7.7. Inspections should occur during the time the permitted activities are taking place or after a certain phase of construction has occurred. Inspections before and after occurrence of the permitted activities are also helpful in determining compliance. (See 1.12.6.4.) Subparagraph 1.12.6.9 allows the AHJ to conduct daily or weekly inspections, if necessary, to determine compliance with any conditions attached to the permit.

1.12.6.10 Any activity authorized by any permit issued under this *Code* shall be conducted by the permittee or the permittee's agents or employees in compliance with all requirements of this *Code* applicable thereto and in accordance with the approved plans and specifications.

1.12.6.11 No permit issued under this *Code* shall be interpreted to justify a violation of any provision of this *Code* or any other applicable law or regulation.

Nothing in the permit process allows a person to violate this *Code* or any other regulations in effect within the jurisdiction. Even if the permit is issued mistakenly to authorize an activity or construction that is not compliant with the *Code,* the mistaken issuance of the permit is not justification to violate the *Code*. The person to whom the permit is issued is responsible for ensuring that all the requirements of this *Code* are met. If the permitted activity needs to be altered or expanded, a new or amended permit must be obtained before commencement of the modified activity.

1.12.6.12 Any addition or alteration of approved plans or specifications shall be approved in advance by the AHJ, as evidenced by the issuance of a new or amended permit.

Frequently, field conditions create a situation where plans or specifications need to be modified to address the field conditions. In those situations, revised plans or specifications need to be submitted to the AHJ to amend the existing permit. If the changes are significant, it might be justified to have the applicant acquire a new permit.

1.12.6.13* Permits shall be issued by the AHJ and shall indicate the following:

(1) Operation, activities, or construction for which the permit is issued
(2) Address or location where the operation, activity, or construction is to be conducted
(3) Name, address, and phone number of the permittee
(4) Permit number
(5) Period of validity of the permit
(6) Inspection requirements
(7) Name of the agency authorizing the permit (AHJ)
(8) Date of issuance
(9) Permit conditions as determined by the AHJ

A.1.12.6.13 Figure A.1.12.6.13 shows a sample permit.

After the AHJ reviews the permit application (as described in 1.12.2.2) and determines that the applicant meets its requirements, a permit can be issued. At a minimum, the permit must include all the information listed in 1.12.6.13 and shown in Figure A.1.12.6.13. The AHJ might require additional information, including plans and specifications.

Side 1

PERMIT
FOR CUTTING AND WELDING
WITH PORTABLE GAS OR ARC EQUIPMENT

Date ______________________

Building ______________________

Dept. ____________ Floor ____________

Work to be done ______________________

____

Special precautions ______________________

____

Is fire watch required? ______________________

The location where this work is to done has been examined, necessary precautions taken, and permission is granted for this work. (See other side.)

Permit expires ______________________

Signed ______________________
(Individual responsible for authorizing welding and cutting)

Time Started ____________ Completed ____________

FINAL CHECK

Work area and all adjacent areas to which sparks and heat might have spread [including floors above and below and on opposite side of wall(s)] were inspected 30 minutes after the work was completed and were found firesafe.

Signed ______________________
(Supervisor or Fire Watcher)

Side 2

ATTENTION

Before approving any cutting and welding permit, the fire safety supervisor or appointee shall inspect the work area and confirm that precautions have been taken to prevent fire in accordance with NFPA 51B.

PRECAUTIONS

- ❑ Sprinklers in service
- ❑ Cutting and welding equipment in good repair

WITHIN 35 FT (10.7 M) OF WORK

- ❑ Floors swept clean of combustibles
- ❑ Combustible floors wet down and covered with damp sand, metal, or other shields
- ❑ All wall and floor openings covered
- ❑ Covers suspended beneath work to collect sparks

WORK ON WALLS OR CEILINGS

- ❑ Construction noncombustible and without combustible covering
- ❑ Combustibles moved away from opposite side of wall

WORK ON ENCLOSED EQUIPMENT
(Tanks, containers, ducts, dust collectors, etc.)

- ❑ Equipment cleaned of all combustibles
- ❑ Containers purged of flammable vapors

FIRE WATCH

- ❑ To be provided during and 30 minutes after operation
- ❑ Supplied with extinguisher and small hose
- ❑ Trained in use of equipment and in sounding fire alarm

FINAL CHECK

- ❑ To be made 30 minutes after completion of any operation unless fire watch is provided

Signed ______________________
(Supervisor)

Δ ***FIGURE A.1.12.6.13*** *Sample Permit.*

1.12.6.14 Any application for, or acceptance of, any permit requested or issued pursuant to this *Code* shall constitute agreement and consent by the person making the application or accepting the permit to allow the AHJ to enter the premises at any reasonable time to conduct such inspections as required by this *Code*.

1.12.7 Revocation or Suspension of Permits.

1.12.7.1 The AHJ shall be permitted to revoke or suspend a permit or approval issued if any violation of this *Code* is found upon inspection or in case any false statements or misrepresentations have been submitted in the application or plans on which the permit or approval was based.

All issued permits and approvals can be revoked for just cause in accordance with 1.12.7.1. Changes to the approval require the review and approval of the AHJ. If, during an inspection, variations to the approval conditions granted or instances of noncompliance with the appropriate *Code* are discovered, the permit or approval can be revoked.

Similarly, if during an inspection or an emergency, a permit is determined to be required but has not been obtained, the operation should be terminated until such time as the appropriate permits and approvals are obtained. See 1.7.15 for additional information on stop work orders.

In many cases, intentionally providing false or fraudulent information to mislead the AHJ is a criminal offense. In these circumstances, the AHJ should consult with law enforcement to determine if a crime has been committed.

1.12.7.2 Revocation or suspension shall be constituted when the permittee is duly notified by the AHJ.

A written notification of revocation and the reasons for it are required before the permit is revoked. (See Section 1.16 for details on notice of violations and penalties.) However, in the case of an imminent danger, the operation must be stopped immediately. (See 1.7.15 for details on stop work orders.) When the work is stopped due to an imminent danger, the AHJ should send a written notification immediately, explaining why the work was stopped and why the permit was revoked. If the permittee cannot be notified, posting notification of the revocation or suspension on-site constitutes sufficient notice.

1.12.7.3 Any person who engages in any business, operation, or occupation, or uses any premises, after the permit issued therefore has been suspended or revoked pursuant to the provisions of this *Code*, and before such suspended permit has been reinstated or a new permit issued, shall be in violation of this *Code*.

Δ **1.12.8** Permits shall be required in accordance with Table 1.12.8(a) through Table 1.12.8(d).

Table 1.12.8(a) describes some of the activities for which the AHJ might require a permit. Based on local experience, the AHJ might identify additional hazards, processes, or construction activities for which permits are required.

Δ ***TABLE 1.12.8(a)*** *Permit Requirements*

Operations and Materials	Permit Required	Cross Reference Section Number
Aerosol products	To store or handle an aggregate quantity of Level 2 or Level 3 aerosol products in excess of 500 lb (226.8 kg)	61.1.2
Aircraft fuel servicing	To provide aircraft fuel servicing	42.10.1.2
Aircraft hangars	For servicing or repairing aircraft	21.1.1
Aircraft refueling vehicles	To operate aircraft refueling vehicles	42.10.1.2
Airport terminal buildings	For construction and alteration	21.2.2.1
Ammonium nitrate	For storage	Chapter 74
Amusement parks	For construction, alteration, or operation of amusement park fire protection safety features	10.15.1
Asbestos removal	For the removal of asbestos	16.8.2
Automatic fire suppression systems	For installation, modification, or removal from service of any automatic fire suppression system*	13.1.1.1; 50.4.2
Automobile wrecking yards	To operate automobile wrecking yards	22.2
Automotive fuel servicing	To provide automotive fuel servicing	42.2.2.1; 42.11.2.2.4; 42.11.3.1
Battery systems	To install or operate stationary lead-acid battery systems having an electrolyte capacity of more than 100 gal (378.5 L) in sprinklered buildings or 50 gal (189.3 L) in nonsprinklered buildings	52.2
Candles, open flames, and portable cooking	To use in connection with assembly areas, dining areas of restaurants, or drinking establishments	17.3.2; 20.1.1.1
Carnivals and fairs	To conduct a carnival or fair	10.15.1
Cellulose nitrate film	To store, handle, use, or display	20.15.7.2
Cellulose nitrate plastic	To store or handle more than 25 lb (11.3 kg)	43.1.1.4
Change of occupancy	For the change of occupancy classification of an existing building	1.7.11.5
Cleanrooms	For construction, alteration, or operation	23.3
Combustible fibers	For storage or handling of combustible fibers greater than 100 ft^3 (2.8 m^3)	45.1.3
Combustible material storage	To store more than 2500 ft^3 (70.8 m^3) gross volume	10.19.2; 19.1.1; 31.2
Commercial rubbish-handling operation	To operate	19.1.1

Δ *TABLE 1.12.8(a) Continued*

Operations and Materials	Permit Required	Cross Reference Section Number
Compressed gases	1. To store, use, or handle compressed gases in excess of the amounts listed in Table 1.12.8(b) 2. When the compressed gases in use or storage exceed the amounts listed in Table 1.12.8(b), a permit is required to install, repair damage to, abandon, remove, place temporarily out of service, close, or substantially modify a compressed gas system 3. For additional permit requirements for compressed gases facility closures, see 63.1.2	63.1.2
Construction	For the construction of a building or structure	1.7.11.8
Covered mall buildings	Annual requirement for facilities that utilize mall area for exhibits or displays with 4 conditions	20.1.5.5.1
Crop maze	To operate a crop maze	10.14.11.1
Cryogens	To produce, store, or handle cryogens in excess of amounts listed in Table 1.12.8(c) *Exception: Where federal or state regulations apply or for fuel systems of a vehicle.*	63.1.2
Cutting and welding operation	For operations within a jurisdiction	41.1.5; 41.3.2.2; 41.3.2.2.2
Display fireworks (1.3G)	For possession, transportation, storage, manufacture, sale, handling, and discharge of display fireworks within the jurisdiction	65.2.3; 65.5.2
Drycleaning plants	To engage in business of drycleaning or to change to a more hazardous cleaning solvent	24.2
Dust-producing operations	To operate a grain elevator, flour mill, starch mill, feed mill, or plant pulverizing aluminum, coal, cocoa, magnesium, spices, sugar, or other similar combustible material	40.2
Energy storage systems, including battery stationary storage systems and capacitor energy storage systems	To install and operate energy storage systems exceeding Table 52.2.1 and Table 52.3.1	52.1.2
Exhibit and trade shows	For operation of all exhibits and trade shows held within a jurisdiction	20.1.5.5.1
Explosives	1. Manufacture, sell, dispose, purchase, storage, use, possess, or transport of explosives within the jurisdiction 2. For additional permit requirements for blasting operations, see 65.9.2	65.9.2
Fire alarm and detection systems and related equipment	For installation, modification, or removal from service of any fire alarm and detection systems and related equipment*	13.1.1.1
Fire apparatus access roads	For the construction of a fire apparatus access road	18.1.2
Fire hydrants and water-control valves	To use a fire hydrant or operate a water-control valve intended for fire suppression purposes	13.1.1.1
Fire pumps and related equipment	For installation of, modification to, or removal from service of any fire pumps, jockey pumps, controllers, and generators*	13.1.1.1
Flame effects	Use of flame effects before an audience	65.4.2
Flammable and combustible liquids	1. To use or operate, repair, or modify a pipeline for the on-site transportation of flammable or combustible liquids 2. To store, handle, or use Class I liquids in excess of 5 gal (18.9 L) in a building or in excess of 10 gal (37.9 L) outside of a building *Exception to item (2): A permit is not required for the following:* *(a) The storage or use of Class I liquids in the fuel tank of a motor vehicle, aircraft, motorboat, mobile power plant, or mobile heating plant unless such storage in the opinion of the chief would cause an unsafe condition*	66.1.5

(continues)

△ *TABLE 1.12.8(a) Continued*

Operations and Materials	Permit Required	Cross Reference Section Number
	(b) The storage or use of paints, oils, varnishes, or similar flammable mixtures when such liquids are stored for maintenance, painting, or similar purposes for a period of not more than 30 days 3. To store, handle, or use Class II or Class III-A liquids in excess of 25 gal (94.6 L) in a building or in excess of 60 gal (227.1 L) outside a building *Exception to item (3): Fuel oil used in connection with oil-burning equipment* 4. To remove Class I or Class II liquids from an underground storage tank used for fueling motor vehicles by any means other than the approved, stationary on-site pumps normally used for dispensing purposes 5. To install, construct, alter, or operate tank vehicles, equipment, tanks, plants, terminals, wells, fuel-dispensing stations, refineries, distilleries, and similar facilities where flammable and combustible liquids are produced, processed, transported, stored, dispensed, or used 6. To install, alter, clean, repair, line with a protective coating, remove, abandon, place temporarily out of service, or otherwise dispose of a flammable or combustible liquid tank 7. To change the type of contents stored in a flammable or combustible liquid tank to a material other than those for which the tank was designed and constructed	
Fruit ripening	To operate a fruit-ripening process	63.1.2
General storage	To store materials indoors or outdoors, representing a broad range of combustibles, including plastics, rubber tires, and roll paper	34.1.2
Grandstands, bleachers, and folding and telescopic seating	For construction, location, erection, or placement of grandstands, bleachers, and folding and telescopic seating	25.1.2
Hazardous materials	1. To store, transport on site, dispense, use, or handle hazardous materials in excess of the amounts listed in Table 1.12.8(d) 2. To install, repair, abandon, remove, place temporarily out of service, close, or substantially modify a storage facility or other area regulated by Chapter 60 when the hazardous materials in use or storage exceed the amounts listed in Table 1.12.8(d)	Chapter 60
High-piled combustible storage	To use any building or portion thereof as a high-piled storage area exceeding 500 ft^2 (46.45 m^2)	20.15.8.2
High-powered rocketry	For the manufacture, sale, and use of high-powered rocketry	65.8.2; 65.7.2
Hot work operations	To conduct hot work	17.3.2; 41.1.5; 41.3.4
Industrial ovens and furnaces	For operation of industrial ovens and furnaces covered by Chapter 51	51.1.2
Laboratories	For construction, alteration, or operation	26.3
Liquefied petroleum gases	1. To store, use, handle, or dispense LP-Gas of 125 gal (0.5 m^3) (water capacity) aggregate capacity or greater 2. To install or modify LP-Gas systems	42.11.2.2.4 69.1.2
Liquid- or gas-fueled vehicles	To display, compete, or demonstrate liquid- or gas-fueled vehicles or equipment in assembly buildings	20.1.5.5.1
Lumberyards and woodworking plants	For storage of lumber exceeding 100,000 board ft	31.2
Marijuana growing, processing, or extraction facilities	For the construction, alteration, or operation of a marijuana growing, processing, or extraction facility	38.2
Marine craft fuel servicing	To provide marine craft fuel servicing	42.9.1.4
Means of egress	For the modification of a means of egress system in an existing building	1.7.11.6

Δ *TABLE 1.12.8(a) Continued*

Operations and Materials	Permit Required	Cross Reference Section Number
Membrane structures, tents, and canopies — permanent	For construction, location, erection, or placement	25.1.2
Membrane structures, tents, and canopies — temporary	To erect or operate an air-supported temporary membrane structure or tent having an area in excess of 200 ft^2 (18.6 m^2) or a canopy in excess of 400 ft^2 (37.2 m^2) *Exception: Temporary membrane structures, tents, or canopy structures used exclusively for camping.*	25.1.2
Mobile cooking operations	To conduct mobile cooking operations	50.7
Motion picture and television production studio soundstages and approved production facilities	To design, construct, operate, and maintain soundstages and approved production facilities used in motion picture and television industry productions	32.2
Oil- and gas-fueled heating appliances	To install oil- and gas-fired heating appliances	11.5.1.8
Open burning	1. To conduct open burning 2. For additional permit requirements for open burning, see 10.11.1	10.11.1
Open fires	1. For kindling or maintaining an open fire 2. For additional permit requirements for open fires, see 10.11.4†	10.11.1
Organic coatings	For operation and maintenance of a facility that manufactures organic coatings	43.1.1.4
Organic peroxide formulations	To store, transport on site, use, or handle materials in excess of amounts listed in Tables 1.12.8(c) and (d)	Chapter 75
Outside storage of tires	To store more than 500 tires outside	33.1.2
Oxidizers	To store, transport on site, use, or handle materials in excess of amounts listed in Tables 1.12.8(c) and (d)	Chapter 70
Parade floats	To use a parade float for public performance, presentation, spectacle, entertainment, or parade	10.17.1
Places of assembly	To operate a place of assembly	10.15.1; 20.1.1.1
Pyrotechnic articles	For the manufacture, storage, sale, or use of pyrotechnic articles within the jurisdiction	65.2.3; 65.3.3; 65.5.2
Pyrotechnics before a proximate audience	For the display and use of pyrotechnic materials before a proximate audience	65.3.3
Pyroxylin plastics	For storage, handling, assembly, or manufacture of pyroxylin plastics	43.1.1.4
Private fire hydrants	For installation, modification, or removal from service of any private fire hydrants	13.1.1.1
Refrigeration equipment	To install or operate a mechanical refrigeration unit or system regulated by this *Code*	53.1.3
Repair garages and service stations	For operation of service stations and repair garages	30.1.1.3; 30.2.1.1
Rocketry manufacturing	For the manufacture of model rocket motors	65.7.2
Rooftop heliports	For construction, modification, or operation of a rooftop heliport	21.3.2.1
Solvent extraction	For storage, use, and handling	44.3
Spraying or dipping of flammable finish	For installation or modification of any spray room, spray booth, or preparation work station, or to conduct a spraying or dipping operation utilizing flammable or combustible liquids or powder coating	43.1.1.4
Standpipe systems	For installation, modification, or removal from service of any standpipe system*	13.1.1.1
Special outdoor events	For the location and operation of special outdoor events	10.15.1

(continues)

Δ *TABLE 1.12.8(a) Continued*

Operations and Materials	Permit Required	Cross Reference Section Number
Tar kettles	To place a tar kettle, a permit must be obtained prior to the placement of a tar kettle	16.7.1.2; 17.3.2
Tire storage	To use an open area or portion thereof to store tires in excess of 500 tires	33.1.2; 34.1.2
Torch-applied roofing operation	For the use of a torch for application of roofing materials	16.6.1
Water supply system for fire flow	For the construction of a water supply system for fire flow	18.1.2
Wildland fire–prone areas	For use of hazardous areas within fire-prone areas	17.3.2
Wood products	To store wood chips, hogged material, wood by-products, lumber, or plywood in excess of 200 ft^3 (5.7 m^3)	31.2

*Maintenance performed in accordance with this *Code* is not considered a modification and does not require a permit.

†Cooking and recreational fires are exempt and do not require a permit.

TABLE 1.12.8(b) Permit Amounts for Compressed Gases

Type of Gas	Amount* ft^3	Amount* m^3
Corrosive	200	0.57
Flammable	200	0.57
Highly toxic	Any amount	
Inert and simple asphyxiant	6000	169.9
Oxidizing (including oxygen)	504	14.3
Pyrophoric	Any amount	
Toxic	Any amount	
Unstable (reactive)	Any amount	

Note: See Chapters 41, 42, 60, 63, and 69 for additional requirements and exceptions.

*Cubic feet measured at normal temperature and pressure.

TABLE 1.12.8(c) Permit Amounts for Cryogens

Type of Cryogen	Inside Building (gal)	Outside Building (gal)
Corrosive	Over 1	Over 1
Flammable	Over 1	60
Toxic/highly toxic	Over 1	Over 1
Nonflammable	60	500
Oxidizer (includes oxygen)	10	50

Note: See Chapter 63.

Δ *TABLE 1.12.8(d) Permit Amounts for Hazardous Materials*

Type of Material	Amount U.S. Unit	Amount Metric Unit
Cellulose nitrate	25 lb	11.3 kg
Combustible fiber	100 ft^3	2.8 m^3
Combustible liquids	*See Table 1.12.8(a)*	
Corrosive gases	*See Table 1.12.8(b)*	
Corrosive liquids	55 gal	208 L
Corrosive solids	500 lb	227 kg
Cryogens	*See Table 1.12.8(c)*	
Display fireworks (1.3G)	Any amount	
Explosives	Any amount	
Flammable gases	*See Table 1.12.8(b)*	
Flammable liquids	*See Table 1.12.8(a)*	
Flammable solids	100 lb	45.4 kg
Highly toxic gases	*See Table 1.12.8(b)*	
Highly toxic liquids	Any amount	
Highly toxic solids	Any amount	
LP-Gas	*See Table 1.12.8(b)*	
Nitrate film (cellulose)	Any amount	
Organic peroxides:	*See Table 1.12.8(a)*	
Class I	Any amount	
Class II	Any amount	
Class III	10 lb	4.5 kg
Class IV	20 lb	9 kg
Class V	Not required	
Unclassified detonable	Any amount	
Oxidizing gases	*See Table 1.12.8(b)*	
Oxidizing liquids:	*See Table 1.12.8(a)*	
Class 4	Any amount	
Class 3	1 gal	3.8 L
Class 2	10 gal	38 L
Class 1	55 gal	208 L

Δ ***TABLE 1.12.8(d)*** *Continued*

Type of Material	Amount U.S. Unit	Amount Metric Unit
Oxidizing solids:	*See Table 1.12.8(a)*	
Class 4	Any amount	
Class 3	10 lb	4.5 kg
Class 2	100 lb	45 kg
Class 1	500 lb	227 kg
Pyrophoric gases	*See Table 1.12.8(b)*	
Pyrophoric liquids	Any amount	
Pyrophoric solids	Any amount	
Toxic gases	*See Table 1.12.8(b)*	
Toxic liquids	10 gal	38 L
Toxic solids	100 lb	45 kg
Unstable (reactive) gases	*See Table 1.12.8(b)*	
Unstable (reactive) liquids:		
Class 4	Any amount	
Class 3	Any amount	
Class 2	5 gal	19 L
Class 1	10 gal	38 L
Unstable (reactive) solids:		
Class 4	Any amount	
Class 3	Any amount	
Class 2	50 lb	22.7 kg
Class 1	100 lb	45 kg
Water reactive liquids:		
Class 3	Any amount	
Class 2	5 gal	19 L
Class 1	10 gal	38 L
Water reactive solids:		
Class 3	Any amount	
Class 2	50 lb	22.7 kg
Class 1	100 lb	45 kg

Note: See Chapter 60 for additional requirements and exceptions.

1.13 Certificates of Fitness

1.13.1 Authorization. The AHJ shall have the authority to require certificates of fitness and collect fees for individuals or companies performing any of the following activities:

(1) Inspection, servicing, or recharging of portable fire extinguishers
(2) Installation, servicing, modification, or recharging of fixed fire extinguishing systems
(3) Installation, servicing, or modification of fire alarm or fire communication systems
(4) Installation, modification, or servicing of gas- or oil-burning heating systems
(5) Chimney sweep operations
(6) Installation, inspection, servicing, or modification of range-hood systems
(7) Installation or servicing of private fire service mains and their appurtenances
(8) Crowd management services required by the Code
(9) Utilization of pyrotechnics before a proximate audience
(10) Installation, modification, or maintenance of liquefied petroleum gas or liquefied natural gas tanks or systems
(11) Installation or modification of medical gas systems where a permit is required by Table 1.12.8(a)
(12) Installation, modification, or maintenance of standpipe systems
(13) Installation, modification, or maintenance of automatic sprinkler systems
(14) Installation, modification, or maintenance of fire pumps
(15) Installation, modification, or maintenance of tanks, wells, or drafting points used for fire protection water supplies

Certificates of fitness, which are addressed in Section 1.13, ensure that persons performing certain activities are experienced in the work they are conducting and are capable of performing it safely. The certificate of fitness also gives the consumer greater security, knowing that these individuals have demonstrated a level of competency in the job they perform. In addition, a certificate of fitness gives the AHJ authority over the activities of the certificate holder. The AHJ can discipline a certificate holder for noncode-compliant practices.

In some jurisdictions, a certificate of fitness may also be known as a license. Many jurisdictions issue licenses for contractors. Therefore, for some of these activities, the state or other jurisdictions may preempt the authority of the AHJ to issue certificates of fitness.

The activities for which the AHJ can require a certificate of fitness under this *Code* are listed in the following paragraphs and correlate with 1.13.1(1) through 1.13.1(15). For many of these activities, no national certification programs are available to which the AHJ can turn for guidance in determining that a person is certified. The following sources of information for each activity can assist the AHJ in deciding whether a person is fit to perform it:

1. Inspecting, Servicing, or Recharging Portable Fire Extinguishers. The Fire Equipment Manufacturers' Association (FEMA) is composed of companies that manufacture portable fire extinguishers and interior fire protection devices. The association promotes the proper installation and use of such equipment.

FEMA
1300 Sumner Avenue
Cleveland, OH 44115-2851, (216) 241-7333
www.femalifesafety.org

The National Association of Fire Equipment Distributors (NAFED) promotes better use of equipment, seeks to raise standards of recharge and service, and conducts service-training programs.

NAFED
122 South Michigan Avenue, Suite 1040
Chicago, IL 60603, (312) 461-9600
www.nafed.org

Individual manufacturers provide training and certification to persons on how to inspect and service their portable fire extinguishers. The names and addresses of companies that manufacture portable fire extinguishers can be found in the online *NFPA® Buyers' Guide.*

NFPA® Buyers' Guide
nfpabuyersguide.org

2. Installing, Servicing, Modifying, or Recharging Fixed Fire Extinguishing Systems. The organizations listed in item 1 (above) are also involved in fixed fire extinguishing systems. Certification is generally offered through the individual manufacturers of such fixed systems. Individuals eligible for certification are generally the manufacturers' employees. Names and addresses of companies that install fixed fire protection systems are in the *NFPA Buyers' Guide*.

In addition, two organizations that assist with automatic sprinkler systems are the American Fire Sprinkler Association (AFSA) and the National Fire Sprinkler Association (NFSA).

AFSA
12750 Merit Drive, Suite 350
Dallas, TX 75251, (214) 349-5965
www.sprinklernet.org

NFSA
514 Profess Drive, Suite A
Linthicum Heights, MD 20190, (443) 863-4464
www.nfsa.org

3. Installing, Servicing, or Modifying Fire Alarm or Fire Communication Systems. The National Institute for Certification in Engineering Technologies (NICET) provides certification of individuals at specific levels for servicing fire alarm or fire communication systems.

NICET
1420 King Street
Alexandria, VA 22314-2794, (888) 476-4238
www.nicet.org

The Electronic Security Association (ESA) (formerly the National Burglar and Fire Alarm Association) is composed of dealers and installers of fire alarm equipment. This association has a training and education committee.

ESA
2300 Valley View Lane, Suite 230
Irving, TX 75062, (888) 447-1689
www.alarm.org

The Automatic Fire Alarm Association (AFAA) is composed of manufacturers and installers of fire detection and alarm systems. They have technical information available.

AFAA
81 Mill Street, Suite 300
Gahanna, OH 43230, (614) 416-8076
www.afaa.org

4. Installing, Modifying, or Servicing Gas- or Oil-Burning Heating Systems. The Air Conditioning Contractors of America (ACCA) is composed of contractors involved in the installation and servicing of heating and air-conditioning systems. The organization provides consulting services, technical training, and instructor certification programs.

ACCA
2800 Shirlington Road, Suite 300
Arlington, VA 22206, (703) 575-4477
www.acca.org

The objectives of the National Propane Gas Association (NPGA) are to promote safety in all aspects of storage, handling, and use of propane gas and to develop materials and programs to educate industry personnel, the fire service, and consumers.

NPGA
1899 L Street NW, Suite 350
Washington, DC 20036, (202) 466-7200
www.npga.org

5. Chimney Sweep Operations. The Chimney Safety Institute of America (CSIA) provides information on the proper and safe installation, maintenance, and operation of chimneys, fireplaces, vents, and solid fuel–burning appliances. It sponsors the National Chimney Sweep Training School and training seminars, provides sweep training study materials, and conducts a certification exam.

CSIA
2155 Commercial Drive
Plainfield, IN 46168, (317) 837-5362
www.csia.org

6. Installing, Inspecting, Servicing, or Modifying Range-Hood Systems. See items 1 and 2 (above) for organizations that are associated with the installation, inspection, and service of fixed fire protection systems. Manufacturers of range-hood systems generally certify only their own employees.

7. Installing or Servicing Private Fire Service Mains and Their Appurtenances. See items 1 and 2 (above) for organizations that are associated with the installation, inspection, and service of fixed fire protection systems.

8. Crowd Management Services Required by this *Code*. The International Association of Venue Managers (IAVM) comprises members representing auditoriums, arenas, convention centers, exhibit halls, stadiums, performing arts theaters, and amphitheaters. IAVM offers online crowd management training programs.

IAVM
635 Fritz Drive, Suite 100
Coppell, TX 75019-4442, (972) 906-7441
www.iavm.org

9. Utilization of Pyrotechnics Before a Proximate Audience. The American Pyrotechnics Association (APA) offers a performance checklist for indoor or proximate pyrotechnics events.

APA
7910 Woodmont Avenue, Suite 1220
Bethesda, MD 20814, (301) 907-8181
www.americanpyro.com

10. Installation, Modification, or Maintenance of Liquefied Petroleum Gas or Liquefied Natural Gas Tanks or Systems. See item 4 (above) for the National Propane Gas Association.

11. Installation or Modification of Medical Gas Systems. The American Society of Sanitary Engineering (ASSE) is a nonprofit organization comprising members who represent all disciplines of the plumbing industry. ASSE develops certification standards for medical gas systems personnel. Training and certification is offered by third-party providers. See the ASSE web site for links to such providers.

ASSE International
18927 Hickory Creek Drive, Suite 220
Mokena, IL 60448, (708) 995-3019
www.asse-plumbing.org

12. Installation, Modification, or Maintenance of Standpipe Systems. See item 2 (above) for organizations that are associated with the installation, inspection, and service of fixed fire protection systems.

13. Installation, Modification, or Maintenance of Automatic Sprinkler Systems. See item 2 (above) for organizations that are associated with the installation, inspection, and service of fixed fire protection systems.

14. Installation, Modification, or Maintenance of Fire Pumps. See item 2 (above) for organizations that are associated with the installation, inspection, and service of fixed fire protection systems.

15. Installation, Modification, or Maintenance of Tanks, Wells, or Drafting Points Used for Fire Protection Water Supplies. See item 2 (above) for organizations that are associated with the installation, inspection, and service of fixed fire protection systems.

1.13.2 Mandatory. The AHJ shall require certificates of fitness and collect fees for individuals or companies performing any of the following activities:

(1) Use of explosive materials
(2) Fireworks displays involving display fireworks, 1.3G

While the AHJ has the authority to require certificates of fitness for the activities listed under 1.13.1, the *Code* mandates certificates of fitness for people engaged in the use of explosive materials and fireworks displays involving display fireworks, 1.3G. Conducting these activities comes with significant risk. Therefore, it is mandatory that qualified individuals conduct these activities. The following organizations can help the AHJ make the determination of whether an individual is qualified to perform the noted activity:

1. Use of Explosive Materials. The Institute of Makers of Explosives (IME) and the International Society of Explosives Engineers (ISEE) offer a range of technical information concerning explosive materials and their use.

IME
1120 19th Street NW, Suite 310
Washington, DC 20036-3605, (202) 429-9280
www.ime.org

ISEE
30325 Bainbridge Road
Cleveland, OH 44139-2295, (440) 349-4400
www.isee.org

2. Fireworks Displays Involving Display Fireworks, 1.3G. The American Pyrotechnics Association (APA) promotes safety in the manufacture, transportation, and use of pyrotechnics through information and education programs.

APA
7910 Woodmont Avenue, Suite 1220
Bethesda, MD 20814, (301) 907-8181
www.americanpyro.com

The Pyrotechnics Guild International Inc. (PGI) offers a variety of information related to the display of fireworks and conducts fireworks safety training courses for those who conduct professional fireworks displays.

PGI
3944 Carthage Road
Randallstown, MD 21133, (410) 655-8594
www.pgi.org

1.13.3 The AHJ shall be responsible for the issuance of certificates of fitness required by the AHJ.

The AHJ issues the certificates of fitness it requires and those required by this *Code*. In some cases, another agency issues certificates of fitness for certain activities for the AHJ. In some instances the state issues licenses or certificates of fitness. For example, many states require contractors, electricians, plumbers, and other building professionals to be licensed. State requirements often supersede and preempt the requirements of the local AHJ.

1.13.4 All applications for a certificate of fitness shall be filed with the AHJ on forms provided by the AHJ.

The jurisdiction should have an application form for certificates of fitness, such as that shown in Exhibit 1.5, as well as an information sheet to explain how to fill out the form. This information sheet should list all of the information that is needed or that must be provided.

1.13.5 Certification of Applicant.

1.13.5.1 Every individual or company applying for a certificate of fitness shall furnish to the AHJ evidence of a familiarity with applicable codes, regulations, standards, listings, guidelines, and construction and safety practices for the activity for which the certificate of fitness is issued.

1.13.5.2* The AHJ shall also utilize certification programs provided by national organizations acceptable to the AHJ, where available, to determine evidence of compliance with 1.13.5.1.

A.1.13.5.2 The following is provided for information purposes only and has been provided by outside sources. Information concerning the noted services has not been independently verified, nor have the services been endorsed by the NFPA or any of its technical committees.

Examples of certification programs for fireworks displays include those conducted through the American Pyrotechnics Association (APA) and the Pyrotechnics Guild International (PGI). Both programs are recognized by several state fire marshals' offices throughout the United States. Authorities having jurisdiction should contact the applicable trade organizations or groups that cover each of the activities listed in 1.13.1 for information on recognized certification program(s).

The AHJ should establish policies and procedures to standardize qualification criteria that are used to evaluate individuals and companies for each of the certificates of fitness required by the AHJ. This will ensure that individuals wishing to enter a field to practice in the jurisdiction will know what criteria are accepted by the jurisdictions. Establishing standard qualification criteria will also ensure that all applicants are treated equally when assessed by the AHJ.

Exhibit 1.5

STATE OF CONNECTICUT
Department of Public Safety
Division of Fire and Building Safety
Bureau of State Fire Marshal
Investigation and Enforcement Section
P O Box 2794-Middletown, CT 06457-9294

APPLICATION FOR CERTIFICATE OF COMPETENCY
TO OPERATE A SPECIAL EFFECTS DISPLAY
(NEW)
APPLICANT'S INSTRUCTIONS

INDICATE CLASS
[ ] Special Effects
[ ] Limited Special Effects

1. Print or type all responses.
2. Enclose two passport type photographs, taken within the last six months and return to the address above.

PERSONAL INFORMATION

NAME: ____
STREET: ____
CITY: ____
STATE: ____
ZIP: ____
DATE OF BIRTH: ____ SSN: ____
HEIGHT: ____ WEIGHT: ____ SEX: MALE [ ] FEMALE [ ]
HOME PHONE: ____ WORK #: ____
CITIZEN OF U.S.A. [ ] YES [ ] NO
HAVE YOU EVER BEEN ISSUED A CERTIFICATE OF COMPETENCY TO OPERATE A SPECIAL EFFECTS DISPLAY IN CONNECTICUT? [ ] YES [ ] NO
HAVE YOU EVER BEEN REFUSED A CERTIFICATE OF COMPETENCY TO OPERATE A SPECIAL EFFECTS DISPLAY ANYWHERE? [ ] YES [ ] NO
IF YES WHERE, WHEN AND WHY ____

HAVE YOU EVER BEEN ARRESTED FOR ANYTHING OTHER THAN A MINOR TRAFFIC VIOLATION? [ ] YES [ ] NO IF YES WHERE, WHEN AND ON WHAT CHARGES? ____

HOW LONG HAVE YOU BEEN FIRING DISPLAYS: ____
FOR WHOM HAVE YOU FIRED DISPLAYS: ____
ARE YOU CURRENTLY LICENSED BY ANOTHER STATE [ ] YES [ ] NO
INDICATE STATE ____, NUMBER ____, TYPE ____
EXPIRATION DATE ____
GIVE YOUR PRESENT OCCUPATION: ____
HAVE ANY INJURIES OR PROPERTY DAMAGE OCCURRED WHILE YOU WERE THE OPERATOR OF A DISPLAY? [ ] YES [ ] NO (IF YES EXPLAIN ON OTHER SIDE) ____
I declare, under the penalties of False Statement, that the answers to the above are true and correct.

DATE: ____ SIGNATURE: ____

1 of 2

FOR OFFICE USE ONLY

[ ] APPROVED [ ] DENIED THIS ____ day of ____ 200____

Rank & Signature of Examining Officer

LICENSE #: ____ DDEP: ____ CHK #: ____
AMT: ____ EXPDATE: ____

SEC. 53a-157. FALSE STATEMENT: CLASS A MISDEMEANOR. (a) A person is guilty of False Statement when he intentionally makes a false written statement under oath or pursuant to a form bearing notice, authorized by law, to the effect that false statements made therein are punishable, which he does not believe to be true and which statement is intended to mislead a public servant in the performance of his official function. (b) False Statement is a Class A Misdemeanor.

The penalty for a Class A Misdemeanor is imprisonment for a term not to exceed one year, or a fine not to exceed $1,000, or both = fine and imprisonment. (Sections 53a-28 (b), 53a-36, and 53a-42.)

The fee for a certificate of Competency is $100.00 and it may be renewed every three years upon payment of a fee of $150.00. Checks should be made payable to the Connecticut Department of Public Safety.

2 of 2

Sample application for a certificate of fitness. (Courtesy of State of Connecticut, Department of Public Safety)

1.13.5.3 The AHJ shall investigate every application for a certificate of fitness.

1.13.5.4* The investigation shall include an examination of the applicant's experience and training in the field of the certificate of fitness for which application has been made.

Δ **A.1.13.5.4** An example of suggested requirements for licensing operators who perform fireworks displays can be found in Annex C, Suggested Requirements for Operator Licensing, of NFPA 1123, 2010 edition.

1.13.5.5 When the AHJ determines that an applicant is not fit to receive the certificate of fitness because of the applicant's inability to comply with the provisions of this *Code*, the AHJ shall refuse to issue the certificate of fitness.

1.13.5.6 If the refusal is based on the applicant's inability to pass an examination given to determine competency, the applicant shall not be permitted to apply again for the certificate of fitness within a 10-day period following the examination.

The AHJ should determine the credentials, courses, experience, and testing necessary for an applicant to qualify for each certificate of fitness. This information should be part of the application package. Applications should not be accepted unless all the appropriate information requested by the AHJ is provided.

If an applicant does not produce the appropriate information as required by the application, the certificate should be refused. Where written or practical tests, or both, are administered and the applicant fails, he or she cannot reapply for a minimum of 10 days. Applicants who fail to provide appropriate credentials or pass an exam should be notified in writing of the reason they are not being issued a certificate of fitness. A failed applicant should also be advised of the procedures required to reapply and any time limits imposed on the reapplication process.

1.13.6 Certificates of fitness shall not be transferable.

1.13.7 Certificates of fitness shall be issued for the period of time as indicated on the certificate of fitness as determined by the AHJ, but such period of time shall not exceed 3 years.

To ensure that applicants keep current with the technology in their fields, certificates of fitness should be issued with an expiration date. This date should not exceed 3 years from the date of issue. Shorter periods might be appropriate for seasonal work or short-term applications, such as for fireworks displays or similar activities.

1.13.8 Applications for renewal of a certificate of fitness shall be filed in the same manner as an application for an original certificate.

Renewal applications should be processed in the same way as first-time applications. After the initial certification period, requirements for maintaining a certificate of fitness could change. This information should be explained in the application, as outlined in 1.13.4. If the applicant does not meet the requirements for renewal, the certificate should not be renewed. A written notice of the reason(s) for nonrenewal should be sent to the applicant. (See Section 1.16.)

1.13.9 Each individual or company holding a certificate of fitness shall notify the AHJ in writing of any address change within 10 days after such change.

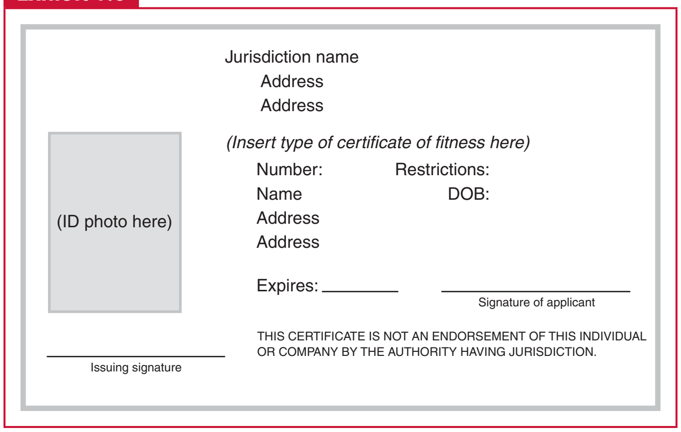
1.13.10 A certificate of fitness shall be in the form of an identification card. The card shall contain the following information:

(1) Purpose for which the certificate of fitness is issued
(2) Date of expiration
(3) Information necessary to easily identify the individual to whom the certificate of fitness is issued
(4) Signature of the individual to whom the certificate of fitness is issued
(5) Name and signature of the AHJ or a designated representative
(6) Statement printed thereon in bold type the following: THIS CERTIFICATE IS NOT AN ENDORSEMENT OF THIS INDIVIDUAL OR COMPANY BY THE AUTHORITY HAVING JURISDICTION.

The certificate of fitness card (see Exhibit 1.6) should contain the information listed in 1.13.10(1) through 1.13.10(6). The best method for identifying the individual certificate holder is a photo, which can be supplied by the applicant. An appropriate photo, similar to a passport photo, can be purchased at numerous retail outlets. A certificate number is also useful for public identification of certificate holders or for specific inquiries.

As stated in the *Code*, the certificate of fitness is not an endorsement by the jurisdiction or AHJ of the certificate holder or any company. The certificate only acknowledges that the holder demonstrated a minimum level of knowledge and skill in a specific activity; this is the reason for the wording on the card. It is important to show clearly on the certificate of fitness card the scope of work that the holder is qualified to perform.

Exhibit 1.6



Sample certificate of fitness card.

Modification of this wording might be necessary, or desirable, to meet local requirements. The legal counsel for the jurisdiction should be consulted on the final wording.

1.13.11 Any individual or company to whom a certificate of fitness has been granted shall, upon request, produce and show proper identification and the certificate of fitness to anyone for whom that individual seeks to render services or to the AHJ.

Any person seeking services, or the AHJ, can request to see the certificate of fitness card at any time. Those who have been issued a certificate should be informed of their duty to carry and produce the card at any time and of the consequences if they fail to do so.

1.13.12 Revocation or Suspension of Certificates of Fitness.

1.13.12.1 The AHJ shall be permitted to revoke or suspend a certificate of fitness issued if any violation of this *Code* is found upon inspection or where any false statements or misrepresentations are submitted in the application on which the approval was based.

Certificates of fitness can be revoked for just cause, which includes a determination that work is performed in an unsafe manner or is in violation of the *Code*.

1.13.12.2 Revocation or suspension shall be constituted when notification is served, posted, or mailed to the address of record for the certificate holder.

If the certificate is revoked, a written notification of the revocation and the reasons for it are required before the revocation is official (see Section 1.16). When a revocation or suspension of a certificate occurs, the AHJ should require that the identification card issued to the certificate holder is returned to the AHJ immediately.

In the case of an imminent danger, the operation in question should be stopped immediately (see 1.7.15). If the work is stopped due to an imminent danger caused by the certificate holder, the certificate of fitness can be revoked immediately, provided that a written notification of the revocation, the reasons for the revocation, and the actions necessary to retain the certificate are provided as soon as possible after the emergency revocation.

1.13.12.3 Failure on the part of an individual to give such notification of a change of address required by 1.13.9 shall constitute grounds for revocation of the certificate of fitness.

1.13.12.4 Revocations or suspensions of a certificate of fitness by the AHJ are appealable to the Board of Appeals as established in Section 1.10.

1.14 Plan Review

1.14.1 Where required by the AHJ for new construction, modification, or rehabilitation, construction documents and shop drawings shall be submitted, reviewed, and approved prior to the start of such work as provided in Section 1.14.

The AHJ has the authority to review plans for *Code* compliance. The AHJ must determine which types of plans to review and ensure that the jurisdiction has the staff and expertise necessary to meet the commitment. The AHJ should also check state and local statutes and ordinances on duties required to be performed to ensure compliance as a minimum with the legal requirements. The AHJ might decide to review plans based on the scope of a project, the occupancies involved, or other criteria. Such criteria should be carefully determined because they will dictate the expected workload.

Once determined, plan review requirements need to be communicated to the developers and architects. Working with the planning/zoning official, local building official, and other local officials, the fire official can ensure that no building permit is issued until all the necessary plan reviews are completed. In many cases, the plan review work of the fire official should start at the civil site plan review stage. This ensures that compliance with Chapter 18 provisions for fire department access and water supply are achieved in the beginning of the site plan design. Work on a project should not begin before a plan review has been conducted and all appropriate approvals and permits have been obtained.

When the AHJ requires a plan review but does not have sufficient time or expertise to perform the review in-house, the AHJ might consider contracting the work to an appropriate expert. In such a case, the property owner or the architect should pay the cost of the contracted review. (See Section 1.15.)

Some communities centralize plan review activity, allowing the applicant to have the plans reviewed by the necessary agencies at a central location. This single-location plan review does not mean the fire official does not review the plans, only that the plans might need to be reviewed at a location other than the fire inspection office, which is usually a town or city hall or building inspector's office. In many cases, a person from the fire official's office is assigned to that location.

Some communities hold a preplan review conference, where the civil engineer, architect, and developer can meet with the AHJ to review the concept for a new project and get initial feedback and review requirements for the project. Conducting this review with all enforcement officials present helps to define the expectations for all parties. The process of getting jurisdictional approvals this way is more beneficial to the applicant.

1.14.2 The applicant shall be responsible to ensure that the following conditions are met:

(1) The construction documents include all of the fire protection requirements.
(2) The shop drawings are correct and in compliance with the applicable codes and standards.
(3) The contractor maintains an approved set of construction documents on site.

The applicant for a plan review must make sure that all required plans are submitted for review and that they meet *Code* requirements, including the civil site design plans, architectural/engineering plans, and shop drawings. An approved set of construction documents must be maintained on-site to ensure that construction is performed in accordance with the approved set of plans. These plans can be referenced by the AHJ when questions arise during site inspections.

1.14.3 It shall be the responsibility of the AHJ to promulgate rules that cover the following:

(1) Criteria to meet the requirements of Section 1.14
(2) Review of documents and construction documents within established time frames for the purpose of acceptance or providing reasons for nonacceptance

The AHJ must specify the criteria and timing for plan review submittals, and the specifications should apply to the types of plans that the AHJ will be concerned with during the review process. These include civil site plans, architectural/engineering plans, and shop drawings.

NFPA 13, *NFPA 72*®, and other installation standards stipulate the information that must be included on or with plans. These codes and standards should be referenced by the AHJ to identify specifications to meet the requirements of 1.14.3.

The turnaround time for the review of plans must be reasonable. If plans must be reviewed by multiple agencies, they should be submitted to each agency at the same time to reduce the overall review time. The submitter should be notified in writing by the AHJ when plans are not approved. The reasons for disapproval should be noted in the letter.

1.14.4 Review and approval by the AHJ shall not relieve the applicant of the responsibility of compliance with this *Code*.

Sometimes items are missed during the design and plan review process, and the plans are approved with *Code* deficiencies. If any *Code* deficiencies are noted during an inspection or after further review of the plans, they must be corrected. Approval of a set of plans by the AHJ does not relieve the permit applicant from complying with this *Code*. Compliance with this *Code* is often part of the licensing requirements for design professionals such as contractors, architects, and engineers. Even after final inspections are passed by the AHJ, the owner is still responsible for correcting items that were missed during the inspection and plan review processes if such violations are brought to the attention of the AHJ and owner at a later date.

1.14.5 When required by the AHJ, revised construction documents or shop drawings shall be prepared and submitted for review and approval to illustrate corrections or modifications necessitated by field conditions or other revisions to approved construction documents.

Conditions often change during construction. Most changes are minor and may not require resubmission of plans before the work continues, or a number of small changes can be captured in one final resubmittal that shows the as-built field conditions. However, some changes might affect system performance, *Code* compliance, or prior approvals. In those circumstances, the AHJ might require that changes be submitted and approved before work proceeds. The resubmission thresholds and criteria are best defined as part of the regulations adopted by the AHJ.

N **1.14.6*** When required by the AHJ, plans and design documents shall be prepared by a registered design professional.

N **A.1.14.6** The AHJ should consider the risk, complexity of the design, qualifications of the AHJ's review staff, and state registration laws/rules to determine if requiring plans/design documents to be prepared by a registered design professional is appropriate.

In some states, scope of work thresholds in statutes or rules state the time within which a design professional is required to complete a set of plans or specifications. In other states, that authority rests solely with the local AHJ. Even in states that have minimum scope of work thresholds that mandate the use of design professionals, there may be circumstances that don't fall within such criteria in which the AHJ thinks a design professional is still necessary. As long as that authority is not preempted to the state, the AHJ has the authority to require a design professional under this section.

1.15 Technical Assistance

1.15.1 The AHJ shall be permitted to require a review by an approved independent third party with expertise in the matter to be reviewed at the submitter's expense.

A third-party review is a common way for an AHJ to get a comprehensive evaluation of a proposed performance-based or other design when the AHJ lacks the expertise in the area covered by the submittal. A third-party review is used in the United States and internationally. Typically, the designer or owner pays for the services of the third-party reviewer, but the reviewer is responsible only to the AHJ.

Choosing a third-party reviewer is partly a function of location. In large metropolitan areas, it is common for the AHJ to maintain a list of local third-party reviewers from which to choose. In other locations, it might be necessary to search beyond the local area for a qualified third-party reviewer. Regardless of how the third-party reviewer is chosen, approval of the use of a particular independent third party rests with the AHJ and not the submitter. The AHJ must ensure that the third party has expertise in the area of review. The expertise of the third party can usually be determined from the resume or CV of the third party and their references.

Guidelines for Peer Review in the Fire Protection Design Process, published by the Society of Fire Protection Engineers (SFPE), can provide additional guidance.

1.15.2 The independent reviewer shall provide an evaluation and recommend necessary changes of the proposed design, operation, process, or new technology to the AHJ.

1.15.3 The AHJ shall be authorized to require design submittals to bear the stamp of a registered design professional.

1.15.4 The AHJ shall make the final determination as to whether the provisions of this *Code* have been met.

Where technical assistance is provided to the AHJ by a third party, the AHJ is ultimately responsible for making the final determination of *Code* compliance and/or granting approval of equivalencies, alternative levels of protection, or modifications. The ethical obligation of the independent third party is to be responsible to the AHJ in achieving the AHJ's objective of *Code* compliance and not to the submitter funding the review or the original designer.

1.16 Notice of Violations and Penalties

1.16.1 Where Required. Whenever the AHJ determines violations of this *Code*, a written notice shall be issued to confirm such findings.

1.16.2 Serving Notice of Violation.

1.16.2.1 Any order or notice of violation issued pursuant to this *Code* shall be served upon the owner, operator, occupant, registered agent, or other person responsible for the condition or violation by one of the following means:

(1) Personal service
(2) Mail to last known address of the owner, operator, or registered agent

A system of issuing orders or notices that is developed in conjunction with the state attorney's office or the jurisdiction's legal counsel can minimize future legal problems. The AHJ's legal counsel should be consulted and assists in prosecuting cases involving violations of this *Code*. In some states, the process for pursuing violations of codes and ordinances may be specified in state law. Therefore, the AHJ should consult the applicable laws before establishing a violation corrections system. Any system that is developed should be used with each notice or order issued, and all procedures must be followed each time to prevent legal problems. In many jurisdictions, a system for pursuing code enforcement action may already exist for pursing other violations such as trash, weeds, junk cars, illegal uses, etc. The AHJ can usually use these existing code enforcement systems for the resolution of *Code* violations if such processes are established before the need to prosecute a *Code* violation.

Where permitted by local or state laws, many of the penalties related to this *Code* can be imposed as a fine via the issuance of a civil citation. In situations where a civil citation process exists, the inspector can write a ticket similar to a traffic ticket. This system reduces prosecution time and generally resolves the issue quickly.

1.16.2.2 For unattended or abandoned locations, a copy of such order or notice of violation shall be posted on the premises in a conspicuous place at or near the entrance to such premises, and the order or notice shall be disseminated in accordance with one of the following:

(1) Mailed to the last known address of the owner, occupant, or registered agent
(2) Published in a newspaper of general circulation wherein the property in violation is located

1.16.2.3 Refusal of an owner, occupant, operator, or other person responsible for the violation to accept the violation notice shall not be cause to invalidate the violation or the notice of violation. When acceptance of a notice of violation is refused, valid notice shall have deemed to have been served under this section provided the methods of service in 1.16.2.1 or 1.16.2.2 have been followed.

1.16.3 Destruction or Removal of Notice. The mutilation, destruction, or removal of a posted order or violation notice without authorization by the AHJ shall be a separate violation of this *Code* and punishable by the penalties established by the AHJ.

1.16.4 Penalties.

1.16.4.1 Any person who fails to comply with the provisions of this *Code*, fails to carry out an order made pursuant to this *Code*, or violates any condition attached to a permit, approval, or certificate shall be subject to the penalties established by the AHJ.

N **1.16.4.2** Violations of the provisions of this *Code* shall be punishable by a fine or imprisonment as determined by a penalty schedule adopted by the AHJ or specified by state law/rules.

1.16.4.3 Where the AHJ has not adopted a separate penalty schedule, or if state laws or rules do not specify a penalty, violations of this *Code* shall be subject to a $100.00 penalty per day for each violation.

AHJs frequently adopt a separate penalty schedule that concerns penalties based on the nature of the violation. As an example, if a building is used without the approval of the AHJ or if an occupancy is overcrowded, a fine of $500 might be appropriate.

1.16.4.4 Failure to comply with the time limits of an order or notice of violation issued by the AHJ shall result in each day that the violation continues being regarded as a separate offense and shall be subject to a separate penalty.

Unless the AHJ adopts a separate penalty schedule to be used with this *Code*, a $100 per day fine would apply to each violation as long as the violations go uncorrected beyond the time specified by the AHJ. As an example, if four violations go uncorrected for 10 days beyond the time limit specified by the AHJ, the penalty would be $4,000.

In determining how long an owner or tenant has to correct a violation before fines begin to accrue, the AHJ should consider the risk created by the existence of the violation. Some violations, such as an out of service fire sprinkler system, overcrowding of an assembly occupancy, or use of a structure without authorization by the AHJ may warrant the need to correct the violation immediately. In other circumstances with relatively minor violations or violations that do not create a significant immediate risk, providing the owner or tenant a limited time frame to correct is appropriate.

It is imperative that the AHJ follow-up on observed *Code* violations. Failure of the AHJ or the AHJ's agents to follow-up on *Code* violations to ensure that they are corrected can put occupants and fire fighters in danger along with exposing property to potential loss. *Code* violations observed but not followed-up on by the AHJ or the AHJ's agents can also create liability for the jurisdiction and the individuals who observed the violation.

1.16.4.5 A separate notice of violation shall not be required to be served each day for a violation to be deemed a separate offense.

The AHJ is not required to issue a separate violation for each day the violation exists. An initial violation notice is sufficient and will continue in force, with penalties accruing each day, as long as the violation continues.

1.16.5 Abatement. Where a violation creates an imminent danger, the AHJ is authorized to abate such hazard in accordance with 1.7.16.

A reasonable time for compliance should be given for all violations other than those that create an imminent danger. Imminent danger violations require immediate action by the AHJ to mitigate the hazard. As an example, this could involve ordering an overcrowded assembly occupancy to reduce the number of occupants immediately, ordering a structure to be vacated since the use is not approved by the AHJ, or ordering a blatantly unsafe hazardous materials process to be shut down. An *imminent danger* is defined in 3.3.159.

N 1.17* Permit Fees

The AHJ shall be authorized to establish a schedule of fees.

N **A.1.17** The schedule of fees should be established to cover the cost of services required to enforce this *Code* by conducting plans review and inspection services. The level of service provided is discussed in detail within NFPA 1730. If fees do not cover the cost of services, then the jurisdiction can choose to subsidize such fees by funding the inspection and plans review services from the general fund or other revenue funding mechanism.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2016 edition.

NFPA *101®*, *Life Safety Code®*, 2018 edition.

NFPA 921, *Guide for Fire and Explosion Investigations*, 2017 edition.

NFPA 1031, *Standard for Professional Qualifications for Fire Inspector and Plan Examiner*, 2014 edition.

NFPA 1033, *Standard for Professional Qualifications for Fire Investigator*, 2014 edition.

NFPA 1037, *Standard on Fire Marshal Professional Qualifications*, 2016 edition.

NFPA® Buyers' Guide.

Society of Fire Protection Engineers (SFPE), 9711 Washingtonian Blvd, Suite 380, Gaithersburg, MD 20878.

Guidelines for Peer Review in the Fire Protection Design Process, 2009.

Referenced Publications

2

Chapter 2 is a list of the codes and standards that are referenced in the chapters of NFPA 1. These references are mandatory. Locating the list in a single chapter simplifies the use of the *Code*, making it easier for adopting jurisdictions to update the references in only one location, rather than throughout the *Code*. The editions of the referenced publications listed in Chapter 2 are legally referenced editions, unless the jurisdiction, when adopting the *Code,* modifies or updates the list of codes and standards.

Annex F contains codes, standards, and publications referenced in the annexes. These documents are not enforceable unless they are also listed in Chapter 2 or specifically adopted by the jurisdiction.

2.1 General

The documents referenced in this chapter or portions of such documents are referenced within this *Code* and shall be considered part of the requirements of this document.

(1)* Documents referenced in this chapter or portion of such documents shall only be applicable to the extent called for within other chapters of this *Code.*

A.2.1(1) For example, Chapter 2 references NFPA 10. Such reference does not mean that all buildings must be provided with portable fire extinguishers. Rather, portable fire extinguishers are mandatory only to the extent called for elsewhere in the *Code*.

(2) Where the requirements of a referenced code or standard differ from the requirements of this *Code,* the requirements of this *Code* shall govern.

N **2.1.1* Compliance with Subsequent Editions of the Referenced Publications.** Compliance with subsequent editions of the referenced publications shall be considered evidence of compliance with the editions specified in this *Code*.

N **A.2.1.1** New editions of referenced publications incorporate advances in knowledge, best practices, and technology. Therefore, if an owner or contractor provides compliance with a new edition of a referenced publication that is specified by this *Code*, the AHJ should accept the new edition as evidence of full compliance with the *Code*.

N **2.1.1.1*** Compliance with subsequent editions of reference publications shall be achieved by complying with the entire subsequent edition of the referenced publication.

N **A.2.1.1.1** The intent of 2.1.1 and 2.1.1.1 is that an AHJ should approve the use of subsequent editions of referenced publications only when the entire new edition of the referenced standard is used. This paragraph is not intended to permit the use of "cherry-picking" specific sections of one edition of a referenced standard but to use the entire subsequent edition of the referenced standard.

N **2.1.1.2*** Compliance with individual specific sections contained in subsequent edition referenced publications, and not the entire reference publication, shall only be approved by the AHJ through technical documentation submitted in compliance with 1.4.1 or 1.4.2.

N **A.2.1.1.2** In circumstances where the AHJ is requested to use a specific section in a subsequent edition of a referenced publication and not the entire subsequent edition, the AHJ should require technical documentation submitted in compliance with 1.4.1 or 1.4.2. Before approving the use of specific sections of subsequent editions of referenced documents and not the entire edition of the subsequent edition, the AHJ should ensure that other changes did not occur to the subsequent edition that might affect the overall level of fire and life safety protection.

Δ 2.2 NFPA Publications

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 2, *Hydrogen Technologies Code,* 2016 edition.

NFPA 4, *Standard for Integrated Fire Protection and Life Safety System Testing,* 2018 edition.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2017 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2016 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2015 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems,* 2015 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2016 edition.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes,* 2016 edition.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies,* 2016 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2016 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2017 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems,* 2015 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2017 edition.

NFPA 17A, *Standard for Wet Chemical Extinguishing Systems,* 2017 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection,* 2016 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection,* 2013 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2016 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2017 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2018 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages,* 2018 edition.

NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products,* 2015 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2016 edition.

NFPA 32, *Standard for Drycleaning Facilities,* 2016 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials,* 2016 edition.

NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids,* 2015 edition.

NFPA 35, *Standard for the Manufacture of Organic Coatings,* 2016 edition.

NFPA 36, *Standard for Solvent Extraction Plants,* 2017 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* 2018 edition.

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film,* 2016 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals,* 2015 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes,* 2018 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2014 edition.

NFPA 52, *Vehicular Natural Gas Fuel Systems Code,* 2016 edition.

NFPA 54/ANSI Z223.1, *National Fuel Gas Code,* 2018 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2016 edition.

NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems,* 2017 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2017 edition.

NFPA 59, *Utility LP-Gas Plant Code,* 2018 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG),* 2016 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities,* 2017 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2013 edition.

NFPA 69, *Standard on Explosion Prevention Systems,* 2014 edition.

NFPA 70®, *National Electrical Code*®, 2017 edition.

NFPA 72®, *National Fire Alarm and Signaling Code,* 2016 edition.

NFPA 75, *Standard for the Protection of Information Technology Equipment,* 2016 edition.

NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities,* 2016 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2016 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment,* 2014 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code,* 2015 edition.

NFPA 86, *Standard for Ovens and Furnaces,* 2015 edition.

NFPA 88A, *Standard for Parking Structures,* 2015 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2018 edition.

NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems,* 2018 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids,* 2015 edition.

NFPA 92, *Standard for Smoke Control Systems,* 2015 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations,* 2017 edition.

NFPA 99, *Health Care Facilities Code,* 2018 edition.

NFPA 99B, *Standard for Hypobaric Facilities,* 2018 edition.

NFPA *101*®, *Life Safety Code*®, 2018 edition.

NFPA 102, *Standard for Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures,* 2016 edition.

NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives,* 2016 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems,* 2016 edition.

NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems,* 2016 edition.

NFPA 115, *Standard for Laser Fire Protection,* 2016 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines,* 2015 edition.

NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities,* 2015 edition.

NFPA 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems,* 2017 edition.

NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations,* 2013 edition.

NFPA 150, *Standard on Fire and Life Safety in Animal Housing Facilities,* 2016 edition.

NFPA 160, *Standard for the Use of Flame Effects Before an Audience,* 2016 edition.

NFPA 170, *Standard for Fire Safety and Emergency Symbols,* 2015 edition.

NFPA 204, *Standard for Smoke and Heat Venting,* 2015 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances,* 2016 edition.

NFPA 220, *Standard on Types of Building Construction,* 2018 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2018 edition.

NFPA 232, *Standard for the Protection of Records,* 2017 edition.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations,* 2013 edition.

NFPA 251, *Standard Methods of Tests of Fire Resistance of Building Construction and Materials,* 2006 edition.

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies,* 2017 edition.

NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source,* 2015 edition.

NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies,* 2017 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials,* 2013 edition.

NFPA 260, *Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture,* 2013 edition.

NFPA 261, *Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes,* 2013 edition.

NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls,* 2015 edition.

NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth,* 2015 edition.

NFPA 288, *Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance–Rated Assemblies,* 2017 edition.

NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages,* 2013 edition.

NFPA 301, *Code for Safety to Life from Fire on Merchant Vessels,* 2018 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft,* 2015 edition.

NFPA 303, *Fire Protection Standard for Marinas and Boatyards,* 2016 edition.

NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves,* 2016 edition.

NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up,* 2016 edition.

NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities,* 2018 edition.

NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair,* 2015 edition.

NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids,* 2017 edition.

NFPA 400, *Hazardous Materials Code,* 2016 edition.

NFPA 403, *Standard for Aircraft Rescue and Fire-Fighting Services at Airports,* 2018 edition.

NFPA 407, *Standard for Aircraft Fuel Servicing,* 2017 edition.

NFPA 408, *Standard for Aircraft Hand Portable Fire Extinguishers,* 2017 edition.

NFPA 409, *Standard on Aircraft Hangars,* 2016 edition.

NFPA 410, *Standard on Aircraft Maintenance,* 2015 edition.

NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways,* 2016 edition.

NFPA 418, *Standard for Heliports,* 2016 edition.

NFPA 423, *Construction and Protection of Aircraft Engine Test Facilities,* 2016 edition.

NFPA 484, *Standard for Combustible Metals,* 2018 edition.

NFPA 495, *Explosive Materials Code,* 2013 edition.

NFPA 498, *Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives,* 2013 edition.

NFPA 501, *Standard on Manufactured Housing,* 2017 edition.

NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities,* 2017 edition.

NFPA 502, *Standard for Road Tunnels, Bridges, and Other Limited Access Highways,* 2017 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations,* 2013 edition.

NFPA 601, *Standard for Security Services in Fire Loss Prevention,* 2015 edition.

NFPA 652, *Standard on the Fundamentals of Combustible Dust,* 2016 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids,* 2017 edition.

NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions,* 2017 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities,* 2017 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films,* 2015 edition.

NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials,* 2018 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response,* 2017 edition.

NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment,* 2015 edition.

NFPA 731, *Standard for the Installation of Electronic Premises Security Systems,* 2017 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2015 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2017 edition.

NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials,* 2014 edition.

NFPA 804, *Standard for Fire Protection for Advanced Light Water Reactor Electric Generating Plants,* 2015 edition.

NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants,* 2015 edition.

NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities,* 2016 edition.

NFPA 909, *Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship,* 2017 edition.

NFPA 914, *Code for Fire Protection of Historic Structures,* 2015 edition.

NFPA 1031, *Standard for Professional Qualifications for Fire Inspector and Plan Examiner,* 2014 edition.

NFPA 1122, *Code for Model Rocketry,* 2018 edition.

NFPA 1123, *Code for Fireworks Display,* 2018 edition.

NFPA 1124, *Code for the Manufacture, Transportation, and Storage of Fireworks and Pyrotechnic Articles,* 2017 edition.

NFPA 1125, *Code for the Manufacture of Model Rocket and High Power Rocket Motors,* 2017 edition.

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience,* 2016 edition.

NFPA 1127, *Code for High Power Rocketry,* 2018 edition.

NFPA 1141, *Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas,* 2017 edition.

NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting,* 2017 edition.

NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildland Fire,* 2018 edition.

NFPA 1192, *Standard on Recreational Vehicles,* 2018 edition.

NFPA 1194, *Standard for Recreational Vehicle Parks and Campgrounds,* 2018 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems,* 2016 edition.

NFPA 1730, *Standard on Organization and Deployment of Fire Prevention Inspection and Code Enforcement, Plan Review, Investigation, and Public Education Operations,* 2016 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus,* 2016 edition.

NFPA 1906, *Standard for Wildland Fire Apparatus,* 2016 edition.

NFPA 1925, *Standard on Marine Fire-Fighting Vessels,* 2013 edition.

NFPA 1963, *Standard for Fire Hose Connections,* 2014 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2015 edition.

NFPA 2010, *Standard for Fixed Aerosol Fire Extinguishing Systems,* 2015 edition.

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Definitions

3

This *Code* is unique in that only a handful of definitions are exclusive to this document. Most of the definitions in NFPA 1 are extracted from other NFPA codes and standards, as identified by the citation within brackets [ ] following the definitions.

This chapter has four sections with definitions organized in the following categories:

- Section 3.1 covers the use of terms and general dictionary usage.
- Section 3.2 includes official NFPA definitions, as defined by the NFPA Standards Council.
- Section 3.3 includes general fire protection terms.
- Section 3.4 includes terms specifically related to performance-based designs.

3.1 General

The definitions contained in this chapter shall apply to the terms used in this *Code*. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions

3.2.1* Approved. Acceptable to the AHJ.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the AHJ may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The AHJ may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A common but incorrect assumption is that the term *approved* means *listed* or *labeled*. Although the authority having jurisdiction (AHJ) might use a listing or a label to assist in approving an item, not all approvals are based on listing or labeling, nor will listing or labels automatically allow a component or system to be approved by the AHJ.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the AHJ may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the AHJ. In many circumstances, the property owner or his or her designated agent assumes the role of the AHJ; at government installations, the commanding officer or departmental official may be the AHJ.

The AHJ is the person or agency responsible for enforcing a *code*. In cases where the *code* is to be enforced legally, the AHJ usually is a fire marshal or building official. The AHJ can also be a safety office, an insurance engineering department, an accreditation service, another agency, or specific personnel in these entities, especially where the *code* is to be enforced at a nongovernment level. It is common practice for multiple AHJs to review the same project, enforcing more than one *code* at a time.

3.2.3* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

A.3.2.3 Code. The decision to designate a standard as a "code" is based on such factors as the size and scope of the document, its intended use and form of adoption, and whether it contains substantial enforcement and administrative provisions.

3.2.4 Guide. A document that is advisory or informative in nature and that contains only nonmandatory provisions. A guide may contain mandatory statements such as when a guide can be used, but the document as a whole is not suitable for adoption into law.

3.2.5 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the AHJ and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.6* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the AHJ and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

A.3.2.6 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The AHJ should utilize the system employed by the listing organization to identify a listed product.

As defined in 3.2.5 and 3.2.6, respectively, NFPA neither labels nor lists materials, products, or services.

3.2.7 Recommended Practice. A document that is similar in content and structure to a code or standard but that contains only nonmandatory provisions using the word "should" to indicate recommendations in the body of the text.

3.2.8 Shall. Indicates a mandatory requirement.

3.2.9 Should. Indicates a recommendation or that which is advised but not required.

3.2.10 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions

3.3.1* Absolute Pressure. Pressure based on a zero reference point, the perfect vacuum. [**55,** 2016]

A.3.3.1 Absolute Pressure. Measured from this reference point, the standard atmospheric pressure at sea level is an absolute pressure of 14.7 psi (101.3 kPa). [**55,** 2016]

3.3.2 Access Box. An approved secure box, accessible by the AHJ's master key or control, containing entrance keys or other devices to gain access to a structure or area.

3.3.3 Addition. An increase in building area, aggregate floor area, building height or number of stories of a structure. [**5000,** 2018]

3.3.4* Aerosol Product. A combination of a container, a propellant, and a material that is dispensed. [**30B,** 2015]

A.3.3.4 Aerosol Product. The base product can be dispensed from the container in such form as a mist, spray, foam, gel, or aerated powder. [**30B,** 2015]

3.3.5 Airport (Aerodrome). An area on land or water that is used or intended to be used for the landing and takeoff of aircraft and includes buildings and facilities. [**402,** 2018]

3.3.6 Airport Ramp. Any outdoor area, including aprons and hardstands, where aircraft can be positioned, stored, serviced, or maintained, irrespective of the nature of the surface of the area. [**415,** 2016]

3.3.7* Aisle Width. The horizontal dimension between the face of the loads in racks under consideration. [**13,** 2016]

A.3.3.7 Aisle Width. See Figure A.3.3.7. [**13,** 2016]

3.3.8 Alarm. An indication of the existence of a condition that requires immediate response. [**72,** 2016]

3.3.9 Alarm Signal. See 3.3.240.1.

3.3.10 Alcohol-Based Hand Rub. An alcohol-containing preparation designed for application to the hands for reducing the number of visible microorganisms on the hands and containing ethanol or isopropanol in an amount not exceeding 95 percent by volume.

3.3.11 Alleyway. An accessible clear space between storage piles or groups of piles suitable for housekeeping operations, visual inspection of piling areas, and initial fire-fighting operations.

3.3.12 Alternative. A system, condition, arrangement, material, or equipment submitted to the AHJ as a substitute for a requirement in a standard. [**1144,** 2018]

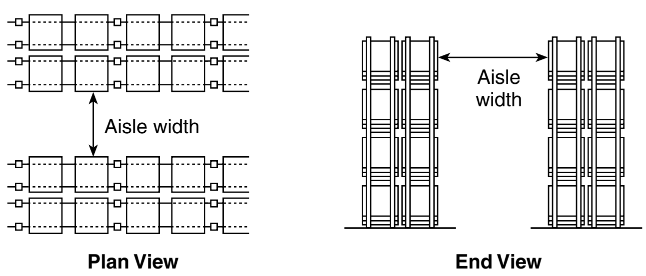


*FIGURE A.3.3.7 Illustration of Aisle Width. [**13,** 2016]*

3.3.13 ANSI/ASME. The designation for American National Standards Institute publication sponsored and published by the American Society of Mechanical Engineers.

3.3.14 Area.

3.3.14.1 Back Stock Area. The area of a mercantile occupancy that is physically separated from the sales area and not intended to be accessible to the public. [**30B,** 2015]

3.3.14.2 Control Area. A building or portion of a building or outdoor area within which hazardous materials are allowed to be stored, dispensed, used, or handled in quantities not exceeding the maximum allowable quantities (MAQ). [**400,** 2016]

3.3.14.3 Fire Area. An area of a building separated from the remainder of the building by construction having a fire resistance of at least 1 hour and having all communicating openings properly protected by an assembly having a fire resistance rating of at least 1 hour. [**30,** 2018]

Fire resistance–rated construction must separate the fire area from all other portions of the building completely, from the floor through the roof or ceiling, in a way that encloses the fire area on the top, bottom, and sides. The fire resistance–rated separation must extend through attic, basement, crawl space, or joist spaces. Thus, in a single-story building, the construction must cut off the crawl space and attic area from the rest of the building, including the joist spaces. Otherwise the ceiling and floor, as well as the walls, must be of rated construction. For further information, see NFPA 220, *Standard on Types of Building Construction*; NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls; and NFPA 5000®, Building Construction and Safety Code®*.

3.3.14.4 Fire Flow Area. The floor area, in square feet, used to determine the required fire flow.

Δ ***3.3.14.5 Indoor Area.*** An area that is within a building or structure having overhead cover, other than a structure qualifying as "weather protection" in accordance with Section 6.6 of NFPA 55. [**55,** 2016]

3.3.14.6 Inside Liquid Storage Area. A room or building used for the storage of liquids in containers or portable tanks, separated from other types of occupancies. [**30,** 2018]

The term *inside liquid storage area* applies to what had been known as "cutoff rooms," "inside rooms," and "attached buildings." The word "inside" now means that the storage room is within a building (i.e., not outdoors); the previous use implied that the storage room was completely enclosed in a building and had no exterior walls. Further, as part of the effort to make the terminology of NFPA 30 consistent with that of NFPA 1, *Fire Code; NFPA 5000*; and the model building and fire codes used throughout the United States, the terms *liquid storage room* and *liquid warehouse* now distinguish between inside liquid storage areas that are less than or equal to 500 ft^2 (46 m^2) and those that are greater than 500 ft^2 (46 m^2), respectively.

3.3.14.7 Organic Peroxide Storage Area. An area used for the storage of organic peroxide formulations. [**400,** 2016]

3.3.14.8 Outdoor Area. An area that is not an indoor area. [**55,** 2016]

3.3.14.9 Permissible Areas.

3.3.14.9.1 Designated Area. A specific location designed and approved for hot work operations that is maintained fire safe such as a maintenance shop or a detached outside location that is of noncombustible or fire-resistive construction, essentially free of combustible and flammable contents, and suitably segregated from adjacent areas. [51B, 2014]

3.3.14.9.2 Permit-Required Area. Any location other than a designated area that is approved for hot work. A permit-required area is an area that is made fire safe by removing or protecting combustibles from ignition sources. [**51B**, 2014]

3.3.14.10 Sales Display Area. The area of a mercantile occupancy that is open to the public for the purpose of viewing and purchasing goods, wares, and merchandise. Individuals are free to circulate among the items, which are typically displayed on shelves, on racks, or on the floor. [**30B,** 2015]

3.3.14.11 Smoking Area. A designated area where smoking is permitted within a premises in which smoking is otherwise generally prohibited.

3.3.14.12* Spray Area. Any fully enclosed, partly enclosed, or unenclosed area in which dangerous quantities of flammable or combustible vapors, mists, residues, dusts, or deposits are present due to the operation of spray processes, including (1) any area in the direct path of a spray application process; (2) the interior of a spray booth, spray room, or limited finishing workstation, as herein defined; (3) the interior of any exhaust plenum, eliminator section, or scrubber section; (4) the interior of any exhaust duct or exhaust stack leading from a spray application process; (5) the interior of any air recirculation path up to and including recirculation particulate filters; (6) any solvent concentrator (pollution abatement) unit or solvent recovery (distillation) unit; and (7) the inside of a membrane enclosure. The following are not part of the spray area: (1) fresh air make-up units; (2) air supply ducts and air supply plenums; (3) recirculation air supply ducts downstream of recirculation particulate filters; and (4) exhaust ducts from solvent concentrator (pollution abatement) units. [**33,** 2016]

A.3.3.14.12 Spray Area. For the purpose of this *Code*, the AHJ can define the limits of the spray area in any specific case. The spray area in the vicinity of spray application operations will necessarily vary with the design and arrangement of the equipment and with the method of operation. Where spray application operations are strictly confined to predetermined spaces that are provided with adequate and reliable ventilation (such as a properly designed and constructed spray booth), the spray area ordinarily will not extend beyond this space. When spray application operations are *not* confined to an adequately ventilated space, then the spray area might extend throughout the room or building area where the spraying is conducted. [**33,** 2016]

- The amount that constitutes "dangerous quantities" in the definition of the term *spray area* is difficult to quantify. If accumulations of residues that have not been cleaned off the walls and floors in a spray area are visible, further inspection is necessary. The AHJ should check behind the overspray collector filters for accumulations of combustible residues.

3.3.15 ASME. American Society of Mechanical Engineers. [**58,** 2017]

3.3.16 ASME Container (or Tank). See 3.3.70.1.

3.3.17 ASTM. American Society for Testing and Materials, now known as "ASTM International." [**55,** 2016]

3.3.18 Automatic Emergency Shutoff Valve. A designated fail-safe automatic closing valve designed to shut off the flow of gases or liquids that is initiated by a control system where the control system is activated by either manual or automatic means. [**55,** 2016]

3.3.19* Baled Cotton. A natural seed fiber wrapped and secured in industry-accepted materials, usually consisting of burlap, woven polypropylene, or sheet polyethylene, and secured with steel, synthetic, or wire bands, or wire; also includes linters (lint removed from the cottonseed) and motes (residual materials from the ginning process).

A.3.3.19 Baled Cotton. See Table A.3.3.19.

The Joint Cotton Industry Bale Packaging Committee (JCIBPC) specifications for baling of cotton now requires that all cotton bales be secured with wire bands, polyester plastic strapping, or cold-rolled high tensile steel strapping, and then covered in fully coated or strip-coated woven polypropylene, polyethylene film, or burlap.

3.3.19.1 Block. A basic yard storage unit for baled cotton comprising multiple-row storage with clear spaces on all sides.

3.3.19.2* Densely Packed Baled Cotton. Cotton, made into banded bales, with a packing density of at least 22 lb/ft^3 (360 kg/m^3), and dimensions complying with the following: a length of 55 in. (ca. 1400 mm ± 20 mm), a width of 21 in. (ca. 530 mm ± 20 mm), and a height of 27.6 in. to 35.4 in. (700 mm to 900 mm).

A.3.3.19.2 Densely Packed Baled Cotton. Experimental work by the U.S. Department of Agriculture, and others (Wakelyn and Hughs, 2002), investigated the flammability of cotton bales with a packing density of at least 22 lb/ft^3 (360 kg/m^2). The research showed that such cotton bales (densely packed cotton bales) did not undergo self-heating or spontaneous combustion, and that the likelihood of sustained smoldering combustion internal to the cotton bale, creating a delayed fire hazard, was extremely low. The same research also showed that, when the cotton bales were exposed to smoldering cigarettes, matches, and open flames (including the gas burner ignition source used for the mattress tests, ASTM E1590, *Standard Test Method for Fire Testing of Mattresses*, and California Technical Bulletin 129), the probability of initiating flaming combustion was at such a low level as not to qualify the densely packed cotton bales as flammable solids. These investigations resulted in harmonization between the U.S. Department of Transportation (49 CFR 172.102, note 137), the United Nations *Recommendations on the Transport of Dangerous Goods,* the International Maritime Organization (the *International Maritime Dangerous Goods Code*), and the International Civil Aviation Organization's *Technical Instructions*, with the removal of the flammable solid designation from densely packed cotton bales, complying with ISO 8115, *Cotton Bales — Dimensions and Density*, and the exemption of such cotton bales from the corresponding transportation hazardous materials regulations.

3.3.19.3 Fire-Packed Baled Cotton. A cotton bale within which a fire has been packed as a result of a process in which ginning is the most frequent cause.

3.3.19.4 Naked Cotton Bale. An unwrapped cotton bale secured with wire or steel straps.

N **3.3.20 Barricade (Explosives or Fireworks).** A natural or artificial barrier that effectively screens a magazine, building, railway, or highway from the effects of an explosion in a magazine or building containing explosives. [**1124,** 2017]

N ***3.3.20.1 Artificial Barricade.*** An artificial mound or revetted wall of earth of a minimum thickness of 3 ft (0.9 m). [**1124,** 2017]

N ***3.3.20.2 Natural Barricade.*** A natural outdoor feature(s), such as hills or trees, with a density sufficient to prevent surrounding

TABLE A.3.3.19 *Typical Cotton Bale Types and Approximate Sizes*

Bale Type	Dimensions in.	Dimensions mm	Average Weight lb	Average Weight kg	Volume ft^3	Volume m^3	Density lb/ft^3	Density kg/m^3
Compressed, standard	57 × 29 × 23	1448 × 736 × 584	500	226.8	22.0	0.62	22.7	366
Gin, standard	55 × 31 × 21	1397 × 787 × 533	500	226.8	20.7	0.58	24.2	391
Compressed, universal	58 × 25 × 21	1475 × 635 × 533	500	226.8	17.6	0.50	28.4	454
Gin, universal	55 × 26 × 21	1397 × 660 × 533	500	226.8	17.4	0.49	28.7	463
Compressed, high density	58 × 22 × 21	1473 × 559 × 533	500	226.8	15.5	0.44	32.2	515
Densely packed baled cotton	55 × 21 × 27.6 to 35.4	1400 × 530 × 700 to 900	500	226.8	21.1	0.60	22.0	360

exposures that require protection from being seen from a magazine or building containing explosives when the trees are bare of leaves. [**1124,** 2017]

3.3.21 Barrel. A unit of volume used in the petroleum industry that is equal to 42 gal (159 L). [**30,** 2018]

The 42 gal (159 L) barrel is a U.S. petroleum industry measurement standard for crude oil and petroleum products. In other countries, petroleum and its products are measured in cubic meters (m^3). The 42 gal (159 L) barrel originated in the early days of the petroleum industry in the United States when crude oil was shipped in 42 gal (159 L) wooden barrels on the basis of 40 gal (150 L) delivered. Supposedly, the 2 gal (7.6 L) difference allowed for evaporation and leakage during transportation. Although no longer used to ship petroleum products, the 42 gal (159 L) barrel has become the petroleum industry's standard unit for measurement, pricing, and application of tax and regulatory codes.

A common mistake is to consider a barrel and a drum as the same item. As used in the *Code,* a barrel is a unit of measure. A drum is a closed container used for shipping and is available in various capacities. The most common drum is one of 55 gal (208 L), although a 30 gal (114 L) size is also used. Larger sizes are available as well [85 gal and 109 gal (322 L and 412 L)]; these are used as environmental recovery drums to hold smaller "leakers."

Although colloquial use treats the terms *barrel* and *drum* as synonyms, this is not the case in the *Code,* and the term *container* is used instead.

3.3.22 Basement. Any story of a building wholly or partly below grade plane that is not considered the first story above grade plane. [**5000,** 2018]

In any particular case, the interpretation of what constitutes a definition of the term *basement* is best left to the AHJ, who should evaluate the extent to which access for fire fighting will be required and the extent to which the configuration of the building might hinder that access. Another factor to consider is whether the configuration of the building would interfere with immediate evacuation by emergency responders.

The definition of the term *basement* might vary. Where the term is used in this *Code* in text extracted from another NFPA code or standard, the source document should be consulted to determine the definition as it applies to the extracted requirement. For example, the definition of *basement* in NFPA 30, *Flammable and Combustible Liquids Code,* differs from the extracted definition of *basement* from *NFPA 5000,* which appears in this *Code*. Exhibit 3.1 illustrates the procedure for determining whether a story is a basement in accordance with NFPA 30 for the purpose of applying requirements.

3.3.23 Battery System. A system that consists of these interconnected subsystems: (1) stationary storage batteries, (2) battery chargers, and (3) a collection of rectifiers, inverters, converters, and associated electrical equipment as required for a particular application.

3.3.24 Battery Types, Stationary.

3.3.24.1 Lithium-Ion Battery. A storage battery that consists of lithium ions imbedded in a carbon graphite or nickel metal-oxide substrate. The electrolyte is a carbonate mixture or a gelled polymer. The lithium ions are the charge carriers of the battery.

3.3.24.2 Lithium Metal Polymer Battery. A storage battery that is comprised of nonaqueous liquid or polymerized electrolytes, which provide ionic conductivity between lithiated positive active material electrically separated from metallic lithium or lithiated negative active material.

3.3.24.3 Nickel Cadmium (NiCad) Battery. An alkaline storage battery in which the positive active material is nickel oxide, the negative contains the cadmium, and the electrolyte is potassium hydroxide.

3.3.24.4* Valve-Regulated (VRLA). A lead-acid battery consisting of sealed cells furnished with a valve that opens to vent the battery whenever the internal pressure of the battery exceeds the ambient pressure by a set amount.

A.3.3.24.4 Valve-Regulated (VRLA). In VRLA batteries, the liquid electrolyte in the cells is immobilized in an absorptive glass mat (AGM cells or batteries) or by the addition of a gelling agent (gel cells or gelled batteries).

3.3.24.5* Vented (Flooded). A lead-acid battery consisting of cells that have electrodes immersed in liquid electrolyte.

A.3.3.24.5 Vented (Flooded). Flooded lead-acid batteries have a provision for the user to add water to the cell and are equipped with a flame-arresting vent that permits the escape of hydrogen and oxygen gas from the cell in a diffused manner such that a spark, or other ignition source, outside the cell will not ignite the gases inside the cell.

3.3.25 Block. See 3.3.19.1.

3.3.26 Board of Appeals. A group of persons appointed by the governing body of the jurisdiction adopting this *Code* for the purpose of hearing and adjudicating differences of opinion between the AHJ and the citizenry in the interpretation, application, and enforcement of this *Code*.

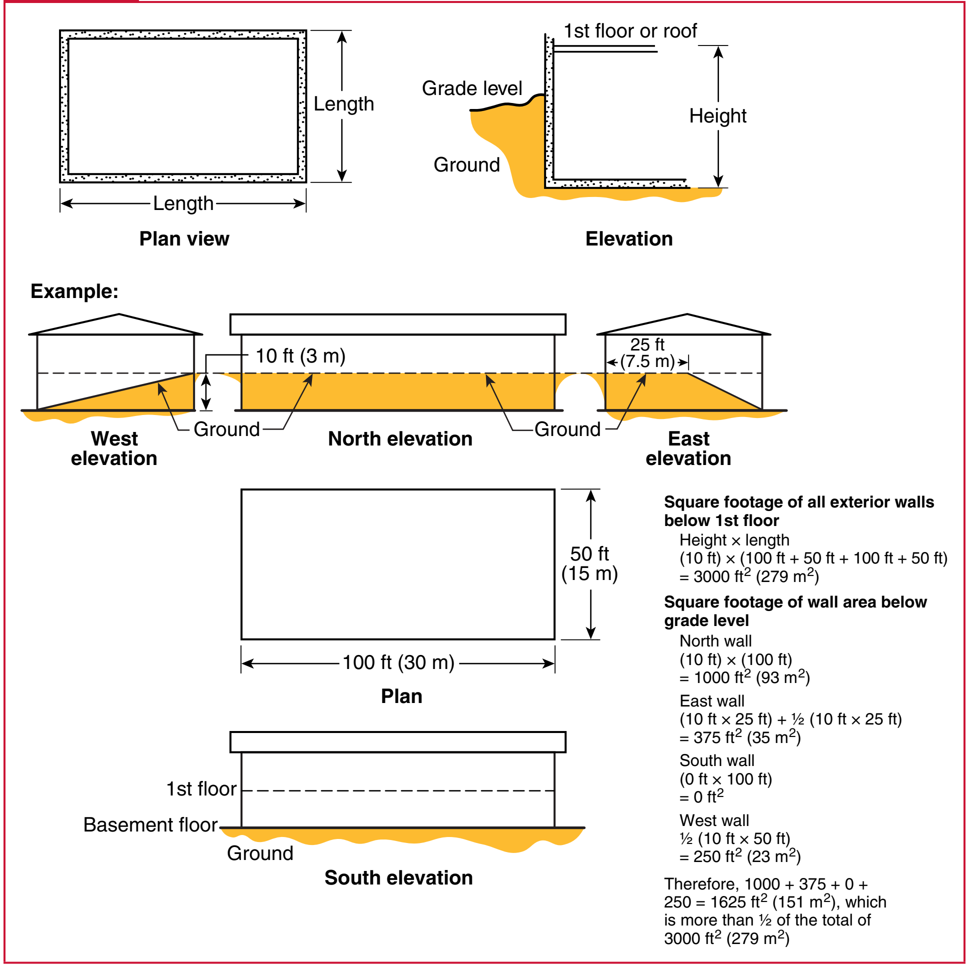
3.3.27* Boiling Point. The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure. [**30,** 2018]

A.3.3.27 Boiling Point. At the boiling point, the surrounding atmospheric pressure can no longer hold the liquid in the liquid state and the liquid boils. A low boiling point is indicative of a high vapor pressure and a high rate of evaporation. [**30,** 2018]

3.3.28* Boil-Over. An event in the burning of certain oils in an open-top tank when, after a long period of quiescent burning, there is a sudden increase in fire intensity associated with expulsion of burning oil from the tank. [**30,** 2018]

Δ **A.3.3.28 Boil-Over.** Boil-over occurs when the residues from surface burning become more dense than the unburned oil and sink below the surface to form a hot layer, which progresses downward much faster than the regression of the liquid surface. When this hot

Exhibit 3.1



Determining whether a lower level of a building is a basement in accordance with NFPA 30.

layer, called a "heat wave," reaches water or water-in-oil emulsion in the bottom of the tank, the water is first superheated and then boils almost explosively, overflowing the tank. Oils subject to boil-over consist of components having a wide range of boiling points, including both light ends and viscous residues. These characteristics are present in most crude oils and can be produced in synthetic mixtures. [**30A,** 2018]

A boil-over is an entirely different phenomenon from a slop-over or froth-over. Slop-over involves a minor frothing that occurs when water is sprayed onto the hot surface of a burning oil. Froth-over is not associated with a fire but results when water is present or enters a tank containing hot viscous oil. Upon mixing, the sudden conversion of water to steam causes a portion of the tank contents to overflow. [**30,** 2018]

Any liquid will boil if heated sufficiently. In open-pool burning, the liquid surface receives radiant energy from the flames, and this energy supports the boiling process. For most liquids, a steady-state condition develops, and burning proceeds until the liquid is consumed. In fact, once a steady state is reached, the burning rate is predictable. In a tank, boiling can result in a rise in the liquid level due to entrained bubbles. Thus, a full tank can overflow if exposed to a surrounding fire. This phenomenon is referred to as a *froth-over*; it is not a boil-over as defined in 3.3.28.

For a boil-over to occur, the liquid must have a range of boiling temperatures and must comprise a substantial proportion of volatile components and a highly viscous residue. It must also have at least a small amount of water-in-oil emulsion. This combination is present in most crude oils but seldom in refined petroleum products or virgin chemical commodities. Sometimes, asphalts are mistakenly presumed to be boil-over liquids. Burning asphalt will certainly froth over when water is applied during firefighting operations, but it is not susceptible to the more violent boil-over phenomenon. Refer to the *Flammable and Combustible Liquids Code Handbook* for more information on boil-over.

3.3.29* Building. Any structure used or intended for supporting or sheltering any use or occupancy. [***101,*** 2018]

Δ **A.3.3.29 Building.** The term *building* is to be understood as if followed by the words *or portions thereof. (See also A.3.3.264, Structure.)* [***101,*** 2018]

3.3.29.1* Airport Terminal Building. A structure used primarily for air passenger enplaning or deplaning, including ticket sales, flight information, baggage handling, and other necessary functions in connection with air transport operations. This term includes any extensions and satellite buildings used for passenger handling or aircraft flight service functions. Aircraft loading walkways and "mobile lounges" are excluded. [**415,** 2016]

A.3.3.29.1 Airport Terminal Building. The term *terminal* is sometimes applied to airport facilities other than those serving passengers, such as cargo- and freight-handling facilities and fuel-handling facilities. These facilities are covered by other NFPA standards, such as NFPA 30. [**415,** 2016]

3.3.29.2 Apartment Building. See 3.3.192.2.

3.3.29.3 Attached Building. A building having only one common wall with another building having other types of occupancies.

3.3.29.4 Bulk Merchandising Retail Building. See 3.3.192.4.

3.3.29.5* Existing Building. A building erected or officially authorized prior to the effective date of the adoption of this edition of the *Code* by the agency or jurisdiction. [***101,*** 2018]

Δ ***A.3.3.29.5 Existing Building.*** With respect to judging whether a building should be considered existing, the deciding factor is not when the building was designed or when construction started but, rather, the date plans were approved for construction by the appropriate AHJ. [***101,*** 2018]

3.3.29.6* High-Rise Building. A building where the floor of an occupiable story is greater than 75 ft (23 m) above the lowest level of fire department vehicle access. [**5000,** 2018]

A.3.3.29.6 High-Rise Building. It is the intent of this definition that, in determining the level from which the highest occupiable floor is to be measured, the enforcing agency should exercise reasonable judgment, including consideration of overall accessibility to the building by fire department personnel and vehicular equipment. Where a building is situated on a sloping terrain and there is building access on more than one level, the enforcing agency might select the level that provides the most logical and adequate fire department access. [**5000,** 2018]

The AHJ must exercise reasonable judgment, including consideration of accessibility to the building by fire department personnel and vehicular equipment, in determining the level from which the highest occupiable floor is to be measured. In the case of a building situated on a sloping terrain with access on more than one level, the AHJ might select the level that provides the most logical and adequate fire department access.

3.3.29.7* Important Building. A building that is considered not expendable in an exposure fire. [**30,** 2018]

A.3.3.29.7 Important Building. Examples of important buildings include occupied buildings where egress within 2 minutes cannot be reasonably expected and control buildings that require presence of personnel for orderly shutdown of important or hazardous processes. Important buildings can also include unprotected storage where products from fire can harm the community or the environment or buildings that contain high-value contents or critical equipment or supplies. [**30,** 2018]

The concept of "important building" is used throughout NFPA 30 to determine the separation between flammable and combustible liquids and the structures, public ways, and property lines to which the liquids represent a fire threat. The intent is that the important building(s) be far enough from a fire involving liquids such that they are not affected by it. What constitutes an important building is determined by the AHJ, but some guidance is provided in this commentary. Certainly, a building that houses high-value contents or critical process control systems would be considered important for the purpose of applying the requirements of NFPA 30. In the latter case, the building might be quite small. Likewise, a building that is normally occupied would be considered important. A large storage building that is used to store spare equipment and that is normally unoccupied might not be considered important within the context of NFPA 30.

3.3.29.8 Mini-Storage Building. See 3.3.192.31.1.

3.3.29.9 Satellite. A structure that can be adjacent to but separated from the airport terminal building, accessible above ground or through subway passages, and used to provide flight service operations, such as passenger check-in, waiting rooms, food service, enplaning or deplaning, etc. [**415,** 2016]

3.3.29.10* Special Amusement Building. A building that is temporary, permanent, or mobile and contains a device or system that conveys passengers or provides a walkway along, around, or over a course in any direction as a form of amusement arranged so that the egress path is not readily apparent due to visual or audio distractions or an intentionally confounded egress path, or is not readily available due to the mode of conveyance through the building or structure. [***101,*** 2018]

A.3.3.29.10 Special Amusement Building. Special amusement buildings include amusements such as a haunted house, a roller coaster–type ride within a building, a multilevel play structure within a building, a submarine ride, and similar amusements where the occupants are not in the open air. [***101,*** 2018]

3.3.29.11 Storage Tank Building. A three-dimensional space that is enclosed by a roof and walls that cover more than one-half of the possible area of the sides of the space, is of sufficient size to allow entry by personnel, will likely limit the dissipation of heat or dispersion of vapors, and restricts access for fire fighting. [**30,** 2018]

A storage tank building was initially conceived as a building housing only storage tanks and their piping plus necessary pumps and other ancillary equipment. The Flammable and Combustible Liquids Code Committee established requirements for storage tank buildings (see Chapter 24 of NFPA 30) to address situations where operators of small tank farms enclosed

Exhibit 3.2

Storage tank installation inside a building.

their tanks with curtain walls and roofs to keep precipitation from accumulating within the tank dike. The reason for doing so was that environmental regulatory agencies had ruled that accumulations of rainwater and snow melt in diked areas had to be collected and treated at great expense. By enclosing the tanks, the accumulation of precipitation was eliminated, as was the need to treat it.

With the exception of inside tanks for fuel oil for oil-burning appliances (NFPA 31, *Standard for the Installation of Oil-Burning Equipment*) and for fuel for stationary engines (NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*), the intent of NFPA 30 is to apply the provisions of Chapter 24 of NFPA 30 to any indoor installation of storage tanks. See Exhibit 3.2 for an example of an indoor storage tank installation.

3.3.30 Bulk Hydrogen Compressed Gas System. See 3.3.267.1.

3.3.31 Bulk Inert Gas System. See 3.3.267.2.

3.3.32 Bulk Liquefied Hydrogen Gas System. See 3.3.267.3.

3.3.33 Bulk Oxygen System. See 3.3.267.4.

3.3.34 Bulk Plant or Terminal. That portion of a property where liquids are received by tank vessel, pipelines, tank car, or tank vehicle and are stored or blended in bulk for the purpose of distributing such liquids by tank vessel, pipeline, tank car, tank vehicle, portable tank, or container.

3.3.35 Burn-It. A fire-fighting strategy that allows for the free-burn of a tire fire.

3.3.36 Bury-It. A fire-fighting strategy in which a tire pile is buried with soil, sand, gravel, cement dust, or other cover material.

3.3.37* Cathodic Protection. A technique to resist the corrosion of a metal surface by making the surface the cathode of an electrochemical cell. [**55,** 2016]

A.3.3.37 Cathodic Protection. This protection renders a metallic container or piping system or component negatively charged with respect to its surrounding environment. [**55,** 2016]

3.3.38 Cathodic Protection Tester. A person who demonstrates an understanding of the principles and measurements of all common types of cathodic protection systems applicable to metal piping and container systems and who has education and experience in soil resistivity, stray current, structure-to-soil potential, and component electrical isolation measurements of metal piping and container systems. [**55,** 2016]

3.3.39 Certificate of Fitness. A written document issued by the AHJ to any person for the purpose of granting permission to such person to conduct or engage in any operation or act for which certification is required.

3.3.40 CFR. The Code of Federal Regulations of the United States Government.

3.3.41 CGA. Compressed Gas Association.

N **3.3.42 Chemical Fume Hood.** A ventilated enclosure designed to contain and exhaust fumes, gases, vapors, mists, and particulate matter generated within the hood interior. [**45,** 2015]

3.3.43 Chemical Heat of Combustion (H_c). The amount of heat released, in Btu/lb (kJ/g), when a substance is oxidized to yield stable end products, including water as a vapor, as measured under actual fire conditions in a normal ambient (air) atmosphere. [**30B,** 2015]

3.3.44 Chemical Name. The scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry or the Chemical Abstracts Service rules of nomenclature, or a name that clearly identifies a chemical for the purpose of conducting an evaluation.

3.3.45 Chemical Plant. A large integrated plant or that portion of such a plant, other than a refinery or distillery, where liquids are produced by chemical reactions or used in chemical reactions. [**30,** 2018]

3.3.46* Chip. A wood chip of various species used in the manufacture of pulp.

A.3.3.46 Chip. Chips are usually ¼ in. to 1¼ in. (6.4 mm to 31.8 mm) in size, with nothing finer than that which is retainable on a ¼ in. (6.4 mm) screen; however, blower and conveyor systems can create some fine dust particles after screening.

3.3.47* Cleaning Media. Materials used to clean piping systems. [**55,** 2016]

Δ **A.3.3.47 Cleaning Media.** Cleaning methods that incorporate chemical washing techniques can include the use of chemical substances, usually liquid, capable of dissolving or dispersing a foreign substance or contaminants and techniques such as rinsing, heating, steaming, or vacuuming applied either individually or in combination with other techniques. Air, inert gas, steam and water are acceptable cleaning media. [**55,** 2016]

3.3.48 Clean Zone. A defined space in which the concentration of airborne particles is controlled to specified limits. [**318,** 2018]

3.3.49 Cleanroom. A room in which the concentration of airborne particles is controlled to specified limits, including areas below the raised floor and above the ceiling grid if these areas are part of the air path and within the rated construction. [**5000,** 2018]

3.3.50 Clear Space. An area free of combustible materials but that can contain noncombustible materials that cannot transmit an exposure fire.

3.3.51 Closed System Use. See 3.3.281.1.

3.3.52 Closed-Top Diking. A dike with a cover intended to minimize the entrance of precipitation into the diked area. [**30,** 2018]

ANSI/UL 142, *Standard for Safety for Steel Aboveground Tanks for Flammable and Combustible Liquids*, defines *closed-top diking* as "a diked aboveground tank with protection on the top of the dike to keep precipitation, debris, or other elements from entering the diked area." Closed-top diking is a construction method used for factory-built horizontal storage tanks in which the tank is mounted in an integral steel dike with a cover at its top (see Exhibit 3.3). The cover is arranged so that precipitation cannot enter the dike, but leakage and overfills from the tank can. ANSI/UL 142 also requires that the closed-top diking be so designed that the diked area cannot be pressurized, even if any fittings should be capped, and that the dike enclosure be provided with emergency relief venting.

3.3.53 Clothes Dryer. A device used to dry wet laundry by means of heat derived from the combustion of fuel or from electric heating elements. [**211,** 2016]

3.3.54 Code.

3.3.54.1 Building Code. The building or construction code adopted by the jurisdiction. [**55,** 2016]

Exhibit 3.3

Aboveground tank with closed-top diking. (Courtesy of Modern Welding Co.)

3.3.54.2 Electrical Code. The electrical code referenced in Section 2.2.

3.3.54.3 Mechanical Code. The mechanical or mechanical construction code adopted by the jurisdiction. [**55,** 2016]

3.3.54.4 Plumbing Code. The plumbing code referenced in Section 2.2.

3.3.55 Cold Deck. A single ranked pile of logs with individual logs of regular or irregular length usually 20 ft to 50 ft (6.1 m to 15.2 m) long, but greater than 8 ft (2.4 m) long.

3.3.56 Column (Paper). A single vertical stack of rolls of paper.

3.3.57 Combustible (Material). A material that, in the form in which it is used and under the conditions anticipated, will ignite and burn; a material that does not meet the definition of noncombustible or limited-combustible. [***101,*** 2018]

3.3.58* Combustible Dust. A finely divided combustible particulate solid that presents a flash fire hazard or explosion hazard when suspended in air or the process-specific oxidizing medium over a range of concentrations. [**654,** 2017]

Δ **A.3.3.58 Combustible Dust.** Dusts traditionally were defined as material 420 μm or smaller (capable of passing through a U.S. No. 40 standard sieve). For consistency with other standards, 500 μm (capable of passing through a U.S. No. 35 standard sieve) is now considered an appropriate size criterion. Particle surface area-to-volume ratio is a key factor in determining the rate of combustion. Combustible particulate solids with a minimum dimension more than 500 μm generally have a surface-to-volume ratio that is too small to pose a deflagration hazard. Flat platelet shaped particles, flakes, or fibers with lengths that are large compared to their diameter usually do not pass through a 500 μm sieve, yet could still pose a deflagration hazard. Many particulates accumulate electrostatic charge in handling, causing them to attract each other, forming agglomerates. Often agglomerates behave as if they were larger particles, yet when they are dispersed they present a significant hazard. Consequently, it can be inferred that any particulate that has a minimum dimension less than or equal to 500 μm could behave as a combustible dust if suspended in air or the process specific oxidizer. If the minimum dimension of the particulate is greater than 500 μm, it is unlikely that the material would be a combustible dust, as determined by test. The determination of whether a sample of combustible material presents a flash fire or explosion hazard could be based on a screening test methodology such as provided in the ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*. Alternatively, a standardized test method such as ASTM E1515, *Standard Test Method for Minimum Explosible Concentration of Combustible Dusts*, could be used to determine dust explosibility. [**654,** 2017]

There is some possibility that a sample will result in a false positive in the 20 L sphere when tested by the ASTM E1226 screening test or the ASTM E1515 test. This is due to the high energy ignition source overdriving the test. When the lowest ignition energy allowed by either method still results in a positive result, the owner/operator can elect to determine whether the sample is a combustible dust with screening tests performed in a larger scale ($\geq$1 m^3) enclosure, which is less susceptible to overdriving and thus will provide more realistic results. [**654,** 2017]

This possibility for false positives has been known for quite some time and is attributed to "overdriven" conditions that exist in the 20 L chamber due to the use of strong pyrotechnic igniters. For that reason, the reference method for explosibility testing is based on a 1 m^3 chamber, and the 20 L chamber test method is calibrated to produce results comparable to those from the 1 m^3 chamber for most dusts. In fact, the U.S. standard for 20 L testing (ASTM E1226) states, "The objective of this test method is to develop data that can be correlated to those from the 1 m^3 chamber (described in ISO 6184-1 and VDI 3673) . . ." ASTM E1226 further states, "Because a number of factors (concentration, uniformity of dispersion, turbulence of ignition, sample age, etc.) can affect the test results, the test vessel to be used for routine work must be standardized using dust samples whose K_{St} and P_{max} I parameters are known in the 1 m^3 chamber." [**654,** 2017]

NFPA 68 also recognizes this problem and addresses it stating that "the 20 L test apparatus is designed to simulate results of the 1 m^3 chamber; however, the igniter discharge makes it problematic to determine K_{St} values less than 50 bar-m/sec. Where the material is expected to yield K_{St} values less than 50 bar-m/sec, testing in a 1 m^3 chamber might yield lower values." [**654,** 2017]

Any time a combustible dust is processed or handled, a potential for deflagration exists. The degree of deflagration hazard varies, depending on the type of combustible dust and the processing methods used. [**654,** 2017]

A dust deflagration has the following four requirements:

(1) Combustible dust
(2) Dust dispersion in air or other oxidant
(3) Sufficient concentration at or exceeding the minimum explosible concentration (MEC)
(4) Sufficiently powerful ignition source such as an electrostatic discharge, an electric current arc, a glowing ember, a hot surface, welding slag, frictional heat, or a flame

[**654,** 2017]

If the deflagration is confined and produces a pressure sufficient to rupture the confining enclosure, the event is, by definition, an "explosion." [**654,** 2017]

Evaluation of the hazard of a combustible dust should be determined by the means of actual test data. Each situation should be evaluated and applicable tests selected. The following list represents the factors that are sometimes used in determining the deflagration hazard of a dust:

(1) MEC
(2) MIE
(3) Particle size distribution
(4) Moisture content as received and as tested
(5) Maximum explosion pressure at optimum concentration
(6) Maximum rate of pressure rise at optimum concentration
(7) K_{St} (normalized rate of pressure rise) as defined in ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*
(8) Layer ignition temperature
(9) Dust cloud ignition temperature
(10) Limiting oxidant concentration (LOC) to prevent ignition
(11) Electrical volume resistivity
(12) Charge relaxation time
(13) Chargeability

[**654,** 2017]

It is important to keep in mind that as a particulate is processed, handled, or transported, the particle size generally decreases due to particle attrition. Consequently, it is often necessary to evaluate the explosibility of the particulate at multiple points along the process. Where process conditions dictate the use of oxidizing media other than air (nominally taken as 21 percent oxygen and 79 percent nitrogen), the applicable tests should be conducted in the appropriate process specific medium. [**654,** 2017]

3.3.59* Combustible Fiber. Any material in a fibrous or shredded form that readily ignites when heat sources are present.

A.3.3.59 Combustible Fiber. Combustible fibers can include cotton, sisal, henequen, ixtle, jute, hemp, tow, cocoa fiber, oakum, baled waste, baled wastepaper, kapok, hay, straw, excelsior, Spanish moss, or other like materials.

3.3.60 Combustible Liquid. See 3.3.169.1.

3.3.61 Combustible Particulate Solid. See 3.3.248.1.

3.3.62 Combustible Refuse. All combustible or loose rubbish, litter, or waste materials generated by an occupancy that are refused, rejected, or considered worthless and are disposed of by incineration on the premises where generated or periodically transported from the premises.

3.3.63* Combustible Waste. Combustible or loose waste material that is generated by an establishment or process and, if salvageable, is retained for scrap or reprocessing on the premises where generated or transported to a plant for processing.

A.3.3.63 Combustible Waste. These materials include but are not limited to all combustible fibers, hay, straw, hair, feathers, down, wood shavings, turnings, all types of paper products, soiled cloth trimmings and cuttings, rubber trimmings and buffings, metal fines, and any mixture of the previously listed items, or any other salvageable combustible waste materials.

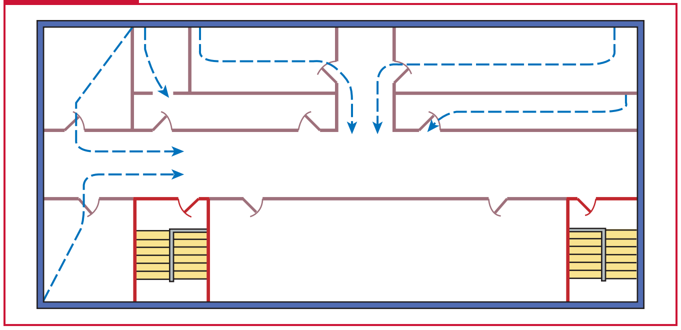
3.3.64 Combustion. A chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light in the form of either a glow or flame.

3.3.65 Commodity. The combination of products, packing material, and container that determines commodity classification. [**13,** 2016]

3.3.66* Common Path of Travel. The portion of exit access that must be traversed before two separate and distinct paths of travel to two exits are available. [***101,*** 2018]

Δ **A.3.3.66 Common Path of Travel.** Common path of travel is measured in the same manner as travel distance but terminates at

Exhibit 3.4



Common paths of travel.

that point where two separate and distinct routes become available. Paths that merge are common paths of travel. [*101,* 2018]

Exhibit 3.4 illustrates the concept of common path of travel. The *Code* limits common path of travel to minimize the probability that occupants will be trapped by a fire by limiting the distance an occupant is forced to travel in one direction before having a choice of traveling in at least two directions to reach separate exits.

3.3.67 Compartment.

3.3.67.1* Fire Compartment. A space within a building that is enclosed by fire barriers on all sides, including the top and bottom. [*101,* 2018]

Δ ***A.3.3.67.1 Fire Compartment.*** Additional fire compartment information is contained in 8.2.2 of NFPA *101*. [*101,* 2018]

In the provisions for fire compartments utilizing the outside walls of a building, it is not intended that the outside wall be specifically fire resistance rated, unless required by other standards. Likewise, it is not intended that outside windows or doors be protected, unless specifically required for exposure protection by another section of this *Code*, NFPA *101*, or by other standards. [*101,* 2018]

3.3.67.2* Smoke Compartment. A space within a building enclosed by smoke barriers on all sides, including the top and bottom. [*101,* 2018]

Δ ***A.3.3.67.2 Smoke Compartment.*** Where smoke compartments using the outside walls or the roof of a building are provided, it is not intended that outside walls or roofs, or any openings therein, be capable of resisting the passage of smoke. Application of smoke compartment criteria where required elsewhere in NFPA *101*, should be in accordance with Section 8.5 of NFPA *101*. [*101,* 2018]

3.3.68 Condition, Existing. See 3.3.104.

3.3.69 Construction Documents. Documents that consist of scaled design drawings and specifications for the purpose of construction of new facilities or modification to existing facilities. *(See also 3.3.239, Shop Drawings.)*

3.3.70 Container. A vessel, including cylinders, tanks, portable tanks, and cargo tanks, used for transporting or storing materials.

3.3.70.1 ASME Container. A container constructed in accordance with the ASME Code. [**58,** 2017]

3.3.70.2 Closed Container. A container as herein defined, so sealed by means of a lid or other device that neither liquid nor vapor will escape from it at ordinary temperatures. [**30,** 2018]

3.3.70.3 Compressed Gas Container. A pressure vessel designed to hold compressed gas at an absolute pressure greater than 1 atmosphere at 68°F (20°C) that includes cylinders, containers, and tanks. [**55,** 2016]

3.3.70.4* Container (Flammable or Combustible Liquid). Any vessel of 119 gal (450 L) or less capacity used for transporting or storing liquids. [**30,** 2018]

A.3.3.70.4 Container (Flammable or Combustible Liquid). The U.S. DOT defines *non-bulk packaging* as having up to 119 gal (450 L) capacity in 49 CFR 171.8. [**30,** 2018]

NFPA 30 defines *container* to be consistent with the U.S. Department of Transportation's (DOT) definition of *non-bulk packaging* in Title 49, Code of Federal Regulations (CFR), Part 171.8, part of which reads "a maximum capacity of 450 L (119 gal) or less as a receptacle for liquids." In this same section, DOT defines *bulk packaging*, as it applies to liquids, as a packaging that has "a maximum capacity greater than 450 L (119 gal)." Bulk packaging includes transport vehicles (in this case, tank vehicles) and large shipping vessels, such as the ISO intermodal tank shown in Exhibit 3.5. Typical ISO tanks are 8 ft (2.4 m), 20 ft (6 m), and 30 ft (9 m) long, with capacities from 10,000 L (2600 gal) to 37,000 L (9800 gal). For the purpose of applying this *Code* and NFPA 30, ISO tanks are treated the same as fixed tanks, as covered in Chapters 21 through 25 of NFPA 30.

Note, however, that Part 178.700 of 49 CFR includes specifications for what it refers to as an "intermediate bulk container" (IBC), a shipping container that has a capacity of not more than 3 m^3 (3000 L, or 793 gal), but not less than 0.45 m^3 (450 L, or

Exhibit 3.5

Typical ISO intermodal tank. (Courtesy of Direct Logistics Pty Ltd.)

Exhibit 3.6

Typical metal intermediate bulk container. (Courtesy of National Packaging Services)

119 gal). Several types of IBCs are available; a metal IBC is shown in Exhibit 3.6. Most IBCs used in the United States tend to be 275 gal to 330 gal (1040 L to 1250 L) capacity and are about 48 in. × 48 in. × 48 in. (1200 mm × 1200 mm × 1200 mm) in size, although the length in any one dimension can range from 40 in. to 50 in. (1015 mm to 1270 mm). The dimensions are compatible with existing rack storage configurations used in warehouses. IBCs of these sizes occupy the same space as four 55 gal (208 L) drums on a pallet, so they represent a 25 to 50 percent increase in warehouse utilization. IBCs are being used more and more in the United States, having been used extensively in Europe for many years.

To minimize confusion, NFPA 30, extracted into this Code, uses a convention whereby containers used to store liquids are separated into three categories:

Container Type	*Capacity, gal (L)*
Non-bulk container	≤119 (450)
Intermediate bulk container	>119 (450) up to 793 (3,000)
Bulk container	>793 (>3,000)

3.3.70.5 Cryogenic Fluids Container. A cryogenic vessel used for transportation, handling, or storage.

3.3.70.6 Intermediate Bulk Container. Any closed vessel having a liquid capacity not exceeding 3000 L (793 gal) and intended for storing and transporting liquids, as defined in Title 49, Code of Federal Regulations, Parts 100 through 199 or in Part 6 of the United Nations *Recommendations on the Transport of Dangerous Goods*. [**30,** 2018]

3.3.70.7 [LP-Gas] Container. Any vessel, including cylinders, tanks, portable tanks, and cargo tanks, used for the transporting or storing of LP-Gases. [**58,** 2017]

As noted in the definition of container, there are several different pressure containers used to store and transport LP-Gas, and each must comply with specific fabrication requirements. The term *container* is a generic description in NFPA 58, *Liquefied Petroleum Gas Code,* and this *Code* for pressure vessels that store LP-Gases and is used by itself whenever it is not necessary to cite a specific type. A container may be either a DOT cylinder or an ASME tank.

3.3.71 Control Area. See 3.3.14.2.

3.3.72* Conventional Pallets. A material-handling aid designed to support a unit load with openings to provide access for material-handling devices. *(See Figure A.3.3.72.)* [**13,** 2016]

A.3.3.72 Conventional Pallets. See Figure A.3.3.72. [**13,** 2016]

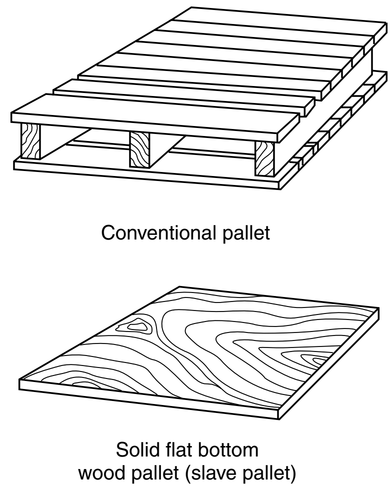


FIGURE A.3.3.72 *Typical Pallets. [**13:**Figure A.3.9.1.10]*

3.3.73 Cooking Fire. The noncommercial, residential burning of materials not exceeding 3 ft (0.9 m) in diameter and 2 ft (0.6 m) in height, other than rubbish in which the fuel burned is contained in an outdoor fireplace, a barbecue grill, or a barbecue pit for the purpose of preparing food.

3.3.74 Cordwood. Logs 8 ft (2.4 m) or less in length customarily intended for pulpwood or fuel uses.

3.3.75 Core. The central tube around which paper is wound to form a roll. [**13,** 2016]

3.3.76* Corrosive Material. See 3.3.180.3.

A.3.3.76 Corrosive Material. A chemical is considered to be corrosive if it destroys or irreversibly changes the structure of the tissue at the site of contact within a specified period of time using one of the *in vivo* or *in vitro* OECD test methods authorized in 49 CFR Part 173.137. For purposes of this code, this term does not refer to action on inanimate surfaces (e.g., steel or aluminum). Available testing data produced prior to September 30, 1995 from the test method in Appendix A to 49 CFR Part 173 in effect on October 1, 1994 can also be used to determine the corrosivity of a material. [**400,** 2016]

3.3.77 Crude Petroleum. Hydrocarbon mixtures that have a flash point below 150°F (65.6°C) and that have not been processed in a refinery. [**30,** 2018]

Technically, a hydrocarbon is a chemical compound that consists only of the elements hydrogen and carbon; for example, heptane [$CH_3(CH2)_5CH_3$]. However, other chemical elements can be present as minor constituents; for example, sulfur (S) or nitrogen (N). For enlightening discussions on the processing of crude petroleum into various petroleum products and into various chemical products, see W. L. Leffler's *Petroleum Refining in Nontechnical Language*, 4th edition, and D. L. Burdick and W. L. Leffler's *Petrochemicals in Nontechnical Language*, 4th edition.

3.3.78 Cryogenic Fluid. A fluid with a boiling point lower than –130°F (–90°C) at an absolute pressure of 14.7 psi (101.3 kPa). [**55,** 2016]

3.3.78.1 Flammable Cryogenic Fluid. A cryogenic fluid that forms flammable mixtures in air when in its vapor state. [**55,** 2016]

3.3.78.2 Inert Cryogenic Fluid. A cryogenic fluid that vaporizes to produce an inert gas when in its vapor state. [**55,** 2016]

3.3.78.3 Oxidizing Cryogenic Fluid. An oxidizing gas in the cryogenic state. [**55,** 2016]

3.3.79* Cultural Resource Properties. Buildings, structures, or sites, or portions thereof, that are culturally significant, or that house culturally significant collections for museums, libraries, and places of worship. [**914,** 2015]

A.3.3.79 Cultural Resource Properties. Such properties include, but are not limited to, museums, libraries, historic structures, and places of worship. [**914,** 2015]

3.3.80 Cylinder. A pressure vessel designed for absolute pressures higher than 40 psi (276 kPa) and having a circular cross-section. It does not include a portable tank, multiunit tank car tank, cargo tank, or tank car. [**55,** 2016]

Exhibit 3.7 illustrates typical U.S. DOT and Transport Canada (U.S. DOT/TC) cylinders. Included are typical industrial truck motor (engine) fuel cylinders and typical stationary and portable cylinders for residential and commercial uses.

Exhibit 3.7

U.S. DOT/TC cylinders. (Courtesy of Manchester Tank)

3.3.81 Cylinder Containment Vessel. A gastight recovery vessel designed so that a leaking compressed gas container can be placed within its confines, thereby encapsulating the leaking container. [**55,** 2016]

3.3.82* Cylinder Pack. An arrangement of cylinders into a cluster where the cylinders are confined into a grouping or arrangement with a strapping or frame system and connections are made to a common manifold. The frame system is allowed to be on skids or wheels to permit movement. [**55,** 2016]

Δ **A.3.3.82 Cylinder Pack.** *Six-packs and twelve-packs* are terms used to further define cylinder packs with a specific number of cylinders. The characteristic internal water volume of individual cylinders in a cylinder pack ranges from 1.52 scf to 1.76 scf (43 L to 50 L) or a water capacity of 95 lb to 110 lb (43 kg to 50 kg). [**55,** 2016]

3.3.83 Damage-Limiting Construction. For the purposes of this code, any set of construction elements, used individually or in combination, which will act to limit damage from an explosion, including open structures, pressure relieving construction, or pressure resistant construction. [**30,** 2018]

With open structures, the force from a combustion explosion — that is, the overpressure — is free to dissipate in all directions. Pressure-relieving construction is used to direct the force in a particular direction by means of pressure-relieving walls or a pressure-relieving roof, with all other structural elements designed to withstand the resulting overpressure. Pressure-resistant construction is designed to contain the force of the explosion.

N **3.3.84 Deficiency.** For the purposes of inspection, testing, and maintenance of water-based fire protection systems, a condition that will or has the potential to adversely impact the performance of a system or portion thereof but does not rise to the level of an impairment. [**25,** 2017]

N ***3.3.84.1 Critical Deficiency.*** A deficiency that, if not corrected, can have a material effect on the ability of the fire protection system or unit to function as intended in a fire event. [**25,** 2017]

N ***3.3.84.2 Noncritical Deficiency.*** A deficiency that does not have a material effect on the ability of the fire protection system or unit to function in a fire event, but correction is needed to meet the requirements of this standard or for the proper inspection, testing, and maintenance of the system or unit. [**25,** 2017]

One of the more difficult tasks associated with the application of this *Code* and NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, is determining how to treat deficiencies that are found while conducting inspections and tests on water-based fire protection systems. While it is clear in the standard that all deficiencies are required to be corrected, NFPA 25 recognizes that all deficiencies do not have the same impact on a system's ability to provide a reasonable degree of protection. Although it might be desirable to treat the correction of all deficiencies the same, it is not practical.

In deference to the concept of reason, the standard recognizes that judgment should be used when determining how to address corrective actions for deficiencies. A system with critical and noncritical deficiencies will still operate, but its performance might be impacted negatively. The term *material effect* is used to separate the deficiencies. There is no way for judgment to be excluded with the classification of deficiencies. Table A.3.3.7 in NFPA 25 provides guidance, but even with this information, it is impossible to classify every situation. Some inspectors classify deficiencies, but the most common industry practice is to have the inspector record all observed deficiencies, followed by a subsequent classification conducted by a qualified individual or team. However, if the inspector identifies any severe impairments, such as a shut water control valve or an inoperable fire pump, those deficiencies must be reported immediately.

3.3.85 Deflagration. Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium. [**68,** 2013]

N **3.3.86 Desolventizing.** The act of removing a solvent from a material.

3.3.87 Detector. A device suitable for connection to a circuit that has a sensor that responds to a physical stimulus such as gas, heat or smoke. [**72,** 2016]

3.3.87.1 Air Sampling–Type Detector. A detector that consists of a piping or tubing distribution network that runs from the detector to the area(s) to be protected. An aspiration fan in the detector housing draws air from the protected area back to the detector through air-sampling ports, piping, or tubing. At the detector, the air is analyzed for fire products. [**72,** 2016]

Exhibit 3.8

Duct smoke detector (passive). (Source: System Sensor Corp., St. Charles, IL)

Air sampling–type detectors are either passive or active. Duct smoke detectors, as shown in Exhibit 3.8, are typically considered passive detection devices. Active sampling requires the creation of a negative pressure within a sampling tube to draw products of combustion from the protected area or protected space into the sampling network. Vacuum pumps or blower assemblies normally create this negative pressure. An active air-sampling smoke detector is illustrated in Exhibit 3.9.

3.3.87.2 Automatic Fire Detector. A device designed to detect the presence of a fire signature and to initiate action. For the purpose of this *Code*, automatic fire detectors are classified as follows: Automatic Fire Extinguishing or Suppression System Operation Detector, Fire–Gas Detector, Heat Detector, Other Fire Detectors, Radiant Energy–Sensing Fire Detector, and Smoke Detector. [**72,** 2016]

3.3.87.3 Automatic Fire Extinguishing or Suppression System Operation Detector. A device that automatically detects the operation of a fire extinguishing or suppression system by means appropriate to the system employed. [**72,** 2016]

Exhibit 3.9

Air-sampling smoke detectors (active). (Source: Vision Fire & Security Inc., Norwell, MA)

Examples of automatic fire extinguishing or suppression system operation alarm initiating devices are agent discharge flow switches and agent discharge pressure switches.

3.3.87.4* Combination Detector. A device that either responds to more than one of the fire phenomena or employs more than one operating principle to sense one of these phenomena. Typical examples are a combination of a heat detector with a smoke detector or a combination rate-of-rise and fixed-temperature heat detector. This device has listings for each sensing method employed. [**72,** 2016]

A.3.3.87.4 Combination Detector. These detectors do not utilize a mathematical evaluation principle of signal processing more than a simple "or" function. Normally, these detectors provide a single response resulting from either sensing method, each of which operates independent of the other. These detectors can provide a separate and distinct response resulting from either sensing method, each of which is processed independent of the other. [**72,** 2016]

3.3.87.5 Electrical Conductivity Heat Detector. A line-type or spot-type sensing element in which resistance varies as a function of temperature. [**72,** 2016]

3.3.87.6 Fire–Gas Detector. A device that detects gases produced by a fire. [**72,** 2016]

Examples of fire gases include hydrogen chloride (HCl) and carbon monoxide (CO). Fire–gas detectors designed for CO detection should not be confused with CO warning equipment designed to prevent CO poisoning by alerting occupants to the presence of CO gas in the home.

3.3.87.7* Fixed-Temperature Detector. A device that responds when its operating element becomes heated to a predetermined level. [**72,** 2016]

A.3.3.87.7 Fixed-Temperature Detector. The difference between the operating temperature of a fixed-temperature device and the surrounding air temperature is proportional to the rate at which the temperature is rising. The rate is commonly referred to as *thermal lag*. The air temperature is always higher than the operating temperature of the device. [**72,** 2016]

Typical examples of fixed-temperature sensing elements are as follows:

(1) *Bimetallic.* A sensing element comprised of two metals that have different coefficients of thermal expansion arranged so that the effect is deflection in one direction when heated and in the opposite direction when cooled.
(2) *Electrical Conductivity.* A line-type or spot-type sensing element in which resistance varies as a function of temperature.
(3) *Fusible Alloy.* A sensing element of a special composition metal (eutectic) that melts rapidly at the rated temperature.
(4) *Heat-Sensitive Cable.* A line-type device in which the sensing element comprises, in one type, two current-carrying wires separated by heat-sensitive insulation that softens at the rated temperature, thus allowing the wires to make electrical contact. In another type, a single wire is centered in a metallic tube, and the intervening space is filled with a substance that becomes conductive at a critical temperature, thus establishing electrical contact between the tube and the wire.
(5) *Liquid Expansion.* A sensing element comprising a liquid that is capable of marked expansion in volume in response to an increase in temperature.

[**72,** 2016]

Exhibit 3.10 illustrates a typical fixed-temperature heat detector.

3.3.87.8* Flame Detector. A radiant energy–sensing fire detector that detects the radiant energy emitted by a flame. (*Refer to A.17.8.2 of NFPA 72.*) [**72,** 2016]

A.3.3.87.8 Flame Detector. Flame detectors are categorized as ultraviolet, single wavelength infrared, ultraviolet infrared, or multiple wavelength infrared. [**72,** 2016]

Exhibit 3.11 illustrates a typical flame detector.

Exhibit 3.10

Typical fixed-temperature (nonrestorable) heat detector. (Source: Kidde-Fenwal, Ashland, MA)

Exhibit 3.11

Typical flame detector. (Source: Det-Tronics Corp., Minneapolis, MN)

3.3.87.9 Gas Detector. A device that detects the presence of a specified gas concentration. Gas detectors can be either spot-type or line-type detectors. [**72,** 2016]

3.3.87.10 Heat Detector. A fire detector that detects either abnormally high temperature or rate of temperature rise, or both. [**72,** 2016]

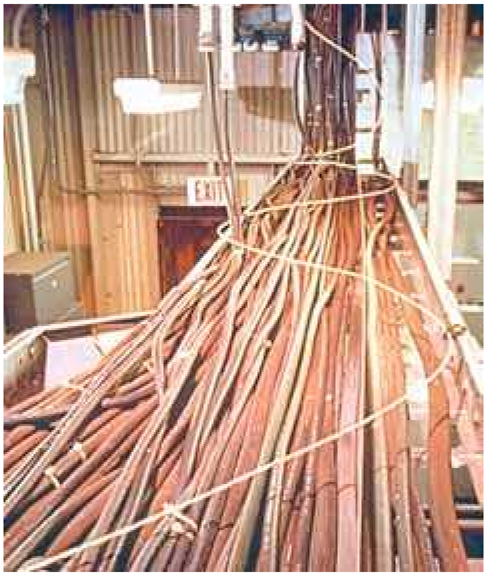
Many types of heat detectors are available. A typical spot-type heat detector is shown in the commentary to 3.3.87.22 (Exhibit 3.13). For descriptions of other types of heat detectors, see the definitions of the terms *electrical conductivity heat detector, fixed-temperature detector* (see Exhibit 3.10), *line-type detector, pneumatic rate-of-rise tubing detector, rate compensation detector,* and *rate-of-rise detector* in 3.3.87.

3.3.87.11 Line-Type Detector. A device in which detection is continuous along a path. Typical examples are rate-of-rise pneumatic tubing detectors, projected beam smoke detectors, and heat-sensitive cable. [**72,** 2016]

Exhibit 3.12 illustrates a typical line-type detector installed in a cable tray application.

3.3.87.12* Multi-Criteria Detector. A device that contains multiple sensors that separately respond to physical stimulus such as heat, smoke, or fire gases, or employs more than one sensor to sense the same stimulus. This sensor is capable of generating only one alarm signal from the sensors employed in the design either independently or in combination. The sensor output signal is mathematically evaluated to determine when an alarm signal is warranted. The evaluation can be performed either at the detector or at the control unit. This detector has a single listing that establishes the primary function of the detector. [**72,** 2016]

Exhibit 3.12



Typical line-type detector. (Courtesy of Protectowire Co. Inc.)

A.3.3.87.12 Multi-Criteria Detector. A multi-criteria detector is a detector that contains multiple sensing methods that respond to fire signature phenomena and utilizes mathematical evaluation principles to determine the collective status of the device and generates a single output. Typical examples of multi-criteria detectors are a combination of a heat detector with a smoke detector, or a combination rate-of-rise and fixed-temperature heat detector that evaluates both signals using an algorithm to generate an output such as pre-alarm or alarm. The evaluation can be performed either at the detector or at the control unit. Other examples are detectors that include sensor combinations that respond in a predictable manner to any combination of heat, smoke, carbon monoxide, or carbon dioxide. [**72,** 2016]

Multi-criteria devices use several sensors to detect multiple conditions and analyze the readings of the sensors. Types of sensors include heat, flame, smoke, and carbon monoxide and predict with improved accuracy, and faster response, the presence of a fire source. The multiple sensing technologies independently collect fire signatures and environmental conditions. The detector uses proprietary software algorithms to evaluate the signals from the array of sensors then provide a single output. Signals are not available as individual outputs. Multi-criteria detectors also have the capability to reject nuisance alarm sources such as dust, smoking, welding, steam, and aerosols.

3.3.87.13* Multi-Sensor Detector. A device that contains multiple sensors that separately respond to physical stimulus such as heat, smoke, or fire gases, or employs more than one sensor to sense the same stimulus. A device capable of generating multiple alarm signals from any one of the sensors employed in the design, independently or in combination. The sensor output signals are mathematically evaluated to determine when an alarm signal is warranted. The evaluation can be performed either at the detector or at the control unit. This device has listings for each sensing method employed. [**72,** 2016]

A.3.3.87.13 Multi-Sensor Detector. Typical examples of multi-sensor detectors are a combination of a heat detector with a smoke detector, or a combination rate-of-rise and fixed-temperature heat detector that evaluates both signals using an algorithm to generate an output such as pre-alarm or alarm. The evaluation can be performed either at the detector or at the control unit. Other examples are detectors that include sensor combinations that respond in a predictable manner to any combination of heat, smoke, carbon monoxide, or carbon dioxide. [**72,** 2016]

3.3.87.14 Other Fire Detectors. Devices that detect a phenomenon other than heat, smoke, flame, or gases produced by a fire. [**72,** 2016]

3.3.87.15 Pneumatic Rate-of-Rise Tubing Heat Detector. A line-type detector comprising small-diameter tubing, usually copper, that is installed on the ceiling or high on the walls throughout the protected area. The tubing is terminated in a detector unit containing diaphragms and associated contacts set to actuate at a predetermined pressure. The system is sealed except for calibrated vents that compensate for normal changes in temperature. [**72,** 2016]

3.3.87.16 Projected Beam–Type Detector. A type of photoelectric light obscuration smoke detector wherein the beam spans the protected area. [**72,** 2016]

Projected beam–type detectors are often used in large open areas such as atria, convention halls, auditoriums, and gymnasiums and where a building or portion of a building has a high ceiling.

3.3.87.17 Radiant Energy–Sensing Fire Detector. A device that detects radiant energy, such as ultraviolet, visible, or infrared, that is emitted as a product of combustion reaction and obeys the laws of optics. [**72,** 2016]

3.3.87.18* Rate Compensation Detector. A device that responds when the temperature of the air surrounding the device reaches a predetermined level, regardless of the rate of temperature rise. [**72,** 2016]

A.3.3.87.18 Rate Compensation Detector. A typical example of a rate compensation detector is a spot-type detector with a tubular casing of a metal that tends to expand lengthwise as it is heated and an associated contact mechanism that closes at a certain point in the elongation. A second metallic element inside the tube exerts an opposing force on the contacts, tending to hold them open. The forces are balanced in such a way that, on a slow rate-of-temperature rise, there is more time for heat to penetrate to the inner element, which inhibits contact closure until the total device has been heated to its rated temperature level. However, on a fast rate-of-temperature rise, there is not as much time for heat to penetrate to the inner element, which exerts less of an inhibiting effect so that contact closure is achieved when the total device has been heated to a lower temperature. This, in effect, compensates for thermal lag. [**72,** 2016]

In addition to the benefit of having limited thermal lag, this type of detector also can be used outdoors in challenging environments. It is a desired substitute initiating device when environmental conditions do not permit the use of a spot-type smoke detector, such as in exterior elevator lobbies where Phase I Emergency Recall Operation is provided.

3.3.87.19* Rate-of-Rise Detector. A device that responds when the temperature rises at a rate exceeding a predetermined value. [**72,** 2016]

A.3.3.87.19 Rate-of-Rise Detector. Typical examples of rate-of-rise detectors are as follows:

(1) *Pneumatic Rate-of-Rise Tubing.* A line-type detector comprising small-diameter tubing, usually copper, that is installed on the ceiling or high on the walls throughout the protected area. The tubing is terminated in a detector unit that contains diaphragms and associated contacts set to actuate at a predetermined pressure. The system is sealed except for calibrated vents that compensate for normal changes in temperature.
(2) *Spot-Type Pneumatic Rate-of-Rise Detector.* A device consisting of an air chamber, a diaphragm, contacts, and a compensating vent in a single enclosure. The principle of operation is the same as that described for pneumatic rate-of-rise tubing.
(3) *Electrical Conductivity–Type Rate-of-Rise Detector.* A line-type or spot-type sensing element in which resistance changes due to a change in temperature. The rate of change of resistance is monitored by associated control equipment, and an alarm is initiated when the rate of temperature increase exceeds a preset value.

[**72,** 2016]

3.3.87.20 Smoke Detector. A device that detects visible or invisible particles of combustion. [**72,** 2016]

The definition of *smoke detector* uses the phrase "particles of combustion" to distinguish the effluent matter consisting of soot particles, gas molecules, vapor molecules, and ash particles from the heat and radiant energy liberated by the combustion reaction that is deemed energy. Matter flowing from the fire in the effluent plume is referenced in the term *smoke*. Types of smoke detectors are distinguished by the technology they use to detect the matter in the smoke plume.

3.3.87.21 Spark/Ember Detector. A radiant energy–sensing fire detector that is designed to detect sparks or embers, or both. These devices are normally intended to operate in dark environments and in the infrared part of the spectrum. [**72,** 2016]

3.3.87.22 Spot-Type Detector. A device in which the detecting element is concentrated at a particular location. Typical examples are bimetallic detectors, fusible alloy detectors, certain pneumatic rate-of-rise detectors, certain smoke detectors, and thermoelectric detectors. [**72,** 2016]

A typical spot-type fixed-temperature heat detector is depicted in Exhibit 3.13.

Exhibit 3.13

A typical spot-type heat detector.

3.3.88 Detonation. Propagation of a combustion zone at a velocity that is greater than the speed of sound in the unreacted medium. [**68,** 2013]

3.3.89 Dispensing. The pouring or transferring of a material from a container tank, or similar vessel whereby vapors, dusts, fumes, mists, or gases could be liberated to the atmosphere. [**5000,** 2018]

3.3.90 Distillery. A plant or that portion of a plant where liquids produced by fermentation are concentrated and where the concentrated products are also mixed, stored, or packaged. [**30,** 2018]

3.3.91 Distributor. A business engaged in the sale or resale, or both, of compressed gases or cryogenic fluids, or both. [**55,** 2016]

3.3.92 Dormitory. See 3.3.192.9

3.3.93 DOT. U.S. Department of Transportation.

3.3.94 Driveway. A clear space suitable for fire-fighting operations by motorized fire apparatus.

3.3.95 Dwelling Unit. One or more rooms arranged for complete, independent housekeeping purposes, with space for eating, living, and sleeping; facilities for cooking; and provisions for sanitation. [**5000,** 2018]

3.3.95.1 One- and Two-Family Dwelling Unit. See 3.3.192.25.1.

3.3.96 Emergency. A fire, explosion, or hazardous condition that poses an immediate threat to the safety of life or damage to property.

3.3.97 Emergency Relief Vent. An opening, construction method, or device that will automatically relieve excessive internal pressure due to an exposure fire. [**30,** 2018]

An emergency relief vent is a device, normally closed, on a storage tank to provide additional pressure relief capacity if the tank is subjected to an external fire. The vent is not there to prevent rupture of the tank due to an explosion within the tank's vapor space. When a storage tank is exposed to an external fire, the contents are heated to the point where vapors evolve faster than can be accommodated by the normal breather vent. The emergency relief vent provides the extra capacity necessary to ensure that the pressure inside the tank does not reach a level that might damage the shell or roof of the tank. This extra capacity is especially important where the exposing fire is intense enough to boil the contents of the tank.

3.3.98 Emergency Shutoff Valve. A designated valve designed to shut off the flow of gases or liquids. [**55,** 2016]

3.3.99 Ethylene Oxide Drum. For the purposes of this code, containers built to UN specification 1A1. [**55,** 2016]

3.3.100 Excess Flow Control. A fail-safe system or approved means designed to shut off flow due to a rupture in pressurized piping systems. [**55,** 2016]

3.3.101 Excess Flow Valve. A valve inserted into a compressed gas cylinder, portable tank, or stationary tank that is designed to positively shut off the flow of gas in the event that its predetermined flow is exceeded.

3.3.102* Exhausted Enclosure. An appliance or piece of equipment that consists of a top, a back, and two sides that provides a means of local exhaust for capturing gases, fumes, vapors, and mists. [**55,** 2016]

A.3.3.102 Exhausted Enclosure. Such enclosures include laboratory hoods, exhaust fume hoods, and similar appliances and equipment used to retain and exhaust locally the gases, fumes, vapors, and mists that could be released. Rooms or areas provided with general ventilation, in and of themselves, are not exhausted enclosures. [**55,** 2016]

3.3.103* Existing. That which is already in existence on the date this edition of the *Code* goes into effect. [***101,*** 2018]

A.3.3.103 Existing. See A.3.3.29.5, Existing Building. [***101,*** 2018]

3.3.104 Existing Condition. Any situation, circumstance, or physical makeup of any structure, premise, or process that was ongoing or in effect prior to the adoption of this *Code*.

3.3.105* Exit. That portion of a means of egress that is separated from all other spaces of the building or structure by construction, location, or equipment as required to provide a protected way of travel to the exit discharge. [***101,*** 2018]

A.3.3.105 Exit. Exits include exterior exit doors, exit passageways, horizontal exits, exit stairs, and exit ramps. In the case of a stairway, the exit includes the stair enclosure, the door to the stair enclosure, stairs and landings inside the enclosure, the door from the stair enclosure to the outside or to the level of exit discharge, and any exit passageway and its associated doors, if such are provided, so as to discharge the stair directly to the outside. In the case of a door leading directly from the street floor to the street or open air, the exit comprises only the door. [***101,*** 2018]

Doors of small individual rooms, as in hotels, while constituting exit access from the room, are not referred to as exits, except where they lead directly to the outside of the building from the street floor. [***101,*** 2018]

The definition of the term *exit* includes the word *location* so as to clarify that the requisite protected way of travel might be accomplished relative to where the exit is located. For example, a door opening to the outside from the main lobby of a building might be considered an exit, although the opening is not separated from other parts of the building. Exhibit 3.14 illustrates an enclosed exit stair that qualifies as being an exit because of its separation from the remainder of the building by fire-rated construction.

3.3.105.1* Horizontal Exit. A way of passage from one building to an area of refuge in another building on approximately the same level, or a way of passage through or around a fire barrier to an area of refuge on approximately the same level in the same building that affords safety from fire and smoke originating from the area of incidence and areas communicating therewith. [***101,*** 2018]

Exhibit 3.14

An enclosed stair that constitutes an exit.

A.3.3.105.1 Horizontal Exit. Horizontal exits should not be confused with egress through doors in smoke barriers. Doors in smoke barriers are designed only for temporary protection against smoke, whereas horizontal exits provide protection against serious fire for a relatively long period of time in addition to providing immediate protection from smoke. *(See 7.2.4 of NFPA 101.)* [***101,*** 2018]

A horizontal exit is a fire barrier with fire doors that provide passage from one fire compartment of a building to another fire compartment in the same building or in an adjoining building on approximately the same level. Substantial fire separations are required because the area to which egress is made serves as a temporary safe haven. The horizontal exit might be a combination of a 2-hour fire resistance–rated barrier separating a building into two areas with 1½-hour fire protection–rated door assemblies that allow travel from one side of the barrier to the other; or the horizontal exit might be a bridge or balcony that allows travel to an adjoining building.

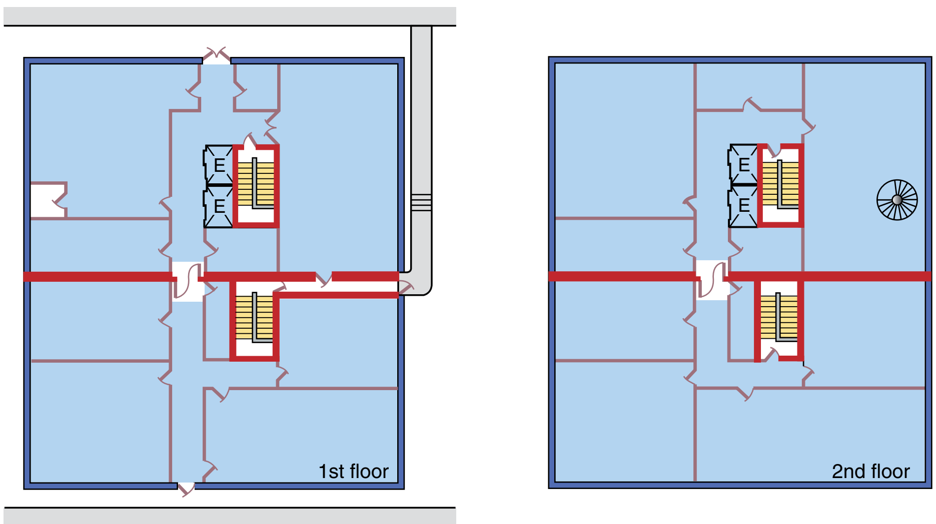
Horizontal exits are useful particularly in health care occupancies and in detention and correctional occupancies where they are important components of an effective defend-in-place occupant protection strategy. Horizontal exits make it possible to move nonambulatory patients to a temporary safe area rather than vertically down stairs. They provide additional safety to residents of detention and correctional occupancies by allowing those residents to be relocated within a building rather than requiring reliance on staff to unlock doors to allow them to evacuate to the outside.

3.3.106 Exit Access. That portion of a means of egress that leads to an exit. [***101,*** 2018]

Exit access includes the rooms and building spaces that people can occupy and the doors, aisles, corridors, unenclosed stairs, and unenclosed ramps that must be traversed to reach an exit. Spaces constituting exit access are shown in Exhibit 3.15.

All spaces occupied and traversed in reaching an exit are considered the exit access portion of the means of egress. From the shading shown in Exhibit 3.15, exit access comprises more

Exhibit 3.15



Spaces constituting exit access.

floor area than either of the other components of means of egress — the exit and exit discharge.

3.3.107 Exit Discharge. That portion of a means of egress between the termination of an exit and a public way. [***101,*** 2018]

Some exits do not discharge directly to a public way, so the exit discharge is defined as a path of travel from the termination of an exit to a public way. This travel might be inside or outside the building. Where an exit opens onto an alley, court, or yard, a safe path of travel must be provided to a public way or equivalent safe area. This portion of the means of egress is the exit discharge. Forms of exit discharge are shown in Exhibit 3.16.

Because occupants leave the building at the first floor only, no exit discharge occurs on the second floor of Exhibit 3.16. On the first floor, the exit discharge includes (a) the exterior path of travel beginning at the exterior doors from the corridor and continuing to the public way (street), (b) the exterior walkway along the side of the building beginning at the door from the exit passageway and continuing to the public way, and (c) the interior path of travel from the second-floor exit stair discharging through a portion of the first-floor corridor. For an occupant from the second floor who must travel across a portion of the first floor, this area is considered exit discharge, yet an occupant of the first floor can travel across the same space and is considered to be within exit access. Requirements for such interior exit discharge arrangements are specified in 14.11.2.

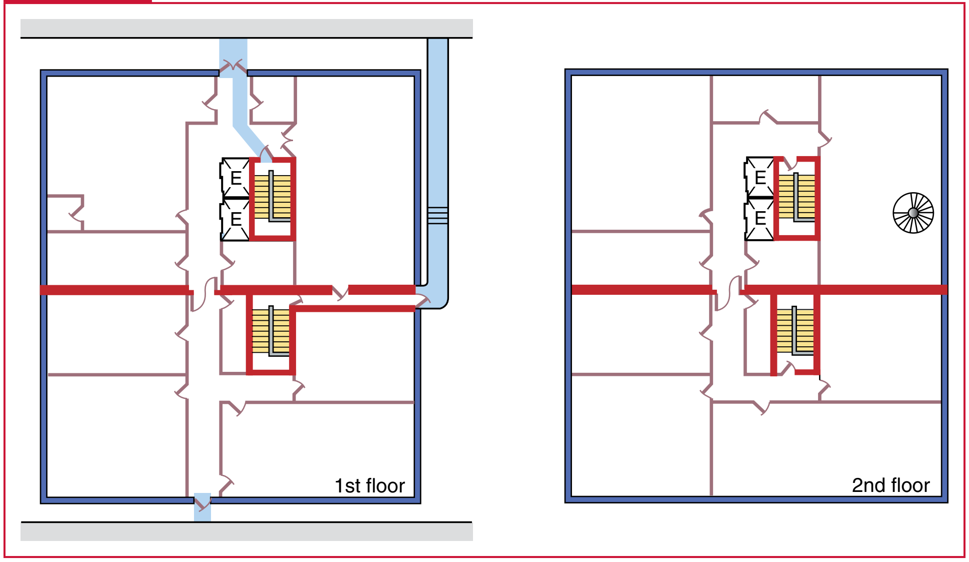
3.3.108 Explosion. The bursting or rupture of an enclosure or a container due to the development of internal pressure from a deflagration. [**69,** 2014]

3.3.109* Explosion Control. A means of either preventing an explosion through the use of explosion suppression, fuel reduction, or oxidant reduction systems or a means to prevent the structural collapse of a building in the event of an explosion through the use of deflagration venting, barricades, or related construction methods. [**55,** 2016]

Δ **A.3.3.109 Explosion Control.** NFPA 68 provides guidance on the use of deflagration venting systems in buildings and other enclosures. The primary purpose of a venting system is to relieve the overpressure produced in an explosion to limit the potential damage to the building where the explosion occurs. Although some structural damage can be anticipated, the use of relief venting is expected to prevent massive building failure and collapse. In cases where detonation is probable, venting is often used in conjunction with barricade construction where the pressure-resistant portions of the building have been constructed to resist the pressures anticipated should an explosive event occur. Design of barricade systems is highly specialized and the subject of military standards applicable to the subject. NFPA 69 provides guidance on the use of suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion. When relief vents are to be used as a means to provide explosion relief, the fundamental requirements of the building code for structural elements, including snow, wind, and seismic events, should be considered. In some instances, the requirements for wind resistance can impose more rigorous requirements on the relief vents than required by the engineering analysis used to determine the relief pressure. In such cases, users must demonstrate that the relief vents will not become airborne or release in such a manner as to create secondary hazards within or external to the building in which they are installed. Specific designs might require approval by the AHJ. [**55,** 2016]

3.3.110* Explosive Material. A chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion. [**5000,** 2018]

Exhibit 3.16



Spaces constituting exit discharge.

A.3.3.110 Explosive Material. The term *explosive material* includes, but is not limited to, dynamite, blackpowder, pellet powder, initiating explosives, detonators, safety fuses, squibs, detonating cord, igniter cord, igniters, and Display Fireworks 1.3G (Class B, Special). The term *explosive* includes any material determined to be within the scope of Title 18, United States Code, Chapter 40, and also includes any material classified as an explosive, other than Consumer Fireworks 1.4G (Class C, Common), by the Hazardous Materials Regulations of the U.S. Department of Transportation (DOT) in 49 CFR. [**5000,** 2018]

The former classification system used by the DOT included the terms *high explosive* and *low explosive*, as further defined in 3.3.406.3.2 of *NFPA 5000*. These terms remain in use by the U.S. Bureau of Alcohol, Tobacco, and Firearms or explosives. Explosive materials classified as hazard Class 1 are further defined under the current system applied by DOT. Compatibility group letters are used in concert with division numbers to specify further limitations on each division noted. For example, the letter G (as in 1.4G) identifies substances or articles that contain a pyrotechnic substance and similar materials. UN/DOT Class 1 Explosives are defined as follows:

(1) Division 1.1 explosives are explosives that are a mass explosion hazard, which is a hazard that instantaneously affects almost the entire load.
(2) Division 1.2 explosives are explosives that are a projection hazard but not a mass explosion hazard.
(3) Division 1.3 explosives are explosives that are a fire hazard and either a minor blast hazard or a minor projection hazard, or both, but not a mass explosion hazard.
(4) Division 1.4 explosives are explosives that pose a minor explosion hazard and meet both of the following criteria:
    (a) The explosive effects are largely confined to the package, and no projection of fragments of appreciable size or range is to be expected.
    (b) An external fire cannot cause virtually instantaneous explosion of almost the entire contents of the package.
(5) Division 1.5 explosives are very insensitive explosives that are comprised of substances that are a mass explosion hazard, but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of transport.
(6) Division 1.6 explosives are extremely insensitive articles that are not a mass explosion hazard, that are comprised of articles that contain only extremely insensitive detonating substances, and that demonstrate a negligible probability of accidental initiation or propagation.

[**5000,** 2018]

N **3.3.111 Extraction Room (Marijuana).** The room or space in which the solvent–based extraction process of marijuana occurs.

3.3.112 Facility. As applied to access and water supply, a structure or use in a fixed location including exterior storage, use, and handling areas that relates to the occupancies and operations covered by this *Code*.

N ***3.3.112.1 Animal Housing Facility.*** Area of a building or structure, including interior and adjacent exterior spaces, where animals are fed, rested, worked, exercised, treated, exhibited, or used for production.

3.3.112.2 Hazardous Material Storage Facility. See 3.3.150.

3.3.112.3 Limited Care Facility. See 3.3.192.16.

3.3.112.4 Motor Fuel Dispensing Facility. See 3.3.192.22.

3.3.112.4.1 Fleet Vehicle Motor Fuel Dispensing Facility. See 3.3.192.22.1.

3.3.112.4.2 Marine Motor Fuel Dispensing Facility. See 3.3.192.22.2.

3.3.112.4.3 Motor Fuel Dispensing Facility Located Inside a Building. See 3.3.192.22.3.

3.3.113 Fail-Safe. A design arrangement incorporating one or more features that automatically counteracts the effect of an anticipated source of failure or which includes a design arrangement that eliminates or mitigates a hazardous condition by compensating automatically for a failure or malfunction.

3.3.114 Festival Seating. A form of audience/spectator accommodation in which no seating, other than a floor or finished ground level, is provided for the audience/spectators gathered to observe a performance. [***101,*** 2018]

3.3.115 Fines (Wood). Small pieces or splinters of wood byproducts that can pass through a 0.25 in. (6.4 mm) screen.

3.3.116 Finish.

3.3.116.1 Interior Ceiling Finish. The interior finish of ceilings. [***101,*** 2018]

3.3.116.2* Interior Finish. The exposed surfaces of walls, ceilings, and floors within buildings. [***101,*** 2018]

A.3.3.116.2 Interior Finish. Interior finish is not intended to apply to surfaces within spaces such as those that are concealed or inaccessible. Furnishings that, in some cases, might be secured in place for functional reasons should not be considered as interior finish. [***101,*** 2018]

3.3.116.3* Interior Floor Finish. The interior finish of floors, ramps, stair treads and risers, and other walking surfaces. [***101,*** 2018]

A.3.3.116.3 Interior Floor Finish. Interior floor finish includes coverings applied over a normal finished floor or stair treads and risers. [***101:***A.3.3.92.3]

3.3.116.4* Interior Wall Finish. The interior finish of columns, fixed or movable walls, and fixed or movable partitions. [***101,*** 2018]

N ***A.3.3.116.4 Interior Wall Finish.*** Such partitions are intended to include washroom water closet partitions. [***101,*** 2018]

3.3.117 Fires, Classification of.

3.3.117.1 Class A Fires. Class A fires are fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics. [**10,** 2017]

3.3.117.2 Class B Fires. Class B fires are fires in flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases. [**10,** 2017]

3.3.117.3 Class C Fires. Class C fires are fires that involve energized electrical equipment. [**10,** 2017]

3.3.117.4 Class D Fires. Class D fires are fires in combustible metals, such as magnesium, titanium, zirconium, sodium, lithium, and potassium. [**10,** 2017]

3.3.117.5 Class K Fires. Class K fires are fires in cooking appliances that involve combustible cooking media (vegetable or animal oils and fats). [**10,** 2017]

Some hand portable fire extinguishers are acceptable for use only on one class of fire. A water fire extinguisher is very efficient at extinguishing Class A fires but is not safe to use on Class B and Class C fires. Water spreads burning liquids and is a conductor of electricity. Some types of fire extinguishers are effective on several types of fires. An A:B:C-type dry chemical unit can extinguish ordinary combustibles and flammable liquids and is safe to use on energized electrical equipment. Class D fire extinguishers are highly specialized, and each type is designed to extinguish fires in a particular combustible metal or group of metals, as indicated on the fire extinguisher label. Class K fire extinguishers are a newer class of fire extinguishers designed to handle the fire challenges of cooking appliances that use combustible cooking media consisting of vegetable or animal oils and fats.

3.3.118 Fire, Recreational. See 3.3.226.

3.3.119 Fire Alarm System. See 3.3.267.10.

3.3.120 Fire Compartment. See 3.3.67.1.

3.3.121 Fire Department Access Road. The road or other means developed to allow access and operational setup for fire-fighting and rescue apparatus.

3.3.122 Fire Door Assembly. Any combination of a fire door, a frame, hardware, and other accessories that together provide a specific degree of fire protection to the opening. [**80,** 2016]

3.3.123 Fire Flow. The flow rate of a water supply, measured at 20 psi (137.9 kPa) residual pressure, that is available for fire fighting.

3.3.124 Fire Hazard. Any situation, process, material, or condition that, on the basis of applicable data, can cause a fire or explosion or that can provide a ready fuel supply to augment the spread or intensity of a fire or explosion, all of which pose a threat to life or property. [**914,** 2015]

3.3.125* Fire Hydrant. A valved connection on a water supply system having one or more outlets and that is used to supply hose and fire department pumpers with water. [**1141,** 2017]

A.3.3.125 Fire Hydrant. See Figure A.3.3.125(a) and Figure A.3.3.125(b). [**25,** 2017]

3.3.126* Fire Lane. A fire department access road, which is marked with approved signs or other approved notices.

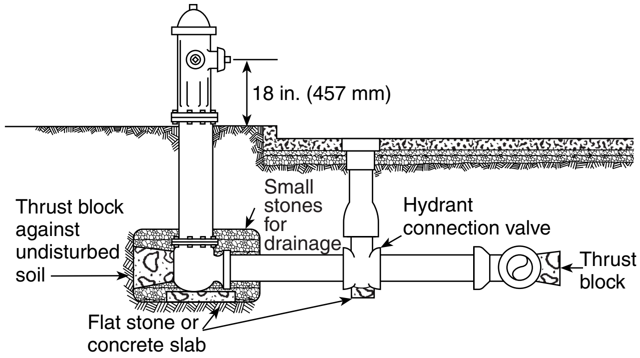


FIGURE A.3.3.125(a) *Typical Fire Hydrant Connection. [**25:**Figure A.3.3.12(a)]*

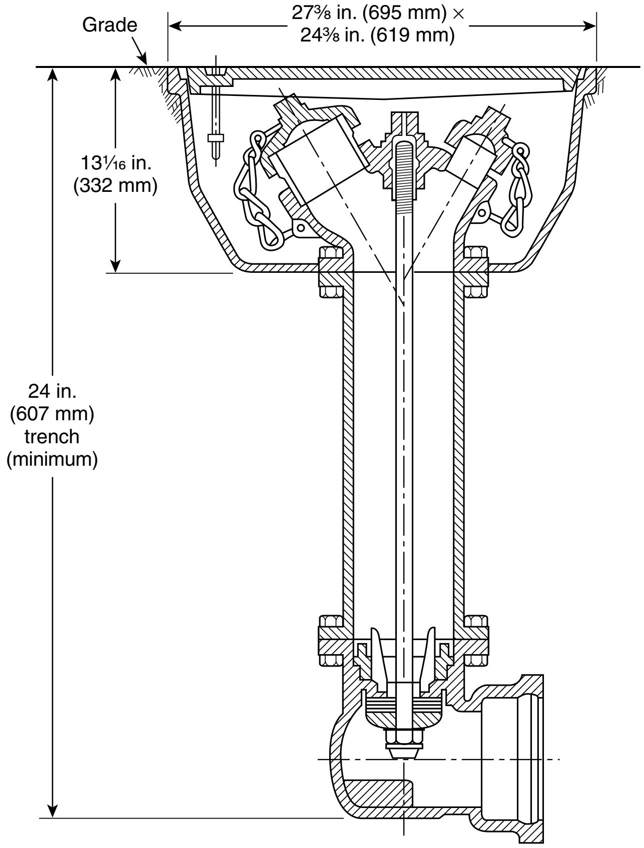


FIGURE A.3.3.125(b) *Flush-Type Hydrant. [**25:**Figure A.3.3.12(b)]*

A.3.3.126 Fire Lane. The traditional term *fire lane* is no longer utilized in this *Code*. However, a fire department access road that is marked and prohibits obstructions in accordance with 18.2.3.6 would meet the traditional intent of a fire lane.

3.3.127 Fire Point. The lowest temperature at which a liquid will ignite and achieve sustained burning when exposed to a test flame in accordance with ASTM D92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester.* [**30,** 2018]

Fire point (or the lack of one) is used to exempt certain liquids from compliance with the NFPA 30 requirements for container storage, as stated in 9.1.4(5) of NFPA 30. See also the commentary to 4.2.4 and Supplement 2, Basic Properties and Definition of Flammable and Combustible Liquids, of the *Flammable and Combustible Liquids Code Handbook.*

3.3.128 Fire Retardant. A liquid, solid, or gas that tends to inhibit combustion when applied on, mixed in, or combined with combustible materials.

Δ **3.3.129 Fire Watch.** The assignment of a person or persons to an area for the express purpose of notifying the fire department, the building occupants, or both of an emergency; preventing a fire from occurring; extinguishing small fires; protecting the public from fire and life safety dangers.

N **3.3.130* Fireworks.** Any composition or device for the purpose of producing a visible or an audible effect for entertainment purposes by combustion, deflagration, or detonation, that meets the definition of *Consumer Fireworks* or *Display Fireworks* as set forth in NFPA 1124. [**1124,** 2017]

N **A.3.3.130 Fireworks.** Toy caps for use in toy pistols, toy canes, toy guns, and novelties and trick noisemakers are not considered to be fireworks *(see Annex C of NFPA 1124)*. The regulations referred to limit the explosive content of each toy cap to not more than an average of 0.25 gr (16.2 mg). Also, each package containing such caps has to be labeled to indicate the maximum explosive content per cap. For information on the use of model rockets and model rocket motors, see NFPA 1122. For information on the use of high power rockets and high power rocket motors, see NFPA 1127. Model rockets, model rocket motors, high power rockets, and high power rocket motors designed, sold, and used for the purpose of propelling recoverable aero models are not considered to be fireworks. [**1124,** 2017]

Δ ***3.3.130.1* Display Fireworks.*** Large fireworks devices that are explosive materials intended for use in fireworks displays and designed to produce visible or audible effects by combustion, deflagration, or detonation, as set forth in 27 CFR 555, 49 CFR 172, and APA 87-1, *Standard for the Construction and Approval for Transportation of Fireworks, Novelties, and Theatrical Pyrotechnics*. [**1124,** 2017]

N ***A.3.3.130.1 Display Fireworks.*** Display fireworks are described as Fireworks, UN0335 and are classified as Explosives, 1.3G by the U.S. Department of Transportation (U.S. DOT) *(see Annex C of NFPA 1124)*.

Display fireworks include, but are not limited to, the following:

(1) Salutes or firecrackers containing more than 2 gr (130 mg) of explosive composition (salute powder)
(2) Aerial shells containing more than 2.1 oz (60 g) of total pyrotechnic and explosive composition
(3) Other display pieces that exceed the limits for classification as consumer fireworks

Such fireworks are also described as fireworks, 49 CFR 172 by the U.S. DOT. [**1124,** 2017]

3.3.131* Flame Spread. The propagation of flame over a surface. [***101,*** 2018]

Δ ***A.3.3.131 Flame Spread.*** See Section 10.2 of NFPA *101*. [***101,*** 2018]

3.3.132 Flame Spread Index. A comparative measure, expressed as a dimensionless number, derived from visual measurements of the spread of flame versus time for a material tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Burning Materials*. [***101,*** 2018]

3.3.133 Flammable Vapors. Flammable vapors are the concentration of flammable constituents in air that exceed 25 percent of their lower flammability limit (LFL).

Δ **3.3.134* Flash Point.** The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitible mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in Section 4.4 of NFPA 30. [**30,** 2018]

A.3.3.134 Flash Point. Flash point is a direct measure of a liquid's ability to emit flammable vapors. The lower the flash point, the greater the risk of fire. Flash point is determined using one of several different test procedures and apparatus that are specified in Section 4.4 of NFPA 30. [**30,** 2018]

A liquid that has a flash point at or below ambient temperature is easy to ignite and will burn quickly. On ignition, the spread of flame over the surface of such a liquid will be rapid, because it is not necessary for the fire to expend energy heating the liquid to generate more vapor. Gasoline is a familiar example. A liquid with a flash point above ambient temperature presents less risk because it must be heated to generate enough vapor to become ignitible; it is more difficult to ignite and presents less potential for the generation and spread of vapor. A common example is home heating oil (Fuel Oil No. 2). Home heating oil must be atomized to a fine mist in order for it to be easily ignited. [**30,** 2018]

Certain solutions of liquids in water exhibit a flash point using the standard closed-cup test procedures but will not burn and could even extinguish a fire. To assist identifying such solutions, the following standards are helpful:

(1) ASTM D4207, *Standard Test Method for Sustained Burning of Low Viscosity Liquid Mixtures by the Wick Test*
(2) ASTM D4206, *Standard Test Method for Sustained Burning of Liquid Mixtures Using the Small Scale Open-Cup Apparatus* [**30,** 2018]

Liquid mixtures that do not sustain combustion for a specified time at a specified temperature are considered to be noncombustible. The tests described in the references listed in A.3.3.134(1) and

A.3.3.134(2) provide additional data for determining proper storage and handling of such mixtures. In a confined space, such mixtures could still create an ignitible vapor–air mixture, depending on the amount of flammable liquid in the mixture and the quantity of the spill. [**30,** 2018]

Related to the flash point is the fire point. The fire point of a liquid is the temperature at which ignition of vapors will result in continued burning. As the term *flash point* suggests, the vapors generated at that temperature will flash but will not necessarily continue to burn. The difference between flash point and fire point has some significance when conducting flash point tests *[see 9.1.4(5) and 9.1.4(6) ofNFPA 30]*. However, a closed-cup flash point is used to classify the liquid and characterize its hazard. [**30,** 2018]

For more information, see ASTM E502, *Standard Test Method for Selection and Use of ASTM Standards for the Determination of Flash Point of Chemicals by Closed Cup Methods*, and the ASTM *Manual on Flash Point Standards and Their Use*. [**30,** 2018]

3.3.135 Floor Area.

3.3.135.1* Gross Floor Area. The floor area within the inside perimeter of the outside walls of the building under consideration with no deduction for hallways, stairs, closets, thickness of interior walls, columns, elevator and building services shafts, or other features, but excluding floor openings associated with atriums and communicating spaces. [**5000,** 2018]

A.3.3.135.1 Gross Floor Area. Where the term *floor area* is used, it should be understood to be gross floor area, unless otherwise specified. [**5000,** 2018]

3.3.135.2 Net Floor Area. The floor area within the inside perimeter of the outside walls, or the outside walls and fire walls of the building, or outside and/or inside walls that bound an occupancy or incidental use area requiring the occupant load to be calculated using net floor area under consideration with deductions for hallways, stairs, closets, thickness of interior walls, columns, or other features. [**5000,** 2018]

Net area does not always have to be calculated for an entire floor or fire compartment. For example, a conference room within a tenant office space is permitted to have its net floor area calculated for purposes of assigning an occupant load to it as an assembly use.

3.3.136 Forecasting. The ability to predict fire progression in a scrap tire storage location prior to the completion of the inventory fire break using heavy equipment.

3.3.137* Fugitive Emissions. Releases of flammable vapor that continuously or intermittently occur from process equipment during normal operations. [**30,** 2018]

A.3.3.137 Fugitive Emissions. These include leaks from pump seals, valve packing, flange gaskets, compressor seals, process drains, and so forth. [**30,** 2018]

3.3.138 Gallon, U.S. Standard. 1 U.S. gal = 0.833 Imperial gal = 231 in.^{3} = 3.785 L. [**58,** 2017]

3.3.139 Garage. A building or portion of a building in which one or more self-propelled vehicles carrying volatile flammable liquid for fuel or power are kept for use, sale, storage, rental, repair, exhibition, or demonstrating purposes, and all that portion of a building that is on or below the floor or floors in which such vehicles are kept and that is not separated therefrom by suitable cutoffs. [**5000,** 2018]

3.3.140 Gas.

3.3.140.1* Compressed Gas. A material, or mixture of materials, that (1) is a gas at 68°F (20°C) or less at an absolute pressure of 14.7 psi (101.3 kPa) and (2) has a boiling point of 68°F (20°C) or less at an absolute pressure of 14.7 psi (101.3 kPa) and that is liquefied, nonliquefied, or in solution, except those gases that have no other health or physical hazard properties are not considered to be compressed until the pressure in the packaging exceeds an absolute pressure of 40.6 psi (280 kPa) at 68°F (20°C). [**55,** 2016]

Δ ***A.3.3.140.1 Compressed Gas.*** The states of a compressed gas are categorized as follows:

(1) Nonliquefied compressed gases are gases, other than those in solution, that are in a packaging under the charged pressure and are entirely gaseous at a temperature of 68°F (20°C).
(2) Liquefied compressed gases are gases that, in a packaging under the charged pressure, are partially liquid at a temperature of 68°F (20°C). Cryogenic fluids represent a transient state of a gas that is created through the use of refrigeration. Cryogenic fluids cannot exist in the liquid form or partial liquid form at temperatures of 68°F (20°C); hence, they are not “compressed gases” as defined.
(3) Compressed gases in solution are nonliquefied gases that are dissolved in a solvent.
(4) Compressed gas mixtures consist of a mixture of two or more compressed gases contained in a packaging, the hazard properties of which are represented by the properties of the mixture as a whole.

[**55,** 2016]

3.3.140.1.1 Compressed Gas Mixtures. A mixture of two or more compressed gases contained in a packaging, the hazard properties of which are represented by the properties of the mixture as a whole.

3.3.140.1.2 Compressed Gases in Solution. Nonliquefied gases that are dissolved in a solvent.

3.3.140.1.3 Liquefied Compressed Gases. Gases that are contained in a packaging under the charged pressure and are partially liquid at a temperature of 68°F (20°C).

3.3.140.1.4 Nonliquefied Compressed Gases. Gases, other than those in solution, that are contained in a packaging under the charged pressure and are entirely gaseous at a temperature of 68°F (20°C).

3.3.140.2 Corrosive Gas. A gas that causes visible destruction of or irreversible alterations in living tissue by chemical action at the site of contact. [**55,** 2016]

3.3.140.3 Flammable Gas. A material that is a gas at 68°F (20°C) or less at an absolute pressure of 14.7 psi (101.3 kPa), that is ignitable at an absolute pressure of 14.7 psi (101.3 kPa) when in a mixture of 13 percent or less by volume with air, or that has a flammable range at an absolute pressure of 14.7 psi (101.3 kPa) with air of at least 12 percent, regardless of the lower limit. [**55,** 2016]

3.3.140.4 Flammable Liquefied Gas. A liquefied compressed gas that, when under a charged pressure, is partially liquid at a temperature of 68°F (20°C) and is flammable. [**55,** 2016]

3.3.140.5 Highly Toxic Gas. A chemical that has a median lethal concentration (LC_{50}) in air of 200 ppm by volume or less of gas or vapor, or 2 mg/L or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each. [**55,** 2016]

3.3.140.6* Inert Gas. A nonreactive, nonflammable, noncorrosive gas such as argon, helium, krypton, neon, nitrogen, and xenon. [**55,** 2016]

• ***A.3.3.140.6 Inert Gas.*** Inert gases do not react readily with other materials under normal temperatures and pressures. For example, nitrogen combines with some of the more active metals such as lithium and magnesium to form nitrides, and at high temperatures it will also combine with hydrogen, oxygen, and other elements. The gases neon, krypton, and xenon are considered rare due to their scarcity. Although these gases are commonly referred to as inert gases, the formation of compounds is possible. For example, xenon combines with fluorine to form various fluorides and with oxygen to form oxides; the compounds formed are crystalline solids. Radon is inert under the definition provided, but because it is radioactive, it is not considered inert for the purposes of NFPA 55. [**55,** 2016]

3.3.140.7 Liquefied Gas. A gas, other than in solution, that in a packaging under the charged pressure exists both as a liquid and a gas at a temperature of 68°F (20°C). [**30,** 2018]

3.3.140.8 Liquefied Natural Gas (LNG). A fluid in the cryogenic liquid state that is composed predominantly of methane and that can contain minor quantities of ethane, propane, nitrogen, and other components normally found in natural gas. [**59A,** 2016]

3.3.140.9* Liquefied Petroleum Gas (LP-Gas). Any material having a vapor pressure not exceeding that allowed for commercial propane that is composed predominantly of the following hydrocarbons, either by themselves (except propylene) or as mixtures: propane, propylene, butane (normal butane or isobutane), and butylenes. [**58,** 2017]

A.3.3.140.9 Liquefied Petroleum Gas (LP-Gas). In the pure state propylene (Chemical Abstract Service 105-07-01) has a vapor pressure of 132.8 psig (915.72 kPa) at 70°F (21.1°C). The vapor pressure of commercial propane (Chemical Abstract Service 74-98-6) at 70°F 21.1°C) is 124 psig (855 kPa). Although commercial propane may contain a minor concentration of propylene as in impurity, propylene in the pure state does not meet the definition of LP-Gas. Propylene in the pure state is commonly found in use as an industrial fuel gas. *(See NFPA 51.)* [**58,** 2017]

LP-Gas can comprise any number of different hydrocarbons, but within the scope of NFPA 58 it is limited to a material with a vapor pressure less than or equal to that of commercial propane. Based on this definition, pure butane or a predominantly butane mix would also be considered an LP-Gas. ASTM D1835, *Standard Specification for Liquefied Petroleum Gases*, defines the vapor pressure for commercial propane to be 208 psi at 100°F (1.43 MPa at 38°C). By the same standard, commercial propane must be "predominantly propane," while HD-5 grade propane must be at least 90 percent propane.

3.3.140.10 Nonflammable Gas. A gas that does not meet the definition of a flammable gas. [**55,** 2016]

3.3.140.11* Other Gas. A gas that is not a corrosive gas, flammable gas, highly toxic gas, oxidizing gas, pyrophoric gas, toxic gas, or unstable reactive gas with a hazard rating of Class 2, Class 3, or Class 4 gas. [**55,** 2016]

A.3.3.140.11 Other Gas. A gas classified as an "other gas" might be a nonflammable gas or an inert gas. [**55,** 2016]

3.3.140.12 Oxidizing Gas. A gas that can support and accelerate combustion of other materials more than air does. [**55:** 2016]

3.3.140.13 Pyrophoric Gas. A gas with an autoignition temperature in air at or below 130°F (54.4°C). [**55,** 2016]

3.3.140.14 Scavenged Gas. A residual process gas that is collected for treatment or release at a location remote from the site of use.

3.3.140.15 Simple Asphyxiant Gas. A gas that does not provide sufficient oxygen to support life and that has none of the other physical or health hazards.

3.3.140.16 Toxic Gas. A gas with a median lethal concentration (LC_{50}) in air of more than 200 ppm but not more than 2000 ppm by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each. [**55,** 2016]

3.3.140.17* Unstable Reactive Gas. A gas that, in the pure state or as commercially produced, will vigorously polymerize, decompose, or condense; become self-reactive; or otherwise undergo a violent chemical change under conditions of shock, pressure, or temperature. [**55,** 2016]

A.3.3.140.17 Unstable Reactive Gas. Unstable reactive materials are subdivided into five classifications. Class 4 materials are materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures. They include the following:

(1) Materials that are sensitive to localized thermal or mechanical shock at normal temperatures and pressures
(2) Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 482°F (250°C) of 1000 W/mL or greater

[**55,** 2016]

Class 3 materials are materials that in themselves are capable of detonation or explosive decomposition or explosive reaction but require a strong initiating source or heat under confinement before initiation. Class 3 materials include the following:

(1) Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 482°F (250°C) at or above 100 W/mL and below 1000 W/mL
(2) Materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures
(3) Materials that react explosively with water without requiring heat or confinement

[**55,** 2016]

Class 2 materials are materials that readily undergo violent chemical change at elevated temperatures and pressures, including the following:

(1) Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 482°F (250°C) at or above 10 W/mL and below 100 W/mL
(2) Materials that react violently with water or form potentially explosive mixtures with water

[**55,** 2016]

Class 1 materials are materials that in themselves are normally stable but that can become unstable at elevated temperatures and pressures, including the following:

(1) Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 482°F (250°C) at or above 0.01 W/mL and below 10 W/mL
(2) Materials that react vigorously with water, but not violently
(3) Materials that change or decompose on exposure to air, light, or moisture

[**55,** 2016]

Class 0 materials are materials that in themselves are normally stable, even under fire conditions, including the following:

(1) Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 482°F (250°C) below 0.01 W/mL
(2) Materials that do not react with water
(3) Materials that do not exhibit an exotherm at temperatures less than or equal to 932°F (500°C) when tested by differential scanning calorimetry

[**55,** 2016]

3.3.141* Gas Cabinet. A fully enclosed, noncombustible enclosure used to provide an isolated environment for compressed gas cylinders in storage or use. [**55,** 2016]

> ***A.3.3.141 Gas Cabinet.*** Doors and access ports for exchanging cylinders and accessing pressure-regulating controls are permitted to be included as part of a gas cabinet. [**55,** 2016]

3.3.142 Gas Manufacturer/Producer. A business that produces compressed gases or cryogenic fluids, or both, or fills portable or stationary gas cylinders, containers, or tanks. [**55:** 2016]

3.3.143 Gas Room. A separately ventilated, fully enclosed room in which only compressed gases, cryogenic fluids, associated equipment, and supplies are stored or used. [**55,** 2016]

3.3.144 Gaseous Hydrogen (GH_2) System. An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, compressors, manifolds, and piping and that terminates at the source valve. [**55,** 2016]

A.3.3.144 Gaseous Hydrogen (GH_2) System. The system includes stationary or portable containers, pressure regulators, pressure-relief devices, manifolds, interconnecting piping, and controls as required. [**55,** 2016]

3.3.145 Ground Kettle. A container that could be mounted on wheels and is used for heating tar, asphalt, or similar substances.

3.3.146 Handling. The deliberate movement of material by any means to a point of storage or use.

3.3.147* Hazard of Contents.

A.3.3.147 Hazard of Contents. Hazardous materials are materials that present physical or health hazards and are regulated by the *Code*. The categories of materials classified as physical hazards, health hazards, or both have been established in concert with those categories identified by OSHA in 29 CFR that are used by preparers of Material Safety Data Sheets (MSDS). In some cases, the hazard categories are further subdivided into classes that have long been established by NFPA standards. For example, while OSHA recognizes flammable liquids as a broad class, including those that are combustible, such liquids are further categorized by building and fire codes with respect to degree of hazard under the system of classification used by NFPA to include Class I, Class II, and Class III liquids. They are further subdivided within these classes to Class IA, Class IB and so forth. A similar approach is used for materials in other categories where there are subcategories of hazard established by existing NFPA standards, including oxidizers, unstable reactives, organic peroxides, water reactives, and others. [**5000,** 2018]

Under the classification system used by OSHA, a hazardous material can have one or more physical or health hazards in categories not currently regulated by the *Code*; for example, irritants, sensitizers, radioactive materials, etiological agents, and others. This is not to say that these materials are not hazardous materials, but rather that the *Code* does not provide specific regulation for the hazard category represented. [**5000,** 2018]

The *Code* defines contents as either high hazard, low hazard, or ordinary hazard. The category of high hazard, which includes hazardous materials, is subdivided into groups in which the hazards of the groups are comparable, that is, high hazard Level 1-5. *(See also A.34.1.1 of NFPA 5000.)* [**5000,** 2018]

3.3.147.1 High Hazard. High hazard contents shall include materials defined as hazardous materials in 3.3.180.4, whether stored, used, or handled. [**5000:**6.3.2.4.1.1]

3.3.147.1.1 High Hazard Level 1 Contents. High hazard Level 1 contents shall include materials that present a detonation hazard including, but not limited to, the following: (1) Explosives; (2) Unclassified detonable organic peroxides; (3) Class 4 oxidizers; (4) Detonable pyrophoric materials; (5) Class 3 detonable and Class 4 unstable (reactive) materials. [**5000:**6.3.2.4.2]

3.3.147.1.2 High Hazard Level 2 Contents. High hazard Level 2 contents shall include materials that present a deflagration hazard or a hazard from accelerated burning including, but not limited to, the following: (1) Class I, Class II, or Class III-A flammable or combustible liquids that are used or stored in normally open containers or systems, or in closed containers or systems at gauge pressures of more than 15 psi (103 kPa); (2) Combustible dusts stored, used, or generated in a manner creating a severe fire or explosion hazard; (3) Flammable gases and flammable cryogenic liquids; (4) Class I organic peroxides; (5) Class 3 solid or liquid oxidizers that are used or stored in normally open containers or systems, or in closed containers or systems at gauge pressures of more than 15 psi (103 kPa); (6) Nondetonable pyrophoric materials; (7) Class 3 nondetonable unstable (reactive) materials; (8) Class 3 water-reactive materials [**5000:**6.3.2.4.3]

This definition of the term *high hazard Level 2 contents* is extracted from *NFPA 5000*. While the assumption that a Class II or Class IIIA liquid can present a deflagration or flash fire hazard if it escapes from a closed system under pressure is reasonable, it is highly doubtful that the same liquids, when used in an open system and without being heated up to or above the flash point, would present a deflagration hazard or flash fire hazard. Nevertheless, for correlation with *NFPA 5000* and NFPA 1, this definition retains the criteria established by *NFPA 5000*.

3.3.147.1.3 High Hazard Level 3 Contents. High hazard Level 3 contents shall include materials that readily support combustion or present a physical hazard including, but not limited to, the following: (1) Level 2 and Level 3 aerosols; (2) Class I, Class II, or Class III-A flammable or combustible liquids that are used or stored in normally closed containers or systems at gauge pressures of less than 15 psi (103 kPa); (3) Flammable solids, other than dusts classified as high hazard Level 2, stored, used, or generated in a manner creating a high fire hazard; (4) Class II and Class III organic peroxides; (5) Class 2 solid or liquid oxidizers; (6) Class 3 solid or liquid oxidizers that are used or stored in normally closed containers or systems at gauge pressures of less than 15 psi (103 kPa); (7) Oxidizing gases and oxidizing cryogenic liquids; (8) Class 2 unstable (reactive) materials; (9) Class 2 water-reactive materials [**5000:**6.3.2.4.4]

3.3.147.1.4 High Hazard Level 4 Contents. High hazard Level 4 contents shall include materials that are acute health hazards including, but not limited to, the following: (1) Corrosives; (2) Highly toxic materials; (3) Toxic materials [**5000:**6.3.2.4.5]

3.3.147.1.5 High Hazard Level 5 Contents. High hazard Level 5 contents include hazardous production materials (HPM) used in the fabrication of semiconductors or semiconductor research and development. [**5000:**6.3.2.4.6]

3.3.147.2* Low Hazard Contents. Low hazard contents shall be classified as those of such low combustibility that no self-propagating fire therein can occur. [**5000:**6.3.2.2]

Δ ***A.3.3.147.2 Low Hazard Contents.*** Chapter 42 of NFPA *101* recognizes storage of noncombustible materials as low hazard. In other occupancies, it is assumed that, even where the actual contents hazard is normally low, there is sufficient likelihood that some combustible materials or hazardous operations will be introduced in connection with building repair or maintenance, or some psychological factor might create conditions conducive to panic, so that the egress facilities cannot safely be reduced below those specified for ordinary hazard contents. [***101,*** 2018]

Very few occupancies qualify as having low hazard contents. An example of low hazard contents might be metal parts stored in metal containers on metal pallets (not wood pallets) supported by metal shelving. If the same metal parts stored in metal containers were placed on wood pallets, the pallets would be capable of sustaining a self-propagating fire. Therefore, the hazard of contents classification would be ordinary hazard.

3.3.147.3* Ordinary Hazard Contents. Ordinary hazard contents shall be classified as those that are likely to burn with moderate rapidity or to give off a considerable volume of smoke. [**5000:**6.3.2.3]

A.3.3.147.3 Ordinary Hazard Contents. Ordinary hazard classification represents the conditions found in most buildings and is the basis for the general requirements of NFPA *101*. [***101,*** 2018]

The fear of poisonous fumes or explosions is necessarily a relative matter to be determined on a judgment basis. All smoke contains some toxic fire gases but, under conditions of ordinary hazard, there should be no unduly dangerous exposure during the period necessary to escape from the fire area, assuming there are proper exits. [***101,*** 2018]

Occupancies containing low hazard or high hazard contents are relatively rare. In deciding which hazard classification applies, users should ask the following questions: Do the contents qualify as a low hazard classification? Do the contents qualify as a high hazard classification? If the answer to each of these questions is no, then the hazard of contents classification must be ordinary hazard.

3.3.148* Hazard Rating. The numerical rating of the health, flammability, self-reactivity, and other hazards of the material, including its reaction with water. [**55,** 2016]

A.3.3.148 Hazard Rating. The criteria for hazard rating are as defined in NFPA 704. [**55,** 2016]

3.3.149 Hazardous Material. See 3.3.180.4.

3.3.150 Hazardous Material Storage Facility. A building, a portion of a building, or exterior area used for the storage of hazardous materials in excess of exempt amounts.

3.3.151 Hazardous Materials Storage Locker. A movable prefabricated structure, manufactured primarily at a site other than the final location of the structure and transported completely assembled or in a ready-to-assemble package to the final location, and intended to meet local, state, and federal requirements for outside storage of hazardous materials. [**30,** 2018]

Although the structures defined in 3.3.151 are referred to as lockers, most are large enough for a person to enter, and even the smallest locker can accommodate several standard-sized shipping drums. These lockers can be considered highly sophisticated storage sheds, incorporating a spill-retention basin, explosion proof electrical equipment, fire suppression or fire alarm systems, and other features. Despite the presumed all-encompassing term *hazardous materials,* the requirements set forth in Chapter 14 of NFPA 30 apply only to liquids and assume that only liquids are present. Exhibit 3.17 shows two examples of these lockers.

3.3.152* Hazardous Reaction or Hazardous Chemical Reaction. Reactions that result in dangers beyond the fire problems relating to flash point and boiling point of either the reactants or of the products. [**30,** 2018]

Exhibit 3.17

Examples of hazardous materials storage lockers. (Courtesy of DENIOS, Inc.)

A.3.3.152 Hazardous Reaction or Hazardous Chemical Reaction. These dangers might include, but are not limited to, toxic effects, reaction speed (including detonation), exothermic reaction, or production of unstable or reactive materials. [**30,** 2018]

3.3.153 Heat Transfer Fluid (HTF). A liquid that is used as a medium to transfer heat energy from a heater or vaporizer to a remote heat consumer (e.g., injection molding machine, oven, or dryer, or jacketed chemical reactor). [**30,** 2018]

3.3.154* Heliport. An identifiable area located on land, on water, or on a structure, that also includes any existing buildings or facilities thereon, used or intended to be used for landing and takeoff of helicopters. [**418,** 2016]

A.3.3.154 Heliport. The term *heliport* applies to all sites used or intended to be used for the landing and takeoff of helicopters. [**418,** 2016]

3.3.155 Hogged Material. Mill waste consisting mainly of hogged bark but possibly including a mixture of bark, chips, dust, or other by-products from trees; also includes material designated as hogged fuel.

3.3.156 Home.

3.3.156.1 Day-Care Home. See 3.3.192.6.

3.3.156.2 Nursing Home. See 3.3.192.24.

3.3.157 Horizontal Exit. See 3.3.105.1.

3.3.158* Immediately Dangerous to Life and Health (IDLH). A concentration of airborne contaminants, normally expressed in parts per million (ppm) or milligrams per cubic meter, that represents the maximum level from which one could escape within 30 minutes without any escape-impairing symptoms or irreversible health effects. [**55,** 2016]

A.3.3.158 Immediately Dangerous to Life and Health (IDLH). This level is established by the National Institute for Occupational Safety and Health (NIOSH). If adequate data do not exist for precise establishment of IDLH, an independent certified industrial hygienist, industrial toxicologist, or appropriate regulatory agency should make such determination. [**55,** 2016]

3.3.159 Imminent Danger. A condition or practice in an occupancy or structure that poses a danger that could reasonably be expected to cause death, serious physical harm, or serious property loss.

The determination of what does or does not pose an imminent danger can be challenging for the AHJ. Existing buildings typically cannot meet the requirements for new buildings, and the threat to safety can come from the building itself, the contents, or the occupants. Each situation must be evaluated based on its individual characteristics. Certain conditions, such as inadequate means of egress arrangements, could result in deaths or serious injuries if a fire occurs. If the AHJ is not satisfied that a reasonable degree of safety exists for the occupants, the building or portions of the building should not be allowed to be occupied.

3.3.160* Incident Commander (IC). The individual responsible for all incident activities, including the development of strategies and tactics and the ordering and the release of resources. [**472,** 2018]

A.3.3.160 Incident Commander (IC). This position is equivalent to the on-scene incident commander as defined in OSHA 1910.120(8), Hazardous Waste Operations and Emergency Response. The IC has overall authority and responsibility for conducting incident operations and is responsible for the management of all incident operations at the incident site. [**472,** 2018]

3.3.161 Incidental Liquid Use or Storage. Use or storage as a subordinate activity to that which establishes the occupancy or area classification. [**30,** 2018]

The determination of whether a specific use is incidental is usually apparent — for example, the use of flammable cleaning agents to remove grease from metal parts in a machine shop. In other cases, such as a coating operation that uses large quantities of flammable liquid, incidental use might not be so apparent. The final determination is to be made by the AHJ.

3.3.162 Indicating Valve. See 3.3.282.1.

3.3.163 Initiating Device Circuit. A circuit to which automatic or manual initiating devices are connected where the signal received does not identify the individual device operated. [**72,** 2016]

Conventional (nonaddressable/nonanalog) initiating devices are typically detectors that use a switch contact or a solid-state switch to short both sides of the initiating device circuit together. By doing so, the initiating device causes a step-function increase in current flowing through the circuit. The fire alarm control unit (FACU) interprets the increase in current as an "alarm" signal from one of the initiating devices. Since any one of the initiating devices can cause the incremental current flow, and no other initiating devices downstream of the activated device can subsequently activate because both sides of the circuit have been shorted by the first responding device, only one signal can be obtained. Sometimes initiating device circuits are called *zones*, and the activated device puts the entire zone into the alarm state.

3.3.164 Inside Liquid Storage Area. See 3.3.14.6.

3.3.165* ISO Module. An assembly of tanks or tubular cylinders permanently mounted in a frame conforming to International Organization for Standardization (ISO) requirements. [**55,** 2016]

Δ **A.3.3.165 ISO Module.** The characteristic internal water volume of individual tubular cylinders is 43 scf (1218 L) or a water capacity of 2686 lb (1218 kg). The frame of an ISO container module and its corner castings are specially designed and dimensioned to be used in multimodal transportation service on container ships, special highway chassis, and container-on-flatcar railroad equipment. [**55,** 2016]

3.3.166 Jurisdiction. A governmental unit or political division or a subdivision.

3.3.167 Limit.

3.3.167.1* Ceiling Limit. The maximum concentration of an airborne contaminant to which one can be exposed. [**5000,** 2018]

A.3.3.167.1 Ceiling Limit. The ceiling limits utilized are to be those published in 29 CFR 1910.1000. [**5000,** 2018]

3.3.167.2* Permissible Exposure Limit (PEL). The maximum permitted 8-hour, time-weighted average concentration of an airborne contaminant. [**55,** 2016]

A.3.3.167.2 Permissible Exposure Limit (PEL). The maximum permitted time-weighted average exposures to be utilized are those published in 29 CFR 1910.1000. [**55,** 2016]

3.3.167.3* Short-Term Exposure Limit (STEL). The concentration to which it is believed that workers can be exposed continuously for a short period of time without suffering from irritation, chronic or irreversible tissue damage, or narcosis of a degree sufficient to increase the likelihood of accidental injury, impairment of self-rescue, or the material reduction of work efficiency, without exceeding the daily permissible exposure limit (PEL). [**55,** 2016]

A.3.3.167.3 Short-Term Exposure Limit (STEL). STEL limits are published in 29 CFR 1910.1000. [**55,** 2016]

3.3.168 Limited-Combustible (Material). *See 4.5.10*. [**5000,** 2018]

3.3.169 Liquid. A material that has a melting point that is equal to or less than 68°F (20°C) and a boiling point that is greater than 68°F (20°C) and 14.7 psia (101.3 kPa). When not otherwise identified, the term liquid shall mean both flammable and combustible liquids. [**5000,** 2018]

Δ ***3.3.169.1 Combustible Liquid.*** Any liquid that has a closed-cup flash point at or above 100°F (37.8°C), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30. Combustible liquids are classified according to Section 4.3 of NFPA 30. [**30,** 2018]

3.3.169.2* Flammable Liquid. Any liquid that has a closed-cup flash point below 100°F (37.8°C), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30 and a Reid vapor pressure that does not exceed an absolute pressure of 40 psi (276 kPa) at 100°F (37.8°C), as determined by ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method).* Flammable liquids are classified according to Section 4.3 of NFPA 30. [**30,** 2018]

Δ ***A.3.3.169.2 Flammable Liquid.*** For the purposes of this *Code*, a material with a Reid vapor pressure greater than an absolute pressure of 40 psi (276 kPa) is considered to be a gas and is, therefore, not within the scope of NFPA 30. See NFPA 58. [**30,** 2018]

A vapor pressure of 40 psi absolute (absolute pressure of 276 kPa) is the accepted dividing line between flammable liquids and flammable gases. For transportation safety regulations, DOT refers to liquefied petroleum gases, liquefied natural gas, and liquefied ammonia as "highly volatile liquids."

The 73°F (22.8°C) dividing line between Classes IA and IB and Class IC is based on an old U.S. Interstate Commerce Commission regulation that required a red label with the word *flammable* on all liquids having flash points below 80°F (26.6°C), using an open-cup flash point procedure, that were shipped in interstate commerce. At the time, an 80°F (26.6°C) open-cup flash point was generally agreed to be about equivalent to a 73°F (22.8°C) closed-cup flash point, and therein lies the basis for using the 73°F (22.8°C) breakpoint. The U.S. Consumer Product Safety Commission uses an 80°F (26.6°C) open-cup criterion in their regulations for flammable consumer commodities.

The boiling point criterion that distinguishes Class IA from Class IB was adopted to identify liquids with unusually low boiling points and consequently very high vapor pressures that can approach the dividing line between liquids and gases (40 psi absolute). Class IA liquids typically require storage in containers other than atmospheric storage tanks. Therefore, NFPA 30 and this *Code* specify stricter requirements for Class IA liquids. Only a relative handful of commercially significant Class IA liquids are available. At normal ambient temperatures, both Class IA and Class IB liquids generate sufficient vapor to create concentrations that are within the flammable range at all times. The differentiation between Class IA and Class IB becomes important in selecting the type of storage tank and in placing limits on quantities stored in buildings.

3.3.169.3 Highly Volatile Liquid. A liquid with a boiling point of less than 68°F (20°C).

3.3.169.4 Stable Liquid. Any liquid not defined as unstable. [**30,** 2018]

3.3.170 Log. Felled tree from which all the branches have been removed.

3.3.171 Loose House. A separate detached building in which unbaled combustible fibers are stored.

3.3.172 Lumber. Wood from felled trees having a section produced by lengthwise sawing or chipping of logs or other solid wood of large dimensions and possible crosscutting and/or further machining to obtain a certain size and includes boards, dimension lumber, timber, and similar wood products.

3.3.173 Manual Emergency Shutoff Valve. A designated valve designed to shut off the flow of gases or liquids that is manually operated. [**55,** 2016]

3.3.174 Manual Fire Alarm Box. A manually operated device used to initiate a fire alarm signal. [**72,** 2016]

Operation of the manual fire alarm box requires one action. One design of a double-action fire alarm box requires the operator to strike a front-mounted hammer to break the glass and expose the recessed pull lever. Another fire alarm box might not use a hammer and glass but might have a push bar. The pull lever then operates as a single action fire alarm box.

Whether one or two actions are involved, it is also permissible to have a listed protective cover, shown in Exhibit 3.18,

Exhibit 3.18

Protective Cover for Double-Action Manual Fire Alarm Box. (Source: Safety Technology International, Inc., Waterford MI)

over the manual fire alarm box. This cover must be lifted to gain access to the double action box, which effectively creates a permitted third action for the user. In some institutional occupancies, the use of key-operated manual fire alarm boxes is permitted by local ordinances, building codes, and NFPA *101*®, *Life Safety Code*®.

3.3.175 Manual Pull Station. See 3.3.174, Manual Fire Alarm Box.

Δ **3.3.176 Marijuana Extraction Equipment.** Equipment or appliances used for the extraction of botanical material, such as essential oils, from marijuana.

Δ **3.3.177 Marijuana Extraction Facility.** A building used for the solvent-based extraction process of marijuana.

3.3.178 Marine Terminal. A facility comprised of one or more berths, piers, wharves, loading and unloading areas, warehouses, and storage yards and used for transfer of people and/or cargo between waterborne and land transportation modes. [**307,** 2016]

3.3.179 Marine Vessel. A water craft or other artificial contrivance used as a means of transportation in or on the water.

3.3.180 Material.

3.3.180.1 Combustible (Material). See 3.3.57.

3.3.180.2 Compatible Material. A material that, when in contact with an oxidizer, will not react with the oxidizer or promote or initiate its decomposition.

3.3.180.3 Corrosive Material. A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. [**400,** 2016]

3.3.180.4 Hazardous Material. A chemical or substance that is classified as a physical hazard material or a health hazard material, whether the chemical or substance is in usable or waste condition. *(See also 3.3.180.6, Health Hazard Material, and 3.3.180.12, Physical Hazard Material.)* [**400,** 2016]

3.3.180.5 Hazardous Production Material (HPM). A solid, liquid, or gas associated with semiconductor manufacturing that has a degree-of-hazard rating of 3 or 4 in health, flammability, instability, or water reactivity in accordance with NFPA 704 and that is used directly in research, laboratory, or production processes that have as their end product materials that are not hazardous. [**5000,** 2018]

3.3.180.6 Health Hazard Material. A chemical or substance classified as a toxic, highly toxic, or corrosive material in accordance with definitions set forth in this *Code*. [**400,** 2016]

3.3.180.7* Highly Toxic Material. A material that produces a lethal dose or lethal concentration that falls within any of following categories: (1) a chemical that has a median lethal dose (LD_{50}) of 50 mg/kg or less of body weight when administered orally to albino rats weighing between 200 g and 300 g each; (2) a chemical that has a median lethal dose (LD_{50}) of 200 mg/kg or less of body weight when administered by continuous contact for 24 hours, or less if death occurs within 24 hours, with the bare skin of albino rabbits weighing between 2 kg and 3 kg each or albino rats weighing 200 g to 300 g each; (3) a chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 mg/L or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour, or less if death occurs within 1 hour, to albino rats weighing between 200 g and 300 g each. [**400,** 2016]

A.3.3.180.7 Highly Toxic Material. While categorization is basically simple in application, the degree of hazard depends on many variables that should be carefully considered individually and in combination. Some examples include the following:

(1) Materials wherein the highly toxic component or mixtures thereof are inextricably bound and cannot be released so there is little or no potential for exposure
(2) Nonfriable solid hazardous materials existing in product forms and in the demonstrated absence of inhalable particles that might not present the same inhalation hazard as the chemical components existing in a friable state
(3) Mixtures of highly toxic materials with ordinary materials, such as water, that might not warrant classification as highly toxic

[**400,** 2016]

Any hazard evaluation that is required for the precise categorization of highly toxic material is required to be performed by experienced, technically competent persons. [**400,** 2016]

3.3.180.8 Hogged Material. See 3.3.155.

3.3.180.9* Incompatible Material. Materials that, when in contact with each other, have the potential to react in a manner that generates heat, fumes, gases or by-products that are hazardous to life or property. [**400,** 2016]

Δ *A.3.3.180.9 Incompatible Material.* Information on incompatible materials can be found in safety data sheets (SDS) or manufacturers' product bulletins. [**400,** 2016]

3.3.180.10 Limited-Combustible Material. See 4.5.10. [**5000,** 2018]

3.3.180.11 Noncombustible Material. See 4.5.9. [**5000,** 2018]

3.3.180.12 Physical Hazard Material. A chemical or substance classified as a combustible liquid, explosive, flammable cryogen, flammable gas, flammable liquid, flammable solid, organic peroxide, oxidizer, oxidizing cryogen, pyrophoric, unstable (reactive), or water-reactive material. [**400,** 2016]

3.3.180.13 Pyrophoric Material. A chemical with an autoignition temperature in air at or below 130°F (54.4°C). [**400,** 2016]

3.3.180.14 Toxic Material.* A material that produces a lethal dose or a lethal concentration within any of the following categories: (1) a chemical or substance that has a median lethal dose (LD_{50}) of more than 50 mg/kg but not more than 500 mg/kg of body weight when administered orally to albino rats weighing between 200 g and 300 g each; (2) a chemical or substance that has a median lethal dose (LD_{50}) of more than 200 mg/kg but not more than 1000 mg/kg of body weight when administered by continuous contact for 24 hours, or less if death occurs within 24 hours, with the bare skin of albino rabbits weighing between 2 kg and 3 kg each; (3) a chemical or substance that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2000 parts per million by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L, of mist, fume, or dust when administered by continuous inhalation for 1 hour, or less if death occurs within 1 hour, to albino rats weighing between 200 g and 300 g each. [**400,** 2016]

A.3.3.180.14 Toxic Material. While categorization is basically simple in application, the degree of hazard depends on many variables that should be carefully considered individually and in combination. Some examples include the following:

(1) Materials wherein the toxic component or mixtures thereof are inextricably bound and cannot be released so there is little or no potential for exposure
(2) Nonfriable solid hazardous materials existing in product forms and in the demonstrated absence of inhalable particles that might not present the same inhalation hazard as the chemical components existing in a friable state
(3) Mixtures of toxic materials with ordinary materials, such as water, that might not warrant classification as toxic

Any hazard evaluation that is required for the precise categorization of toxic material is required to be performed by experienced, technically competent persons.
[**400,** 2016]

3.3.180.15 Unstable (Reactive) Material.* A material that, in the pure state or as commercially produced, will vigorously polymerize, decompose or condense, become self-reactive, or otherwise undergo a violent chemical change under conditions of shock, pressure, or temperature. [**400,** 2016]

A.3.3.180.15 Unstable (Reactive) Material. Unstable (reactive) material is classified as follows:

(1) Class 4 unstable (reactive) materials are those that, in themselves, are readily capable of detonation, explosive decomposition, or explosive reaction at normal temperatures and pressures and include, among others, materials that are sensitive to localized thermal or mechanical shock at normal temperatures and pressures.
(2) Class 3 unstable (reactive) materials are those that, in themselves, are capable of detonation, explosive decomposition, or explosive reaction, but that require a strong initiating source or that must be heated under confinement before initiation, and include, among others, materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.
(3) Class 2 unstable (reactive) materials are those that readily undergo violent chemical change at elevated temperatures and pressures and include, among others, materials that exhibit an exotherm at temperatures less than or equal to 30°F (−1°C) when tested by differential scanning calorimetry.
(4) Class 1 unstable (reactive) materials are those that, in themselves, are normally stable, but that can become unstable at elevated temperatures and pressures and include among others, materials that change or decompose on exposure to air, light, or moisture and that exhibit an exotherm at temperatures greater than 30°F (−1°C), but less than or equal to 57°F (14°C), when tested by differential scanning calorimetry.

[**400,** 2016]

3.3.180.16 Water-Reactive Material.* A material that explodes, violently reacts, produces flammable, toxic, or other hazardous gases; or evolves enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture. [**400,** 2016]

A.3.3.180.16 Water-Reactive Material.

Class 1 Water-Reactive Materials. Materials whose heat of mixing is at or above 30 cal/g and less than 100 cal/g.

Class 2 Water-Reactive Materials. Materials whose heat of mixing is at or above 100 cal/g and less than 600 cal/g.

Class 3 Water-Reactive Materials. Materials whose heat of mixing is greater or equal to 600 cal/g.
[**704:** Table F.2]

• *3.3.181* Maximum Allowable Quantity (MAQ).* The quantity of hazardous material permitted in a control area.

A.3.3.181 Maximum Allowable Quantity (MAQ). Quantities are permitted to exceed the MAQ when they are located in an area complying with Protection Levels 1–5 in accordance with the building code.

3.3.182* Means of Egress. A continuous and unobstructed way of travel from any point in a building or structure to a public way consisting of three separate and distinct parts: (1) the exit access, (2) the exit, and (3) the exit discharge. [***101,*** 2018]

Δ **A.3.3.182 Means of Egress.** A means of egress comprises the vertical and horizontal travel and includes intervening room spaces, doorways, hallways, corridors, passageways, balconies, ramps, stairs, elevators, enclosures, lobbies, escalators, horizontal exits, courts, and yards. [***101,*** 2018]

A means of egress, by definition, provides a path of egress travel to a public way. In effect, the *Code* emphasizes the need to move building occupants to a safe place. In means of egress arrangements for university campuses, military bases, resorts, and other large complexes are many areas a building occupant could get to before reaching a public way that supplies the intended level of safety from a building fire. The *Code*'s intent is that occupants should be able to move to a safe place from which they can continue to retreat from a burning building, as necessary. At that safe point, *Code* requirements cease to apply. This concept provides the basis for A.14.12.1.1, which applies to illumination of means of egress. This annex text states that the extent to which illumination needs to be provided outside the building — that is, in the exit discharge portions of the means of egress — should lead to either a public way or a distance away from the building that is considered safe, whichever is closer to the building being evacuated.

From every location in a building, a means of egress or path of travel is required over which a person can move to gain access to the outside or to a place of safety. People who enter a building usually have available to them that same route from which they can leave. However, one important consideration makes egressing more than just reversing one's route of entry, especially if emergency conditions exist. This reverse route might consist of features that were not obstacles on entrance but prove to be such at egress. For example, a door leaf hinged to swing in the direction of entry can become an obstacle when multiple occupants attempt to leave the building simultaneously in the opposite direction. The door leaf swings against the flow of traffic — a flow that, during emergency egress, is greatly increased, compared with the leisurely flow of people entering a building. As another example, in assembly occupancies where turnstiles are used to meter ingress, reversing one's route often is not possible if additional openings independent of the turnstiles are not provided.

A basic principle of the *Code* requires that every component of a means of egress be operable by, and under the control of, the occupants attempting egress. Where the *Code* makes exemptions to this concept — for example, in health care occupancies where locked door assemblies are permitted if it is necessary for special protective measures or the clinical needs of the patients — it does so by substituting requirements adequate to achieve the same level of life safety that would exist if the means of egress system were fully under the control of the building occupants. For example, in the case of health care occupancy door assemblies that are locked for the clinical needs of the patients, staff is required to carry the keys needed to unlock those door assemblies at all times.

3.3.183 Means of Escape. A way out of a building or structure that does not conform to the strict definition of means of egress but does provide an alternate way out. [***101,*** 2018]

3.3.184 Mezzanine. An intermediate level between the floor and the ceiling of any room or space. [***101,*** 2018]

N **3.3.185 Miscella.** A mixture, in any proportion, of the extracted oil or fat and the extracting solvent.

3.3.186* Mobile Supply Unit. Any supply source that is equipped with wheels so it is able to be moved around. [**55,** 2016]

A.3.3.186 Mobile Supply Unit. Examples include ISO modules, tube trailers, and cylinder packs. [**55,** 2016]

N **3.3.187* Mobile or Temporary Cooking.** Any cooking apparatus or equipment operated on a one-time basis, interim basis, or for less than 90 days in the same location, other than at a fixed location, building, or structure that has been inspected and permitted under another section of this *Code*, regulation, or statute.

N **A.3.3.187 Mobile or Temporary Cooking.** Mobile or temporary cooking can include self-propelled trucks and vehicles; trailered units; push carts; equipment located under cover of awnings, canopies, or pop-up tents; or other structures for which a building permit has not been issued.

3.3.188 Motor Vehicle Fluid. A fluid that is a flammable, combustible, or hazardous material, such as crankcase fluids, fuel, brake fluids, transmission fluids, radiator fluids, and gear oil.

3.3.189 Nesting. A method of securing cylinders upright in a tight mass using a contiguous three-point contact system whereby all cylinders in a group have a minimum of three contact points with other cylinders or a solid support structure (e.g., a wall or railing). [**55,** 2016]

3.3.190* Normal Temperature and Pressure (NTP). A temperature of 70°F (21°C) at an absolute pressure of 14.7 psi (101.3 kPa). [**55,** 2016]

A.3.3.190 Normal Temperature and Pressure (NTP). There are different definitions of normal conditions. The normal conditions defined here are the ones most commonly used in the compressed gas and cryogenic fluid industry. [**55,** 2016]

N **3.3.191 Observation.** For the purposes of marijuana extraction equipment field verification, a practice or condition not technically noncompliant with other regulations or requirements, but could lead to noncompliance if left unaddressed.

3.3.192 Occupancy. The purpose for which a building or other structure, or part thereof, is used or intended to be used. [**ASCE/SEI 7:**1.2]

3.3.192.1* Ambulatory Health Care Occupancy. An occupancy used to provide services or treatment simultaneously to four or more patients that provides, on an outpatient basis, one or more of the following: (1) treatment for patients that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others; (2) anesthesia that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others; (3) treatment for patients who, due to the nature of their injury or illness, are incapable of taking action for self-preservation under emergency conditions without the assistance of others [***101,*** 2018]

Δ *A.3.3.192.1 **Ambulatory Health Care Occupancy.*** It is not the intent that occupants be considered to be incapable of self-preservation just because they are in a wheelchair or use assistive walking devices, such as a cane, a walker, or crutches. Rather it is the intent to address treatment centers that receive patients who have been rendered incapable of self-preservation, such as being rendered unconscious as a result of an accident or being unable to move due to sudden illness. [***101,*** 2018]

It is not the intent that the term *anesthesia* be limited to general anesthesia. [***101,*** 2018]

3.3.192.2* Apartment Building. A building or portion thereof containing three or more dwelling units with independent cooking and bathroom facilities. [***101,*** 2018]

*A.3.3.192.2 **Apartment Building.*** The *Code* specifies that, wherever there are three or more living units in a building, the building is considered an apartment building and is required to comply with Chapter 30 or Chapter 31 of NFPA *101*, as appropriate. Townhouse units are considered to be apartment buildings if there are three or more units in the building. The type of wall required between units in order to consider them to be separate buildings is normally established by the AHJ. If the units are separated by a wall of sufficient fire resistance and structural integrity to be considered as separate buildings, then the provisions of Chapter 24 of NFPA *101*, apply to each townhouse. Condominium status is a form of ownership, not occupancy; for example, there are condominium warehouses, condominium apartments, and condominium offices. [***101,*** 2018]

3.3.192.3* Assembly Occupancy. An occupancy (1) used for a gathering of 50 or more persons for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses; or (2) used as a special amusement building, regardless of occupant load. [***101,*** 2018]

Δ *A.3.3.192.3 **Assembly Occupancy.*** Assembly occupancies might include the following:

(1) Armories
(2) Assembly halls
(3) Auditoriums
(4) Bowling lanes
(5) Club rooms
(6) College and university classrooms, 50 persons and over
(7) Conference rooms
(8) Courtrooms
(9) Dance halls
(10) Drinking establishments
(11) Exhibition halls
(12) Gymnasiums
(13) Libraries
(14) Mortuary chapels
(15) Motion picture theaters
(16) Museums
(17) Passenger stations and terminals of air, surface, underground, and marine public transportation facilities
(18) Places of religious worship
(19) Pool rooms
(20) Recreation piers
(21) Restaurants
(22) Skating rinks
(23) Special amusement buildings, regardless of occupant load
(24) Theaters

[***101,*** 2018]

Assembly occupancies are characterized by the presence or potential presence of crowds with attendant panic hazard in case of fire or other emergency. They are generally open or occasionally open to the public, and the occupants, who are present voluntarily, are not ordinarily subject to discipline or control. Such buildings are ordinarily occupied by able-bodied persons and are not used for sleeping purposes. Special conference rooms, snack areas, and other areas incidental to, and under the control of, the management of other occupancies, such as offices, fall under the 50-person limitation. [***101,*** 2018]

Restaurants and drinking establishments with an occupant load of fewer than 50 persons should be classified as mercantile occupancies. [***101,*** 2018]

For special amusement buildings, see 12.4.8 and 13.4.8 of NFPA *101*. [***101,*** 2018]

Assembly occupancies are characterized by crowds with a potential presence of panic hazard in the event of fire or other emergency. These occupancies are generally or occasionally open to the public, and the occupants, who are present voluntarily, are not ordinarily subject to discipline or control. The need for alternative egress routes for small commercial assembly occupancies, such as restaurants, lounges, and theaters with capacities of as few as 50 persons, is specially treated in this method of classification.

Paragraph A.3.3.192.3(23) further clarifies that a special amusement building is an assembly occupancy, even if the occupant load is fewer than 50 persons. As an assembly occupancy, a special amusement building is subject to the provisions of 20.1.4 of this *Code* and Chapter 12 or Chapter 13 — especially 12.4.8 or 13.4.8 — of NFPA *101*. If an assembly occupancy were not subject to these provisions, a haunted house amusement building at a carnival, for example, might be treated as a business occupancy because it does not have the minimum 50-person occupant load typically associated with an assembly occupancy. If this building were treated as a business occupancy, the necessary level of life safety would probably not be provided. Because special amusement buildings purposely confound the egress path and further confuse the occupants with sound and lighting effects, they need to meet the special requirements of 20.1.4 of this *Code* and 12.4.8 or 13.4.8 of NFPA *101*. For other than special amusement buildings, the threshold at which an assembly use becomes an assembly occupancy is the 50-person occupant load.

3.3.192.4 Bulk Merchandising Retail Building. A building in which the sales area includes the storage of combustible materials on pallets, in solid piles, or in racks in excess of 12 ft (3660 mm) in storage height. [***101,*** 2018]

3.3.192.5* Business Occupancy. An occupancy used for the transaction of business other than mercantile. [***101,*** 2018]

A.3.3.192.5 Business Occupancy. Business occupancies include the following:

(1) Airport traffic control towers (ATCTs)
(2) City halls
(3) College and university instructional buildings, classrooms under 50 persons, and instructional laboratories
(4) Courthouses
(5) Dentists' offices
(6) Doctors' offices
(7) General offices
(8) Outpatient Clinics (ambulatory)
(9) Town halls

[***101,*** 2018]

Doctors' and dentists' offices are included, unless of such character as to be classified as ambulatory health care occupancies. *(See 3.3.192.1.)* [***101,*** 2018]

Birth centers should be classified as business occupancies if they are occupied by fewer than four patients, not including infants, at any one time; do not provide sleeping facilities for four or more occupants; and do not provide treatment procedures that render four or more patients, not including infants, incapable of self-preservation at any one time. For birth centers occupied by patients not meeting these parameters, see Chapter 18 or Chapter 19 of NFPA *101*, as appropriate. [***101,*** 2018].

Service facilities common to city office buildings such as newsstands, lunch counters serving fewer than 50 persons, barber shops, and beauty parlors are included in the business occupancy group. [***101,*** 2018]

City halls, town halls, and courthouses are included in the business occupancy group insofar as their principal function is the transaction of public business and the keeping of books and records. Insofar as they are used for assembly purposes, they are classified as assembly occupancies. [***101,*** 2018]

For birth centers that are occupied by patients but do not meet the criteria in A.3.3.192.5, see the requirements for ambulatory health care facilities (Section 20.6 of this *Code* and Chapters 20 and 21 of NFPA *101*) or health care occupancies (Section 20.4 of this *Code* and Chapters 18 and 19 of NFPA *101*), as appropriate.

3.3.192.6* Day-Care Home. A building or portion of a building in which more than 3 but not more than 12 clients receive care, maintenance, and supervision, by other than their relative(s) or legal guardian(s), for less than 24 hours per day. [***101,*** 2018]

Δ ***A.3.3.192.6 Day-Care Home.*** A day-care home is generally located within a dwelling unit. [***101,*** 2018]

Group day-care homes are often located in buildings that house apartment occupancies, mercantile occupancies, business occupancies, or assembly occupancies. A day-care facility that is housed as a tenant together with another occupancy type cannot control safety issues in hallways and other areas outside of its tenant space. The AHJ can impose additional safeguards, in the form of a larger staff-to-client ratio, to ensure client safety. If safeguards or fire protection features beyond those required by NFPA 1 and NFPA *101* are in place, the AHJ can permit a reduced staff-to-client ratio.

3.3.192.7* Day-Care Occupancy. An occupancy in which four or more clients receive care, maintenance, and supervision, by other than their relatives or legal guardians, for less than 24 hours per day. [***101,*** 2018]

A.3.3.192.7 Day-Care Occupancy. Day-care occupancies include the following:

(1) Adult day-care occupancies, except where part of a health care occupancy
(2) Child day-care occupancies
(3) Day-care homes
(4) Kindergarten classes that are incidental to a child day-care occupancy
(5) Nursery schools

[***101,*** 2018]

In areas where public schools offer only half-day kindergarten programs, many child day-care occupancies offer state-approved kindergarten classes for children who need full-day care. Because these classes are normally incidental to the day-care occupancy, the requirements of the day-care occupancy should be followed. [***101,*** 2018]

3.3.192.8* Detention and Correctional Occupancy. An occupancy used to house one or more persons under varied degrees of restraint or security where such occupants are mostly incapable of self-preservation because of security measures not under the occupants' control. [***101,*** 2018]

Δ ***A.3.3.192.8 Detention and Correctional Occupancy.*** Detention and correctional occupancies include the following:

(1) Adult and juvenile substance abuse centers
(2) Adult and juvenile work camps
(3) Adult community residential centers
(4) Adult correctional institutions
(5) Adult local detention facilities
(6) Juvenile community residential centers
(7) Juvenile detention facilities
(8) Juvenile training schools

[***101,*** 2018]

It is not the intent to classify as detention and correctional occupancies the areas of health care occupancies where doors are locked against patient egress where needed for the clinical needs of the patients. For example, a dementia treatment center can be adequately protected by the health care occupancies requirements of Chapter 19 of NFPA *101*. *[See 19.1.1.1.7, 19.2.2.2.2, 19.2.2.2.4(1), and 19.2.2.2.6 of NFPA 101.]* [***101,*** 2018]

The one-resident threshold requirement of 23.1.1.1.6 of NFPA *101* is not meant to force a residential occupancy, where security is imposed on one or more occupants, to be reclassified as a detention and correctional occupancy. [***101,*** 2018]

3.3.192.8.1 Detention and Correctional Use Condition. For application of the life safety requirements in Section 20.7, the resident user category is divided into the five use conditions.

Δ ***3.3.192.8.1.1 Use Condition I — Free Egress.*** A condition under which free movement is allowed from sleeping areas and other spaces where access or occupancy is permitted to the exterior via means of egress that meet the requirements of NFPA *101*. [***101,*** 2018]

3.3.192.8.1.2 Use Condition II — Zoned Egress. A condition under which free movement is allowed from sleeping areas and any other occupied smoke compartment to one or more other smoke compartments. [***101,*** 2018]

3.3.192.8.1.3 Use Condition III — Zoned Impeded Egress. A condition under which free movement is allowed within individual smoke compartments, such as within a residential unit comprised of individual sleeping rooms and a group activity space, with egress impeded by remote-controlled release of means of egress from such a smoke compartment to another smoke compartment. [***101,*** 2018]

3.3.192.8.1.4 Use Condition IV — Impeded Egress. A condition under which free movement is restricted from an occupied space, and remote-controlled release is provided to allow movement from all sleeping rooms, activity spaces, and other occupied areas within the smoke compartment to another smoke compartment. [***101,*** 2018]

3.3.192.8.1.5 Use Condition V — Contained. A condition under which free movement is restricted from an occupied space, and staff-controlled manual release at each door is provided to allow movement from all sleeping rooms, activity spaces, and other occupied areas within the smoke compartment to another smoke compartment. [***101,*** 2018]

3.3.192.9* Dormitory. A building or a space in a building in which group sleeping accommodations are provided for more than 16 persons who are not members of the same family in one room, or a series of closely associated rooms under joint occupancy and single management, with or without meals, but without individual cooking facilities. [***101,*** 2018]

Δ ***A.3.3.192.9 Dormitory.*** Rooms within dormitories intended for the use of individuals for combined living and sleeping purposes are guest rooms or guest suites. Examples of dormitories are college dormitories, fraternity and sorority houses, and military barracks. [***101,*** 2018]

The phrase *without individual cooking facilities* refers to the prohibition or required absence of cooking equipment in any room or unit of a dormitory. If this equipment is present throughout a facility, the occupancy should be classified as an apartment building. The phrase with or without meals indicates that a central cafeteria might be available to serve meals for the occupants of the dormitory.

3.3.192.10* Educational Occupancy. An occupancy used for educational purposes through the twelfth grade by six or more persons for 4 or more hours per day or more than 12 hours per week. [***101,*** 2018]

A.3.3.192.10 Educational Occupancy. Educational occupancies include the following:

(1) Academies
(2) Kindergartens
(3) Schools

[***101,*** 2018]

An educational occupancy is distinguished from an assembly occupancy in that the same occupants are regularly present. [***101,*** 2018]

Educational occupancies are limited to facilities used for educational purposes through the twelfth grade. College classroom buildings do not meet this criterion and should be classified as business occupancies. Regardless of the educational level, where the occupant load of a classroom is 50 or more persons, the classroom should be classified as an assembly occupancy.

An educational occupancy is distinguished from an assembly occupancy in that the same occupants use an educational occupancy on a regular basis and are subject to discipline and control.

3.3.192.11* Health Care Occupancy. An occupancy used to provide medical or other treatment or care simultaneously to four or more patients on an inpatient basis, where such patients are mostly incapable of self-preservation due to age, physical or mental disability, or because of security measures not under the occupants' control. [***101,*** 2018]

A.3.3.192.11 Health Care Occupancy. Health care occupancies include the following:

(1) Hospitals
(2) Limited care facilities
(3) Nursing homes

[***101,*** 2018]

Occupants of health care occupancies typically have physical or mental illness, disease, or infirmity. They also include infants, convalescents, or infirm aged persons. [***101,*** 2018]

It is not the intent to consider occupants incapable of self-preservation because they are in a wheelchair or use assistive walking devices, such as a cane, a walker, or crutches. [***101,*** 2018]

Health care occupancies, by definition, accommodate four or more persons who are generally incapable of self-preservation.

Since the *Code* allows one- and two-family dwellings to accommodate up to three persons not related to the occupying family, three or fewer persons incapable of self-preservation do not constitute a health care occupancy.

N **3.3.192.12* High-Risk Occupancy.** An occupancy that has a history of high frequency of fires, high potential for loss of life or economic loss, or that has a low or moderate history of fires or loss of life but the occupants have a high dependency on the built-in fire protection features or staff to assist in evacuation during a fire or other emergency. [**1730,** 2016]

N **A.3.3.192.12 High-Risk Occupancy.** Examples of high-risk occupancies are apartment buildings, hotels, dormitories, lodging and rooming, assembly, child care, detention, educational, and health care. [**1730,** 2016]

3.3.192.13 Hospital. A building or portion thereof used on a 24-hour basis for the medical, psychiatric, obstetrical, or surgical care of four or more inpatients. [***101,*** 2018]

A building must house four or more persons incapable of self-preservation on a 24-hour basis to be classified as a hospital. Occupants of hospitals or nursing homes are assumed to be nonambulatory and incapable of self-preservation. In making this judgment, due consideration should be given to the use of physical restraints and tranquilizing drugs, which render occupants immobile. Variable staffing criteria and levels of care further differentiate hospitals from nursing homes.

3.3.192.14* Hotel. A building or groups of buildings under the same management in which there are sleeping accommodations for more than 16 persons and primarily used by transients for lodging with or without meals. [***101,*** 2018]

Δ ***A.3.3.192.14 Hotel.*** So-called apartment hotels should be classified as hotels, because they are potentially subject to the same transient occupancy as hotels. Transients are those who occupy accommodations for less than 30 days. [***101,*** 2018]

A residential occupancy that is called a lodging house or a rooming house by its operators, but that has sleeping accommodations for more than 16 people, must be classified as a hotel. In the definition of the term *hotel,* the reference to a 30-day time period helps to define the term *transient*. A building containing guest rooms with individual cooking facilities should be classified as an apartment building. However, where the AHJ thinks that the potential for hazards associated with both a hotel (which is occupied by guests unfamiliar with surroundings) and an apartment building (which contains a higher fuel load and a greater number of ignition sources and in which egress is subject to travel through multiple rooms) is present, the classification of the building as a mixed occupancy (hotel and apartment building) might be appropriate.

3.3.192.15* Industrial Occupancy. An occupancy in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, or repair operations are conducted. [***101,*** 2018]

A.3.3.192.15 Industrial Occupancy. Industrial occupancies include the following:

(1) Drycleaning plants
(2) Factories of all kinds
(3) Food processing plants
(4) Gas plants

Industrial occupancies expose occupants to a range of processes and materials of varying hazards. The classification decision should be based on the extent and nature of the associated hazards.

(5) Hangars (for servicing/maintenance)
(6) Laundries
(7) Power plants
(8) Pumping stations
(9) Refineries
(10) Sawmills
(11) Telephone exchanges

[***101,*** 2018]

In evaluating the appropriate classification of laboratories, the AHJ should treat each case individually, based on the extent and nature of the associated hazards. Some laboratories are classified as occupancies other than industrial; for example, a physical therapy laboratory or a computer laboratory. [***101,*** 2018]

For laboratories within the scope of NFPA 45, the occupancies are defined in NFPA 45, Section 3.3, as follows:

(1) Noninstructional labs are considered industrial.
(2) Labs within the scope of NFPA 99 are considered health care.
(3) Instructional labs for grades 12 and below are considered educational.
(4) Labs for grades above grade 12 and Class D labs are business occupancies.

[**5000,** 2018]

3.3.192.16* Limited Care Facility. A building or portion of a building used on a 24-hour basis for the housing of four or more persons who are incapable of self-preservation because of age; physical limitations due to accident or illness; or limitations such as mental retardation/developmental disability, mental illness, or chemical dependency. [***101,*** 2018]

A.3.3.192.16 Limited Care Facility. Limited care facilities and residential board and care occupancies both provide care to people with physical and mental limitations. However, the goals and programs of the two types of occupancies differ greatly. The requirements in NFPA *101* for limited care facilities are based on the assumption that these are medical facilities, that they provide medical care and treatment, and that the patients are not trained to respond to the fire alarm; that is, the patients do not participate in fire drills but, rather, await rescue. *(See Section 18.7 of NFPA 101.)* [***101,*** 2018]

The requirements for residential board and care occupancies are based on the assumption that the residents are provided with personal care and activities that foster continued independence, that the residents are encouraged and taught to overcome their limitations, and that most residents, including all residents in prompt and slow homes, are trained to respond to fire drills to the extent they are able. Residents are required to participate in fire drills. *(See Section 32.7 of NFPA 101.)* [***101,*** 2018]

Persons with Alzheimer's and related illnesses might be located in a nursing home, limited care facility, or board and care facility. For such persons, it is the level of care provided, not the medical diagnosis, that matters for the purposes of determining whether the facility should meet the requirements for limited care. Where personal care is provided but medical or custodial care is not, the limited care definition does not typically apply. It is the intent of this definition that it not apply to persons not receiving medical or custodial care, provided they are able to assist in their own evacuation, regardless of their medical diagnosis. [***101,*** 2018]

3.3.192.17 Lodging or Rooming House. A building or portion thereof that does not qualify as a one- or two-family dwelling, that provides sleeping accommodations for a total of 16 or fewer people on a transient or permanent basis, without personal care services, with or without meals, but without separate cooking facilities for individual occupants. [***101,*** 2018]

If sleeping accommodations for more than 16 people are provided, the occupancy should be classified as a hotel or dormitory. Chapter 24 of NFPA *101* contains the provision for allowing rooms to be occupied by a maximum of three outsiders in addition to family members in one- and two-family dwellings without changing the occupancy classification.

N ***3.3.192.18* Low-Risk Occupancy.*** An occupancy that has a history of low frequency of fires and minimal potential for loss of life or economic loss. [**1730,** 2016]

N ***A.3.3.192.18 Low-Risk Occupancy.*** Examples of low-risk occupancies are storage, mercantile, and business. [**1730,** 2016]

3.3.192.19* Mercantile Occupancy. An occupancy used for the display and sale of merchandise. [***101,*** 2018]

A.3.3.192.19 Mercantile Occupancy. Mercantile occupancies include the following:

(1) Auction rooms
(2) Department stores
(3) Drugstores
(4) Restaurants with fewer than 50 persons
(5) Shopping centers
(6) Supermarkets

[***101,*** 2018]

Office, storage, and service facilities incidental to the sale of merchandise and located in the same building should be considered part of the mercantile occupancy classification. [***101,*** 2018]

Bulk merchandising retail buildings, which characteristically consist of a warehouse-type building occupied for sales purposes, are a subclass of mercantile occupancies and have a greater potential for hazards than traditional mercantile operations.

3.3.192.19.1 Class A Mercantile Occupancy. All mercantile occupancies having an aggregate gross area of more than 30,000 ft^2 (2800 m^2) or occupying more than three stories for sales purposes. [***101,*** 2018]

3.3.192.19.2 Class B Mercantile Occupancy. All mercantile occupancies of more than 3000 ft^2 (280 m^2), but not more than 30,000 ft^2 (2800 m^2), aggregate gross area and occupying not more than three stories for sales purposes. Class B also includes all mercantile occupancies of not more than 3000 ft^2 (280 m^2) gross area and occupying two or three stories for sales purposes. [***101,*** 2018]

3.3.192.19.3 Class C Mercantile Occupancy. All mercantile occupancies of not more than 3000 ft^2 (280 m^2) gross area and used for sales purposes occupying one story only, excluding mezzanines. [***101,*** 2018]

3.3.192.20 Mixed Occupancy. A multiple occupancy where the occupancies are intermingled. [***101,*** 2018]

N ***3.3.192.21* Moderate-Risk Occupancy.*** An occupancy that has a history of moderate frequency of fires or a moderate potential for loss of life or economic loss. [**1730,** 2016]

N ***A.3.3.192.21 Moderate-Risk Occupancy.*** Examples of moderate-risk occupancies are ambulatory health care, and industrial. [**1730,** 2016]

3.3.192.22 Motor Fuel Dispensing Facility. That portion of a property where motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles or marine craft or into approved containers, including all equipment used in connection therewith. [**30A,** 2018]

3.3.192.22.1 Fleet Vehicle Motor Fuel Dispensing Facility. A motor fuel dispensing facility at a commercial, industrial, governmental, or manufacturing property where motor fuels are dispensed into the fuel tanks of motor vehicles that are used in connection with the business or operation of that property by persons within the employ of such business or operation. [**30A,** 2018]

3.3.192.22.2 Marine Motor Fuel Dispensing Facility. A motor fuel dispensing facility at or adjacent to shore, a pier, a wharf, or a floating dock where motor fuels are dispensed into the fuel tanks of marine craft. [**30A,** 2018]

3.3.192.22.3* Motor Fuel Dispensing Facility Located Inside a Building. That portion of a motor fuel dispensing facility located within the perimeter of a building or building structure that also contains other occupancies. [**30A,** 2018]

A.3.3.192.22.3 Motor Fuel Dispensing Facility Located Inside a Building. The motor fuel dispensing facility can be either enclosed or partially enclosed by the building walls, floors, ceilings, or partitions or can be open to the outside. The motor fuel dispensing area is that area required for dispensing of fuels to motor vehicles. Dispensing of fuel at manufacturing, assembly, and testing operations is not included within this definition. [**30A,** 2018]

3.3.192.23 Multiple Occupancy. A building or structure in which two or more classes of occupancy exist. [**101,** 2018]

3.3.192.24 Nursing Home. A building or portion of a building used on a 24-hour basis for the housing and nursing care of four or more persons who, because of mental or physical incapacity, might be unable to provide for their own needs and safety without the assistance of another person. [***101,*** 2018]

A building must house four or more persons who are incapable of self-preservation on a 24-hour basis to be classified as a nursing home. Occupants of nursing homes are assumed to be nonambulatory and incapable of self-preservation. In making this judgment, due consideration should be given to the use of physical restraints and tranquilizing drugs, which can render occupants immobile. Variable staffing criteria and levels of care further differentiate hospitals from nursing homes.

3.3.192.25 One- and Two-Family Dwelling. One- and two-family dwellings include buildings containing not more than two dwelling units in which each dwelling unit is occupied by members of a single family with not more than three outsiders, if any, accommodated in rented rooms.

3.3.192.25.1 One- and Two-Family Dwelling Unit. A building that contains not more than two dwelling units with independent cooking and bathroom facilities. [***101,*** 2018]

3.3.192.26* Parking Structure. A building, structure, or portion thereof used for the parking, storage, or both, of motor vehicles. [**88A,** 2015]

A.3.3.192.26 Parking Structure. A parking structure is permitted to be enclosed or open, use ramps, and use mechanical control push-button-type elevators to transfer vehicles from one floor to another. Motor vehicles are permitted to be parked by the driver or an attendant or are permitted to be parked mechanically by automated facilities. Where automated type parking is provided, the operator of those facilities is permitted either to remain at the entry level or to travel to another level. Motor fuel is permitted to be dispensed, and motor vehicles are permitted to be serviced in a parking structure in accordance with NFPA 30A. [**88A,** 2015] Δ

3.3.192.26.1 Basement and Underground Parking Structures. Parking structures that are located below grade. A basement parking structure has other occupancies above it and an underground parking structure has no occupancy other than parking above it. Basement and underground parking structures are considered as specific cases of enclosed parking structures.

3.3.192.26.2 Enclosed Parking Structure. Any parking structure that is not an open parking structure. [**88A,** 2015]

3.3.192.26.3 Open Parking Structure. A parking structure that meets the requirements of Section 5.5 of *NFPA 88A*. [**88A,** 2015]

3.3.192.27 Repair Garages.

3.3.192.27.1 Major Repair Garage. A building or portions of a building where major repairs, such as engine overhauls, painting, body and fender work, and repairs that require draining of the motor vehicle fuel tank are performed on motor vehicles, including associated floor space used for offices, parking, or showrooms.

3.3.192.27.2 Minor Repair Garage. A building or portions of a building used for lubrication, inspection, and minor automotive maintenance work, such as engine tune-ups, replacement of parts, fluid changes (e.g., oil, antifreeze, transmission fluid, brake fluid, air conditioning refrigerants, etc.), brake system repairs, tire rotation, and similar routine maintenance work, including associated floor space used for offices, parking, or showrooms.

3.3.192.28* Residential Board and Care Occupancy. An occupancy used for lodging and boarding of four or more residents, not related by blood or marriage to the owners or operators, for the purpose of providing personal care services. [***101,*** 2018]

A.3.3.192.28 Residential Board and Care Occupancy. The following are examples of facilities that are classified as residential board and care occupancies:

(1) Group housing arrangement for physically or mentally handicapped persons who normally attend school in the community, attend worship in the community, or otherwise use community facilities
(2) Group housing arrangement for physically or mentally handicapped persons who are undergoing training in preparation for independent living, for paid employment, or for other normal community activities
(3) Group housing arrangement for the elderly that provides personal care services but that does not provide nursing care
(4) Facilities for social rehabilitation, alcoholism, drug abuse, or mental health problems that contain a group housing arrangement and that provide personal care services but do not provide acute care
(5) Assisted living facilities
(6) Other group housing arrangements that provide personal care services but not nursing care

[***101,*** 2018]

3.3.192.29* Residential Occupancy. An occupancy that provides sleeping accommodations for purposes other than health care or detention and correctional. [***101,*** 2018]

A.3.3.192.29 Residential Occupancy. Residential occupancies are treated as separate occupancies in this *Code* as follows:

(1) One- and two-family dwellings (Chapter 24 of NFPA *101*)
(2) Lodging or rooming houses (Chapter 26 of NFPA *101*)
(3) Hotels, motels, and dormitories (Chapters 28 and 29 of NFPA *101*)
(4) Apartment buildings (Chapters 30 and 31 of NFPA *101*)

[***101,*** 2018]

3.3.192.30 Separated Occupancy. A multiple occupancy where the occupancies are separated by fire resistance–rated assemblies. [***101,*** 2018]

3.3.192.31* Storage Occupancy. An occupancy used primarily for the storage or sheltering of goods, merchandise, products, or vehicles. [***101,*** 2018]

A.3.3.192.31 Storage Occupancy. Storage occupancies include the following:

(1) Barns
(2) Bulk oil storage

(3) Cold storage
(4) Freight terminals
(5) Grain elevators
(6) Hangars (for storage only)
(7) Parking structures
(8) Truck and marine terminals
(9) Warehouses
[***101,*** 2018]

Storage occupancies are characterized by the presence of relatively small numbers of persons in proportion to the area. [***101,*** 2018]

3.3.192.31.1* Mini-Storage Building. A storage occupancy partitioned into individual storage units, with a majority of the individual units not greater than 750 ft^2 in area, that are rented or leased for the purposes of storing personal or business items where all of the following apply: (1) the storage units are separated from each other by less than a 1-hour fire resistance rated barrier, (2) the owner of the facility does not have unrestricted access to the storage units, and (3) the items being stored are concealed from view from outside the storage unit.

A.3.3.192.31.1 Mini-Storage Building. Mini-storage buildings are typically designed to accommodate relatively small transient tenants who are often private individuals or persons who own small businesses and need additional storage space that is generally very small in area to accommodate their short-term storage needs. This definition is not intended to apply to large warehouse buildings designed to be rented or leased to relatively large multiple tenants who are generally storing their wares in conjunction with their businesses. Garage units that are primarily intended for vehicular storage as part of a multifamily development are not intended to be classified as mini-storage buildings. [**5000,** 2018]

3.3.193 Occupant Load. The total number of persons that might occupy a building or portion thereof at any one time. [***101,*** 2018]

3.3.194 Open System Use. See 3.3.281.2.

3.3.195 Operating Pressure. The pressure at which a system operates.

3.3.196* Operating Unit (Vessel) or Process Unit (Vessel). The equipment in which a unit operation or unit process is conducted. *(See also 3.3.277, Unit Operation or Unit Process.)* [**30,** 2018]

A.3.3.196 Operating Unit (Vessel) or Process Unit (Vessel). Unit operations include, but are not limited to, distillation, oxidation, cracking, and polymerization. [**30,** 2018]

The operating unit or process unit can be a simple tank, or it can be a sophisticated piece of equipment such as a distillation column, absorption tower, or catalytic cracking unit in a petroleum refinery.

3.3.197 Operations. A general term that includes, but is not limited to, the use, transfer, storage, and processing of liquids. [**30,** 2018]

3.3.198 Organic Peroxide. Any organic compound having a double oxygen or peroxy (-O-O-) group in its chemical structure. [**400,** 2016]

Δ ***3.3.198.1* Organic Peroxide Formulation.*** A pure or technically pure organic peroxide or a mixture of organic peroxides with an active oxygen (aO) concentration greater than 1 % alone or in combination with one or more materials. [**400,** 2016]

A.3.3.198.1 Organic Peroxide Formulation. Terms such as *accelerator*, *catalyst*, *initiator*, *curing agent*, and so forth, are sometimes used to describe organic peroxide formulations. These terms are misleading because they can also refer to materials that are not or do not contain organic peroxides, some of which might present increased hazard when mixed with organic peroxides. [**400,** 2016]

3.3.198.1.1 Class I. Class I describes those formulations that are more severe than a Class II but do not detonate. [**400,** 2016]

3.3.198.1.2 Class II. Class II describes those formulations that burn very rapidly and that present a severe reactivity hazard. [**400,** 2016]

3.3.198.1.3 Class III. Class III describes those formulations that burn rapidly and that present a moderate reactivity hazard. [**400,** 2016]

3.3.198.1.4 Class IV. Class IV describes those formulations that burn in the same manner as ordinary combustibles and that present a minimal reactivity hazard. [**400,** 2016]

3.3.198.1.5 Class V. Class V describes those formulations that burn with less intensity than ordinary combustibles or do not sustain combustion and that present no reactivity hazard. [**400,** 2016]

3.3.198.2 Organic Peroxide Storage Area. See 3.3.14.7.

3.3.199 OSHA. The Occupational Safety and Health Administration of the U.S. Department of Labor. [**55,** 2016]

3.3.200 Overcrowded. A situation where the occupant load exceeds the exit capacity or the posted occupant load.

3.3.201* Oxidizer. Any solid or liquid material that readily yields oxygen or other oxidizing gas or that readily reacts to promote or initiate combustion of combustible materials and that can, under some circumstances undergo a vigorous self-sustained decomposition due to contamination or heat exposure. [**400,** 2016]

A.3.3.201 Oxidizer. Examples of other oxidizing gases include bromine, chlorine, and fluorine. [**400,** 2016]

The classification of oxidizers is based on the technical committee's evaluation of available scientific and technical data, actual experience, and its considered opinion. Classification refers to the pure oxidizer. Gross contamination can cause oxidizers of all classes to undergo exothermic or explosive reaction, particularly if they also are subjected to confinement and heating. *(See B.5.2.2 through B.5.2.5 for oxidizer classifications.)* [**400,** 2016]

The classification of oxidizers is based on the degree to which an oxidizing chemical increases, if at all, the burning rate of available combustible fuels. Factors that can influence the burning rate of oxidizers are concentration, particle size, product form, product packaging, and packaging configuration. Examples of Class 1, 2, 3, and 4 chemical oxidizers are listed in B.5.2.2. The definition of the current classes and the oxidizers listed as typical of each Class in B.5.2.1 are based on the technical committee's evaluation of available data, experience, and results of tests done by the Bureau of Mines and GE Research in the 1970s. [**400,** 2016]

The definition of Class 1, 2, 3, and 4 oxidizers is subjective. Currently, there is no bench scale test method that adequately measures the burning rate of oxidizers for large scale storage. The UN's *Recommendations on the Transport of Dangerous Goods, Model Regulations,* includes a bench scale test method (Test O.1) to assign packing groups to solid oxidizers. Thirty grams (1.06 oz) of a mixture of the test substance and cellulose powder is ignited with a Nichrome wire. The time from ignition to the end of visible burning of the mixture is compared with the burning time of several different mixtures of potassium bromate (Class 3) and cellulose powder. The test does not characterize chemical reactivity or thermal stability. The test is not representative of packaged oxidizers. The determination of burning time is strongly dependent on test conditions, particle size, and the test operator's perception of the end of active burning. [**400,** 2016]

The Fire Protection Research Foundation (FPRF) published *National Oxidizing Pool Chemicals Storage Fire Test Project* in August 1998. The technical report includes literature abstracts, large-scale calorimetry test data, and intermediate scale rack storage tests. The peak rate of heat release of packaging and packaged oxidizers trichloroisocyanuric acid (Trichlor, Class 1) and calcium hypochlorite (available chlorine >68%, Class 3) are summarized in Table A.3.3.201. [**400,** 2016]

The Class 1 Trichlor did not increase the burning rate of the combustible packaging. Class 3 calcium hypochlorite (available chlorine >68%) caused a severe increase in the burning rate of the combustible packaging. In 2006, the FPRF published a report on the *Development of an Enhanced Hazard Classification System for Oxidizers*. The report includes a review of fire losses, historical test data, and current test methods for oxidizing materials used by transportation and environmental regulatory agencies. Two classification schemes with multiple test methods and performance-based criteria were proposed to distinguish between Class 1, 2, 3, and 4 oxidizers in a storage situation. [**400,** 2016]

Future FPRF effort is proposed to define an appropriate bench scale test, validated by medium scale free burn testing, for oxidizers. The goal of the enhanced classification system would be to prescribe tests and use performance-based criteria to define the different classes of oxidizers based on the degree of burning rate enhancement, chemical reactivity, and thermal stability. [**400,** 2016]

The FPRF completed a project that resulted in the development of a bench-scale test, validated by intermediate scale testing, for solid oxidizers. An enhanced classification system with prescribed tests and performance-based criteria to define the different classes of oxidizers based on the degree of burning rate enhancement was developed. [Buc, Elizabeth C., *Oxidizer Classification Research Project: Tests and Criteria*, Fire Protection Research Foundation, November 2009] [**400,** 2016]

TABLE A.3.3.201 *Results of Large-Scale Calorimetry Tests with Packaging and Packaged Oxidizers on Wood Pallets*

Oxidizer and Packaging	Total Weight with Pallets (lb)	Peak Convective HRR (kW)
40 cartons of empty HDPE 2 lb capacity containers	300	1736
40 cartons of pea gravel filled HDPE 2 lb capacity containers	1631	464
40 cartons of granular Trichlor in HDPE 2 lb capacity containers	1891	649
40 cartons of tablet form Trichlor in HDPE 2 lb capacity containers	1882	877
48 cartons of granular calcium hypochlorite in 1 lb capacity Surlin (plastic) bags	1468	6696
36 cartons of granular calcium hypochlorite in HDPE 1 lb capacity containers	1452	>16184

For SI units, 1 lb = 0.45 kg.

Source: FPRF, *National Oxidizing Pool Chemicals Storage Fire Test Project*, Aug. 1998.

[**400,** 2016]

3.3.201.1 Class 1. An oxidizer that does not moderately increase the burning rate of combustible materials with which it comes into contact or a solid oxidizer classified as Class 1 when tested in accordance with the test protocol set forth in G.1 of NFPA 400. [**400,** 2016]

3.3.201.2 Class 2. An oxidizer that causes a moderate increase in the burning rate of combustible materials with which it comes into contact or a solid oxidizer classified as Class 2 when tested in accordance with the test protocol set forth in G.1 of NFPA 400. [**400,** 2016]

3.3.201.3 Class 3. An oxidizer that causes a severe increase in the burning rate of combustible materials with which it comes into contact or a solid oxidizer classified as Class 3 when tested in accordance with the test protocol set forth in G.1 of NFPA 400. [**400,** 2016]

3.3.201.4 Class 4. An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock and that causes a severe increase in the burning rate of combustible materials with which it comes into contact. [**400,** 2016]

3.3.202 Ozone Generator. Equipment that causes the production of ozone.

3.3.203 Packaging. A commodity wrapping, cushioning, or container. [**13,** 2016]

3.3.204 Paper. Felted sheets made from natural fibrous materials, usually vegetable but sometimes mineral or animal, and formed on a fine wire screen by means of water suspension.

3.3.205 Patch Kettle. Any pot or container with a capacity of less than 6 gal (22.7 L) used for preheating tar, asphalt, pitch, or similar substances for the repair of roofs, streets, floors, pipes, or similar objects.

3.3.206 Permissible Exposure Limit (PEL). See 3.3.167.2.

3.3.207 Permit. A document issued by the AHJ for the purpose of authorizing performance of a specified activity.

3.3.208 Peroxide-Forming Chemical. A chemical that, when exposed to air, forms explosive peroxides that are shock sensitive, pressure sensitive, or heat sensitive.

3.3.209* Personal Care. The care of residents who do not require chronic or convalescent medical or nursing care. [***101,*** 2018]

Δ **A.3.3.209 Personal Care.** Personal care involves responsibility for the safety of the resident while inside the building. Personal care might include daily awareness by management of the resident's functioning and whereabouts, making and reminding a resident of appointments, the ability and readiness for intervention in the event of a resident experiencing a crisis, supervision in the areas of nutrition and medication, and actual provision of transient medical care. [***101,*** 2018]

3.3.210 Pesticide. Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest or for use as a plant regulator, defoliant, or desiccant.

3.3.211 Physical Hazard. A chemical for which there is scientifically valid evidence that the chemical is an organic peroxide or oxidizer.

3.3.212* Pier. A structure, usually of greater length than width and projecting from the shore into a body of water with direct access from land, that can be either open deck or provided with a superstructure. [**307**, 2016]

A.3.3.212 Pier. The terms *pier* and *wharf* are used interchangeably. [**307,** 2016]

3.3.213* Pressure Vessel. A container, process vessel, or other component designed in accordance with the ASME *Boiler and Pressure Vessel Code*, DOT, or other approved standards. [**400,** 2016]

A.3.3.213 Pressure Vessel. Pressure vessels of any type can be subject to additional regulations imposed by various states or other legal jurisdictions. Users should be aware that compliance with DOT or ASME requirements might not satisfy all of the required regulations for the location in which the vessel is to be installed or used. [**55,** 2016]

3.3.214 Primary Containment. The first level of containment, consisting of the inside portion of that container that comes into immediate contact on its inner surface with the material being contained.

3.3.215* Process or Processing. An integrated sequence of operations. [**30,** 2018]

A.3.3.215 Process or Processing. The sequence can include both physical and chemical operations, unless the term is modified to restrict it to one or the other. The sequence can involve, but is not limited to, preparation, separation, purification, or change in state, energy content, or composition. [**30,** 2018]

3.3.216 Process Unit (Vessel). See 3.3.196, Operating Unit (Vessel) or Process Unit (Vessel).

3.3.217 Proprietary Information. Information regarding compounds or ingredients used in a process or production that do not qualify as trade secrets but that provide an industry or business with a competitive advantage.

3.3.218 Protection for Exposures. Fire protection for structures on property adjacent to liquid storage that is provided by (1) a public fire department or (2) a private fire brigade maintained on the property adjacent to the liquid storage, either of which is capable of providing cooling water streams to protect the property adjacent to the liquid storage. [**30,** 2018]

An important distinction to understand is that the phrase *protection for exposures* refers to fire protection provided for adjacent property, *not* to the property on which the flammable or combustible liquid is located. Protection for exposures depends on some means to provide a barrier to the transmission of the heat generated by a flammable or combustible liquid fire to that adjacent property. The means can be on-site, such as an on-site fire brigade, or it can be the reasonably quick response of a municipal fire department. If protection for the exposed property is present and sufficient, then NFPA 30 and this *Code* allow a reduction in the separation distance between the shell of a storage tank or the wall of a liquid warehouse and the property line between the two facilities. So, for example, a bulk fuel plant can position its storage tanks closer to the property line separating it from a neighboring facility if the latter has protection for exposures, such as a fire brigade. The bulk fuel plant might or might not have a fire brigade of its own.

A public fire department normally has the capability to provide protection to the exposed property. Large plant fire brigades also normally have this capability, but they require an extensive private water supply and hose system or mobile fire apparatus in addition to trained personnel. Ultimately, the AHJ has the responsibility to determine whether protection for exposures exists.

3.3.219 Public Way. A street, alley, or other similar parcel of land essentially open to the outside air deeded, dedicated, or otherwise permanently appropriated to the public for public use and having a clear width and height of not less than 10 ft (3050 mm). [***101,*** 2018]

3.3.220 Purging. A method used to free the internal volume of a piping system of unwanted contents that results in the existing contents being removed or replaced. [**55,** 2016]

3.3.221 Pyrophoric. A chemical that spontaneously ignites in air at or below a temperature of 130°F (54.5°C).

3.3.222 Quality Assurance. The procedures conducted by the registered design professionals (RDPs) responsible for design and the registered design professionals responsible for inspection that provide evidence and documentation to the RDPs, the owner, and the AHJ that the work is being constructed in accordance with the approved construction documents. [**5000,** 2018]

3.3.223 Quality Assurance Program. A predefined set of observations, special inspections, tests, and other procedures that provide an independent record to the owner, AHJ, and RDP responsible for design that the construction is in general conformance with the approved construction documents. [**5000,** 2018]

3.3.224* Rack. Any combination of vertical, horizontal, and diagonal members that supports stored materials.

A.3.3.224 Rack. Some rack structures use solid shelves. Racks are permitted to be fixed, portable, or movable. Loading is permitted to be either manual, using lift trucks, stacker cranes, or hand placement, or automatic, using machine-controlled storage and retrieval systems. *[See Figure A.34.7.3.1(a) through Figure A.34.7.3.1(k).]*

3.3.224.1 Double-Row Racks. Racks less than or equal to 12 ft (3700 mm) in depth or single-row racks placed back to back having an aggregate depth up to 12 ft (3700 mm), with aisles having an aisle width of at least 3.5 ft (1100 mm) between loads on racks. [**13,** 2016]

3.3.224.2* Movable Racks. Racks on fixed rails or guides.

A.3.3.224.2 Movable Racks. Movable racks can be moved back and forth only in a horizontal, two-dimensional plane. A moving aisle is created as abutting racks are either loaded or unloaded, then moved across the aisle to abut other racks.

3.3.224.3 Multiple-Row Racks. Racks greater than 12 ft (3700 mm) in depth or single- or double-row racks separated by aisles less than 3.5 ft (1100 mm) wide having an overall width greater than 12 ft (3700 mm). [**13,** 2016]

3.3.224.4* Portable Racks. Racks that are not fixed in place and can be arranged in any number of configurations. [**13,** 2016]

A.3.3.224.4 Portable Racks. Portable racks can be arranged in any number of configurations.

3.3.224.5 Single-Row Racks. Racks that have no longitudinal flue space and that have a depth up to 6 ft (1.8 m) with aisles having a width of at least 3.5 ft (1.1 m) between loads on racks. [**13,** 2016]

3.3.225* Ramp. A walking surface that has a slope steeper than 1 in 20. [***101,*** 2018]

Δ **A.3.3.225 Ramp.** See 7.2.5 of NFPA *101*. [***101,*** 2018]

3.3.226 Recreational Fire. The noncommercial burning of materials other than rubbish for pleasure, religious, ceremonial, cooking, or similar purposes in which the fuel burned is not contained in an incinerator, a barbecue grill, or a barbecue pit, and the total fuel area is not exceeding 3 ft (0.9 m) in diameter and 2 ft (0.6 m) in height.

3.3.227 Refinery. A plant in which flammable or combustible liquids are produced on a commercial scale from crude petroleum, natural gasoline, or other hydrocarbon sources. [**30,** 2018]

3.3.228 Registered Design Professional (RDP). An individual who is registered or licensed to practice his/her respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed. [**5000,** 2018]

3.3.229 Relocatable Power Tap. A device for indoor use consisting of an attachment plug on one end of a flexible cord and two or more receptacles on the opposite end, and has overcurrent protection.

3.3.230 Row. A minimum yard storage unit comprised of adjoining cotton bales.

N **3.3.231 Rubberized Asphalt Melter (Melter).** Portable equipment used for the heating of rubberized asphalt material that is a mix of asphalt, rubber polymer, and filler material.

N **3.3.232 Rural.** Those areas that are not unsettled wilderness or uninhabitable territory but are sparsely populated with densities below 500 persons per square mile. [**1142,** 2017]

3.3.233* Safety Can. A listed container of not more than 5.3 gal (20 L) capacity having a screen or strainer in each fill and pour opening, and having a spring-closing lid and spout cover, designed to safely relieve internal pressure when exposed to fire. [**30,** 2018]

A.3.3.233 Safety Can. Safety cans listed to ANSI/UL 30, *Standard for Metal Safety Cans,* are limited to 5 U.S. gal (19 L). ANSI/UL 1313, *Standard for Nonmetallic Safety Cans for Petroleum Products,* allows for capacities up to 5 Imperial gal (23 L). [**30,** 2018]

Safety cans come in a variety of styles and sizes; however, there are two main types. Type I has a single, short, stubby spout that is used both for filling the can and for pouring from it, such as the one shown in Exhibit 3.19. Type II has separate filling and pouring spouts; the pouring spout is fitted with a flexible or rigid tubular nozzle, as shown in Exhibit 3.20.

There are also special-purpose safety cans. An example is the plunger can shown in Exhibit 3.21, which is used to pump a measured amount of liquid up through the perforated dish to soak a wipe rag. While these special-purpose cans are not considered safety cans, they are covered by their own standard: FM Global's *Approval Standard for Bench, Swab, Plunger, and Dispenser Cans — Class Number 6053, 6054, and 6055.*

Exhibit 3.19

Typical Type I safety can. (Courtesy of Justrite Manufacturing Co.)

Exhibit 3.20

Typical Type II safety can. (Courtesy of Justrite Manufacturing Co.)

Exhibit 3.21

Plunger-type safety can. (Courtesy of Justrite Manufacturing Co.)

The required features of a safety can are as follows:

- A spring-loaded, self-closing spout cover, held open with a handle
- The ability to relieve internal pressure if the can is exposed to a fire
- A capacity of not more than 5.3 gal (20 L)
- A screen or strainer in each spout

Note the maximum capacities stated in A.3.3.233. FM Global's *Approval Standard for Safety Containers and Filling, Supply and Disposal Containers — Class Number 6051 and 6052*, and ANSI/UL 30, *Standard for Metal Safety Cans,* both limit the capacity of a safety can to 5 gal (19 L).

The main purpose of a safety can is to prevent rupture of the container if it is exposed to a fire, while still providing the utility of a closed container. This feature is accomplished by the spring-loaded, self-closing cover on the pouring spout. This cover serves two purposes: It snaps shut as soon as the operating handle is released, so dropping the can would not result in a spill; and, if exposed to a fire, it releases internal pressure before the pressure rises to the point where the can will rupture.

The spring of the self-closing cover is rather strong and will keep the cover closed until some degree of pressure builds up inside the can. When the cover *does* lift, the velocity of the escaping vapors is greater than the intrinsic velocity of a flame through the vapors. Therefore, a flashback into the safety can would be highly unlikely if the vapors were ignited by an external source. For this reason, NFPA 30 does not require a flame arrester. Nevertheless, most safety cans are provided with a screen device, as shown in Exhibit 3.22, to meet listing requirements. Interestingly,

Exhibit 3.22

Internal view of safety can showing flame arrester below spout. (Courtesy of Justrite Manufacturing Co.)

FM Global's standard refers to this device as a *flame arrester* and tests it functionally, while ANSI/UL 30 refers to it as "a screen to trap and permit removal of dirt or other foreign material."

Historically, as explained above, it has been conventional wisdom that a safety can does not require a flash arrester. However, for the 2015 edition of NFPA 30, the definition was revised to acknowledge the fact that each of its spouts has a screen device.

Another feature that is not required but frequently provided is a grounding point. Generally, this is accomplished by taping a convenient spot on the handle before the can is painted. The user removes the tape before using, exposing a bare metal spot that can be used to attach a ground clamp. If this grounding point is not provided, the user must ensure that any ground clamp used "bites" through the paint to establish a good metal-to-metal contact, as shown in Exhibit 3.23.

Safety cans are not intended for use in areas where the periodic release of flammable vapors might create a hazardous atmosphere, such as in the trunk of an automobile or in an outbuilding that will experience wide swings in temperature. A safety can placed in such a location can "burp" vapors as temperatures increase, leading to a buildup of vapors in the enclosed space that could be ignited easily.

Exhibit 3.23

Applying a grounding clamp to a safety can. (Courtesy of Justrite Manufacturing Co.)

N **3.3.234 Safety Data Sheet (SDS).** The document that describes composition of a material, hazardous properties and hazard mitigation, and disposal information. [**400,** 2016]

3.3.235 Sales Display Area. See 3.3.14.10.

3.3.236 Salvage Vehicle. A vehicle that is dismantled for parts or awaiting destruction.

3.3.237 Self-Closing. Equipped with an approved device that ensures closing after opening. [***101,*** 2018]

Exhibit 3.24 illustrates self-closing hardware on a door leaf of a door assembly. The self-closer in this case takes the form of a hydraulic arm. Doors might also be made self-closing via the provision of spring hinges.

Exhibit 3.24

Door leaf with self-closing hardware.

3.3.238 Separation of Hazards. Physically separated by a specified distance, construction, or appliance. [**55,** 2016]

3.3.239 Shop Drawings. Scaled working drawings, equipment cutsheets, and design calculations. *(See 3.3.12, Plan, of NFPA 1031.)* [**1031,** 2014]

3.3.240* Signal. An indication of a condition communicated by electrical, visible, audible, wireless, or other means. [**72,** 2016]

A.3.3.240 Signal.

3.3.240.1* Alarm Signal. A signal that results from the manual or automatic detection of an alarm condition. [**72,** 2016]

A.3.3.240.1 Alarm Signal. Examples of alarm signals include outputs of activated alarm initiating devices, the light and sound from actuated alarm notification appliances, alarm data transmission to a supervising station, and so forth. [**72,** 2016]

An alarm signal is a form of notification to warn of a condition that requires immediate response. It may be related, for example, to a fire or carbon monoxide condition through the automatic activation of an initiating device, or it may be manually activated to warn of a fire, weather, environmental, or hostile situation.

3.3.240.2* Fire Alarm Signal. A signal that results from the manual or automatic detection of a fire alarm condition. [**72,** 2016]

A.3.3.240.2 Fire Alarm Signal. Examples include outputs from activated fire alarm initiating devices (manual fire alarm box, automatic fire detector, waterflow switch, etc.), the light and sound from actuated fire alarm notification appliances, fire alarm data transmission to a supervising station, and so forth. [**72,** 2016]

3.3.240.3* Supervisory Signal. A signal that results from the detection of a supervisory condition. [**72,** 2016]

A.3.3.240.3 Supervisory Signal. Examples include activated supervisory signal-initiating device outputs, supervisory data transmissions to supervising stations, the light and sound from actuated supervisory notification appliances, a delinquency signal indicating a guard's tour supervisory condition, and so forth. [**72,** 2016]

The term *guard's tour supervisory signal*, associated with systems supporting guard's tour supervisory service, is a message indicating that a guard has activated a guard's tour reporting station (not in itself an indication of a supervisory condition). Guard's tour supervisory signals are not a subset of the general category of supervisory signals as used in this *Code*. [**72,** 2016]

3.3.240.4* Trouble Signal. A signal that results from the detection of a trouble condition. [**72,** 2016]

A.3.3.240.4 Trouble Signal. Examples include off-normal outputs from integrity monitoring circuits, the light and sound from actuated trouble notification appliances, trouble data transmission to a supervising station, and so forth. [**72,** 2016]

3.3.241 Simple Asphyxiant Gas. See 3.3.140.15.

3.3.242 Smoke Alarm. A single or multiple-station alarm responsive to smoke. [**72,** 2016]

Exhibit 3.25 illustrates a typical single-station smoke alarm.

Exhibit 3.25

Single-Station Smoke Alarm. (Source: Gentex Corp., Zeeland, MI)

3.3.243* Smoke Barrier. A continuous membrane, or a membrane with discontinuities created by protected openings, where such membrane is designed and constructed to restrict the movement of smoke. [**5000,** 2018]

A.3.3.243 Smoke Barrier. A smoke barrier, such as a wall, floor, or ceiling assembly, might be aligned vertically or horizontally. A smoke barrier might or might not have a fire resistance rating. Application of smoke barrier criteria where required elsewhere in the *Code* should be in accordance with Section 12.9.

3.3.244 Smoke Compartment. See 3.3.67.2.

3.3.245* Smoke Partition. A continuous membrane that is designed to form a barrier to limit the transfer of smoke. [***101,*** 2018]

A.3.3.245 Smoke Partition. A smoke partition is not required to have a fire resistance rating. [***101,*** 2018]

3.3.246 Smoking. The use or carrying of a lighted pipe, cigar, cigarette, tobacco, or any other type of smoking substance.

3.3.247 Smoking Area. See 3.3.14.11.

3.3.248 Solid.

3.3.248.1* Combustible Particulate Solid. An oxidizable, solid-phase material comprising distinct particles or pieces. [**69,** 2014]

A.3.3.248.1 Combustible Particulate Solid. Combustible particulate solids include dusts, fibers, fines, chips, chunks, flakes, and mixtures of these. A definition of this breadth is necessary because it is crucial to address the fact that there is attrition of the material as it is conveyed. Pieces and particles rub against each other and collide with the walls of the duct as they travel through the system. The rubbing and collision break down the material and produce a mixture of pieces and much finer particles, called dusts. Consequently, it is expected that every conveying system produces dusts, regardless of the starting size of the material, as an inherent by-product of the conveying process. [**69,** 2014]

3.3.248.2* Flammable Solid. A solid substance, other than a substance defined as a blasting agent or explosive, that is liable to cause fire resulting from friction or retained heat from manufacture, that has an ignition temperature below 212°F (100°C), or that burns so vigorously or persistently when ignited that it creates a serious hazard. [**400,** 2016]

A.3.3.248.2 Flammable Solid. Flammable solids include finely divided solid materials that, when dispersed in air as a cloud, could be ignited and cause an explosion. [**400,** 2016]

3.3.249 Solid Material. A material that has a melting point, decomposes, or sublimes at a temperature greater than 68°F (20°C). [**5000,** 2018]

3.3.250 Solid Shelving. Shelving that is fixed in place, slatted, wire mesh, or other type of shelves located within racks. The area of a solid shelf is defined by perimeter aisle or flue space on all four sides or by placement of loads that block openings that otherwise serve as the required flue spaces. Solid shelves having an area equal to or less than 20 ft^2 (1.9 m^2) are defined as open racks. Shelves of wire mesh, slats, or other materials more than 50 percent open and where the flue spaces are maintained are defined as open racks. [**13,** 2016]

Exhibit 3.26 illustrates a storage rack with solid shelving, which is defined in 3.3.250.

3.3.251 Special Use. See 3.3.281.3.

3.3.252 Spray Area. See 3.3.14.12.

3.3.253* Spray Booth. A power-ventilated enclosure for a spray application operation or process that confines and limits the escape of the material being sprayed, including vapors, mists, dusts, and residues that are produced by the spraying operation and conducts or directs these materials to an exhaust system. [**33,** 2016]

Exhibit 3.26

Storage Rack with Solid Shelving.

Exhibit 3.27

Example of High-Piled Storage. (Courtesy of Telgian Corporation)

A.3.3.253 Spray Booth. Spray booths are manufactured in a variety of forms, including automotive refinishing, downdraft, open-face, traveling, tunnel, and updraft booths. This definition is not intended to limit the term *spray booth* to any particular design. The entire spray booth is part of the spray area. A spray booth is not a spray room. [**33,** 2016]

3.3.254* Spray Room. A power-ventilated fully enclosed room used exclusively for open spraying of flammable or combustible materials. [**33,** 2016]

A.3.3.254 Spray Room. The entire spray room is considered part of the spray area. A spray booth is not a spray room. [**33,** 2016]

3.3.255 Standard Cubic Foot (scf) of Gas. An amount of gas that occupies one cubic foot at an absolute pressure of 14.7 psi (101 kPa) and a temperature of 70°F (21°C). [**55,** 2016]

3.3.256 Standard Temperature and Pressure (STP). A temperature of 70°F (21°C) and a pressure of 1 atmosphere (14.7 psi or 760 mm Hg).

3.3.257 Standpipe System. See 3.3.267.13.

3.3.258 Storage.

3.3.258.1 Banded Tire Storage. Storage in which a number of tires are strapped together.

3.3.258.2 Cartoned Storage. Storage consisting of corrugated cardboard or paperboard containers that fully enclose the commodity.

3.3.258.3 Detached Storage. Storage in a separate building or in an outside area located away from all structures.

3.3.258.4 High-Piled Storage. Solid-piled, palletized, rack storage, bin box, and shelf storage in excess of 12 ft (3.7 m) in height. [**13,** 2016]

Storage heights exceeding 12 ft (3.7 m) are considered high-piled storage by NFPA 13, *Standard for the Installation of Sprinkler Systems*. See Section 5.6 and Chapter 12 of NFPA 13 for the relevant sprinkler system criteria. Exhibit 3.27 illustrates an example of high-piled storage consisting of on-floor, palletized, and future rack storage.

3.3.258.5 Isolated Storage. Storage in a different storage room or in a separate and detached building located at a safe distance.

3.3.258.6 Laced Tire Storage. Tires stored where the sides of the tires overlap, creating a woven or laced appearance. *[See Figure A.34.8.1(g).]* [**13,** 2016]

3.3.258.7* Miscellaneous Tire Storage. The storage of rubber tires that is incidental to the main use of the building; storage areas do not exceed 2000 ft^2 (186 m^2) and on-tread storage piles, regardless of storage method, do not exceed 25 ft (7.6 m) in the direction of the wheel holes. Acceptable storage arrangements include (a) on-floor, on-side storage up to 12 ft (300 mm) high; (b) on-floor, on-tread storage up to 5 ft (1.5 m) high; (c) double-row or multirow fixed or portable rack storage on-side or on-tread up to 5 ft (1.5 m) high; (d) single-row fixed or portable rack storage on-side or on-tread up to 12 ft (3700 mm) high; and (e) laced tires in racks up to 5 ft (1.5 m) in height. [**13,** 2016]

A.3.3.258.7 Miscellaneous Tire Storage. The limitations on the type and size of storage are intended to identify those situations where tire storage is present in limited quantities and incidental to the main use of the building. Occupancies such as aircraft hangars, automobile dealers, repair garages, retail storage facilities, automotive and truck assembly plants, and mobile home assembly plants are types of facilities where miscellaneous storage could be present. [**13,** 2016]

3.3.258.8 On-Side Tire Storage. Tires stored horizontally or flat. [**13,** 2016]

3.3.258.9 On-Tread Tire Storage. Tires stored vertically or on their treads. [**13,** 2016]

An example of on-side tire storage on portable racks is shown in Exhibit 3.28. Exhibit 3.29 shows an example of on-tread tire storage on racks.

3.3.258.10 Palletized Tire Storage. Storage on portable racks of various types utilizing a conventional pallet as a base. [**13,** 2016]

3.3.258.11 Segregated Storage. Storage located in the same room or inside area that is physically separated by distance from incompatible materials.

3.3.258.12 Yard Storage. Storage of commodities in outdoor areas.

3.3.259 Storage Aids. Commodity storage devices, such as pallets, dunnage, separators, and skids. [**13,** 2016]

Exhibit 3.28

On-Side Tire Storage on Portable Racks. (Courtesy of Ford Motor Company)

Exhibit 3.29

On-Tread Tire Storage on Racks.

3.3.260 Story. The portion of a building located between the upper surface of a floor and the upper surface of the floor or roof next above. [**5000,** 2018]

The definition of *story* includes a usable basement. This detail is important because several of the requirements in this *Code* are based on the number of stories in a building. Therefore, if a requirement applies to a three-story building, and the building in question includes a basement and two stories above grade, the requirement would apply to the building. Where this *Code* uses the phrase *stories in height,* the determination of the number of stories is based on the story that meets the definition of the phrase *level of exit discharge* in accordance with 4.6.3 of NFPA *101.*

3.3.260.1 Occupiable Story. A story occupied by people on a regular basis. [***101,*** 2018]

3.3.261 Street. A public thoroughfare that has been dedicated for vehicular use by the public and can be used for access by fire department vehicles. [***101,*** 2018]

3.3.262* Street Floor. A story or floor level accessible from the street or from outside the building at the finished ground level, with the floor level at the main entrance located not more than three risers above or below the finished ground level, and arranged and utilized to qualify as the main floor. [***101,*** 2018]

A.3.3.262 Street Floor. Where, due to differences in street levels, there are two or more stories accessible from the street, each is a street floor. Where there is no floor level within the specified limits for a street floor above or below ground level, the building has no street floor.

3.3.263 Structural Element. The columns and girders, beams, trusses, joists, braced frames, moment-resistant frames, and vertical and lateral resisting elements, and other framing members that are designed to carry any portion of the dead or live load and lateral forces, that are essential to the stability of the building or structure. [**5000,** 2018]

3.3.264* Structure. That which is built or constructed. [***101,*** 2018]

Δ **A.3.3.264 Structure.** The term *structure* is to be understood as if followed by the words *or portion thereof. (See also 3.3.29, Building.)* [***101,*** 2018]

N **3.3.265* Suburb or Suburban.** Those moderately inhabited areas with population densities of at least 500 persons per square mile but less than 1000 persons per square mile. [**1142,** 2017]

N **A.3.3.265 Suburb or Suburban.** Suburban areas can include populous towns or large villages or be located outside the official limits of a densely settled city of 2500 to 50,000 people per census block, or those areas that interface with the outer rim of an urban cluster (UC). Suburban communities usually exist within commuting distance of urban areas but exhibit their own jurisdictional autonomy. [**1142,** 2017]

3.3.266 Summarily Abate. To immediately judge a condition to be a fire hazard to life or property and to order immediate correction of such condition.

3.3.267 System. Several items of equipment assembled, grouped, or otherwise interconnected for the accomplishment of a purpose or function.

Δ ***3.3.267.1* Bulk Hydrogen Compressed Gas System.*** A gaseous hydrogen (GH_2) system with a storage capacity of more than 5000 scf (141.6 Nm^3) of compressed hydrogen gas. [**55,** 2016]

N ***A.3.3.267.1 Bulk Hydrogen Compressed Gas System.*** The bulk system terminates at the source valve, which is the point where the gas supply, at service pressure, first enters the supply line, or at a piece of equipment that utilizes the hydrogen gas, such as a hydrogen dispenser. The containers are either stationary or movable, and the source gas for the system is stored as a compressed gas.

Bulk hydrogen compressed gas systems can include a bulk storage source, transfer piping and manifold system, compression system, and other components. The gaseous source can include a tube trailer, tube bank, or other high pressure storage vessels used to serve the piping system that transports hydrogen to the end user. Compressors can be installed downstream of the storage supply to boost the pressure of the source gas, and intermediate high pressure storage might be present. This is done where the end use requires hydrogen at a pressure higher than that of the bulk supply. In these instances, there may be intermediate storage vessels used to store the gas at elevated pressures. It is not uncommon for the bulk supply as delivered to be furnished at nominal gauge pressure of 3000 psi (20,684 kPa), and the intermediate high pressure storage to be stored at gauge pressures up to 15,000 psi (103,421 kPa). See Figure A.3.3.267.1(a) through Figure A.3.3.267.1(f).

3.3.267.2 Bulk Inert Gas System. An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, vaporizers, manifolds, and piping, with a storage capacity of more than 20,000 scf (566 Nm^3) of inert gas, including unconnected reserves on hand at the site, and that terminates at the source valve. [**55,** 2016]

Δ ***3.3.267.3 Bulk Liquefied Hydrogen System.*** A liquefied hydrogen (LH_2) system with a storage capacity of more than 39.7 gal (150 L) of liquefied hydrogen. [**55,** 2016]

3.3.267.4* Bulk Oxygen System. An assembly of equipment, such as oxygen storage containers, pressure regulators, pressure relief devices, vaporizers, manifolds, and interconnecting piping, that has a storage capacity of more than 20,000 scf (566 Nm^3) of oxygen and that terminates at the source valve. [**55,** 2016]

A.3.3.267.4 Bulk Oxygen System. The bulk oxygen system terminates at the source valve, which is commonly the point where oxygen at service pressure first enters the supply line or a piece of equipment that utilizes the oxygen gas or liquid. The oxygen containers are either stationary or movable, and the oxygen is stored as a compressed gas or cryogenic fluid.

Bulk oxygen systems can be used to supply gas in either its compressed gaseous or liquefied form. Systems that may be used to supply both gaseous and liquid forms are referred to as hybrid systems. The following bulk oxygen systems are typical of those in use:

(1) When the primary supply of the gas as stored is from a compressed gaseous source that is used in the compressed and gaseous form, the bulk oxygen system is said to be a bulk compressed oxygen gas system.
(2) When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer only liquid, the system is said to be a bulk liquefied oxygen system.

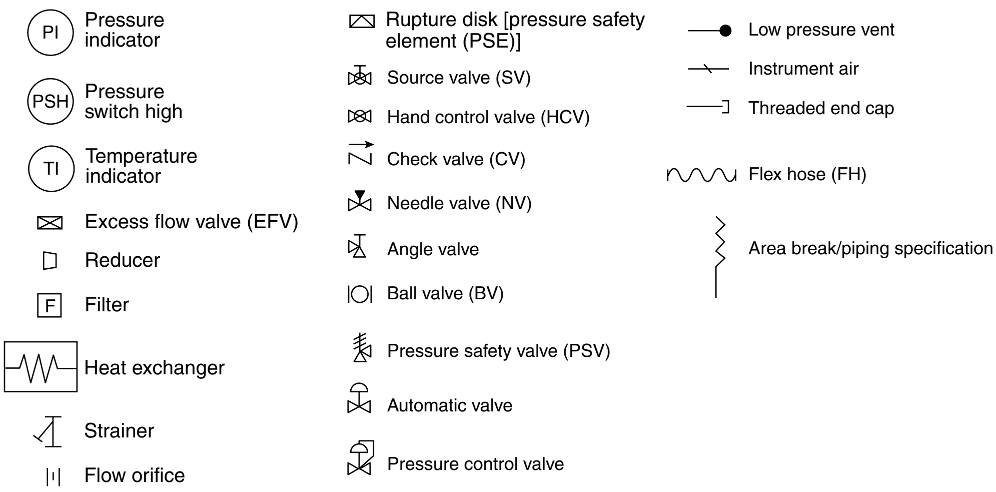


FIGURE A.3.3.267.1(a) *Symbol Legend for Figure A.3.3.258.1(b) through Figure A.3.3.258.1(f). [**55,** 2016]*

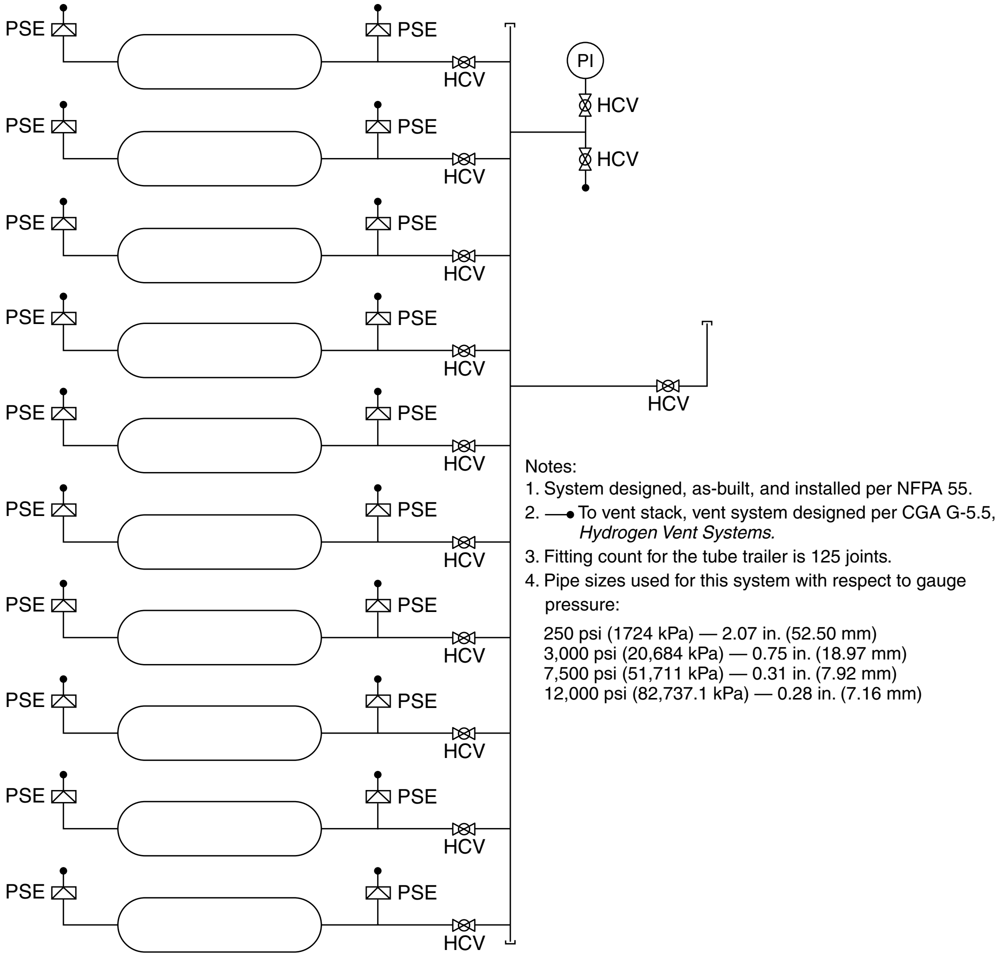


FIGURE A.3.3.267.1(b) *Typical Tube Trailer. [**55,** 2016]*

(3) When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer or store the gas in a compressed gaseous form, with or without a feature that may also allow the subsequent transfer and use of liquid, the bulk oxygen system is said to be a hybrid bulk oxygen system. For the purposes of the application of the code, a hybrid system is viewed as a bulk liquefied oxygen system.

[**55,** 2016]

3.3.267.5 Central Station Service Alarm System. A system or group of systems in which the operations of circuits and devices are transmitted automatically to, recorded in, maintained by, and supervised from a listed central station that has competent and experienced servers and operators who, upon receipt of a signal, take such action as required by *NFPA 72*. Such service is to be controlled and operated by a person, firm, or corporation whose business is the furnishing, maintaining, or monitoring of supervised alarm systems. [**72,** 2016]

An example of a central station fire alarm system monitoring facility is illustrated in Exhibit 3.30.

3.3.267.6 Compressed Gas System. An assembly of equipment designed to contain, distribute, or transport compressed gases. [**318,** 2018]

3.3.267.7 Continuous Gas Detection System. A gas detection system in which the instrument is maintained in continuous operation and the interval between sampling of any point does not exceed 30 minutes. [**55,** 2016]

3.3.267.8 Cylinder Containment System. A gastight recovery system comprising equipment or devices that can be placed over a leak in a compressed gas container, thereby stopping or controlling the escape of gas from the leaking container. [**55,** 2016]

3.3.267.9 Dedicated Smoke-Control System. A system that is intended for the purpose of smoke control only, which are separate systems of air moving and distribution equipment that do not function under normal building operating conditions.

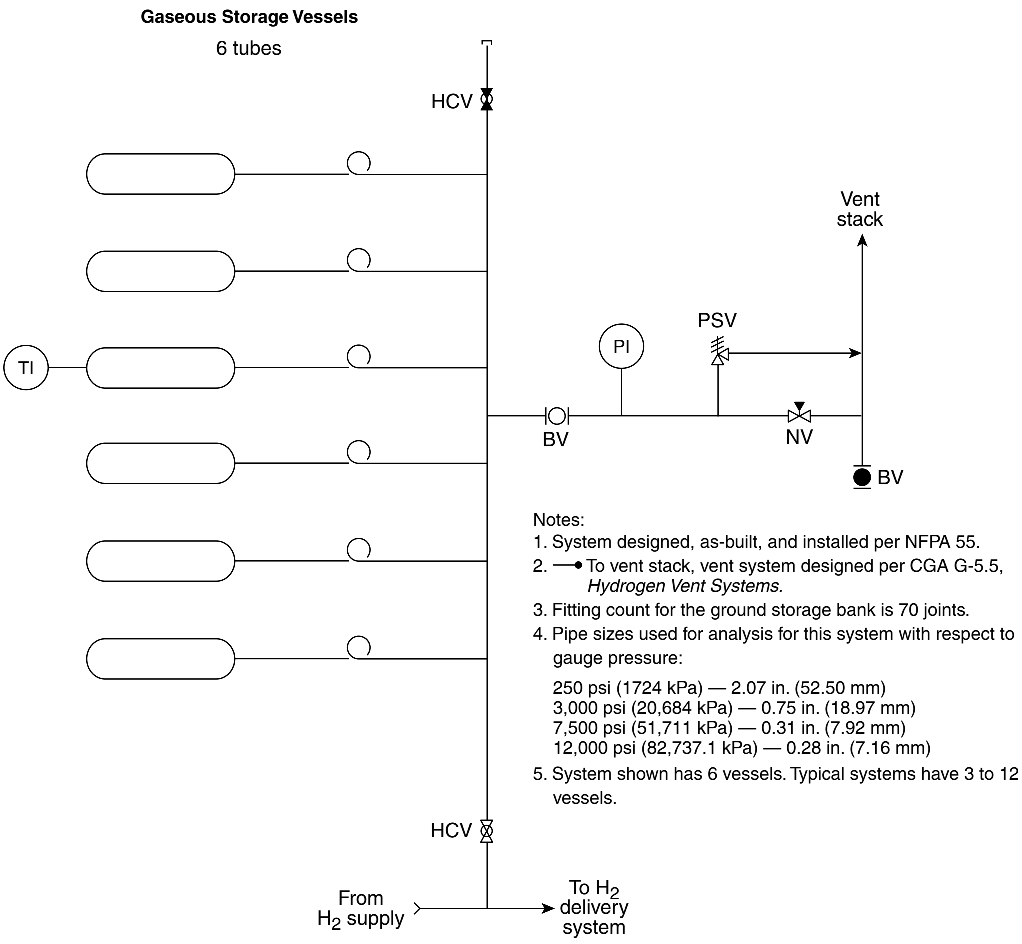


*FIGURE A.3.3.267.1(c) Typical Bulk Compressed Gaseous Storage System. [**55,** 2016]*

Exhibit 3.30

Central Station with Display in Background Indicating Signal Traffic and Availability to Process Incoming Signals. (Source: SimplexGrinnell, Westminster, MA)

3.3.267.10 Fire Alarm System. A system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals. [**72,** 2016]

The definition of *fire alarm system* includes fire alarm systems that provide a specific function or functions, such as sprinkler supervisory service.

3.3.267.11 Fire Protection System. Any fire alarm device or system or fire-extinguishing device or system, or combination thereof, that is designed and installed for detecting, controlling, or extinguishing a fire or otherwise alerting occupants, or the fire department, or both, that a fire has occurred. [**1141,** 2017]

3.3.267.12 Nondedicated Smoke-Control System. A smoke-control system that shares components with some other system(s), such as the building HVAC system, which changes its mode of operation to achieve the smoke-control objective.

3.3.267.13* Standpipe System. An arrangement of piping, valves, hose connections, and associated equipment installed

Notes:
1. System designed, as-built, and installed per NFPA 55.
2. —• To vent stack, vent system designed per CGA G-5.5, *Hydrogen Vent Systems.*
3. Fitting count for the pressure control manifold is 111 joints.
4. Fitting count for the stanchion is 29 joints.
5. Pipe sizes used for analysis for this system with respect to gauge pressure:
   250 psi (1724 kPa) — 2.07 in. (52.50 mm)
   3,000 psi (20,684 kPa) — 0.75 in. (18.97 mm)
   7,500 psi (51,711 kPa) — 0.31 in. (7.92 mm)
   12,000 psi (82,737.1 kPa) — 0.28 in. (7.16 mm)

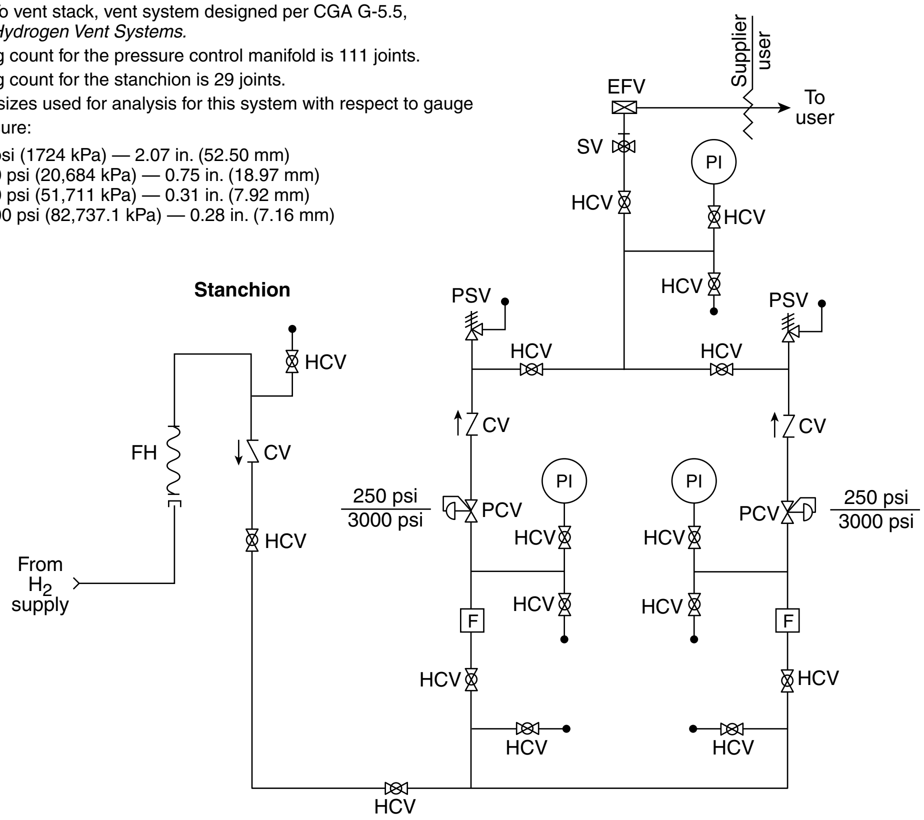


FIGURE A.3.3.267.1(d) Typical Tube Trailer Discharge Stanchion and Pressure Control Manifold. [55, 2016]

in a building or structure, with the hose connections located in such a manner that water can be discharged in streams or spray patterns through attached hose and nozzles, for the purpose of extinguishing a fire, thereby protecting a building or structure and its contents in addition to protecting the occupants. [**14,** 2016]

A.3.3.267.13 Standpipe System. This arrangement is accomplished by means of connections to water supply systems or by means of pumps, tanks, and other equipment necessary to provide an adequate supply of water to the hose connections. [**14,** 2016]

3.3.267.14 Treatment System. An assembly of equipment capable of processing a hazardous gas and reducing the gas concentration to a predetermined level at the point of discharge from the system to the atmosphere. [**55,** 2016]

3.3.267.15* Vapor Processing System. A system designed to capture and process vapors displaced during transfer or filling operations by use of mechanical or chemical means. [**30,** 2018]

A.3.3.267.15 Vapor Processing System. Examples are systems using blower-assist for capturing vapors and refrigeration, absorption, and combustion systems for processing vapors. [**30,** 2018]

3.3.267.16* Vapor Recovery System. A system designed to capture and retain, without processing, vapors displaced during transfer or filling operations. [**30,** 2018]

A.3.3.267.16 Vapor Recovery System. Examples are balanced-pressure vapor displacement systems and vacuum-assist systems without vapor processing. [**30,** 2018]

3.3.268 Tank.

3.3.268.1 Aboveground Storage Tank. A horizontal or vertical tank that is listed and intended for fixed installation, without backfill, above or below grade and is used within the scope of its approval or listing. [**30A,** 2018]

See Exhibit 3.31 for an illustration of horizontal aboveground atmospheric storage tanks.

3.3.268.2 Aboveground Tank. A tank that is installed above grade, at grade, or below grade without backfill. [**30,** 2018]

Exhibit 3.32 illustrates aboveground tanks installed above grade, at grade, and below grade without backfill.

3.3.268.2.1 Protected Aboveground Tank. An atmospheric aboveground storage tank with integral secondary containment

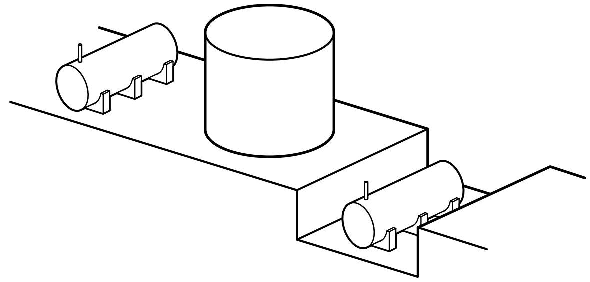
Exhibit 3.31

Horizontal aboveground atmospheric storage tanks.

and thermal insulation that has been evaluated for resistance to physical damage and for limiting the heat transferred to the primary tank when exposed to a hydrocarbon pool fire and is listed in accordance with ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids,* or an equivalent test procedure. [**30:**22.2.3]

3.3.268.3 ASME Tank. See 3.3.70.1, ASME Container.

Exhibit 3.32



Aboveground tanks installed above grade, at grade, and below grade without backfill.

3.3.268.4* Portable Tank. Any vessel having a liquid capacity over 60 gal (230 L) intended for storing liquids and not intended for fixed installation. [**30,** 2018]

The term *portable tank*, in the context of this *Code*, refers strictly to a steel shipping vessel of 60 gal to 660 gal (227 L to 2500 L) capacity used to transport liquid commodities and constructed according to specifications established by the DOT in Title 49, *Code of Federal Regulations,* Part 178.245, "Specification 51 — Steel Portable Tanks." For the purposes of the *Code* and this

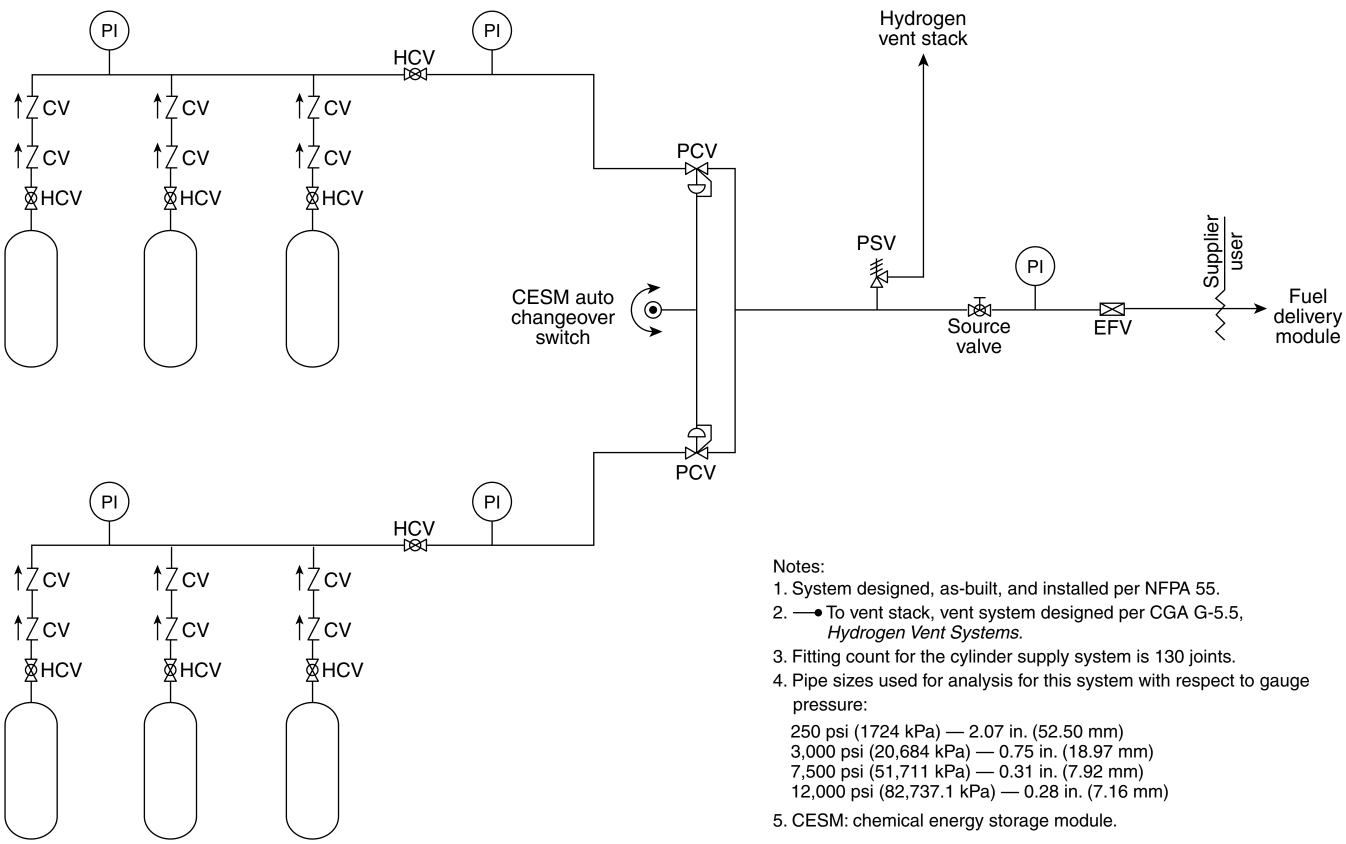
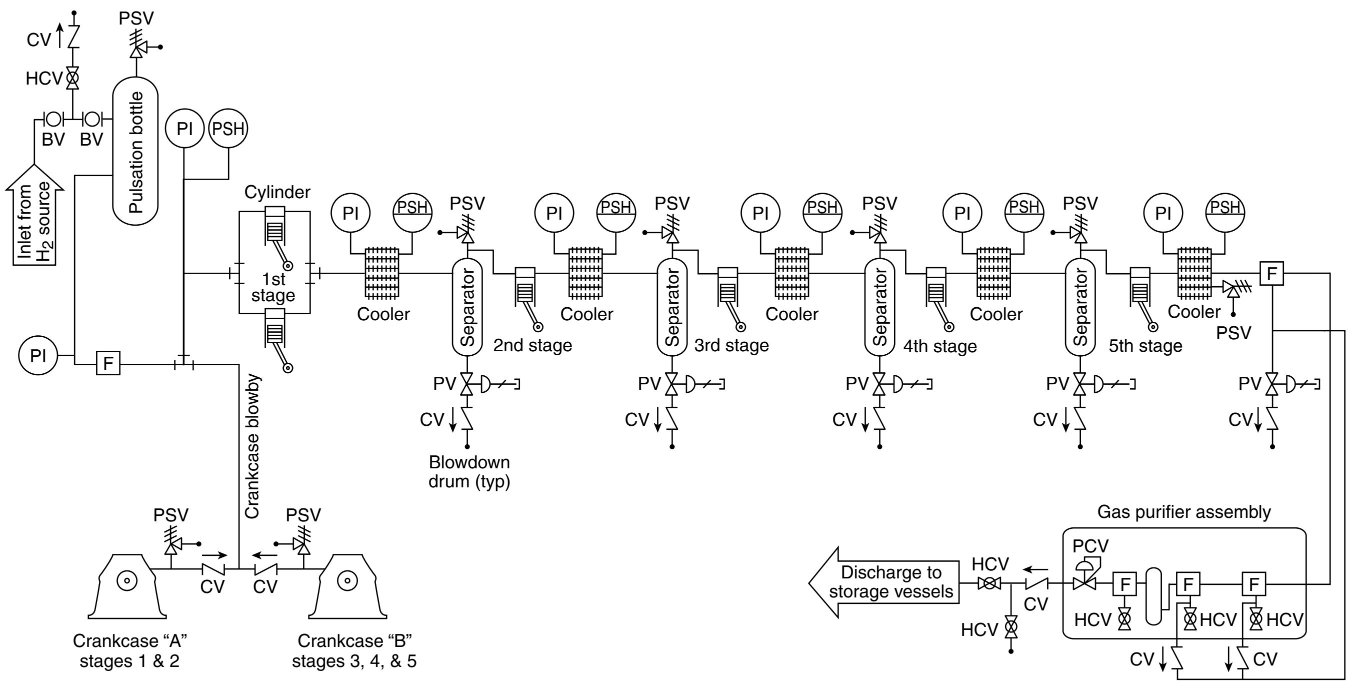


FIGURE A.3.3.267.1(e) *Typical Chemical Energy Storage Module (CESM). [**55,** 2016]*



Notes:
1. System designed, as-built, and installed per NFPA 55.
2. —● To vent stack, vent system designed per CGA G-5.5, *Hydrogen Vent Systems.*
3. Fitting count for the compression system is 225 joints.
4. Pipe sizes used for analysis for this system with respect to gauge pressure:

250 psi (1724 kPa) — 2.07 in. (52.50 mm)
3,000 psi (20,684 kPa) — 0.75 in. (18.97 mm)
7,500 psi (51,711 kPa) — 0.31 in. (7.92 mm)
12,000 psi (82,737.1 kPa) — 0.28 in. (7.16 mm)

FIGURE A.3.3.267.1(f) *Typical Compressor Module. [**55,** 2016]*

handbook, the term *portable tank* can be considered a subset of the term *intermediate bulk container.*

Any vessel referred to as a portable tank that exceeds the maximum capacity specified for an intermediate bulk container of 793 gal (3000 L) is to be treated as a storage tank and is governed by Chapters 21 and 22 of NFPA 30. In the transportation arena, many intermodal tanks, such as the one shown in Exhibit 3.5, are referred to colloquially as portable tanks. In this handbook, the term *intermediate bulk container* also refers to Specification 51 portable tanks as already described.

A.3.3.268.4 Portable Tank. A portable tank does not include any cylinder having less than 1000 lb (453.5 kg) water capacity, cargo tank, tank car tank, or trailers carrying cylinders of over 1000 lb (453.5 kg) water capacity. [**55,** 2016]

3.3.268.5 Secondary Containment Tank. A tank that has an inner and outer wall with an interstitial space (annulus) between the walls and that has a means for monitoring the interstitial space for a leak. [**30,** 2018]

A secondary containment tank is an aboveground variant of the double-walled tanks commonly used underground. See Exhibit 3.33. They typically are of double-wall design with means for testing the annular space for a leak. Secondary containment tanks are discussed in more detail in 66.22.11.4. Note that any protected tank that is listed to ANSI/UL 2085, *Standard for*

Exhibit 3.33

Typical secondary containment tank. (Courtesy of Modern Welding Co.)

Protected Aboveground Tanks for Flammable and Combustible Liquids, is also a secondary containment tank. A fire-resistant tank listed to UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*, might or might not be of secondary containment design.

3.3.268.6* Stationary Tank. A packaging designed primarily for stationary installations not intended for loading, unloading, or attachment to a transport vehicle as part of its normal operation in the process of use. [**55,** 2016]

A.3.3.268.6 Stationary Tank. A stationary tank does not include a cylinder having less than 1000 lb (453.5 kg) water capacity. [**55,** 2016]

3.3.268.7 Storage Tank. Any vessel having a liquid capacity that exceeds 60 gal (230 L), is intended for fixed installation, and is not used for processing. [**30,** 2018]

Any fixed tank, including a portable tank as defined in 3.3.268.4, is considered a storage tank and is thus subject to the requirements of Section 66.21 and either Section 66.22 or Section 66.23, if it is connected to a fixed piping system. The phrase *not used for processing* is intended to minimize conflict between storage tanks, as defined in 3.3.268.7, and tanks that are part of a unit operation or unit process. The lower limit of 60 gal (230 L) was established years ago in NFPA 30 and coincided with the original NFPA 30 definition of the term *container* [up to 60 gal (230 L)] and the lower limit of its definition of the term *portable tank*. Any fixed tank of 60 gal (230 L) or less is not considered to be within the scope of Sections 66.21 through 66.23.

3.3.269 Temporary Wiring. Approved wiring for power and lighting during a period of construction, remodeling, maintenance, repair, or demolition, and decorative lighting, carnival power and lighting, and similar purposes.

3.3.270 Tire.

3.3.270.1 Rubber Tires. Pneumatic tires for passenger automobiles, aircraft, light and heavy trucks, trailers, farm equipment, construction equipment (off-the-road), and buses. [**13,** 2016]

3.3.270.2 Scrap Tire. A tire that can no longer be used for its original purpose due to wear or damage.

3.3.271 TC. Transport Canada. [**55,** 2016]

3.3.272 Toxic Material. See 3.3.180.14.

3.3.273* Traffic Calming Device. A roadway design element utilized to reduce vehicle speeds, decrease motor vehicle volumes, and increase safety for pedestrians and nonmotorized vehicles.

A.3.3.273 Traffic Calming Device. Traffic calming devices typically consist of, but are not limited to, speed bumps, speed humps, and traffic circles.

N **3.3.274* Transfilling.** The process of transferring a gas, either in compressed or liquid form from one cylinder or container to another cylinder or container.

N **A.3.3.274 Transfilling.** Transfilling usually occurs from a bulk container to a smaller container, such as filling a small compressed gas cylinder.

3.3.275* Tube Trailer. A truck or semitrailer on which a number of very long compressed gas tubular cylinders have been mounted and manifolded into a common piping system. [**55,** 2016]

Δ **A.3.3.275 Tube Trailer.** The characteristic internal water volume of individual tubular cylinders ranges from 43 scf to 93 scf (1218 L to 2632 L) or a water capacity of 2686 lb to 5803 lb (1218 kg to 2632 kg). [**55,** 2016]

3.3.276 Unauthorized Discharge. A release or emission of materials in a manner that does not conform to the provisions of this *Code* or applicable public health and safety regulations.

3.3.277 Unit Operation or Unit Process. A segment of a physical or chemical process that might or might not be integrated with other segments to constitute the manufacturing sequence. [**30,** 2018]

3.3.278 Unit Process. See 3.3.277, Unit Operation or Unit Process.

3.3.279 Unit (Vessel), Operating or Process. See 3.3.196.

3.3.280 Unstable (Reactive) Material. See 3.3.180.15.

3.3.281* Use. To place a material, including solids, liquids, and gases into action. [**400,** 2016]

A.3.3.281 Use. Examples of use include, but are not limited to, blending, mixing, reacting, distillation, heating or cooling, pumping, compressing, drying, screening, filling, loading and unloading, repackaging, scrubbing, absorbing, neutralizing, and incineration. [**400,** 2016]

3.3.281.1* Closed System Use. Use of a solid or liquid hazardous material in a closed vessel or system that remains closed during normal operations where vapors emitted by the product are not liberated outside of the vessel or system and the product is not exposed to the atmosphere during normal operations, and all uses of compressed gases. [**400,** 2016]

A.3.3.281.1 Closed System Use. Examples of closed systems for solids and liquids include reaction process operations and product conveyed through a piping system into a closed vessel, system, or piece of equipment. [**400,** 2016]

3.3.281.2* Open System Use. Use of a solid or liquid hazardous material in a vessel or system that is continuously open to the atmosphere during normal operations and where vapors are liberated, or the product is exposed to the atmosphere during normal operations. [**400,** 2016]

A.3.3.281.2 Open System Use. Examples of open systems for solids and liquids include dispensing from or into open beakers or containers, and dip tank and plating tank operations. [**400,** 2016]

3.3.281.3 Special Use. A use that includes, but is not limited to, events or occurrences during which life safety–threatening situations or fire hazards exist or are likely to exist as determined by the AHJ.

3.3.282* Valve.

N **A.3.3.282** See also A.3.3.27.

3.3.282.1 Indicating Valve. A valve that has components that show if the valve is open or closed. Examples are outside screw and yoke (OS&Y) gate valves and underground gate valves with indicator posts.

Exhibit 3.34 and Exhibit 3.35 illustrate types of indicating valves.

Exhibit 3.34

Vertical indicator post.

Exhibit 3.35

Outside screw and yoke (OS&Y) gate valve.

3.3.282.2 Reduced Flow Valve. A valve equipped with a restricted flow orifice that is designed to reduce the maximum flow from the valve under full flow conditions.

3.3.282.3 Valve Outlet Cap or Plug. A removable device that forms a gastight seal on the outlet to the control valve that is provided on a source containing a compressed gas or cryogenic fluid. [**55,** 2016]

3.3.282.4 Valve Protection Cap. A rigid, removable cover provided for container valve protection during handling, transportation, and storage. [**55,** 2016]

3.3.282.5 Valve Protection Device. A device attached to the neck ring or body of a cylinder for the purpose of protecting the cylinder valve from being struck or from being damaged by the impact resulting from a fall or an object striking the cylinder.

3.3.283* Vapor Pressure. The pressure, measured in pounds per square inch, absolute (psia), exerted by a liquid, as determined by ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method).* [**30,** 2018]

A.3.3.283 Vapor Pressure. Vapor pressure is a measure of the pressure that the liquid exerts against the atmosphere above it. Just as the atmosphere exerts pressure on the surface of the liquid, the liquid pushes back. Vapor pressure is normally less than atmospheric pressure and is a measure of the liquid's tendency to evaporate (i.e., to move from the liquid to the gaseous state). This tendency is also referred to as volatility, thus the use of the term *volatile* to describe liquids that evaporate very easily. The higher the vapor pressure, the greater the rate of evaporation and the lower the boiling point. Simply put, this means more vapors and increased fire risk. [**30:**A.4.2.6]

3.3.284 Vapor Processing System. See 3.3.267.15.

3.3.285 Vapor Recovery System. See 3.3.267.16.

3.3.286 Warehouse.

Δ ***3.3.286.1 General-Purpose Warehouse.*** A separate, detached building or portion of a building used only for warehousing-type operations and classified as a "storage — low hazard" or "storage — ordinary hazard" occupancy by the building code and by NFPA *101*. [**30,** 2018]

3.3.286.2 Liquid Warehouse. A separate, detached building or an attached building that is used for warehousing-type operations for liquids and whose exterior wall comprises at least 25 percent of the building perimeter. [**30,** 2018]

One key distinction between a general-purpose warehouse and a liquid warehouse is that the former handles a variety of combustible commodities, some of which *might* be flammable or combustible liquids, while the latter handles liquids almost exclusively. Regulations governing each type vary significantly.

3.3.287 Water Capacity. The amount of water at 60°F (16°C) required to fill a container. [**58,** 2017]

The water capacity of a container is the maximum amount of water the container can hold at 60°F (16°C). The water capacity (full of water) is expressed in pounds (kilograms) for cylinders and gallons (cubic meters) for ASME containers.

The water capacity is different from the propane capacity of a container. Water capacity is measured with the container 100 percent full, whereas the maximum permitted filling limit allowed for propane is typically set at 80 percent of the water capacity, although there are exceptions to this practice as described in Chapter 7.

For example, the typical 1000 gal (3.8 m^3) water capacity ASME container is allowed to hold about 800 gal (3 m^3) of propane (80 percent capacity). However, a 30,000 gal (114 m^3) container can be filled to 25,800 gal (98 m^3) of propane [86 percent capacity at 40°F (4°C)]. Larger containers minimize extreme swings in the temperature of the total product due to daytime solar heating and night cooling. This reduces expansion and contraction of the propane, which indirectly reduces large pressure swings.

The maximum propane capacity of a cylinder is determined by its water capacity, but the capacity is given in pounds (kilograms). For cylinders measured by weight, the weight allowance for propane is 42 percent of the weight of the water. This percentage is determined by first taking into account the density difference between propane and water before an additional reduction for expansion/contraction allowances, similar to that for ASME containers, as shown in the following equation:

$$\begin{gathered}84\%\ \text{(expansion and contraction)} \times 50\%\ \text{(density)}\\ \times\ \text{water weight [lb]}\\ = 42\% \times \text{water weight [lb]}\\ = \text{propane weight [lb]}\end{gathered}$$

If the water capacity of a cylinder is marked as being 48 lb (36 kg), the propane capacity is 42 percent of 48 lb (36 kg), or about 20 lb (9 kg).

3.3.288* Wharf. A structure at the shoreline that has a platform built along and parallel to a body of water with either an open deck or a superstructure. [**307,** 2016]

A.3.3.288 Wharf. The terms *wharf* and *pier* are used interchangeably. [**307,** 2016]

3.3.289* Wildland/Urban Interface. An area where wildland fuels abut structures, with a clear line of demarcation between residential, business, and public structures and wildland fuels. [**1144,** 2018]

N **A.3.3.289 Wildland/Urban Interface.** The term *wildland/urban interface* can distort the perception of the primary issue. It can direct attention to "where" structures are located (e.g., at the edge of communities near the wildland) rather than if they are highly ignitable. And if so, the focus on "where" can result in a concern about things that will not make a big difference in reducing structure loss (i.e., how fire fighters and equipment get there, what type of fire equipment is needed, and the location of fire hydrants and water sources). How wide the roads are and where the fire hydrants are located become of little value if there are more structures at risk than equipment to protect them, or if it is too dangerous to safely be there with fire-fighting forces. [**1144,** 2018]

The essence of this issue is not where structures and domestic landscapes adjoin wildland, but the location, density, and availability of ignitable structures. Which structures are at the greatest risk, ignition-resistant homes bordering the wildland or a dense subdivision with wood shingle roofs several miles away from wildland fuels? The wildland/urban interface is not geographic location, but rather a set of conditions that can exist in many communities. [**1144,** 2018]

3.3.290 Wood Panel. Board or sheet made from veneers, particles, or fibers of wood and includes plywood, oriented strandboard, and similar wood products.

3.3.291 Written Notice. A notification in writing delivered in person to the individual or parties intended, or delivered at, or sent by certified or registered mail to, the last residential or business address of legal record.

3.4 Special Performance-Based Definitions

3.4.1 Alternative Calculation Procedure. A calculation procedure that differs from the procedure originally employed by the design team but that provides predictions for the same variables of interest. [***101,*** 2018]

3.4.2 Analysis.

3.4.2.1 Sensitivity Analysis. An analysis performed to determine the degree to which a predicted output will vary given a specified change in an input parameter, usually in relation to models. [**5000,** 2018]

3.4.2.2 Uncertainty Analysis. An analysis intended to (1) identify key sources of uncertainties in the predictions of a model, (2) assess the potential impacts of these uncertainties on the predictions, and (3) assess the likelihood of these potential impacts. Per this definition, sensitivity analysis performs some but not all of the functions of uncertainty analysis. [**805,** 2015]

3.4.3 Data Conversion. The process of developing the input data set for the assessment method of choice. [***101,*** 2018]

3.4.4 Design Fire Scenario. See 3.4.9.1.

3.4.5* Design Specification. A building characteristic and other conditions that are under the control of the design team. [**5000,** 2018]

A.3.4.5 Design Specification. Design specifications include both hardware and human factors, such as the conditions produced by maintenance and training. For purposes of performance-based design, the design specifications of interest are those that affect the ability of the building to meet the stated goals and objectives. [**5000,** 2018]

3.4.6 Design Team. A group of stakeholders including, but not limited to, representatives of the architect, client, and any pertinent engineers and other designers. [***101,*** 2018]

3.4.7* Exposure Fire. A fire that starts at a location that is remote from the area being protected and grows to expose that which is being protected. [***101,*** 2018]

A.3.4.7 Exposure Fire. An exposure fire usually refers to a fire that starts outside a building, such as a wildlands fire or vehicle fire, and that, consequently, exposes the building to a fire. [***101,*** 2018]

3.4.8* Fire Model. Mathematical prediction of fire growth, environmental conditions, and potential effects on structures, systems, or components based on the conservation equations or empirical data. [**805,** 2015]

Δ **A.3.4.8 Fire Model.** Due to the complex nature of the principles involved, models are often packaged as computer software. Any relevant input data, assumptions, and limitations needed to properly implement the model will be attached to the fire models. [***101,*** 2018]

3.4.9* Fire Scenario. A set of conditions that defines the development of fire, the spread of combustion products throughout a building or portion of a building, the reactions of people to fire, and the effects of combustion products. [***101,*** 2018]

A.3.4.9 Fire Scenario. A fire scenario defines the conditions under which a proposed design is expected to meet the fire safety goals. Factors typically include fuel characteristics, ignition sources, ventilation, building characteristics, and occupant locations and characteristics. The term *fire scenario* includes more than the characteristics of the fire itself but excludes design specifications and any characteristics that do not vary from one fire to another; the latter are called assumptions. The term *fire scenario* is used here to mean only those specifications required to calculate the fire's development and effects, but, in other contexts, the term might be used to mean both the initial specifications and the subsequent development and effects (i.e., a complete description of fire from conditions prior to ignition to conditions following extinguishment). [***101,*** 2018]

Δ ***3.4.9.1 Design Fire Scenario.*** A fire scenario selected for evaluation of a proposed design. [***101,*** 2018]

3.4.10* Fuel Load. The total quantity of combustible contents of a building, space, or fire area. [**5000,** 2018]

A.3.4.10 Fuel Load. Fuel load includes interior finish and trim. [**5000,** 2018]

3.4.11 Incapacitation. A condition under which humans do not function adequately and become unable to escape untenable conditions. [***101,*** 2018]

3.4.12 Input Data Specification. Information required by the verification method. [***101,*** 2018]

3.4.13 Occupant Characteristics. The abilities or behaviors of people before and during a fire. [***101,*** 2018]

3.4.14* Performance Criteria. Threshold values on measurement scales that are based on quantified performance objectives. [***101,*** 2018]

A.3.4.14 Performance Criteria. Performance criteria are stated in engineering terms. Engineering terms include temperatures, radiant heat flux, and levels of exposure to fire products. Performance criteria provide threshold values used to evaluate a proposed design. [***101,*** 2018]

3.4.15* Proposed Design. A design developed by a design team and submitted to the AHJ for approval. [***101,*** 2018]

A.3.4.15 Proposed Design. The design team might develop a number of trial designs that will be evaluated to determine whether they meet the performance criteria. One of the trial designs will be selected from those that meet the performance criteria for submission to the AHJ as the proposed design. [***101,*** 2018]

The proposed design is not necessarily limited to fire protection systems and building features. It also includes any component of the proposed design that is installed, established, or maintained for the purpose of life safety, without which the proposed design could fail to achieve specified performance criteria. Therefore, the proposed design often includes emergency procedures and organizational structures that are needed to meet the performance criteria specified for the proposed design. [***101,*** 2018]

3.4.16 Safe Location. A location remote or separated from the effects of a fire so that such effects no longer pose a threat. [***101,*** 2018]

3.4.17 Safety Factor. A factor applied to a predicted value to ensure that a sufficient safety margin is maintained. [***101,*** 2018]

3.4.18 Safety Margin. The difference between a predicted value and the actual value where a fault condition is expected. [***101,*** 2018]

3.4.19 Sensitivity Analysis. See 3.4.2.1.

3.4.20 Stakeholder. An individual, or representative of same, having an interest in the successful completion of a project. [***101,*** 2018]

3.4.21 Uncertainty Analysis. See 3.4.2.2.

3.4.22 Verification Method. A procedure or process used to demonstrate or confirm that the proposed design meets the specified criteria. [***101,*** 2018]

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ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*, 1997, revised 2010.
UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*, 1st edition, 2006.

U.S. Government Publishing Office, Washington, DC 20402.

Title 49, Code of Federal Regulations, Part 171.8, "Transportation."
Title 49, Code of Federal Regulations, Parts 172 through 179, "Hazardous Materials Transportation Regulations."
Title 49, Code of Federal Regulations, Part 178.245, "Specification 51 — Steel Portable Tanks."
Title 49, Code of Federal Regulations, Part 178.700.

General Requirements

4

Chapter 4 presents general information about goals and objectives, inherent assumptions, and applicable options that concern compliance with the life safety and property protection requirements of NFPA 1, as well as information regarding how the *Code* is applied. (See Sections 4.1 through 4.4.) These goals and objectives establish the broad areas that this *Code* governs. They can be achieved by applying the prescriptive-based compliance option (4.3.1) or the performance-based option (4.3.2). Additionally, the *Code's* goals and objectives can be reviewed when making the determination whether a proposed equivalency meets the *Code's* intent.

General administrative and application requirements that apply to all facilities and buildings are also in this chapter. (See Section 4.5.)

4.1* Goals and Objectives

The goals and objectives of the *Code*, as stated in Section 4.1, identify in broad terms the compliance this *Code* is intended to achieve. Goals are qualitative statements that describe, in general terms, how a building or facility that is designed and constructed in accordance with this *Code,* or how an operation that is regulated by the provisions herein, is expected to perform. Because the requirements in Section 4.1 are written in general terms, they are intended to be easily understood by those without a background in building and facility design and construction or extensive expertise in the operations regulated by this *Code*. However, these general terms do not provide sufficient information for designing or constructing a building or facility or for completely setting up an effective protection system for the operations regulated by this *Code*. Additional details are provided by the *Code*'s objectives. (See 4.1.3 through 4.1.5.)

A.4.1 The overall goals of this *Code* are presented in 4.1.1. These overall goals are treated in greater depth in 4.1.3 through 4.1.5. In each of these subsections, an overall goal for the subsection is defined, specific goals relating to the overall goal are presented next, and the objectives that relate to the specific goal follow. This format is intended to enhance the usability of the *Code*.

The subjects addressed in Chapter 4 are general in nature and supplement the provisions of Chapter 1, Administration. NFPA publication style dictates that Chapter 1 of all codes and standards is to include only title, scope, purpose, application, equivalency, units and formulas, and enforcement sections. All other general provisions are to be contained in Chapter 4, General Requirements, which follows Chapter 2, Referenced Publications, and Chapter 3, Definitions.

Chapter 4 provides general information about the *Code's* goals and objectives, inherent assumptions, options that can be applied for compliance with life safety and property protection requirements, and information regarding how the *Code* is applied *(see Sections 4.1 through 4.5)*. These goals and objectives establish the broad areas that this *Code* governs. They can be achieved via prescriptive-based options or performance-based options. Additionally, the goals and objectives can be reviewed to determine whether satisfactory conditions are being provided when equivalency options are being considered.

General administrative and application requirements that apply to all facilities and buildings are also included in this chapter *(see Section 4.5)*.

4.1.1* Goals. The goals of this *Code* shall be to provide a reasonable level of safety, property protection, and public welfare from the hazards created by fire, explosion, and other hazardous conditions.

A.4.1.1 These highest level goals are intentionally general in nature. Each includes a broad spectrum of topics as shown in 4.1.3. The property protection goal is not just a goal unto itself, as it is also achieved in part as a result of designing to achieve the other stated goals. A reasonable level of safety is further defined by subsequent language in the *Code*. The facility/property owner or an insurance representative might also have other goals, which might necessitate more stringent objectives as well as more demanding criteria.

The primary goals of this *Code* are to provide a reasonable level of the following:

1. Safety to people
2. Protection of property
3. Protection of the public welfare

The protection of property is achieved, in part, as a result of planning to achieve the other stated goals. Another primary goal is safety for people, which is outlined in citing specific requirements and references in NFPA *101*®, *Life Safety Code*®. However, these goals may also be goals or variations of goals of other codes, building codes, or building construction or life safety codes. Any discrepancies in goals between such codes must be resolved to ensure that a building, built in compliance with the applicable building construction code and other codes, is not deemed noncompliant with the fire code that might be enforced. This goal is consistent with the purpose of the *Code*, as indicated in Section 1.2.

4.1.2* Objectives. To achieve the goals stated in 4.1.1, the goals and objectives of 4.1.3 through 4.1.5 shall be used to determine the intent of this *Code*.

A.4.1.2 The objectives apply regardless of which option a user of the *Code* selects for a design — the performance-based option or the prescriptive-based option. The objectives are stated in more specific terms than the goals and tend to be more quantitative. The goals and objectives, taken together, form the broad, general targets at which a performance-based design can take aim. Specific criteria for design follow in Chapter 5.

Although the goals state generally what compliance with NFPA 1 is intended to accomplish, the objectives, stated in 4.1.3 through 4.1.5, provide additional details on how this compliance is achieved.

4.1.3* Safety. This *Code* shall provide for life safety by reducing the probability of injury or death from fire, explosions, or events involving hazardous materials.

A.4.1.3 The concept of providing for safety applies not only to safety during a fire, explosion, or hazardous materials incident, but also during the normal use of a building or facility. A reasonable level of safety should be provided for occupants in and individuals near the facility or building in question. The resultant design in addition to providing for occupant's safety also promotes the public welfare. Public welfare is also provided as a result of the mission continuity provisions of this *Code*.

Safety goals are associated with situations that are immediately or acutely hazardous. Hazards that do not pose an immediate threat but could be harmful to occupants subject to long-term or chronic exposures are not necessarily addressed in this *Code*, but they are typically addressed in building construction codes or other NFPA codes and standards. Examples of these hazards include sanitation, airborne contaminants, and standing water.

4.1.3.1 Safety from Fire.

4.1.3.1.1* Safety-from-Fire Goals. The fire safety goals of this *Code* shall be as follows:

(1) To provide an environment for the occupants in a building or facility and for the public near a building or facility that is reasonably safe from fire and similar emergencies
(2) To protect fire fighters and emergency responders

A.4.1.3.1.1 The phrase *reasonably safe* from fire is defined by subsequent language in this *Code*, primarily in the objectives.

Paragraph 4.1.3.1.1(1) describes providing safety for occupants in a building and for individuals near the building or facility in question. The distance considered to be near a building or facility is determined on a case-by-case basis, depending on the potential damage of a fire or hazardous materials–related event; the proximity of the event to the public, a property line, or an adjacent property; and the number of people nearby who might be injured by the event. For example, hazards associated with the unintentional release of a hazardous material are of a much greater concern if the release is near a busy street and sidewalk, as compared to the same release in a remote, sparsely populated area.

Paragraph 4.1.3.1.1(2) refers to protection of fire fighters and other emergency responders. Such protection, however, is not necessarily intended to be provided for an unlimited period of time. Paragraph 4.1.3.1.2.2 provides guidance for the protection of fire fighters.

4.1.3.1.2 Safety-from-Fire Objectives.

4.1.3.1.2.1 Buildings and facilities shall be designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development for the amount of time needed to evacuate, relocate, or defend in place.

Paragraph 4.1.3.1.2.1 requires protection for occupants who are not intimate with the initial fire development. The corollary of this provision is that the *Code* does not require the protection of people who *are* intimate with initial fire development. The phrase *intimate with the initial fire development* covers situations in which people, through intentional acts, carelessness, or other circumstances, are close to the initial ignition point and thus are unable to flee before being engulfed by fire, succumbing to the by-products of combustion, or becoming exposed to other untenable conditions. Examples of individuals considered to be intimate with the initial fire development include someone who falls asleep in bed smoking a cigarette that ignites the mattress and bedding, or an unprotected worker in an industrial facility that is in the midst of a flash fire caused by the ignition of vapors from a flammable liquid.

The determination of who is and who is not intimate with the initial fire development is subjective and varies greatly depending on the facility itself, its fuel load and ignition sources, and its occupants and their characteristics. From a practical standpoint, determination would most often be made when evaluating individual fire design scenarios as part of a performance-based design option. (See 5.4.2.)

Although not readily achievable or possible in most cases, some features and systems provided in some facilities and buildings, such as ignition-resistant mattresses and flame-resistant garments for protection of industrial personnel against flash fires, can impart a level of protection to occupants who are intimate with ignition. Residential sprinkler systems are another example of a system that imparts some protection to those intimate with initial ignition and might increase their probability of survival.

4.1.3.1.2.2* Buildings shall be designed and constructed to provide reasonable safety for fire fighters and emergency responders during search and rescue operations.

A.4.1.3.1.2.2 In many cases, the provisions of the *Code* to provide safety for occupants satisfies this goal for protection of emergency responders.

As a fire develops, the level of danger to fire fighters carrying out operations inside, on top of, or adjacent to a building increases. Paragraph 4.1.3.1.2.2 requires that fire fighters and emergency responders be protected for the time necessary to perform search and rescue operations. This *Code* does not intend to provide protection for fire fighters conducting an interior attack on a working fire for an indefinite period of time because such an expectation would be unrealistic.

In determining the amount of time needed to conduct search and rescue operations, it is necessary to factor in the times needed for the emergency responders to be alerted, to arrive on the scene and deploy, and to initiate and complete search and rescue operations. In many cases, this time will involve the emergency responders assisting occupants in evacuating the building. Alternatively, it might involve the removal or relocation of nonambulatory patients. The time needed to accomplish search and rescue operations needs to be factored into the final protection scheme for the building or facility.

Structural integrity is anticipated to be maintained for a sufficient time to protect against collapse during search and rescue operations. Another expectation is that the emergency responders will not be exposed to untenable conditions that cannot be mitigated by the equipment they are expected to wear or use during the deployment, such as structural fire-fighting protective clothing (bunker gear) and self-contained breathing apparatus.

4.1.3.1.2.3 Buildings shall be designed, located, and constructed to reasonably protect adjacent persons from injury or death as a result of a fire.

As indicated in A.4.1.3, the concept of providing safety applies not only to safety during a fire, explosion, or hazardous materials incident, but also during the normal use of a building or facility. A reasonable level of safety should be provided for occupants in and individuals near the facility or building in question. The resulting design, in addition to providing for occupant's safety, also promotes the public welfare. Public welfare is also provided as a result of the mission continuity provisions of this *Code*.

4.1.3.1.2.4 Buildings shall be designed, located, and constructed to provide reasonable access to the building for emergency responders.

Emergency responders must arrive quickly to the immediate vicinity of the building or facility to deploy and conduct emergency response operations. Immediate access requires them to transport emergency response equipment and apparatus from the fire station or other staging point to the incident location without delay. To accomplish this, responders must be provided with an acceptable roadway that can be negotiated by their responding vehicles during all reasonably foreseen weather conditions. The roadway must not be too steep or winding to be negotiated by any emergency response vehicle with a potential to be deployed. Provisions must also be made for the passing of vehicles proceeding in the opposite direction and for prohibiting parked vehicles or other obstructions on the roadway or access areas that would hinder responders from initiating search and rescue and suppression operations in a timely fashion. The local fire department or other applicable agency should be consulted as early as possible in the design process to determine the requirements for access, given the emergency vehicles that are likely to be deployed to a fire, hazardous materials, or other emergency event.

Building owners have control over access features and requirements on their own property but might not have control over roadway provisions on public thoroughfares or private property owned by others. However, access limitations experienced anywhere en route to the facility that delay emergency responder deployment to the facility or building must be factored into how the goals and objectives of this *Code* are to be met. Additional safety provisions might need to be incorporated to offset emergency response delays. Examples of anticipated delays include, but are not limited to, the following:

1. Access crossing a heavily traveled rail line
2. Access roads that are subject to frequent flooding or other adverse weather conditions
3. Access roads that experience severe congestion

Access to the building should also take into consideration the location of the building footprint in relation to fire department access roads. Specialized fire apparatus, such as aerial apparatus, often need to be deployed at specific locations relative to the building to effectively perform fire suppression operations. Exhibit 4.1 depicts an access roadway.

Exhibit 4.1

Access roadway.

4.1.3.1.2.5* Operations shall be conducted at facilities in a safe manner that minimizes, reduces, controls, or mitigates the risk of fire injury or death for the operators, while protecting the occupants not intimate with initial fire development for the amount of time needed to evacuate, relocate, or defend in place.

A.4.1.3.1.2.5 This provision addresses the fire safety objectives of operations addressed elsewhere in the *Code*, such as hot work, tar kettle operation, and so forth, that are not directly related to building construction and use.

4.1.3.2 Safety During Building Use.

4.1.3.2.1* Safety-During-Building-Use Goal. The safety-during-building-use goal of this *Code* shall be to provide an environment for the occupants of the building that is reasonably safe during the normal use of the building.

A.4.1.3.2.1 The phrase *reasonably safe during normal use* is defined by subsequent language in this *Code*, primarily in the objectives. Certain requirements, such as heights of guards and stair dimensions, are provided to ensure that the occupants are safe during nonemergency use of the buildings. Failure to address these features could result in falls or other injuries to occupants in their normal day-to-day activities in the building.

The intent of 4.1.3.2.1 is to protect people against injury in the performance of the task they would typically perform in the building during construction, normal use, and demolition.

4.1.3.2.2 Safety-During-Building-Use Objectives.

4.1.3.2.2.1 Buildings shall be designed and constructed to reduce the probability of death or injury of persons from falling during normal use of the building.

The objectives of 4.1.3.2.2.1 are to protect occupants from accidentally falling from an elevation so high that they could be injured and to protect them from tripping hazards associated with stairs and uneven walking surfaces. Providing protective railings, barriers, and nationally recognized stair geometries and walking surfaces are ways these objectives can be met.

4.1.3.2.2.2 Buildings shall be designed and constructed to provide for reasonably safe crowd movement during emergency and non-emergency conditions.

The objective of 4.1.3.2.2.2 is to provide safe crowd movement because overly crowded conditions can be dangerous. In addition to occurring during emergencies, overly crowded conditions occur in routine situations. For example, in 1979, 11 people died in a stampede at a rock concert in Cincinnati, Ohio. In 2003, 21 people died in a crowd crush in a club in Chicago, Illinois.

4.1.3.2.2.3 Buildings shall be designed and constructed to provide reasonable life safety for occupants and workers during construction and demolition.

4.1.3.2.2.4 Buildings shall be designed and constructed to provide reasonable notification to occupants of fire and other emergency situations.

The objective of 4.1.3.2.2.4 is to require reasonable occupant notification in the event of a fire or other emergency. Such notification can be provided in a number of ways, such as the notification of personnel at a constantly attended location, and could require an automatic fire alarm system with audible and visual notification to all occupants.

4.1.3.2.2.5 Buildings shall be designed and constructed to provide reasonable signage and lighting to identify hazards, exits, means of egress, and other building safety features.

The objective of 4.1.3.2.2.5 is to assist occupants during an emergency by providing signage and lighting to identify hazards, exits, means of egress, and other safety features. In some cases, illuminated signs and lighting need to function effectively for a specified time after a loss of primary power, depending on the occupancy characteristics.

4.1.3.3 Safety from Hazardous Materials.

4.1.3.3.1 Safety-from-Hazardous-Materials Goal. The safety-from-hazardous-materials goal of this *Code* shall be to provide an environment for the occupants in a building or facility and to those adjacent to a building or facility that is reasonably safe from exposures to adverse affects from hazardous materials present therein.

4.1.3.3.2 Safety-from-Hazardous-Materials Objectives.

The objectives associated with 4.1.3.3.2 are intended to address hazards associated with the unplanned release of a hazardous material, a fire impinging on the hazardous material, or the unwanted hazardous reaction of the material. The level of safeguards needed to meet this goal depends on a number of factors, including the nature and amounts of the hazardous materials involved.

The owner, occupants, and emergency responders must have a thorough understanding of the hazardous materials on-site, limit the quantities of the materials to agreed on amounts that will not overwhelm the safety systems, and maintain records of the hazardous materials so that emergency response operations are conducted in a more informed manner in the event of a hazardous materials incident. Safe practices should be agreed on and followed in the storage, handling, and use of the hazardous materials.

4.1.3.3.2.1 The storage, use, or handling of hazardous materials in a building or facility shall be accomplished in a manner that provides a reasonable level of safety for occupants and for those adjacent to a building or facility from health hazards, illness, injury, or death during normal storage, use, or handling operations and conditions.

4.1.3.3.2.2* The storage, use, or handling of hazardous materials in a building or facility shall be accomplished in a manner that provides a reasonable level of safety for occupants and for those adjacent to a building or facility from illness, injury, or death due to the following conditions:

(1) An unplanned release of the hazardous material
(2) A fire impinging upon the hazardous material or the involvement of the material in a fire
(3) The application of an external force on the hazardous material that is likely to result in an unsafe condition

A.4.1.3.3.2.2 For item 3, the phrase *external force* refers to the application of factors such as heat, water, shock, or other phenomenon onto hazardous materials that are sensitive to such factors and could react vigorously to produce unsafe conditions.

4.1.4 Property Protection.

4.1.4.1 Property Protection Goal. The property protection goal of this *Code* shall be to limit damage created by a fire, explosion, or event associated with hazardous materials to a reasonable level to the building or facility and adjacent property.

The protection of property is a primary goal of this *Code*, and may be a goal of other codes, building codes, and building construction or life safety codes. Discrepancies between codes in this regard must be resolved to ensure that a building, built in compliance with the applicable building construction code and other codes, is not deemed noncompliant with the fire code that might be enforced. This goal is consistent with the purpose of the *Code*, as stated in Section 1.2.

Determining what constitutes a reasonable level of property loss is a process that should involve the stakeholders in the facility, including the owner, occupant, insurer, authority having jurisdiction (AHJ), and/or other affected parties. Additional information on making such a determination is included in the *SFPE Engineering Guide to Performance-Based Fire Protection* and in A.5.1.4.

4.1.4.2 Property Protection Objectives.

4.1.4.2.1* Prevention of Ignition. The facility shall be designed, constructed, and maintained, and operations associated with the facility shall be conducted, to prevent unintentional explosions and fires that result in failure of or damage to adjacent compartments, emergency life safety systems, adjacent properties, adjacent outside storage, and the facility's structural elements.

A.4.1.4.2.1 Ignition occurs when combustible materials come into contact with a source of heat of sufficient temperature and power for a requisite time in an atmosphere where oxygen is present. Combustible material does not necessarily ignite immediately upon contact with a source of heat.

4.1.4.2.2* Fire Spread and Explosions. In the event that a fire or explosion occurs, the building or facility shall be sited, designed, constructed, or maintained, and operations associated with the facility shall be conducted and protected, to reasonably reduce the impact of unwanted fires and explosions on the adjacent compartments, emergency life safety systems, adjacent properties, adjacent outside storage, and the facility's structural elements.

A.4.1.4.2.2 Examples of specific conditions to avoid include, but are not limited to, flashover, fire spread beyond the item or room of fire origin, overheating of equipment, and overpressure of exterior walls.

4.1.4.2.3 Structural Integrity. The facility shall be designed, constructed, protected, and maintained, and operations associated with the facility shall be conducted, to provide a reasonable level of protection for the facility, its contents, and adjacent properties from building collapse due to a loss of structural integrity resulting from a fire.

4.1.4.2.4 Hazardous Materials. The facility shall be designed, constructed, and maintained, and operations associated with the facility shall be conducted, to provide reasonable property protection from damage resulting from fires, explosions, and other unsafe conditions associated with the storage, use, and handling of hazardous materials therein.

4.1.5 Public Welfare.

Subsection 4.1.5 includes requirements intended to maintain a high probability that certain buildings or facilities operate during and after an emergency event, such as a fire, explosion, or hazardous materials event, to provide an anticipated critical public service. Such facilities might include hospitals and public safety buildings (fire and police stations). (See A.4.1.5.2.)

4.1.5.1* Public Welfare Goal. The public welfare goal of this *Code* shall be to maintain a high probability that buildings and facilities that provide a public welfare role for a community continue to perform the function for their intended purpose following a fire, explosion, or hazardous materials event.

A.4.1.5.1 This goal is applicable to certain buildings and facilities that have been deemed to be necessary to the continued welfare of a community. Depending on the nature of the critical mission provided by the building, various stakeholders, including community leaders, AHJs, and owners will identify the mission critical buildings. Mission critical areas should be identified and appropriately protected. The objectives for property protection and mission continuity are sometimes difficult to differentiate. Achieving the objectives for property protection could, to a certain extent, accomplish the objectives for mission continuity.

4.1.5.2* Public Welfare Objective. Buildings and facilities that provide a public welfare role for a community shall be designed, constructed, maintained, and operated to provide reasonable assurance of continued function following a fire, explosion, or hazardous materials event.

A.4.1.5.2 Examples of buildings and facilities that provide a public welfare role for a community could include hospitals, police and fire stations, evacuation centers, schools, water and sewerage facilities, and electrical generating plants. Also included are buildings and facilities with significant impact on the economic viability of the community. This objective is intended to ensure that such buildings and facilities are capable of providing essential services following a disaster since the community's well-being depends on such service being available.

The objectives of 4.1.5.2 are intended to apply to buildings and facilities that perform essential public service functions, examples of which are included in A.4.1.5.2. Community leadership should identify buildings and facilities required to comply with these goals and objectives and the stakeholder involved with the facility. In some cases, financial institutions might wish to impose such mission continuity goals on their operations to ensure that backed-up data or redundant facilities can make up for the loss of a primary facility due to fire or other disaster. Additional information on a process to determine stakeholder goals and objectives in this regard is included in the *SFPE Engineering Guide to Performance-Based Fire Protection* and in A.5.1.4.

4.2 Assumptions

4.2.1* Single Fire Source.

A.4.2.1 Additional assumptions that need to be identified for a performance-based design are addressed in Chapter 5.

For the user of the traditional, prescriptive, specification-based requirements, the single fire source assumption is a piece of explanatory information, not a requirement. The assumption explains that the *Code* authors developed the requirements with the challenge of a single fire source in mind. Thus, most occupancies require a minimum of two means of egress; if a single fire blocks one, then the other should be available for egress. If the *Code* had been written to protect against fires that begin in two locations, then occupancy requirements for a minimum of three means of egress probably would be common. Historically, the *Code*'s approach to protecting against a single fire source has proved to meet society's expectations and to provide an acceptable level of safety.

4.2.1.1 The fire protection methods of this *Code* shall assume that multiple simultaneous fire incidents will not occur.

4.2.1.2 The single fire source assumption shall not preclude the evaluation of multiple design fire scenarios as required by Section 5.4.

4.2.2* Single Hazardous Material Release.

A.4.2.2 It is not assumed that a design scenario will be considered that simulates the hazards produced when unauthorized releases of hazardous materials occur simultaneously at different locations within a facility, unless it is reasonable to expect that a single incident, such as a fork lift accident or pipe failure, could be expected to create such a condition. However, when hazardous materials are in close proximity to one another, such as on a shelf or in adjacent storage cabinets, it could be reasonable to apply a design scenario where multiple releases of the hazardous materials occur simultaneously from these close proximity areas. In this case, it is not unreasonable to expect the shelf to collapse or a forklift to damage adjacent hazardous materials containers.

A key assumption in this *Code* is that unauthorized releases of hazardous materials from the locations in which they are likely to be stored, used, or handled should be considered, and that protection methods must be provided to mitigate the hazards associated with such releases so that the goals and objectives of the *Code* can be met. It is not considered reasonable to require that the goals and objectives of this *Code* be met, assuming that two completely independent hazardous material releases occur simultaneously in different locations within a facility. Subsection 4.2.2 assumes that unauthorized releases occur because of faulty containment or packaging, not because of external fires or other events impinging on the hazardous materials. See 4.2.3 for assumptions associated with the impingement of unwanted events involving hazardous materials.

4.2.2.1 The protection methods of this *Code* shall assume that multiple simultaneous unauthorized releases of hazardous materials from different locations will not occur.

4.2.2.2 The single hazardous material release assumption shall not preclude the evaluation of multiple design scenarios as required by Section 5.4.

4.2.3* Incidents Impinging on Hazardous Materials. The protection methods of this *Code* shall assume that a fire, explosion, hazardous materials release, or external force that creates a dangerous condition has the potential to impinge on hazardous materials being stored, handled, or used in the building or facility under normal conditions. *(See Section 5.4 for performance-based design scenarios.)*

A.4.2.3 It is not assumed that a design scenario will be considered that simulates the hazards produced when a fire, explosion, or external force that creates a dangerous condition occurs at the same time that hazardous materials have been subject to an unauthorized release. This does not preclude considering a scenario where a fire or explosion occurs and impinges on hazardous materials that are in their normal storage, use, or handling conditions.

The phrase *external force that creates a dangerous condition* refers to the application of factors such as heat, water, shock, or other phenomenon onto hazardous materials that are sensitive to such factors and could react vigorously to produce unsafe conditions.

The assumption stated in 4.2.3 covers a situation in which a fire, explosion, or external force impinges on hazardous materials stored, used, or handled within the facility. See A.4.2.3 for additional details.

4.3 Compliance Options

Compliance with the goals and objectives of Section 4.1 shall be provided in accordance with either of the following:

(1) The prescriptive-based provisions per 4.3.1
(2) The performance-based provisions per 4.3.2

Traditionally, fire and life safety codes have required compliance with prescriptive, specification-based requirements and offered additional design flexibility via an equivalency concept, such as that contained in Section 1.4. This *Code* offers the option of designing buildings and facilities using either the prescriptive-based option described in 4.3.1 or the performance-based option described in 4.3.2.

4.3.1 Prescriptive-Based Option.

4.3.1.1 A prescriptive-based option shall be in accordance with Chapter 1 through Chapter 4, Chapter 6, and Chapter 10 through Chapter 75 of this *Code*.

A prescriptive-based building design is the traditional norm. Each applicable requirement is met individually, and the resultant level of building performance is deemed to meet the goals and objectives of Section 4.1.

4.3.1.2 Where specific requirements contained in Chapter 20 for occupancies differ from general requirements contained in Chapter 1 through Chapter 4 and Chapter 10 through Chapter 75, the requirements of Chapter 20 shall govern.

For buildings designed and constructed in accordance with the prescriptive-based option, compliance with the prescriptive provisions in Chapters 1 through 4 and Chapters 6 through 75 achieves the goals and objectives stated in Section 4.1. For prescriptive-based designs, an analysis of the goals and objectives in Section 4.1 is typically not necessary, except in cases where the equivalency option in 1.4.1 is used. NFPA 1 is formatted such that Chapters 1 through 4 and Chapters 6 through 19 contain administrative provisions and fundamental requirements establishing minimum acceptance criteria for general applications. Chapters 20 through 37 establish detailed criteria for specific occupancies and facilities. Chapters 40 through 44 and Chapters 50 through 54 contain provisions for protecting hazardous processes and hazardous equipment. Finally, Chapters 60 through 75 contain hazardous material–related provisions.

Paragraph 4.3.1.2 clarifies that, where the occupancy-based provisions of Chapter 20 conflict with or differ from similar requirements in the other chapters of this *Code*, the Chapter 20 provisions should be applied.

4.3.2 Performance-Based Option.

By definition, a performance-based design is not expected to comply with the prescriptive provisions in Chapters 10 through 75, but it must meet the administrative and general requirements of Chapters 1 through 4. The performance-based design must also comply with all applicable performance-based option requirements in Chapter 5. Note that Section 5.3 contains a limited number of prescriptive provisions that have been retained from Chapters 10, 14 (via reference to NFPA *101*), and 16 that must be enforced as part of the performance-based option.

4.3.2.1 A performance-based option shall be in accordance with Chapter 1 through Chapter 5 of this *Code*.

4.3.2.2 Prescriptive requirements shall be permitted to be used as part of the performance approach, if they, in conjunction with the performance features, meet the overall goals and objectives of this *Code*.

4.4 Fundamental Requirements

Section 4.4 outlines the fundamental requirements that must be followed to ensure compliance with the *Code*. These apply to both prescriptive-based and performance-based designs. The following fundamental requirements provide an acceptable level of life safety and property protection:

1. Protection must not depend on any single safeguard.
2. Safeguards must be appropriate for the particular application, taking into consideration the unique characteristics of the building, its occupants, and other related factors.
3. Egress paths must be clear and unobstructed.
4. Egress routes must be marked clearly and illuminated sufficiently.
5. Occupants must be provided with an adequate warning of fire.
6. Vertical openings must be provided with suitable protection to avoid unwanted movement of smoke and fire through the building, while allowing for required egress.
7. Fire protection systems must be designed and installed in compliance with applicable installation standards.

4.4.1 Multiple Safeguards.

4.4.1.1 The design of every building or structure intended for human occupancy shall be such that reliance for property protection and safety to life does not depend solely on any single safeguard.

4.4.1.2 Additional safeguard(s) shall be provided for property protection and life safety in the event that any single safeguard is ineffective due to inappropriate human actions, building failure, or system failure.

4.4.2 Appropriateness of Safeguards. Every building or structure shall be provided with means of egress and other safeguards of the kinds, numbers, locations, and capacities appropriate to the individual building or structure, with due regard to the following:

(1) Characteristics of the occupancy
(2) Capabilities of the occupants
(3) Number of persons exposed
(4) Fire protection available
(5) Capabilities of response personnel
(6) Height and type of construction of the building or structure
(7) Other factors necessary to provide occupants with a reasonable degree of safety
(8) Other factors necessary to protect the building and contents from damage

4.4.3 Means of Egress.

4.4.3.1 Unobstructed Egress.

4.4.3.1.1 In every occupied building or structure, means of egress from all parts of the building shall be maintained free and unobstructed.

4.4.3.1.2 No lock or fastening shall be permitted that prevents free escape from the inside of any building other than in health care occupancies and detention and correctional occupancies where staff are continually on duty and effective provisions are made to remove occupants in case of fire or other emergency.

4.4.3.1.3 Means of egress shall be accessible to the extent necessary to ensure reasonable safety for occupants having impaired mobility.

4.4.3.2 Awareness of Egress System.

4.4.3.2.1 Every exit shall be clearly visible, or the route to reach every exit shall be conspicuously indicated.

4.4.3.2.2 Each means of egress, in its entirety, shall be arranged or marked so that the way to a place of safety is indicated in a clear manner.

Δ **4.4.3.2.3 Lighting.** Illumination of means of egress shall be provided. [*See 5.3.4(10)*.]

4.4.4* Occupant Notification. In every building or structure of such size, arrangement, or occupancy that a fire itself could not provide adequate occupant warning, fire alarm systems shall be provided where necessary to warn occupants of the existence of fire.

A.4.4.4 Fire alarms alert occupants to initiate emergency procedures, facilitate orderly conduct of fire drills, and initiate response by emergency services.

4.4.5 Vertical Openings. Every vertical opening between the floors of a building shall be suitably enclosed or protected, as necessary, to provide the following:

(1) Reasonable safety to occupants while using the means of egress by preventing spread of fire, smoke, or fumes through vertical openings from floor to floor to allow occupants to complete their use of the means of egress
(2) Limitation of damage to the buildings and its contents

4.4.6 System Design/Installation. Any fire protection system, building service equipment, feature of protection, or safeguard provided to achieve the goals of this *Code* shall be designed, installed, and approved in accordance with applicable codes and standards referenced in Chapter 2.

4.5 General Requirements

4.5.1 Authority Having Jurisdiction (AHJ).

4.5.1.1 The AHJ shall determine whether the provisions of this *Code* are met.

4.5.1.2 Where it is evident that a reasonable degree of safety is provided, any requirement shall be permitted to be modified if its application would be hazardous under normal occupancy conditions in the judgment of the AHJ.

Paragraph 4.5.1.2 gives the AHJ latitude in permitting a requirement to be modified if strict enforcement of the provision would otherwise create more of a hazard and, thus, lessen the overall safety that is achieved by the modification. For example, the *Code* requires an exit sign at an exit and, via the provisions of 14.14.1.2.1, requires that the sign be visible from any direction of exit access. If the exit door in question were installed in the plane of a corridor wall, the exit sign would need to be positioned perpendicular to the corridor wall. If headroom at the door is limited, perhaps due to a ceiling projection such as a beam running across the corridor at that point, the exit sign might be so low occupants would bump their heads. This provision permits the AHJ to allow the exit sign to be mounted flush against the corridor wall based on the judgment that a reasonable degree of safety is provided.

4.5.2 Historic Structures and Cultural Resource Buildings. The provisions of this *Code* shall be permitted to be modified by the AHJ for buildings or structures identified and classified as historic structures in accordance with Section 20.17.

Rather than providing historic structures and cultural resource buildings undergoing rehabilitation with a blanket exemption from *Code* requirements, 4.5.2 permits the AHJ to modify the provisions of the *Code*, provided that the resulting requirements provide a reasonable level of safety and protection. The AHJ should consult NFPA 909, *Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship*, and NFPA 914, *Code for Fire Protection of Historic Structures*, which provide both prescriptive-based and performance-based options that have specific applications to the unique nature of such properties. Also see Section 20.17.

4.5.3 Provisions in Excess of *Code* Requirements. Nothing in this *Code* shall be construed to prohibit a better type of building construction, an additional means of egress, or an otherwise more safe condition than that specified by the minimum requirements of this *Code*.

Although the *Code* specifies minimum requirements, the use of a design that exceeds its provisions is not prohibited. In most cases, economic considerations discourage the use of a design that exceeds minimum requirements. However, in some instances, the building owner or other parties might wish to provide a level of protection that is higher than that required by the *Code*. Exceeding minimum requirements might be considered for a variety of reasons, including mission continuity, where disruption of an operation could result in a significant financial loss to a business.

The AHJ is generally not in a position to require protection unilaterally in excess of *Code* requirements, unless the requirements imposed are essential for the safety of the occupants or the property, and except in cases of imminent danger to address this situation adequately.

4.5.4 Conditions for Occupancy. No new construction or existing building shall be occupied in whole or in part in violation of the provisions of this *Code* unless the following conditions exist:

(1) A plan of correction has been approved.
(2) The occupancy classification remains the same.
(3) No serious life safety hazard exists as judged by the AHJ.

4.5.5 Warrant of Fitness.

4.5.5.1 Where compliance with this *Code* is effected by means of a performance-based design, the owner shall annually certify compliance with the conditions and limitations of the design by submitting a warrant of fitness acceptable to the AHJ.

4.5.5.2 The warrant of fitness shall attest that the building features, systems, and use have been inspected and confirmed to remain consistent with design specifications outlined in the documentation required by 5.1.8 and 5.7.3 and that they continue to satisfy the goals and objectives specified in Section 4.1. *(See 5.1.11.)*

The provisions of 4.5.5.1 and 4.5.5.2 apply only to performance-based designs and require the owner to provide an annual warrant of fitness certifying that the facility continues to comply with the conditions and limitations of the design. This requirement corresponds to the requirements included in 5.1.11. For additional information, see A.5.1.10 and A.5.1.11.

4.5.6 Construction, Repair, and Improvement Operations.

4.5.6.1 Buildings or portions of buildings shall be permitted to be occupied during construction, repair, alterations, or additions only where required means of egress and required fire protection features are in place and continuously maintained for the portion occupied or where alternative life safety measures and building protection measures acceptable to the AHJ are in place.

The provisions of 4.5.6.1 help to control a relatively common practice — the occupancy of completed portions of a partially completed structure. The *Code* permits such occupancy if certain conditions are met. For example, the *Code* requires that egress features for the occupied portion be complete and maintained to be usable. In many cases, the egress facilities, although completed, are not usable because they are blocked with stored building materials and equipment needed for the ongoing construction, or doors are locked to limit access to parts of the building still under construction. In such cases, occupancy is prohibited.

The *Code* also requires that fire protection features be in place and maintained continuously. The incidence of fire is more frequent and, therefore, more likely during construction or rehabilitation. Extra caution and concern need to be exercised to ensure adequate egress capacity and arrangement during periods of construction in an occupied building.

Paragraph 4.5.6.1 recognizes that, in lieu of strict adherence to the egress and fire protection features, alternative life safety measures might make the building safe enough to be occupied. As usual, the AHJ is charged with judging whether the alternative measures provide an acceptable level of safety. Paragraph 4.5.6.1 is conceptually similar to 4.6.10.1 of NFPA *101*.

4.5.6.2 Escape Facilities.

4.5.6.2.1 In buildings under construction, adequate escape facilities shall be maintained at all times for the use of construction workers.

4.5.6.2.2 Escape facilities shall consist of doors, walkways, stairs, ramps, fire escapes, ladders, or other approved means or devices arranged in accordance with the general principles of the *Code* insofar as they can reasonably be applied to buildings under construction.

4.5.6.3 Flammable, hazardous, or explosive substances or equipment for repairs or alterations shall be permitted in a building while the building is occupied if the condition of use and safeguards provided do not create any additional danger or impediment to egress beyond the normally permissible conditions in the building and is such that materials are safeguarded when the building is unoccupied.

4.5.7* Changes of Occupancy.

A.4.5.7 Examples of changes from one occupancy subclassification to another subclassification of the same occupancy could include a change from a Class B to a Class A mercantile occupancy. Hospitals and nursing homes are both health care occupancies and are defined separately, but they are not established as separate suboccupancies; thus, a change from one to the other does not constitute a change of occupancy subclassification.

For example, a building was used as a hospital but has been closed for 4 years. It is again to be used as a hospital. As long as the building was not used as another occupancy during the time it was closed, it would be considered an existing hospital.

Hotels and apartments, although both residential occupancies, are treated separately, and a change from one to the other constitutes a change of occupancy.

4.5.7.1 In any building or structure, whether or not a physical alteration is needed, a change from one occupancy classification to another shall be permitted only where such a structure, building, or portion thereof conforms with the requirements of this *Code* that apply to new construction for the proposed new use, except as follows:

(1) Where, in the opinion of the AHJ, the proposed occupancy or change in use is not more hazardous than the existing use, based on life safety and fire risk, the AHJ shall be permitted to approve such change of occupancy provided compliance with the requirements of this *Code* for buildings of like occupancy or use are specifically incorporated to safeguard the life, health, and welfare of persons.
(2) Change of tenants or ownership shall not be construed to be a change of occupancy classification where the nature of use and assigned occupancy classification remain the same.

4.5.7.2 Where specifically permitted elsewhere in the *Code*, existing construction features shall be permitted to be continued in use in conversions.

4.5.8 Maintenance, Inspection, and Testing.

4.5.8.1 Whenever or wherever any device, equipment, system, condition, arrangement, level of protection, fire-resistive construction, or any other feature is required for compliance with the provisions of this *Code*, such device, equipment, system, condition, arrangement, level of protection, fire-resistive construction, or other feature shall thereafter be continuously maintained. Maintenance shall be provided in accordance with applicable NFPA requirements or requirements developed as part of a performance-based design, or as directed by the AHJ. [***101:***4.6.12.1]

Paragraph 4.5.8.1 emphasizes the importance of maintaining items required by the *Code*. It is useless to have an egress door that will not open, a self-closing device that does not close the door, or a sprinkler system with no water.

4.5.8.2 No existing life safety feature shall be removed or reduced where such feature is a requirement for new construction. [***101:***4.6.12.2]

4.5.8.3* Existing life safety features obvious to the public, if not required by the *Code*, shall be either maintained or removed. [***101:***4.6.12.3]

A.4.5.8.3 Examples of such features include automatic sprinklers, fire alarm systems, standpipes, and portable fire extinguishers. The presence of a life safety feature, such as sprinklers or fire alarm devices, creates a reasonable expectation by the public that these safety features are functional. When systems are inoperable or taken out of service but the devices remain, they present a false sense of safety. Also, before taking any life safety features out of service, extreme care needs to be exercised to ensure that the feature is not required, was not originally provided as an alternative or equivalent, or is no longer required due to other new requirements in the current *Code*. It is not intended that the entire system or protection feature be removed. Instead, components such as sprinklers, initiating devices, notification appliances, standpipe hose, and exit systems should be removed to reduce the likelihood of relying on inoperable systems or features. Conversely, equipment, such as fire or smoke dampers, that is not obvious to the public should be able to be taken out of service if no longer required by this *Code*. Where a door that is not required to be fire protection-rated is equipped with a fire protection listing label, it is not the intent of 4.5.8.3 to require such door to be self- or automatic-closing due merely to the presence of the label. [***101:***A.4.6.12.3]

The *Code* directs that nonrequired life safety features that are obvious to the public be either maintained or removed to prevent false expectations or a false sense of security by building occupants. For example, if the water supply to a nonrequired wet standpipe system were permanently shut off because the system piping leaked, but the hose and nozzle for occupant use were left attached to the standpipe, an occupant could be endangered while attempting to use the system. If the nonrequired standpipe system were turned off and abandoned, it would be necessary, as a minimum, to remove all hose and nozzles and to place prominent signage at each outlet station advising that the system is out of service. The standpipe system piping, however, should not have to be removed.

4.5.8.4* Existing life safety features that exceed the requirements for new buildings shall be permitted to be decreased to those required for new buildings. [***101:***4.6.7.4]

A.4.5.8.4 In some cases, the requirements for new construction are less restrictive, and it might be justifiable to permit an existing building to use the less restrictive requirements. However, extreme care needs to be exercised when granting such permission, because the less restrictive provision might be the result of a new requirement elsewhere in the *Code*. For example, in editions of the *Code* prior to 1991, corridors in new health care occupancies were required to have a 1-hour fire resistance rating. Since 1991, such corridors have been required only to resist the passage of smoke. However, this provision is based on the new requirement that all new health care facilities be protected throughout by automatic sprinklers. *(See A.4.5.8.5.)* [***101:***A.4.6.7.4]

4.5.8.5* Existing life safety features that do not meet the requirements for new buildings, but that exceed the requirements for existing buildings, shall not be further diminished. [***101:***4.6.7.5]

A.4.5.8.5 An example of what is intended by 4.5.8.4 and 4.5.8.5 follows. In a hospital that has 6 ft (1830 mm) wide corridors, such corridors cannot be reduced in width, even though the provisions for existing hospitals do not require 6 ft (1830 mm) wide corridors. However, if a hospital has 10 ft (3050 mm) wide corridors, they are permitted to be reduced to 8 ft (2440 mm) in width, which is the requirement for new construction. If the hospital corridor is 36 in. (915 mm) wide, it would have to be increased to 48 in. (1220 mm), which is the requirement for existing hospitals. [***101:***A.4.6.7.5]

The intent behind 4.5.8.4 and 4.5.8.5 is to prevent life safety features that exceed the requirement for existing buildings from being changed to a level less than that required for new construction. For example, a new hospital is constructed with 8 ft (2440 mm) wide corridors for compliance with 18.2.3.4 of NFPA *101*. In subsequent years, the building becomes an existing hospital subject to the provisions of Chapter 19 of NFPA *101*. The minimum corridor width required by 19.2.3.4 of NFPA *101* for an existing hospital is 48 in. (1220 mm). The minimum 48 in. (1220 mm) criterion is meant to apply to existing situations but is not intended to permit the existing 8 ft (2440 mm) corridor to be decreased in width.

For a similar concept related to the removal of existing life safety features, see 4.6.12.2 of NFPA *101*.

4.5.8.6 Any device, equipment, system, condition, arrangement, level of protection, fire-resistive construction, or any other feature requiring periodic testing, inspection, or operation to ensure its maintenance shall be tested, inspected, or operated as specified elsewhere in this *Code* or as directed by the AHJ. [***101:***4.6.12.4]

4.5.8.7 Maintenance, inspection, and testing shall be performed under the supervision of a responsible person who shall ensure that testing, inspection, and maintenance are made at specified intervals in accordance with applicable NFPA standards or as directed by the AHJ. [***101:***4.6.12.5]

Subsection 4.5.8 stresses that the application of maintenance, inspection, and testing requires a three-component approach. None of the three components — maintenance, inspection, or testing — applied alone, or applied in tandem with only one of the other two, will ensure that the life safety features and systems will continue to work as required.

4.5.9 Noncombustible Material.

Δ **4.5.9.1** A material that complies with any one of the following shall be considered a noncombustible material:

(1)* The material, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat.
(2) The material is reported as passing ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*.
(3) The material is reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with the test method and procedure in ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C*.

[**5000:**7.1.4.1.1]

Subsection 4.5.9 represents a refinement of what had been the Chapter 3 definition of the term *noncombustible material* before the 2012 edition of the *Code*. The former definition included requirements that should not be part of the defined term. *Code* users who attempt to locate the definition of *noncombustible material* in Chapter 3 are now directed by 3.3.180.11 to see 4.5.9. The provision of 4.5.9.1(1) recognizes that some materials are inherently noncombustible and do not require testing to receive a classification of noncombustible. Examples of such materials are provided in A.4.5.9.1(1).

A.4.5.9.1(1) Examples of such materials include steel, concrete, masonry, and glass. [**5000:**A.7.1.4.1.1(1)]

4.5.9.2 Where the term *limited-combustible* is used in this *Code*, it shall also include the term *noncombustible*. [**5000:**7.1.4.1.2]

4.5.10 Limited-Combustible Material. A material shall be considered a limited-combustible material where both of the following conditions of 4.5.10.1, and 4.5.10.2, and the conditions of either 4.5.10.3 or 4.5.10.4, are met. [**5000:**7.1.4.2]

4.5.10.1 The material does not comply with the requirements for a noncombustible material in accordance with 4.5.9. [**5000:**7.1.4.2(1)]

Δ **4.5.10.2** The material, in the form in which it is used, exhibits a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg) where tested in accordance with NFPA 259. [**5000:**7.1.4.2(2)]

4.5.10.3 The material has a structural base of a noncombustible material with a surfacing not exceeding a thickness of ⅛ in. (3.2 mm) where the surfacing exhibits a flame spread index not greater than 50 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. [**5000:**7.1.4.2.1]

4.5.10.4 The material is composed of materials which, in the form and thickness used, neither exhibit a flame spread index greater than 25 nor evidence of continued progressive combustion when tested in accordance with ASTM E84 or ANSI/UL 723, and are of such composition that all surfaces that would be exposed by cutting through the material on any plane would neither exhibit a flame spread index greater than 25 nor evidence of continued progressive combustion when tested in accordance with ASTM E84 or ANSI/UL 723. [**5000:**7.1.4.2.2]

N **4.5.10.5** An alternate approach for a material to be considered a limited combustible material is where the material is tested in accordance with ASTM E2965, *Standard Test for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Combustion Calorimeter*, at an incident heat flux of 75 kW/m^2 for a 20-minute exposure, the peak heat release rate does not exceed 150 kW/m^2 for longer than 10 seconds, and the total heat released does not exceed 8 MJ/m^2. [**5000:**7.1.4.2.3]

4.5.10.6 Where the term *limited-combustible* is used in this Code, it shall also include the term *noncombustible*. [**5000:**7.1.4.2.4]

Subsection 4.5.10 represents a refinement of what had been the Chapter 3 definition of the term *limited-combustible material* before the 2012 edition of the *Code*. The former definition included requirements that should not be part of the defined term. *Code* users who attempt to locate the definition of *limited-combustible material* in Chapter 3 are now directed by 3.3.168 to see 4.5.10. The provision of 4.5.10.5 explains that, wherever the *Code* requires a material to be limited-combustible, the use of a noncombustible material is permitted.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA *101®*, *Life Safety Code®*, 2018 edition.

NFPA 909, *Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship*, 2017 edition.

NFPA 914, *Code for Fire Protection of Historic Structures*, 2015 edition.

SFPE Engineering Guide to Performance-Based Fire Protection, 2007.

Performance-Based Option

5

Chapter 5 provides requirements for performance-based designs applied to building projects. Chapter 5 is used in conjunction with the goals and objectives outlined in Chapter 4.

5.1* General

A.5.1 The performance option of this *Code* establishes acceptable levels of risk for facilities (i.e., buildings and other structures and the operations therewith associated) as addressed in Section 1.3. (Note that "facility" and "building" can be used interchangeably with facility being the more general term.) While the performance option of this *Code* does contain goals, objectives, and performance criteria necessary to provide for an acceptable level of risk, it does not describe how to meet these goals, objectives, and performance criteria. Design and engineering are needed to meet the provisions of Chapter 5. For fire protection designs, the *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* provides a framework for these assessments.

Pre-construction design requirements address those issues, which have to be considered before the certificate of occupancy is issued for a facility.

Historically, fundamental fire code provisions have been prescriptive in nature and have included specific requirements to ensure compliance. Requirements have typically evolved through a number of *Code* revision cycles, often as the result of lessons learned from past failures; new technologies, products, and applications; results obtained from research efforts; changes in construction practices; and many other reasons. Unfortunately, in the course of this evolution, the underlying reasons for particular *Code* provisions often are lost. This loss, in itself, is not necessarily detrimental. However, when a construction method or practice is encountered that is not addressed effectively by the *Code*, and equivalency and alternative provisions of Section 1.4 are needed, the loss of the underlying reason for a requirement can make it difficult to determine whether a proposed alternative provides an equivalent level of safety or protection.

Section 4.1 provides, in general, the goals and objectives of the provisions of the *Code*. Making decisions regarding whether to accept alternative designs and practices on the basis of these goals and objectives should provide for effective *Code* enforcement, since the Section 4.1 provisions apply to both the prescriptive-based and performance-based *Code* provisions.

Where the performance-based design option of 4.3.2 is selected for a particular application, the material included in Chapter 5 becomes a required part of the *Code* requirements to be applied to the design. If the prescriptive-based option in 4.3.1 is selected, Chapter 5 does not apply.

A number of organizations and educational institutions are advancing the science that forms the foundation for an effective performance-based fire protection design. Leading these organizations is the Society of Fire Protection Engineers (SFPE). A number of SFPE resources can be drawn on to support an effective performance-based fire protection design. In particular, the SFPE provides educational seminars and short courses, technical symposia and conferences, books and publications, and other materials designed to advance fire protection engineering and provide technical information to the fire protection community. The SFPE also sponsors task groups that address areas of concern in technical areas related to performance-based fire protection design, including topics such as risk, design performance criteria, design basis fires, human behavior in fire, design team liaison, and other areas. As pointed out in A.5.1.4, the *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* is an excellent resource for determining effective procedures to be followed in the performance-based design process. Another resource is the *SFPE Code Official's Guide to Performance-Based Design Review* (www.sfpe.org).

The U.S. Fire Administration offers a 6-day course to fire personnel, *Evaluating Performance Based Designs,* that can assist authorities having jurisdiction (AHJs) in performance-based designs (see www.usfa.fema.gov for details).

5.1.1 Application. The requirements of this chapter shall apply to facilities designed to the performance-based option permitted by Section 4.3.

5.1.2 Goals and Objectives. The performance-based design shall meet the goals and objectives of this *Code* in accordance with Section 4.1 and Section 4.2.

5.1.3* Approved Qualifications. The performance-based design shall be prepared by a person with qualifications acceptable to the AHJ.

A.5.1.3 Qualifications should include experience, education, and credentials that demonstrate knowledgeable and responsible use of applicable models and methods.

5.1.4* Plan Submittal Documentation. When a performance-based design is submitted to the AHJ for review and approval, the owner shall document, in an approved format, each performance objective and applicable scenario, including any calculation methods or models used in establishing the proposed design's fire and life safety performance.

A.5.1.4 The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* outlines a process for using a performance-based approach in the design and assessment of building fire safety design and identifies parameters that should be considered in the analysis of a performance-based design. As can be seen this process requires the involvement of all stakeholders who have a share or interest in the successful completion of the project. The steps that are recommended by the *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* for this process are shown in Figure A.5.1.4.

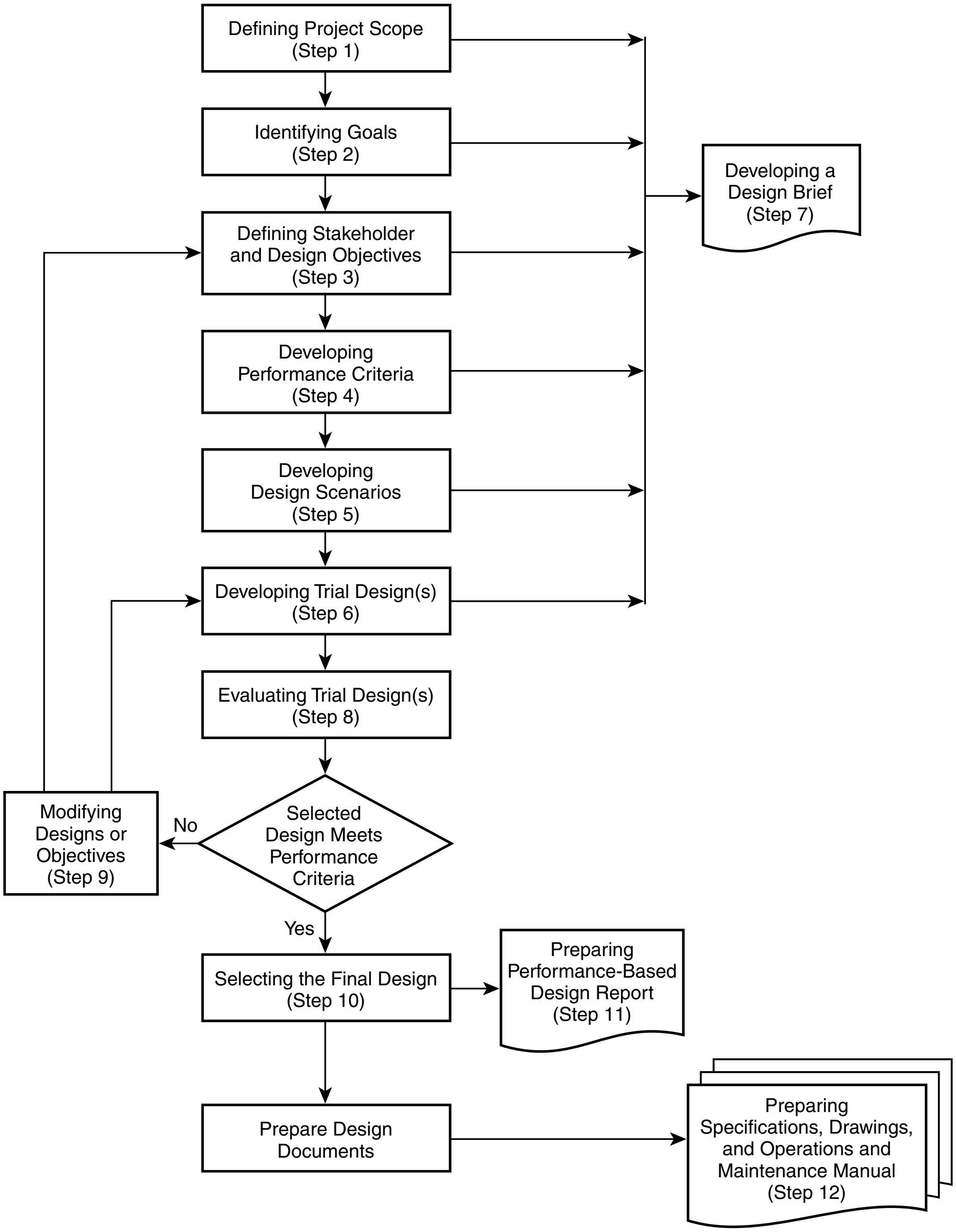

FIGURE A.5.1.4 *Steps in the Performance-Based Analysis and the Conceptual Design Procedure for Fire Protection Design.*

The guide specifically addresses building fire safety performance-based design. It might not be directly applicable to performance-based designs involving other systems and operations covered within this *Code*, such as hot work operations or hazardous materials storage. However, the various steps for defining, developing, evaluating, and documenting the performance-based design should still provide a useful framework for the overall design process.

Paragraph A.5.1.4 provides a summary of the procedure described in the *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* for conducting a performance-based design. This information is useful for understanding the arrangement of Chapter 5 requirements. The concepts, among many others described in A.5.1.4, such as performance criteria, design scenarios, and operations and maintenance manuals, form an integral part of the Chapter 5 requirements. All parties involved in a performance-based design are strongly encouraged to read and understand the recommendations included in the SFPE guide and to conduct the performance-based design, review, approval, and commissioning process in accordance with its recommendations.

The steps in the performance-based design process are as follows:

(1) *Step 1: Defining Project Scope.* The first step in a performance-based design is to define the scope of the project. Defining the scope consists of identifying and documenting the following:
   (a) Constraints on the design and project schedule
   (b) The stakeholders associated with project
   (c) The proposed building construction and features desired by the owner or tenant
   (d) Occupant and building characteristics
   (e) The intended use and occupancy of the building
   (f) Applicable codes and regulations
   An understanding of these items is needed to ensure that a performance-based design meets the stakeholders' needs.
(2) *Step 2: Identifying Goals.* Once the scope of the project is defined, the next step in the performance-based design process is to identify and document the fire safety goals of various stakeholders. Fire safety goals could include levels of protection for people and property, or they could provide for continuity of operations, historical preservation, and environmental protection. Goals could be unique for different projects, based on the stakeholders needs and desires. The stakeholders should discuss which goals are the most important for the project. In order to avoid problems later in the design process, all stakeholders should be aware of and agree to the goals prior to proceeding with the performance-based design process *(see Step 7)*.
(3) *Step 3: Defining Stakeholder and Design Objectives.* The third step in the design process is to develop objectives. The objectives are essentially the design goals that are further refined into tangible values that can be quantified in engineering terms. Objectives could include mitigating the consequences of a fire expressed in terms of dollar values, loss of life, or other impact on property operations, or maximum allowable conditions, such as extent of fire spread, temperature, spread of combustion products, and so forth.
(4) *Step 4: Developing Performance Criteria.* The fourth step in the design process is the development of performance criteria to be met by the design. These criteria are a further refinement of the design objectives and are numerical values to which the expected performance of the trial designs can be compared. Performance criteria could include threshold values for temperatures of materials, gas temperatures, carboxyhemoglobin (COHb) levels, smoke obscuration, and thermal exposure levels.
(5) *Step 5: Developing Design Scenarios.* Once the performance criteria have been established, the engineer will develop and analyze design alternatives to meet performance criteria. The first part of this process is the identification of possible scenarios and design scenarios. Fire scenarios are descriptions of possible fire events, and consist of fire characteristics, building characteristics (including facility operations), and occupant characteristics. The fire scenarios identified will subsequently be filtered (i.e., combined or eliminated) into a subset of design fire scenarios against which trial designs will be evaluated. Hazardous materials scenarios can be treated similarly.
(6) *Step 6: Developing Trial Design(s).* Once the project scope, performance criteria, and design scenarios are established, the engineer develops preliminary designs, referred to as trial designs, intended to meet the project requirements. The trial design(s) include proposed fire protection systems, construction features, and operation that are provided in order for a design to meet the performance criteria when evaluated using the design fire scenarios. The evaluation method should also be determined at this point. The evaluation methods used should be appropriate for the situation and agreeable to the stakeholders.
(7) *Step 7: Developing a Fire Protection Engineering Design Brief.* At this point in the process a fire protection engineering design brief should be prepared and provided to all stakeholders for their review and concurrence. This brief should document the project scope, goals, objectives, trial designs, performance criteria, design fire scenarios, and analysis methods. Documenting and agreeing upon these factors at this point in the design process will help avoid possible misunderstandings later.
(8) *Step 8: Evaluating Trial Designs.* Each trial design is then evaluated using each design scenario. The evaluation results will indicate whether the trial design will meet the performance criteria. Only trial design(s) that meet the performance criteria can be considered as final design proposals. Yet, the performance criteria can be revised with the stakeholders' approval. The criteria cannot be arbitrarily changed to ensure that a trial design meets a criterion, but can be changed based on additional analysis and the consideration of additional data.

(9) *Step 9: Modifying Designs or Objectives.* If none of the trial designs evaluated comply with the previously agreed upon performance criteria, it could be necessary to either develop and evaluate new trial designs, or revisit the objectives and performance criteria previously agreed upon by the stakeholders to determine if stakeholder objectives and performance criteria should be modified.

(10) *Step 10: Selecting the Final Design.* Once an acceptable trial design is identified using the evaluation, it can be considered for the final project design. If multiple trial designs are evaluated, further analysis will be needed to select a final design. The selection of an acceptable trial design for the final design could be based on a variety of factors, such as financial considerations, timeliness of installation, system and material availability, ease of installation, maintenance and use, and other factors.

(11) *Step 11: Preparing Performance-Based Design Report.* Once the final design is identified, design documents need to be prepared. Proper documentation will ensure that all stakeholders understand what is necessary for the design implementation, maintenance, and continuity of the fire protection design. The documentation should include the fire protection engineering design brief, a performance design report, detailed specifications and drawings, and a facility operations and maintenance manual.

(12) *Step 12: Preparing Specifications, Drawings, and Operations and Maintenance Manual.* The specifications and drawings portion of the performance-based design report convey to building and system designers and installing contractors how to implement the performance design. Specifications and drawings could include required sprinkler densities, hydraulic characteristics and spacing requirements, the fire detection and alarm system components and programming, special construction requirements including means of egress and location of fire-resistive walls, compartmentation, and the coordination of interactive systems. The detailed specifications are the implementation document of the performance-based design report. The detailed drawings will graphically represent the results of the performance design. The Operations and Maintenance (O&M) Manual clearly states the requirement of the facility operator to ensure that the components of the performance design are in place and operating properly. The O&M Manual describes the commissioning requirements and the interaction of the different systems' interfaces. All subsystems are identified, and inspection and testing regimes and schedules are created.

The O&M Manual also gives instruction to the facility operator on restrictions placed on facility operations. These limitations are based on the engineering assumptions made during the design and analysis. These limiting factors could include critical fire load, sprinkler design requirements, building use and occupancy, and reliability and maintenance of systems. The O&M Manual can be used to communicate to tenants and occupants these limits and their responsibilities as a tenant. It could also be used as a guide for renovations and changes. It also can be used to document agreements between stakeholders.

5.1.5* Independent Review. The AHJ shall be permitted to require an approved, independent third party to review the proposed design and provide an evaluation of the design to the AHJ at the expense of the owner.

A.5.1.5 A third-party reviewer is a person or group of persons chosen by the AHJ to review proposed performance-based designs. Qualifications of the third-party reviewer should include experience, education, and credentials that demonstrate knowledgeable and responsible use of applicable models and methods.

In some cases, a jurisdiction might have neither the resources nor skills necessary to conduct an effective review of a performance-based design submittal. To evaluate a complex performance-based design submittal effectively, the AHJ should meet the following criteria:

1. Expertise in the scientific foundation on which the design is based
2. Knowledge of the calculations and modeling tools used, as well as their limitations
3. Understanding of how the entire performance-based design process works

Where the staff of a jurisdiction does not possess this expertise, the AHJ is authorized to require a third-party review of the design and a report on the technical basis of the design. The third-party reviewer should possess the necessary qualifications and, as part of the independent review, provide sufficient findings regarding compliance issues so that the AHJ can make an informed decision about the action to be taken on the design (e.g., accept, reject, or require modifications). The third party, or peer reviewer, might be another engineering firm or reviewers from another jurisdiction.

Subsection 5.1.5 specifies that the AHJ has the option of requiring the owner to bear the costs of conducting the peer review. These costs could be recovered as an increased review fee and paid directly to the third party, or the AHJ could require that the owner directly pay the third party. The requirements of Section 1.15 regarding technical assistance can also apply to this independent review.

5.1.6 Sources of Data. Data sources shall be identified and documented for each input data requirement that is required to be met using a source other than a required design scenario, an assumption, or a facility design specification.

5.1.6.1 The degree of conservatism reflected in such data shall be specified, and a justification for the source shall be provided.

5.1.6.2 Copies of all references relied upon by the performance-based design to support assumptions, design features, or any other part of the design shall be made available to the AHJ if requested.

5.1.7 Final Determination. The AHJ shall make the final determination as to whether the performance objectives have been met.

The AHJ has the final decision-making authority regarding whether to accept a design, although the design professionals who prepared the design must also be confident that the design is satisfactory. If questions about the validity of the design arise, the design professional must be in a position to provide convincing evidence to the AHJ that the approach, designs, and methods of the submitted plans provide realistic results and are based on realistic scenarios.

5.1.8* Operations and Maintenance Manual. An approved Operations and Maintenance (O&M) Manual shall be provided by the owner to the AHJ and the fire department and shall be maintained at the facility in an approved location.

A.5.1.8 See Step 12 of A.5.1.4 for a description of these documents.

5.1.9* Information Transfer to the Fire Service. Where a performance-based design is approved and used, the designer shall ensure that information regarding the operating procedures of the performance-based designed fire protection system is transferred to the owner and to the local fire service for inclusion in the pre-fire plan.

A.5.1.9 Information that could be needed by the fire service arriving at the scene of a fire in a performance-based designed facility includes, but is not limited to, the following:

(1) Safe shutdown procedures of equipment and processes
(2) Facility personnel responsible for assisting the fire service
(3) Operating procedures required to maintain the effectiveness of the performance-based designed fire protection system: when it is and is not appropriate to alter, shut down, or turn off a design feature; assumptions that have to be maintained if a fire occurs; suggested fire-fighting tactics that relate to the specific nature of the performance-based design

The design specifications and O&M Manual documentation described in 5.1.8 should provide a guide for the facility owner and tenants to follow in order to maintain the required level of safety anticipated by the original design. It should also provide a guide for the AHJ to use in conducting ongoing inspections of the facility.

5.1.10* Design Feature Maintenance.

A.5.1.10 Continued compliance with the goals and objectives of the *Code* involves many factors. The building construction, including openings, interior finish, and fire- and smoke-resistive construction, and the building and fire protection systems need to retain at least the same level of performance as is provided for by the original design parameters. The use and occupancy should not change to the degree that assumptions made about the occupant characteristics, combustibility of furnishings, and existence of trained personnel are no longer valid. In addition, actions provided by other personnel, such as emergency responders, should not be diminished below the documented assumed levels. Also, actions needed to maintain reliability of systems at the anticipated level need to meet the initial design criteria.

Subsection 5.1.10 deals with issues that arise after the facility has been constructed and a certificate of occupancy has been issued. Therefore, any changes to the facility or the operations conducted therein, up to and including the demolition of the facility, that affect the assumptions of the original design are considered as part of the management of change.

The following is a process for evaluating performance-based facilities:

(1) Review of original design analysis and documentation as follows:
  (a) Assumptions
  (b) Input parameter values
  (c) Predictions and/or results of other calculations
(2) Review of design analysis and documentation for any subsequent renovations, additions, modifications, and so forth, as in Step 1 of A.5.1.4
(3) Review of the facility's operations and maintenance manual, including any and all revisions to it
(4) On-site inspection, involving the following:
  (a) Consideration of "prescriptive" issues (e.g., blocked egress paths, poor maintenance of systems)
  (b) Comparison of assumptions to specific, pertinent on-site conditions
  (c) Comparison of input parameter values to pertinent on-site conditions
  (d) Review of maintenance and testing documentation to ensure adherence to the schedules detailed in the facility's O&M Manual
(5) Reconciliation of discrepancies as follows:
  (a) Develop a list of discrepancies
  (b) Consultation with the facility owner and/or their representative
  (c) Preparation of a schedule that reconciles the discrepancies

The critical features of the initial design must be maintained for the life of the facility to ensure that those initially evaluated in accordance with the performance-based design option continue to comply with *Code* requirements. These features are unique for each design and must be maintained for future reference, since the prescriptive requirements of the *Code* are not applicable to the determination of ongoing compliance.

More important, documentation required as part of the performance-based design option must be maintained and used by both facility personnel and the AHJ to ensure that the facility or building maintains compliance with the *Code*. In particular, the Operations and Maintenance (O&M) Manual required in 5.1.8 is a crucial document.

In conducting periodic inspections of the facility, the AHJ should use the O&M Manual as a crucial part of the inspection because it describes the design features required for compliance. Attempting to use the prescriptive-based *Code* provisions can create problems.

As an example, one particular performance-based design might require the owner to control the quantity of combustible materials in a given area, such as a casino, well below the level of combustibles permitted by the prescriptive-based *Code* provisions. This limitation would be documented in the O&M Manual and would need to be strictly controlled on an ongoing basis by the building owner. If neither the owner nor the AHJ were aware of this critical design feature, and only the less stringent prescriptive requirements for combustibles in this area were applied, the facility would not achieve the *Code*'s basic goals and objectives and would not provide an acceptable level of protection.

Another performance-based design might not require a fire alarm system with automatic detection in a given area, even though such a system would be required by the prescriptive-based *Code* requirements. In this example, the performance-based design requires a constantly attended guard station within the area, along with a means to provide occupant notification initiated by the guards and additional exits from the area in excess of those required by the prescriptive *Code* provisions. An attempt by the AHJ to require a fire alarm system with automatic detection during subsequent inspections would not be warranted because the existing design features achieve the desired goals and objectives and provide an acceptable level of protection.

If changes to the facility's design features are desired, A.5.1.10 describes a process for evaluating compliance for a facility or building that was initially designed in accordance with the performance-based design option.

5.1.10.1 The design features required for the facility to meet the performance goals and objectives shall be maintained by the owner and be readily accessible to the AHJ for the life of the facility.

5.1.10.2 The facility shall be maintained in accordance with all documented assumptions and design specifications.

5.1.10.2.1 Any proposed changes or variations from the approved design shall be approved by the AHJ prior to the actual change.

5.1.10.2.2 Any approved changes to the original design shall be maintained in the same manner as the original design.

5.1.11* Annual Certification. Where a performance-based design is approved and used, the property owner shall annually certify that the design features and systems have been maintained in accordance with the approved original performance-based design and assumptions and any subsequent approved changes or modifications to the original performance-based design.

A.5.1.11 Private fire inspection services can be used to meet this provision provided that they are qualified to assess the impact of changes on the performance-based design and assumptions.

5.1.12 Hazardous Materials.

5.1.12.1 Performance-based designs for facilities containing high hazard contents shall identify the properties of hazardous materials to be stored, used, or handled and shall provide adequate and reliable safeguards to accomplish the following objectives, considering both normal operations and possible abnormal conditions:

(1) Minimize the potential occurrence of unwanted releases, fire, or other emergency incidents resulting from the storage, use, or handling of hazardous materials
(2) Minimize the potential failure of buildings, equipment, or processes involving hazardous materials by ensuring that such buildings, equipment, or processes are reliably designed and are suitable for the hazards present
(3) Minimize the potential exposure of people or property to unsafe conditions or events involving an unintended reaction or release of hazardous materials
(4) Minimize the potential for an unintentional reaction that results in a fire, explosion, or other dangerous condition
(5) Provide a means to contain, treat, neutralize, or otherwise handle plausible releases of hazardous materials to minimize the potential for adverse impacts to persons or property outside of the immediate area of a release
(6) Provide appropriate safeguards to minimize the risk of and limit damage and injury that could result from an explosion involving hazardous materials that present explosion hazards
(7) Detect hazardous levels of gases or vapors that are dangerous to health and alert appropriate persons or mitigate the hazard when the physiological warning properties for such gases or vapors are inadequate to warn of danger prior to personal injury
(8) Maintain power to provide for continued operation of safeguards and important systems that are relied upon to prevent or control an emergency condition involving hazardous materials
(9) Maintain ventilation where ventilation is relied upon to minimize the risk of emergency conditions involving hazardous materials
(10) Minimize the potential for exposing combustible hazardous materials to unintended sources of ignition and for exposing any hazardous material to fire or physical damage that can lead to endangerment of people or property

5.1.12.2 A process hazard analysis and off-site consequence analysis shall be conducted when required by the AHJ to ensure that people and property are satisfactorily protected from potentially dangerous conditions involving hazardous materials. The results of such analyses shall be considered when determining active and passive mitigation measures used in accomplishing the objectives of 4.1.3.3.2 and 4.1.4.2.

5.1.12.3 Written procedures for pre-start-up safety reviews, normal and emergency operations, management of change, emergency response, and accident investigation shall be developed prior to beginning operations at a facility designed in accordance with Section 5.1. Such procedures shall be developed with the participation of employees.

Fire and building codes historically have included prescriptive requirements for regulating the use, handling, and storage of hazardous materials. These requirements often supplemented federal requirements, such as those covered by the U.S. Occupational Safety and Health Administration's Process Safety Management (PSM) program and the U.S. Environmental Protection Agency's Risk Management Planning (RMP) program, which were based on regulations contained in Title 29 and Title 40, Code of Federal Regulations.

Performance-based risk management designs have been used for a number of years for facilities in which hazardous materials are stored, used, or handled. Paragraph 5.1.12.2 includes related requirements for conducting process hazard analyses and off-site consequence analyses when deemed appropriate by the AHJ.

5.1.13 Special Definitions. A list of special terms used in this chapter shall be as follows:

(1) Design Fire Scenario. *(See 3.4.9.1.)*
(2) Design Specification. *(See 3.4.5.)*
(3) Design Team. *(See 3.4.6.)*
(4) Exposure Fire. *(See 3.4.7.)*
(5) Fire Model. *(See 3.4.8.)*
(6) Fire Scenario. *(See 3.4.9.)*
(7) Fuel Load. *(See 3.4.10.)*
(8) Input Data Specification. *(See 3.4.12.)*
(9) Occupant Characteristics. *(See 3.4.13.)*
(10) Performance Criteria. *(See 3.4.14.)*
(11) Proposed Design. *(See 3.4.15.)*
(12) Safety Factor. *(See 3.4.17.)*
(13) Safety Margin. *(See 3.4.18.)*
(14) Sensitivity Analysis. *(See 3.4.2.1.)*
(15) Stakeholder. *(See 3.4.20.)*
(16) Uncertainty Analysis. *(See 3.4.2.2.)*
(17) Verification Method. *(See 3.4.22.)*

5.2 Performance Criteria

Performance criteria are threshold values used to judge the adequacy of a performance-based design and should be stated in engineering terms. For fire protection designs, performance criteria might include maximum temperatures, minimum smoke layer elevations, or maximum heat fluxes. For structural designs, performance criteria might be stated as a minimum load-carrying capability under a range of external loads.

The performance criteria presented in Section 5.2 were written to be general enough for use in any performance-based design project. However, further quantification of the performance criteria is likely to be necessary to provide numerical values that can be used to determine whether a proposed design strategy is acceptable. Annex A is intended to provide information and reference sources that can be used to develop quantitative performance criteria.

Eight types of performance criteria are presented in 5.2.2. These criteria relate to fire conditions (5.2.2.1), explosion conditions (5.2.2.2), hazardous materials exposure (5.2.2.3), property protection (5.2.2.4), public welfare (5.2.2.5), occupant protection from untenable conditions (5.2.2.6), emergency responder protection (5.2.2.7), and occupant protection from structural failure (5.2.2.8). Additional information on determining performance criteria is included in A.5.1.4, Step 4.

5.2.1 General. A design shall meet the objectives specified in Section 4.1 if, for each required design scenario, assumption, and design specification, the performance criteria of 5.2.2 are met.

5.2.2* Specific Performance Criteria.

A.5.2.2 The performance criteria in 5.2.2 define an acceptable level of performance that should be agreed upon by the stakeholders, including the owner and the AHJ. The acceptable level of performance can vary widely between different facilities based on a number of factors, including the existence of potential ignition sources, potential fuel loads present, reactivity and quantity of hazardous materials present, the nature of the operations conducted at the facility, and the characteristics and number of personnel likely to be present at the facility.

5.2.2.1* Fire Conditions.

Δ **A.5.2.2.1** Many of the performance criteria related to safety from fire can also be found in the annex of NFPA *101*.

5.2.2.2* Explosion Conditions. The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of unintentional detonation or deflagration.

A.5.2.2.2 It is anticipated that the design provides protection for occupants who are not intimate with the initial unintentional detonation or deflagration of explosive materials, and individuals immediately adjacent to the property. It is recognized that employees should be trained and knowledgeable in the hazards of the materials present in the workplace. It is recognized that some of these individuals could experience psychological and physical injuries, such as hearing problems, on either a short- or long-term basis. However, the intent is that they do not experience thermal burns or loss of life or limb as a direct result of the explosion.

It is not the intent of the *Code* to provide protection against explosions caused by acts of terrorism. This would involve the introduction of an unknown quantity of explosives in an unknown location within or adjacent to a building. Where protection is needed against such acts of terrorism, the appropriate military and law enforcement agencies should be consulted.

5.2.2.3* Hazardous Materials Exposure. The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of an unauthorized release of hazardous materials or the unintentional reaction of hazardous materials.

A.5.2.2.3 Given the nature and variety of hazardous materials, more than one performance criterion for a specific facility could need to be developed. Criteria have to be developed for each hazardous material and possibly for different personnel; for example, higher levels of exposure can be tolerated by personnel that are in some way protected than those personnel having no protection. Development of performance criteria for hazardous materials should be developed by the facility owner and the facility's safety personnel in conjunction with the AHJ and the emergency response personnel expected to respond to an incident.

It is anticipated that the design provides protection for occupants inside or immediately adjacent to the facility who are not intimate with the initial unauthorized release of hazardous materials, or the initial unintentional reaction of hazardous materials. However, it is assumed that these individuals depart from the area of the incident in a time frame reasonable for their circumstances, based on their observation of the event, or some other form of notification.

It is also anticipated that employees and emergency response personnel are trained and aware of the hazardous materials present in the facility, and the potential consequences of their involvement in the incident, and take appropriate measures to ensure their own safety during search and rescue operations.

It is not the intent of the *Code* to provide protection against acts of terrorism involving the introduction of hazardous materials into a facility. This involves the introduction of an unknown quantity of materials in an unknown location within or adjacent to a building. Where protection is needed against such acts of terrorism, the appropriate military and law enforcement agencies should be consulted.

5.2.2.4* Property Protection. The facility design shall limit the effects of all required design scenarios from causing an unacceptable level of property damage.

A.5.2.2.4 Each facility designed using a performance-based approach most likely has different levels of acceptable and unacceptable property damage. This reflects the unique aspects of the performance-based designed facility and the reasons for pursuing a performance-based design. Therefore, the definition of an acceptable and an unacceptable level of property damage results from discussions between the facility's owner, manager and engineer, the designer, (possibly) the insurance underwriter and field engineer, and the AHJ. There could be cases where a property damage criterion is not needed.

Note that the structural integrity performance criteria for property damage most likely differs from the structural integrity performance criteria for life safety. This reflects the difference in the associated objectives: a life safety criterion probably is more restrictive than one for property damage.

5.2.2.5* Public Welfare. For facilities that serve a public welfare role as defined in 4.1.5, the facility design shall limit the effects of all required design scenarios from causing an unacceptable interruption of the facility's mission.

A.5.2.2.5 Each facility designed using a performance-based approach most likely has a different level of acceptable and unacceptable interruption of the facility's mission. This reflects the unique aspects of the performance-based designed facility and the reasons for pursuing a performance-based design. Therefore, the definition of an acceptable and an unacceptable interruption of the facility's mission results from discussions between the facility's owner, manager and engineer, the designer, (possibly) the insurance underwriter and field engineer, and the AHJ. There could be cases where a mission continuity criterion is not needed.

5.2.2.6 Occupant Protection from Untenable Conditions. Means shall be provided to evacuate, relocate, or defend in place occupants not intimate with ignition for sufficient time so that they are not exposed to instantaneous or cumulative untenable conditions from smoke, heat, or flames.

5.2.2.7 Emergency Responder Protection. Buildings shall be designed and constructed to reasonably prevent structural failure under fire conditions for sufficient time to enable fire fighters and emergency responders to conduct search and rescue operations.

5.2.2.8 Occupant Protection from Structural Failure. Buildings shall be designed and constructed to reasonably prevent structural failure under fire conditions for sufficient time to protect the occupants.

The requirements of 5.2.2.7 and 5.2.2.8 to protect against structural failure can be met by limiting the size of potential fires. This goal can be accomplished by suppression or control of combustibles, either by creating a structure that would provide sufficient load-carrying capacity at the temperatures the combustibles would be expected to reach in a fire or by providing supplemental protection to the structure. In both cases, the stakeholders must be in agreement on the types of materials likely to be involved in the fire to determine the thermal impact expected to be imposed on key structural members.

Paragraph 5.2.2.7 requires that structural stability be provided long enough for the fire service to conduct search and rescue operations. The requirement does not intend that structural stability be provided indefinitely or for a time sufficient for the fire service to put out a fire.

The total time needed to conduct search and rescue operations needs to be determined and should include the time required for responders to arrive on scene, deploy, conduct search and rescue operations, and vacate the building (or a portion thereof) before its collapse.

The total time anticipated for these operations should be determined and documented in the plan submittal documentation (see 5.1.4). The critical factors associated with these response search and rescue times should be treated as design features and documented in the O&M Manual (see 5.1.8). If factors arise at a later date that affect the emergency responders' ability to complete the search and rescue operations in the allotted time, these factors will need to be evaluated as proposed design changes.

For example, if a particular design assumes a four-person emergency response would be provided from a fire station 5 minutes away and the station was subsequently closed, the increased travel distance from the next closest station would need to be determined and factored into the total response time. Compliance with these performance criteria would then have to be determined.

The inclusion of fire service performance measures as part of the performance-based design has been greatly debated. Questions such as the following arise:

1. Is the fire department part of the design equation?
2. If the design is based on a particular station location, performance measure, or staffing level, can the municipality change these parameters, or are they locked in?

3. What if the first-due personnel are on another run and a second-due company must respond?
4. Can the municipality close or move a fire station?

5.3 Retained Prescriptive Requirements

Section 5.3 includes a number of retained prescriptive requirements from Chapters 10 through 75 that are a required part of the performance-based design option. These prescriptive requirements are an essential part of any facility or building. If compliance with the specific requirements included in this section is not feasible, the equivalency options of Section 1.4 should be considered. However, these equivalencies could be difficult to determine, and it would ultimately be up to the AHJ to rule on the acceptability of any changes to these requirements.

5.3.1 Systems and Features. All fire protection systems and features of the building shall comply with applicable NFPA standards for those systems and features.

5.3.2 Electrical Systems. Electrical systems shall comply with applicable NFPA standards for those systems.

5.3.3 General. The design shall comply with the following requirements in addition to the performance criteria of Section 5.2 and the methods of Section 5.4 through Section 5.7:

(1) Fundamental requirements in Section 10.1
(2) Fire drills in Section 10.5
(3) Smoking in Section 10.9
(4) Open flame, candles, open fires, and incinerators in Section 10.10
(5) Fire protection markings in Section 10.11
(6) Seasonal and vacant buildings and premises in Section 10.12
(7) Combustible vegetation in Section 10.13
(8) Safeguards during building construction, alteration, and demolition operations in Chapter 16

Δ **5.3.4 Means of Egress.** The design shall comply with the following NFPA *101* requirements in addition to the performance criteria of Section 5.2 and the methods of Section 5.4 through Section 5.7:

(1) Changes in level in means of egress: 7.1.7 of NFPA *101*
(2) Guards: 7.1.8 of NFPA *101*
(3) Door openings: 7.2.1 of NFPA *101*
(4) Stairs: 7.2.2 of NFPA *101*

Exception: The provisions of 7.2.2.5.1, 7.2.2.5.2, 7.2.2.6.2, 7.2.2.6.3, and 7.2.2.6.4 of NFPA 101 shall be exempted.

(5) Ramps: 7.2.5 of NFPA *101*

Exception: The provisions of 7.2.5.3.1, 7.2.5.5, and 7.2.5.6.1 of NFPA 101 shall be exempted.

(6) Fire escape ladders: 7.2.9 of NFPA *101*
(7) Alternating tread devices: 7.2.11 of NFPA *101*
(8) Capacity of means of egress: Section 7.3 of NFPA *101*

Exception: The provisions of 7.3.3 and 7.3.4 of NFPA 101 shall be exempted.

(9) Impediments to egress: 7.5.2 of NFPA *101*
(10) Illumination of means of egress: Section 7.8 of NFPA *101*
(11) Emergency lighting: Section 7.9 of NFPA *101*
(12) Marking of means of egress: Section 7.10 of NFPA *101*

5.3.5 Equivalency. Equivalent designs for the features covered in the retained prescriptive requirements mandated by 5.3.1 through 5.3.4 shall be addressed in accordance with the equivalency provisions of Section 1.4.

5.4* Design Scenarios

A.5.4 Many events can occur during the life of a facility; some have a higher probability of occurrence than others. Some events, though not typical, could have a devastating effect on the facility. A reasonable design should be able to achieve the goals, objectives, and performance criteria of this *Code* for any typical or common design scenario and for some of the nontypical, potentially devastating scenarios, up to some level commensurate with society's expectations as reflected in this *Code*.

The challenge in selecting design scenarios is finding a manageable number that are sufficiently diverse and representative so that, if the design is reasonably safe for those scenarios, it should then be reasonably safe for all scenarios, except for those specifically excluded as being unrealistically severe or sufficiently infrequent to be fair tests of the design.

Section 5.4 contains requirements for design scenarios, which characterize the loads or hazards that a building is expected to withstand.

Paragraph 5.4.1.1 requires AHJ approval of the design scenario parameters. The types of parameters involved in a design scenario include quantification of loads, heat release rates, and quantification of the onset of hazardous conditions. The evaluation of design scenarios, as required by 5.4.1.2, is typically accomplished by using models or other tools. See Section 5.5 for additional information. Paragraph 5.4.1.4 addresses translating the design scenario into specifications. For example, the fire scenarios in 5.4.2 can be translated into heat release rates and quantification of hazards.

The commentary that follows suggests how suitable scenarios can be developed.

Introduction

To provide a comprehensive design (i.e., to demonstrate how the fire safety systems or the structural system will respond to a variety of challenges), more than one scenario should be considered. At least the following three types of scenarios should be considered:

1. High frequency, low consequence (typical)
2. Low frequency, high consequence (high challenge)
3. Special problems

For a fire event, the first scenario is used to demonstrate that the fire safety system can manage fires that start as relatively small fires but are frequent, such as a wastebasket fire. The second scenario covers fires such as one in an egress path, which would likely present a greater challenge to the fire safety system. The intent of this scenario is to consider a larger fire than the first scenario but not one so unrealistically large that it ensures the proposed design (or any other) will not perform adequately. The first two scenario types tacitly assume that the fire safety system will function as designed. However, the third scenario is included to account for situations in which some aspect of the fire safety system might be compromised. Examples of the third scenario include an improperly closed valve on a sprinkler system; a detection/alarm system temporarily out of service; multiple ignitions, which are characteristic of an arson fire; or degradation of the egress system after an earthquake or other natural disaster. The third scenario can also be used to consider the reliability of the fire safety system design.

Commentary Table 5.1 provides examples of general scenarios that might be experienced by most, if not all, occupancies. The table presents examples of typical and high-challenge fires, based on slow-, moderate-, and fast-developing fires that expose people in the room of origin who are not intimate with ignition and that occur in a room not normally occupied. Commentary Table 5.1 also presents examples of special problem fires for these same individuals.

The left-hand column of Commentary Table 5.1 indicates a general fire type, characterized by the rate at which a potential fire hazard might develop. Fire development is defined by a heat release rate curve. An additional factor in defining the type of fire is the peak heat release rate, which must be severe enough to challenge the fire safety system but not so severe that no design can reduce the hazards of the hypothetical fires effectively. The peak heat release rate is a function of the amount of fuel of the first item ignited, if the fire doesn't spread beyond it, or the maximum amount of fuel within the room of origin (i.e., room goes to flashover).

Scenario Components

At a minimum, a fire scenario consists of the following:

1. Ignition factors: source, location, and material; other items ignited, if applicable
2. At least one heat release rate curve (HRRC)
3. Occupant locations (see 5.4.5.3 of NFPA *101*®, *Life Safety Code*®)
4. Occupant characteristics (see 5.4.5 of NFPA *101*)
5. Special factors: shielded, systems unreliable, open door

Ignition Factors. Ignition factors include the source of ignition; the material that is first ignited and, if it is a solid, where it is ignited; and whether other items are also ignited. Ignition factors to consider when constructing these aspects of the scenario are shown in Commentary Table 5.2.

Ignition Sources. Ignition sources are of primary interest when considering the frequency of design fires. Sources of ignition include the following:

1. Smoking materials
2. Open flame
3. Electrical source
4. Incendiary
5. Hot surface
6. Spontaneous combustion
7. Radiant source

Various electrical ignition scenarios are possible, and historical data should be consulted to determine which type of ignition is most appropriate for the scenario and occupancy being considered. In addition to smoking-related ignitions and open flames, another example of incendiary ignition might be a runaway chemical reaction. Hot surfaces are most often associated with equipment used with either cooking, such as stoves or hot

COMMENTARY TABLE 5.1 *General Scenarios*

	Scenario	
Fire Type	***Occupant in Room of Fire Origin but Not Intimate***	***Room of Fire Origin Normally Unoccupied***
Slow-developing fire	Cigarette ignition of upholstered furniture Electrical ignition of small appliance or lighting, or overloaded outlet	Overloaded or failed wiring igniting switch gear, electrical devices, or insulation, followed by ignition of wooden structural members
Moderate-developing fire	Kitchen/cooking fire Trash can fire Open flame ignition of upholstered furniture	Wildland or exposure fire (e.g., from a neighboring building or parked car) Lightning-induced ignition of building roof Laundry room fire
Fast-developing fire	Flammable liquids	Flammable liquid storage
Shielded from systems or other problems present	Fire with impaired "first line of defense" Shielded flaming fires; limited fuel and larger	External trash collection or trash chute fire Flammable liquid storage Room of fire origin door open Fire in egress path

plates, or industrial processes, such as engines or furnaces. Spontaneous combustion is essentially an uncontrolled exothermic chemical reaction due to either a buildup of flammable vapors (e.g., due to improper storage or decomposition) or accidental mixing of reactive chemicals (e.g., some cleaning fluids). A common radiant source is a portable heater.

First Item Ignited. The first item ignited is somewhat dependent on the ignition source. For example, an overheated electrical wire is most likely to ignite its own insulation. Cooking fires usually ignite items close to the flames, rather than structural assemblies (e.g., walls or ceiling finish materials). The first item ignited is of interest for two reasons. The first is that it might pose either a thermal or a nonthermal hazard by itself, such as an occupied mattress or the toxic products resulting from its combustion. The second reason is that the first item might ignite a second item that poses an additional or greater hazard. Examples of second items include merchandise, structural assemblies, and carpets capable of releasing toxic combustion products. The column for "second item ignited" in Commentary Table 5.2 might not be necessary if the first item ignited presents enough of a hazard by itself. Certain types of upholstered furniture are in this category because of the toxic combustion products released and a relatively high heat release rate.

Second Item Ignited. Ignition of a second item is important in scenarios involving flashover or where structural stability is an issue. Ignition of a second item should be reflected in the heat release rate curve for the room of origin. Ignition of a second item can have the following two effects on the room heat release rate curve:

1. The peak heat release rate might be increased.
2. The growth phase of the fire might be accelerated.

The possibility of both phenomena occurring might apply to certain scenarios, for example, if the second item involves flammable liquids or gases.

Heat Release Rate Curves. Heat release rate curves can be constructed by referring to the *SFPE Handbook of Fire Protection Engineering* and Drysdale's *An Introduction to Fire Dynamics*, or by using manufacturers' test data.

Special Factors. Several factors, including ignition location, fire spread, relative location, interference with evacuation, and compartmentation barriers, can be critical to the development of scenarios.

Ignition Location. The location of the point of ignition can affect the eventual course and spread of a fire. In some cases, specifying a location also implies additional items in the scenario. For example, a kitchen fire could actually be a cooking fire that involves a burner igniting loose clothing or a grease fire igniting ordinary combustibles nearby.

Fire Spread. With regard to fire spread, the point of ignition is significant because it might, in part, determine the severity of the fire. An aspect of potential severity is the availability of oxygen. If the first item ignited is an upholstered chair, one of the following two scenarios could result, depending on whether the ignition location is other than the chair itself, such as a wastebasket fire, or directly involved with the chair, such as a cigarette located between the seat cushion and an arm of the chair.

Additionally, the point of origin might contribute to localized flashover, which has been observed in experiments involving bunk beds and desks with enclosed leg wells or modesty

COMMENTARY TABLE 5.2 *Ignition Factors*

Ignition Source	*First Item Ignited*	*Second Item Ignited*
Cigarette	Electrical equipment[1]	Structural assembly[2]
Electrical lighting	Wiring	Library book stack
Incendiary	Seating	Merchandise display
Spontaneous combustion	Sets and decorations	Carpets
Stove/hot plate	Exhibit displays	Curtains
Process-inherent[3]	Upholstered furniture	
	Electrical appliance	
	Trash	
	Ordinary combustibles[4]	
	Gas leaks	
	Flammable liquids	
	Mattress	
	Medical equipment	

[1]Includes, but is not limited to, dust collectors, uninterruptible power supplies, generators, HVAC equipment, dryers, and freezers.

[2]Consists of exterior/interior wall or ceiling finish, wall studs, ceiling joists, and insulation.

[3]Applies primarily to industrial settings.

[4]Includes mixtures of paper, common plastics, and other materials.

panels. These geometries tend to concentrate heat energy such that an intense fire is created in a relatively small area.

Relative Location. Relative location can be connected to the localized flashover. These fires are characterized by the fact that the ignition point is shielded from fire protection systems. The initial fire development is not sensed by the fire detection system, and, thus, the detection response is delayed. Delay results in a larger fire at the time of detection and a commensurate decrease in the time to evacuate. A common scenario involving shielded fires is a fire in warehouse rack storage.

Interference with Evacuation. The loss or degradation of any one egress path can place a significant burden on the fire safety system of a facility. One way that such a loss occurs is when a fire originates in part of the egress system. Degrees of severity vary. If more than two exits are available, the loss of one will have less of an impact than if only one or two exits are available. If a fire originates in a location shared by more than one egress path, such as where two egress paths merge into a single corridor or a dead-end corridor, the impact is greater than if the fire originates in one of several parallel egress routes.

Compartmentation Barriers. This situation involves the fire breaching a barrier or originating in a concealed space or on an exterior surface. When the fire breaches a barrier, the potential for a severe fire increases. The problem with fire originating in a concealed space or on an exterior surface is similar to that addressed in the "Relative Location" section of this commentary: the fire is shielded from detection or suppression systems.

General Design Scenarios

The general design scenarios shown in Commentary Table 5.3 are recommended as a starting point because they encompass the issues addressed in earlier commentary. For the instances where Commentary Table 5.3 does not apply, a process is provided for customizing the selection of factors in site-specific scenarios that address the concepts of the general scenarios.

Development of Scenarios. Guidelines that follow are for use in specifying fire scenarios.

1. Scenarios can be described partly through routine statistical analysis of fire experiences in similar buildings. Common or typical scenarios provide a good prediction of a building's performance if fire occurs. Such scenarios also tend to fit easily within the scope of available fire models and calculation methods. The AHJ can review the results for these scenarios to obtain a sense of the building's level of safety and the appropriateness of the calculations.

2. High-challenge scenarios are scenarios that pose unusual fire challenges to the building design. They are developed by refining common scenarios (e.g., changing the area of fire origin) to create a greater challenge. Also, high-challenge scenarios can be developed by reducing the challenge in scenarios previously identified as beyond the design expectations (i.e., too severe to use as the basis for evaluation).

Developing High-Challenge Scenarios from Common Scenarios. The following are illustrative techniques for developing high-challenge scenarios from common scenarios:

1. Change the area of fire origin.

- **a.** Consider an area (e.g., a bedroom) where occupants are likely to be particularly vulnerable.
- **b.** Consider an area (e.g., a concealed space, an external surface) where fire can develop outside the effective range of key fire protection features (such as detectors or sprinklers).
- **c.** Consider an area (e.g., an egress corridor) that is critical to occupant movement to safety.

2. Increase the initial size or speed of the fire's development. This might be done by adjusting the parameters in a fire growth model (e.g., increasing the alpha value in a *t*-squared–modeled fire; creating a scenario that reflects a fast or ultra-fast fire; increasing the peak heat release rate value for the fire) or by

COMMENTARY TABLE 5.3 *General Design Scenarios*

Typical Scenario	***High-Challenge Scenario***	***Special Problem Scenario***
Fast growth in room contents	Flammable liquids in means of egress	Ordinary fire in typical unoccupied room with sprinklers or detectors out of commission
Ordinary fire: • in attic or challenging concealed space • in typical occupied room with people not intimate with ignition	Largest room fire, fastest growth consistent with use Worst-case occupant characteristics	
Slow-developing fire in typical occupied room with worst-case occupant characteristics	Worst-case flame spread fire, if area critical to egress Flammable room linings or decorations	

increasing the assumed room fuel load or decreasing the space between major combustible items.

3. Assume common degradations in design assumptions. For example, assume the doors are blocked open, allowing the passage of fire effects to secondary spaces; or assume an unlimited oxygen supply for fire growth that could result from open doors, broken windows, or other circumstances.

4. Increase the toxicity or yields of products of combustion.

Developing High-Challenge Scenarios from Scenarios Beyond Design Expectations. Developing high-challenge scenarios from scenarios beyond design expectations involves less challenging quantitative assumptions. For example, if the bomb used in the New York City World Trade Center incident of 1993 was deemed too severe for a high-rise office building, how small a bomb would constitute an appropriate high-challenge test? To pose another example, if the *Code* cannot ensure protection of occupants who are intimate with initial fire development, how close can occupants be without being considered intimate?

5.4.1 General.

5.4.1.1 The proposed design shall be considered to meet the goals and objectives if it achieves the performance criteria for each required design scenario. The AHJ shall approve the parameters involved with required design scenarios.

5.4.1.2* Design scenarios shall be evaluated for each required scenario using a method acceptable to the AHJ and appropriate for the conditions. Each scenario shall be as challenging and realistic as any that could realistically occur in the building.

A.5.4.1.2 The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* identifies methods for evaluating fire scenarios.

5.4.1.3* Scenarios selected as design scenarios shall include, but not be limited to, those specified in 5.4.2 through 5.4.5.

A.5.4.1.3 It is desirable to consider a wide variety of different design scenarios to evaluate the complete capabilities of the building or structure. Design scenarios should not be limited to a single or a couple of worst-case events.

5.4.1.3.1 Design fire scenarios demonstrated by the design team to the satisfaction of the AHJ as inappropriate for the building use and conditions shall not be required to be evaluated fully.

5.4.1.3.2 Fire Design Scenario 8 *(see 5.4.2.8)* shall not be required to be applied to fire protection systems or features for which both the level of reliability and the design performance in the absence of the system or feature are acceptable to the AHJ.

5.4.1.4 Each design scenario used in the performance-based design proposal shall be translated into input data specifications, as appropriate for the calculation method or model.

5.4.1.5 Any design scenario specifications that the design analyses do not explicitly address or incorporate and that are, therefore, omitted from input data specifications shall be identified, and a sensitivity analysis of the consequences of that omission shall be performed.

5.4.1.6 Any design scenario specifications modified in input data specifications, because of limitations in test methods or other data generation procedures, shall be identified, and a sensitivity analysis of the consequences of the modification shall be performed.

5.4.2 Required Design Scenarios — Fire.

5.4.2.1* Fire Design Scenario 1. Fire Design Scenario 1 involves an occupancy-specific design scenario representative of a typical fire for the occupancy.

A.5.4.2.1 An example of such a scenario for a health care occupancy involves a patient room with two occupied beds with a fire initially involving one bed and the room door open. This is a cursory example in that much of the explicitly required information indicated in 5.4.2.1 can be determined from the information provided in the example. Note that it is usually necessary to consider more than one scenario to capture the features and conditions typical of an occupancy.

5.4.2.1.1 This design scenario shall explicitly account for the following:

(1) Occupant activities
(2) Number and location of occupants
(3) Room size
(4) Furnishings and contents
(5) Fuel properties and ignition sources
(6) Ventilation conditions

5.4.2.1.2 The first item ignited and its location shall be explicitly defined.

The idea behind Fire Design Scenario 1 in 5.4.2.1 is to ensure that the types of fires most likely to occur in a given occupancy type — that is, the statistically most significant scenarios — are considered in the design analysis. These scenarios can also be considered to be the statistically most significant scenarios — that is, those that happen most often in the type of facility being designed. These scenarios vary greatly, from small fires experienced weekly at aluminum rolling mills to kitchen fires in high-rise apartment buildings (i.e., residences).

5.4.2.2* Fire Design Scenario 2. Fire Design Scenario 2 involves an ultrafast-developing fire in the primary means of egress with interior doors open at the start of the fire. This design scenario shall address the concern regarding a reduction in the number of available means of egress.

A.5.4.2.2 Examples of such scenarios are a fire involving ignition of gasoline as an accelerant in a means of egress, clothing racks in corridors, renovation materials, or other fuel configurations that can cause an ultrafast fire. The means of egress chosen is the doorway with the largest egress capacity among doorways normally used in the ordinary operation of the building. The baseline occupant characteristics for the property are assumed. At ignition, doors are assumed to be open throughout the building.

Fire Design Scenario 2 is intended to provide information on the maximum potential spread of fire effects, mostly smoke and toxic products. It answers the question, "What is the maximum extent of smoke that might be experienced if an egress path is blocked?"

5.4.2.3* Fire Design Scenario 3. Fire Design Scenario 3 involves a fire that starts in a normally unoccupied room that can potentially endanger a large number of occupants in a large room or other area. This design scenario shall address the concern regarding a fire starting in a normally unoccupied room and migrating into the space that can, potentially, hold the greatest number of occupants in the building.

A.5.4.2.3 An example of such a scenario is a fire in a storage room adjacent to the largest occupiable room in the building. The contents of the room of fire origin are specified to provide the largest fuel load and the most rapid growth in fire severity consistent with the normal use of the room. The adjacent occupiable room is assumed to be filled to capacity with occupants. Occupants are assumed to be somewhat impaired in whatever form is most consistent with the intended use of the building. At ignition, doors from both rooms are assumed to be open. Depending on the design, doorways connect the two rooms or they connect via a common hallway or corridor.

For purposes of this scenario, an occupiable room is a room that could contain people (i.e., a location within a building where people are typically found).

5.4.2.4* Fire Design Scenario 4. Fire Design Scenario 4 involves a fire that originates in a concealed wall or ceiling space adjacent to a large occupied room. This design scenario shall address the concern regarding a fire originating in a concealed space that does not have either a detection system or suppression system and then spreading into the room within the building that can, potentially, hold the greatest number of occupants.

A.5.4.2.4 An example of such a scenario is a fire originating in a concealed wall- or ceiling-space adjacent to a large, occupied function room. Ignition involves concealed combustibles, including wire or cable insulation and thermal or acoustical insulation. The adjacent function room is assumed to be occupied to capacity. The baseline occupant characteristics for the property are assumed. At ignition, doors are assumed to be open throughout the building.

5.4.2.5* Fire Design Scenario 5. Fire Design Scenario 5 involves a slow-developing fire, shielded from fire protection systems, in close proximity to a high occupancy area. This design scenario shall address the concern regarding a relatively small ignition source causing a significant fire.

A.5.4.2.5 An example of such a scenario is a cigarette fire in a trash can. The trash can is close enough to room contents to ignite more substantial fuel sources but is not close enough to any occupant to create an intimate-with-ignition situation. If the intended use of the property involves the potential for some occupants to be incapable of movement at any time, then the room of origin is chosen as the type of room likely to have such occupants, filled to capacity with occupants in that condition. If the intended use of the property does not involve the potential for some occupants to be incapable of movement, then the room of origin is chosen to be an assembly or function area characteristic of the use of the property, and the trash can is placed so that it is shielded by furniture from suppression systems. At ignition, doors are assumed to be open throughout the building.

5.4.2.6* Fire Design Scenario 6. Fire Design Scenario 6 involves the most severe fire resulting from the largest possible fuel load characteristic of the normal operation of the building. This design scenario shall address the concern regarding a rapidly developing fire with occupants present.

A.5.4.2.6 An example of such a scenario is a fire originating in the largest fuel load of combustibles possible in normal operation in a function or assembly room or in a process/manufacturing area, characteristic of the normal operation of the property. The configuration, type, and geometry of the combustibles are chosen so as to produce the most rapid and severe fire growth or smoke generation consistent with the normal operation of the property. The baseline occupant characteristics for the property are assumed. At ignition, doors are assumed to be closed throughout the building.

This scenario includes everything from a big couch fire in a small dwelling to a rack storage fire in combustible liquids stock in a big box retail store.

The Dupont Plaza Hotel fire of 1986 in San Juan, Puerto Rico, in which 98 persons lost their lives, is an example of Fire Design Scenario 6 described in 5.4.2.6. The storage of chairs was part of the normal operating procedures of the hotel. The location and potential heat release of the chairs were evidently considered a small threat because of the lack of an ignition source. Unfortunately, a source was supplied, with tragic results.

5.4.2.7* Fire Design Scenario 7. Fire Design Scenario 7 involves an outside exposure fire. This design scenario shall address the concern regarding a fire starting at a location remote from the area of concern and either spreading into the area, blocking escape from the area, or developing untenable conditions within the area.

A.5.4.2.7 An example of such a scenario is an exposure fire. The initiating fire is the closest and most severe fire possible consistent with the placement and type of adjacent properties and the placement of plants and combustible adornments on the property. The baseline occupant characteristics of the property are assumed.

This category includes wildland/urban interface fires and exterior wood shingle problems, where applicable.

5.4.2.8* Fire Design Scenario 8. Fire Design Scenario 8 involves a fire originating in ordinary combustibles in a room or area with each passive or active fire protection system or feature independently rendered ineffective. This set of design scenarios shall address concerns regarding each fire protection system or fire protection feature, considered individually, being unreliable or becoming unavailable. This scenario shall not be required to be applied to fire protection systems or features for which both the level of reliability and the design performance in the absence of the system are acceptable to the AHJ.

A.5.4.2.8 This scenario addresses a set of conditions with a typical fire originating in the building with any one passive or active fire protection system or feature being ineffective. Examples include unprotected openings between floors or between fire walls or fire barrier walls, rated fire doors that fail to close automatically or are blocked open, sprinkler system water supply that is shut off, fire alarm system that's nonoperative, smoke management system that is not operational, or automatic smoke dampers that are blocked open. This scenario should represent a reasonable challenge to the other building features provided by the design and presumed to be available.

The exemption from Fire Design Scenario 8 is applied to each active or passive fire protection system individually and requires two different types of information to be developed by analysis and approved by the AHJ. System reliability is to be analyzed and accepted. Design performance in the absence of the system is also to be analyzed and accepted, but acceptable performance does not require fully meeting the stated goals and objectives. It might not be possible to meet fully the goals and objectives if a key system is unavailable, and yet no system is totally reliable. The AHJ determines which level of performance, possibly short of the stated goals and objectives, is acceptable, given the very low probability (that is, the system's unreliability probability) that the system will not be available.

Fire Design Scenario 8 provides information to the AHJ by answering a series of "What if . . . " questions. For example, what if the hotel sprinkler system is out of service when a fire occurs? What might be the extent of the fire and smoke and their subsequent effects on the egress system? Similar questions can be posed for other fire protection system components and subsystems.

5.4.3 Required Design Scenarios — Explosion.

5.4.3.1* Explosion Design Scenario 1.

A.5.4.3.1 This scenario is intended to address facilities where explosives, and products containing explosives, are manufactured, stored, sold, or handled. From an overall safety standpoint, the operations being performed at these facilities should include stringent safety procedures that significantly reduce the likelihood of an explosion from occurring. However, if an explosion does occur, protection methods such as storage magazines, property set backs, deflagration, and explosion venting and containment need to be in place, as appropriate, to minimize potential injury and loss of life and property.

Where products containing explosives, such as pyrotechnic displays or fireworks, are stored, handled, or used in buildings, such as arenas, an explosion scenario should not result in significant injuries to occupants not intimate with the materials.

5.4.3.1.1 Explosion Design Scenario 1 is the detonation or deflagration of explosive materials being manufactured, stored, handled, or used in a facility.

5.4.3.1.2 Explosion Design Scenario 1 shall address the concern regarding safety of individuals not intimate with the explosion and property protection of adjacent properties and buildings.

5.4.4* Required Design Scenarios — Hazardous Materials.

A.5.4.4 Design hazardous materials scenarios should explicitly account for the following:

(1) Occupant activities, training, and knowledge
(2) Number and location of occupants
(3) Discharge location and surroundings
(4) Hazardous materials' properties
(5) Ventilation, inerting, and dilution systems and conditions
(6) Normal and emergency operating procedures
(7) Safe shutdown and other hazard mitigating systems and procedures
(8) Weather conditions affecting the hazard
(9) Potential exposure to off-site personnel

Design hazardous materials scenarios should be evaluated as many times as necessary by varying the factors previously indicated. Design hazardous materials scenarios could need to be established for each different type of hazardous material stored or used at the facility.

5.4.4.1 Hazardous Materials Design Scenario 1. Hazardous Materials Design Scenario 1 involves an unauthorized release of hazardous materials from a single control area. This design scenario shall address the concern regarding the spread of hazardous conditions from the point of release.

5.4.4.2 Hazardous Materials Design Scenario 2. Hazardous Materials Design Scenario 2 involves an exposure fire on a location where hazardous materials are stored, used, handled, or dispensed. This design scenario shall address the concern regarding how a fire in a facility affects the safe storage, handling, or use of hazardous materials.

5.4.4.3 Hazardous Materials Design Scenario 3. Hazardous Materials Design Scenario 3 involves the application of an external factor to the hazardous material that is likely to result in a fire, explosion, toxic release, or other unsafe condition. This design scenario shall address the concern regarding the initiation of a hazardous materials event by the application of heat, shock, impact, or water onto a hazardous material being stored, used, handled, or dispensed in the facility.

5.4.4.4 Hazardous Materials Design Scenario 4.

5.4.4.4.1 Hazardous Materials Design Scenario 4 involves an unauthorized discharge with each protection system independently rendered ineffective. This set of design hazardous materials scenarios shall address concern regarding each protection system or protection feature, considered individually, being unreliable or becoming unavailable.

5.4.4.4.2* Hazardous Materials Design Scenario 4 shall not be required to be applied to protection systems or features for which both the level of reliability and the design performance in the absence of the system are acceptable to the AHJ.

A.5.4.4.4.2 This provision should be applied to each protection system individually and requires two different types of information to be developed by analysis and approved by the AHJ. System reliability is to be analyzed and accepted. Design performance in the absence of the system is also to be analyzed and accepted, but acceptable performance does not require fully meeting the stated goals and objectives. It might not be possible to meet fully the goals and objectives if a key system is unavailable, and yet no system is totally reliable. The AHJ determines which level of performance, possibly short of stated goals and objectives, is acceptable, given the very low probability (that is, the systems' unreliability probability) that the system will be unavailable.

The four hazardous materials design scenarios of 5.4.4 are intended to cover a variety of fault scenarios related to the storage, use, and handling of hazardous materials. Scenarios 1 through 3 require compliance with the goals and objectives to be achieved under a single fault condition related to the normal facility operations. These scenarios do not anticipate that simultaneous faults will occur concurrently, such as the simultaneous release of reactive materials for different control areas, the unauthorized release of a hazardous material, and simultaneous application of a force that causes that material to react violently. This scenario would include, as an example, the unauthorized release of a water-reactive material and the simultaneous application of water from an automatic sprinkler system in a location where the material is not normally stored, used, or handled.

Note that Scenario 4 *does* require a design to comply with the performance criteria in the event that an unauthorized release occurs and a detection or protection system is rendered ineffective (two simultaneous fault conditions). However, as noted in 5.4.4.4.2, this scenario is not required if the protection system has a high degree of reliability and the performance without a protection system is acceptable to the AHJ.

Part of the basis for requiring only a single fault condition to be considered for most of these scenarios is the assumption that protection systems are present in facilities containing hazardous materials, and quality control and safety-related practices are in place and used effectively by both facility management personnel and the workers involved with the materials and safety systems. Such systems and practices, if critical to achieve the goals and objectives of this *Code,* should be carefully documented in the facility's O&M Manual and verified during periodic inspections and other quality control audits.

5.4.5 Required Design Scenarios — Safety During Building Use.

5.4.5.1* Building Use Design Scenario 1. Building Use Design Scenario 1 involves an event in which the maximum occupant load is in the assembly building and an emergency event occurs blocking the principal exit/entrance to the building. This design scenario shall address the concern of occupants having to take alternative exit routes under crowded conditions.

A.5.4.5.1 An example of such a scenario would involve a fire or earthquake effectively blocking the principal entrance/exit but not immediately endangering the occupants. The full occupant load of the assembly space has to exit using secondary means.

5.4.5.2 Building Use Design Scenario 2. Building Use Design Scenario 2 involves a fire in an area of a building undergoing construction or demolition while the remainder of the building is occupied. The normal fire suppression system in the area undergoing construction or demolition has been taken out of service. This design scenario shall address the concern regarding the inoperability of certain building fire safety features during construction and demolition in a partially occupied building.

The two building use design scenarios described in 5.4.5 ensure some redundancy in the event primary exits are obstructed, blocked, or otherwise unavailable (Scenario 1), and they identify which effects might be imposed on egress time if select fire protection systems are unavailable.

Building Use Design Scenario 1 is directed at assembly occupancies where the principal exit, which is usually the means used by most occupants to enter the venue, is not available. This scenario, in many ways, is an adjunct to Fire Design Scenario 2 and Fire Design Scenario 7. (See 5.4.2.2 and 5.4.2.7.) Paragraph 5.4.5.1 does not, however, limit itself to fire events that might trigger the emergency. Fights, civil disturbances outside the building, and even weather-related events could cause crowd movement incidents that should be considered.

Building Use Design Scenario 2 is directed at any occupancy where the normal complement of safety features and systems is not present because of construction or demolition operations. Scenario 2 is an adjunct to Fire Design Scenario 8. (See 5.4.2.8.) Any proposed design should include alternate safety measures that would either remain in place or be provided temporarily until the work is complete and the permanent systems and features are back in place.

5.5 Evaluation of Proposed Designs

Evaluating proposed designs in accordance with Section 5.5 is typically accomplished by using models or other tools to compare the conditions that result through the use of a proposed design strategy to the performance criteria in Section 5.2. The types of models that might be used to evaluate proposed designs include physical models, such as full-scale or reduced-scale models, computer models, or hand calculations using simple equations.

5.5.1 General.

5.5.1.1 A proposed design's performance shall be assessed relative to each performance objective in Section 4.1 and each applicable scenario in Section 5.4, with the assessment conducted through the use of appropriate calculation methods.

5.5.1.2 The choice of assessment methods shall require the approval of the AHJ.

5.5.2 Use. The design professional shall use the assessment methods to demonstrate that the proposed design achieves the goals and objectives, as measured by the performance criteria in light of the safety margins and uncertainty analysis, for each scenario, given the assumptions.

5.5.3 Input Data.

5.5.3.1 Data.

5.5.3.1.1 Input data for computer fire models shall be obtained in accordance with ASTM E1591, *Standard Guide for Data for Fire Models*.

5.5.3.1.2 Data for use in analytical models that are not computer-based fire models shall be obtained using appropriate measurement, recording, and storage techniques to ensure the applicability of the data to the analytical method being used.

5.5.3.2 Data Requirements. A complete listing of input data requirements for all models, engineering methods, and other calculation or verification methods required or proposed as part of the performance-based design shall be provided.

5.5.3.3 Uncertainty and Conservatism of Data. Uncertainty in input data shall be analyzed and, as determined appropriate by the AHJ, addressed through the use of conservative values.

Just as evaluation methods have limitations, input data, as addressed in 5.5.3, might have limitations that must be identified and addressed. For example, heat release rate data obtained from burning a piece of furniture might be limited to that specific make and model of furniture. Use of data applicable to other types of furniture might introduce uncertainty, which would need to be addressed.

5.5.4 Output Data. The assessment methods used shall accurately and appropriately produce the required output data from input data based on the design specifications, assumptions, and scenarios.

5.5.5 Validity. Evidence shall be provided confirming that the assessment methods are valid and appropriate for the proposed facility, use, and conditions.

5.6* Safety Factors

Approved safety factors shall be included in the design methods and calculations to reflect uncertainty in the assumptions, data, and other factors associated with the performance-based design.

A.5.6 The assessment of precision required in 5.7.2 requires a sensitivity and uncertainty analysis, which can be translated into safety factors.

Sensitivity Analysis. The first run a model user makes should be labeled as the base case, using the nominal values of the various input parameters. However, the model user should not rely on a single run as the basis for any performance-based fire safety system design. Ideally, each variable or parameter that the model user made to develop the nominal input data should have multiple runs associated with it, as should combinations of key variables and parameters. Thus, a sensitivity analysis should be conducted that provides the model user with data that indicates how the effects of a real fire could vary and how the response of the proposed fire safety design could also vary.

The interpretation of a model's predictions can be a difficult exercise if the model user does not have knowledge of fire dynamics or human behavior.

Reasonableness Check. The model user should first try to determine whether the predictions actually make sense, that is, they don't upset intuition or preconceived expectations. Most likely, if the results don't pass this test, an input error has been committed.

Sometimes the predictions appear to be reasonable but are, in fact, incorrect. For example, a model can predict higher temperatures farther from the fire than close to it. The values themselves could be reasonable, for example, they are not hotter than the fire, but they don't "flow" down the energy as expected.

A margin of safety can be developed using the results of the sensitivity analysis in conjunction with the performance criteria to provide the possible range of time during which a condition is estimated to occur.

Safety factors and margin of safety are two concepts used to quantify the amount of uncertainty in engineering analyses. Safety factors are used to provide a margin of safety and represent, or address, the gap in knowledge between the theoretically perfect model, that is, reality and the engineering models that can only partially represent reality.

Safety factors can be applied to either the predicted level of a physical condition or to the time at which the condition is predicted to occur. Thus, a physical or a temporal safety factor, or both, can be applied to any predicted condition. A predicted condition (that is, a parameter's value) and the time at which it occurs are best represented as distributions. Ideally, a computer fire model predicts the expected or nominal value of the distribution. Safety factors are intended to represent the spread of these distributions.

Given the uncertainty associated with data acquisition and reduction, and the limitations of computer modeling, any condition predicted by a computer model can be thought of as an expected or nominal value within a broader range. For example, an upper layer temperature of 1110°F (600°C) is predicted at a given time. If the modeled scenario is then tested (that is, full-scale experiment based on the computer model's input data), the actual temperature at that given time could be 1185°F or 1085°F (640°C or 585°C). Therefore, the temperature should be reported as 1110°F + 75°F, –25°F (600°C + 40°C, –15°C) or as a range of 1085°F to 1184°F (585°C to 640°C).

Ideally, predictions are reported as a nominal value, a percentage, or an absolute value. As an example, an upper layer temperature prediction could be reported as 1112°F (600°C), 86°F (30°C) or 1112°F (600°C), 5 percent. In this case, the physical safety factor is 0.05 (that is, the amount by which the nominal value should be degraded and enhanced). Given the state-of-the-art of computer fire modeling, this is a very low safety factor. Physical safety factors tend to be on the order of tens of percent. A safety factor of 50 percent is not unheard of.

Part of the problem in establishing safety factors is that it is difficult to state the percentage or range that is appropriate. These values can be obtained when the computer model predictions are compared to test data. However, using computer fire models in a design mode does not facilitate this since (1) the room being analyzed has not been built yet and (2) test scenarios do not necessarily depict the intended design.

A sensitivity analysis should be performed based on the assumptions that affect the condition of interest. A base case that uses all nominal values for input parameters should be developed. The input parameters should be varied over reasonable ranges, and the variation in predicted output should be noted. This output variation can then become the basis for physical safety factors.

The temporal safety factor addresses the issue of when a condition is predicted and is a function of the rate at which processes are expected to occur. If a condition is predicted to occur 2 minutes after the start of the fire, then this can be used as a nominal value. A process similar to that described for physical safety factors can also be employed to develop temporal safety factors. In this case, however, the rates (for example, of heat release and toxic product generation) will be varied instead of absolute values (for example, material properties).

The margin of safety can be thought of as a reflection of societal values and can be imposed by the AHJ for that purpose. Since the time for which a condition is predicted is most likely the focus of the AHJ (for example, the model predicts occupants have 5 minutes to safely evacuate), the margin of safety is characterized by temporal aspects and tacitly applied to the physical margin of safety.

Escaping the harmful effects of fire (or mitigating them) is, effectively, a race against time. When assessing fire safety system designs based on computer model predictions, the choice of an acceptable time is important. When an AHJ is faced with the predicted time of untenability, a decision needs to be made regarding whether sufficient time is available to ensure the safety of facility occupants. The AHJ is assessing the margin of safety. Is there sufficient time to get everyone out safely? If the AHJ feels that the predicted egress time is too close to the time of untenability, then the AHJ can impose an additional time that the designer has to incorporate into the system design. In other words, the AHJ can impose a greater margin of safety than that originally proposed by the designer.

5.7 Documentation Requirements

5.7.1* General.

A.5.7.1 The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* describes the documentation that should be provided for a performance-based design.

Proper documentation of a performance design is critical to the design acceptance and construction. Proper documentation also ensures that all parties involved understand what is necessary for the design implementation, maintenance, and continuity of the fire protection design. If attention to details is maintained in the documentation, then there should be little dispute during approval, construction, start-up, and use.

Poor documentation could result in rejection of an otherwise good design, poor implementation of the design, inadequate system maintenance and reliability, and an incomplete record for future changes or for testing the design forensically.

5.7.1.1 All aspects of the design, including those described in 5.7.2 through 5.7.14, shall be documented.

5.7.1.2 The format and content of the documentation shall be acceptable to the AHJ.

5.7.2* Technical References and Resources.

A.5.7.2 The sources, methodologies, and data used in performance-based designs should be based on technical references that are widely accepted and used by the appropriate professions and professional groups. This acceptance is often based on documents that are developed, reviewed, and validated under one of the following processes:

(1) Standards developed under an open consensus process conducted by recognized professional societies, codes or standards organizations, or governmental bodies
(2) Technical references that are subject to a peer review process and published in widely recognized peer-reviewed journals, conference reports, or other publications
(3) Resource publications such as the *SFPE Handbook of Fire Protection Engineering*, which are widely recognized technical sources of information

The following factors are helpful in determining the acceptability of the individual method or source:

(1) Extent of general acceptance in the relevant professional community. Indications of this acceptance include peer-reviewed publication, widespread citation in the technical literature, and adoption by or within a consensus document.
(2) Extent of documentation of the method, including the analytical method itself, assumptions, scope, limitations, data sources, and data reduction methods.
(3) Extent of validation and analysis of uncertainties. This includes comparison of the overall method with experimental data to estimate error rates as well as analysis of the uncertainties of input data, uncertainties and limitations in the analytical method, and uncertainties in the associated performance criteria.
(4) Extent to which the method is based on sound scientific principles.
(5) Extent to which the proposed application is within the stated scope and limitations of the supporting information, including the range of applicability for which there is documented validation. Factors such as spatial dimensions, occupant characteristics, and ambient conditions can limit valid applications.

In many cases, a method is built from and includes numerous component analyses. These component analyses should be evaluated using the same factors that are applied to the overall method as outlined in items (1) through (5).

A method to address a specific fire safety issue, within documented limitations or validation regimes, might not exist. In such a case, sources and calculation methods can be used outside of their limitations, provided that the design team recognizes the limitations and addresses the resulting implications.

The technical references and methodologies to be used in a performance-based design should be closely evaluated by the design team and the AHJ, and possibly by a third-party reviewer. The strength of the technical justification should be judged using criteria in items (1) through (5). This justification can be strengthened by the presence of data obtained from fire testing.

5.7.2.1 The AHJ shall be provided with sufficient documentation to support the validity, accuracy, relevance, and precision of the proposed methods.

5.7.2.2 The engineering standards, calculation methods, and other forms of scientific information provided shall be appropriate for the particular application and methodologies used.

5.7.3 Facility Design Specifications. All details of the proposed facility design that affect the ability of the facility to meet the stated goals and objectives shall be documented.

5.7.4 Performance Criteria. Performance criteria, with sources, shall be documented.

5.7.5 Occupant Characteristics. Assumptions about occupant characteristics shall be documented.

5.7.6 Design Scenarios. Descriptions of design hazard scenarios shall be documented.

5.7.7 Input Data. Input data to models and assessment methods, including sensitivity analysis, shall be documented.

5.7.8 Output Data. Output data from models and assessment methods, including sensitivity analysis, shall be documented.

5.7.9 Safety Factors. Safety factors utilized shall be documented.

5.7.10 Prescriptive Requirements. Retained prescriptive requirements shall be documented.

5.7.11* Modeling Features.

A.5.7.11 Documentation for modeling should conform to ASTM E1472, *Standard Guide for Documenting Computer Software for Fire Models*, although most, if not all, models were originally developed before this standard was promulgated.

5.7.11.1 Assumptions made by the model user, and descriptions of models and methods used, including known limitations, shall be documented.

5.7.11.2 Documentation shall be provided that the assessment methods have been used validly and appropriately to address the design specifications, assumptions, and scenarios.

5.7.12 Evidence of Modeler Capability. The design team's relevant experience with the models, test methods, databases, and other assessment methods used in the performance-based design proposal shall be documented.

5.7.13 Performance Evaluation. The performance evaluation summary shall be documented.

5.7.14 Use of Performance-Based Design Option. Design proposals shall include documentation that provides anyone involved in ownership or management of the facility with all of the following notification:

(1) The facility was approved as a performance-based design with certain specified design criteria and assumptions.
(2) Any remodeling, modification, renovation, change in use, or change in the established assumptions requires a re-evaluation and re-approval.

References Cited in Commentary

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Classification of Occupancy

6

Chapter 6 addresses the following considerations needed for accurately determining which *Code* provisions apply to a specific building:

1. Classification of occupancy
2. Choice of treating multiple occupancies as either mixed occupancies or separated occupancies
3. Categorization of the relative hazard presented by the contents or use of the building

Proper classification of the occupancy is crucial. Since the *Code* is not a one-size-fits-all document, the selection of the proper occupancy is of paramount importance to ensure that the correct chapters and sections of the *Code* are used. The occupancy classification scheme uses general descriptions of each occupancy (e.g., assembly, educational, day-care, or health care). The annex text that accompanies each of the occupancy classifications provides lists of the most common building uses for each classification.

Occupancy classification of a building often encompasses more than one category. Multiple occupancy types commonly coexist within a single building. For example, a hotel often consists of a multiple occupancy that includes hotel, assembly, mercantile, and business occupancies. Paragraph 6.1.14.1.1 permits multiple occupancies to be treated as either mixed occupancies or separated occupancies. An office building with a newsstand and sundries shop located off the main lobby might be classified wholly as a business occupancy by considering the mercantile use as incidental to the predominant business use as permitted by 6.1.14.1.3(1), thus avoiding the provisions applicable to a multiple occupancy.

6.1 Classification of Occupancy

Each of the occupancy groupings addressed by Chapter 6 was initially developed for use in NFPA *101*®, *Life Safety Code*®, to reflect the design features, usage patterns, and unique life safety needs of occupants who are characteristic of a given occupancy. This approach was used to assess the degree to which the features contained in the core chapters of NFPA *101* need to be combined to achieve the minimum level of life safety necessary for an occupancy. Correct classification of the occupancy is extremely important, because the *Code* requirements differ for each type of occupancy. Improper classification might result in an inadequate level of life safety or overspending on nonrequired items. The occupancy groupings are as follows:

1. *Assembly*. Assembly occupancies generally contain large numbers of people who are unfamiliar with the space and are, therefore, subject to indecision regarding the best means of egress in an emergency.

2. *Educational*. Educational occupancies primarily include large numbers of young people found in school buildings.

3. *Day-care.* Day-care occupancies contain both young and adult clients who are under the supervision of adults other than their relatives or legal guardians. In cases where day-care occupancies cater to preschool-age children, the occupants might need to be carried out of the facility during evacuation.

4. *Health care.* Health care occupancies are characterized by occupants who are incapable of self-preservation and occupy the occupancy on an inpatient basis. (For occupancies that provide health care services on an outpatient basis, see the description that follows on ambulatory health care occupancies.) In a health care occupancy, the occupants may not be able to use exits, regardless of the number of exits provided. Occupants might be immobile, connected to monitoring equipment, debilitated, recovering from surgery, or disabled in some other way. The *Code,* in this instance, calls for a defend-in-place design strategy that uses horizontal movement and compartmentation. It recognizes that the occupants are to be provided enough protection to enable them to survive the fire by remaining in the structure, at least temporarily.

5. *Ambulatory health care.* Ambulatory health care occupancies are similar to health care occupancies in that the occupants are generally incapable of self-preservation, but, unlike health care occupancies, the patients receive medical care on an outpatient basis. In many cases, the treatment causes the patient to be incapable of self-preservation. In other cases, a procedure, such as administering general anesthesia that is needed in conjunction with a treatment, renders the patient incapable of self-preservation. In yet other cases, the patient arrives at the ambulatory health care facility incapable of self-preservation due to an injury or illness, as is common in an emergency or urgent care outpatient facility. The ambulatory health care occupancy operates on an outpatient basis, so no individual patient occupies the building for a period of 24 hours or more.

6. *Detention and correctional.* Detention and correctional occupancies, as in the case of health care occupancies, house occupants who are incapable of self-preservation. In a detention and correctional occupancy, however, the incapability for self-preservation is due to the security imposed on the occupants. Because doors are not unlocked to allow free egress to the public way, the defend-in-place design strategy is used.

7. *Residential.* Residential occupancies are characterized by occupants who are asleep for a portion of the time they occupy the building. The sleeping that takes place is for normal restorative rest, as opposed to the sleeping that takes place in a hospital or residential board and care facility where caretakers are present. Sleeping occupants might be unaware of an incipient fire and might be trapped before egress can occur, thus creating a need for early warning smoke alarms. This occupancy group is further divided into one- and two-family dwellings, lodging or rooming houses, hotels and dormitories, and apartment buildings. Each occupancy in the group has characteristic needs that differ from the others. For this reason, separate occupancy-specific provisions address each of these subgroups.

8. *Residential board and care.* Residential board and care occupancies, as in the case of residential occupancies, provide sleeping accommodations. However, the residents also receive personal care services by caretakers who live with the residents. Personal care includes assistance with many of the activities of daily living, such as bathing and dressing. Personal care does not include medical care.

9. *Mercantile.* Mercantile occupancies, as in the case of assembly occupancies, are characterized by large numbers of people who gather in a space that is relatively unfamiliar to them. In addition, mercantile occupancies often contain sizable quantities of combustible contents and use circuitous egress paths that are deliberately arranged to force occupants to travel around displays of materials that are available for sale.

10. *Business.* Business occupancies generally have a lower occupant density than mercantile occupancies, and the occupants are usually more familiar with their surroundings. However, confusing and indirect egress paths are often developed due to office layouts and the arrangement of tenant spaces. The *Code* requirements for such occupancies address the needs of visitors unfamiliar with the building.

11. *Industrial.* Industrial occupancies expose occupants to a wide range of processes and materials of varying hazard. Special-purpose industrial occupancies, which are characterized by large installations of equipment that dominate the space, are addressed separately from general-purpose industrial facilities, which have higher densities of human occupancy.

12. *Storage.* Storage occupancies are characterized by relatively low human occupancy in comparison with building size and by varied hazards associated with the materials stored.

6.1.1 General.

6.1.1.1 Occupancy Classification. The occupancy of a building or structure, or portion of a building or structure, shall be classified in accordance with 6.1.2 through 6.1.13. Occupancy classification shall be subject to the ruling of the AHJ where there is a question of proper classification in any individual case. [***101:***6.1.1.1]

Because the appropriate occupancy classification is not always easily determined, the *Code* assigns the authority having jurisdiction (AHJ) the responsibility of determining whether the designer, the owner's representative, or other applicable person has correctly classified the occupancy.

6.1.1.2 Special Structures. Occupancies in special structures shall conform to the requirements of Section 20.16. [***101:***6.1.1.2]

The provision of 6.1.1.2 clarifies that placing an occupancy in a special structure — such as a limited access, underground, water-surrounded, or high-rise building — does not create a unique occupancy. Rather, the occupancy is classified as one of those addressed by Chapters 12 through 42 of NFPA *101*. Chapter 11 is then consulted to identify any permitted leniencies or additional requirements that apply to the special structure.

6.1.2 Assembly.
For requirements, see Section 20.1. [***101:***6.1.2]

6.1.2.1* Definition — Assembly Occupancy. An occupancy (1) used for a gathering of 50 or more persons for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses; or (2) used as a special amusement building, regardless of occupant load. [***101:***6.1.2.1]

Δ **A.6.1.2.1 Assembly Occupancy.** Assembly occupancies might include the following:

(1) Armories
(2) Assembly halls
(3) Auditoriums
(4) Bowling lanes
(5) Club rooms
(6) College and university classrooms, 50 persons and over
(7) Conference rooms
(8) Courtrooms
(9) Dance halls
(10) Drinking establishments
(11) Exhibition halls
(12) Gymnasiums

(13) Libraries
(14) Mortuary chapels
(15) Motion picture theaters
(16) Museums
(17) Passenger stations and terminals of air, surface, underground, and marine public transportation facilities
(18) Places of religious worship
(19) Pool rooms
(20) Recreation piers
(21) Restaurants
(22) Skating rinks
(23) Special amusement buildings, regardless of occupant load
(24) Theaters

[***101:***A.6.1.2.1]

Assembly occupancies are characterized by the presence or potential presence of crowds with attendant panic hazard in case of fire or other emergency. They are generally or occasionally open to the public, and the occupants, who are present voluntarily, are not ordinarily subject to discipline or control. Such buildings are ordinarily not used for sleeping purposes. Special conference rooms, snack areas, and other areas incidental to, and under the control of, the management of other occupancies, such as offices, fall under the 50-person limitation. [***101:***A.6.1.2.1]

Restaurants and drinking establishments with an occupant load of fewer than 50 persons should be classified as mercantile occupancies. [***101:***A.6.1.2.1]

Occupancy of any room or space for assembly purposes by fewer than 50 persons in another occupancy, and incidental to such other occupancy, should be classified as part of the other occupancy and should be subject to the provisions applicable thereto. [***101:***A.6.1.2.1]

For special amusement buildings, see 12.4.7 and 13.4.7 of NFPA *101*. [***101:***A.6.1.2.1]

No *Code*-sanctioned occupancy is termed a *small assembly occupancy*. An occupancy used for the purposes of item (1) in 6.1.2.1 either is or is not an assembly occupancy, based on the 50-person criterion, with an exception for special amusement buildings, as addressed in item (2) of 6.1.2.1. As the fourth paragraph of A.6.1.2.1 advises, small assembly uses, which have an occupant load of fewer than 50 people, are considered part of the predominant occupancy [see 6.1.14.1.3(2)]. Except for special amusement buildings, as addressed in item (2) of 6.1.2.1, occupancies with occupant loads of fewer than 50 persons are not considered assembly occupancies. Exhibit 6.1 depicts an assembly occupancy.

6.1.2.2 Other. (Reserved)

6.1.3 Educational. For requirements, see Section 20.2. [***101:***6.1.3]

6.1.3.1* Definition — Educational Occupancy. An occupancy used for educational purposes through the twelfth grade by six or more persons for 4 or more hours per day or more than 12 hours per week. [***101:***6.1.3.1]

Exhibit 6.1

An assembly occupancy. (© Álvaro Germán Vilela, Dreamstime.com)

A.6.1.3.1 Educational Occupancy. Educational occupancies include the following:

(1) Academies
(2) Kindergartens
(3) Schools

[***101:***A.6.1.3.1]

An educational occupancy is distinguished from an assembly occupancy in that the same occupants are regularly present. [***101:***A.6.1.3.1]

6.1.3.2 Other Occupancies. Other occupancies associated with educational institutions shall be in accordance with the appropriate parts of this *Code* and NFPA *101*. [***101:***6.1.3.2]

6.1.3.3 Incidental Instruction. In cases where instruction is incidental to some other occupancy, the section of this *Code* and NFPA *101* governing such other occupancy shall apply. [***101:***6.1.3.3]

Exhibit 6.2 depicts an educational occupancy.

An elementary school classroom used for the requisite hours detailed in 6.1.3.1, with an occupant load of 50 or more,

Exhibit 6.2

An educational occupancy. (© Cynthia Farmer, Dreamstime.com) is classified as an educational occupancy, not an assembly occupancy. The assembly occupancy criteria of 6.1.2.1 involve not just the minimum 50-person criterion but also the use criterion of gathering for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar use. See 14.2.5.4 and 15.2.5.4 of NFPA *101*, which require a second exit access door from any educational occupancy room with an occupant load of more than 50 persons.

Educational occupancies are limited to facilities used for educational purposes through the twelfth grade. A college classroom does not meet this criterion and is classified as a business occupancy or, where the college classroom has an occupant load of 50 or more, as an assembly occupancy.

Incidental instruction, as addressed in 6.1.3.3, conducted in some other occupancy is permitted to be considered part of that other occupancy and is subject to the provisions applicable to such other occupancy. For example, a developer of learning software might have a test lab where students, under the direction of teaching specialists, test the effectiveness of such software. The laboratory experience does not substitute for the students' normal schooling. The instruction is incidental to the building functioning as a business occupancy. The occupancy is classified as a business occupancy and is subject to the provisions of Section 20.13 of this *Code* and Chapter 38 or Chapter 39 of NFPA *101*.

6.1.4 Day Care. For requirements, see Section 20.3. [***101***:6.1.4]

6.1.4.1* Definition — Day-Care Occupancy. An occupancy in which four or more clients receive care, maintenance, and supervision, by other than their relatives or legal guardians, for less than 24 hours per day. [***101***:6.1.4.1]

A.6.1.4.1 Day-Care Occupancy. Day-care occupancies include the following:

(1) Adult day-care occupancies, except where part of a health care occupancy
(2) Child day-care occupancies
(3) Day-care homes
(4) Kindergarten classes that are incidental to a child day-care occupancy
(5) Nursery schools

[***101***:A.6.1.4.1]

In areas where public schools offer only half-day kindergarten programs, many child day-care occupancies offer state-approved kindergarten classes for children who need full-day care. Because these classes are normally incidental to the day-care occupancy, the requirements of the day-care occupancy should be followed. [***101***:A.6.1.4.1]

Exhibit 6.3 depicts a day-care occupancy.

Day-care occupancies have some similarities with educational occupancies. However, in lieu of educational activity involving classroom occupants and teachers, the activities involve clients and staff, with staff serving as caretakers. The clients of a day-care occupancy might be adults. It has become fairly common practice for elderly adults to attend a day-care facility.

Exhibit 6.3

A day-care occupancy. (© Designpicssub, Dreamstime.com)

The provision of 6.1.14.1.3(2) permits a nonresidential use with an occupant load lower than the threshold established by Section 6.1 for a given occupancy to be considered part of the predominant occupancy where such nonresidential use is incidental to the predominant occupancy. Consider a day-care center for 10 clients where such center occupies less than 1000 ft² (93 m²) in a 100,000 ft² (9300 m²) office building. The day-care center is a nonresidential use. The occupancy threshold for day-care occupancy classification is four or more clients per 6.1.4.1. The day-care center occupies less than 1 percent of the building area, but it cannot be considered incidental to the business use. Per 6.1.4.1 and 6.1.14.1.3(2), it must be classified as a day-care occupancy. Thus, the building is classified as a multiple occupancy comprising both a business occupancy and a day-care occupancy. The building must meet the provisions of 6.1.14, including protection as either separated occupancies or mixed occupancies. In other words, the provisions for day-care occupancies must be applied, even though the day-care center is small in comparison to the remainder of the building. Otherwise, the day-care clients would not be adequately protected.

6.1.4.2 Other. (Reserved)

6.1.5 Health Care. For requirements, see Section 20.4. [***101***:6.1.5]

6.1.5.1* Definition — Health Care Occupancy. An occupancy used to provide medical or other treatment or care simultaneously to four or more patients on an inpatient basis, where such patients are mostly incapable of self-preservation due to age, physical or mental disability, or because of security measures not under the occupants' control. [***101***:6.1.5.1]

A.6.1.5.1 Health Care Occupancy. Health care occupancies include the following:

(1) Hospitals
(2) Limited care facilities
(3) Nursing homes
[*101:*A.6.1.5.1]

Occupants of health care occupancies typically have physical or mental illness, disease, or infirmity. They also include infants, convalescents, or infirm aged persons. [*101:*A.6.1.5.1]

Exhibit 6.4 depicts a health care occupancy.

Section 20.4 of this *Code* and Chapters 18 and 19 of NFPA *101* address hospitals, nursing homes, and limited care facilities as health care occupancies. These subclassifications of health care occupancies are defined in 3.3.192.13, 3.3.192.24, and 3.3.192.11, respectively. The definitions specify that each type of facility accommodate four or more persons. Because 24.1.1.2 of NFPA *101* permits a living unit housing a family and up to three outsiders to be classified as a one-family dwelling, a home with three or fewer persons incapable of self-preservation does not constitute a health care occupancy.

The definition of the term *health care occupancy* in 6.1.5.1 clarifies that it applies to patient care on an inpatient basis. In editions prior to 2009, the *Code* user learned this clarification by inference after reading the definition of the term *ambulatory health care occupancy,* which clearly stipulates the outpatient criterion. See 18.1.1.1.5, 18.1.1.1.9, 19.1.1.1.5, and 19.1.1.1.9 of NFPA *101* for criteria related to providing sleeping accommodations for more than 24 hours (i.e., the inpatient criterion). Health care occupancies, if they are to be protected by the provisions of Chapter 18 or Chapter 19 of NFPA *101*, must have at least four inpatients. A health care facility used only for outpatients is addressed by 6.1.6.1 as an ambulatory health care occupancy and is subject to the provisions of Section 20.6 of this *Code* and to those of Chapter 20 or Chapter 21 of NFPA *101*.

A definition of the term *birth center* appears in 3.3.34 of NFPA *101*. Also, guidance for whether a birth center is to be classified as a business occupancy or as a health care occupancy is provided in the third paragraph of A.6.1.11.1.

6.1.5.2 Other. (Reserved)

6.1.6 Ambulatory Health Care. For requirements, see Section 20.6. [*101:*6.1.6]

Δ **6.1.6.1* Definition — Ambulatory Health Care Occupancy.** An occupancy used to provide services or treatment simultaneously to four or more patients that provides, on an outpatient basis, one or more of the following:

(1) Treatment for patients that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others
(2) Anesthesia that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others
(3) Emergency or urgent care for patients who, due to the nature of their injury or illness, are incapable of taking action for self-preservation under emergency conditions without the assistance of others

[*101:*6.1.6.1]

A.6.1.6.1 Ambulatory Health Care Occupancy. It is not the intent that occupants be considered to be incapable of self-preservation just because they are in a wheelchair or use assistive walking devices, such as a cane, a walker, or crutches. Rather, it is the intent to address emergency care centers that receive patients who have been rendered incapable of self-preservation due to the emergency, such as being rendered unconscious as a result of an accident or being unable to move due to sudden illness. [*101:*A.6.1.6.1]

Exhibit 6.5 depicts an ambulatory health care occupancy.

Note that the definition of the term *ambulatory health care occupancy* in 6.1.6.1 stipulates an outpatient criterion and that

Exhibit 6.4

A health care occupancy. (© Paul Brennan, Dreamstime.com)

Exhibit 6.5

An ambulatory health care occupancy. (© Mark Winfrey, Dreamstime .com) the definition of the term *health care occupancy* in 6.1.5.1 stipulates an inpatient criterion. A health care facility used only for outpatients is addressed by 6.1.6.1 as an ambulatory health care occupancy and is subject to the provisions of Section 20.6 of this *Code* and to those of Chapter 20 or Chapter 21 of NFPA *101*. Health care occupancies, if they are to be protected by the provisions of Section 20.4 of this *Code* and by Chapter 18 or Chapter 19 of NFPA *101*, must have at least four inpatients. See 18.1.1.1.5, 18.1.1.1.9, 19.1.1.1.5, and 19.1.1.1.9 of NFPA *101* for criteria related to providing sleeping accommodations for more than 24 hours (i.e., the inpatient criterion).

Section 20.6 of this *Code* and Chapters 20 and 21 of NFPA *101* address the outpatient form of a health care occupancy. The requirements draw heavily from those applicable to business occupancies but supplement them with special provisions that address the fact that some patients in such occupancies are incapable of self-preservation. As is the case with other health care occupancies, the facility must accommodate at least four persons. The provisions of 6.1.6.1(1) through (3) further define the treatment, care, and initial condition of the patient that can render the patient incapable of self-preservation.

Dialysis treatment centers that accommodate four or more patients at one time generally fall under the classification of ambulatory health care occupancy based on 6.1.6.1(1). The blood-filtering treatment often wreaks havoc with the patients' blood pressure. Even if the patients are provided with instructions on how to clamp and cut their blood-filtering tubing, there is no guarantee that they have the capability of immediately evacuating the facility without the assistance of others.

Day surgery centers that accommodate four or more patients at one time generally fall under the classification of ambulatory health care occupancy based on 6.1.6.1(2). The anesthesia used prevents the patients from taking action for self-preservation under emergency conditions without the assistance of others.

Urgent-care centers that accommodate four or more patients at one time generally fall under the classification of ambulatory health care occupancy based on 6.1.6.1(3). The nature of the injury, illness, or condition present when the patients arrive for treatment prevents the patients from taking action for self-preservation under emergency conditions without the assistance of others.

The four-person criterion of 6.1.6.1 is meant to be applied independently on an area-by-area basis within a building. For example, a common practice is for individual health care practitioners to rent their own tenant space within a multi-tenant office building. Assume three dentists, each specializing in tooth extraction where the patients are under general anesthesia, have their own tenant spaces. Each of the three dentists does not have more than two patients under anesthesia or recovering from the effects of anesthesia at any time. Although, collectively, the three dentists might have six patients simultaneously rendered incapable of self-preservation due to anesthesia, the four-person criterion is not satisfied within any tenant space considered independently. Each dentist's office would be considered a business occupancy and not an ambulatory health care occupancy.

6.1.6.2 Other. (Reserved)

6.1.7 Detention and Correctional. For requirements, see Section 20.7. [***101:***6.1.7]

6.1.7.1* Definition — Detention and Correctional Occupancy. An occupancy used to house one or more persons under varied degrees of restraint or security where such occupants are mostly incapable of self-preservation because of security measures not under the occupants' control. [***101:***6.1.7.1]

A.6.1.7.1 Detention and Correctional Occupancy. Detention and correctional occupancies include the following:

(1) Adult and juvenile substance abuse centers
(2) Adult and juvenile work camps
(3) Adult community residential centers
(4) Adult correctional institutions
(5) Adult local detention facilities
(6) Juvenile community residential centers
(7) Juvenile detention facilities
(8) Juvenile training schools

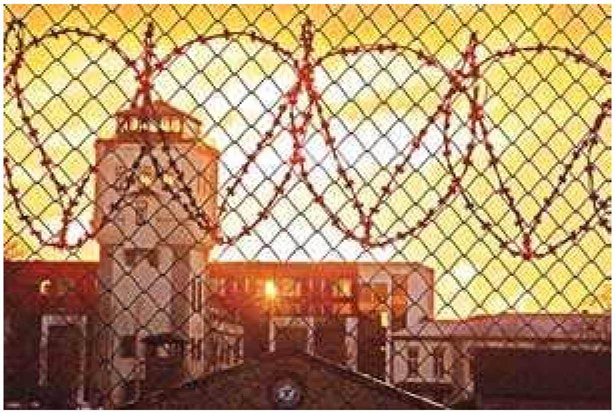
[***101:***A.6.1.7.1]

See A.22.1.1.1.6 and A.23.1.1.1.6 of NFPA *101*. [***101:***A.6.1.7.1]

Exhibit 6.6 depicts a detention and correctional occupancy.

The definition of the term *detention and correctional occupancy* (see 6.1.7.1) applies at the threshold of one or more persons. In editions prior to 2006, the threshold was four or more persons. This criterion for one person correlates with the provisions for lockups in other than detention and correctional occupancies, as addressed in 22.4.5 and 23.4.5 of NFPA *101*, which were added to that *Code* in 2006. The provisions for lockups are needed for application, even when only one

Exhibit 6.6



A detention and correctional occupancy. (© Maigi, Dreamstime.com) person is detained, because the locked doors characteristic of such detention deny the occupant free egress as required by 7.2.1.5 of NFPA *101*. A lockup in an occupancy other than detention and correctional that detains any individual for more than 24 hours is required to be classified as a detention and correctional occupancy (see 22.4.5.1.2 and 23.4.5.1.2 of NFPA *101*) and is subject to the provisions of Section 20.7 of this *Code* and to Chapter 22 or Chapter 23 of NFPA *101*. Thus, the provisions of Section 20.7 of this *Code* and of Chapters 22 and 23 of NFPA *101* needed to be made applicable to one or more residents.

Section 20.7 of this *Code* and Chapters 22 and 23 of NFPA *101* are intended to apply only to those areas of detention and correctional facilities used for occupant housing, such as sleeping and day activity areas. Other occupied spaces within the facility are to receive an occupancy classification representative of their use and are to be regulated by the applicable provisions of Chapter 20 of this *Code* and Chapters 12 through 21 and Chapters 24 through 42 of NFPA *101*. For example, cafeterias are regulated using the assembly occupancy chapters, and metal shops follow the requirements of the industrial occupancy chapter. The AHJ usually modifies the occupancy requirements of those chapters due to special security needs.

6.1.7.2* Nonresidential Uses. Within detention and correctional facilities, uses other than residential housing shall be in accordance with the appropriate chapter of this *Code* and NFPA *101*. *(See 22.1.2.3 and 23.1.2.3 of* NFPA *101.)* [***101:***6.1.7.2]

A.6.1.7.2 Chapters 22 and 23 of NFPA *101* address the residential housing areas of the detention and correctional occupancy as defined in 3.3.178.5 of NFPA *101*. Examples of uses, other than residential housing, include gymnasiums or industries. [***101:***A.6.1.7.2]

6.1.8 Residential. For requirements, see Sections 20.5 and 20.8 through 20.11. [***101:***6.1.8]

6.1.8.1 Definition — Residential Occupancy. An occupancy that provides sleeping accommodations for purposes other than health care or detention and correctional. [***101:***6.1.8.1]

6.1.8.1.1* Definition — One- and Two-Family Dwelling Unit. A building that contains not more than two dwelling units, each dwelling unit occupied by members of a single family with not more than three outsiders, if any, accommodated in rented rooms. [***101:***6.1.8.1.1]

A.6.1.8.1.1 One- and Two-Family Dwelling Unit. The application statement of 24.1.1.1 of NFPA *101* limits each dwelling unit to being "occupied by members of a single family with not more than three outsiders." This *Code* and NFPA *101* do not define the term *family*. The definition of family is subject to federal, state, and local regulations and might not be restricted to a person or a couple (two people) and their children. The following examples aid in differentiating between a single-family dwelling and a lodging or rooming house:

(1) An individual or a couple (two people) who rent a house from a landlord and then sublease space for up to three individuals should be considered a family renting to a maximum of three outsiders, and the house should be regulated as a single-family dwelling in accordance with Chapter 24 of NFPA *101*.
(2) A house rented from a landlord by an individual or a couple (two people) in which space is subleased to four or more individuals, but not more than 16, should be considered and regulated as a lodging or rooming house in accordance with Chapter 26 of NFPA *101*.
(3) A residential building that is occupied by four or more individuals, but not more than 16, each renting from a landlord, without separate cooking facilities, should be considered and regulated as a lodging or rooming house in accordance with Chapter 26 of NFPA *101*.

[***101:***A.6.1.8.1.1]

Exhibit 6.7 depicts a one-family dwelling unit. The definition of the term *one- and two-family dwelling unit* was revised in 6.1.8.1.1 for the 2018 edition of the *Code* to correlate with application of Chapter 24 (see 24.1.1.2) of NFPA *101*.

Exhibit 6.7

A one-family dwelling unit. (© Ligonography, Dreamstime.com)

6.1.8.1.2 Definition — Lodging or Rooming House. A building or portion thereof that does not qualify as a one- or two-family dwelling, that provides sleeping accommodations for a total of 16 or fewer people on a transient or permanent basis, without personal care services, with or without meals, but without separate cooking facilities for individual occupants. [***101:***6.1.8.1.2]

Exhibit 6.8 depicts a lodging or rooming house.

6.1.8.1.3* Definition — Hotel. A building or groups of buildings under the same management in which there are sleeping accommodations for more than 16 persons and primarily used by transients for lodging with or without meals. [***101:***6.1.8.1.3]

Exhibit 6.8

A lodging or rooming house. (© Margiew, Dreamstime.com)

A.6.1.8.1.3 Hotel. So-called apartment hotels should be classified as hotels, because they are potentially subject to the same transient occupancy as hotels. Transients are those who occupy accommodations for less than 30 days. [***101:***A.6.1.8.1.3]

Exhibit 6.9 depicts a hotel.

6.1.8.1.4* Definition — Dormitory. A building or a space in a building in which group sleeping accommodations are provided for more than 16 persons who are not members of the same family in one room, or a series of closely associated rooms, under joint occupancy and single management, with or without meals, but without individual cooking facilities. [***101:***6.1.8.1.4]

Exhibit 6.9

A hotel. (© Arbaes, Dreamstime.com)

A.6.1.8.1.4 Dormitory. Rooms within dormitories intended for the use of individuals for combined living and sleeping purposes are guest rooms or guest suites. Examples of dormitories include college dormitories, fraternity and sorority houses, and military barracks. [***101:***A.6.1.8.1.4]

Exhibit 6.10 depicts a dormitory.

Exhibit 6.10

A dormitory. (© Arim44, Dreamstime.com)

6.1.8.1.5 Definition — Apartment Building. A building or portion thereof containing three or more dwelling units with independent cooking and bathroom facilities. [***101:***6.1.8.1.5]

Exhibit 6.11 depicts an apartment building.

Residential occupancies are characterized by occupants who are asleep for a portion of the time they occupy the building. The sleeping that takes place is for normal restorative rest, as opposed to the sleeping that takes place in a hospital or residential board and care facility, where caretakers are present. Sleeping occupants might be unaware of an incipient fire and might be trapped before egress can occur. This occupancy group is further divided into one- and two-family dwellings, lodging or rooming houses, hotels and dormitories, and apartment buildings. Each occupancy in the group has characteristic needs that differ from the others. For this reason, separate chapters of the *Code* address each of these subgroups or subclassifications.

The residential occupancy subclassifications of one- and two-family dwellings, lodging or rooming houses, hotels, dormitories, and apartment buildings are defined in 6.1.8.1.1 through 6.1.8.1.5.

The definition of *apartment building* in 6.1.8.1.5 is copied from that in 3.3.192.2, which has advisory text in A.3.3.192.2. The text of A.3.3.192.2 clarifies that town house–type apartments — particularly those under condominium ownership — are to be

Exhibit 6.11

An apartment building. (© Tupungato, Dreamstime.com)

classified as apartment buildings. It is sometimes mistakenly believed that condominiums are a form of occupancy rather than a form of ownership.

Although people sleep in health care occupancies and detention and correctional occupancies, they occupy such facilities for other than normal residential purposes. Because the occupants of those facilities are incapable of self-preservation — in one case due to illness or infirmity and in the other as a result of security measures — the provisions that apply to normal residential occupancies might not provide the necessary level of life safety. The user is referred to Section 20.4 of this *Code* and Chapters 18 and 19 of NFPA *101* for inpatient health care occupancies and Section 20.7 of this *Code* and Chapters 22 and 23 of NFPA *101* for detention and correctional occupancies. See also 6.1.5 and 6.1.7.

6.1.8.2 Other. (Reserved)

6.1.9 Residential Board and Care. For requirements, see Section 20.5. [***101:***6.1.9]

6.1.9.1* Definition — Residential Board and Care Occupancy. An occupancy used for lodging and boarding of four or more residents, not related by blood or marriage to the owners or operators, for the purpose of providing personal care services. [***101:***6.1.9.1]

A.6.1.9.1 Residential Board and Care Occupancy. The following are examples of facilities classified as residential board and care occupancies:

(1) Group housing arrangement for physically or mentally handicapped persons who normally attend school in the community, attend worship in the community, or otherwise use community facilities
(2) Group housing arrangement for physically or mentally handicapped persons who are undergoing training in preparation for independent living, for paid employment, or for other normal community activities
(3) Group housing arrangement for the elderly that provides personal care services but that does not provide nursing care
(4) Facilities for social rehabilitation, alcoholism, drug abuse, or mental health problems that contain a group housing arrangement and that provide personal care services but do not provide acute care
(5) Assisted living facilities
(6) Other group housing arrangements that provide personal care services but not nursing care

[***101:***A.6.1.9.1]

Exhibit 6.12 depicts a residential board and care occupancy.

Residential board and care occupancies, as in the case of residential occupancies, provide sleeping accommodations. However, the residents also receive personal care services by caretakers who live with the residents. Personal care includes assistance with many of the activities of daily living, such as bathing and dressing. Personal care does not include medical care.

The provision of personal care services to residents of residential board and care facilities is an indicator that the residents might have special needs. The requirements of Chapters 32 and 33 of NFPA *101* credit the combined abilities of staff and residents to evacuate the building or relocate to a point of safety.

6.1.9.2 Other. (Reserved)

6.1.10 Mercantile. For requirements, see Section 20.12. [***101:***6.1.10]

Exhibit 6.12

A residential board and care occupancy. (© Jennifer Walz, Dreamstime .com)

6.1.10.1* Definition — Mercantile Occupancy. An occupancy used for the display and sale of merchandise. [***101:***6.1.10.1]

A.6.1.10.1 Mercantile Occupancy. Mercantile occupancies include the following:

(1) Auction rooms
(2) Department stores
(3) Drugstores
(4) Restaurants with fewer than 50 persons
(5) Shopping centers
(6) Supermarkets
[***101:***A.6.1.10.1]

Office, storage, and service facilities incidental to the sale of merchandise and located in the same building should be considered part of the mercantile occupancy classification. [***101:***A.6.1.10.1]

Exhibit 6.13 depicts a mercantile occupancy.

Mercantile occupancies, as in the case of assembly occupancies, are characterized by large numbers of people who gather in a space that is relatively unfamiliar to them. In addition, mercantile occupancies often contain sizable quantities of combustible contents and use circuitous egress paths that are deliberately arranged to force occupants to travel around displays of materials that are available for sale.

Mall buildings, while predominantly occupied by mercantile occupancies, typically have assembly occupancies within them (e.g., food courts or cinemas), classifying the mall building as a multiple occupancy building. In 12.1.3.3 and 13.1.3.3 of NFPA *101*, applicable to new and existing assembly occupancies, respectively, the provisions are made applicable to the assembly occupancy tenant space, but the specialized mall criteria of 36.4.4 and 37.4.4 of NFPA *101* are made applicable to the space outside the assembly occupancy tenant space, because that space might be used for egress by the occupants of the assembly occupancy.

Bulk merchandising retail buildings, which characteristically consist of a warehouse-type building occupied for sales purposes, are a subclass of mercantile occupancy with a greater potential for hazards than more traditional mercantile operations. See also Section 20.12 of this *Code* and 36.4.5 and 37.4.5 of NFPA *101*.

Exhibit 6.13

A mercantile occupancy. (© Michael Ludwig, Dreamstime.com)

6.1.10.2 Other. (Reserved)

6.1.11 Business. For requirements, see Section 20.13. [***101:***6.1.11]

6.1.11.1* Definition — Business Occupancy. An occupancy used for the transaction of business other than mercantile. [***101:***6.1.11.1]

A.6.1.11.1 Business Occupancy. Business occupancies include the following:

(1) Airport traffic control towers (ATCTs)
(2) City halls
(3) College and university instructional buildings, classrooms under 50 persons, and instructional laboratories
(4) Courthouses
(5) Dentists' offices
(6) Doctors' offices
(7) General offices
(8) Outpatient clinics (ambulatory)
(9) Town halls [***101:***A.6.1.11.1]

Doctors' and dentists' offices are included, unless of such character as to be classified as ambulatory health care occupancies. *(See 3.3.188.1 of NFPA 101.)* [***101:***A.6.1.11.1]

Birth centers should be classified as business occupancies if they are occupied by fewer than four patients, not including infants, at any one time; do not provide sleeping facilities for four or more occupants; and do not provide treatment procedures that render four or more patients, not including infants, incapable of self-preservation at any one time. For birth centers occupied by patients not meeting these parameters, see Chapter 18 or Chapter 19 of NFPA *101*, as appropriate. [***101:***A.6.1.11.1]

Service facilities common to city office buildings, such as newsstands, lunch counters serving fewer than 50 persons, barber shops, and beauty parlors are included in the business occupancy group. [***101:***A.6.1.11.1]

City halls, town halls, and courthouses are included in this occupancy group, insofar as their principal function is the transaction of public business and the keeping of books and records. Insofar as they are used for assembly purposes, they are classified as assembly occupancies. [***101:***A.6.1.11.1]

Exhibit 6.14 depicts a business occupancy.

Business occupancies generally have a lower occupant density than mercantile occupancies, and the occupants are usually more familiar with their surroundings. However, confusing and indirect egress paths often exist due to office layouts and the arrangement of tenant spaces. The *Code* requirements for such occupancies address the needs of visitors unfamiliar with the building.

Depending on the characteristics of a laboratory, it may be classified as a business occupancy, industrial occupancy, or other occupancy.

Paragraph A.6.1.11.1 provides guidance in classifying a birth center as a business occupancy or a health care occupancy. The definition of the term *birth center* appears in 3.3.34 of NFPA *101*, along with explanatory material in A.3.3.34 of NFPA *101*.

A medical office that provides treatment or performs procedures that render patients incapable of self-preservation might be classified as an ambulatory health care occupancy or as a business occupancy. Guidance on the subject appears in the commentary that follows A.6.1.6.1.

6.1.11.2 Other. (Reserved)

6.1.12 Industrial. For requirements, see Section 20.14. [***101:***6.1.12]

6.1.12.1* Definition — Industrial Occupancy. An occupancy in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, or repair operations are conducted. [***101:***6.1.12.1]

A.6.1.12.1 Industrial Occupancy. Industrial occupancies include the following:

(1) Drycleaning plants
(2) Factories of all kinds
(3) Food processing plants
(4) Gas plants
(5) Hangars (for servicing/maintenance)
(6) Laundries
(7) Power plants
(8) Pumping stations
(9) Refineries
(10) Sawmills
(11) Telephone exchanges

[***101:***A.6.1.12.1]

In evaluating the appropriate classification of laboratories, the AHJ should treat each case individually, based on the extent and nature of the associated hazards. Some laboratories are classified as occupancies other than industrial; for example, a physical therapy laboratory or a computer laboratory. [***101:***A.6.1.12.1]

Exhibit 6.15 depicts an industrial occupancy.

Industrial occupancies expose occupants to a wide range of processes and materials of varying hazards. Special-purpose industrial occupancies, which are characterized by large installations of equipment that dominate the space, are addressed separately from general-purpose industrial facilities, which have higher densities of human occupancy.

Industrial occupancy buildings, along with storage occupancy buildings, are more likely than any other occupancy to have contents with a wide range of hazards. Where industrial operations in a special-purpose industrial occupancy or general-purpose industrial occupancy include high hazard materials, processes, or contents (see 6.2.2.4 of NFPA *101*), the occupancy is to be classified as a high hazard industrial occupancy and not as a special-purpose or general-purpose industrial occupancy.

Depending on the characteristics of a laboratory, it may be classified as a business occupancy, industrial occupancy, or other occupancy.

6.1.12.2 Other. (Reserved)

6.1.13 Storage. For requirements, see Section 20.15. [***101:***6.1.13]

6.1.13.1* Definition — Storage Occupancy. An occupancy used primarily for the storage or sheltering of goods, merchandise, products, or vehicles. [***101:***6.1.13.1]

Exhibit 6.14

A business occupancy. (© Brianguest, Dreamstime.com)

Exhibit 6.15

An industrial occupancy. (© Typhoonski, Dreamstime.com)

A.6.1.13.1 Storage Occupancy. Storage occupancies include the following:

(1) Barns
(2) Bulk oil storage
(3) Cold storage
(4) Freight terminals
(5) Grain elevators
(6) Hangars (for storage only)
(7) Parking structures
(8) Truck and marine terminals
(9) Warehouses
[***101:***A.6.1.13.1]

Storage occupancies are characterized by the presence of relatively small numbers of persons in proportion to the area. [***101:***A.6.1.13.1]

Exhibit 6.16 depicts a storage occupancy.

Storage occupancies are characterized by relatively low human occupancy in comparison to building size and by varied hazards associated with the materials stored.

Storage occupancy buildings, along with industrial occupancy buildings, are more likely than any other type of occupancy to have contents with a wide range of hazards.

Bulk merchandising retail buildings, which characteristically consist of a warehouse-type building occupied for sales purposes, are a subclass of mercantile occupancy rather than a storage occupancy. See 36.4.5 and 37.4.5 of NFPA *101*.

In *Code* editions prior to 2009, the sheltering of animals was one of the examples of a storage occupancy. The phrase *sheltering of animals* was deleted, because not all facilities housing animals are storage occupancies. See NFPA 150, *Standard on Fire and Life Safety in Animal Housing Facilities.*

Exhibit 6.16

A storage occupancy. (© Pemmett, Dreamstime.com)

6.1.13.2 Other. (Reserved)

6.1.14 Multiple Occupancies.

6.1.14.1 General.

Δ **6.1.14.1.1** Multiple occupancies shall comply with the requirements of 6.1.14.1 and one of the following:

(1) Mixed occupancies — 6.1.14.3
(2) Separated occupancies — 6.1.14.4
[***101:***6.1.14.1.1]

Classifying a building simply as a multiple occupancy is an incomplete classification, since the options for occupancy classification are limited to assembly, educational, day-care, health care, ambulatory health care, detention and correctional, residential (one- and two-family dwellings, lodging or rooming houses, hotels and dormitories, or apartment buildings), residential board and care, mercantile, business, industrial, and storage. Rather, a classification of multiple occupancy needs to include mention of the occupancy types involved. For example, a multiple occupancy building with spaces used for sales and spaces used for storage should be classified as a multiple occupancy that is part mercantile occupancy and part storage occupancy.

Once a building is classified as a multiple occupancy and the occupancy types present are identified, the provisions of 6.1.14.1.1 are applied. Paragraph 6.1.14.1.1 offers the option of protecting multiple occupancies via the mixed occupancies requirements of 6.1.14.3 or via the separated occupancies requirements of 6.1.14.4.

If the mixed occupancies option of 6.1.14.3 is chosen for the protection of the multiple occupancy, the *Code* provisions for all occupancy types present must be compared. For each subject area addressed, the most stringent requirement from the applicable occupancy chapters must be identified and followed. Consider, for example, a new multiple occupancy building that is part ordinary hazard mercantile occupancy and part ordinary hazard storage occupancy for which the mixed occupancies form of protection is to be provided. In comparing the requirements of Chapter 36 for new mercantile occupancies and Chapter 42 for ordinary hazard storage occupancies in NFPA *101*, it becomes evident that neither occupancy is consistently stricter than the other on all features and systems addressed by the occupancy chapter. For example, both occupancies are permitted to use sensor-release of electrical locking systems in accordance with 14.5.3.2, but mercantile occupancies are permitted to do so only if the entire building is protected throughout by either a fire detection system or a sprinkler system (see 36.2.2.2.6 and 42.2.2.2.3 of NFPA *101*). Mercantile occupancies are permitted to use horizontal or vertical security grilles or doors in accordance with 7.2.1.4.1(3) of NFPA *101* as part of the means of egress from a tenant space (see 36.2.2.2.7 of NFPA *101*), but no such permission is given for storage occupancies in 42.2.2.2 of NFPA *101*. In each case, the more stringent provision must be followed in the multiple occupancy being protected as a mixed occupancy.

If the separated occupancies option of 6.1.14.4 is chosen for the protection of the multiple occupancy, the *Code* user must identify the appropriate cell or cells of Table 6.1.14.4.1(a) or Table 6.1.14.4.1(b) to determine the minimum hourly fire resistance rating needed for the barriers separating the occupancies from each other.

6.1.14.1.2 Where exit access from an occupancy traverses another occupancy, the multiple occupancy shall be treated as a mixed occupancy. [***101:***6.1.14.1.2]

Paragraph 6.1.14.1.2 was new to the 2006 edition of the *Code*. It was added to clarify the original intent, which was not fully explained when the provisions for multiple occupancies were added to the 2003 edition. Users incorrectly believed they could satisfy the provisions for multiple occupancies protected as separated occupancies by complying with the following two-step approach:

1. Separate the multiple occupancies from each other by the fire resistance–rated construction required by Table 6.1.14.4.1(a) or Table 6.1.14.4.1(b).
2. Provide egress paths from one of the occupancies to involve travel through doors in the separating construction into the other occupancy (meaning that the two occupancies would share exit access, e.g., in a common corridor). See Exhibit 6.17.

The shared exit access corridor system does not permit the multiple occupancy to be protected as separated occupancies. Instead, the multiple occupancy must be protected as mixed occupancies.

In Exhibit 6.18, the two required means of egress for the business occupancy are provided by two remotely located doors opening directly to the outside. The door openings to the corridor, located in the fire resistance–rated occupancy separation barrier, are convenient extras not required by the *Code*. With this arrangement, the multiple occupancy is permitted to be protected as separated occupancies.

Δ **6.1.14.1.3*** Where incidental to another occupancy, areas used as follows shall be permitted to be considered part of the predominant occupancy and shall be subject to the provisions of this *Code* and NFPA *101* that apply to the predominant occupancy:

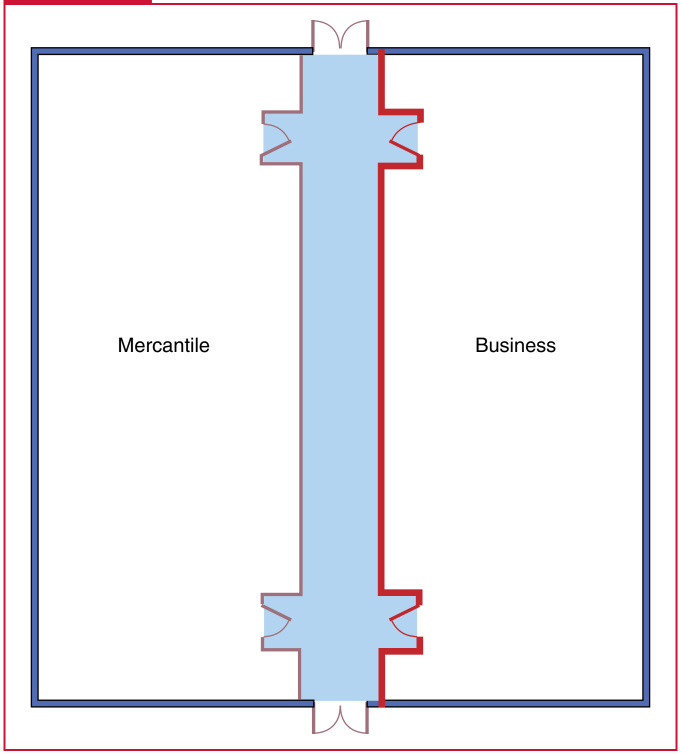
(1) Mercantile, business, industrial, or storage use
(2)* Nonresidential use with an occupant load fewer than that established by Section 6.1 for the occupancy threshold

[***101:***6.1.14.1.3]

A.6.1.14.1.3 Examples of uses that might be incidental to another occupancy include the following:

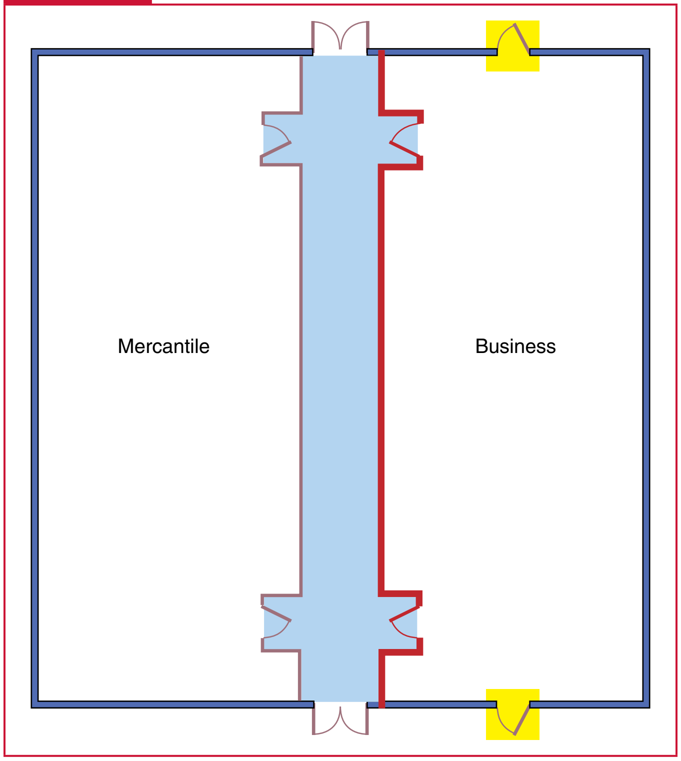
(1) Newsstand (mercantile) in an office building
(2) Giftshop (mercantile) in a hotel

Exhibit 6.17



Multiple occupancy building with shared egress corridor, which prohibits it from protection via the separated occupancy provisions.

Exhibit 6.18



Multiple occupancy building permitted to be protected via the separated occupancy provisions.

(3) Small storage area (storage) in any occupancy
(4) Minor office space (business) in any occupancy
(5) Maintenance area (industrial) in any occupancy
[***101:***A.6.1.14.1.3]

A.6.1.14.1.3(2) Examples of uses that have occupant loads below the occupancy classification threshold levels include the following:

(1) Assembly use with fewer than 50 persons within a business occupancy
(2) Educational use with fewer than 6 persons within an apartment building.
[***101:***A.6.1.14.1.3(2)]

Paragraph 6.1.14.1.3 clarifies that some, but not all, incidental uses can be considered part of the predominant occupancy. Incidental residential uses, regardless of the number of persons for whom sleeping accommodations are provided, are classified as residential occupancies and are subject to the appropriate residential occupancy chapter requirements. For example, if there are sleeping facilities for five fire fighters in a fire station, the *Code* does not permit the building to be classified simply as a storage occupancy where motor vehicles are sheltered. Rather, the proper classification is a multiple occupancy that is part storage occupancy and part residential occupancy (i.e., lodging or rooming house in this case). The requirements that apply to both occupancies need to be compared, with the more stringent provisions applied in accordance with 6.1.14.3, or the occupancies need to be separated from each other by fire resistance–rated construction in accordance with 6.1.14.4, in which case each occupancy is prohibited from sharing the other occupancy's exit access per 6.1.14.1.2.

In addition, a day-care use with more than 3 clients is not exempted by either of the criteria of 6.1.14.1.3. For example, a small day-care center with 14 clients located in a high-rise office building is not part of the predominant business occupancy. The more stringent of the requirements that apply to day-care occupancies and business occupancies need to be implemented in accordance with 6.1.14.3, or the occupancies need to be separated from each other by fire resistance–rated construction in accordance with 6.1.14.4, in which case each occupancy is prohibited from sharing the other occupancy's exit access per 6.1.14.1.2.

If the day-care use in the high-rise office building addressed in the preceding paragraph had only 3 clients, that number of clients would be less than the threshold number of 4 clients at which a day-care use becomes a day-care occupancy (see 6.1.4.1). The day-care use could, therefore, be classified as incidental to the business occupancy as permitted by 6.1.14.1.3(2).

6.1.14.2 Definitions.

6.1.14.2.1 Multiple Occupancy. A building or structure in which two or more classes of occupancy exist. [***101:***6.1.14.2.1]

6.1.14.2.2 Mixed Occupancy. A multiple occupancy where the occupancies are intermingled. [***101:***6.1.14.2.2]

6.1.14.2.3 Separated Occupancy. A multiple occupancy where the occupancies are separated by fire barriers. [***101:***6.1.14.2.3]

6.1.14.3 Mixed Occupancies.

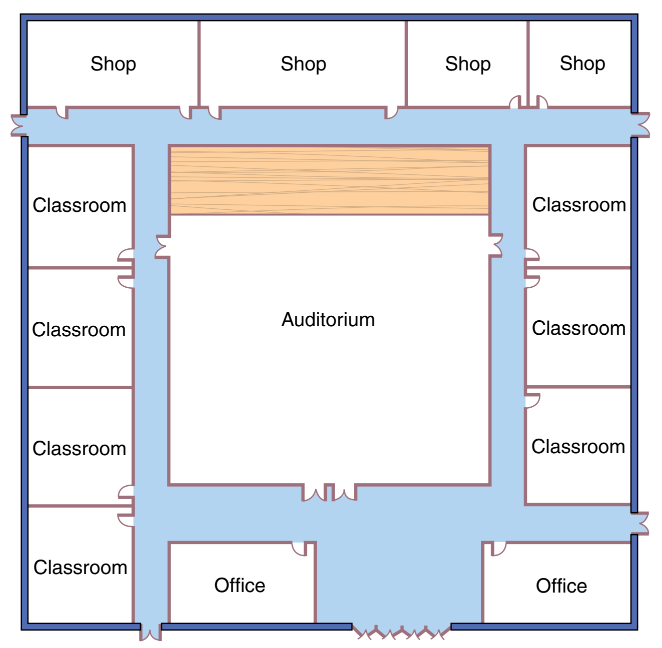
6.1.14.3.1 Each portion of the building shall be classified as to its use in accordance with Section 6.1. [***101:***6.1.14.3.1]

6.1.14.3.2 The building shall comply with the most restrictive requirements of the occupancies involved unless separate safeguards are approved. [***101:***6.1.14.3.2]

An example of a multiple occupancy building that is protected as a mixed occupancy is illustrated in Exhibit 6.19. Because the assembly occupancy (i.e., the auditorium) shares the internal corridor egress system with the educational occupancy classrooms and shops, separating the individual occupancies from each other so that they do not share any common exit access is impractical. Therefore, the provision of 6.1.14.1.2 requires that the multiple occupancy be protected as a mixed occupancy.

In the building depicted in Exhibit 6.19, assume that the office space (business occupancy) is considered incidental and that the predominant occupancies are educational (i.e., the classrooms and shops) and assembly (i.e., the auditorium) as permitted by 6.1.14.1.3(1). Assuming also that the building is new, the occupancy requirements of Section 20.1 of this *Code* and Chapter 12 of NFPA *101* for new assembly occupancies are

Exhibit 6.19



Multiple occupancy building protected via the mixed occupancy provisions.

compared with those of Section 20.2 of this *Code* and Chapter 14 of NFPA *101* for new educational occupancies for each of the subjects addressed by the *Code*. In each comparison of requirements between the applicable occupancy chapters, the more stringent requirement is chosen as having applicability to the multiple occupancy.

For example, the 6 ft (1830 mm) minimum corridor width requirement of 14.2.3.2 of NFPA *101* for educational occupancies is stricter than the 44 in. (1120 mm) minimum requirement of 12.2.3.8 of NFPA *101* for assembly occupancies and, thus, applies throughout the floor. The panic hardware requirement of 12.2.2.2.3 of NFPA *101* for assembly occupancies is identical to that in 14.2.2.2.2 of NFPA *101* for educational occupancies; therefore, this common requirement applies to all doors provided with latches or locks throughout the multiple occupancy. With regard to travel distance, in assembly occupancies, travel distance to the nearest exit is limited by 12.2.6.2 of NFPA *101* to a maximum of 200 ft (61 m) in a nonsprinklered building or 250 ft (76 m) in a sprinklered building; educational occupancies are limited by 14.2.6.2 and 14.2.6.3 of NFPA *101* to a 150 ft (46 m) travel distance in a nonsprinklered building and 200 ft (61 m) in a sprinklered building. So, the stricter travel distance requirement from the educational occupancy chapter applies to the multiple occupancy.

Paragraph 6.1.14.3.2 was revised for the 2012 edition of the *Code*. The revision reinstitutes a concept that was lost when the provisions for multiple occupancy buildings were rewritten for the 2003 edition of NFPA *101*. Where separate safeguards are approved (see 3.2.1), one or more of the applicable *Code* requirements are permitted to be relaxed to that applicable to the occupancy in question, rather than the most restrictive requirement of the occupancies involved. For example, a common path of travel that occurs wholly in a business tenant space in a multiple occupancy building containing assembly and business occupancies should not have to meet the assembly occupancy common path of travel limitation.

6.1.14.4 Separated Occupancies. (See also 6.1.14.4.2.) [***101:*** 6.1.14.4]

6.1.14.4.1 Where separated occupancies are provided, each part of the building comprising a distinct occupancy, as described in this chapter, shall be completely separated from other occupancies by fire-barriers as specified in 6.1.14.4.2, 6.1.14.4.3, and Table 6.1.14.4.1(a) and Table 6.1.14.4.1(b), unless separation is provided by approved existing separations or as otherwise permitted by 6.1.14.4.6. [***101:***6.1.14.4.1]

6.1.14.4.2 Occupancy separation fire barriers shall be classified as 3-hour fire resistance–rated, 2-hour fire resistance–rated, or 1-hour fire resistance–rated and shall meet the requirements of Chapter 8 of NFPA *101*. [***101:***6.1.14.4.2]

6.1.14.4.3 The fire barrier minimum fire resistance rating specified in Table 6.1.14.4.1(a) and Table 6.1.14.4.1(b) shall be permitted to be reduced by 1 hour, but in no case shall it be reduced to less than 1 hour, where the building is protected throughout by an approved automatic sprinkler system in accordance with NFPA 13 and supervised in accordance with 13.3.1.8, unless prohibited by the double-dagger footnote entries in the tables. [***101:***6.1.14.4.3]

6.1.14.4.4 Occupancy separation fire barriers shall be vertical, horizontal, or both or, when necessary, of such other form as required to provide complete separation between occupancy divisions in the building. [***101:***6.1.14.4.4]

6.1.14.4.5* Each separated portion of the building shall comply with the requirements for the occupancy therein. [***101:***6.1.14.4.5]

A.6.1.14.4.5 Where the Code text states that the provision has applicability to the building, rather than just to the occupancy, the provision applies to the entire building, regardless of whether the separated occupancies form of protection is used. For example, the provision of 18.3.5.1 of NFPA *101* requires that the entire building housing a health care occupancy be sprinklered. Contrast that with the requirement of 20.3.4.1 of NFPA *101* which requires an ambulatory health care facility, and not the entire building, to be provided with a fire alarm system. [***101:***A.6.1.14.4.5]

Δ **6.1.14.4.6** Where permitted in Chapters 11 through 43 of NFPA *101*, atrium walls shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis, provided all of the following are met:

(1) The atrium is separated from adjacent areas by walls that are smoke partitions in accordance with Section 8.4 of NFPA *101*.
(2) Doors in the smoke partitions required by 6.1.14.4.6(1) are equipped with positive latching hardware.
(3) The atrium meets the provisions of 8.6.7 of NFPA *101* that are applicable to new atriums.

[***101:***6.1.14.4.6]

Note that 6.1.14.4.1 requires the fire barriers separating occupancies protected as separated occupancies to have the minimum fire resistance rating specified in Table 6.1.14.4.1(a) and Table 6.1.14.4.1(b), unless separation is provided by approved existing separations. The phrase "unless separation is provided by approved existing separations" does not mean that existing separations are exempt from the requirements of Table 6.1.14.4.1(a) and Table 6.1.14.4.1(b). An approved existing separation is a separation approved by the current authority having jurisdiction and is different from a previously approved separation. See 3.3.84.1 in NFPA *101* for the definition of the term *approved existing* and 3.3.221 in NFPA *101* for the definition of the term *previously approved*. If the current AHJ refuses to approve an existing separation, the provisions of Table 6.1.14.4.1(a) and Table 6.1.14.4.1(b) can be invoked, as applicable. For example, where an existing separation stops at the underside of a suspended ceiling, the AHJ can withhold approval of the existing separation and require compliance with Table 6.1.14.4.1(a) and Table 6.1.14.4.1(b). In another example, the existing separation in a sprinklered building is judged to have approximately 45 minutes of fire resistance rating, but Table 6.1.14.4.1(a) and Table 6.1.14.4.1(b) require a

△ *TABLE 6.1.14.4.1(a) Required Separation of Occupancies (hours),*[†] *Part 1*

Occupancy	Assembly ≤300	Assembly >300 to ≤1000	Assembly >1000	Educational	Day-Care >12 Clients	Day-Care Homes	Health Care	Ambulatory Health Care	Detention & Correctional	One- & Two-Family Dwellings	Lodging or Rooming Houses	Hotels & Dormitories
Assembly ≤ 300	—	0	0	2	2	1	2[‡]	2	2[‡]	2	2	2
Assembly >300 to ≤1000	0	—	0	2	2	2	2[‡]	2	2[‡]	2	2	2
Assembly >1000	0	0	—	2	2	2	2[‡]	2	2[‡]	2	2	2
Educational	2	2	2	—	2	2	2[‡]	2	2[‡]	2	2	2
Day-Care >12 Clients	2	2	2	2	—	1	2[‡]	2	2[‡]	2	2	2
Day-Care Homes	1	2	2	2	1	—	2[‡]	2	2[‡]	2	2	2
Health Care	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	—	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]
Ambulatory Health Care	2	2	2	2	2	2	2[‡]	—	2[‡]	2	2	2
Detention & Correctional	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	—	2[‡]	2[‡]	2[‡]
One- & Two- Family Dwellings	2	2	2	2	2	2	2[‡]	2	2[‡]	—	1	1
Lodging or Rooming Houses	2	2	2	2	2	2	2[‡]	2	2[‡]	1	—	1
Hotels & Dormitories	2	2	2	2	2	2	2[‡]	2	2[‡]	1	1	—
Apartment Buildings	2	2	2	2	2	2	2[‡]	2	2[‡]	1	1	1
Board & Care, Small	2	2	2	2	2	2	2[‡]	2	2[‡]	1	2	2
Board & Care, Large	2	2	2	2	2	2	2[‡]	2	2[‡]	2	2	2
Mercantile	2	2	2	2	2	2	2[‡]	2	2[‡]	2	2	2
Mercantile, Mall	2	2	2	2	2	2	2[‡]	2	2[‡]	2	2	2
Mercantile, Bulk Retail	3	3	3	3	3	3	2[‡]	2[‡]	2[‡]	3	3	3
Business	1	2	2	2	2	2	2[‡]	1	2[‡]	2	2	2
Industrial, General Purpose	2	2	3	3	3	3	2[‡]	2	2[‡]	2	2	2
Industrial, Special-Purpose	2	2	2	3	3	3	2[‡]	2	2[‡]	2	2	2
Industrial, High Hazard	3	3	3	3	3	3	2[‡]	2[‡]	NP	3	3	3
Storage, Low & Ordinary Hazard	2	2	3	3	3	2	2[‡]	2	2[‡]	2	2	2
Storage, High Hazard	3	3	3	3	3	3	2[‡]	2[‡]	NP	3	3	3

NP: Not permitted.

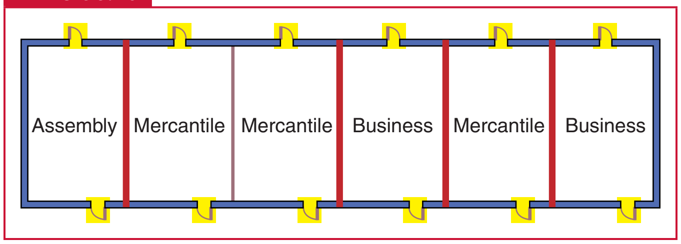
[†]*Minimum Fire Resistance Rating.* The fire resistance rating is permitted to be reduced by 1 hour, but in no case to less than 1 hour, where the building is protected throughout by an approved automatic sprinkler system in accordance with NFPA 13 and supervised in accordance with 13.3.1.8.

[‡]The 1-hour reduction due to the presence of sprinklers in accordance with the single-dagger footnote is not permitted. [***101:***Table 6.1.14.4.1(a)]

minimum 1-hour rating in such a building. The AHJ judges the existing separation acceptable and approves it. The existing separation becomes an approved existing separation not subject to the requirements of Table 6.1.14.4.1(a) and Table 6.1.14.4.1(b).

Exhibit 6.20 illustrates a simple example of a multiple occupancy building where the individual occupancies can easily be protected as separated occupancies. Because each individual-use space is arranged to meet its egress requirements independently of its neighbors, meeting only the requirements that apply to the occupancy of that individual-use space (see 6.1.14.4.5) is adequate to protect each space if the fire resistance–rated

Exhibit 6.20



Multiple occupancy building protected via the separated occupancy provisions.

Δ ***TABLE 6.1.14.4.1(b)*** *Required Separation of Occupancies (hours),*[†] *Part 2*

Occupancy	Apartment Buildings	Board & Care, Small	Board & Care, Large	Mercantile	Mercantile, Mall	Mercantile, Bulk Retail	Business	Industrial, General Purpose	Industrial, Special-Purpose	Industrial, High Hazard	Storage, Low & Ordinary Hazard	Storage, High Hazard
Assembly ≤ 300	2	2	2	2	2	3	1	2	2	3	2	3
Assembly >300 to ≤1000	2	2	2	2	2	3	2	2	2	3	2	3
Assembly >1000	2	2	2	2	2	3	2	3	2	3	3	3
Educational	2	2	2	2	2	3	2	3	3	3	3	3
Day-Care >12 Clients	2	2	2	2	2	3	2	3	3	3	3	3
Day-Care Homes	2	2	2	2	2	3	2	3	3	3	2	3
Health Care	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]
Ambulatory Health Care	2	2	2	2	2	2[‡]	1	2	2	2[‡]	2	2[‡]
Detention & Correctional	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	2[‡]	NP	2[‡]	NP
One- & Two- Family Dwellings	1	1	2	2	2	3	2	2	2	3	2	3
Lodging or Rooming Houses	1	2	2	2	2	3	2	2	2	3	2	3
Hotels & Dormitories	1	2	2	2	2	3	2	2	2	3	2	3
Apartment Buildings	—	2	2	2	2	3	2	2	2	3	2	3
Board & Care, Small	2	—	1	2	2	3	2	3	3	3	3	3
Board & Care, Large	2	1	—	2	2	3	2	3	3	3	3	3
Mercantile	2	2	2	—	0	3	2	2	2	3	2	3
Mercantile, Mall	2	2	2	0	—	3	2	3	3	3	2	3
Mercantile, Bulk Retail	3	3	3	3	3	—	2	2	2	3	2	2
Business	2	2	2	2	2	2	—	2	2	2	2	2
Industrial, General Purpose	2	3	3	2	3	2	2	—	1	1	1	1
Industrial, Special-Purpose	2	3	3	2	3	2	2	1	—	1	1	1
Industrial, High Hazard	3	3	3	3	3	3	2	1	1	—	1	1
Storage, Low & Ordinary Hazard	2	3	3	2	2	2	2	1	1	1	—	1
Storage, High Hazard	3	3	3	3	3	2	2	1	1	1	1	—

NP: Not permitted.

[†]*Minimum Fire Resistance Rating.* The fire resistance rating is permitted to be reduced by 1 hour, but in no case to less than 1 hour, where the building is protected throughout by an approved automatic sprinkler system in accordance with NFPA 13 and supervised in accordance with 13.3.1.8.

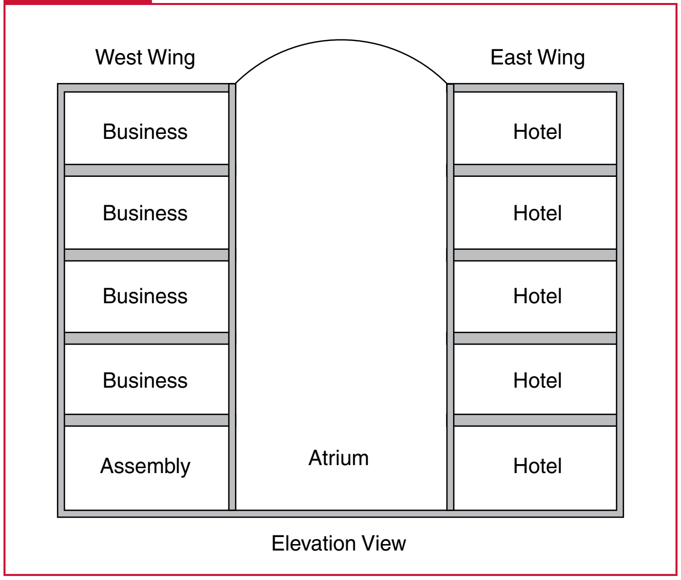
[‡]The 1-hour reduction due to the presence of sprinklers in accordance with the single-dagger footnote is not permitted. [***101:***Table 6.1.14.4.1(b)]

separations required by Table 6.1.14.4.1(a) or Table 6.1.14.4.1(b) are provided.

In the case of a multiple occupancy that is part mercantile occupancy and part business occupancy, the corresponding cell in Table 6.1.14.4.1(b) specifies that a 2-hour fire barrier is required to achieve protection of the multiple occupancy as separated occupancies if the building is not sprinklered. If the multiple occupancy building is sprinklered and the sprinkler system is electrically supervised, the 2-hour fire barrier is permitted to be reduced to 1 hour per the dagger symbol footnote to Table 6.1.14.4.1(b) and its reference to the sprinkler system supervision requirements of 9.7.2.

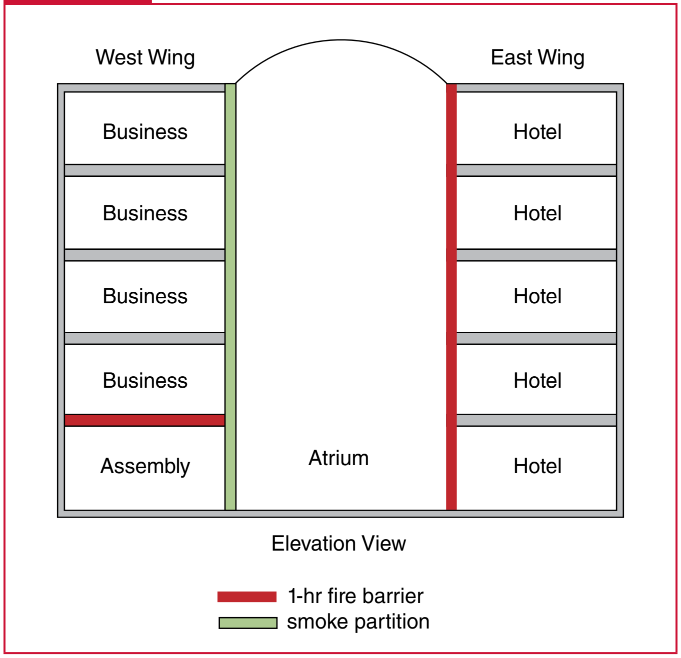
The provision of 6.1.14.4.6 recognizes an atrium as part of the separation required for protecting multiple occupancies as separated occupancies, but only where an occupancy chapter specifically permits its use. For example, health care occupancies permit the use of 6.1.14.4.6 in 18.1.3.2 and 19.1.3.2 of NFPA *101*. Further, 6.1.14.4.6 permits the atrium to serve as part of the separation of occupancies only on a story-by-story basis. This concept is explained in the following paragraphs.

Exhibit 6.21



Multiple occupancy building with atrium.

Exhibit 6.22



Multiple occupancy building utilizing atrium walls in occupancy separations.

Exhibit 6.21 illustrates a multiple occupancy building, with an atrium, under design. The west wing will include assembly occupancy on floor 1 and business occupancy on floors 2 through 4. The east wing will be hotel occupancy on floors 1 through 4. The building (i.e., the combination of the west wing, atrium, and east wing) will be protected throughout by approved sprinkler systems in accordance with 9.7.1.1(1) NFPA *101* that are supervised in accordance with 9.7.2 of NFPA *101*. For purposes of simplifying this example, the atrium will be an indoor garden with occupants relegated only to the paths connecting the west and east wings. The atrium will fully comply with the requirements of 8.6.7 that are applicable to new atriums, meaning that the atrium will have a smoke control system for compliance with the performance criteria of 8.6.7(5) of NFPA *101*.

The multiple occupancy building illustrated in Exhibit 6.21 could be protected as mixed occupancies in accordance with 6.1.14.1.1(1) or as separated occupancies in accordance with 6.1.14.1.1(2). The building designer, on behalf of the owner, has chosen to protect the multiple occupancy building as separated occupancies. Further, the designer has chosen to utilize the provision of 6.1.14.4.6 as permitted by 12.1.3.2 of NFPA *101* for assembly occupancies and by 38.1.3.3 of NFPA *101* for business occupancies. As a point of interesting, but unneeded, information — as addressed below — the hotel occupancy provisions of 28.1.3.3 of NFPA *101* also permit the use of 6.1.14.4.6. Occupants of each occupancy will have access to their required exits without using the exit access paths of any other occupancy (see 6.1.14.1.2). The required separation between occupancies is a 1-hour fire barrier based on the presence of sprinkler protection as detailed in the daggered footnote to Table 6.1.14.4.1(a) or Table 6.1.14.4.1(b).

Exhibit 6.22 illustrates that the required separation between the assembly occupancy on floor 1 and the business occupancy on floors 2 through 4 of the west wing will be provided by the combination of the 1-hour fire resistance–rated floor-ceiling assembly and the smoke partition composed of the west wall of the atrium, as shown in the exhibit. Given that 6.1.14.4.6 permits the atrium wall to serve as part of an occupancy separation only on a floor-by-floor basis, the hotel occupancy in the east wing can meet its required separation from the west wing only via the traditional side-by-side arrangement. It achieves the separation from the west wing by making the east wall of the atrium a 1-hour fire barrier. Note that the smoke partition at the atrium west wall serves only as part of an occupancy separation in conjunction with a floor-ceiling assembly, whereas the fire-rated atrium east wall serves, by itself, as an occupancy separation.

Combining the Mixed Occupancies and Separated Occupancies Forms of Protection

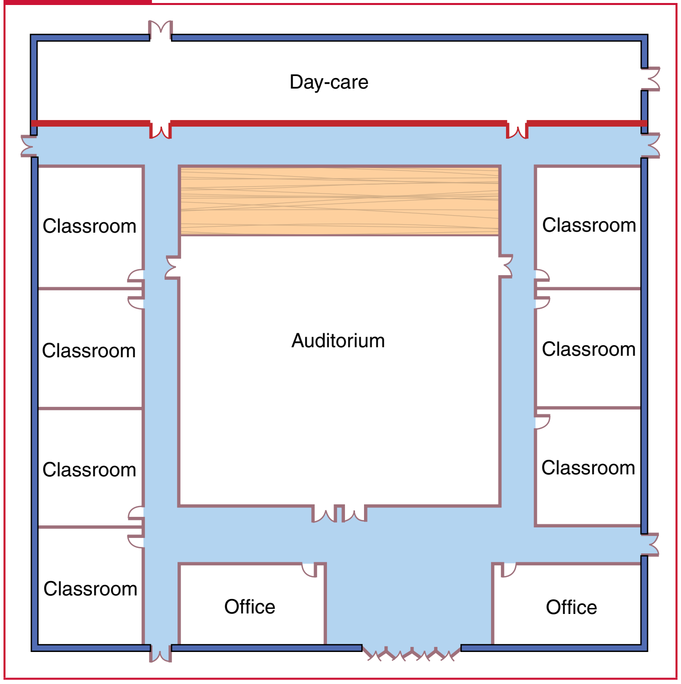
Exhibit 6.19 and the commentary that follows 6.1.14.3.2 address the mixed occupancies form of protection. Exhibits 6.20 through 6.22 and the commentary that follows 6.1.14.4.6 address the separated occupancies form of protection. In multiple occupancy buildings with three or more occupancies, it is not the intent of 6.1.14.1.1 to require all the occupancies to be protected by one common scheme, whether the scheme be that for mixed occupancies or that for separated occupancies. In other words, it is possible for a portion of a multiple occupancy building to be protected as a mixed occupancy and for another portion of the same multiple occupancy building to be separated from the mixed occupancies by fire-rated barriers as required by Table 6.1.14.4.1(a) or Table 6.1.14.4.1(b) so as to be considered a separated occupancy.

Exhibit 6.23 assumes that (1) the building is new; (2) the building is protected throughout by an approved automatic sprinkler system in accordance with NFPA 13 and supervised in accordance with 13.3.1.8; and (3) the office space (business occupancy) is considered incidental to the predominant occupancies of educational (i.e., the classrooms), assembly (i.e., the auditorium, which, in this case, has an occupant load exceeding 300), and day-care, as permitted by 6.1.14.1.3(1). The day-care occupancy space satisfies all required egress features via the two sets of doors that discharge directly outside; the doors from the day-care space to the corridor are convenience doors provided in excess of *Code* requirements. The day-care occupancy space is separated from the combined assembly occupancy and educational occupancy spaces by 1-hour fire resistance–rated construction in compliance with Table 6.1.14.4.1(a) so as to meet the separated occupancies form of protection. Table 6.1.14.4.1(a) was used to establish the minimum 1-hour fire-rated separation as follows:

1. In the first column, in the row for Assembly >300 to ≤1000, the user moves across the table to the column for Day-care >12 clients, noting the required fire rating of 2 hours.
2. In the first column, in the row for Educational, the user moves across the table to the column for Day-care >12 clients, noting the required fire rating of 2 hours.
3. In the title of Table 6.1.14.4.1(a), the user notes the superscript dagger symbol and references the corresponding footnote. The building is protected throughout by an approved automatic sprinkler system in accordance with NFPA 13 and supervised in accordance with 13.3.1.8, so the required fire-rated separation values of 2 hours from the applicable table cells are reduced to 1 hour.

Returning to Exhibit 6.23, the assembly occupancy space, which is landlocked at the center of the building, shares its exit access with that of the educational occupancy spaces. The provision of 6.1.14.1.2 requires that the portion of the multiple occupancy building that houses the assembly occupancy and the educational occupancy be protected as mixed occupancies. The occupancy requirements for new assembly occupancies (Section 20.1 of this *Code* and Chapter 12 of NFPA *101*) are compared with those for new educational occupancies (Section 20.2 of this *Code* and Chapter 14 of NFPA *101*) for each of the subjects addressed by the *Code*. In each comparison of requirements between the applicable occupancy chapters, the more stringent requirement is chosen as having applicability to the portion of the multiple occupancy building housing the assembly occupancy and educational occupancy spaces being protected as mixed occupancies, unless separate safeguards are approved (see 6.1.14.3.2).

Exhibit 6.23



Multiple occupancy building protected via combination of the mixed occupancy and separated occupancy provisions.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.

NFPA *101*®, *Life Safety Code*®, 2018 edition.

NFPA 150, *Standard on Fire and Life Safety in Animal Housing Facilities*, 2016 edition.

7–9

Reserved

In the 2018 edition of NFPA 1, *Fire Code,* the following chapters have been reserved for future use:

- Chapter 7
- Chapter 8
- Chapter 9

General Safety Requirements

10

Chapter 10 includes requirements for new and existing buildings, structures, and premises in the following key areas:

- Fundamental requirements (Section 10.1)
- Owner/occupant responsibilities (Section 10.2)
- Occupancy (Section 10.3)
- Building evacuation (Section 10.4)
- Fire drills (Section 10.5)
- Reporting of fires and other emergencies (Section 10.6)
- Tampering with fire safety equipment (Section 10.7)
- Emergency action plans (Section 10.8)
- Smoking (Section 10.9)
- Open flames, candles, open fires, and incinerators (Section 10.10)
- Fire protection markings (Section 10.11)
- Seasonal and vacant buildings and premises (Section 10.12)
- Combustible vegetation (Section 10.13)
- Special outdoor events, carnivals, and fairs (Section 10.14)
- Outside storage (Section 10.15)
- Parade floats (Section 10.16)
- Powered industrial trucks (Section 10.17)
- Storage of combustible materials (Section 10.18)
- Indoor children's playground structures (Section 10.19)

10.1 Fundamental Requirements

10.1.1 Every new and existing building or structure shall be constructed, arranged, equipped, maintained, and operated in accordance with this *Code* so as to provide a reasonable level of life safety, property protection, and public welfare from the actual and potential hazards created by fire, explosion, and other hazardous conditions.

The premise of this *Code* is that a minimum level of safety to life and property is required for all buildings, structures, and premises, whether they are new or existing. This protection takes many forms, from active protection, such as fire alarm systems and sprinkler systems, to passive protection, such as fire doors and fire barriers, or a combination of these features. The goal is to prevent injuries and death from fire, explosions, and other hazardous conditions and to limit property damage.

Δ **10.1.2*** ***Life Safety Code.*** Every new and existing building shall comply with this *Code* and NFPA *101*.

Δ **A.10.1.2** It is the intent of this *Code* that all existing buildings comply with the referenced edition of NFPA *101*.

NFPA *101*®, *Life Safety Code*®, is the key document for defining the requirements to protect building occupants from fire and similar emergencies in new and existing buildings. This *Code* and NFPA *101* work together to provide a protection package for life safety and property protection. NFPA *101* is the primary document from which the life safety requirements of NFPA 1, *Fire Code,* are drawn.

10.1.3 Building Code. Where a building code has been adopted, all new construction shall comply with this *Code* and the building code.

In jurisdictions where no building code has been adopted, this *Code* does not require that the fire official adopt a building code. Where a building code has been adopted, it must be applied to all new construction in addition to the requirements of this *Code.*

10.1.4 Structural Hazards.

10.1.4.1 Where structural elements have visible damage, the AHJ shall be permitted to require a technical analysis prepared in accordance with Section 1.15 to determine if repairs are necessary to restore structural integrity.

Fire inspectors frequently find damage to structural elements during inspections. The authority having jurisdiction (AHJ) can require an analysis of the damage to ensure structural stability and should notify the building department. This analysis in most cases will take place by or under the auspices of the building department. The fire department should be notified when structural deficiencies are found, because such deficiencies can impact fire fighter safety.

10.1.4.2 Where the technical analysis recommends repairs to the structure, such repairs shall be made.

10.1.5 Any person who deliberately, or through negligence, sets fire to or causes the burning of any combustible material in such a manner as to endanger the safety of any person or property shall be deemed to be in violation of this *Code*.

The intent of 10.1.5 is not to prohibit nonhostile fires, such as those used for cooking, heating, or industrial processes, provided that they do not otherwise violate the applicable requirements of this *Code*.

10.1.6 The AHJ shall have the authority to prohibit any or all open flames or other sources of ignition where circumstances make such conditions hazardous.

This *Code* does not specifically address all types of open flame or other sources of ignition. Therefore, 10.1.6 permits the AHJ to prohibit open flame or other ignition sources when it is judged such flame or other ignition source presents a hazard. Examples might include fire jugglers and the use of candles.

10.1.7 Listed and Labeled. Listed and labeled equipment, devices, and materials shall be installed and used in accordance with the listing limitations and the manufacturers' instructions.

10.2 Owner/Occupant Responsibilities

10.2.1 The owner, operator, or occupant shall be responsible for compliance with this *Code*.

As stated in 10.2.1, the person responsible for the property is responsible for complying with this *Code*. The AHJ should work with property owners, operators, and occupants to educate them on the requirements of this *Code*. Such cooperation can help correct violations and prevent the need to issue citations when inspections are conducted. If a violation notice is issued as a result of an inspection, the responsible party should ensure that the violations are corrected as soon as possible after the notice is received. If management takes a proactive approach to fire safety, others in the organization will likely do the same, thus increasing the fire safety of the property and reducing violations.

10.2.2 The owner, operator, or occupant of a building shall notify the AHJ prior to a change of occupancy as specified in 4.5.7 and 10.3.4.

A building might undergo a change in occupancy classification without requiring physical modification, thus alleviating the usual requirement for a building permit. The requirement of 10.2.2 ensures that the AHJ will be notified of such change of occupancy classification so compliance with the *Code* requirements applicable to the new occupancy can be verified. An example might be a former military barracks (dormitory) converted to a nursing home (health care) or a restaurant with fewer than 50 occupants (mercantile) to a restaurant with an occupant load of 50 or more occupants (assembly) with no associated construction. Such a change in occupancy classification will most likely significantly alter the protection requirements specified by the *Code*. Chapter 43 of NFPA *101* provides detailed requirements addressing change of occupancy classification.

10.2.3 The AHJ shall be permitted to require the owner, operator, or occupant to provide tests or test reports, without expense to the AHJ, as proof of compliance with the intent of this *Code*.

If the AHJ is not confident of *Code* compliance (e.g., where a fire protection system is in questionable working order, or a particular interior finish lacks documentation of *Code* compliance), 10.2.3 permits the AHJ to require the property owner to conduct the necessary testing or to produce test reports showing that the system or materials in question comply with the *Code*. The AHJ can require receipt of the documentation on testing and maintenance of fire protection systems after such work has been performed. The cost of such tests or reports is the responsibility of the property owner or agent.

10.2.4 The owner, operator, or occupant of a building that is deemed unsafe by the AHJ shall abate, through corrective action approved by the AHJ, the condition causing the building to be unsafe either by repair, rehabilitation, demolition, or other corrective action approved by the AHJ.

Any proposed corrective action requires approval of the AHJ. To avoid any misunderstanding, the AHJ should require a written corrective plan of action, including key completion dates, from the property owner. The AHJ should then issue its approval of the plan in writing. Once the work has begun, the AHJ should monitor the progress of the work to ensure that the corrections are being made in a timely manner and according to approvals. Plans and permits might be required before some corrective actions take place. (See Sections 1.12 and 1.14.)

10.2.5 The owner, operator, or occupant, or any person in control of a building or premises shall keep records of all maintenance, inspections, and testing of fire protection systems, fire alarm systems, smoke control systems, emergency evacuation and relocation drills, emergency action plans, emergency power, elevators, and other equipment as required by the AHJ.

10.2.6 All records required to be kept shall be maintained until their useful life has been served, as required by law, or as required by the AHJ.

Maintenance, testing, and inspection reports are necessary to ensure that fire protection and other systems are maintained in accordance with the *Code* and are in operating condition. Records of evacuation and fire drills and other records required by this *Code* need to be available to the AHJ upon request. The inspector should ask to see these records at each inspection to ensure that the appropriate maintenance and testing are being performed and that all required records are being retained.

Most states have laws requiring records retention. Some NFPA codes and standards also have requirements for how long records are to be kept. Records should be maintained long enough for the fire inspector to review at least the last two reports. If the inspection cycle is every 3 years, at least 3 years, if not 6 years, of records should be retained. The jurisdiction's legal counsel should be consulted to determine how long each type of record must be maintained.

N **10.2.7 Minimum Fire Prevention Inspection Frequencies for Existing Occupancies.**

N **10.2.7.1** Fire prevention inspections shall occur on existing premises in accordance with the minimum inspection frequency schedule specified in Table 10.2.7.1.

N **10.2.7.2** Where required or permitted by the AHJ, the required fire prevention inspection shall be conducted by an approved party that is qualified in accordance with NFPA 1031.

N **10.2.7.3** The AHJ shall be permitted to approve alternative qualifications for the approved party specified in 10.2.7.2.

N **10.2.7.4** The provisions of 10.2.7 shall not apply to detached one- and two-family dwellings or townhomes.

NFPA 1730, *Standard on Organization and Deployment of Fire Prevention Inspection and Code Enforcement, Plan Review, Investigation, and Public Education Operations,* from which Table 10.2.7.1 is extracted, is the first edition of that standard. It addresses the organization and deployment of a fire prevention organization, which includes code enforcement, plans examinations, investigation, and public education and also contains minimum inspection frequencies for existing occupancies. To ensure that existing occupancies comply with the fire prevention code, a fire prevention inspection is required as part of the standard of care as specified in NFPA 1730. Section 10.2.7 is new for 2018 and incorporates that standard of care into NFPA 1. The default is that the local fire AHJ should conduct the inspection in accordance with Table 10.2.7.1. However, if staffing does not permit or if the local jurisdiction does not have a qualified individual, the owner, occupant, or operator can retain an AHJ-approved NFPA 1031–qualified individual to conduct the inspection, thereby achieving fire code compliance in accordance with NFPA 1730.

TABLE 10.2.7.1 *Minimum Inspection Frequency*

Occupancy Risk Classification	Frequency
High	Annually
Moderate	Biennially
Low	Triennially
Critical infrastructure	Per AHJ

[**1730:**Table 6.7]

10.3 Occupancy

10.3.1 No new construction or existing building shall be occupied in whole or in part in violation of the provisions of this *Code*.

From an enforcement standpoint, 10.3.1 is probably one of the most important paragraphs in this *Code,* because it states that a building, whether new or existing, is prohibited from being occupied if it is in violation of the provisions of the *Code*. In no case should a new building be occupied unless it complies with the *Code*.

10.3.2 Existing buildings that are occupied at the time of adoption of this *Code* shall remain in use provided that the following conditions are met:

(1) The occupancy classification remains the same.
(2) No condition deemed hazardous to life or property exists that would constitute an imminent danger.

Because this *Code* applies retroactively, 10.3.1 prohibits the use of existing nonconforming facilities. However, 10.3.2 permits the building to continue to be used, provided that the occupancy classification remains the same and no serious life safety hazard is present, as judged by the AHJ, which would constitute an imminent danger. This provision does not exempt the building from compliance with the *Code* but permits it to continue in use until it is brought into compliance.

10.3.3* Buildings or portions of buildings, except for routine maintenance or repair, shall not be occupied during construction, repair, or alteration without the approval of the AHJ if required means of egress are impaired or required fire protection systems are out of service.

A.10.3.3 The AHJ should take into account the maintenance of required means of egress and fire protection systems during the construction, repair, alteration, or addition to the building. If necessary, alternative protection features can be required to ensure that no imminent hazards exist as the result of modifications.

Care should be taken when reviewing plans for construction in an existing building. Often during construction, egress routes are blocked or removed and fire protection systems are taken out of service. *Code* requirements should be reviewed to ensure that the building is still in compliance before construction work is approved. See 10.3.2 and Chapter 16 for additional guidance.

10.3.4 Change of Use or Occupancy Classification.

10.3.4.1 In any building or structure, whether or not a physical alteration is needed, a change from one use or occupancy classification to another shall comply with 4.6.7 of NFPA *101*. [***101:***4.6.11]

Change of use or change of occupancy classification is treated as a category of rehabilitation. Such changes are required by 4.6.7 of NFPA *101* to comply with the provisions of Chapter 43 of NFPA *101*.

10.3.4.2 Occupancy classifications and subclassifications, as defined, shall be in accordance with Chapter 6.

See Chapter 3 for definitions of specific occupancies and their subclassifications and Chapter 6 for further information on occupancy classification.

The reference to NFPA *101* in 10.3.4.1 requires buildings undergoing a change of use or change of occupancy classification to comply with the requirements of Chapter 43 of NFPA *101* on building rehabilitation, regardless of associated construction or the lack thereof. NFPA *101* defines a change of use as a change in the purpose or level of activity within a structure that involves a change in application of the requirements of the *Code*. An example of a change of use might be the conversion of a restaurant (assembly occupancy with an occupant load of 150) to a nightclub (assembly occupancy with an occupant load of 300). While such conversion does not constitute a change of occupancy (assembly to assembly), the increased occupancy load leads to a change in the character of use and affects the application of the *Code*.

The term *change of occupancy classification* is defined in NFPA *101* as "the change in the occupancy classification of a structure or portion of a structure." In evaluating changes of occupancy classification, NFPA *101* assigns each occupancy a hazard category that relates to the relative occupant risk. If the change of occupancy classification involves a change to an occupancy having the same or a lesser hazard category, the new occupancy is permitted to comply with requirements applicable to existing occupancies. Automatic sprinklers, fire alarm systems, and hazardous areas, however, must comply with the requirements applicable to new occupancies. For example, where a former office building (business occupancy) is converted into a hotel (hotel and dormitory), the two classifications are within the same hazard category; therefore, the *Code* requirements applicable to *existing* hotels and dormitories are applied to the *new* hotel. The new hotel and dormitory requirements must be consulted, however, to determine requirements for sprinkler and fire alarm systems and any hazardous areas.

In all cases where a change of occupancy classification involves a change to a higher hazard category, the new occupancy must comply with the requirements applicable to new occupancies. An example is the conversion of a bed and breakfast (lodging or rooming house) to a group home for developmentally disabled residents (residential board and care). The new residential board and care facility is required to comply with all *Code* requirements applicable to new residential board and care occupancies. Chapter 43 of NFPA *101* should be consulted for details on its application to changes of use and changes of occupancy classification.

10.4 Building Evacuation

10.4.1 Persons shall not fail to leave a building when notified to do so or when directed by the AHJ as a result of a known or perceived emergency.

10.4.2* Persons shall not fail to leave any overcrowded premises when ordered to do so by the AHJ.

A.10.4.2 Premises are deemed to be overcrowded when the occupant load exceeds the exit capacity or the posted occupant load.

Subsection 10.4.2 applies to all occupancies, but overcrowding is commonly a problem in assembly occupancies such as nightclubs and bars. All assembly occupancies are required to have the occupancy load posted in a conspicuous place near the main entrance. See Exhibit 10.1 for an example of an occupant load sign for a multipurpose assembly room used for dining and receptions. See Section 20.1 of this *Code* and 12.7.9.3 and 13.7.9.3 of NFPA *101* for more information on occupant load posting in assembly occupancies.

The AHJ should verify the occupant load during inspections. See 14.8.1 for guidance on determining occupant loads. Note that the occupant load calculated in accordance with 14.8.1 is the minimum number of occupants for which sufficient means of egress and other protection features must be provided; it is not necessarily the maximum number of occupants permitted in a building or portion thereof.

10.4.3* Persons shall not fail to leave a building when a fire alarm system is activated, unless otherwise provided for in an approved building fire evacuation plan or during routine testing or maintenance.

A.10.4.3 This requirement is not necessarily intended to apply to facilities utilizing a "defend in place" strategy or other occupancies where total evacuation is not intended or desired (detention, health care, high rise). A written emergency response plan can clarify how a facility can conform to this requirement.

Many times, responding fire personnel arrive at a building where a fire alarm system has activated to find the occupants still in the building. Fire fighters must then tell people to leave while also trying to locate the cause of the alarm, wasting valuable time and possibly placing occupants in harm's way. The provision of 10.4.3 requires all occupants to leave the building on notification of a fire alarm activation. Occupancies that have an approved fire evacuation plan, such as a defend-in-place or relocation strategy, must follow that plan, which may not call for building evacuation. Building occupants can remain in the building during

Exhibit 10.1

Typical occupant load signage for an assembly occupancy.

testing and maintenance as long as they have been advised that testing is taking place and that they are to disregard the alarms unless otherwise informed.

10.5* Fire Drills

A.10.5 The purpose of emergency egress and relocation drills is to educate the participants in the fire safety features of the building, the egress facilities available, and the procedures to be followed. Speed in emptying buildings or relocating occupants, while desirable, is not the only objective. Prior to an evaluation of the performance of an emergency egress and relocation drill, an opportunity for instruction and practice should be provided. This educational opportunity should be presented in a nonthreatening manner, with consideration given to the prior knowledge, age, and ability of audience. [***101:***A.4.7]

The usefulness of an emergency egress and relocation drill, and the extent to which it can be performed, depends on the character of the occupancy. [***101:***A.4.7]

In buildings where the occupant load is of a changing character, such as hotels or department stores, no regularly organized emergency egress and relocation drill is possible. In such cases, the emergency egress and relocation drills are to be limited to the regular employees, who can be thoroughly schooled in the proper procedure and can be trained to properly direct other occupants of the building in case of emergency evacuation or relocation. In occupancies such as hospitals, regular employees can be rehearsed in the proper procedure in case of fire; such training is always advisable in all occupancies, regardless of whether regular emergency egress and relocation drills can be held. [***101:***A.4.7]

10.5.1 Where Required. Emergency egress and relocation drills conforming to the provisions of this *Code* shall be conducted as specified by the provisions of Chapter 20 of this *Code* or Chapters 11 through 42 of NFPA *101*, or by appropriate action of the AHJ. Drills shall be designed in cooperation with the local authorities. [***101:***4.7.1]

10.5.2* Drill Frequency. Emergency egress and relocation drills, where required by Chapter 20 of this *Code* or Chapters 11 through 42 of NFPA *101*, or the AHJ, shall be held with sufficient frequency to familiarize occupants with the drill procedure and to establish conduct of the drill as a matter of routine. Drills shall include suitable procedures to ensure that all persons subject to the drill participate. [***101:***4.7.2]

A.10.5.2 If an emergency egress and relocation drill is considered merely as a routine exercise from which some persons are allowed to be excused, there is a grave danger that, in an actual emergency, the evacuation and relocation will not be successful. However, there might be circumstances under which all occupants do not participate in an emergency egress and relocation drill, for example, infirm or bedridden patients in a health care occupancy. [***101:***A.4.7.2]

10.5.3 Orderly Evacuation. When conducting drills, emphasis shall be placed on orderly evacuation rather than on speed. [***101:***4.7.3]

10.5.4* Simulated Conditions. Drills shall be held at expected and unexpected times and under varying conditions to simulate the unusual conditions that can occur in an actual emergency. [***101:***4.7.4]

A.10.5.4 Fire is always unexpected. If the drill is always held in the same way at the same time, it loses much of its value. When, for some reason during an actual fire, it is not possible to follow the usual routine of the emergency egress and relocation drill to which occupants have become accustomed, confusion and panic might ensue. Drills should be carefully planned to simulate actual fire conditions. Not only should drills be held at varying times, but different means of exit or relocation areas should be used, based on an assumption that fire or smoke might prevent the use of normal egress and relocation avenues. [***101:***A.4.7.4]

10.5.5 Relocation Area. Drill participants shall relocate to a predetermined location and remain at such location until a recall or dismissal signal is given. [***101:***4.7.5]

10.5.6* A written record of each drill shall be completed by the person responsible for conducting the drill and maintained in an approved manner. [***101:***4.7.6]

A.10.5.6 The written record required by this paragraph should include such details as the date, time, participants, location, and results of that drill. [***101:***A.4.7.6]

10.6 Reporting of Fires and Other Emergencies

10.6.1 Fire Reporting.

10.6.1.1 The person discovering any unwanted fire, regardless of magnitude, shall immediately notify the fire department.

10.6.1.2 Facilities that have established on-premises fire-fighting organizations and have coordinated and arranged procedures approved by the AHJ shall not need to notify the fire department.

Where an established on-premises fire-fighting organization exists, the AHJ must review and approve procedures that can replace or provide specific guidance on notification of the jurisdiction's fire department. Individuals occupying an on-premises fire-fighting site must still notify the on-site fire-fighting organization when a fire occurs.

10.6.1.3* The owner, manager, occupant, or any person in control of such building or premises, upon discovery of an unwanted fire or evidence of a previous unwanted fire that had apparently been extinguished, shall immediately notify the fire department.

A.10.6.1.3 This requirement should not be construed to forbid the owner, manager, or other person in control of the aforementioned building or premises from using all diligence necessary to extinguish such fire prior to the arrival of the fire department.

The fire department, building owner, and building occupants must be aware of any fire, regardless of how small. Many cases have been documented in which building occupants were not notified of a fire in the building, with disastrous and often fatal results. For example, when a rubbish fire is discovered and quickly extinguished by a building occupant, the fire department is often not notified. Such action is in violation of the *Code* requirements. All fires should be reported to the fire department so full extinguishment can be determined and the fire cause can be investigated.

10.6.1.4 Persons shall not make, issue, post, or maintain any regulation or order, written or verbal, that would require any person to take any unnecessary delaying action prior to reporting a fire to the fire department.

Paragraph 10.6.1.4 prohibits any person from restricting or delaying another person from notifying the fire department or building occupants when a fire is discovered. This provision is violated where building management requires security or building employees to check on the source of an alarm or a reported fire before notifying the fire department. This provision is also violated if a building occupant is prevented from notifying the fire department or other occupants of a fire in the building by persons representing building management.

10.6.2 Persons shall not deliberately or maliciously turn in an alarm of fire when in fact that person knows that no fire exists.

10.6.3 Notification of unauthorized discharge of hazardous materials shall be in accordance with Chapter 60.

See 60.5.1.3.4 for the requirements for reporting discharges of hazardous materials.

10.6.4 Any person who willfully makes any false, fraudulent, misleading, or unfounded report or statement or willfully misrepresents any fact with the intention of misleading any fire department personnel or who interferes with the operation of the fire department shall be in violation of this *Code*.

Subsection 10.6.4 can be used to cite persons found to be dishonest with an inspector when questioned about the amounts of flammable liquids or gases on the property or found to have misrepresented other facts regarding the property.

Paragraph 10.6.4 also gives fire investigators the authority to cite persons involved in a fire investigation who are uncooperative with fire investigators. The *Code* recognizes that persons do have rights against self-incrimination, and 10.6.4 is not intended to diminish those rights. Also see 1.8.3 for information on obstruction of operations.

10.7 Tampering with Fire Safety Equipment

10.7.1 Persons shall not render any portable or fixed fire-extinguishing system or device or any fire-warning system or device inoperative or inaccessible.

Fire safety devices and fire-extinguishing systems or devices protect buildings, equipment, and building occupants. Anyone who willfully disables a fire protection system or device is in violation of this *Code*. Tampering with fire safety equipment can have dire consequences. Part of ensuring that occupants do not tamper with or render fire safety equipment inoperative involves educating occupants on the type of equipment present in buildings as well as its purpose. Increasing awareness of equipment such as fire extinguishers, smoke alarms and detectors, automatic sprinklers, and notification appliances can help to prevent tampering with the systems. Common examples of violations to this Code section include covering or removing smoke detection equipment, blocking access to fire extinguishers, and tampering with sprinkler heads.

10.7.1.1 As necessary during emergencies, maintenance, drills, prescribed testing, alterations, or renovations, portable or fixed fire-extinguishing systems or devices or any fire-warning system or device shall be permitted to be made inoperative or inaccessible.

Extra diligence should be exercised to ensure proper notification when fire protection systems are out of service for the purpose of alterations, renovations, or maintenance and testing. Such impairments should be handled by following the requirements in the applicable codes and standards, with proper precautions taken to reduce exposure and the size and duration of the impairment. For example, NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, contains detailed requirements for both planned and unplanned impairments of such systems. Also see 13.3.3.6 for sprinkler system impairments and 13.7.1.4.3 for fire alarm system impairments. All systems should be restored to a ready state as soon as possible after alterations, renovations, testing, maintenance, or an emergency.

10.7.2 Persons shall not render a fire protection system or device inoperative during an emergency unless by direction of the incident commander.

Subsection 10.7.2 prohibits those in the employ of the building management or anyone else from shutting off an alarm system, a sprinkler system, or any other system that could affect the outcome of a fire, without the permission of the incident commander. See also 1.8.3 and 10.6.4.

10.7.3 Persons, except a person authorized by the AHJ, shall not remove, unlock, destroy, or tamper with in any manner any locked gate, door, or barricade; chain; enclosure; sign; tag; or seal that has been required by the AHJ pursuant to this *Code*.

The AHJ might require locks, barricades, signs, or other items to be placed at or attached to fire protection equipment or buildings. The removal of these items is prohibited, except under the orders of, or by a representative of, the AHJ. The AHJ should have a formal procedure for a lockout/tagout system in accordance with Occupational Safety and Health Administration (OSHA) regulations.

10.8 Emergency Action Plans

10.8.1 Where Required. Emergency action plans shall be provided for high-rise, health care, ambulatory health care, residential board and care, assembly, day-care centers, special amusement buildings, hotels and dormitories, detention and correctional occupancies, educational, underground and windowless structures, facilities storing or handling materials covered by Chapter 60, or where required by the AHJ.

Subsection 10.8.1 requires emergency action plans for all high-rise buildings, regardless of occupancy and also for the other listed occupancies and structures, regardless of whether they are high rise or not. The emergency action plans required by 10.8.1 are in addition to any plans that might be required by the occupancy provisions in Chapter 20 or elsewhere in this *Code*. The emergency action plan requirements of 10.8.2 are extracted from NFPA *101*.

10.8.2 Plan Requirements.

10.8.2.1* Emergency action plans shall include the following:

(1) Procedures for reporting of emergencies
(2) Occupant and staff response to emergencies
(3)* Evacuation, relocation and shelter-in-place procedures appropriate to the building, its occupancy, emergencies, and hazards
(4) Appropriateness of the use of elevators
(5) Design and conduct of fire drills
(6) Type and coverage of building fire protection systems
(7) Other items required by the AHJ

[***101:***4.8.2.1]

Δ **A.10.8.2.1** Items to be considered in preparing an emergency plan should include the following:

(1) Purpose of plan
(2) Building description, including certificate of occupancy
(3) Appointment, organization, and contact details of designated building staff to carry out the emergency duties
(4) Identification of events (man-made and natural) considered life safety hazards impacting the building
(5) Responsibilities matrix (role-driven assignments)
(6) Policies and procedures for those left behind to operate critical equipment
(7) Specific procedures to be used for each type of emergency
(8) Requirements and responsibilities for assisting people with disabilities
(9) Procedures for accounting for employees
(10) Training of building staff, building emergency response teams, and other occupants in their responsibilities
(11) Documents, including diagrams, showing the type, location, and operation of the building emergency features, components, and systems
(12) Practices for controlling life safety hazards in the building
(13) Inspection and maintenance of building facilities that provide for the safety of occupants
(14) Conducting fire and evacuation drills
(15) Interface between key building management and emergency responders
(16) Names or job titles of persons who can be contacted for further information or explanation of duties
(17) Post-event (including drill) critique/evaluation, as addressed in Chapter 9 of *NFPA 1600*
(18) Means to update the plan, as necessary

[***101:***A.4.8.2.1]

A lesson learned from the September 11, 2001, terrorist attacks on the World Trade Center towers in New York City and the Pentagon building in Arlington, Virginia, is the importance of having a detailed emergency action plan that is tailored to the building and its occupants. The 18 topics listed in A.10.8.2.1 for the development of an emergency action plan broadly cover the needed facets of such a plan.

Δ **A.10.8.2.1(3)** It is assumed that a majority of buildings will use a total evacuation strategy during a fire. It should be noted that evacuation from a building could occur for reasons other than a fire, but such other reasons are not the primary focus of the *Code*. As used herein, total evacuation is defined as the process in which all, or substantially all, occupants leave a building or facility in either an unmanaged or managed sequence or order. An alternative to total evacuation, is partial evacuation, which can be defined as the process in which a select portion of a building or facility is cleared or emptied of its occupants while occupants in other portions mostly carry on normal activity. In either case, the evacuation process can be ordered or managed in accordance with an established priority in which some or all occupants of a building or facility clear their area and utilize means of egress routes. This is typically done so that the more endangered occupants are removed before occupants in less endangered areas. Alternative terms describing this sequencing or ordering of evacuation are *staged evacuation* and *phased evacuation*. [***101:***A.4.8.2.1(3)]

Table A.10.8.2.1(3) illustrates options for extent of management and extent of evacuation. Some of the options shown might not be appropriate. As noted in Table A.10.8.2.1(3), either total or partial evacuation can include staged (zoned) evacuation or phased evacuation, which is referred to as managed or controlled evacuation. It should also be noted that the evacuation process might not include relocation to the outside of the building but might instead include relocation to an area of refuge or might defend the occupants in place to minimize the need for evacuation. [***101:***A.4.8.2.1(3)]

The different methods of evacuation are also used in several contexts throughout NFPA *101*. Though most of the methods of evacuation are not specifically defined or do not have established criteria, various sections of NFPA *101* promulgate them as alternatives to total evacuation. The following sections of NFPA *101* discuss these alternatives in more detail:

(1) Section 4.7 — Provides requirements for fire and relocation drills
(2) 7.2.12 — Provides requirements for area of refuge
(3) 7.2.4 — Provides requirements for horizontal exits
(4) 9.6.3.6 — Provides the alarm signal requirements for different methods of evacuation
(5) 9.6.3.9 — Permits automatically transmitted or live voice evacuation or relocation instructions to occupants and requires them in accordance with *NFPA 72*

TABLE A.10.8.2.1(3) Occupant Evacuation Strategies

	Extent of Management	
Extent of Evacuation	**Managed Sequence**	**Unmanaged Sequence**
Shelter in place	No movement — shelter in place upon direction	No movement — shelter in place per prior instruction
Relocation or partial evacuation	Managed or controlled partial evacuation In-building relocation on same floor In-building relocation to different floors Occupants of some floors leave building	Unmanaged movement
Total evacuation	Managed or controlled total evacuation	Unmanaged or uncontrolled total evacuation

[***101:*** Table A.4.8.2.1(3)]

(6) 14.3.4.2.3 (also Chapter 15) — Describes alternative protection systems in educational occupancies
(7) 18.1.1.2/18.1.1.3/Section 18.7 (also Chapter 19) — Provide methods of evacuation for health care occupancies
(8) Chapters 22 and 23 — Provide methods of evacuation for detention and correctional occupancies, including the five groups of resident user categories
(9) Chapters 32 and 33 — Provide methods of evacuation for residential board and care occupancies
(10) 32.1.5/33.1.5 — For residential board and care occupancies, state that "no means of escape or means of egress shall be considered as complying with the minimum criteria for acceptance, unless emergency evacuation drills are regularly conducted"
(11) 40.2.5.2.2 — For industrial occupancies, states that "ancillary facilities in special-purpose industrial occupancies where delayed evacuation is anticipated shall have not less than a 2-hour fire resistance–rated separation from the predominant industrial occupancy and shall have one means of egress that is separated from the predominant industrial occupancy by 2-hour fire resistance–rated construction"[***101:***A.4.8.2.1(3)]

The method of evacuation should be accomplished in the context of the physical facilities, the type of activities undertaken, and the provisions for the capabilities of occupants (and staff, if available). Therefore, in addition to meeting the requirements of the *Code*, or when establishing an equivalency or a performance-based design, the following recommendations and general guidance information should be taken into account when designing, selecting, executing, and maintaining a method of evacuation:

(1) When choosing a method of evacuation, the available safe egress time (ASET) must always be greater than the required safe egress time (RSET).
(2) The occupants' characteristics will drive the method of evacuation. For example, occupants might be incapable of evacuating themselves because of age, physical or mental disabilities, physical restraint, or a combination thereof. However, some buildings might be staffed with people who could assist in evacuating. Therefore, the method of evacuation is dependent on the ability of occupants to move as a group, with or without assistance. For more information, see the definitions under the term *Evacuation Capability* in Chapter 3 of NFPA *101*.
(3) An alternative method of evacuation might or might not have a faster evacuation time than a total evacuation. However, the priority of evacuation should be such that the occupants in the most danger are given a higher priority. This prioritization will ensure that occupants more intimate with the fire will have a faster evacuation time.
(4) Design, construction, and compartmentation are also variables in choosing a method of evacuation. The design, construction, and compartmentation should limit the development and spread of a fire and smoke and reduce the need for occupant evacuation. The fire should be limited to the room or compartment of fire origin. Therefore, the following factors need to be considered:
   (a) Overall fire resistance rating of the building
   (b) Fire-rated compartmentation provided with the building
   (c) Number and arrangement of the means of egress
(5) Fire safety systems should be installed that complement the method of evacuation and should include consideration of the following:
   (a) Detection of fire
   (b) Control of fire development
   (c) Confinement of the effects of fire
   (d) Extinguishment of fire
   (e) Provision of refuge or evacuation facilities, or both
(6) One of the most important fire safety systems is the fire alarm and communication system, particularly the notification

system. The fire alarm system should be in accordance with *NFPA 72* and should take into account the following:

(a) Initial notification of only the occupants in the affected zone(s) (e.g., zone of fire origin and adjacent zones)
(b) Provisions to notify occupants in other unaffected zones to allow orderly evacuation of the entire building
(c) Need for live voice communication
(d) Reliability of the fire alarm and communication system

(7) The capabilities of the staff assisting in the evacuation process should be considered in determining the method of evacuation.
(8) The ability of the fire department to interact with the evacuation should be analyzed. It is important to determine if the fire department can assist in the evacuation or if fire department operations hinder the evacuation efforts.
(9) Evacuation scenarios for hazards that are normally outside of the scope of the *Code* should be considered to the extent practicable. (*See 4.3.1 of NFPA 101.*)
(10) Consideration should be given to the desire of the occupants to self-evacuate, especially if the nature of the building or the fire warrants evacuation in the minds of the occupants. Self-evacuation might also be initiated by communication between the occupants themselves through face-to-face contact, mobile phones, and so forth.
(11) An investigation period, a delay in the notification of occupants after the first activation of the fire alarm, could help to reduce the number of false alarms and unnecessary evacuations. However, a limit to such a delay should be established before a general alarm is sounded, such as positive alarm sequence as defined in *NFPA 72*.
(12) Consideration should be given to the need for an evacuation that might be necessary for a scenario other than a fire (e.g., bomb threat, earthquake).
(13) Contingency plans should be established in the event the fire alarm and communication system fail, which might facilitate the need for total evacuation.
(14) The means of egress systems should be properly maintained to ensure the dependability of the method of evacuation.
(15) Fire prevention policies or procedures, or both, should be implemented that reduce the chance of a fire (e.g., limiting smoking or providing fire-safe trash cans).
(16) The method of evacuation should be properly documented, and written forms of communication should be provided to all of the occupants, which might include sign postings throughout the building. Consideration should be given to the development of documentation for an operation and maintenance manual or a fire emergency plan, or both.
(17) Emergency egress drills should be performed on a regular basis. For more information, see Section 4.7 of NFPA *101*.
(18) The AHJ should also be consulted when developing the method of evacuation.

[***101:***A.4.8.2.1(3)]

Measures should be in place and be employed to sequence or control the order of a total evacuation, so that such evacuations proceed in a reasonably safe, efficient manner. Such measures include special attention to the evacuation capabilities and needs of occupants with disabilities, either permanent or temporary. For comprehensive guidance on facilitating life safety for such populations, go to www.nfpa.org. For specific guidance on stair travel devices, see ANSI/RESNA ED-1, *Emergency Stair Travel Devices Used by Individuals with Disabilities.* [***101:***A.4.8.2.1(3)]

In larger buildings, especially high-rise buildings, it is recommended that all evacuations — whether partial or total — be managed to sequence or control the order in which certain occupants are evacuated from their origin areas and to make use of available means of egress. In high-rise buildings, the exit stairs, at any level, are designed to accommodate the egress flow of only a very small portion of the occupants — from only one or a few stories, and within a relatively short time period — on the order of a few minutes. In case of a fire, only the immediately affected floor(s) should be given priority use of the means of egress serving that floor(s). Other floors should then be given priority use of the means of egress, depending on the anticipated spread of the fire and its combustion products, and for the purpose of clearing certain floors to facilitate eventual fire service operations. Typically, this means that the one or two floors above and below a fire floor will have secondary priority immediately after the fire floor. Depending on where combustion products move, for example, upward through a building with cool-weather stack effect, the next priority floors will be the uppermost occupied floors in the building. [***101:***A.4.8.2.1(3)]

Generally, in order to minimize evacuation time for most or all of a relatively tall building to be evacuated, occupants from upper floors should have priority use of exit stairs. For people descending many stories of stairs, this priority will maximize their opportunity to take rest stops without unduly extending their overall time to evacuate a building. Thus, the precedence behavior of evacuees should be that people already in an exit stair should normally not defer to people attempting to enter the exit stair from lower floors, except for those lower floors most directly impacted by a fire or other imminent danger. Notably, this is contrary to the often observed behavior of evacuees in high-rise building evacuations where lower floor precedence behavior occurs. (Similarly, in the most commonly observed behavior of people normally disembarking a passenger airliner, people within the aisle defer to people entering the aisle, so that the areas closest to the exit typically clear first.) Changing, and generally managing, the sequence or order within which egress occurs will require effectively informing building occupants and evaluating resulting performance in a program of education, training, and drills. [***101:***A.4.8.2.1(3)]

When designing the method of evacuation for a complex building, all forms of egress should be considered. For example, consideration could be given to an elevator evacuation system. An elevator evacuation system involves an elevator design that provides protection from fire effects so that elevators can be used safely for egress. See 7.2.13 and A.7.2.12.2.4 of NFPA *101* for more information. [***101:***A.4.8.2.1(3)]

For further guidance, see the following publications:

(1) *SFPE Engineering Guide to Human Behavior in Fire*, which provides information on occupant characteristics, response to fire cues, decision making in fire situations, and methods for predicting evacuation time

(2) *NFPA Fire Protection Handbook*, 20th edition, Section 1, Chapter 9, which provides good methodology for managing exposures and determining the method of evacuation
(3) *NFPA Fire Protection Handbook*, 20th edition, Section 20, which provides further commentary on methods of evacuation for different occupancies
(4) *SFPE Handbook of Fire Protection Engineering*, Volume II, Chapters 58-61, which provide an overview of some of the research on methods of evacuation and methods for predicting evacuation times

[***101:***A.4.8.2.1(3)]

The text of A.10.8.2.1(3) serves as a primer on the subject of evacuation strategies. A wide range of strategies is offered, from total evacuation to partial evacuation to sheltering in place without evacuation. For any given building and its occupants, no one evacuation strategy fits all possible emergencies. An effective action plan calls for more than one evacuation strategy and for a way to communicate to occupants at the time of an emergency the strategy that is to be employed.

10.8.2.2 Emergency action plans shall be submitted to the AHJ for review when required by the AHJ.

10.8.2.3* Emergency action plans shall be reviewed and updated as required by the AHJ. [***101:***4.8.2.3]

No one generic emergency plan can adequately address the needs of all buildings. The AHJ has great latitude in establishing requirements that will result in the creation and upkeep of an emergency action plan tailored to the needs of a particular facility. See A.10.8.2.3 for additional details on updating emergency action plans based on lessons learned from emergency relocation or evacuation drills and lessons learned from actual fire incidents that necessitated emergency relocation or evacuation. Such lessons should become inputs to an improved, more customized emergency action plan.

A.10.8.2.3 Emergency action plans are a critical component of assuring life safety in buildings. Life safety is the result of an interaction of technical and social systems within the building and in the community. Gathering information to evaluate the performance and effectiveness of emergency action plans is important for verifying system performance and as a basis for improvement. Such reports should be retained by building management and used to inform the process for revision of the building emergency action plan. [***101:***A.4.8.2.3]

Following any drill or actual emergency or reported emergency occurring in the building, an after action report should be prepared by the building owner or designated representative to document the function of the building's life safety hardware, procedures, and occupant emergency organization. [***101:***A.4.8.2.3]

For ordinary drills and reported emergencies, areas of success and areas for improvement should be identified. [***101:***A.4.8.2.3]

For actual emergencies in the building, where there is major occupant movement, damage, or casualties, additional information should be collected. This includes questions concerning the event, as well as performance of life safety systems. It also identifies improvements in areas such as training, maintenance, interaction with local emergency response organizations, or occupant management. The reports from these significant events should be shared with the local emergency response organization. [***101:***A.4.8.2.3]

10.9 Smoking

For the purposes of this *Code*, smoking is defined as carrying lighted pipes, cigars, cigarettes, tobacco, or any other lighted type of smoking substance through an area. People might mistakenly believe that they actually have to be smoking a tobacco product in order to violate the nonsmoking designation. Certain areas are often designated as nonsmoking areas because of the presence of combustible materials or the possible presence of flammable vapors or gas. Carrying lighted tobacco products through, or depositing them in, nonsmoking areas can be as dangerous as actually using the products in proximity to such materials, vapors, or gases.

10.9.1 Where smoking is considered a fire hazard, the AHJ shall be authorized to order the owner in writing to post "No Smoking" signs in conspicuous, designated locations where smoking is prohibited.

The "No Smoking" sign should be large enough to be readily seen, and either the sign or the lettering on the sign should be of a color that contrasts with the background of the location where it is posted. The sign text also needs to be in languages appropriate for the building occupants. Exhibit 10.2 shows an example of a "No Smoking" sign complying with 10.9.1.

10.9.2 In areas where smoking is permitted, noncombustible ashtrays shall be provided.

10.9.3 Removal or destruction of any required "No Smoking" sign shall be prohibited.

10.9.4 Smoking or depositing any lighted or smoldering substance in a place where required "No Smoking" signs are posted shall be prohibited.

Exhibit 10.2

"No Smoking" sign.

10.10 Open Flames, Candles, Open Fires, and Incinerators

10.10.1 Permits. Permits, where required, shall comply with Section 1.12.

Section 1.12 gives the AHJ the power to issue a permit for the kindling or maintenance of any open fire or a fire in any public street, alley, road, or other public or private ground.

10.10.1.1 Permits shall not be required for cooking and recreational fires.

10.10.1.2 Where burning is conducted on public property or the property of someone other than the permit applicant, the permit applicant shall demonstrate that permission has been obtained by the appropriate government agency, the owner, or the owner's authorized agent.

10.10.1.3 When limits for atmospheric conditions or hours restrict burning, such limits shall be designated in the permit restrictions.

Some atmospheric conditions that could cause open fires to be hazardous are high winds, heavy fog, and smog alerts. An example of a local condition that could lead the AHJ to prohibit an open fire would be when the fire department is extremely busy, such as during an outdoor event, a major emergency, or another large event that would limit fire-fighting resources.

10.10.1.4 Instructions or stipulations of permit shall be followed.

10.10.2 The AHJ shall have the authority to prohibit any or all open flames, candles, and open, recreational, and cooking fires or other sources of ignition, or establish special regulations on the use of any form of fire or smoking material where circumstances make such conditions hazardous.

In many parts of the country, the danger of fire is extremely high during certain times of the year. During such periods, as stated in 10.10.2, the AHJ should prohibit any open burning. The public should be notified that burning is prohibited, and special care should be taken to prevent fires from occurring.

The reference to candles in 10.10.2 gives the AHJ the authority to prohibit their use wherever such use is deemed to be hazardous. While this provision gives the AHJ broad authority to prohibit candles, reasonable judgment should be exercised. For example, in a restaurant, protected candles with noncombustible, substantial bases on the dining tables should not be deemed to be overly hazardous.

10.10.3 Outdoor Fires.

10.10.3.1* Outdoor fires shall not be built, ignited, or maintained in or upon hazardous fire areas, except by permit from the AHJ.

A.10.10.3.1 Areas for such use can include inhabited premises or designated campsites where such fires are built in a permanent barbecue, portable barbecue, outdoor fireplace, incinerator, or grill.

10.10.3.2 Permanent barbecues, portable barbecues, outdoor fireplaces, or grills shall not be used for the disposal of rubbish, trash, or combustible waste material.

10.10.4 Open Fires.

10.10.4.1 Permitted open fires shall be located not less than 50 ft (15 m) from any structure.

In the event that brands and embers are given off or that the fire is out of control, the 50 ft (15 m) requirement provides some distance between the fire and the structures. Depending on conditions, the AHJ can increase this distance to provide adequate protection.

10.10.4.2 Burning hours shall be prescribed by the AHJ.

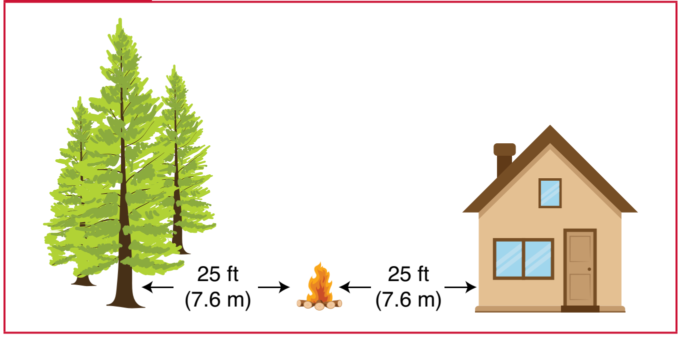
The AHJ can determine the hours that burning is to take place. Many jurisdictions permit burning during daylight hours and others only at night. The fire department and the dispatch center should be kept informed of where burning is taking place, because they will undoubtedly receive calls reporting smoke or flames in the area.

10.10.4.3 Recreational fires shall not be located within 25 ft (7.6 m) of a structure or combustible material unless contained in an approved manner.

10.10.4.4 Conditions that could cause a fire to spread to within 25 ft (7.6 m) of a structure shall be eliminated prior to ignition.

Recreational fires may include campfires or other similar-type fires. The 25 ft (7.6 m) separation requirement provides a safe distance between the fire and other structures or combustible materials. Caution should be used when differentiating between a recreational fire and a permitted open fire as addressed in 10.10.4.1. A permitted open fire is usually larger and more regulated. It should not be considered a recreational fire. Exhibit 10.3 shows the minimum separation distance between a recreational fire and a structure or combustible material. This is not occupancy specific and should be enforced as best as possible within the capacity of the local AHJ.

Exhibit 10.3



Minimum separation distance between recreational fire and structure or combustible material.

Where it is not possible for a recreational fire to be located at least 25 ft (7.6 m) from a structure or combustible material, the AHJ can approve a method to contain the fire. Anyone wanting to start a recreational fire must consult local requirements. Some areas of the United States have strict provisions, even prohibitions, on recreational fires, based upon geography, weather conditions, conservation and preservation efforts, and local wildfire risks. Recreational fires can go wrong quickly and every effort must be made to keep the fire under control at all times.

10.10.5 Fire Attendant.

10.10.5.1 Open, recreational, and cooking fires shall be constantly attended by a competent person until such fire is extinguished.

The presence of a competent person who has access to readily available fire-extinguishing equipment and knowledge of how to use that equipment is important to maintaining a safe outdoor fire. Outdoor fires frequently burn out of control because no one is in attendance to notify the fire department and to take action to prevent fire spread. The AHJ should establish guidelines for safe burning and can require fire apparatus to be present where the situation warrants.

10.10.5.2 This person shall have a garden hose connected to the water supply or other fire-extinguishing equipment readily available for use.

10.10.6 Cooking Equipment.

10.10.6.1 For other than one- and two-family dwellings, no hibachi, grill, or other similar devices used for cooking, heating, or any other purpose shall be used or kindled on any balcony, under any overhanging portion, or within 10 ft (3 m) of any structure.

10.10.6.2 For other than one-and two-family dwellings, no hibachi, grill, or other similar devices used for cooking shall be stored on a balcony.

10.10.6.3* Listed equipment permanently installed in accordance with its listing, applicable codes, and manufacturer's instructions shall be permitted.

A.10.10.6.3 It is not the intent of this paragraph to allow the permanent installation of portable equipment unless it is permitted by its listing.

For all occupancies other than one- and two-family dwellings, the use of gas grills, charcoal grills, fireplaces, and other heat-producing devices is prohibited on balconies and patios, under any overhang, and within 10 ft (3 m) of any structure, unless such cooking equipment is permanently installed in accordance with its listing. In addition, 10.10.6.2 prohibits the storage of such cooking equipment on balconies of other than one- and two-family dwellings; where grills are stored on balconies, the probability is high they will be used there as well.

With regard to 10.10.6, a frequently asked question is whether electric grills are included in this provision. The answer is yes. Some research into past *Code* changes shows that in the 2006 edition, 10.11.7 (now 10.10.6.1) read as follows:

> **10.11.7** For other than one- and two-family dwellings, no hibachi, gas-fired grill, charcoal grill, or other similar devices used for cooking, heating, or any other purpose, shall be used or kindled on any balcony or under any overhanging portion or within 10 ft (3 m) of any structure. Listed electric ranges, grills, or similar electrical apparatus shall be permitted.

However, for the 2009 edition of the *Code*, that paragraph was revised to read as follows:

> **10.11.6** For other than one- and two-family dwellings, no hibachi, grill, or other similar devices used for cooking, heating, or any other purpose shall be used or kindled on any balcony, under any overhanging portion, or within 10 ft (3 m) of any structure.

In the 2009 text, the last sentence was removed, thus including electric ranges, grills, and similar electrical apparatus in its application. While the answer to this frequently asked question requires the user to look back to the 2006 edition, it is still relevant in the application of the 2018 edition of the *Code*.

The inspection of every balcony of every multifamily dwelling is an impractical enforcement task. Compliance through public education is more readily achievable. The AHJ can provide written notification of these requirements to condominium associations, property management agencies, and others who are affected. When the potential danger posed by grills is understood, voluntary compliance is easier to obtain. Landlords can also include this prohibition in leases to ensure that tenants are aware of the restrictions.

10.10.7 Installation of Patio Heaters. The installation of patio heaters shall comply with 69.3.13.

The requirements addressing patio heaters in 69.3.13, as referenced by 10.10.7, recognize the growing use of these portable outdoor appliances used to heat outdoor areas when the climate is too cool to comfortably sit or stand outdoors. They are used extensively in restaurants with outdoor seating areas to enable the areas to be used for a greater number of weeks each year. They are also used where attendants, such as those working for a valet parking service, wait outdoors. Exhibit 10.4 depicts typical patio heaters.

A minimum 5 ft (1.5 m) separation between patio heaters and exits in assembly occupancies is specified by 69.3.13.1.3 and recognizes that patio heaters are commonly used in restaurants. The term *assembly occupancy* is defined in Chapters 3 and 6. While restaurants are the most likely assembly occupancies to use patio heaters in outdoor areas, other assembly occupancies might use them as well.

Exhibit 10.4

Patio heaters. (Courtesy of Richard Fredenberg, North Carolina Department of Agriculture and Consumer Services)

Exhibit 10.5

Sky lanterns. (Solarseven/shutterstock)

10.10.8 Incinerators and Fireplaces.

10.10.8.1 Incinerators, outdoor fireplaces, permanent barbecues, and grills shall not be built, installed, or maintained without prior approval of the AHJ.

10.10.8.2 Incinerators, outdoor fireplaces, permanent barbecues, and grills shall be maintained in good repair and in a safe condition at all times.

10.10.8.3 Openings in incinerators, outdoor fireplaces, permanent barbecues, and grills shall be provided with an approved spark arrester, screen, or door.

10.10.9 Open-Flame Devices.

10.10.9.1* Welding torches, tar pots, decorative torches, and other devices, machines, or processes liable to start or cause fire shall not be operated or used in or upon any areas, except by permit from the AHJ.

Δ **A.10.10.9.1** Areas for such use can include inhabited premises or designated campsites that maintain a defensible space in accordance with NFPA 1144.

10.10.9.2 Flame-employing devices, such as lanterns or kerosene road flares, and fuses shall not be operated or used as a signal or marker in or upon any areas unless at the scene of emergencies or railroad operations. *(See Chapter 16 and Chapter 65 for additional guidance.)*

10.10.9.3 The use of unmanned, free-floating sky lanterns and similar devices utilizing an open flame shall be prohibited.

The provision of 10.10.9.3 was new to the 2015 edition of the *Code* and gives the AHJ specific language that can be cited to prohibit the use of unmanned, free-floating sky lanterns and similar devices, such as those depicted in Exhibit 10.5. The potential hazard posed by sky lanterns should be obvious — once ignited and released, the device becomes an uncontrolled, flying ignition source, whose direction of travel is dependent on the wind direction, which can change unpredictably. Although the combustible fuel load of the device itself might be small, the potential exists for the device to ignite vegetation or other combustibles in the area and cause a significant fire if it is not quickly extinguished.

10.10.10* Discontinuance. The AHJ shall be authorized to require any fire or smoke to be immediately discontinued if the fire is determined to constitute a hazardous condition.

N **A.10.10.10** A hazardous condition is intended to include any fire that generates smoke or products of combustion that could obstruct visibility in traffic, create health issues, damage property, or contribute to conditions that create property, safety, or health hazards. As numerous variables can go into this determination, the authority having jurisdiction will need to evaluate each situation on a case-by-case basis.

10.11 Fire Protection Markings

10.11.1* Premises Identification.

N **A.10.11.1** An additional means to identify the locations of new and existing buildings is to co-geolocate each building with U.S. National Grid 108 ft^2 (10 m^2) coordinates to the primary entrance.

10.11.1.1* New and existing buildings shall have approved address numbers placed in a position to be plainly legible and visible from the street or road fronting the property.

A.10.11.1.1 Where a building is not routinely identified by a street address, other means of building identification such as building name or number should be permitted.

Exhibit 10.6

Address number.

To assist emergency responders in locating properties, building address numbers must be visible from the street. Address numbers can be mounted either on the building itself or, if the building is not visible from the street, on a post located on the street. The numbers should contrast with the background of the building or post and be large enough to be easily seen from the street. Exhibit 10.6 depicts an example of effective address numbers.

N **10.11.1.2** Address numbers shall be a minimum of 4 in. (100 mm) high with a minimum stroke width of ½ in. (13 mm).

N **10.11.1.3*** Telecommunications equipment utilized to communicate address data to E911 communication centers shall be programmed and maintained to accurately convey such address information to the E911 communication center.

N **A.10.11.1.3** E911, or Enhanced 911, attempts to automatically associate a location with a call's origin. The location could be a physical address or a geographic reference point. When E911 is in place, the address or geographic reference point is transmitted to the public safety answering point (PSAP). Paragraph 10.11.1.xx ensures that telecommunications equipment that is part of the transmission path is programmed to communicate correct address information to the E911 PSAP. It is not the intent of this provision to require E911 capability of the telecommunications equipment where the PSAP is not capable of receiving such data.

N **10.11.1.4** The assignment of addresses to buildings shall be in accordance with a method approved by the AHJ.

N **10.11.1.5** Addresses shall not be changed unless approved by that AHJ.

N **10.11.1.6** Address numbers for suites within a multiple tenant building or complex shall be individually identified in a manner approved by the AHJ.

10.11.1.7 Address numbers shall contrast with their background.

10.11.1.8 Address numbers shall be arabic numerals or alphabet letters.

Paragraphs 10.11.1.2 through 10.11.1.8 are new to the 2018 edition of the *Code* and expand and further clarify the existing requirements for premises identification. Details such as minimum height and width for address numbers help to ensure a reasonable level of visibility to emergency responders. Paragraph 10.11.1.1 requires only that addresses be plainly legible and visible from the street, which could result in conflict and differences of opinion.

Proper programing of telecommunications equipment to convey correct address information in the event of an E911 call is imperative. Incorrect information can result in a delayed response to a fire, medical, or other emergency. The code should require owners/occupants to do their part in ensuring that their chain in the E911 communication is correct and maintained.

Assignment of addresses to buildings and changes of addresses to existing buildings can create significant difficulties for emergency responders if a consistent approach is not utilized. Maintaining a current addressing methodology is becoming increasingly important as addressing databases are being used in new technology application during a response, such as a geographic information system (GIS). The AHJ should have a formal initial addressing mechanism and method to review and approve changes to existing addresses in order to ensure that databases are maintained and response times are not adversely affected.

In previous editions of the *Code*, 10.11.1 has not provided any provision for the addressing of individual suites in a multiple-tenant environment. A shopping center could have one single address, displayed at the street in accordance with 10.11.1.1, but specific suites that are unidentified could still have been in compliance with 10.11.1.1. That created the potential for significant delays in response times by emergency responders trying to locate a particular suite within a multiple-suite complex. New 10.11.1.6 clarifies that address numbers for suites within a multiple-tenant building or complex are to be individually identified in a manner approved by the AHJ.

10.11.2 Shaftways to Be Marked for Fire Fighter Safety.

10.11.2.1 Every outside opening accessible to the fire department that opens directly on any hoistway or shaftway communicating between two or more floors in a building shall be plainly marked with a sign in accordance with 10.11.2.2 and 10.11.2.3.

Markings are required to protect fire fighters from falling into a shaftway. Paragraph 10.11.2.1 requires exterior shaft openings to be marked where the shaft connects two or more stories. For added safety, all openings to shaftways, whether interior or exterior, should be marked to alert persons to the potential hazard.

10.11.2.2 Shaftway signs shall be in red letters at least 6 in. (152 mm) high on a white background stating "SHAFTWAY."

10.11.2.3 Such warning signs shall be placed so as to be readily discernible from the outside of the building.

FIGURE A.10.11.3 *Example of a Stairway Marking Sign. [**101:**Figure A.7.2.2.5.4]*

10.11.3* Stairway Identification.

A.10.11.3 Figure A.10.11.3 shows an example of a stairway marking sign. [***101:***A.7.2.2.5.4]

10.11.3.1 New enclosed stairs serving three or more stories and existing enclosed stairs other than those addressed in 10.11.3.1.16, serving five or more stories shall comply with 10.11.3.1.1 through 10.11.3.1.15. [***101:***7.2.2.5.4.1]

10.11.3.1.1 The stairs shall be provided with special signage within the enclosure at each floor landing. [***101:***7.2.2.5.4.1(A)]

10.11.3.1.2 The signage shall indicate the floor level. [***101:***7.2.2.5.4.1(B)]

10.11.3.1.3 The signage shall indicate the terminus of the top and bottom of the stair enclosure. [***101:***7.2.2.5.4.1(C)]

10.11.3.1.4 The signage shall indicate the identification of the stair enclosure. [***101:***7.2.2.5.4.1(D)]

10.11.3.1.5 The signage shall indicate the floor level of, and the direction to, exit discharge. [***101:***7.2.2.5.4.1(E)]

10.11.3.1.6 The signage shall be located inside the stair enclosure. [***101:***7.2.2.5.4.1(F)]

10.11.3.1.7 The bottom of the signage shall be located a minimum of 48 in. (1220 mm) above the floor landing and the top of the signage shall be located a maximum of 84 in. (2135 mm) above the floor landing. [***101:***7.2.2.5.4.1(G)]

10.11.3.1.8 The signage shall be in a position that is visible from within the stair enclosure when the door is in the open or closed position. [***101:***7.2.2.5.4.1(H)]

10.11.3.1.9 The signage shall comply with 14.14.8.1 and 14.14.8.2. [***101:***7.2.2.5.4.1(I)]

Δ **10.11.3.1.10** The floor level designation shall also be tactile in accordance with ICC/ANSI A117.1, *Accessible and Usable Buildings and Facilities*. [***101:***7.2.2.5.4.1(J)]

10.11.3.1.11 The signage shall be painted or stenciled on the wall or on a separate sign securely attached to the wall. [***101:***7.2.2.5.4.1(K)]

10.11.3.1.12 The stairway identification shall be located at the top of the sign in minimum 1 in. (25 mm) high lettering and shall be in accordance with 14.14.8.2. [***101:***7.2.2.5.4.1(L)]

10.11.3.1.13* Signage that reads NO ROOF ACCESS shall designate stairways that do not provide roof access. Lettering shall be a minimum of 1 in. (25 mm) high and shall be in accordance with 14.14.8.2. [***101:***7.2.2.5.4.1(M)]

A.10.11.3.1.13 It is not the intent to require a sign that reads ROOF ACCESS, as such message might be misinterpreted by building occupants as an alternative egress route. However, signs that read ROOF ACCESS are not prohibited, as many such signs have been installed in existing buildings so as to make a requirement for removal impractical. Historically, the ROOF ACCESS sign has provided information for the fire department. Where there is no roof access, such information will be posted via a NO ROOF ACCESS sign. The absence of the NO ROOF ACCESS sign should be understood by the fire department to mean that roof access is possible. [***101:***A.7.2.2.5.4.1(M)]

10.11.3.1.14 The floor level number shall be located below the stairway identifier in minimum 5 in. (125 mm) high numbers and shall be in accordance with 14.14.8.2. Mezzanine levels shall have the letter "M" or other appropriate identification letter preceding the floor number, while basement levels shall have the letter "B" or other appropriate identification letter preceding the floor level number. [***101:***7.2.2.5.4.1(N)]

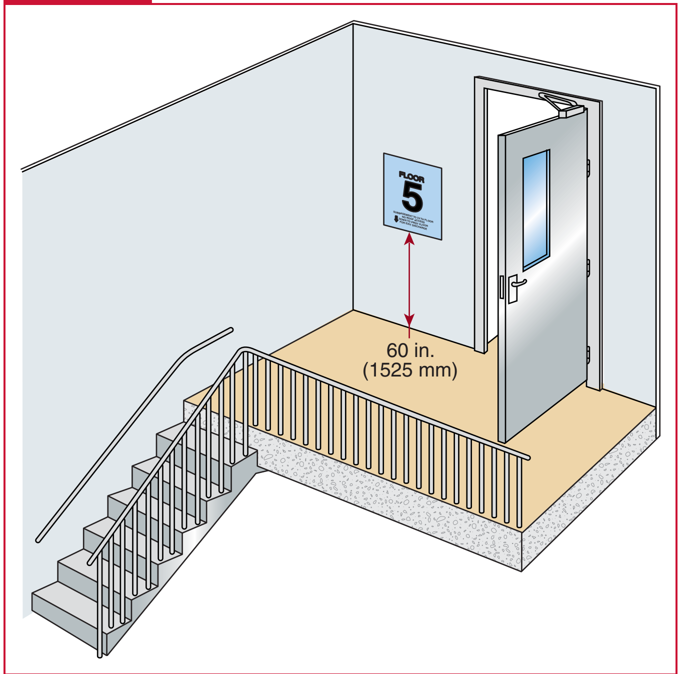
10.11.3.1.15 Identification of the lower and upper terminus of the stairway shall be on the sign in minimum 1 in. (25 mm) high letters or numbers and shall be in accordance with 14.14.8.2. [***101:***7.2.2.5.4.1(O)]

10.11.3.1.16 Previously approved, existing signage shall not be required to comply with 10.11.3.1.12 through 10.11.3.1.15. [***101:***7.2.2.5.4.1(P)]

The provisions of 10.11.3.1 require the posting of important information at each floor landing in each stairwell if a new stair serves three or more stories or an existing stair serves five or more stories. The information is for fire-fighting personnel and building occupants in an emergency. The term *signage* is used to signify that the required information might appear on multiple signs mounted adjacent to each other. The information most helpful to fire fighters can be put on one sign, and the information most useful to occupants on another. See Figure A.10.11.3.

The signage must identify the stair, indicate the floor level of the landing [this element additionally must be tactile per 10.11.3.1.10] and where the stairwell terminates at the top and bottom, and identify and show the direction to the exit discharge.

Exhibit 10.7



Stair sign placement.

Exhibit 10.8

Stairway identification sign with tactile floor level designator.

Exhibit 10.7 illustrates the placement required to ensure that the sign is readily visible, whether the door leaf is open or closed.

The indication of the direction to the level of exit discharge can be extremely useful to occupants of a building, especially if the occupants are below the level of exit discharge. The natural tendency of occupants is to attempt egress by traveling downward in a stair; this is counterproductive where the exit discharge is located on an upper level. Also, many buildings have multiple levels of entrance, which create confusion with respect to travel direction in a given stair.

The requirements of 10.11.3 are not exempted for existing buildings, because it is feasible and cost effective to install signs providing the required information. Because stair enclosures are usually not as aesthetically well finished as occupied portions of a building, the requirement for the signage (other than for the tactile floor level designator) is often met by stenciling the information directly onto the walls.

The provision of 10.11.3.1.13 was revised for the 2009 edition of the *Code*. In prior editions, roof access or lack of roof access was required to be designated by a sign. In many cases, roof access was provided for emergency responders only, and a sign reading "Roof Access" was misleading to building occupants. The current provision requires that only the lack of roof access be designated by a sign.

The provision of 10.11.3.1.7 was new to the 2015 edition of the *Code*. It replaced a provision that required the signage to be located approximately 60 in. (1525 mm) above the floor landing. The *Code* user now has a definitive height range for placement of the sign above the floor landing. Other criteria were moved or combined for clarification.

The provision of 10.11.3.1.16 is needed so that signs installed prior to 2009, when subitems (L) through (O) were added, are not unfairly reclassified as noncompliant.

The provision of 10.11.3.1.8 was revised for the 2018 edition of the *Code* to add the words "from within the stair enclosure," because misinterpretations were being made that occupants must be able to see the sign before entering the exit stair enclosure.

Exhibit 10.8 shows a stairway identification sign with the information required by 10.11.3.1. The element reading *Level 2* was provided for compliance with 10.11.3.1.2, which requires that the signage indicate the floor level, and for compliance with 10.11.3.1.10, which requires that the floor level designation also be tactile in accordance with ICC/ANSI A117.1, *Accessible and Usable Buildings and Facilities*. The minimum 5 in. (125 mm) high floor level number — the large *2* in this case — that was provided for compliance with 10.11.3.1.14 cannot serve as the tactile floor level designation because ICC/ANSI A117.1 limits raised characters to being not more than 2 in. (51 mm) in height. Further, the floor level designation is provided in braille below the tactile element, because ICC/ANSI A117.1 requires that raised letters be duplicated in braille.

Δ **10.11.3.2** Wherever an enclosed stair requires travel in an upward direction to reach the level of exit discharge, special signs with directional indicators showing the direction to the level of exit discharge shall be provided at each floor level landing from which upward direction of travel is required, unless otherwise provided in 10.11.3.2.1 and 10.11.3.2.2, and both of the following also shall apply:

(1) Such signage shall comply with 14.14.8.1 and 14.14.8.2.
(2) Such signage shall be visible when the door leaf is in the open or closed position.

[***101:***7.2.2.5.4.2]

10.11.3.2.1 The requirement of 10.11.3.2 shall not apply where signs required by 10.11.3.1.1 are provided. [***101:***7.2.2.5.4.2(A)]

10.11.3.2.2 The requirement of 10.11.3.2 shall not apply to stairs extending not more than one story below the level of exit discharge where the exit discharge is clearly obvious. [***101:***7.2.2.5.4.2(B)]

10.11.3.3* Stairway Tread Marking. Where new contrasting marking is applied to stairs, such marking shall comply with all of the following:

(1) The marking shall include a continuous strip as a coating on, or as a material integral with, the full width of the leading edge of each tread.
(2) The marking shall include a continuous strip as a coating on, or as a material integral with, the full width of the leading edge of each landing nosing.
(3) The marking strip width, measured horizontally from the leading vertical edge of the nosing, shall be consistent at all nosings.
(4) The marking strip width shall be 1 in. to 2 in. (25 mm to 51 mm).

[***101:***7.2.2.5.4.3]

A.10.11.3.3 Where environmental conditions (such as illumination levels and directionality or a complex visual field that draws a person's attention away from stair treads) lead to a hazardous reduction in one's ability to perceive stair treads, they should be made of a material that allows ready discrimination of the number and position of treads. In all cases, the leading edges of all treads should be readily visible during both ascent and descent. A major factor in injury-producing stair accidents, and in the ability to use stairs efficiently in conditions such as egress, is the clarity of the stair treads as separate stepping surfaces. [***101:***A.7.2.2.5.4.3]

For stair nosing marking, surface-applied material, such as adhesive-backed tape and magnetic strips, should not be used, as it is not durable under the scuffing from users' feet and, in coming loose, it creates a tripping hazard. While a carefully applied and consistently maintained coating is acceptable, contrasting color or photoluminescent material integral with the nosings is preferable because of its permanence. See also 7.1.6.4 and 7.2.2.3.6 of NFPA *101* for slip resistance uniformity requirements, as well as prohibition of projections on the treads. [***101:***A.7.2.2.5.4.3]

Guidance on the use of photoluminescent marking is provided by ASTM E2030, *Guide for Recommended Uses of Photoluminescent (Phosphorescent) Safety Markings*. Additional marking, for example, at the side boundaries of the stair, should be applied in accordance with the guidance provided therein. [***101:***A.7.2.2.5.4.3]

10.11.3.4* Where new contrast marking is provided for stairway handrails, it shall be applied to, or be part of, at least the upper surface of the handrail; have a minimum width of ½ in. (13 mm); and extend the full length of each handrail. After marking, the handrail shall comply with 7.2.2.4.4 of NFPA *101*. Where handrails or handrail extensions bend or turn corners, the stripe shall be permitted to have a gap of not more than 4 in. (100 mm). [***101:***7.2.2.5.4.4]

A.10.11.3.4 Coatings and other applied markings, if used, should be durable for the expected usage, especially at end terminations of the marking and at changes in stair direction where usage is more extensive and hand forces are larger. [***101:***A.7.2.2.5.4.4]

The criteria of 10.11.3.3(1) through (4) are needed to prevent the marking strips from providing misleading cues to stair users that might make use of the stair less safe or more confusing than if the marking strips were not installed. For example, 10.11.3.3 (4) limits the marking strip to a maximum width of 2 in. (51 mm) to ensure that all but the leading edge of the tread is left unmarked, so a person using the stair in the downward direction sees individual tread edges and not one continuously marked sloping plane. The undesired continuously marked sloping plane would create a ramp effect, with no indication of the location of the leading edge of each tread. Exhibit 10.9 shows an outside stair where tread marking provided by paint application has worn away to the point that the tread locations are imperceptible.

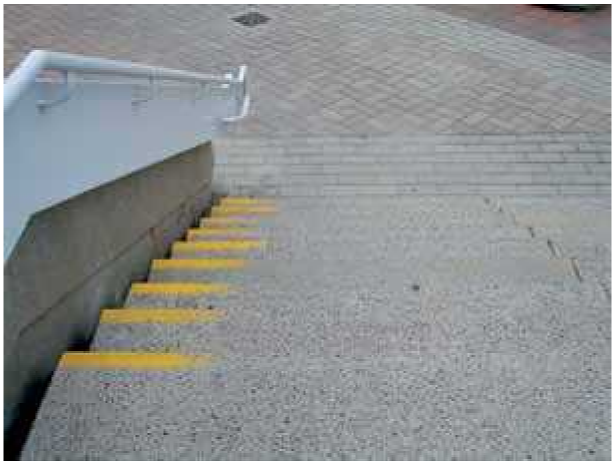
The provisions of 10.11.3.4 do not mandate that contrasting marking be applied to stair handrails. Where such contrast marking is provided for handrails, it regulates such installation so that the markings are useful and not misleading. For example, it requires that the marking stripe extend the full length of each handrail so the stair user can assess the extent of the stair flight before beginning any vertical movement on the stair.

Contrast marking, where applied, will usually be in the form of a photoluminescent or glow-in-the-dark material. See 7.2.2.5.5.10 of NFPA *101*. The third sentence of 10.11.3.4 permits short gaps in the contrast marking striping at handrail bends and turns in recognition of the fact that some photoluminescent materials are too rigid to be applied effectively at bends and turns.

10.11.3.5 These signs shall be maintained in an approved manner.

10.11.3.6 Existing approved signs shall be permitted.

Exhibit 10.9



Stair tread marking worn away so as to make tread location imperceptible. (Photo courtesy of Jake Pauls)

10.12 Seasonal and Vacant Buildings and Premises

Vacant buildings, such as the one shown in Exhibit 10.10, especially those of combustible construction, pose a hazard to adjacent exposures, fire fighters, and the community. For example, 6 fire fighters in Worcester, Massachusetts, died in late 1999 fighting a fire in an abandoned cold storage warehouse. More recently, 2 Chicago, Illinois, fire fighters died while fighting a fire in an abandoned warehouse on December 22, 2010, which, coincidentally, was the 100th anniversary of the 1910 Union Stockyard fire that killed 21 Chicago fire fighters.

Reducing the fuel load in a vacant building is critical because, in the event of a fire, little or no combustible contents should contribute to the spread of the fire. Seasonal buildings are exempt from the requirement for removal of combustibles by 10.12.1.1.

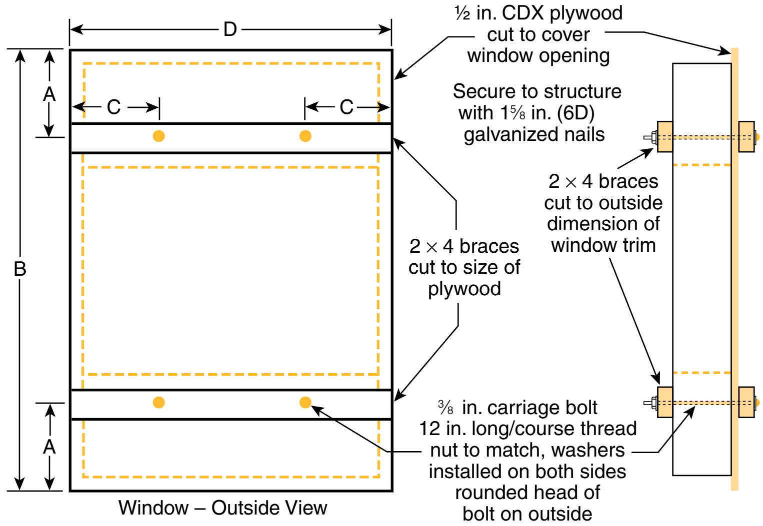
Vacant buildings are subject to vandalism and arson and, therefore, must be kept secure by placing substantial barricades on all doors, windows, and other openings at all levels where access can be gained. (See Exhibit 10.11.)

Barricades should be of plywood or other material acceptable to the AHJ. They should be screwed (not nailed) every 6 in. (152 mm), on center, around the entire perimeter of the barricade or should have substantial backer boards of at least 2 in. × 4 in. (51 mm × 102 mm) nominal dimension that span the opening, with ⅜ in. (10 mm) carriage bolts that are through-bolted to secure the plywood barricade in the opening. Sources of ignition or fuel such as energized electrical circuits, fuel gas lines, and heating appliances should be limited to those necessary to

Exhibit 10.10

Vacant building. (Source: © Acesarek, Dreamstime.com)

Exhibit 10.11



Notes:
1. For double hung windows, slide sash to center of unit and pass bolts through openings at top and bottom.
2. Storm windows ahould be removed and stored inside structure.
3. Outside trim may have to be removed to accommodate a flush and tight fit.
4. Tighten nuts from inside enough to slightly compress 2 × 4 brace.
5. Brace locations: A = ⅓B (SEE DIMENSION LOCATIONS ON DRAWING)
6. Location of bolt holes: C = ⅓D (SEE DIMENSION LOCATIONS ON DRAWING)

Suggested methods of barricading exterior windows or doors in a vacant building. (Courtesy of USFA) maintain fire protection systems in the building. During times when no tenants are in the building or when the building is being remodeled, security should be maintained at a level equal to that which would be provided to an occupied building or area.

For additional guidance in dealing with vacant/abandoned buildings, the United States Fire Administration and International Association of Arson Investigators have developed a free Abandoned Building Project Tool Box, available at www.interfire.org. It contains a background paper on the hazards posed, lesson plans and a PowerPoint presentation, a building evaluation form, a flowchart for identifying building owners, a template for developing floor plans, a reference list, specifications and drawings for securing buildings, and case studies.

10.12.1 Every person owning or having charge or control of any vacant building, premises, or portion thereof shall remove all combustible storage, waste, refuse, and vegetation and shall lock, barricade, or otherwise secure the building or premises to prohibit entry by unauthorized persons.

10.12.1.1 The requirement of 10.12.1 shall not apply to buildings used on a seasonal basis, or the temporary vacancy of a building for tenant change or remodeling purposes.

10.12.2 All fire protection systems shall be maintained in service in seasonal and vacant buildings, unless otherwise approved by the AHJ.

10.12.2.1* With the approval of the AHJ, fire protection and fire alarm systems in seasonal and vacant buildings shall be permitted to be removed from service.

A.10.12.2.1 Issues to be considered by the AHJ should include, but not be limited to, the availability of utilities to the building.

10.12.2.2 When required by the AHJ, other systems or components pertaining to fire protection shall be maintained.

All fire protection systems, including fire alarm, sprinkler, and standpipe systems, and all associated waterflow and supervisory alarm systems must be maintained in a manner acceptable to the AHJ. The maintenance of the associated alarm systems and supervisory systems is important to ensure that they are monitored properly and have the ability to transmit alarms when needed. In climates where freezing is of concern, the conversion from a wet sprinkler or standpipe system to a dry system might be necessary if heat is not maintained in the building.

Vacant buildings of totally fire-resistant construction that are void of any combustible contents and that pose no hazard to exposures might be exempt from maintaining fire alarm, sprinkler, and standpipe systems where approved by the AHJ.

Fire protection components referenced in 10.12.2.2 might include fire doors, fire barriers, and other passive and active systems.

10.12.3 The AHJ shall have the authority to require an inspection and test of any fire protection system or fire alarm system that has been out of service for 30 days or more before restored back into service.

Whenever a fire protection system is shut off for an extended period of time, an inspection and test of the system for system integrity are necessary before the system is put back in service. Wet pipe systems can develop leaks in gaskets, seals, and joints that have dried out from nonuse. Standpipe valves can be open, caps missing, or hose or threads damaged. Fire alarm system detection devices can accumulate dirt or develop battery problems if a proper charge is not maintained. When any system is out of service, the potential exists for damage or vandalism that might not be detected until the system is tested.

10.13 Combustible Vegetation

Combustible vegetation can include a variety of items, such as hay bales, limbs, leaves, and Christmas trees. These items, by their nature, are initially fire retardant. The problem arises when they have been cut and packaged without access to water for extended periods of time. The fire danger of Christmas trees and similar vegetation increases when the butt or bottom end of the tree is not freshly cut and immediately placed in water when purchased.

Other concerns include the length of time Christmas trees are on display (retail stores often set up outdoor displays of trees before Thanksgiving) and the misconception that fire retardants for Christmas trees are effective. The effectiveness of fire retardants on Christmas trees is a controversial issue, particularly when a fire marshal's approval is shown on a label. Research at the University of Washington indicates that most retardants are salt-based and actually accelerate the drying process. Trees that are displayed in water will fare better than those that are treated.

The species of tree and the rate of moisture loss are important factors in determining the extent of moisture loss. Of the various types of evergreen trees available, the Noble fir retains its moisture longer than other species.

The best preventive measures include using a freshly harvested tree, cutting the butt or bottom end immediately before placing it in water, and checking the water level frequently to ensure that the tree water container is filled. To check the tree itself for dryness, the person responsible for the display should periodically grasp a branch near the trunk and allow it to slide between the thumb and forefinger. When needles shed easily, the tree should be removed or replaced, since trees dry from the inside out. See "Pining for Water" in the November/December 1999 issue of *NFPA Journal*®.

10.13.1 Combustible vegetation, including natural cut Christmas trees, shall be in accordance with Section 10.13.

Christmas trees are prohibited or limited in their placement in occupancies that pose special problems due to the capabilities of occupants, occupant or management control, or the number of occupants. Some exceptions permit live, balled trees, if maintained, and trees in locations where automatic sprinkler systems

Δ *TABLE 10.13.1.1 Provisions for Christmas Trees by Occupancy*

Occupancy	No Trees Permitted	Cut Tree Permitted With Automatic Sprinkler Systems	Cut Tree Permitted Without Automatic Sprinkler Systems	Balled Tree Permitted
Ambulatory health care				X
Apartment buildings		Within unit	Within unit	X
Assembly	X			
Board and care	X			
Business		X		X
Day-care		X		X
Detention and correctional	X			
Dormitories	X			
Educational	X			
Health care				X
Hotels	X			
Industrial		X	X	X
Lodging and rooming				X
Mercantile		X		X
One and two family		X	X	X
Storage		X	X	X

are installed. Because a living tree needs moisture to stay alive, a balled, living tree should be placed in a container so that the root structure of the tree can be kept moist.

10.13.1.1 Christmas tree placement within buildings shall comply with Table 10.13.1.1.

10.13.2 In any occupancy, limited quantities of combustible vegetation shall be permitted where the AHJ determines that adequate safeguards are provided based on the quantity and nature of the combustible vegetation.

Subsection 10.13.2 permits limited quantities of combustible vegetation if the AHJ determines adequate safeguards are in place. Examples of common combustible vegetation include hay or straw, tree cuttings, flowers, leaves, and other decorative materials based on the particular season or holiday. Adequate safeguards might include sprinkler protection, limited quantities, moisture content, and placement. It is not the intent of the *Code* to permit a Christmas tree to be considered "limited quantity of combustible vegetation" where the display of Christmas trees is otherwise prohibited by Table 10.13.1.1.

10.13.3* Provisions for Fire Retardance for Artificial Vegetation.

Δ **A.10.13.3** One example of acceptable fire retardance is for the individual decorative vegetation item to exhibit a maximum heat release rate of 100 kilowatts (kW) when tested in accordance with UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, or NFPA 289 using the 20 kW ignition source. Another example of acceptable fire retardance is for the individual artificial Christmas trees, when exposed to the flames from 1 lb of shredded newspaper distributed around the tree, to meet the following three criteria:

(1) To have flames that do not extend more than 3 ft (0.9 m) above the tree
(2) To have no significant lateral flame spread away from the area affected by the ignition source
(3) To have no flaming droplets that continue flaming after reaching the floor

10.13.3.1 Artificial vegetation and artificial Christmas trees shall be labeled or otherwise identified or certified by the manufacturer as being fire retardant.

10.13.3.2 Such fire retardance shall be demonstrated by each individual decorative vegetation item, including any decorative lighting, in an approved manner.

10.13.4 Vegetation and Christmas trees shall not obstruct corridors, exit ways, or other means of egress.

No means of egress is permitted to be obstructed by any combustible vegetation item or Christmas tree. This provision is further reinforced by the requirements of Chapter 14. The preferred location for a Christmas tree from a property owner's perspective is often in the lobby, the reception area, or a similar area. However, trees located in these areas often encroach on the means of egress and present an increased danger.

10.13.5 Only listed electrical lights and wiring shall be used on natural or artificial combustible vegetation, natural or artificial Christmas trees, and other similar decorations.

10.13.6 Electrical lights shall be prohibited on metal artificial trees.

10.13.7 Open flames such as from candles, lanterns, kerosene heaters, and gas-fired heaters shall not be located on or near combustible vegetation, Christmas trees, or other similar combustible materials.

10.13.8 Combustible vegetation and natural cut Christmas trees shall not be located near heating vents or other fixed or portable heating devices that could cause it to dry out prematurely or to be ignited.

When determining where to place combustible vegetation items or Christmas trees, an important consideration is that they might fall over, especially if children or pets come in contact with the tree or vegetation. Placing a portable heater, other heat source, or heating vent near combustible vegetation is prohibited, because the vegetation might fall over and also because the heater will prematurely dry the vegetation, increasing the risk of a fire.

10.13.9 Provisions for Natural Cut Trees.

10.13.9.1 Where a natural cut tree is permitted, the bottom end of the trunk shall be cut off with a straight fresh cut at least ½ in. (13 mm) above the end prior to placing the tree in a stand to allow the tree to absorb water.

10.13.9.2 The tree shall be placed in a suitable stand with water.

10.13.9.3 The water level shall be maintained above the fresh cut and checked at least once daily.

The tree water should be checked daily. Because new trees absorb water more rapidly than trees that have been displayed for some time, a newly displayed tree might need to be checked a few times per day in order to ensure that the water level is adequate. When the tree becomes dry, it should be removed immediately. See the National Institute of Standards and Technology (NIST) Building and Fire Research Laboratory's Fire Research Division website, fire.nist.gov/tree_fire.htm, for tree fire videos, including a video comparing the fire performance of a dry tree with that of a moist tree. In 2015, a live burn event at the U.S. Consumer Product Safety Commission's research lab in Rockville, MD showed just how fast a dried-out Christmas tree will burn. Footage of the burn can be seen at https://community.nfpa.org/community/safety-source/blog/2015/12/10/live-burn-shows-just-how-quickly-christmas-tree-fires-can-turn-devastating-and-deadly.

10.13.9.4* The tree shall be removed from the building immediately upon evidence of dryness.

A.10.13.9.4 A method to check for dryness is to grasp a tree branch with a reasonably firm pressure and pull your hand to you, allowing the branch to slip through your grasp. If the needles fall off readily, the tree does not have adequate moisture content and should be removed.

10.13.10 Exterior Vegetation.

10.13.10.1 Cut or uncut weeds, grass, vines, and other vegetation shall be removed when determined by the AHJ to be a fire hazard.

Exhibit 10.12

Example of vegetation close to a building.

Paragraph 10.13.10.1 is not intended to prohibit landscaping around buildings or in other areas. This requirement addresses unmaintained materials such as weeds, grass, and brush. (See Exhibit 10.12.) In many instances, fire has spread either into an area or a building or between areas or buildings because of vegetation that has grown up around a building. Vegetation should be removed from around buildings, storage areas, and other areas to prevent the spread of fire. Fires have occurred in wood chips and mulch placed around buildings and then extended to the buildings. See Chapter 17 for additional guidance.

10.13.10.2 When the AHJ determines that total removal of growth is impractical due to size or environmental factors, approved fuel breaks shall be established.

10.13.10.3 Designated areas shall be cleared of combustible vegetation to establish the fuel breaks.

10.14 Special Outdoor Events, Carnivals, and Fairs

10.14.1 Permits. Permits, where required, shall comply with Section 1.12.

Per Table 1.12.8(a), permits are required for conducting a carnival or fair; operation of a crop maze; use of a parade float for public performance, presentation, spectacle, entertainment, or parade; and for the location and operation of special outdoor events.

10.14.2 The AHJ shall be permitted to regulate all outdoor events such as carnivals and fairs as it pertains to access for emergency vehicles; access to fire protection equipment; placement of stands, concession booths, and exhibits; and the control of hazardous conditions dangerous to life and property.

10.14.3 Life Safety Evaluation. The AHJ shall be permitted to order a life safety evaluation in accordance with this subsection.

The life safety evaluation (LSE) detailed in 10.14.3 is required by NFPA *101* under any of three conditions:

1. Where the occupant load exceeds 6000 persons — see 12/13.1.7.3 and 12/13.1.7.4 of NFPA *101*
2. Where indoor festival seating (i.e., a form of general admission) is used for more than 250 persons — see 12/13.2.5.4.1(2) NFPA *101*
3. Where a reduction in egress path sizing occurs for the special arrangement known as smoke-protected assembly seating — see 12/13.4.2.2 NFPA *101*

The LSE provisions of 10.14.3 were expanded for the 2015 edition of the *Code* to improve their utility. Historically the LSE was performed, approved by the AHJ, updated for special or unusual conditions as needed, and presented to the AHJ for re-approval on a yearly basis. The LSE was lacking in that it did not tie together, at the time the facility was designed and built, the physical elements and how the facility was to be managed.

For the 2015 edition of the *Code*, a new assembly venue subject to the LSE must be assessed prior to construction to ensure that the needed physical elements are part of the design. Also, facility management must be evaluated prior to building occupancy. The expanded LSE provisions help to facilitate better communication among the designers and those who manage the facilities after construction. The goal is to provide managers with safety systems that are compatible with actual building use.

The LSE provisions of 10.14.3 are intended to apply to both new and existing assembly occupancies, other than those related to preconstruction criteria, which only apply to new assembly occupancies. In addition to the building systems and facility management assessments, the LSE criteria include requirements for a life safety narrative, floor plans, engineering analysis and calculations, operational plans, and systems reference guide.

Δ **10.14.3.1* General.** Where a life safety evaluation is required by other provisions of the *Code*, it shall comply with all of the following:

(1) The life safety evaluation shall be performed by persons acceptable to the AHJ.
(2) The life safety evaluation shall include a written assessment of safety measures for conditions listed in 10.14.3.2 and of the building systems and facility management in accordance with 10.14.3.3.
(3) The life safety evaluation shall be approved annually and shall be updated for special or unusual conditions in accordance with the provisions of 13.4.1 of NFPA *101* for existing assembly occupancies.

[***101:***12.4.1.1]

A.10.14.3.1 Life safety evaluations are examples of performance-based approaches to life safety. In this respect, significant guidance in the form and process of life safety evaluations is provided by Chapter 5 of NFPA *101*, keeping in mind the fire safety emphasis in Chapter 5 of NFPA *101*. Performance criteria, scenarios, evaluation, safety factors, documentation, maintenance, and periodic assessment (including a warrant of fitness) all apply to the broader considerations in a life safety evaluation. A life safety evaluation deals not only with fire but also with storms, collapse, crowd behavior, and other related safety considerations for which a checklist is provided in A.10.14.3.3. Chapter 5 of NFPA *101* provides guidance, based on fire safety requirements, for establishing a documented case showing that products of combustion in all conceivable fire scenarios will not significantly endanger occupants using means of egress in the facility (for example, due to fire detection, automatic suppression, smoke control, large-volume space, or management procedures). Moreover, means of egress facilities plus facility management capabilities should be adequate to cope with scenarios where certain egress routes are blocked for some reason. [***101:***A.12.4.1.1]

In addition to making realistic assumptions about the capabilities of persons in the facility (e.g., an assembled crowd including many disabled persons or persons unfamiliar with the facility), the life safety evaluation should include a factor of safety of not less than 2.0 in all calculations relating to hazard development time and required egress time (the combination of flow time and other time needed to detect and assess an emergency condition, initiate egress, and move along the egress routes). The factor of safety takes into account the possibility that half of the egress routes might not be used (or be usable) in certain situations. [***101:***A.12.4.1.1]

Regarding crowd behavior, the potential hazards created by larger masses of people and greater crowd densities (which can be problematic during ingress, occupancy, and egress) demand that technology be used by designers, managers, and authorities responsible for buildings to compensate for the relaxed egress capacity provisions of Table 12.4.2.3 of NFPA *101*. In very large buildings for assembly use, the hazard of crowd crushes can exceed that of fire or structural failure. Therefore, the building designers, managers, event planners, security personnel, police authorities, and fire authorities, as well as the building construction authorities, should understand the potential problems and solutions, including coordination of their activities. For crowd behavior, this understanding includes factors of space, energy, time, and information, as well as specific crowd management techniques, such as metering. Published guidance on these factors and techniques is found in the *SFPE Handbook of Fire Protection Engineering*, Section 3, Chapter 13, pp. 3-342–3-366 (Proulx, G., "Movement of People"), and the publications referenced therein. [***101:***A.12.4.1.1]

Table 12.2.3.2 and Table 12.4.2.3 of NFPA *101* are based on a linear relationship between number of seats and nominal flow time, with not less than 200 seconds (3.3 minutes) for 2000 seats plus 1 second for every additional 50 seats up to 25,000. Beyond 25,000 total seats, the nominal flow time is limited to 660 seconds (11 minutes). Nominal flow time refers to the flow time for the most able group of patrons; some groups less familiar with the premises or less able groups might take longer to pass a point in the egress system. Although three or more digits are noted in the tables, the resulting calculations should be assumed to provide only two significant figures of precision. [***101:***A.12.4.1.1]

Δ **10.14.3.2 Conditions to Be Assessed.** Life safety evaluations shall include an assessment of all of the following conditions and related appropriate safety measures:

(1) Nature of the events and the participants and attendees
(2) Access and egress movement, including crowd density problems
(3) Medical emergencies
(4) Fire hazards
(5) Permanent and temporary structural systems
(6) Severe weather conditions
(7) Earthquakes
(8) Civil or other disturbances
(9) Hazardous materials incidents within and near the facility
(10) Relationships among facility management, event participants, emergency response agencies, and others having a role in the events accommodated in the facility

[***101:***12.4.1.2]

10.14.3.3* Building Systems and Facility Management Assessments. Life safety evaluations shall include assessments of both building systems and facility management upon which reliance is placed for the safety of facility occupants, and such assessments shall consider scenarios appropriate to the facility. [***101:***12.4.1.3]

A.10.14.3.3 Factors to be considered in a life safety evaluation include the following:

(1) Nature of the events being accommodated, including the following:
  (a) Ingress, intra-event movement, and egress patterns
  (b) Ticketing and seating policies/practices
  (c) Event purpose (e.g., sports contest, religious meeting)
  (d) Emotional qualities (e.g., competitiveness) of event
  (e) Time of day when event is held
  (f) Time duration of single event
  (g) Time duration of attendees' occupancy of the building
(2) Occupant characteristics and behavior, including the following:
  (a) Homogeneity
  (b) Cohesiveness
  (c) Familiarity with building
  (d) Familiarity with similar events
  (e) Capability (as influenced by factors such as age, physical abilities)
  (f) Socioeconomic factors
  (g) Small minority involved with recreational violence
  (h) Emotional involvement with the event and other occupants
  (i) Use of alcohol or drugs
  (j) Food consumption
  (k) Washroom utilization
(3) Management, including the following:
  (a) Clear, contractual arrangements for facility operation/use as follows:
    i. Between facility owner and operator
    ii. Between facility operator and event promoter
    iii. Between event promoter and performer
    iv. Between event promoter and attendee
    v. With police forces
    vi. With private security services
    vii. With ushering services
  (b) Experience with the building
  (c) Experience with similar events and attendees
  (d) Thorough, up-to-date operations manual
  (e) Training of personnel
  (f) Supervision of personnel
  (g) Communications systems and utilization
  (h) Ratios of management and other personnel to attendees
  (i) Location/distribution of personnel
  (j) Central command location
  (k) Rapport between personnel and attendees
  (l) Personnel support of attendee goals
  (m) Respect of attendees for personnel due to the following:
    i. Dress (uniform) standards
    ii. Age and perceived experience
    iii. Personnel behavior, including interaction
    vi. Distinction between crowd management and control
    v. Management concern for facility quality (e.g., cleanliness)
    vi. Management concern for entire event experience of attendees (i.e., not just during the occupancy of the building)
(4) Emergency management preparedness, including the following:
  (a) Complete range of emergencies addressed in operations manual
  (b) Power loss
  (c) Fire
  (d) Severe weather
  (e) Earthquake
  (f) Crowd incident
  (g) Terrorism
  (h) Hazardous materials
  (i) Transportation accident (e.g., road, rail, air)
  (j) Communications systems available
  (k) Personnel and emergency forces ready to respond
  (l) Attendees clearly informed of situation and proper behavior
(5) Building systems, including the following:
  (a) Structural soundness
  (b) Normal static loads
  (c) Abnormal static loads (e.g., crowds, precipitation)
  (d) Dynamic loads (e.g., crowd sway, impact, explosion, wind, earthquake)
  (e) Stability of nonstructural components (e.g., lighting)
  (f) Stability of movable (e.g., telescoping) structures
  (g) Fire protection
  (h) Fire prevention (e.g., maintenance, contents, housekeeping)
  (i) Compartmentation
  (j) Automatic detection and suppression of fire

(k) Smoke control
(l) Alarm and communications systems
(m) Fire department access routes and response capability
(n) Structural integrity
(o) Weather protection
(p) Wind
(q) Precipitation (attendees rush for shelter or hold up egress of others)
(r) Lightning protection
(s) Circulation systems
(t) Flowline or network analysis
(u) Waywinding and orientation
(v) Merging of paths (e.g., precedence behavior)
(w) Decision/branching points
(x) Route redundancies
(y) Counterflow, crossflow, and queuing situations
(z) Control possibilities, including metering
(aa) Flow capacity adequacy
(ab) System balance
(ac) Movement time performance
(ad) Flow times
(ae) Travel times
(af) Queuing times
(ag) Route quality
(ah) Walking surfaces (e.g., traction, discontinuities)
(ai) Appropriate widths and boundary conditions
(aj) Handrails, guardrails, and other rails
(ak) Ramp slopes
(al) Step geometries
(am) Perceptual aspects (e.g., orientation, signage, marking, lighting, glare, distractions)
(an) Route choices, especially for vertical travel
(ao) Resting/waiting areas
(ap) Levels of service (overall crowd movement quality)
(aq) Services
(ar) Washroom provision and distribution
(as) Concessions
(at) First aid and EMS facilities
(au) General attendee services

[***101:***A.12.4.1.3]

A scenario-based approach to performance-based fire safety is addressed in Chapter 5 of NFPA *101*. In addition to using such scenarios and, more generally, the attention to performance criteria, evaluation, safety factors, documentation, maintenance, and periodic assessment required when the Chapter 5 of NFPA *101* option is used, life safety evaluations should consider scenarios based on characteristics important in assembly occupancies. These characteristics include the following:

(1) Whether there is a local or mass awareness of an incident, event, or condition that might provoke egress
(2) Whether the incident, event, or condition stays localized or spreads
(3) Whether or not egress is desired by facility occupants
(4) Whether there is a localized start to any egress or mass start to egress
(5) Whether exits are available or not available

[***101:***A.12.4.1.3]

Examples of scenarios and sets of characteristics that might occur in a facility follow. [***101:***A.12.4.1.3]

Scenario 1. Characteristics: mass start, egress desired (by management and attendees), exits not available, local awareness. [***101:***A.12.4.1.3]

Normal egress at the end of an event occurs just as a severe weather condition induces evacuees at the exterior doors to retard or stop their egress. The backup that occurs in the egress system is not known to most evacuees, who continue to press forward, potentially resulting in a crowd crush. [***101:***A.12.4.1.3]

Scenario 2. Characteristics: mass start, egress not desired (by management), exits possibly not available, mass awareness. [***101:***A.12.4.1.3]

An earthquake occurs during an event. The attendees are relatively safe in the seating area. The means of egress outside the seating areas are relatively unsafe and vulnerable to aftershock damage. Facility management discourages mass egress until the means of egress can be checked and cleared for use. [***101:***A.12.4.1.3]

Scenario 3. Characteristics: local start, incident stays local, egress desired (by attendees and management), exits available, mass awareness. [***101:***A.12.4.1.3]

A localized civil disturbance (e.g., firearms violence) provokes localized egress, which is seen by attendees, generally, who then decide to leave also. [***101:***A.12.4.1.3]

Scenario 4. Characteristics: mass start, egress desired (by attendees), incident spreads, exits not available, mass awareness. [***101:***A.12.4.1.3]

In an open-air facility unprotected from wind, precipitation, and lightning, sudden severe weather prompts egress to shelter, but not from the facility. The means of egress congest and block quickly as people in front stop once they are under shelter while people behind them continue to press forward, potentially resulting in a crowd crush. [***101:***A.12.4.1.3]

These scenarios illustrate some of the broader factors to be taken into account when assessing the capability of both building systems and management features on which reliance is placed in a range of situations, not just fire emergencies. Some scenarios also illustrate the conflicting motivations of management and attendees, based on differing perceptions of danger and differing knowledge of hazards, countermeasures, and capabilities. Mass egress might not be the most appropriate life safety strategy in some scenarios, such as Scenario 2. [***101:***A.12.4.1.3]

Table A.10.14.3.3 summarizes the characteristics in the scenarios and provides a framework for developing other characteristics and scenarios that might be important for a particular facility, hazard, occupant type, event, or management. [***101:***A.12.4.1.3]

10.14.3.3.1 Building Systems. Prior to issuance of the building permit, the design team shall provide the AHJ with building systems documentation in accordance with 10.14.3.4. [***101:***12.4.1.3.1]

TABLE A.10.14.3.3 *Life Safety Evaluation Scenario Characteristics Matrix*

					Management		Occupants						
Scenario	**Local Awareness**	**Mass Awareness**	**Incident Localized**	**Incident Spreads**	**Egress Desired**	**Egress Not Desired**	**Egress Desired**	**Egress Not Desired**	**Local Start**	**Mass Start**	**Exits Available**	**Exits Not Available**	**Other**
1	X	—	—	—	X	—	X	—	—	X	—	X	—
2	—	X	—	—	—	X	—	—	—	X	—	X	—
3	—	X	X	—	X	—	X	—	X	—	X	—	—
4	—	X	—	X	—	—	X	—	—	X	—	X	—

[***101:*** Table A.12.4.1.3]

10.14.3.3.2 Facility Management. Prior to issuance of the certificate of occupancy, the facility management shall provide the AHJ with facility management documentation in accordance with 10.14.3.5. [***101:***12.4.1.3.2]

10.14.3.3.3 Life Safety Evaluation.

10.14.3.3.3.1 Prior to issuance of the building permit, the persons performing the life safety evaluation shall confirm that the building systems provide safety measures. [***101:***12.4.1.3.3.1]

10.14.3.3.3.2 Prior to issuance of the certificate of occupancy, the owner shall confirm that the facility management and operational plans provide appropriate safety measures. [***101:***12.4.1.3.3.2]

Δ **10.14.3.3.3.3** The life safety evaluation shall be performed by persons acceptable to the authority having jurisdiction. [***101:***12.4.1.3.3.3]

10.14.3.4 Life Safety Building Systems Document. The AHJ shall be provided with a life safety building systems document providing the information required in 10.14.3.4.2 through 10.14.3.4.4. [***101:***12.4.1.4]

10.14.3.4.1 Document Distribution. The persons performing the life safety evaluation, the AHJ, the A/E design team and the building owner shall receive a copy of the life safety building systems document prior to issuance of the building permit. [***101:***12.4.1.4.1]

Δ **10.14.3.4.2 Life Safety Narrative.** A life safety narrative shall be provided describing the following, as applicable:

(1) Building occupancy, construction type, and intended uses and events
(2) Building area and population capacity of the proposed facility
(3) Principal fire and life safety features/strategies for the building, including the following, as applicable:
 (a) Egress
 (b) Access control
 (c) Fire barriers, smoke barriers, and smoke partitions
 (d) Fire suppression systems
 (e) Smoke control/protection
 (f) Fire detection and alarm
 (g) PA system
 (h) Emergency elevator operation
 (i) Emergency power and lighting
 (j) Provisions for patrons with disabilities
 (k) Fire department access
 (l) Fire/emergency command center
(4) Exterior construction design parameters used/applied

[***101:***12.4.1.4.2]

Δ **10.14.3.4.3 Life Safety Floor Plans.** Life safety floor plans of each level shall be provided, as applicable, with the following:

(1) Occupant load, exit location, egress capacity, main entrance/exit, horizontal exits, travel distance and exit discharge
(2) Fire barriers, smoke barriers, and smoke partitions
(3) Areas of smoke protected assembly occupancy
(4) Separate smoke protected areas or zones
(5) Areas of other occupancy type and separations
(6) Unprotected vertical openings
(7) Event plans for each anticipated type of event depicting the following:
 (a) Seating configuration
 (b) Exhibit booth layout
 (c) Stage location
 (d) Occupant load, egress capacity required, exits provided and travel distance
 (e) Any floor or stage use restrictions
 (f) Plan and/or section drawing indicating where sprinkler protection is omitted
 (g) Areas of refuge — interior and exterior

[***101:***12.4.1.4.3]

Δ **10.14.3.4.4 Engineering Analysis and Calculations.** Where active or passive smoke control is used, an engineering analysis shall be provided and shall include the following:

(1) Smoke protection analysis to substitute the use of smoke-protected assembly seating as follows:
 (1) Performance-based design methods approved by the AHJ
 (2) Smoke control air requirements per NFPA 92

(3) Smoke control assumptions, such as fire scenario description, fire size quantification, and smoke development/smoke movement analysis
(4) Proposed testing protocol for smoke control system and pass/fail criteria
(5) Timed egress analysis
(6) Assumed flow rates and travel speeds

(2) Sprinkler protection calculations, including an engineering analysis substantiating locations in accordance with 12.3.5.3 where sprinkler protection would be ineffective due to height and combustible loading
(3) Load diagram of rigging/load capacity of gridiron, fly loft, or long-span roof structure used for hanging overhead objects

[***101:***12.4.1.4.4]

10.14.3.5 Life Safety Management Document. The AHJ shall be provided with a life safety management document providing the information required in 10.14.3.5.2 through 10.14.3.5.7. [***101:***12.4.1.5]

10.14.3.5.1 Document Distribution. The persons performing the life safety evaluation, the AHJ, the A/E design team and the building owner shall receive a copy of the life safety management document prior to issuance of the certificate of occupancy. [***101:***12.4.1.5.1]

10.14.3.5.2 Facility Management and Operational Plans. Facility management and operational plans shall address the following, as applicable:

(1) Best practices adopted or recognized
(2) Emergency plans
(3) Evacuation plans
(4) Shelter-in-place plans, including capacities and protection considerations
(5) Crowd management training plan
(6) Safety plans, which include the following:
  (a) Training plans
  (b) Safety equipment plans
(7) Fire alarm, smoke control system protocol and testing plans
(8) First aid or medical treatment plans, which include the following:
  (a) Defined levels of service
  (b) Standing orders adopted
  (c) Supply and equipment plan
(9) Housekeeping plans — biological, medical, hazardous materials cleaning
(10) Emergency communication plans, which include the following:
  (a) Chain of authority and incident command system employed
  (b) Contact information for the following:
    (i) Venue personnel
    (ii) Emergency management and response organizations (such as fire, police, medical, utility, transportation, and key stakeholders)
  (c) Communication systems
  (d) Standard announcement for incidents or emergency situations
(11) Risk and threat assessment for venue and surrounding area for the following:
  (a) Severe weather
  (b) Hazardous materials
  (c) Terrorism
  (d) Hostile intruder
(12) Operating procedures and protocols for risks, such as the following:
  (a) Severe weather preparedness and monitoring plans
  (b) Hazardous materials incidence response plans
  (c) Terrorism response plans
  (d) Hostile intruder response plans
(13) First responder response/arrival routes plans
(14) Alcohol management plans
(15) Food safety plans
(16) Rigging and temporary performance structure, which includes the following:
  (a) Design and safety review plans
  (b) Emergency action plans
(17) Chemical and hazardous materials information and data
(18) Barrier and wall protection plans for motor sports or similar events

[***101:***12.4.1.5.2]

Δ **10.14.3.5.3 Records.** Records of the facility management plans, including procedures and location, shall be maintained, for the following:

(1) Crowd management training
(2) Safety training
(3) Fire alarm, smoke control system maintenance, and test records
(4) First aid or medical treatment and regulation compliance

[***101:***12.4.1.5.3]

10.14.3.5.4 Building Systems Reference Guide. A building systems reference guide shall be provided in accordance with 10.14.3.5.4.1 through 10.14.3.5.4.3. [***101:***12.4.1.5.4]

10.14.3.5.4.1 A basic life safety building systems reference guide shall be developed and maintained. [***101:***12.4.1.5.4.1]

10.14.3.5.4.2 The life safety building systems reference guide shall contain the important and key information for the venue management's use when planning events/activities for the safety of patrons, performers/participants, employees and vendors. [***101:***12.4.1.5.4.2]

Δ **10.14.3.5.4.3** The life safety building systems document in accordance with 10.14.3.4 shall be permitted to be used, and additionally the life safety building systems reference guide shall include the following, as applicable:

(1) Occupant capacity of every space/room
(2) Egress flow diagrams, including assumed flow rates, and capacities of all aisles and hallways, including public and nonpublic areas
(3) Capacities of all exterior doors and/or choke points in immediate perimeter areas

(4) Limitations or assumptions for ingress control that could be in place during an emergency egress/evacuation, including control gates, queuing barriers, and turnstiles
(5) Capacities of immediate perimeter exterior walkways, including assumed flow rates for exterior areas
(6) Assumed egress paths for normal conditions — transportation modes
(7) Management-level sequencing charts for alarm and emergency communication systems, the manual, or override options/instructions that include the following:
   (a) List of codes or alarm signals
   (b) Location of manual overrides
   (c) Description of sequence of operations during an alarm, such as exhaust fans operate or doors open
(8) Principal fire and life safety features/strategies, such as sprinklers, smoke control, fire alarm notifications, PA system, emergency power, and fire department access
(9) Assumptions when developing occupancy plans for venue floor, open areas, and nonevent spaces, such as the following:
   (a) Event floor plans/setup diagrams for each typical event/activity
   (b) Fire sprinkler and smoke protection capabilities
(10) Severe weather shelter areas, locations, structure considerations (limitations), capacities (occupancy and density factor)
(11) Command center, which includes the following:
   (a) Location (formal or informal)
   (b) Structural integrity considerations
   (c) Redundant locations and/or capabilities
   (d) Jurisdictional rights — assumed and/or applied
(12) Locations and capacities of wheelchair and mobility-impaired seating
(13) Locations and capacities of areas of refuge and other safe areas
(14) Rigging or structural load capacities of grids, truss structure, fly lofts, ceilings, floors, ramps, and staging
(15) List of locations of emergency equipment such as fire extinguishers, fire hose cabinets, fire hydrants, and AEDs.
(16) Sequencing of electrical service, such as the following:
   (a) Emergency generators and charts of all areas illuminated during power outages
   (b) Multiple electrical feed capabilities
(17) List of mechanical, movable equipment in the facility
(18) Potential hazards in the surrounding neighborhood, including train tracks and propane stations
(19) Assumptions or accommodations considered and used in design

[***101:***12.4.1.5.4.3]

10.14.3.5.5 The facility management plans shall be maintained and adjusted as necessary for changes to the venue structure, operating purposes and style, and event occupancy. [***101:***12.4.1.5.5]

10.14.3.5.6 Facility management and operational plans shall be submitted to the AHJ annually. [***101:***12.4.1.5.6]

Δ **10.14.3.5.7** For events and activities at the venue that are outside the normal operating conditions or vary from the normal facility management plans, the following shall apply:

(1) Facility management shall perform an event/activity specific facility management plan for the AHJ to review.
(2) Approval of the AHJ for the specific facility management plan shall occur prior to such event.

[***101:***12.4.1.5.7]

10.14.4 Standby Fire Personnel. Where required by the AHJ, standby fire personnel shall be provided and comply with 1.7.17.

When needed to provide adequate protection of life and property due to special outdoor events, the AHJ can require that standby fire personnel be in attendance. The number and type of personnel are based on the type of event, the number of people in attendance, and other hazards present. See 1.7.17 for additional guidance.

10.14.5 Portable Fire Extinguishers. A minimum of one portable fire extinguisher shall be provided for each concession stand where required by the AHJ in accordance with Section 13.6.

Each concession stand, regardless of size, is required to be provided with a portable fire extinguisher. This provides easy access to a fire extinguisher without having to determine in which stand the extinguisher is located and avoids placing them in public areas where they could be blocked, tampered with, removed, or damaged.

10.14.6 Smoke Alarms. A minimum of one single station smoke alarm shall be located in all stock or equipment trailers when they are used for sleeping purposes.

Stock and equipment trailers are frequently used for sleeping purposes after they are unloaded. In these cases, as in all residential occupancies, smoke alarms are required to protect sleeping individuals in such trailers.

10.14.7 Electrical Equipment. Electrical equipment and installations shall comply with Section 11.1.

10.14.8 Cooking. Concession stands utilized for cooking shall have a minimum of 10 ft (3 m) of clearance on two sides and shall not be located within 10 ft (3 m) of amusement rides or devices.

Paragraph 10.14.8 requires cooking concession stands to be separated from other structures by a distance of not less than 10 ft (3 m). This distance might need to be increased based on the construction or makeup of the stands, fuels used, and combustible material present. Providing a minimum clearance distance on at least two sides of the concession stand helps to prevent a fire from spreading to adjacent concession stands in multiple directions, which could potentially impact occupant safety, egress, and/or fire department access in addition to the potential for the fire to grow and spread rapidly. Exhibit 10.13 shows a concession stand that is separated from the other concession stands by at least 10 ft (3 m) and also not located within 10 ft (3 m) of amusement rides.

Exhibit 10.13

Concession stands meeting the minimum 10 ft (3 m) clearance.

Exhibit 10.14

Entrance to a crop maze. (Courtesy of Town Stone Management Company, Inc.)

10.14.9 Communications. Where required by the AHJ, a method of notifying the fire department in the event of an emergency shall be provided.

10.14.9.1 Methods of notifying the fire department shall consist of a telephone, an alarm system connected to the fire department or other approved agency, or other approved means.

10.14.9.2 Methods of notifying the fire department shall be readily available to the public.

10.14.10 Internal Combustion Power Sources.

10.14.10.1 Fueling. Fuel tanks shall be of adequate capacity to permit uninterrupted operation during normal operating hours.

Refueling of internal combustion engines, such as generators, creates significant risk of fire. The intent of 10.14.10.1 is to prevent the fueling of generators and other fuel-fired equipment while people are in the area. Having an adequate fuel capacity for equipment that needs to operate for 12 hours or more might be impractical. In these cases, the AHJ should be consulted regarding refueling of equipment that is expected to be in operation for long periods of time, especially during special events or during long power outages.

10.14.10.2 Refueling. Refueling shall be conducted only when not in use.

10.14.10.3 Protection. Internal combustion power sources shall be isolated from contact with the public by either physical guards, fencing, or an enclosure.

Internal combustion power sources such as generators create many hazards, such as fuel, heat, noise, and electrical hazards. They should be located in isolated areas inaccessible to the public to prevent unauthorized access. Fences can serve to isolate these areas.

10.14.10.4 Fire Extinguishers. A minimum of one portable fire extinguisher with a rating of not less than 2-A:10-B:C shall be provided.

Section 10.14.10.4 requires a minimum of one portable fire extinguisher at the internal combustion power source, such as at the location of the generator. Requirements for fire extinguishers for the concession stand are addressed in 10.14.5.

10.14.11 Crop Maze.

Crop mazes pose unique fire safety problems due to their configuration (confusing paths and lack of marked egress) and the inherent combustibility of the maze materials. Exhibit 10.14 depicts the entrance to a crop maze.

10.14.11.1 Permits. Permits, where required, shall comply with Section 1.12.

10.14.11.2 General.

10.14.11.2.1 The owner or operator of a crop maze amusement attraction shall advise all employees of the fire and life safety regulations established in this subsection prior to the employees assuming their respective duties.

Employees need to be trained in the duties they are expected to perform and in emergency procedures, as outlined in 10.14.11.

10.14.11.2.2 The owner or operator of a crop maze or their employees shall provide safety instructions to the visitors and patrons of a crop maze prior to their entrance to the maze.

Safety instructions should be given to patrons visiting the crop maze. Written instructions or a briefing before patrons go into the maze can meet this requirement.

10.14.11.2.3 Employee Monitor.

10.14.11.2.3.1 A minimum of two employees shall be on duty to monitor a crop maze during hours of operation.

The size of a crop maze might dictate the need for more than two employees to monitor conditions effectively. These employees are in addition to other employees such as ticket takers, concession stand personnel, and other employees not directly monitoring the maze.

10.14.11.2.3.2 A minimum of one of the employees shall be located on an elevated platform a minimum of 10 ft (3 m) above the maze.

The requirement for the platform to be at least 10 ft (3 m) above the height of the maze permits employees to view the activity in the maze and where patrons are located. Employees can then direct people away from any hazard, stop unsafe activities, and direct emergency personnel in the event of fire or other emergency. Because most corn crops are 6 ft to 8 ft (1.8 m to 2.4 m) high, the platform will be over 18 ft (5.5 m) from ground level.

10.14.11.2.4 The owner or operator of a crop maze shall contact the local fire department and provide the fire department with the opportunity to prepare a pre-plan of the crop maze amusement attraction prior to the start of seasonal operations.

The fire department should be contacted prior to the opening of the attraction so it can prepare an incident preplan for the crop maze in the event it needs to respond to an emergency. In those instances where the fire department does not provide emergency medical service (EMS), the EMS provider should be contacted and should participate in the preplanning. Preplanning should consider severe weather events, since crop mazes are located outdoors.

10.14.11.2.5 Motorized vehicles shall not be parked within 75 ft (23 m) of a crop maze.

10.14.11.2.6 A fuel break of a minimum of 20 ft (6 m) wide shall be cleared between a crop maze and any vehicles or vegetation outside the maze.

10.14.11.2.7 Public Address System.

A means to communicate with crop maze patrons must be provided. This requirement is fairly easy and inexpensive to meet, since the *Code* permits portable bullhorns and loud speakers. Multiple bullhorns can be placed strategically around the maze for staff use.

10.14.11.2.7.1 A public address system shall be readily available to employees at a crop maze to assist them in making announcements to the visitors or patrons of a crop maze in the event of an emergency.

10.14.11.2.7.2 A bull horn or loud speaker shall suffice as a public address system.

10.14.11.2.8 The entrance and exit from a crop maze shall not be blocked or obstructed at any time the maze is open for business and occupied by the public.

10.14.11.2.9 No more than 200 persons per acre, including adults and children, shall occupy the crop maze at any one time.

Paragraph 10.14.11.2.9 provides an occupant load limitation for the crop maze. The occupant load should be determined before the maze opens to the public. A means to determine the number of patrons in the maze at any time needs to be established. Counters or tags, which are given to each person upon entry and collected upon leaving, can be used to meet this requirement. Such accountability also assists the fire department in the event of an emergency.

10.14.11.3 Prohibited.

10.14.11.3.1* No open flame-producing devices or equipment shall be permitted within the confines of the crop maze.

A.10.14.11.3.1 Visitors to the crop maze should only use flashlights, chemical lights, or similar devices to illuminate their travel through the maze. Candles, gas-fired lanterns, cigarette lighters, or similar open flame or flame-producing devices are prohibited for use inside a crop maze at all times.

10.14.11.3.2 No smoking shall be permitted within the confines of the crop maze.

Due to the combustible nature of crop mazes, all open flames, including lit cigarettes, machinery, candles, and lanterns, are prohibited from crop mazes and surrounding areas. The use of signage can assist in communicating the rules and regulations of the corn maze to patrons. Exhibit 10.15 shows a sign in a crop maze reminding patrons that smoking is prohibited.

10.14.11.4 Fireworks.

10.14.11.4.1 Fireworks shall not be discharged within a minimum of 300 ft (91 m) of any crop maze at any time.

Exhibit 10.15

"No Smoking" sign in a corn maze.

The requirement of 10.14.11.4.1 does not override the distance requirements in NFPA 1123, *Code for Fireworks Display*, which might require greater distances, based on shell size.

10.14.11.4.2 The use of display fireworks shall comply with Chapter 65 in addition to the requirements of 10.14.11.4.

10.15* Outside Storage

A.10.15 For additional guidance, see Chapter 34 for provisions for indoor and outdoor storage of material. Chapter 33 contains provisions for outside storage of tires.

For requirements on combustible waste and refuse stored outside, see Chapter 19.

10.15.1 Outside storage of combustible materials shall not be located within 10 ft (3 m) of a property line.

10.15.2 The separation distance shall be allowed to be reduced to 3 ft (0.9 m) for storage not exceeding 6 ft (1.8 m) in height.

10.15.3 The separation distance shall be allowed to be reduced where the AHJ determines that no hazard to the adjoining property exists.

10.15.4 Combustible material shall not be stored beneath a building or structure unless specifically constructed or protected for this purpose.

10.15.5 Combustible storage in the open shall not exceed 20 ft (6.1 m) in height.

10.16 Parade Floats

10.16.1 Permits. Permits, where required, shall comply with Section 1.12.

10.16.2 Fire Protection. Motorized parade floats and towing apparatus shall be provided with a minimum 2-A:10-B:C-rated portable fire extinguisher readily accessible to the operator.

Δ 10.17 Powered Industrial Trucks

Powered industrial trucks shall be operated and maintained in accordance with NFPA 505.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, applies to fork trucks, tractors, platform lift trucks, motorized hand trucks, and other specialized industrial trucks powered by electric motors or internal combustion engines. NFPA 505 does not apply to compressed air–operated or nonflammable compressed gas–operated industrial trucks, farm vehicles, or automotive vehicles for highway use. For the design and installation of the compressed natural gas (CNG) fuel systems on CNG-powered and dual fuel–powered (gasoline and CNG) industrial trucks, see NFPA 52, *Vehicular Natural Gas Fuel Systems Code*. For the design and installation of LP-Gas fuel systems on LP-Gas–powered and dual fuel–powered (gasoline and LP-Gas) industrial trucks, see NFPA 58, *Liquefied Petroleum Gas Code*.

10.18* Storage of Combustible Materials

A.10.18 See A.10.15.

10.18.1 General. Storage of combustible materials shall be orderly.

10.18.2 Permits. Permits, where required, shall comply with Section 1.12.

10.18.3 Ceiling Clearance.

10.18.3.1 Storage shall be maintained 2 ft (0.61 m) or more from the ceiling in nonsprinklered areas of buildings.

The 2 ft (0.61 m) clearance requirements for nonsprinklered buildings permits fire department hose streams to reach the ceiling. The 2 ft (0.61 m) clearance requirement does not apply to storage against walls.

10.18.3.2 The clearance between the deflector and the top of storage shall be 18 in. (450 mm) or greater. [**13:**8.6.6.1]

Sprinklers installed near wall-mounted shelves or piled storage located against a wall are not intended to be governed by the requirements of 10.18.3.2 (see Exhibit 10.16, left). The clear space beneath the sprinkler is needed for the spray pattern to fully develop to allow proper wetting of the floor and not the wall (see Exhibit 10.16, right).

Δ **10.18.3.3** The 18 in. (450 mm) dimension shall not limit the height of shelving on a wall or shelving against a wall in accordance with 10.18.3, of this *Code*, and 8.7.6, 8.8.6, and Section 8.9 of NFPA 13. [**13:**8.6.6.2]

10.18.3.3.1 Where shelving is installed on a wall and is not directly below sprinklers, the shelves, including storage thereon, shall be permitted to extend above the level of a plane located 18 in. (450 mm) below ceiling sprinkler deflectors. [**13:**8.6.6.2.1]

10.18.3.3.2 Shelving, and any storage thereon, directly below the sprinklers shall not extend above a plane located 18 in. (450 mm) below the ceiling sprinkler deflectors. [**13:**8.6.6.2.2]

The discharge pattern of upright and pendent spray sprinklers takes a parabolic shape. To ensure the distribution of water over the area that the sprinkler was designed to protect, the spray pattern must encounter minimal obstructions. Rack storage fire tests, other tests with solid-piled storage, and field experience

Exhibit 10.16

Examples of storage room clearances: (left) room with storage against wall extending to ceiling with sprinklers and (right) storage room with proper clearance below sprinklers.

have shown that standard spray sprinklers are effective with a minimum 18 in. (450 mm) clearance.

One example of the need to observe the clearance provisions required for special sprinklers or special design features is specified in the design provisions for miscellaneous storage in Chapter 13 of NFPA 13, *Standard for the Installation of Sprinkler Systems,* for Group A plastics. The design criteria for storage of Group A plastics vary as the clearance increases.

10.18.3.4 Where other standards specify greater clearance to storage minimums, they shall be followed. [**13:**8.6.6.3]

10.18.4 Means of Egress. Combustible material shall not be stored in exits.

An exit enclosure shall not be used for any purpose that has the potential to interfere with its use as an exit and, if so designated, as an area of refuge. See 14.3.3.

10.18.5 Equipment Rooms.

10.18.5.1 Combustible material shall not be stored in boiler rooms, mechanical rooms, or electrical equipment rooms.

10.18.5.2 Materials and supplies for the operation and maintenance of the equipment in the room shall be permitted.

The use of equipment rooms to store items, such as those needed for the equipment in the room, is normal. The storage of materials and supplies related to the operation of the equipment is permitted in accordance with 10.18.5.2. Equipment should be stored in cabinets or other protected areas to limit the hazard. Materials not associated with the equipment are not permitted to be stored within equipment rooms.

10.18.6 Attic, Under-Floor, and Concealed Spaces. Attic, under-floor, and concealed spaces used for storage of combustible materials shall comply with the protection from hazards requirements for storage rooms in NFPA *101*.

Areas not designed or protected as storage areas should not be used as storage areas unless provided with the proper protection, typically automatic sprinklers, rated separation, or both, as specified by Section 8.7 of NFPA *101* and the applicable occupancy chapters of NFPA *101*.

10.18.7 Fueled Equipment. Fueled equipment, including but not limited to motorcycles, mopeds, lawn-care equipment, and portable cooking equipment, shall not be stored, operated, or repaired within a building except under one of the following conditions:

(1) The building or room has been constructed for such use in accordance with the building code.
(2) The use is allowed by other provisions of this *Code*.

Buildings or areas within buildings that have not been designed to accommodate the storage and/or use of fueled equipment such as motorcycles, lawn mowers, and portable cooking equipment will not have the necessary construction or protection features necessary to accommodate for the hazards presented by that type of equipment. A building code will prescribe the minimum construction type as well as required protection from adjacent areas and other fire protection features, as necessary, to account for the presence of this type of equipment.

10.19 Indoor Children's Playground Structures

Δ **10.19.1** Structures intended as children's playgrounds installed indoors and exceeding 10 ft (3.1 m) in height or 160 ft^2 (14.9 m^2) in area shall comply with the specifications in 10.19.1.1 through 10.19.1.4.

Δ **10.19.1.1** Indoor children's playground structures shall be constructed of noncombustible materials or of combustible materials that comply with the following:

(1) Fire retardant–treated wood.
(2) Light-transmitting plastics complying with the requirements in 10.19.1.2.
(3) Foam plastics (including the pipe foam used in soft-contained play equipment structures) having a maximum heat-release rate not greater than 100 kW when tested in accordance with UL 1975 or NFPA 289 using the 20 kW ignition source.
(4) Aluminum composite material (ACM) meeting the requirements of Class A interior finish in accordance with Chapter 10 of NFPA *101* when tested as an assembly in the maximum thickness intended for use.
(5) Textiles and films complying with the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701.
(6) Plastic materials used to construct rigid components of soft-contained play equipment structures (such as tubes, windows, panels, junction boxes, pipes, slides, and decks) exhibiting a peak rate of heat release not exceeding 400 kW/m^2 when tested in accordance with ASTM E1354 at an incident heat flux of 0.24 in. 50 kW/m^2 in the horizontal orientation at a thickness of 0.24 in. (6 mm).
(7) Balls used in ball pools, in soft-contained play equipment structures, shall have a maximum heat release rate not greater than 100 kW when tested in accordance with UL 1975 or NFPA 289 using the 20 kW ignition source. The minimum specimen test size shall be 36 in. × 36 in. (0.91 m × 0.91 m) by an average of 21 in. (0.56 m) deep, and the balls shall be held in a box constructed of galvanized steel poultry netting wire mesh.
(8) Foam plastics shall be covered by fabric, coating, or film meeting the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701.
(9) The floor covering within the children's playground structure shall exhibit a Class I interior floor finish classification, as described in Chapter 10 of NFPA *101*, when tested in accordance with NFPA 253 or with ASTM E648, *Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*.

10.19.1.2* Light-transmitting plastics used for children's playgrounds shall meet all of the following criteria:

(1) They shall have a self-ignition temperature of 650°F (343°C) or greater when tested in accordance with ASTM D1929.
(2) They shall have a smoke developed index not greater than 450 when tested in the manner intended for use in accordance with ASTM E84, *Standard Test Method of Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, or not greater than 75 when tested in the thickness intended for use in accordance with ASTM D2843, *Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics*.
(3) They shall meet the criteria of one of the following classifications:
   (a) CC1 — Plastic materials that have a burn length of 1 in. (25 mm) or less and flame extinguishment when tested at a nominal thickness of 0.060 in. (1.5 mm), or in the thickness intended for use, in accordance with ASTM D635, *Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position*
   (b) CC2 — Plastic materials that have a burning rate of 2½ in./min (64 mm/min) or less when tested at a nominal thickness of 0.060 in. (1.5 mm), or at a thickness intended for use, in accordance with ASTM D635

Δ **A.10.19.1.2** The flame-retardant requirements for light-transmitting plastics can also be found in Chapter 48 of *NFPA 5000*.

10.19.1.3 Indoor children's playground structures shall have a minimum horizontal separation from other structures of 20 ft (6.1 m).

10.19.1.4 Indoor children's playground structures shall not exceed 300 ft^2 (28 m^2) in area, unless approved by the AHJ.

The requirements of Section 10.19 regulate the fire properties of materials used in the construction of indoor children's playground structures. The mazelike configuration will hinder evacuation in the event of a fire. Multilevel play structures are also considered special amusement buildings where they exceed 10 ft (3050 mm) in height and have aggregate horizontal projections exceeding 160 ft^2 (15 m^2) (see 20.1.4). Exhibit 10.17 depicts an indoor children's playground structure.

Exhibit 10.17

Indoor children's play structure. (Courtesy of Amazing Adventures Playland, Ontario, Canada)

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2013 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2014 edition.

NFPA 52, *Vehicular Gaseous Fuel Systems Code*, 2013 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2014 edition.

NFPA *101*®, *Life Safety Code*®, 2015 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, 2013 edition.

NFPA 1123, *Code for Fireworks Display*, 2014 edition.

NFPA 1730, *Standard on Organization and Deployment of Fire Prevention Inspection and Code Enforcement, Plan Review, Investigation, and Public Education Operations,* 2016 edition.

Wood, C. B., "Pining for Water," *NFPA Journal*® vol. 93, no. 6 (November/December 1999).

American National Standards Institute, Inc., 25 West 43rd Street, 4th floor, New York, NY 10036.

ICC/ANSI A117.1, *Accessible and Usable Buildings and Facilities,* 2009.

Building Services

11

Chapter 11 addresses electrical fire safety; heating, ventilation, and air-conditioning (HVAC) equipment; elevators and escalators; utilities; heating appliances; waste and laundry chutes and incinerators; stationary generators and standby power systems; smoke control; emergency command centers; two-way radio communication enhancement systems; medical gas and vacuum systems; and photovoltaic systems.

11.1 Electrical Fire Safety

The approval of new electrical installations or approval of modifications to an existing electrical system is a function typically performed by an electrical inspector or other building code enforcement official using the requirements of *NFPA 70®*, *National Electrical Code®*. However, in many cases, prior to a building or other facility being constructed or occupied, fire marshals or fire inspectors perform periodic inspections to ensure that the safety systems and features of the premises are in place, are in proper working order, and have not been compromised or adversely modified. Electrical systems are often subject to this type of periodic safety inspection. In general, the focus of this type of inspection is compliance with fundamental electrical safety provisions that have long been required by *NFPA 70*. Requirements covering the integrity of enclosures housing electrical wiring and equipment, the proper use of electrical appliances, the proper application and use of flexible cords, the complete and up-to-date identification of circuit disconnecting means, and the proper maintenance and operation of electrically powered emergency features, such as battery-operated emergency lighting units, are among the items typically included in these periodic safety inspections.

11.1.1 General. Section 11.1 shall apply to permanent and temporary electrical appliances, equipment, fixtures, and wiring.

11.1.2 Permanent Wiring, Fixtures, and Equipment.

Δ **11.1.2.1** All new electrical wiring, fixtures, appliances and equipment shall be installed in accordance with *NFPA 70*.

Δ **11.1.2.2** Unless determined to present an imminent danger, existing electrical wiring, fixtures, appliances, and equipment shall be permitted to be maintained in accordance with the edition of *NFPA 70* in effect at the time of the installation.

11.1.2.3 Permanent wiring abandoned in place shall be tagged or otherwise identified at its termination and junction points as "Abandoned in Place" or removed from all accessible areas and insulated from contact with other live electrical wiring or devices.

No wiring should be abandoned unless it has been physically disconnected at its power source. Wiring that is disconnected should be tagged, noting that it is disconnected. The removal of the wiring is better practice because, in most cases, the wiring will never be reused and if left in place for extended periods will increase the fire load.

11.1.3 Multiplug Adapters.

11.1.3.1 Multiplug adapters, such as multiplug extension cords, cube adapters, strip plugs, and other devices, shall be listed and used in accordance with their listing.

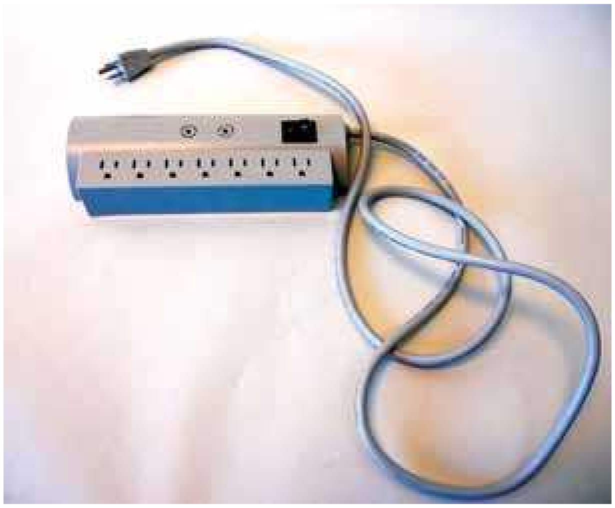
11.1.3.2 Multiplug adapters shall not be used as a substitute for permanent wiring or receptacles.

11.1.4 Relocatable Power Taps.

Relocatable power taps, commonly known as power strips or surge suppressors, are commonly used for computers, printers, and other peripherals at workstations, offices, and dormitories, where additional electrical power receptacles are needed. During inspections, power taps that are plugged into other power taps (daisy-chained) should be removed, because such arrangement is prohibited. Relocatable power taps are for temporary use and should not take the place of permanently installed receptacles. Exhibit 11.1 shows an example of a listed relocatable power tap.

Δ **11.1.4.1** Relocatable power taps shall be listed to UL 1363, *Standard for Relocatable Power Taps,* or UL 1363A, *Outline of Investigation for Special Purpose Relocatable Power Taps,* where applicable.

Exhibit 11.1



Listed relocatable power tap.

11.1.4.2 The relocatable power taps shall be directly connected to a permanently installed receptacle.

Mandating that relocatable power taps be listed is not a new *Code* provision, but references to the specific listing standards, UL 1363, *Standard for Relocatable Power Taps*, and UL 1363A, *Outline of Investigation for Special Purpose Relocatable Power Taps,* are new for the 2018 edition of the *Code*. In addition to the current *Code* requirements for relocatable power taps to be polarized or grounded type with overcurrent protection, which is covered in Sections 13 and 14 of UL 1363, requiring the relocatable power taps to be listed in accordance with UL 1363 will also address all other applicable safety requirements for relocatable power taps used in occupancies other than health care occupancies.

The addition of UL 1363A addresses the specific requirements for relocatable power taps used in general care space or critical care space as defined by Article 517, Health Care Facilities, of the *National Electrical Code*. UL 1363A requires compliance with UL 1363, with additional requirements specific to the use, such as the use of hospital-grade receptacle outlets and plugs, and verification of electrical and mechanical integrity where used with medical equipment.

Relocatable power taps are not to be plugged into extension cords to extend their reach. Where extension cords are used for other than temporary purposes, additional permanent receptacles should be installed in accordance with Section 11.1 and 11.1.5.6.

11.1.4.3 Relocatable power tap cords shall not extend through walls, ceilings, or floors; under doors or floor coverings; or be subject to environmental or physical damage.

Where relocatable power taps extend through walls and floors or under doors or rugs, the installation of permanent receptacles should be required in accordance with 11.1.2.

11.1.5 Extension Cords.

11.1.5.1 Extension cords shall be plugged directly into an approved receptacle, power tap, or multiplug adapter and shall, except for approved multiplug extension cords, serve only one portable appliance.

Extension cords should not be used in place of permanent wiring. Where extension cords are used to permanently power equipment, the fire official should require the installation of permanent wiring in accordance with 11.1.2.

11.1.5.2* The ampacity of the extension cords shall not be less than the rated capacity of the portable appliance supplied by the cord.

A.11.1.5.2 See Table A.11.1.5.2.

11.1.5.3 The extension cords shall be maintained in good condition without splices, deterioration, or damage.

11.1.5.4 Extension cords shall be grounded when servicing grounded portable appliances.

11.1.5.5 Extension cords and flexible cords shall not be affixed to structures; extend through walls, ceilings, or floors, or under doors or floor coverings; or be subject to environmental or physical damage.

Where extension cords extend through walls and floors or under doors or rugs, the installation of permanent receptacles should be required in accordance with 11.1.2.

11.1.5.6 Extension cords shall not be used as a substitute for permanent wiring.

11.1.6 Temporary Installations.

11.1.6.1 Scope. The provisions of 11.1.6 shall apply to temporary electric power and lighting installations. [***70:***590.1]

11.1.6.2 All Wiring Installations.

11.1.6.2.1 Other Articles. Except as specifically modified in Article 590 of *NFPA 70*, all other requirements of *NFPA 70* for permanent wiring shall apply to temporary wiring installations. [***70:***590.2(A)]

Temporary installations of electrical equipment must be installed in accordance with all applicable permanent installation requirements, except as modified by 11.1.6. For example, the requirements of Section 300.15 of *NFPA 70* specify that a box or other enclosure must be used where splices are made. *NFPA 70* permits exceptions to the enclosure requirement for certain applications such as construction sites. Consult *NFPA 70* for additional guidance.

11.1.6.2.2 Approval. Temporary wiring methods shall be acceptable only if approved based on the conditions of use and any special requirements of the temporary installation. [***70:***590.2(B)]

All temporary wiring methods must be approved based on criteria such as (1) length of time in service, (2) severity of physical

TABLE A.11.1.5.2 Recommended Extension Cord Sizes for Portable Electric Tools

Extension Cord Length (ft)	Nameplate Ampere Rating											
	0–2.0		2.1–3.4		3.5–5.0		5.1–7.0		7.1–12.0		12.1–16.0	
	115 V	230 V	115 V	230 V	115 V	230 V	115 V	230 V	115 V	230 V	115 V	230 V
25	18	18	18	18	18	18	18	18	16	18	14	16
50	18	18	18	18	18	18	16	18	14	16	12	14
75	18	18	18	18	16	18	14	16	12	14	10	12
100	18	18	16	18	14	16	12	14	10	12	8	10
200	16	18	14	16	12	14	10	12	8	10	6	8
300	14	16	12	14	10	14	8	12	6	10	4	6
400	12	16	10	14	8	12	6	10	4	8	4	6
500	12	14	10	12	8	12	6	10	4	6	2	4
600	10	14	8	12	6	10	4	8	2	6	2	4
800	10	12	8	10	6	8	4	6	2	4	1	2
1000	8	12	6	10	4	8	2	6	1	4	0	2

Notes:

(1) Size is based on current equivalent to 150 percent of full load of tool and a loss in voltage of not over 5 volts.

(2) If voltage is already low at the source (outlet), voltage should be increased to standard, or a larger cord than listed should be used to minimize the total voltage drop.

[**70B:** Table 29.5.1]

abuse, (3) exposure to weather, and (4) other special requirements. Special requirements might range from tunnel construction projects and tent cities constructed after a natural disaster to flammable hazardous reclamation projects.

11.1.6.3 Time Constraints.

11.1.6.3.1 During the Period of Construction. Temporary electric power and lighting installations shall be permitted during the period of construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment, or similar activities. [***70:***590.3(A)]

11.1.6.3.2 90 Days. Temporary electric power and lighting installations shall be permitted for a period not to exceed 90 days for holiday decorative lighting and similar purposes. [***70:***590.3(B)]

Note that the 90-day time limit applies only to temporary electrical installations associated with holiday displays. Construction, emergency, and test temporary wiring installations are not bound by this time limit.

11.1.6.3.3 Emergencies and Tests. Temporary electric power and lighting installations shall be permitted during emergencies and for tests, experiments, and developmental work. [***70:***590.3(C)]

11.1.6.3.4 Removal. Temporary wiring shall be removed immediately upon completion of construction or purpose for which the wiring was installed. [***70:***590.3(D)]

Permitted temporary wiring installations might not meet all the requirements for a permanent installation. Therefore, all temporary wiring must be not only disconnected but also removed from the building, structure, or other location of installation.

11.1.7 Building Disconnect.

11.1.7.1* Means shall be provided for the fire department to disconnect the electrical service to a building, structure, or facility when the electrical installation is covered under the scope of *NFPA 70*.

Δ **A.11.1.7.1** Section 230.70 of *NFPA 70* (*NEC*), includes requirements for the location and marking of service disconnect means. *NFPA 70* applies to most public and private buildings, structures, yards, parking lots, and similar installations. It does not apply to certain electrical installations under the exclusive control of communications utilities or electric utilities, and other specific installations. *(See NFPA 70, Section 90.2.)* Multiple service disconnect means could be provided as allowed by *NFPA 70*.

The building disconnecting means should be in a location accessible to the fire department in the event of an emergency. A disconnecting means located in the center of the building interior requires fire fighters to enter the building to disconnect power. Disconnects should be located in rooms with access either directly to the outside or in close proximity to an outside door. Shunt trips or other devices might be permitted if approved by the fire department.

11.1.7.2 The disconnecting means shall be maintained accessible to the fire department.

11.1.7.3 Identification of Disconnecting Means.

11.1.7.3.1 Each disconnecting means shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident. The marking shall be of sufficient durability to withstand the environment involved. [***70:***110.22(A)]

Proper identification needs to be specific. For example, the marking should indicate not simply "motor" but, rather, "motor, water pump," or not simply "lights" but, rather, "lights, front lobby." Consideration also should be given to the form of identification. Marking often fades or is covered by paint after installation. See Section 408.4 of *NFPA 70* for further information on circuit directories for switchboards and panelboards.

11.1.8 Covers. All panelboard and switchboards, pull boxes, junction boxes, switches, receptacles, and conduit bodies shall be provided with covers compatible with the box or conduit body construction and suitable for the conditions of use.

11.2 Heating, Ventilation, and Air-Conditioning

Δ **11.2.1 Air-Conditioning, Heating, Ventilating Ductwork, and Related Equipment.** Air-conditioning, heating, ventilating ductwork, and related equipment shall be in accordance with NFPA 90A or NFPA 90B as applicable, unless such installations are approved existing installations, which shall be permitted to be continued in service. [***101:***9.2.1]

For the proper installation of HVAC systems, 11.2.1 refers the *Code* user to NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems.* For occupancies with small overall volumes, such as one- and two-family dwellings, the *Code* refers the user to NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.*

For example, NFPA 90A addresses fire damper requirements for both ductwork and air-transfer grilles that penetrate fire barriers. NFPA 90A also prohibits means of egress corridors in health care, detention and correctional, and residential occupancies from being used as a portion of a supply-, return-, or exhaust-air system serving adjoining areas. Exhibit 11.2 identifies some of the areas where fire dampers and smoke dampers would be required by NFPA 90A.

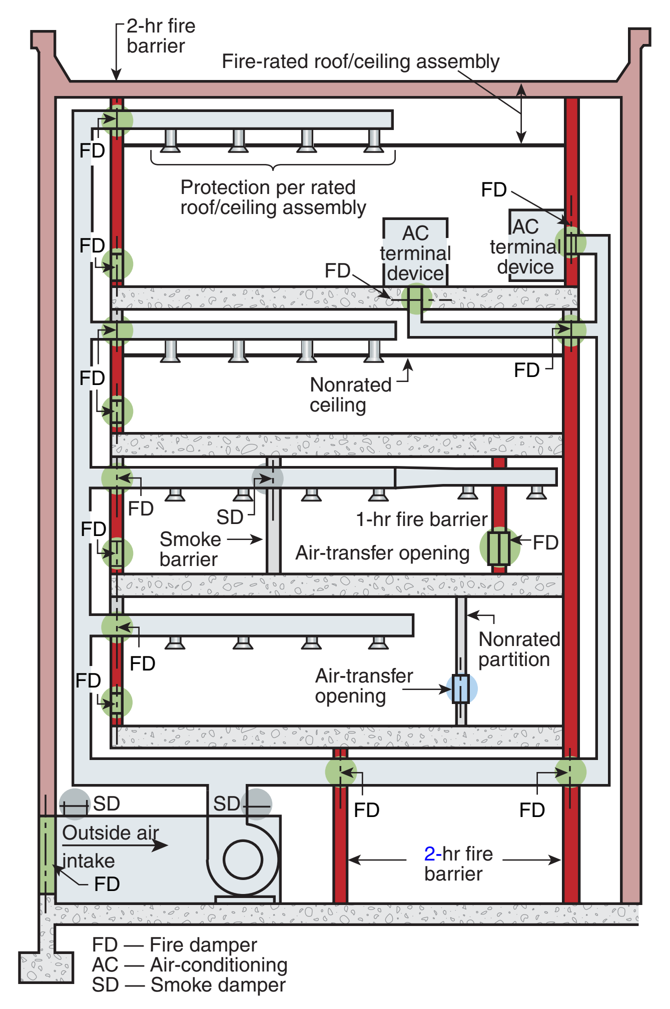
Δ **11.2.2 Ventilating or Heat-Producing Equipment.** Ventilating or heat-producing equipment shall be in accordance with NFPA 91, NFPA 211, NFPA 31, NFPA 54, or *NFPA 70*, as applicable, unless such installations are approved existing installations, which shall be permitted to be continued in service. [***101:***9.2.2]

11.3 Elevators, Escalators, and Conveyors

11.3.1 Fire Fighters' Emergency Operations.

Because an elevator stopping at a fire floor (intentionally or unintentionally) is an extreme hazard, the *Code* mandates compliance with the fire fighters' emergency operations requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators,* and ASME A17.3, *Safety Code for Existing Elevators and Escalators,* for new and existing elevators, respectively. The fire fighters' emergency operations requirements establish elevator recall activated by smoke detection in each elevator lobby and in associated elevator machine rooms. A three-position, key-operated switch, normally located in the main lobby at the elevator, controls the recall function. The requirements mandate specific functions for the "RESET," "OFF," and "ON" positions of this switch. The requirements also provide for emergency in-car operations or what is often referred to as fire fighters' service. Fire fighters' service requires a three-position, key-operated switch in each elevator car. The functions of the "ON," "OFF," and "HOLD" positions are specified in the elevator code. For specific details, refer to ASME A17.1/CSA B44. Explanatory material on these rules can be found in the ASME A17.1/CSA B44 *Handbook on Safety Code for Elevators and Escalators.*

Exhibit 11.2



Partition and fire barrier penetration protection.

11.3.1.1 All new elevators shall conform to the fire fighters' emergency operations requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*. [***101:***9.4.3.1]

11.3.1.2 All existing elevators having a travel distance of 25 ft (7620 mm) or more above or below the level that best serves the needs of emergency personnel for fire-fighting or rescue purposes shall conform to the fire fighters' emergency operations requirements of ASME A17.3, *Safety Code for Existing Elevators and Escalators*. [***101:***9.4.3.2]

11.3.2 Number of Cars. The number of elevator cars permitted in a hoistway shall be in accordance with 8.6.9.4 of NFPA *101*. [***101:***9.4.4]

11.3.3* Elevator Machine Rooms. Elevator machine rooms that contain solid-state equipment for elevators, other than existing elevators, having a travel distance exceeding 50 ft (15 m) above the level of exit discharge or exceeding 30 ft (9.1 m) below the level of exit discharge shall be provided with independent ventilation or air-conditioning systems to maintain temperature during fire fighters' emergency operations for elevator operation *(see 11.3.1)*. The operating temperature shall be established by the elevator equipment manufacturer's specifications. When standby power is connected to the elevator, the machine room ventilation or air-conditioning shall be connected to standby power. [***101:***9.4.5]

A.11.3.3 Continued operation of solid-state elevator equipment is contingent on maintaining the ambient temperature in the range specified by the elevator manufacturer. If the machine room ventilation/air conditioning is connected to the general building system, and that system is shut down during a fire, the fire department might lose the use of elevators due to excessive heat in the elevator machine room. [***101:***A.9.4.5]

The intent of the requirement for a ventilation or an air-conditioning system to help keep the elevator controls operable is explained in 11.3.3 and A.11.3.3. For many typical installations, this requirement can be met by the installation of an independent, through-the-wall air-conditioning unit. Regardless of shutdown of the building's HVAC system, the independent unit will continue to run, provided that its power supply is not interrupted.

11.3.4 Elevator Testing.

Because emergency responders might use elevators to move personnel and equipment and potentially to assist in the evacuation of mobility-impaired occupants, it is important to routinely test elevators to help ensure they can be used when needed under fire and other emergency conditions.

11.3.4.1 Elevators shall be subject to periodic inspections and tests as specified in ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*. [***101:***9.4.6.1]

11.3.4.2 All elevators equipped with fire fighters' emergency operations in accordance with 11.3.1 shall be subject to a monthly operation with a written record of the findings made and kept on the premises as required by ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*. [***101:***9.4.6.2]

Δ **11.3.4.3** The elevator inspections and tests required by 11.3.4.1 shall be performed at frequencies complying with one of the following:

(1) Inspection and test frequencies specified in Appendix N of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*
(2) Inspection and test frequencies specified by the AHJ

[***101:***9.4.6.3]

11.3.5 Openings to Exit Enclosures. Conveyors, elevators, dumbwaiters, and pneumatic conveyors serving various stories of a building shall not open to an exit enclosure. [***101:***9.4.7]

Openings to exit enclosures are strictly limited by the provisions of 14.3.1(9) to doors that provide access to the exit from normally occupied spaces or corridors and means to leave the exit enclosure. Elevators and other conveyors are not considered normally occupied areas. Additionally, an elevator, with its associated cables, controls, and mechanical equipment, would introduce combustibles into an exit enclosure, which conflicts with the objective of making the exit enclosure a safe place free of combustibles.

11.3.6 Standardized Fire Service Elevator Keys.

11.3.6.1 Buildings with elevators equipped with Phase I emergency recall, Phase II emergency in-car operation, or a fire service access elevator shall be equipped to operate with a standardized fire service key complying with ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, except as otherwise permitted by 11.3.6.

11.3.6.2 Existing buildings with elevators equipped with Phase I emergency recall or Phase II emergency in-car operation shall be permitted to comply with 11.3.6.3.

11.3.6.3 Existing Buildings. Existing buildings shall be in compliance with the provisions of 11.3.6.3.1 one year after adoption by the AHJ.

11.3.6.3.1 Where a standardized key cylinder cannot be installed in an existing elevator key switch assembly, the building's nonstandardized fire service elevator keys shall be provided in an access box in accordance with 11.3.6.3.1.1 through 11.3.6.3.1.6.

11.3.6.3.1.1 The access box shall be compatible with an existing rapid-entry access box system in use in the jurisdiction and approved by the AHJ.

11.3.6.3.1.2 The front cover shall be permanently labeled with the words "Fire Department Use Only — Elevator Keys."

11.3.6.3.1.3 The access box shall be mounted at each elevator bank at the lobby nearest to the lowest level of fire department access.

11.3.6.3.1.4 The access box shall be mounted at a location approved by the AHJ.

11.3.6.3.1.5 Contents of the access box shall be limited to the fire service elevator key. Additional elevator access tools, keys, and information pertinent to emergency planning or elevator access shall be permitted when authorized by the AHJ.

11.3.6.3.1.6 In buildings with two or more elevator banks, a single access box shall be permitted to be used where such elevator banks are separated by not more than 30 ft (9140 mm). Additional access boxes shall be provided for each individual elevator or elevator bank separated by more than 30 ft (9140 mm).

11.3.6.3.1.7 A single access box shall be permitted to be located adjacent to a fire command center, or the nonstandard fire service elevator key shall be secured in an access box used for other purposes and located in accordance with 18.2.2.1 when approved by the AHJ.

The requirements of 11.3.6 mandate the standardization of fire service elevator keys to reduce the number of keys necessary for accessing elevators in an emergency. All new elevators must be equipped to use standard keys as approved by the authority having jurisdiction (AHJ), and all existing elevators with fire fighters' emergency operations must be retrofitted to use standard keys within 1 year of the adoption of the *Code* by the jurisdiction. Where the physical limitations of existing elevators do not permit such retrofit, the *Code* permits the installation of access boxes opened by standard fire department keys for the housing of nonstandard elevator keys. It is noted that the 2012 edition of the *Code* prescribed requirements for the standardized fire service key that differed from the requirements of ASME A17.1/CSA B44. The 2015 edition was revised to simply reference the standardized key requirements of ASME A17.1/CSA B44 to eliminate any potential conflicts.

Δ **11.3.7 Elevators for Occupant-Controlled Evacuation Prior to Phase I Emergency Recall Operations and Fire Service Access Elevators.** An approved method to prevent automatic sprinkler water from infiltrating into the hoistway enclosure from the operation of the automatic sprinkler system outside the enclosed occupant evacuation elevator lobby shall be provided where the hoistway serves elevators in accordance with any of the following:

(1) Occupant-controlled evacuation elevators in accordance with Section 7.14 of NFPA *101*
(2) Occupant-controlled evacuation elevators in accordance with the building code
(3) Fire service access elevators in accordance with the building code

The provisions of 11.3.7, which were new to the 2015 edition of the *Code*, do not mandate that elevators comply with the provisions for occupant-controlled evacuation or fire service access in accordance with NFPA *101* or the applicable building code. Rather, they specify that the means of preventing sprinkler water infiltration into the hoistway must be maintained over the life of the building. See A.7.15.9.6 of NFPA *101* for additional guidance.

Δ 11.4 Utilities

Equipment using fuel gas and related gas piping shall be in accordance with NFPA 54 or NFPA 58. *(See Chapter 69 for LP-Gas fuel supply and storage installations.)*

11.4.1 Existing installations shall be permitted to be continued in service, subject to approval by the AHJ.

11.4.2 Aboveground gas meters, regulators, and piping exposed to vehicular damage shall be protected in accordance with 60.5.1.9.

See Chapter 69 for additional requirements involving NFPA 58, *Liquefied Petroleum Gas Code*, and LP-Gas.

11.5 Heating Appliances

11.5.1 General.

Δ **11.5.1.1** The installation of stationary liquid fuel–burning appliances, including but not limited to industrial-, commercial-, and residential-type steam, hot water, or warm air heating appliances; domestic-type range burners; space heaters; and portable liquid fuel–burning equipment shall comply with Section 11.5 and NFPA 31.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, is the standard for the safe, efficient design and installation of heating appliances that use a liquid fuel, typically No. 2 heating oil, but also lighter fuels, such as kerosene and diesel fuel, and heavier fuels, such as No. 4 fuel oil. NFPA 31 applies to the installation of these systems in residential, commercial, and industrial occupancies.

Δ **11.5.1.2** Section 11.5 shall also apply to all accessories and control systems, whether electric, thermostatic, or mechanical, and all electrical wiring connected to liquid fuel–burning appliances. [**31:**1.1.2]

Δ **11.5.1.3** Section 11.5 shall also apply to the installation of liquid fuel storage and supply systems connected to liquid fuel–burning appliances. [**31:**1.1.3]

11.5.1.4 Section 11.5 shall also apply to those multifueled appliances in which a liquid fuel is one of the standard or optional fuels. [**31:**1.1.4]

11.5.1.5* Section 11.5 shall not apply to internal combustion engines, oil lamps, or portable devices not specifically covered in NFPA 31. *(See Chapter 11 of NFPA 31 for portable devices that are covered in NFPA 31.)* [**31:**1.1.5]

A.11.5.1.5 Examples of portable devices not covered by NFPA 31 are blowtorches, melting pots, and weed burners. [**31:**A.1.1.5]

11.5.1.6 The installation of gas-fired heating appliances shall comply with Section 11.5 and NFPA 54. *(See Chapter 69 for LP-Gas fuel supply and storage installations.)*

NFPA 54, *National Fuel Gas Code*, addresses the installation of fuel gas piping systems, fuel gas utilization equipment, and related accessories, including piping systems, operating pressure, installation, combustion, ventilation air, and venting. The use of unvented fuel-fired heaters is prohibited by this *Code* and NFPA *101*®, *Life Safety Code*®, in numerous occupancies, unless they are approved units that comply with NFPA 54. The use of such equipment is prohibited in all residential board and care occupancies regardless of compliance with NFPA 54.

11.5.1.7 All heating appliances shall be approved or listed.

11.5.1.8 Permits. Permits, where required, shall comply with Section 1.12.

This *Code* requires that a permit be obtained in order to store, use, or handle LP-Gas or Class I, Class II, or Class IIIA flammable or combustible liquids.

11.5.1.9 Electrical wiring and utilization equipment used in connection with oil-burning appliances or equipment shall be installed in accordance with Section 11.1. [**31:**4.4.1]

11.5.1.10 Acceptable Liquid Fuels.

Δ **11.5.1.10.1*** The type and grade of liquid fuel used in a liquid fuel–burning appliance shall be that liquid fuel for which the appliance is listed and approved or is stipulated by the manufacturer. Liquid fuels shall meet one of the following specifications and shall not contain gasoline or any other flammable liquid:

(1) ASTM D396, *Standard Specification for Fuel Oils*
(2) ASTM D3699, *Standard Specification for Kerosene*
(3) ASTM D6448, *Industrial Burner Fuels from Used Lube Oils*
(4) ASTM D6751, *Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuel*
(5) ASTM D6823, *Commercial Burner Fuels from Used Lube Oils*

[**31:**4.5.1]

A.11.5.1.10.1 See Chapter 11 of NFPA 31 for additional requirements for oil-burning stoves, kerosene-burning room heaters, and kerosene-burning portable heaters. See Chapter 12 of NFPA 31 for additional requirements for used oil–burning appliances. See Chapter 13 of NFPA 31 for additional requirements for combination oil-and-gas–burning appliances. [**31:**A.4.5.1]

Δ **11.5.1.10.2** Appliances that burn crankcase oil or used oil shall not be used in a residential occupancy. Such appliances shall only be used if all of the following conditions are met:

(1) The installation is in a commercial or industrial occupancy.
(2) The oil-burning appliance is designed to burn crankcase oil or used oil and is listed for such use.
(3) The appliance is installed in accordance with the manufacturer's instructions and with the terms of its listing.
(4) The installation meets the applicable requirements of Section 4.6 and Chapter 12 of NFPA 31.

[**31:**4.5.2]

Δ **11.5.1.10.3*** Where heavy oils are used, the following shall be required:

(1) The oil-burning appliance shall be designed to burn such fuels.
(2) Means shall be provided to maintain the oil at its proper atomizing temperature.
(3) Automatically operated burners that require preheating of oil shall be arranged so that no oil can be delivered for combustion until the oil is at the proper atomizing temperature.
(4)* Use of an oil-fired appliance that is listed in accordance with ANSI/UL 296A, *Standard for Waste Oil-Burning Air-Heating Appliances*, shall be deemed as meeting the intent of 11.5.1.10.3(1) through 11.5.1.10.3(3).

[**31:**4.5.3]

A.11.5.1.10.3 Where heavy oils are used, provisions should be made to maintain the oil within the recommended temperature range indicated in Table A.11.5.1.10.3 so that proper atomization is maintained. [**31:**A.4.5.3]

A.11.5.1.10.3(4) ANSI/UL 296A, *Standard for Waste Oil-Burning Air Heating Appliances*, specifies that a burner provided with preheating means for the fuel oil can be provided with an oil temperature interlock device to prevent delivery of the fuel oil to the firing portion of the burner until the fuel oil has reached a predetermined minimum temperature. On a burner that is not equipped

Δ ***TABLE A.11.5.1.10.3*** *Recommended Temperature Range for Proper Atomization of Heavy Oils*

Fuel No.	Viscosity in SSU at 100°F	Low Temperature Limit (°F)	High Temperature Limit (°F)
4	45	35*	50
	50	35*	65
	60	45*	85
	75	62	105
	100	80	125
5	150	100	145
	200	112	160
	300	130	180
	400	140	190
	500	150	200
6	1,000	170	225
	2,000	190	245
	3,000	205	260
	4,000	212	270
	5,000	218	275
	10,000	240	290

*At these temperatures, proper operation of the appliance might not be attained because of unsatisfactory atomization of the fuel. For this reason, the fuel oil should be kept at the high end of the recommended temperature range.

[**31:** Table A.4.5.3]

with oil-preheating equipment, an oil temperature interlock device should not be provided on the burner and should be bypassed during any firing tests of the burner. [**31:**A.4.5.3(4)]

11.5.1.10.4 A properly sized and rated oil filter or strainer shall be installed in the oil supply line to an oil burner. [**31:**4.5.4]

Section 4.6 of NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* provides the applicable requirements for the use of crankcase oil and used oil as a fuel. Typical locations are burner areas, fuel-handling areas, fuel storage areas, pits, sumps, and low spots where fuel leakage or vapors can accumulate. Chapter 5 of *NFPA 70* provides information for classifying such areas and defines requirements for electrical installations in areas so classified.

Crankcase oil and used oil properties can vary considerably, and light volatile materials can be released during storage or handling or upon heating. Because of this characteristic, appropriate and adequate provisions should be made to safely handle, store, and burn crankcase oil and used oil. Flexibility built into the facility is desirable to accommodate the expected range of properties of the fuels in use. Failure to observe the necessary design, installation, and operating and maintenance procedures can result in fire, explosion, or personal injury.

Extensive treatment of this subject is beyond the scope of this *Code*. The AHJ should be responsible for classifying areas where fuel is stored, handled, or burned and for revising the classification if conditions are changed. Installation of electrical equipment in such areas must conform to *NFPA 70*. Additional guidance can be obtained from NFPA 30, *Flammable and Combustible Liquids Code,* and NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*.

11.5.1.11 Clothes Dryers.

11.5.1.11.1 Clothes dryers shall be cleaned to maintain the lint trap and keep the mechanical and heating components free from excessive accumulations of lint.

11.5.1.11.2 The requirements of 11.5.1.11.1 shall not apply to clothes dryers in individual dwelling units of residential occupancies.

11.5.2 Kerosene Burners and Oil Stoves.

Kerosene stoves are self-contained, self-supporting, kerosene-burning ranges, room heaters, or water heaters not connected to chimneys but equipped with integral fuel supply tanks with a maximum capacity of 2 gal (7.6 L). Kerosene room heaters are often referred to as cabinet heaters and space heaters. See Exhibit 11.3 for an example of a kerosene heater.

Because these heaters are not connected to chimneys, they can be moved rather easily, although they generally are not considered portable. Each year, many serious fires result from the improper use of these heaters. Because of their mobility, these stoves pose a hazard when placed near combustible materials or where they can block a means of egress.

Exhibit 11.3

Kerosene heater.

Exhibit 11.4

Kerosene fuel container. (Courtesy of Blitz USA)

Another fire hazard is the use of gasoline instead of kerosene fuel. Kerosene fuel should be stored in an approved container. See Exhibit 11.4 for an example of a kerosene fuel container. These containers are of a blue color to distinguish them from other flammable liquid containers that might be in the home.

11.5.2.1 Kerosene burners and oil stoves shall be equipped with a primary safety control furnished as an integral part of the appliance by the manufacturer to stop the flow of oil in the event of flame failure. Barometric oil feed shall not be considered a primary safety control.

11.5.2.2 A conversion range oil burner shall be equipped with a thermal (heat-actuated) valve in the oil supply line, located in the burner compartment of the stove.

Conversion range oil burners consist of a single-sleeve or double-sleeve burner assembly, regulating valves, and an oil supply assembly with a suitable supporting stand and seamless connecting tubing. A thermal valve located in the burner compartment of the stove adjacent to the burner is installed in the oil supply line.

Range oil burners, which are found most frequently in the northeastern United States, are designed to burn kerosene, range oil, or similar fuel. They are primarily installed in stoves or ranges originally designed to use solid fuel. Range oil burners should not be mistaken for vaporizing-pot conversion oil burners that are designed for the conversion of central heating appliances.

Δ **11.5.2.3** Kerosene heaters shall be listed and labeled in accordance with UL 647, *Standard for Unvented Kerosene-Fired Room Heaters and Portable Heaters,* and their use shall meet all of the following:

(1) Adequate ventilation shall be provided.
(2) Kerosene heaters shall not be placed on carpeting.
(3) Kerosene heaters shall be located not less than 3 ft (0.9 m) from combustible furnishings and drapes.
(4) Only approved Type 1-K water clear kerosene shall be used.
(5) Kerosene heaters shall be allowed to cool before refueling.

Portable kerosene heaters pose a hazard similar to that of kerosene stoves, since they are not connected to a chimney. However, the hazard is increased by their greater portability and subsequent misuse and improper placement. They are also subject to improper fueling, substitution of gasoline or other inappropriate liquid fuel, and refueling when hot, which can produce and ignite flammable vapors. The safest heaters incorporate fire safety features, such as special types of latching devices and integral sheet-metal trays under the burners to catch oil drips. They usually employ wick-type burners that are integral with the oil reservoir. Portable kerosene heaters should include a tip-over switch that automatically snuffs the burner if the unit is jostled or tipped. Also see 11.5.2.1.

UL 647, *Standard for Unvented Kerosene-Fired Room Heaters and Portable Heaters,* provides requirements for unvented kerosene-fired room heaters, including either requiring automatic primary safety controls or for the heater to be inherently constructed to prevent abnormal discharge of fuel at the burner in case of ignition failure or premature flame extinguishment. Reference to UL 647 as the specific listing standard is new for the 2018 edition of the *Code*. Kerosene stoves listed by testing laboratories incorporate fire protection features that might be missing from stoves that are not listed. Important features of listed stoves include substantial construction materials, provision of primary control valves, and use of drip pans to catch any leaking fuel, confining it to the stove.

11.5.3 Portable Electric Heater.

11.5.3.1 The AHJ shall be permitted to prohibit use of portable electric heaters in occupancies or situations where such use or operation would present an undue danger to life or property.

During cold weather, portable electric space heaters are used in many locations, including under desks. Although placing a heater under a desk or table lessens the chance of the heater being easily overturned, the heater also can easily be forgotten. A heater that is left on for an extended time can overheat combustible materials that might also be stored under the desk or table. Managers of facilities that allow the use of electric space heaters should be instructed to remind employees to shut them off at the end of the day and keep combustible material away from the heater.

In addition, because of the amount of electric current drawn by space heaters, electric heaters should be used only where they can be plugged directly into appropriate receptacles or extension cords of adequate current capacity. See 11.1.5 for requirements addressing extension cords.

The AHJ is permitted to prohibit the use of space heaters where an undue danger to life or property exists. The AHJ can use past inspection findings, such as portable heaters that were left turned on and unattended, fire incidents, and other reasons to prohibit the use of such heaters.

11.5.3.2 Portable electric heaters shall be designed and located so that they cannot be easily overturned.

11.5.3.3 All portable electric heaters shall be listed.

11.5.4 Vents. All chimneys, smokestacks, or similar devices for conveying smoke or hot gases to the outer air and the stoves, furnaces, incinerators, boilers, or any other heat-producing devices or appliances shall be installed and maintained in accordance with NFPA 54 and NFPA 211.

11.6 Waste Chutes, Incinerators, and Laundry Chutes

11.6.1 Enclosure.

11.6.1.1 Waste chutes and laundry chutes shall be separately enclosed by walls or partitions in accordance with the provisions of Section 12.7. [***101:***9.5.1.1]

11.6.1.2 Chute intake openings shall be protected in accordance with Section 12.7. [***101:***9.5.1.2]

11.6.1.3 The doors of chutes specified in 11.6.1.2 shall open only to a room that is designed and used exclusively for accessing the chute opening. [***101:***9.5.1.3]

11.6.1.4 Chute service opening rooms shall be separated from other spaces in accordance with Section 8.7 of NFPA *101*. [***101:***9.5.1.4]

Δ **11.6.1.5** The requirements of 11.6.1.1 through 11.6.1.4 shall not apply where otherwise permitted by the following:

(1) Existing installations having properly enclosed service chutes and properly installed and maintained chute intake doors shall be permitted to have chute intake doors open to a corridor or normally occupied space.
(2) Waste chutes and laundry chutes shall be permitted to open into rooms not exceeding 400 ft² (37 m²) that are used for storage, provided that the room is protected by automatic sprinklers.

[***101***:9.5.1.5]

Waste chutes are often associated with a trash collection room, and laundry chutes are often associated with a laundry/storage room. The provision of 11.6.1.5(2) permits chutes to open into such rooms, provided that the area of the room does not exceed 400 ft² (37 m²). Without this provision, the user might interpret the words "used exclusively" in 11.6.1.3 as limiting the use of that room to serving the chute only.

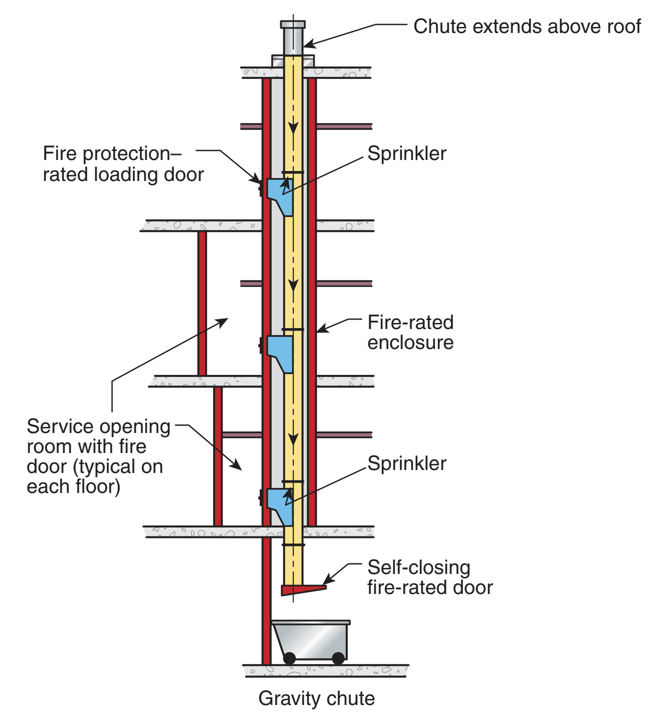
Δ **11.6.2 Installation and Maintenance.** Waste chutes, laundry chutes, and incinerators shall be installed and maintained in accordance with NFPA 82 unless such installations are approved existing installations, which shall be permitted to be continued in service. [***101***:9.5.2]

Shafts containing waste and linen chutes must be enclosed according to the requirements for the protection of vertical openings found in Section 11.6. The installation of the chute itself must meet the requirements of NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment.*

Additional concerns regarding chutes opening to other parts of the building need to be addressed. For convenience, service openings for loading are usually located to be accessible from corridors on the upper floors of the building. However, these corridors also serve as exit access, and a fire in the chute with an open loading door could result in the obstruction of the corridor by smoke and other products of combustion. To address this hazard, the *Code* and NFPA 82 require the construction of service opening rooms to form a buffer between the chute and the building space. The special hazard protection provisions in Section 8.7 of NFPA *101* for the separation of the service opening are referenced in 11.6.1.4. The result is a room that is separated from the rest of the building by construction with a 1-hour fire resistance rating or protected with an automatic extinguishing system. The door to this room is required to have a ¾-hour fire protection rating. Exhibit 11.5 illustrates the protection arrangement required for waste and linen chutes by NFPA 82.

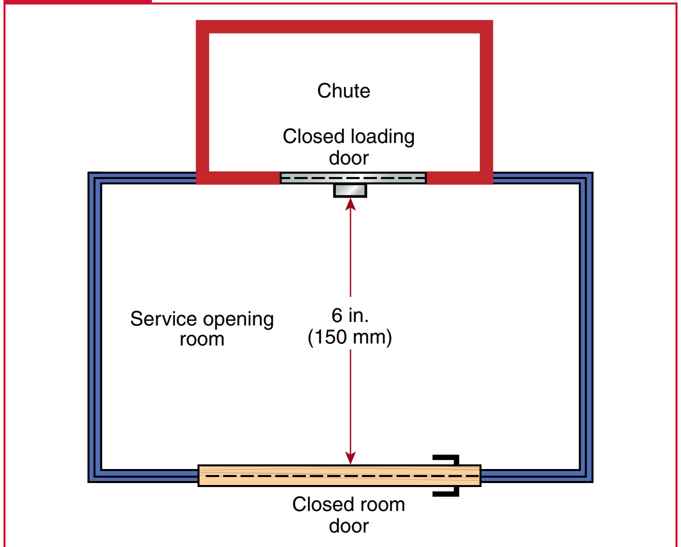
Additionally, NFPA 82 requires the service opening room to be sized to maintain a minimum 6 in. (150 mm) clearance between the closed chute loading door and the closed room door. Exhibit 11.6 illustrates the measurement of this clearance.

Exhibit 11.5



Protection of waste and linen chutes.

Exhibit 11.6



Clearance in service opening room.

11.7 Stationary Generators and Standby Power Systems

11.7.1 Stationary Combustion Engines and Gas Turbines Installation. Stationary generator sets shall be installed in accordance with NFPA 37 and *NFPA 70*.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* applies to stationary combustion engines and gas turbines, portable engines that remain connected for use in the same location for a period of 1 week or more, new installations, and those portions of existing equipment and installations that are changed or modified.

11.7.2 Portable Generators.

11.7.2.1* Portable generators shall not be operated or refueled within buildings, on balconies, or on roofs.

A.11.7.2.1 It is not the intent of this section to prohibit the installation or use of portable generators within outside structures such as lean-tos or sheds intended solely to provide weather protection for the generator.

11.7.2.1.1 Portable generators shall be permitted to be operated or refueled in a building or room that has been constructed for such use in accordance with the building code.

11.7.2.1.2 Fueling from a container shall be permitted when the engine is shut down and engine surface temperature is below the autoignition temperature of the fuel.

11.7.2.2 Portable generators shall be positioned so that the exhaust is directed as follows:

(1) At least 5 ft (1.5 m) in any direction away from any openings or air intakes
(2) Away from the building

Portable generators have been a life safety problem for years, especially when storms knock out power for extended periods of time, such as during hurricanes or snowstorms. Each year, many people are killed or injured by carbon monoxide due to improper placement and use of portable generators. People often purchase generators to provide power during power outages without knowing the associated risks and end up using them improperly or wiring them incorrectly. Portable generators should never be run or fueled indoors unless the room has the proper fire protection and ventilation required in the building code. Wiring should never be directly tied into the distribution panel where it could potentially feed back into the electrical distribution system, endangering electrical company workers who are restoring power. A properly installed transfer switch should be provided.

Portable generator exhaust should be pointed away from the building and be placed no closer than 5 ft (1.5 m) from any openings, including doors, windows, and vents.

11.7.3 Emergency and Legally Required Standby Power Systems.

Δ **11.7.3.1 General.** New stationary generators for emergency use or for legally required standby power required by this *Code*, the building code, or other codes and standards shall be installed in accordance with NFPA 110.

NFPA 110, *Standard for Emergency and Standby Power Systems,* covers performance requirements for emergency and standby power systems providing an alternative source of electrical power to loads in buildings and facilities in the event that the primary power source fails. Power systems covered in NFPA 110 include power sources, transfer equipment, controls, supervisory equipment, and all related electrical and mechanical auxiliary and accessory equipment needed to supply electrical power to the load terminals of the transfer equipment.

NFPA 110 covers installation, maintenance, operation, and testing requirements as they pertain to the performance of the emergency power supply system (EPSS). NFPA 110 does not cover the following:

1. Application of the EPSS
2. Emergency lighting unit equipment
3. Distribution wiring
4. Utility service, when such service is permitted as the EPSS
5. Parameters for stored energy devices
6. Equipment of systems not classed as Level 1 or Level 2 systems in accordance with Chapter 4 of NFPA 110

11.7.3.2 Acceptance. Newly installed stationary generators for emergency use or for legally required standby power for fire protection systems and features shall demonstrate the capacity of the energy converter, with its controls and accessories, to survive without damage from common and abnormal disturbances in actual load circuits by any of the following means:

(1) By tests on separate prototype models
(2) By acceptance tests on the system components as performed by the component suppliers
(3) By listing for emergency service as a completely factory-assembled and factory-tested apparatus

11.7.4 Stored Electrical Energy Emergency and Legally Required Standby Power System Installation. Stored electrical energy systems required by this *Code*, the building code, or other NFPA codes and standards shall be installed in accordance with NFPA 111 and *NFPA 70*.

NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems,* covers the performance requirements for stored electrical energy systems providing an alternative source of electrical power in buildings and facilities in the event that the normal electrical power source fails.

Systems covered by NFPA 111 include power sources, transfer equipment, controls, supervisory equipment, and accessory equipment, including integral accessory equipment, needed to supply electrical power to the selected circuits. NFPA 111 also covers the installation, maintenance, operation, and testing requirements as they pertain to the performance of the stored emergency power supply system (SEPSS). NFPA 111 does not cover the following:

1. Application of the SEPSS
2. Distribution wiring

3. Systems having total outputs less than 500 volt-amperes or less than 24 volts, or systems less than Class 0.033
4. Unit equipment
5. Nuclear sources, solar systems, and wind energy systems
6. Uninterruptible power supply systems (UPS) supplied by an emergency power supply system (EPSS)

11.7.5 Maintenance and Testing.

11.7.5.1 Stationary generators used for emergency or legally required standby power shall be tested and maintained in accordance with NFPA 110 and NFPA 37.

11.7.5.2 Stationary generators required by this *Code*, the building code, or other NFPA codes and standards shall be maintained in accordance with NFPA 110.

Paragraph 11.7.5.2 does not require the installation of emergency generators, but it mandates that, where required and where such systems are installed for *Code* compliance, an approved maintenance and testing program must be provided to ensure operational integrity. Routine maintenance and operational testing are covered in Chapter 8 of NFPA 110.

11.7.5.3 Stored electrical energy systems required by this *Code*, the building code, or other NFPA codes and standards shall be maintained in accordance with NFPA 111.

Paragraph 11.7.5.3 does not require the installation of standby power systems, but it mandates that, where required and where such systems are installed for *Code* compliance, an approved maintenance and testing program must be provided to ensure operational integrity.

11.8* Smoke Control

Δ **A.11.8** NFPA 92 provides guidance in implementing systems using pressure differentials to accomplish one or more of the following:

(1) Maintain a tenable environment in the means of egress during the time required for evacuation
(2) Control and reduce the migration of smoke from the fire area
(3) Provide conditions outside the fire zone that assist emergency response personnel to conduct search and rescue operations and to locate and control the fire
(4) Contribute to the protection of life and reduction of property loss

Section 11.8 does not require smoke control systems but mandates that, where such systems are installed for *Code* compliance, an approved maintenance and testing program must be provided to ensure operational integrity. A smoke control system dedicated to emergency use only will not be subject to daily use, and, therefore, maintenance and testing of smoke control systems are necessary.

Some requirements of NFPA *101*, such as those applicable to atriums, mandate smoke control systems via performance-based language that requires tenable smoke conditions during egress.

11.8.1 Newly installed smoke-control systems shall be inspected by the AHJ and tested in accordance with the criteria established in the approved design documents, NFPA 204 and NFPA 92.

NFPA 204, *Standard for Smoke and Heat Venting,* applies to the design of venting systems for the emergency venting of products of combustion from fires in buildings. The provisions of Chapters 4 through 10 of NFPA 204 apply to the design of venting systems for the emergency venting of products of combustion from fires in nonsprinklered, single-story buildings using both hand calculations and computer-based solution methods. Chapter 11 of NFPA 204 applies to venting in sprinklered buildings.

NFPA 204 does not specify under which conditions venting is to be provided or required. It also does not specify or require ventilation within a building designed for regulation of environmental air for personnel comfort, regulation of commercial cooking operations, regulation of odor or humidity in toilet and bathing facilities, regulation of cooling of production equipment, or venting for explosion pressure relief.

NFPA 92, *Standard for Smoke Control Systems,* serves as a resource for the design, installation, acceptance testing, operation, and ongoing periodic testing of mechanical smoke control systems. It establishes requirements for smoke control systems that use pressure differences across barriers that accomplish one or more of the following:

1. Inhibit smoke from entering stairwells, means of egress, smoke refuge areas, elevator shafts, or similar areas
2. Maintain a tenable environment in smoke refuge areas and means of egress during the time required for evacuation
3. Inhibit the migration of smoke from the smoke zone
4. Provide conditions outside the smoke zone that enable emergency response personnel to conduct search and rescue operations and to locate and control the fire
5. Contribute to the protection of life and to the reduction of property loss

Other codes and standards specify the conditions under which a smoke control system must be provided.

An engineered smoke control system or smoke removal system acceptable to the AHJ has been required since the atrium provisions were first introduced in the 1981 edition of NFPA *101*. As advisory, but nonmandatory, information, the appendix of earlier editions suggested that, depending on atrium height and volume, either four or six air changes per hour could provide the smoke exhaust rate needed to meet the tenability conditions intended by the requirement for atrium smoke control.

The guideline for six air changes per hour came to be considered law by many AHJs and was thus accepted as the norm by many system designers. The AHJs then subjected such systems to acceptance testing using smoke bombs that produce cold smoke, which does not have the heat, buoyancy, and entrainment of air from a real fire. The acceptance criteria were further complicated by those who mistakenly believed that the intent of the smoke control requirement was, for example, that no smoke be visible within the atrium at the end of a 10-minute test. Designers found that, to ensure that the acceptance test could be passed, the system should provide approximately 10 to 12 air changes per hour. In effect, atrium smoke control systems were typically designed to pass the acceptance test with no consideration or assurance of effective smoke control under real fire conditions. NFPA 92 warns that a system designed in accordance with that standard and capable of providing the intended smoke management might not pass smoke bomb tests. Conversely, it is possible for a system that is incapable of providing the intended smoke management to pass smoke bomb tests. Because of the impracticality of conducting real fire tests within an atrium, the acceptance tests described in NFPA 92 are directed at those aspects of smoke management systems that can be verified through direct measurement (e.g., pressure differences across smoke zones as defined by the smoke control system's engineered design).

The smoke control system's performance objectives and acceptance criteria should be approved by the AHJ prior to its installation. In some cases, the code mandating the system specifies the performance objectives. For example, in accordance with NFPA *101*, atriums require an engineering analysis to demonstrate that smoke will be managed for the time necessary to evacuate the building. The analysis must prove that the smoke layer will be maintained above the highest unprotected opening to adjoining spaces, or 6 ft (1830 mm) above the highest floor level of exit access open to the atrium for a time equal to 1½ times the calculated egress time or 20 minutes, whichever is greater. (See the *Life Safety Code® Handbook* for additional details on atrium smoke control.) Where the system designers and the AHJ lack a documented agreement of the system's objectives and acceptance criteria, change orders following the system's installation can prove extremely costly.

11.8.2 Smoke-control systems shall have an approved maintenance and testing program to ensure operational integrity in accordance with this section. Components of such systems shall be operated, maintained, and tested in accordance with their operation and maintenance manuals.

11.8.2.1 Testing. Operational testing of the smoke-control system shall be in accordance with NFPA 92, and shall include all equipment related to the system including, but not limited to, initiating devices, fans, dampers, controls, doors, and windows.

11.8.2.1.1 An approved written schedule for such operational tests shall be established.

11.8.2.2 Test records shall be maintained on the premises and must indicate the date of such testing, the qualified service personnel, and any corrective measures needed or taken.

11.8.3 All smoke-control systems and devices shall be maintained in a reliable operating condition and shall be replaced or repaired where defective.

11.8.4 The AHJ shall be notified when any smoke-control system is out of service for more than 4 hours in a 24-hour period and again upon restoration of service of such systems.

11.8.5 The AHJ shall be permitted to require the building to be evacuated or an approved fire watch to be provided for all portions left unprotected by the fire protection system shutdown until the fire protection system has been returned to service.

11.9 Emergency Command Center

Where required, emergency command centers shall comply with Section 11.9.

11.9.1 The location, design, content, and fire department access of the emergency command center shall be approved by the fire department.

Approval by the fire department is required with regard to the location of, design of, and access to the emergency command center. As the primary user of the space, the fire department's input is important. The emergency command center should be easily accessible from the outside without requiring entrance into the building. The emergency command center can be either located in a room near an entrance or exit or accessible from outside the building.

11.9.2 The emergency command center shall be separated from the remainder of the building by a fire barrier having a fire resistance rating of not less than 1 hour.

11.9.3 New emergency command center rooms shall be a minimum of 200 ft² (19 m²) with a minimum dimension of 10 ft (3050 mm).

N **11.9.3.1** Existing emergency command center rooms shall be maintained with the minimum square footage and dimensions previously approved by the AHJ.

The emergency command center should be sized to accommodate all the equipment and supplies outlined in 11.9.4 and 11.9.5. It should also be large enough to provide fire department personnel with adequate room to work and store additional supplies required by the fire department. If the emergency command center is not large enough to store needed supplies, the room size should be increased or an additional room should be provided.

The minimum dimensions for the emergency command center have been revised for the 2018 edition of the *Code*. New emergency command centers are required to be a minimum of 200 ft² (19 m²). This change was for consistency with building code requirements. So that this change does not put an undue burden on existing emergency command centers that might not meet the minimum 200 ft² (19 m²) size, a new 11.9.3.1 has been added to address existing emergency command centers and to ensure that the square footage and dimensions of such centers are not reduced unless approved by the AHJ.

11.9.4 The following shall be provided in the emergency command center:

(1) The fire department communication unit
(2) A telephone for fire department use with controlled access to the public telephone system

(3) Schematic building plans indicating the typical floor plan and detailing the building core means of egress, fire protection systems, fire-fighting equipment, and fire department access
(4) Work table
(5) If applicable, hazardous material management plans for the building

11.9.5 Where otherwise required, the following devices or functions shall be provided within the emergency command center:

(1) The emergency voice/alarm communication system unit
(2) Fire detection and alarm system annunciator unit
(3) Annunciator visually indicating the location of the elevators and whether they are operational
(4) Status indicators and controls for air-handling systems
(5) Controls for unlocking stairway doors simultaneously
(6) Sprinkler valve and waterflow detector display panels
(7) Emergency and standby power status indicators
(8) Fire pump status indicators
(9) Generator supervision devices and manual start and transfer features
(10) Public address system, where specifically required by other sections of this *Code*
(11) Controls required for smoke control

The emergency command center gives the fire department access to valuable communication, control, and protection system annunciators. According to 11.9.1, the fire department must approve the design and layout of the emergency command center, including the layout of those devices and functions outlined in 11.9.4 and 11.9.5.

11.9.6 Emergency Command Center Acceptance Testing. Devices, equipment, components, and sequences shall be individually tested in accordance with appropriate standards and manufacturers' documented instructions.

The devices, equipment, controls, and other items installed or provided in the emergency command center need to be tested to ensure they function properly. Testing should be performed on the initial installation and at varying intervals as required by the AHJ or applicable standards.

11.10* Two-Way Radio Communication Enhancement Systems

A.11.10 Two-way radio communication enhancement systems provide for greater flexibility and safety for emergency responders during in-building operations.

11.10.1 In all new and existing buildings, minimum radio signal strength for fire department communications shall be maintained at a level determined by the AHJ.

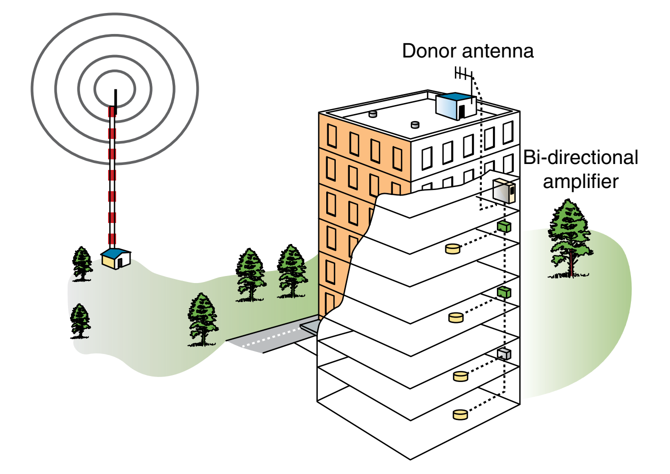
11.10.2 Where required by the AHJ, two-way radio communication enhancement systems shall comply with NFPA 1221.

11.10.3 Where a two-way radio communication enhancement system is required and such system, components, or equipment has a negative impact on the normal operations of the facility at which it is installed, the AHJ shall have the authority to accept an automatically activated responder system.

The 2009 edition of *the Code* provided guidance on the design of two-way radio communication enhancement systems in Annex O. Annex O was deleted for the 2012 edition, because much of its criteria was incorporated into *NFPA 72®*, *National Fire Alarm and Signaling Code®*. For the 2012 edition of this *Code*, the mandatory reference to *NFPA 72* was added to Section 11.10 for enforcement where the AHJ determines that a building requires such a system to facilitate fire department communications in the building. For the 2018 edition, the reference to *NFPA 72* in Section 11.10.2 was replaced with a reference to NFPA 1221, *Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems*. The 2016 edition of NFPA 1221 added requirements regarding two-way communications enhancement systems from NFPA 72.

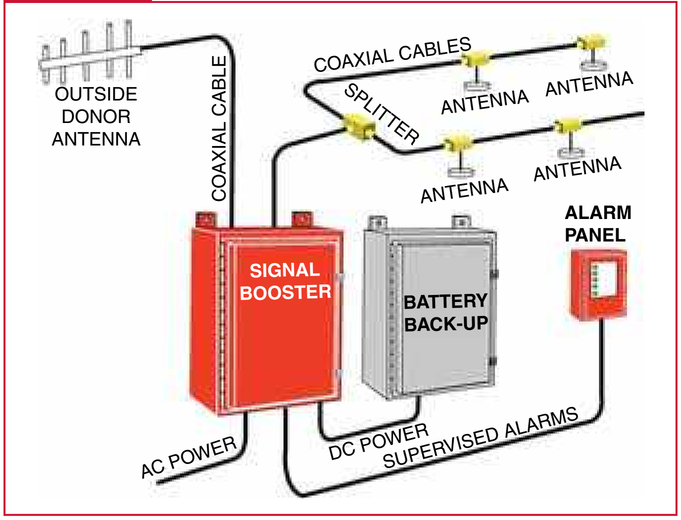
Fire department radio systems might not operate properly where concrete and steel construction interfere with radio traffic. One means of enhancing fire department radio communication within a building is to install antennae and repeaters at strategic locations, typically called bi-directional amplifier systems. This method is often preferred by fire departments because it allows them to use their normal radio equipment and communication procedures within the building. See Exhibit 11.7 and Exhibit 11.8 for examples of two-way in-building radio communication enhancement systems.

Exhibit 11.7



Bi-directional amplifier system. (Source: Copyright © Jack Daniel Company, Victorville, CA)

Exhibit 11.8



Bi-directional amplifier system floor layout. (Source: Copyright © Jack Daniel Company, Victorville, CA)

Δ 11.11 Medical Gas and Vacuum Systems

Medical gas and vacuum systems shall comply with NFPA 99.

Section 11.11 references NFPA 99, *Health Care Facilities Code*, for medical gas and vacuum systems. NFPA 99 establishes criteria to minimize the hazards of fire, explosion, and electricity in health care facilities providing services to human beings. NFPA 99 defines the term *health care facilities* as "buildings, portions of buildings, or mobile enclosures in which medical, dental, psychiatric, nursing, obstetrical, or surgical care is provided."

Health care facilities as defined by NFPA 99 include, but are not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory health care centers, whether permanent or movable. This definition applies to normal, regular operations and does not pertain to facilities during declared local or national disasters. A health care facility is not a type of occupancy classification as defined by this *Code* or NFPA *101*. Therefore, the term *health care facility* should not be confused with the term *health care occupancy*. All health care occupancies (and ambulatory health care occupancies) are considered health care facilities; however, not all health care facilities are considered health care occupancies, since health care facilities also include ambulatory health care occupancies and business occupancies.

For additional details on medical gas and piping systems, refer to the *Medical Gas and Vacuum Systems Installation Handbook*, which includes the relevant portions of NFPA 99 as referenced by this *Code*.

11.12 Photovoltaic Systems

Many new and existing buildings are being provided with photovoltaic (PV) systems, which produce electrical power from sunlight but present unique hazards to building occupants and fire fighters. Such electrical systems carry voltages of up to 600 volts (dc) and currents of up to 8 amperes in residential applications. Exhibit 11.9 depicts a roof-mounted PV system. There is no way to isolate the power at the PV modules during daytime hours. Because of the life-threatening voltage and current, these systems pose significant risks to people on the roofs of buildings — particularly fire fighters conducting ventilation operations (among others) during fire suppression operations. PV system installations should take into consideration the tactics employed by the fire service by providing safe roof access and means for identification of the presence of a PV system. The provisions of Section 11.12 are intended to address fire fighter safety during fire suppression operations.

Section 11.12 is revised for the 2018 edition of the Code. The 2012 edition of NFPA 1 and the 2011 edition of *NFPA 70* contained matching requirements to aid emergency responders when interacting with live PV power systems. As the provisions were further developed, it was understood that the electrical requirements would be deleted from NFPA 1 and retained in *NFPA 70* as appropriate. First, the 2018 edition of this *Code* deletes the electrical provisions (existing 11.12.2.1) and replaces it with a new section establishing labeling requirements for the rapid shutdown markings for PV systems, which is within the scope of NFPA 1. Second, the existing provision for roof access (11.12.2.2) is replaced with updated provisions for roof access that include language for the AHJ to permit a reduction or modification to roof access based upon fire department ventilation procedures or alternative methods to ensure adequate fire department access, pathways, and smoke ventilation. Additional clarifications to ventilation options, pathway dimensions, and terminology are

Exhibit 11.9

Roof-mounted photovoltaic system. (Thinkstock) also included in the revisions. Third, 11.12.3 is updated to provide flexibility to the AHJ to enforce provisions appropriate to the scale of a ground-mounted PV installation. Where previous editions of the *Code* required a gravel base or other noncombustible base acceptable to the AHJ to be installed and maintained under and around all ground-mounted PV installations, the new provisions require a vegetation management plan or other noncombustible base acceptable to the AHJ be maintained under and around the installation only where required by the AHJ. The rate of ground-mounted PV system installations is increasing, but for many jurisdictions nationwide, this is still considered a new or first-time development. The risks and hazards also differ widely when the installation is ground mounted rather than rooftop mounted. As a result, many AHJs do not have much familiarity with large-scale ground-mounted installations, nor are they as familiar with applying the appropriate interpretations when the *Code* does not clearly address this topic.

Another impacting concern is the environmental aspect. There are a variety of environmental factors considered as development and permitting challenges as ground-mount projects undergo environmental studies. Environmental requirements that would directly conflict with the literal requirement for only gravel or noncombustible bases underneath the system installation include, but are not limited to:

- Dust control (air)
- Water usage limitations in dry areas (water)
- Logistics to transport/haul/lay gravel (water/sustainability/air emissions)
- Native revegetation (flora)
- Natural habitat preservation (flora/fauna)

A project plan requiring a "noncombustible" or gravel base for a large-scale PV installation would never be permitted because of these reasons. All project permits for large PV installations require minimally invasive surface preparation techniques and natural vegetation recruitment or revegetation to greater or lesser extents during the operation of the power plant as a default requirement.

11.12.1 Photovoltaic systems shall be in accordance with Section 11.12 and *NFPA 70*.

11.12.2 Building-Mounted Photovoltaic Installations.

11.12.2.1* Marking. Photovoltaic systems shall be permanently marked as specified in this subsection.

A.11.12.2.1 Marking is needed to provide emergency responders with appropriate warning and guidance with respect to working around and isolating the solar electric system. This can facilitate identifying energized electrical lines that connect the solar modules to the inverter, which should not be cut when venting for smoke removal during fire-fighting operations.

• *N* **11.12.2.1.1* Rapid Shutdown Marking.** Buildings with a PV system shall be provided with permanent labels as described in 11.12.2.1.1.1 through 11.12.2.1.1.7.

N **A.11.12.2.1.1** To clarify what the labels described in the text of 11.12.2.1.1 should look like, this annex information provides a pictorial depiction of the sign to be similarly replicated for compliance with 11.12.2.1.1. Figure A.11.12.2.1.1(a) depicts the sign required by 11.12.2.1.1.1. Figure A.11.12.2.1.1(b) depicts the sign required by 11.12.2.1.1.2.

N **11.12.2.1.1.1 Rapid Shutdown Type.** The type of PV system rapid shutdown shall be labeled as described in 11.12.2.1.1.1.1 or 11.12.2.1.1.1.2.

N **11.12.2.1.1.1.1** For PV systems that shut down the array and conductors leaving the array:

EMERGENCY RESPONDER:
THIS SOLAR PV SYSTEM IS EQUIPPED
WITH RAPID SHUTDOWN

TURN RAPID SHUTDOWN SWITCH TO THE "OFF"
POSITION TO SHUT DOWN ENTIRE PV SYSTEM

N **11.12.2.1.1.1.2** For PV systems that only shut down conductors leaving the array:

EMERGENCY RESPONDER:
THIS SOLAR PV SYSTEM IS EQUIPPED
WITH RAPID SHUTDOWN

TURN RAPID SHUTDOWN SWITCH TO
THE "OFF" POSITION.
ONLY CONDUCTORS INSIDE BUILDING OR
OFF THE ROOF WILL SHUT DOWN

N **11.12.2.1.1.2** The label shall be reflective, with all letters capitalized and having a minimum height of ⅜ in. (9.5 mm), in white on a red background.

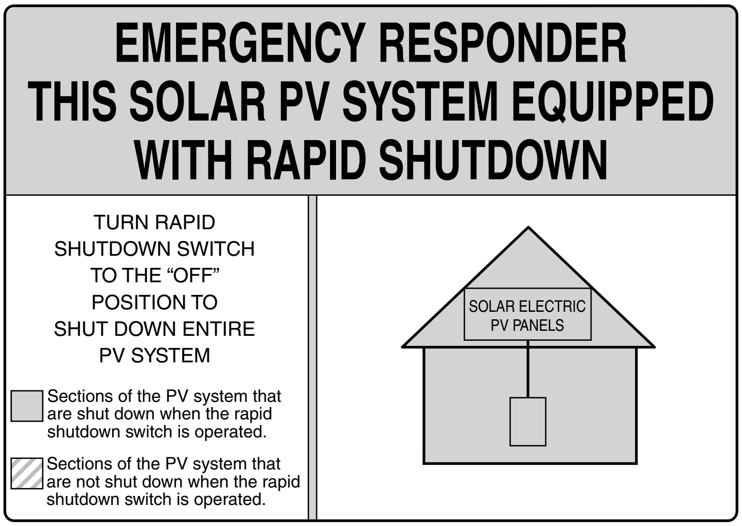
N **11.12.2.1.1.3** The label shall include a simple diagram of a building with a roof. Diagram sections in red shall signify sections of the PV system that are not shut down when the rapid shutdown switch is operated. Sections of the diagram in green shall signify sections of the PV system that are shut down when the rapid shutdown switch is operated.

N **11.12.2.1.1.4** The rapid shutdown label shall be located on or no more than 3 ft (1 m) from the service disconnecting means to which the PV systems are connected, and the label shall indicate the location of the rapid shutdown switch if it is not at the same location.

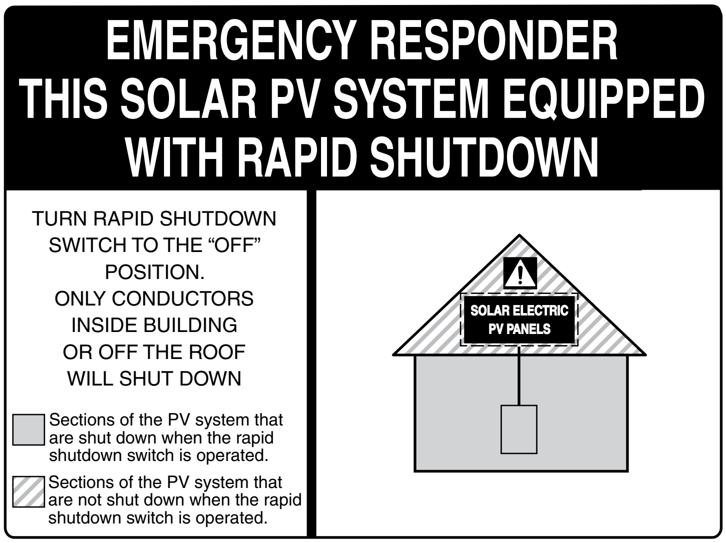
N **11.12.2.1.1.5 Buildings with More Than One Rapid Shutdown Type.** For buildings that have PV systems with both rapid shutdown types, or a rapid shutdown type and a PV system with no rapid shutdown, a detailed plan view diagram of the roof shall be provided showing each PV system and a dotted line around areas that remain energized after the rapid shutdown switch is operated.

N **11.12.2.1.1.6 Rapid Shutdown Switch.** The rapid shutdown switch shall have a label located on or no more than 3 ft (1 m) from the switch that includes the following words:

RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM



Δ *FIGURE A.11.12.2.1.1(a) Sign Required by 11.12.2.1.1.1.*



Δ *FIGURE A.11.12.2.1.1(b) Sign Required by 11.12.2.1.1.2.*

N **11.12.2.1.1.7** The label required by 11.12.2.1.1.6 shall be reflective, with all letters capitalized and having a minimum height of ⅜ in. (9.5 mm), in white on red background. [***70:***690.56(C)]

N **11.12.2.1.2** Each PV system disconnecting means shall be permanently marked to identify it as a PV system disconnect and shall indicate whether in the open or closed position. [***70:***690.13(B)]

N **11.12.2.1.3 Markings for Direct-Current Photovoltaic Source and Direct-Current Output Circuits on or Inside a Building.** The following wiring methods and enclosures that contain PV power source conductors shall be marked with the words WARNING: PHOTOVOLTAIC POWER SOURCE by means of permanently affixed labels or other approved permanent marking:

(1) Exposed raceways, cable trays, and other wiring methods
(2) Covers or enclosures of pull boxes and junction boxes
(3) Conduit bodies in which any of the available conduit openings are unused

[***70:***690.31(G)(3)]

N **11.12.2.1.3.1 Marking Locations and Methods.** The labels or markings shall be visible after installation. The labels shall be reflective and shall have all letters capitalized with a minimum height of ⅜ in. (9.5 mm) white on red background. PV power circuit labels shall appear on every section of the wiring system that is separated by enclosures, walls, partitions, ceilings, or floors. Spacing between labels or markings, or between a label and a marking, shall not be more than 10 ft (3 m). Labels required by this section shall be suitable for the environment where they are installed. [*70:*690.31(G)(4)]

N **11.12.2.1.4 Secondary Power Source Markings.** A permanent plaque or directory, denoting all electric power sources on or in the premises, shall be installed at each service equipment location and at locations of all electric power production sources capable of being interconnected. [*70:*705.10]

N **11.12.2.1.5 Installer Information.** A label shall be installed adjacent to the main disconnect indicating the name and emergency telephone number of the company currently servicing the PV system.

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N **11.12.2.2 Roof Access.**

N **11.12.2.2.1 General.** Access and spacing requirements shall be required to provide emergency access to the roof, provide pathways to specific areas of the roof, provide for smoke ventilation opportunity areas, and to provide emergency egress from the roof. The AHJ shall be permitted to reduce or modify roof access based upon fire department ventilation procedures or alternative methods that ensure adequate fire department access, pathways, and smoke ventilation.

N **11.12.2.2.2 One- and Two-Family Dwellings and Townhouses.** Photovoltaic systems installed in one- and two-family dwellings and townhouses shall provide roof access in accordance with 11.12.2.2.2. Designation of ridges shall not apply to roofs with 2 in 12 or less pitch.

N **11.12.2.2.2.1 Pathways.** Not less than two 36 in. (914 mm) wide pathways on separate roof planes, from gutter to ridge, shall be provided on all buildings. One pathway shall be provided on the street or driveway side of the roof. For each roof plane with a PV array, a 36 in. (914 mm) wide pathway from gutter to ridge shall be provided on the same roof plane as the PV array, on an adjacent roof plane or straddling the same and adjacent roof planes. Pathways shall be located in areas with minimal obstructions such as vent pipes, conduit, or mechanical equipment.

N **11.12.2.2.2.2** For PV arrays occupying up to 33 percent of the plan view roof area, a minimum 18 in. (457 mm) pathway shall be provided on either side of a horizontal ridge. For PV arrays occupying more than 33 percent of the plan view roof area, a minimum of 36 in. (914 mm) pathway shall be provided on either side of a horizontal ridge.

N **11.12.2.2.2.3 Buildings Other Than One- and Two-Family Dwellings and Townhouses.** Photovoltaic systems installed on any building other than one- and two-family dwellings and townhouses shall provide roof access in accordance with 11.12.2.2.2.3. Where the AHJ determines that the roof configuration is similar to a one- and two-family dwelling or townhouse, the AHJ shall allow the roof access requirements of 11.12.2.2.2. Detached, nonhabitable structures including, but not limited to, parking shade structures, carports, solar trellises, and similar structures shall not be required to provide roof access.

N **11.12.2.2.2.3.1 Perimeter Pathways.** A minimum 4 ft (1219 mm) wide perimeter pathway shall be provided around the edges of the roof for buildings with a length or width of 250 ft (76.2 m) or less along either axis. A minimum 6 ft (1829 mm) wide perimeter pathway shall be provided around the edges of the roof for buildings having length or width greater than 250 ft (76.2 m) along either axis.

N **11.12.2.2.2.3.2 Other Pathways.** Pathways shall be over areas capable of supporting fire fighters accessing the roof and shall be provided between array sections as follows:

(1) Pathways shall be provided in a straight line 48 in. (1219 mm) or greater in width to all ventilation hatches, and roof standpipes.
(2) Pathways shall be provided 48 in. (1219 mm) or greater in width around roof access hatches with at least one 48 in. (1219 mm) or greater in width pathway to the parapet or roof edge.
(3) Pathways shall be provided at intervals no greater than 150 ft (46 m) throughout the length and width of the roof.

N **11.12.2.2.2.3.3 Smoke Ventilation.** A pathway shall be provided 48 in. (1219 mm) or greater in width bordering all sides of nongravity-operated smoke and heat vents. Ventilation options between array sections shall be one of the following:

(1) A pathway 96 in. (2438 mm) or greater in width
(2) A pathway 48 in. (1219 mm) or greater in width and bordering on existing roof skylights or gravity-operated dropout smoke and heat vents on not less than one side
(3) A pathway 48 in. (1219 mm) or greater in width and bordering 48 in. (1219 mm) by 96 in. (2438 mm) venting cutouts options every 20 ft (6096 mm)

N **11.12.2.2.2.3.4 Minimizing Obstructions in Pathways.** Pathways shall be located in areas with minimal obstructions such as vent pipes, conduit, or mechanical equipment to reduce trip hazards and maximize ventilation opportunities.

11.12.3 Ground-Mounted Photovoltaic System Installations. Ground-mounted photovoltaic systems shall be installed in accordance with 11.12.3.1 through 11.12.3.3.

11.12.3.1* Clearances. A clear area of 10 ft (3048 mm) around ground-mounted photovoltaic installations shall be provided.

A.11.12.3.1 The zoning regulations of the jurisdiction setback requirements between buildings or property lines, and accessory structures may apply.

11.12.3.2* Vegetation Management Plan. A vegetation management plan or noncombustible base acceptable to the AHJ shall be approved and maintained under and around the installation where required by the AHJ.

A.11.12.3.2 Though dirt with minor growth is not considered noncombustible, the AHJ might approve dirt bases as long as any growth is maintained under and around the installation to reduce the risk of ignition from the electrical system. This could be a serious consideration for large ground-mounted photovoltaic systems. Not only should the base be considered under the systems, but also around the systems to the point that the risk of fire from growth or other ignition sources will be reduced.

11.12.3.3* Security Barriers. Fencing, skirting, or other suitable security barriers shall be installed when required by the AHJ.

A.11.12.3.3 Security barriers are intended to protect individuals and animals from contact with energized conductors or other components.

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Features of Fire Protection

12

Chapter 12 discusses features of fire protection and addresses the topics of construction types, fire-resistive materials and construction, fire doors and other opening protectives, interior finish, contents and furnishings, fire barriers, smoke partitions, and smoke barriers.

12.1 General

This chapter shall apply to new, existing, permanent, or temporary buildings.

12.2* Construction

A.12.2 Table A.12.2 provides a cross reference from the NFPA construction types to the model building codes.

Δ **12.2.1*** Where required by this *Code*, a type of building construction shall comply with NFPA 220.

Δ **A.12.2.1** Building construction types are defined in NFPA 220. The following material is extracted verbatim from NFPA 220 and is included here as a convenience for users of this *Code*. Any requests for Formal Interpretations (FIs) or Tentative Interim Amendments (TIAs) on the following material should be directed to the Technical Committee on Building Construction. See Table A.12.2.1 for fire resistance ratings for each building construction type.

Type I and Type II Construction. Type I (442 or 332) and Type II (222, 111, or 000) construction shall be those types in which the fire walls, structural elements, walls, arches, floors, and roofs are of approved noncombustible or limited-combustible materials. [**220:**4.3.1]

Type III Construction. Type III (211 or 200) construction shall be that type in which exterior walls and structural elements that are portions of exterior walls are of approved noncombustible or limited-combustible materials, and in which fire walls, interior structural elements, walls, arches, floors, and roofs, are entirely or partially of wood of smaller dimensions than required for Type IV construction or are of approved noncombustible, limited-combustible, or other approved combustible materials. [**220:**4.4.1]

Type IV Construction. Type IV (2HH) construction shall be that type in which fire walls, exterior walls, and interior bearing walls and structural elements that are portions of such walls are of approved

TABLE A.12.2 *Cross Reference of Building Construction Types*

Code Source NFPA 220	I(442)	I(332)	II(222)	II(111)	II(000)	III(211)	III(200)	IV(2HH)	V(111)	V(000)
B/NBC	1A	1B	2A	2B	2C	3A	3B	4	5A	5B
IBC	—	IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
SBC	I	II	—	IV 1 hr	IV UNP	V 1 hr	V UNP	III	VI 1 hr	VI UNP
UBC	—	I FR	II FR	II 1 hr	II N	III 1 hr	III N	IV HT	V 1 hr	V N

B/NBC: *BOCA/National Building Code.*

FR: Fire resistive.

HT: Heavy timber.

IBC: *International Building Code.*

N: Nonrequirement.

SBC: *Standard Building Code.*

UBC: *Uniform Building Code.*

UNP: Unprotected.

TABLE A.12.2.1 Fire Resistance Ratings for Type I through Type V Construction (hr)

	Type I		Type II			Type III		Type IV	Type V	
	442	332	222	111	000	211	200	2HH	111	000
Exterior Bearing Walls[a]										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting one floor only	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting a roof only	4	3	1	1	0[b]	2	2	2	1	0[b]
Interior Bearing Walls										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	2	1	0
Supporting one floor only	3	2	2	1	0	1	0	1	1	0
Supporting roofs only	3	2	1	1	0	1	0	1	1	0
Columns										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	3	2	2	1	0	1	0	H	1	0
Supporting roofs only	3	2	1	1	0	1	0	H	1	0
Beams, Girders, Trusses, and Arches										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	2	2	2	1	0	1	0	H	1	0
Supporting roofs only	2	2	1	1	0	1	0	H	1	0
Floor-Ceiling Assemblies	2	2	2	1	0	1	0	H	1	0
Roof-Ceiling Assemblies	2	1½	1	1	0	1	0	H	1	0
Interior Nonbearing Walls	0	0	0	0	0	0	0	0	0	0
Exterior Nonbearing Walls[c]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]

Note: H = heavy timber members *(see NFPA 220 text for requirements).*

[a]See *NFPA 5000,* 7.3.2.1.

[b]See *NFPA 5000,* Section 7.3.

[c]See 4.3.2.12, 4.4.2.3, and 4.5.6.8 of NFPA 220.

[**220:** Table 4.1.1]

noncombustible or limited-combustible materials, except as allowed for exterior walls in 4.5.6.7 of NFPA 220. Other interior structural elements, arches, floors, and roofs shall be of solid or laminated wood or cross-laminated timber without concealed spaces or with concealed spaces conforming to 4.5.4 of NFPA 220 and shall comply with the allowable dimensions of 4.5.5 of NFPA 220. [**220:**4.5.1]

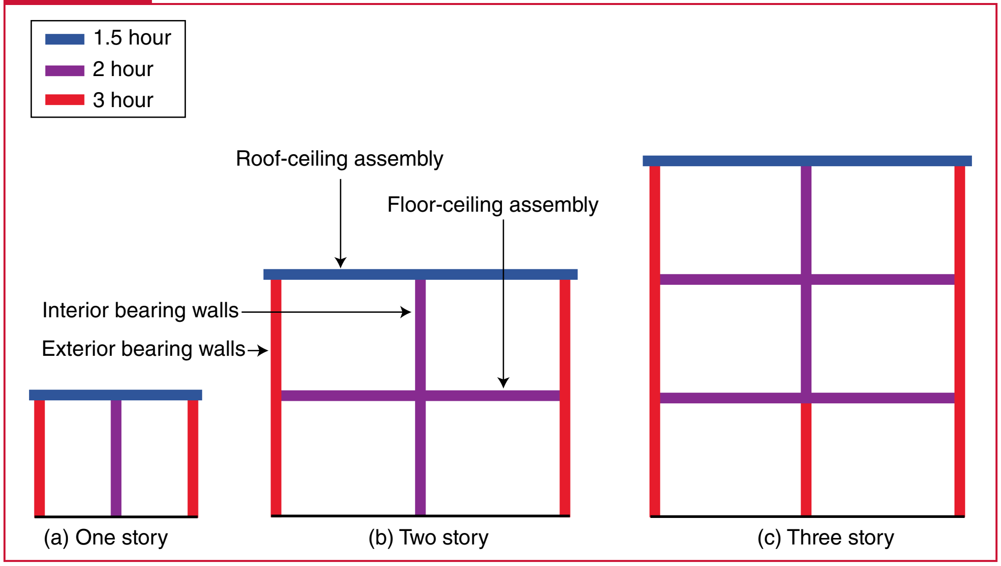
Type V (111 or 000) Construction. Type V (111 or 000) construction shall be that type in which structural elements, walls, arches, floors, and roofs are entirely or partially of wood or other approved material. [**220:**4.6]

NFPA 220, *Standard on Types of Building Construction*, is the reference document used throughout this *Code* to define specific types of building construction.

Table A.12.2.1 identifies the minimum fire resistance rating of certain building components. Typically the shorthand notation, such as Type I (332), provides the minimum hourly fire resistance ratings required to meet the definition of that construction type for three components of the building — exterior bearing walls, structural frame/columns/girders, and floor construction. In the example of Type I (332) construction, the exterior bearing walls would have a 3-hour fire resistance rating, the structural frame/columns/girders, and floor construction would have a 3-hour fire resistance rating, and the floor construction would have a 2-hour fire resistance rating. To fully meet the construction type, other building components, such as roof construction and interior bearing walls, need to meet the minimum fire resistance ratings outlined in Table A.12.2.1. Occasionally the required fire resistance rating may be less than the shorthand notation states if the building element supports just the roof, or one floor only. Exhibit 12.1 shows how to use the table and how fire resistance rating requirements can vary depending on what the building component supports.

The three parts of Exhibit 12.1 are examples of requirements for a Type I (332) building. The first step in evaluating the

Exhibit 12.1



Examples of requirements for a Type I (332) building.

required fire resistance rating is to determine what the building element supports. For many components Table A.12.2.1 lists three different options, "supporting a roof only," "supporting one floor only," "supporting more than one floor, columns, or other bearing walls." Typically, the building elements on the top floor of a building will fall into the "supporting a roof only" category. Those building elements on the floor below the top floor will fall into the "supporting one floor only" category, and everything below that would fall into the "supporting more than one floor, columns, or other bearing walls" category.

Part (a) of Exhibit 12.1 shows a one-story building of Type I (332) construction. Since there are no additional floors, all building components are supporting the roof only. To determine the required fire resistance rating of the columns for a Type I (332) construction type, follow the bottom row ("supporting roof only") of the "Columns" section, over to where it intersects with the row for Type I (332) construction. At the intersection point, there is a 2. This means that the columns would only require a 2-hour fire resistance rating. Following the same procedure for the exterior bearing walls, we find that a 3-hour fire resistance rating would be required even when those walls only support the roof.

Part (b) shows a two-story building of Type I (332) construction. To determine the fire resistance rating for the interior bearing walls on the bottom floor, you would look at the middle row, "Supporting one floor only," under the "Interior Bearing Walls" section. There, you would find that a 2-hour fire resistance rating is required. The 2-hour fire resistance rating also applies to the interior bearing walls on the top floor, where the walls are only supporting the roof.

Part (c) shows a three-story building of Type I (332) construction. To determine the fire resistance rating for the interior bearing walls on the bottom floor, you would look at the top row ("Supporting more than one floor, columns, or other bearing walls") under the "Interior Bearing Walls" section. Following the row over to Type I (332) we find that a 3-hour fire resistance rating is required. The interior bearing walls on the second floor would only require a 2-hour fire resistance rating since they are supporting one floor only. The interior bearing walls on the top floor would also only require a 2-hour fire resistance rating. Another useful reference is the "Guideline on Fire Ratings of Archaic Materials and Assemblies," which is Annex O of NFPA 914, *Code for Fire Protection of Historic Structures*. This annex can assist in the determination of the fire resistance ratings of materials used in older construction.

Exhibit 12.2 shows some examples of different construction types. Part (a) shows an example of Type I construction which is typically associated with concrete and steel structures. An example of Type II construction is shown in part (b). Type III construction is a mixture of masonry and wood construction. Type II is typically made of steel and may or may not have fireproofing. Part (c) shows an example of Type III construction which usually consists of masonry exterior walls and a wood interior and roof. Type IV construction is sometimes referred to as "heavy timber" or "mass timber" construction. Typically, it is constructed of large wood beams similar to old mill building construction. Part (d) shows an example of Type IV construction. Type V construction, or "stick-built" construction is made of combustible materials, usually dimensional lumber. Part (e) shows an example of Type V construction.

Exhibit 12.2

(a) Type I construction

(b) Type II construction

(c) Type III construction

(d) Type IV construction

(e) Type V construction

Examples of different construction types. (Images courtesy of Thinkstock)

12.2.2 Fire safety construction features for new and existing occupancies shall comply with this *Code* and the referenced edition of NFPA *101*.

Subsection X.1.6 of each occupancy chapter in NFPA *101*®, *Life Safety Code*®, where X is the applicable occupancy chapter number, specifies the minimum type of construction for those occupancy classifications that regulate construction type. For example, construction is regulated in assembly and health care occupancies because the construction serves as a life safety feature — the building must remain structurally stable during a fire to allow for extended evacuation times in the case of assembly occupancies and the defend-in-place strategy associated with health care occupancies. Other occupancies, such as business and residential occupancies, specify no minimum construction types because it is assumed that occupants will quickly evacuate upon notification of a fire in the building.

NFPA *101* also requires other construction features, such as protection of vertical openings and protection of hazards. Other referenced codes and standards might also require specific construction types or features.

12.3 Fire-Resistive Materials and Construction

Δ **12.3.1** The design and construction of fire walls and fire barrier walls that are required to separate buildings or subdivide a building to prevent the spread of fire shall comply with Section 12.3 and NFPA 221.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* prescribes minimum requirements for the design and construction of high challenge fire walls, fire walls, and fire barrier walls for use in providing safety to life and protection of property from fire. These requirements apply to walls that are required to separate buildings or subdivide a building to prevent the spread of fire. The minimum fire resistance rating of a wall assembly is outside the scope of NFPA 221. This *Code* and referenced codes and standards might require the installation of a fire wall or fire barrier wall for a specific application. High challenge fire walls are not specifically required by the *Code*. It is up to the designer/engineer to determine when a fire wall needs to be a high challenge fire wall. The intended use of a high challenge fire wall is in areas where an explosion is expected. The additional requirements for a high challenge fire wall allow it to remain stable after a structural collapse due to fire on either side of the wall. NFPA 221 provides the requirements necessary to evaluate the design and construction of high challenge fire walls, fire walls, and fire barrier walls.

12.3.2* Quality Assurance for Penetrations and Joints. In new buildings three stories or greater in height, a quality assurance program for the installation of devices and systems installed to protect penetration and joints shall be prepared and monitored by the RDP responsible for design. Inspections of firestop systems and fire-resistive joint systems shall be in accordance with 12.3.2.1 and 12.3.2.2.

Δ **A.12.3.2** The scoping provision of 12.3.2 is extracted from *NFPA 5000*, but limited to new buildings that are three or more stories in height. Such threshold is reasonable from the fire inspection perspective.

12.3.2.1 Inspection of firestop systems of the types tested in accordance with ASTM E814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops*, or /UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*, shall be conducted in accordance with ASTM E2174, *Standard Practice for On-Site Inspection of Installed Fire Stops*. [***5000:***40.9.1]

12.3.2.2 Inspection of fire-resistive joint systems of the types tested in accordance with ASTM E1966, *Standard Test Method for Fire-Resistive Joint Systems*, or UL 2079, *Standard for Tests for Fire Resistance of Buildings Joint Systems*, shall be conducted in accordance with ASTM E2393, *Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers*. [***5000:***40.9.2]

Quality assurance for the proper design, installation, and inspection of through-penetrations and joint systems in fire walls and fire barrier walls is critically important to controlling fire spread in multistory buildings. The provisions of 12.3.2, which are extracted from *NFPA 5000®*, *Building Construction and Safety Code®*, mandate the establishment of a quality assurance program for such penetrations and joint systems in new buildings. The authority having jurisdiction (AHJ) should verify that inspections are conducted in accordance with the standards mandated by 12.3.2.1 and 12.3.2.2. Such inspections should occur before any penetrations or joint systems, for example, above a gypsum board ceiling, are permanently concealed.

12.3.3* Maintenance of Fire-Resistive Construction, Draft-Stop Partitions, and Roof Coverings.

A.12.3.3 Fire-resistive construction also includes fire-resistive coatings and sprayed fire-resistive materials, as well as membrane and through-penetration firestops and fire-resistive joint systems. It is important to conduct periodic inspections of fire-resistive construction, especially these elements and components that are directly visible or readily accessible for inspection.

Inspections of sprayed fire-resistive materials and coatings are especially important since they can be subject to delamination, removal, physical abuse, deterioration, and degradation over time. Periodic inspections should be able to identify apparent deficiencies, especially where they crumble or fall off when touched. When such conditions are identified, they should be further inspected or tested by qualified third parties to verify their integrity and effectiveness. Where they are found to be deficient, appropriate corrective action should be taken to restore them to their original condition.

Tested and listed firestop systems should be installed to the listing in order to perform as expected. Systems installed in accordance with an engineering judgment (EJ) should be installed in accordance with the EJ. The firestop systems should be inspected periodically to assure continued performance. To inspect firestops, the listed system design or EJ should be accessible. Firestop installations are only able to be identified by the listing design, the listing references, the materials to be used, and installation parameters. Without the listing, neither the inspector, building owner, nor building management company has any idea how to inspect or repair the firestop systems.

Firestop systems can be marked at the location of the installation using a variety of methods from paper labels to complex plastic tear-away labels, ceramic fiber, or metal tags. These can be attached to the assembly or to the penetrating item(s). A variety of marking methods can be used and they should provide important information, such as the listing number, date, manufacturer, and installing contractor.

12.3.3.1 Required fire-resistive construction, including fire barriers, fire walls, exterior walls due to location on property, fire-resistive requirements based on type of construction, draft-stop partitions, and roof coverings, shall be maintained and shall be properly repaired, restored, or replaced where damaged, altered, breached, penetrated, removed, or improperly installed.

Returning any damaged fire resistance–rated construction to its original condition is important. Damage or breaches to such materials or the creation of unprotected penetrations through them reduces or eliminates their fire-resistive characteristics, making them ineffective in the event of a fire. Inspectors should ensure that fire resistance–rated construction is maintained. Damage might not always be obvious, because penetrations and breaches sometimes occur above ceilings. Therefore, areas above ceilings must be carefully inspected where such areas can be accessed without damaging the building. See 1.7.13 for additional guidance.

Exhibit 12.3 illustrates cable penetrations through a fire barrier.

12.3.3.2 Where required, fire-rated gypsum wallboard walls or ceilings that are damaged to the extent that through openings exist, the damaged gypsum wallboard shall be replaced or returned to the required level of fire resistance using a listed repair system or using materials and methods equivalent to the original construction.

Where holes exist in gypsum wallboard, the damaged sections must be replaced or, if possible, repaired in an approved manner with a listed material or system.

Exhibit 12.3

Cable penetrations through a fire barrier.

12.3.3.3 Where readily accessible, required fire-resistance-rated assemblies in high-rise buildings shall be visually inspected for integrity at least once every 3 years.

12.3.3.3.1 The person responsible for conducting the visual inspection shall demonstrate appropriate technical knowledge and experience in fire-resistance-rated design and construction acceptable to the AHJ.

12.3.3.3.2 A written report prepared by the person responsible for conducting the visual inspection shall be submitted to the AHJ documenting the results of the visual inspection.

The fire resistance of high-rise building structural components is of paramount importance for building occupants and fire fighters, given the potential for prolonged evacuation times. The requirements of 12.3.3.3 mandate visual inspections of readily accessible structural components every 5 years to ensure that the fire resistance has not been diminished due to construction projects, environmental conditions, or any other reason. The AHJ should periodically review the inspection reports provided by the owner to verify the qualifications of the inspectors and to ensure that, where any issues were located, they were properly remedied.

12.4 Fire Doors and Other Opening Protectives

Δ **12.4.1*** The installation and maintenance of assemblies and devices used to protect openings in walls, floors, and ceilings against the spread of fire and smoke within, into, or out of buildings shall comply with Section 12.4 and NFPA 80. [**80:**1.1]

A.12.4.1 See Annex K of NFPA 80 for general information about fire doors. [**80:**A.1.1]

New installations of fire doors and fire windows should be in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*. Chapter 5 of NFPA 80 covers the care and maintenance of new and existing fire doors and fire windows.

12.4.2* With the exception of fabric fire safety curtain assemblies, Section 12.4 addresses assemblies that have been subjected to standardized fire tests. *(See Chapter 20 of* NFPA 80.*)* [**80:**1.1.1]

A.12.4.2 No fire test standard requirement currently exists to which fabric fire safety curtain assemblies can be tested. Only the curtain fabric is tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*. The perimeter and internal framework and all supporting, guide, and operating components used in specific applications are not tested. Variations in size of proscenium openings and the amount of side and head clearances available for individual stages dictate the number of variations in design of the assemblies. [**80:**A.1.1.1]

12.4.3* Incinerator doors, record room doors, and vault doors are not covered in Section 12.4. [**80:**1.1.2]

Δ **A.12.4.3** For requirements on their installation, see NFPA 82 and NFPA 232. [**80:**A.1.1.2]

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment,* addresses fire doors on incinerators and waste handling systems. NFPA 232, *Standard for the Protection of Records*, addresses fire doors for record rooms and vaults.

12.4.4* Requirements for horizontally sliding, vertically sliding, and swinging doors as used in this *Code* do not apply to hoistway doors for elevators and dumbwaiters. [**80:**1.1.3]

A.12.4.4 For requirements on the installation of hoistway doors for elevators and dumbwaiters, see the applicable sections of ASME A17.1 CSA B44-2010, *Safety Code for Existing Elevators and Escalators*, or ASME A17.3/CSA B44-13, *Safety Code for Existing Elevators and Escalators*. [**80:**A.1.1.3]

12.4.5* Section 12.4 shall not cover fire resistance glazing materials and horizontally sliding accordion or folding assemblies fabricated for use as walls and tested as wall assemblies in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*. [**80:**1.1.4]

Δ **A.12.4.5** The fire performance evaluation of these assemblies is tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, for horizontal access doors, NFPA 252 for fire doors and shutters, NFPA 257 for fire windows and glass block, and NFPA 288 for doors in horizontal fire-rated assemblies. It is not the intent of this section to establish the degree of protection required or to constitute the approval of any product. These are determined by the AHJ. [**80:**A.1.1.4]

Currently doors and windows are being used that are tested and listed in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials,* as wall assemblies. When evaluating fire doors and fire windows, the listing obtained from the testing laboratory should be carefully reviewed to ensure compliance with the applicable requirements.

12.4.6 Care and Maintenance of Fire Doors and Other Opening Protectives.

12.4.6.1 Subsection 12.4.6 shall cover the inspection, testing, and maintenance of fire doors, fire shutters, fire windows, and opening protectives other than fire dampers and fabric fire safety curtains. [**80:**5.1.1.1]

N **12.4.6.2** The requirements of Section 12.4 shall apply to new and existing installations. [**80:**5.1.1.2]

NFPA 80 is an installation standard and is applicable to new installations. It is not intended to be applied retroactively. The exception to that rule is Chapter 5, which is applicable to new *and* existing installations. One very important point regarding

Chapter 5 is that older fire door assemblies need to be inspected with the code requirements that were applicable at the time of installation. It is not the intent that existing installations meet the provisions for new installations, unless the AHJ has determined that the existing situation involves a distinct hazard to life or property. For example, for many years, ¼ in. (6.35 mm) clear wire glass was the only type of glazing material permitted to be installed in fire doors. Today, however, ¼ in. (6.35 mm) clear wire glass is severely restricted as to where it can be used, due to the invention of newer and better fire-rated glazing products. When older fire doors are inspected, inspectors should not cite the presence of ¼ in. (6.35 mm) wire glass as a deficiency since that was permitted at the time of installation. On the other hand, if the clear wire glass is damaged and needs to be replaced, the replacement glazing material needs to comply with the edition of NFPA 80 that is enforced at the time of replacement.

12.4.6.3 Operability.

12.4.6.3.1 Doors, shutters, and windows shall be operable at all times. [**80:**5.1.2.1]

Paragraph 12.4.6.3.1 requires that fire doors, shutters, and windows be operable throughout the life of their installation, which is why the provisions of Chapter 5 of NFPA 80 are applicable to new and existing assemblies. Operability includes opening, closing, and, where required, latching in the closed position, as specified elsewhere in NFPA 80. Fire doors, shutters, and windows are not required to be operable after exposure to the elevated temperatures of a fire, but will require replacement.

12.4.6.3.2 Doors, shutters, and windows shall be kept closed and latched or arranged for automatic closing. [**80:**5.1.2.2]

N **12.4.6.3.3 Prevention of Door Blockage.**

The subparagraphs of 12.4.6.3.3 require the area leading to and away from door openings to be unobstructed and clear of anything (e.g., furniture, boxes, and other equipment) that might prevent doors from opening and closing. Swinging door leaves need to move freely to their full open and closed positions. In applications where materials and equipment might interfere with sliding doors, barriers need to be constructed to ensure that the doors are free to open and close. Blocking or wedging doors in the open position is expressly prohibited by 12.4.6.3.3.3. Kickdown door stops and wood/rubber wedges used to hold open swinging fire doors are frequently cited by AHJs as code violations.

N **12.4.6.3.3.1** Door openings and their surrounding areas shall be kept clear of anything that could obstruct or interfere with the free operation of the door. [**80:**5.1.2.3.2]

N **12.4.6.3.3.2** Where necessary, a barrier shall be built to prevent the piling of material against sliding doors. [**80:**5.1.2.3.2]

N **12.4.6.3.3.3** Blocking or wedging of doors in the open position shall be prohibited. [**80:**5.1.2.3.3]

12.4.6.4 Replacement. Where it is necessary to replace fire doors, shutters, windows or their frames, glazing materials, hardware, and closing mechanisms, replacements shall meet the requirements for fire protection and shall be installed and tested as required by this section for new installations. [**80:**5.1.3]

When fire door assemblies need new components (e.g., hinges, rollers, closing devices, glass, and latching hardware) or complete replacement, the new items must comply with the requirements for new installations. Paragraph 12.4.6.4 applies directly to provisions and requirements of 12.4.6.11, Maintenance.

N **12.4.6.5 Field Labeling.**

The requirements in 12.4.6.5.1 through 12.4.6.5, which cover field labeling of existing fire doors, shutters, and windows, were new to the 2016 edition of NFPA 80. Nationally recognized testing laboratories (e.g., Underwriters Laboratories, Intertek/Warnock Hersey, and FM Global) have offered field labeling services for installed assemblies for many years.

Field labeling is used to replace labels on door frames and doors where the original labels have been painted over, removed, or incorrectly labeled or where modifications have been made to the door frames or doors. Previous editions of NFPA 80 did not address the long-standing industry practice of field labeling.

Paragraph 12.4.6.5.3 lists the minimum information to be printed on the field labels for fire doors and fire door frames.

Paragraphs 12.4.6.5.4 and 12.4.6.5.6 cover situations concerning converting non–fire-rated assemblies into fire-rated assemblies. Paragraph 12.4.6.5.4 requires modifications to non–fire-rated door assemblies to be completed in compliance with 12.4.6.6. In these cases, the manufacturer of the modified component(s) will need to seek approval from one of the nationally recognized testing laboratories. Most likely, that testing lab will follow up the modifications with a field inspection to confirm that the work resulted in creating a fire-rated door assembly and, where the modifications comply with NFPA 80 and the respective manufacturer's published listings, the testing lab will field label the modified assemblies.

Paragraph 12.4.6.5.6 applies to all the fire door assemblies covered in NFPA 80, with the possible exception of swinging doors with builders hardware, which are covered in Chapter 6. Unlike the other types of fire door assemblies, swinging doors with builders hardware are component-based systems; each component is required to be labeled or listed. Because they are component-based systems, converting non–fire-rated assemblies into fire-rated assemblies could be accomplished by replacing door leaves with ones that are labeled and, where necessary, upgrading hardware components — provided door frames are labeled or capable of being labeled. Where existing door frames are not capable of being labeled, replacing entire assemblies is necessary.

Other types of door assemblies are unit-based systems, and the label on the door covers the entire assembly. For example, the label on the curtains of rolling steel fire doors covers the curtain, tracks, guides, rollers, cables, fusible links, pulleys, springs, hoods, and all other components. Consequently, converting non–fire-rated unit-based door assemblies such as these is not possible and requires new fire-rated door assemblies to be installed in their stead.

N **12.4.6.5.1** Field labeling shall be performed only by individuals or companies that have been certified or listed, or by individuals or companies that are representatives of a labeling service that maintains periodic inspections of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner. [**80:**5.1.4.1]

N **12.4.6.5.2** Individuals performing the service shall provide proof of qualifications to the authority having jurisdiction prior to performing work, as described in 12.4.6.5.1. [**80:**5.1.4.2]

N **12.4.6.5.3** At a minimum, field labels shall contain the following information:

(1) The words "field inspected" or "field labeled"
(2) The words "fire door" or "fire door frame"
(3) The marking of a third-party certification agency
(4) The fire protection rating
(5) A unique serial number (if provided by the listing agency)
(6) The fire test standard designation to which the assembly was tested

[**80:**5.1.4.3]

N **12.4.6.5.4** Field modifications shall not be permitted to be made to a non-fire-rated door assembly to achieve a fire rating unless the field modification is completed under label service. [**80:**5.1.4.4]

N **12.4.6.5.5** Doors in which a field modification in accordance with 5.1.4.4 has been completed shall be labeled. [**80:**5.1.4.5]

N **12.4.6.5.6** When an opening with a non-fire-rated door requires a fire door, the door assembly shall be replaced. [**80:**5.1.4.6]

12.4.6.6 Field Modifications.

Any work performed on fire door assemblies that requires drilling into or cutting material needs to be carefully considered beforehand. Chapter 4 of NFPA 80 explicitly identifies work that can be done in the field as part of the installation process. When the work about to be performed is not explicitly permitted by 4.1.3.2 through 4.1.3.2.5 of NFPA 80, the work falls under the category of a field modification and is subject to the requirements of 12.4.6.6 of this *Code*.

One of the main requirements to bear in mind is that each component attached to a swinging fire door with builders hardware needs to be labeled for use on fire door assemblies. For example, very few door contact switches are labeled and/or listed for use on swinging fire doors. Some models of contact switches require a round hole to be drilled into the rabbets of door frames that is larger than the 1 in. (25.4 mm) permitted in 4.1.3.2.2 and 4.1.3.2.3 of NFPA 80. Just as important, it needs to be confirmed with the manufacturer of the doors and frames that their specific products are listed for use with the components that are intended to be installed on them. Not all fire-rated components can be used together — some components are restricted to very specific applications.

The unfortunate reality is that the fire protection ratings of many swinging fire doors have been compromised in the field by the installation of electrified hardware and access control devices by persons who were not aware of the requirements before they modified the fire door assemblies. Inspections based on NFPA 80 will eventually find and correct these problems, but the costs for repairing or replacing the damaged door assemblies could be expensive.

One frequently asked question regards painting a door. Generally, fire doors are permitted to be painted by the facility/building owner. The one caveat to painting fire doors is that moving parts (e.g., hinges, latches, and door closer arms) need to be able to move freely. Layers of accumulated paint can inhibit the operation of such items and prevent door leaves from functioning properly. In those cases, the old layers of paint have to be removed to restore the moving parts to their proper operation. Paragraph 12.4.6.8.3.8 has a specific requirement regarding the accumulation of paint on moving parts.

12.4.6.6.1* In cases where a field modification to a fire door or a fire door assembly is desired and is not permitted by 4.1.3.2 through 4.1.3.42.5 of NFPA 80, the laboratory with which the product or component being modified is listed shall be contacted through the manufacturer and a written or graphic description of the modifications shall be presented to that laboratory. [**80:**5.1.5.1]

A.12.4.6.6.1 Field modifications beyond the scope of the prescriptive allowances permitted by 4.1.3.2 through 4.1.3.42.5 of NFPA 80 typically result in voiding the fire rating of the assembly. Paragraph 5.1.4.1 of NFPA 80 provides an alternative method whereby proposed modifications can be documented and presented to the labeling agency prior to work commencing. Where the proposed modification(s) are within the parameters of the manufacturer's procedures and will not degrade the fire resistance of the assembly, the labeling agency is permitted to authorize such modifications without a requirement for a subsequent field inspection. [**80:**A.5.1.4.1]

Generally, the replacement of hardware components on swinging doors (hinges, pivots, door closers, etc.) is not considered to be a field modification, provided the replacement hardware does not require additional cutting, mortising, or boring into the doors and frames and the hardware meets the criteria specified elsewhere in NFPA 80. Likewise, the installation of surface-mounted items like protection plates is not considered to be field modifications. Cutting doors for vision panels, enlarging existing cutouts for vision panels, and trimming doors in height or width are examples of field modifications. Similarly, installing hardware components that require additional cutting and mortising of the doors or frames are examples of field modifications.

12.4.6.6.2 Field modifications shall be permitted without a field visit from the laboratory upon written authorization from that laboratory. [**80:**5.1.5.2]

12.4.6.6.3 When the manufacturer is no longer available, the laboratory shall be permitted to provide an engineering evaluation supporting the field modification. [**80:**5.1.5.3]

12.4.6.7 Removal of Door or Window. Where a fire door or fire window opening no longer functions as an opening, or the door or window is removed and not replaced, the opening shall be filled to maintain the required rating of the wall assembly. [**80:**5.1.6]

Where a door or window opening is no longer in use, the opening must be filled with construction materials equivalent to those of the wall to maintain the required rating of the wall assembly. Many times, doors are no longer used as doors and functionally become walls. For example, an office (or similar space) might have two doors installed for convenience. Over time, one of the doors is no longer needed or used and has items placed in front of it to prevent its use. When the door no longer functions as a door and has materials placed against it or in close proximity to it, the effectiveness and rating of the fire barrier are reduced. The fire testing requirements differ for a wall and a door, and care should be taken when a fire door or a fire window is no longer used as a door or window.

12.4.6.8* Inspection and Testing.

Section 5.2 contains all the provisions related to inspection and test procedures for fire doors, fire windows, and fire shutters. Paragraphs 12.4.6.8.1 and 12.4.6.8.2 address general inspection and testing criteria, including record keeping, that is applicable to all fire door, fire window, and fire shutter inspections. Paragraph 12.4.6.8.2 also includes the requirements for inspections and testing upon completion of installation of the assembly and after maintenance work. Paragraph 12.4.6.8.3 addresses acceptance tests and provides all the minimum requirements that must be met during these tests, including a visual inspection. Finally, 12.4.6.8.4 addresses periodic inspection and testing and provides the minimum required frequency for inspections and makes a reference back to 12.4.6.8.3 for the criteria that must be met.

There are at least three occurrences when an inspection and test of fire door, fire window, and fire shutter assemblies must be performed:

1. Upon completion of installation of a fire door, fire window, or fire shutter assembly (12.4.6.8.3)
2. Periodically, but not less than annually (12.4.6.8.4)
3. Upon completion of maintenance work (12.4.6.8.3)

A.12.4.6.8 Doors, shutters, and windows are of no value unless they are properly maintained and closed or are able to close at the time of fire. A periodic inspection and maintenance program is generally the responsibility of the building owner. [**80:**A.5.2]

12.4.6.8.1* Upon completion of the installation, door, shutters, and window assemblies shall be inspected and tested in accordance with 5.2.4 of NFPA 80. [**80:**5.2.1]

A.12.4.6.8.1 Hinges, catches, closers, latches, and stay rollers are especially subject to wear. [**80:**A.5.2.1]

Once the installation of a fire door, fire window, or fire shutter assembly has been completed, the assembly must be tested to ensure that it works properly. This includes verifying that the door closes and latches and that all closing devices are working properly and effectively. It should be verified that no floor coverings or obstructions interfere with the proper operation of the door or window assembly at the time of installation. In addition to this initial visual and functional test, a written record must be retained and made available to the AHJ if necessary.

12.4.6.8.2* A record of all inspections and testing shall be signed by the inspector and kept for inspection by the AHJ. [**80:**5.2.2]

A.12.4.6.8.2 Newer technology includes use of barcodes and other electronic devices. This section recognizes that completed and filed barcode reports should be considered signed by the inspector. [**80:**A.5.2.2]

In past editions of NFPA 80, records of fire door, fire window, and fire shutter inspections have been required. For the 2013 edition of NFPA 80, the significant details of those records were added to address the length of time to retain the records at a facility and the type of information that the records should include.

Maintaining records of inspection, testing, and maintenance is critical for the performance and the condition of the opening protectives. Records ensure not only that the inspections and testing have occurred, but that they have occurred on a timely basis and by a person with the appropriate qualifications.

12.4.6.8.2.1 Records of acceptance tests shall be retained for the life of the assembly. [**80:**5.2.2.1]

12.4.6.8.2.2* Unless a longer period is required by Section 5.4 of NFPA 80, records shall be retained for a period of at least 3 years. [**80:**5.2.2.2]

Δ **A.12.4.6.8.2.2** In many cases, AHJs are not able to inspect each building in their jurisdiction each year. Inspection and testing records need to be retained during the intervening periods between the AHJ's formal visits to provide evidence that the inspections and testing were performed as required by NFPA 80. Additionally, maintenance records documenting that the necessary corrective actions have been made in accordance with this standard should be stored with the inspection and testing records for the same period of time. Retaining the records for 7 years allows the AHJ the ability to look back over an extended period of time to verify that the fire door assemblies are being properly maintained. [**80:**A.5.2.2.2]

12.4.6.8.2.3* The records shall be on a medium that will survive the retention period. Paper or electronic media shall be permitted. [**72:**14.6.2.3]

With the tremendous growth of technology and the move from paper to electronic resources in many industries, the need to retain electronic records of fire door, fire window, and fire shutter inspections is also growing. A number of companies are producing systems that allow fire doors, fire windows, and fire shutters in a building to be scanned electronically, using either a barcode or another code on the door, window, or shutter. An inspection form can be filled out either on a mobile device or on a computer, and all records can be updated, signed, and tracked electronically. This technology allows for a quicker inspection procedure and minimizes the risk of records being lost or destroyed. NFPA 80 and this *Code* recognize records in both paper and electronic formats.

A.12.4.6.8.2.3 Installation of new fire door assemblies should be documented in the same manner and level of detail as the periodic inspections and testing of fire door assemblies required by 12.4.6.8.3 and 12.4.6.8.4. Records of new fire door assemblies should be retained with the periodic inspections and testing records for the facility. [**80:**A.5.2.2.3]

12.4.6.8.2.4 A record of all inspections and testing shall be provided that includes, but is not limited to, the following information:

(1) Date of inspection
(2) Name of facility
(3) Address of facility
(4) Name of person(s) performing inspections and testing
(5) Company name and address of inspecting company
(6) Signature of inspector of record
(7) Individual record of each inspected and tested fire door assembly
(8)* Opening identifier and location of each inspected and tested fire door assembly

The information required by 12.4.6.8.2.4 is a minimum. Other information can be included as part of the inspection and testing records. Items 8 through 11 apply to each door, shutter, and window assembly subject to NFPA 80's inspections and testing. For example, each assembly needs to have its own identifier code. Identifier codes can be as simple as a door number, but they can be a barcode, a radio-frequency identification (RFID) chip, or some other unique code that can be tracked in the inspection records. Item 10 documents the inspection and operational testing of the assemblies. Item 11 captures the deficiencies discovered during the inspection and testing.

A.12.4.6.8.2.4(8) Each fire door assembly inspected and tested should be assigned a unique identifier code (e.g., door number as assigned by the facility) that can be used to track the assembly's compliance and maintenance records throughout the lifetime of its installation. Identifier codes could be a door assembly number, barcode, or other code that is unique to each fire door assembly. [**80:**A.5.2.2.4(8)]

(9)* Type and description of each inspected and tested fire door assembly

A.12.4.6.8.2.4(9) To aid the AHJ during the review of the inspections and testing reports, the records should include a description of the type of fire door assembly as follows:

Type 6: Swinging door with builders hardware

Type 7: Swinging fire door with fire door hardware

Type 8: Horizontally sliding fire door

Type 9: Special purpose horizontally sliding accordion or folding door

Type 10: Vertically sliding fire door

Type 11: Rolling steel door

Type 12: Fire shutter

Type 13: Service counter fire door

Type 14: Hoistway doors for elevators and dumbwaiter

Type 15: Chute door

Type 16: Access door

Type 17: Fire window

[**80:**A.5.2.2.4(9)]

(10)* Verification of visual inspection and functional operation

A.12.4.6.8.2.4(10) Functional operation of fire door assemblies should include testing of the closing device, complete closure of the fire door, and full engagement of latch(es) where required by door type. Functional testing of automatic-closing or power-operated fire door assemblies and electrically controlled latching hardware or release devices might need to be coordinated with the facility during other electrically controlled system tests. [**80:**A.5.2.2.4(10)]

(11) Listing of deficiencies in accordance with 12.4.6.8.3, 12.4.6.9, and 12.4.6.10

[**80:**5.2.2.4]

Δ **12.4.6.8.2.5*** Upon completion of maintenance work, fire door assemblies shall be inspected and tested in accordance with 12.4.6.8.3. [**80:**5.2.2.5]

Δ **A.12.4.6.8.2.5** Existing fire door assemblies that have been repaired should be inspected and tested immediately upon completion of the repair work to ensure that they are in compliance with NFPA 80. [**80:**A.5.2.2.5]

12.4.6.8.3 Acceptance Testing.

12.4.6.8.3.1* Acceptance testing of fire door and window assemblies shall be performed by a qualified person with knowledge and understanding of the operating components of the type of assembly being subject to testing. [**80:**5.2.3.1]

A.12.4.6.8.3.1 Visual inspection and functional testing of fire door and fire window assemblies require the persons performing the inspections and testing to be thoroughly knowledgeable of the various components and systems that are used to create fire-rated assemblies. In the case of swinging doors with builders hardware, these assemblies are comprised of labeled and listed components from several manufacturers. Often, the listing of the door leaf determines which products are permitted to be installed on an assembly. Inspectors of swinging doors with builders hardware need be able to recognize which components can or cannot be used on specific assemblies, which requires training and experience on behalf of the persons performing the inspections. Additionally, AHJs need to be able to rely on the competency, expertise, experience, and knowledge of the fire door inspectors in their jurisdiction. [**80:**A.5.2.3.1]

The *Code* is not explicit with regard to the qualifications of persons performing fire door inspections and testing, nor does the *Code* mandate that the inspections be performed by third-party inspectors. While the *Code* does not require professional certification, professional certification might assure AHJs that the persons performing the inspections are properly trained. In addition, the *Code* does not distinguish the persons who perform the inspections from the persons who perform the corrective actions.

A commonly asked question is whether building owners can use their own personnel to perform these inspections. The issue is the need to satisfy the AHJ's concern that the persons performing the inspections be qualified and trained to perform the inspections. Large facilities and institutions (e.g., universities) that have an established maintenance program with appropriately trained personnel will most likely rely on their own personnel for the inspections. The *Code* does not require professional certification, but professional certification can help assure the AHJ that the persons performing the inspections are properly trained. In addition, the *Code* does not distinguish between the persons who perform the inspections and the persons who perform the corrective actions. Ultimately, it is up to the local AHJ to determine if the person(s) performing the required inspections and test meet the definition of *qualified person* according to Chapter 3 of NFPA 80.

12.4.6.8.3.2* Before testing, a visual inspection shall be performed to identify any damaged or missing parts that can create a hazard during testing or affect operation or resetting. [**80:**5.2.3.2]

A.12.4.6.8.3.2 Any fire door or fire window assembly or component that has a history of reoccurring failures should be evaluated for possible replacement or other corrective measures. [**80:**A.5.2.3.2]

12.4.6.8.3.3 Acceptance testing shall include the closing of the door by all means of activation. [**80:**5.2.3.3]

An important requirement of operational testing is that assemblies arranged for automatic closing must be tested by all means of activation. For example, automatic-closing cross-corridor swinging doors might be held open by wall-mounted magnetic door holders or by electrically controlled door closers. In either case, the hold-open devices are required to release the doors upon actuation of the fire alarm system, actuation of local smoke/heat detectors, or loss of power. Upon release, the doors must close completely and latch. These same doors must also operate as self-closing doors when they are not electrically held open.

Operational testing of door assemblies with fusible links (e.g., horizontal sliding doors and rolling steel doors) include removing one or more of the fusible links to verify that the doors close correctly. Paragraph 12.4.6.8.3.3 requires operational testing of the doors to include "all means of activation." Operational testing of automatic-closing and power-operated assemblies requires coordination of testing with other building systems (e.g., fire alarm) to verify that the doors release and close as designed.

Δ **12.4.6.8.3.4** A record of these inspections and testing shall be made in accordance with 12.4.6.8.2. [**80:**5.2.3.4]

12.4.6.8.3.5 Swinging Doors with Builders Hardware or Fire Door Hardware.

12.4.6.8.3.5.1 Fire door assemblies shall be visually inspected from both sides to assess the overall condition of door assembly. [**80:**5.2.3.5.1]

12.4.6.8.3.5.2 As a minimum, the following items shall be verified:

(1) Labels are clearly visible and legible.
(2) No open holes or breaks exist in surfaces of either the door or frame.
(3) Glazing, vision light frames, and glazing beads are intact and securely fastened in place, if so equipped.
(4) The door, frame, hinges, hardware, and noncombustible threshold are secured, aligned, and in working order with no visible signs of damage.
(5) No parts are missing or broken.
(6) Door clearances do not exceed clearances listed in 4.8.4 and 6.3.1.7 of NFPA 80.
(7) The self-closing device is operational; that is, the active door completely closes when operated from the full open position.
(8) If a coordinator is installed, the inactive leaf closes before the active leaf.
(9) Latching hardware operates and secures the door when it is in the closed position.
(10) Auxiliary hardware items that interfere or prohibit operation are not installed on the door or frame.
(11) No field modifications to the door assembly have been performed that void the label.
(12) Meeting edge protection, gasketing and edge seals, where required, are inspected to verify their presence and integrity.
(13) Signage affixed to a door meets the requirements listed in 4.1.4 of NFPA 80.

[**80:**5.2.3.5.2]

It is important to remember that the list of inspection items in 12.4.6.8.3.5.2 is a minimum list. In many cases, the requirements of Chapters 4 and 6 of NFPA 80 also need to be applied to correctly assess the condition of the fire door assembly. For example, NFPA 80 does not explicitly address the maintenance, inspection, and testing of fire pins. However, because fire pins are a critical component on pairs of swinging fire doors without active bottom latch or bolt assemblies, the inspectors should include them in their assessment of the complete fire door assembly.

The application of fire pins on pairs of doors is governed by the listing of the door leaves — not all door leaves, especially older existing door leaves, are listed for use with fire pins. When fire pins were first introduced in the 1990s, very few types of door construction were tested for use with fire pins. Fire pins have become a common component on many of today's pairs of fire doors.

There really is no practical way to test fire pins in the field; once the pins release and engage, the door leaves are basically fixed in place. The door leaves would need to be removed from the frame in order to replace the fire pins — fire pins cannot be reset or reused after they have been activated/released.

The labels, per 12.4.6.8.3.5.2(1), on door frames, doors, and, where required, individual components need to be visible after installation. Labels contain important information regarding the assembly. For example, the level of fire protection rating (or fire resistance rating) is stated on the label. Some labels contain additional information regarding the dimension of latch throw, the requirement for fire exit hardware, temperature-rise rating, and "S" markings for smoke door assemblies. Painted labels on doors and frames are one of the most commonly cited deficiencies during inspections and testing. Where labels show signs of tampering, they should be captured in the inspection reports; follow-up field labeling services to replace the labels correctly might be required. Many hollow metal (e.g., steel) door frames have labels that are embossed into the soffit area of the hinge and strike jambs (the vertical jamb members). When the door frames are painted, embossed labels are difficult to read. For that reason, it might be necessary for owners to periodically strip built-up layers of paint covering the embossed labels to make them legible.

Paragraph 12.4.6.11.7 provides instructions for how to properly repair holes, as referenced by 12.4.6.8.3.5.2(2), that are left in a door or frame due to changes or removal of plant-on hardware. Exhibit 12.4 shows a fire door where the holes were drilled in preparation for installing the closing device. The set of four holes was actually drilled twice, thus leaving four exposed open holes in the fire door that were not filled properly.

Exhibit 12.4

Fire door with an extra set of holes for installation of closing device. (Courtesy of Lori Greene)

Glazing materials used in fire door assemblies include ¼ in. (6.35 mm) clear wire glass and glass ceramic products. Clear wire glass installed prior to the enforcement of the 1992 edition of NFPA 80 was not required to be individually labeled. Since then, each individual piece of glazing material (including clear wire glass) is required to have a visible label. Glazing materials installed in fire door frames and doors installed in accordance with recent model building codes are also required to be marked with the coding system given in Table 4.2.2 of NFPA 80. There are two categories of glazing materials, fire protection–rated and fire resistance–rated. Depending on the location of the fire door assembly, the model building codes designate which type of glazing material is needed in door assemblies. *Glazing bead*, as referenced in 12.4.6.8.3.5.2(3), is a term used to identify the removable piece of trim, usually made of metal, that holds the glazing material securely in the door or frame. Glazing beads can be snap-in or screw-in designs.

Damage to a door leaf or frame, as referenced in 12.4.6.8.3.5.2(4), varies. In the case of hollow metal doors and frames, a dent that prevents the door from closing completely or causes the door to rub the frame is one example. A dent that penetrates the face of the door is another example. Rust-through is one more example. In the case of wood fire doors (including plastic laminate–faced doors), any damage that penetrates the skin or face of the door needs to be repaired. Older wood fire doors were constructed with salt-treated stiles (vertical) and rails (horizontal), which were infamous for splitting if the installers did not drill the proper sized pilot holes for the screws. Edge stiles on modern wood fire doors are somewhat less susceptible to splitting, but it does occur.

Delamination, the separation of the door face or edges from the core construction of the door leaves, is a common type of damage that can occur on wood, plastic laminate–faced, and hollow metal fire doors.

In all of the above-mentioned cases, the actual repair work needs to be performed under authorized licensed service, which will require the door leaves to be removed from the building and worked on in a dedicated shop that is authorized by a testing lab and licensed by the door leaf manufacturer. Work that needs to be done in place in the building falls under the category of field modifications and is subject to the requirements of 12.4.6.6. The *Code* does not require the door assemblies to be maintained in like-new condition; rather, it requires the door assemblies to be maintained in working condition. Minor scuffs, scratches, dents, and dings are acceptable.

Exhibit 12.5 is an example of a fire door with a hinge pin not secured in the proper position. Exhibit 12.6 shows a fire door where the top corner is broken and there are cracks in the door.

Clearances between the doors and the frames, as referenced in 12.4.6.8.3.5.2(6), affect latch bolt engagement in the strike plates and other types of strikes. For example, latching hardware devices that extend from the bottom of the door need to fully engage in floor-mounted strikes. In fact, many bottom-mounted flush bolts are not correctly adjusted or aligned to fit into their

Exhibit 12.5

Fire door with hinge pin not secured in proper position.

Exhibit 12.6

Fire door with broken corner and cracks. (Courtesy of Lori Greene)

strikes. In other words, it is possible to have a door with a bottom clearance that complies with 4.8.4 of NFPA 80 [meaning it has ¾ in. (19 mm) clearance] but does not latch correctly.

Where clearance dimensions between door frames and doors or meeting stiles of paired doors exceed NFPA 80's maximum dimensions, latch bolt projection into the strike plates is proportionately reduced. Latching hardware cannot be expected to perform as tested if latch bolts do not project far enough into their strike plates.

NFPA 80's clearance dimensions also ensure that the doors overlap the door frames sufficiently to form a barrier that resists the passage of smoke, gases, and flames through the assembly. If the clearance dimensions are greater than those allowed by NFPA 80, the assemblies cannot be expected to provide their intended level of fire protection. Note that Chapter 7 of NFPA 80 does not specify clearance dimensions between door frames and doors for swinging doors. Exhibit 12.7 and Exhibit 12.8 are examples of pairs of fire doors where the clearance is in excess of that permitted by 6.3.1.7 of NFPA 80. It should be noted that in Exhibit 12.6 the installed kickdown is also in violation of NFPA 80.

Self-closing mechanisms, as referenced in 12.4.6.8.3.5.2(7), are perhaps one of the most important pieces of hardware on a fire door or window. Closing mechanisms ensure that the door will close and protect the opening at the time of fire. Without closing mechanisms or with damaged or improperly installed closing mechanisms, the risk is that an opening could be exposed and unprotected during a fire, thus leaving a path open for fire and smoke to spread to multiple fire compartments. In the case of swinging doors, closing devices need to be adjusted so that they close doors completely when doors are opened to *any* position. Swinging doors covered in Chapter 6 of NFPA 80 need to reliably latch in the closed position, regardless of how far the doors are opened. Accordingly, closing devices should be adjusted to overcome HVAC pressures (e.g., stack pressure) and resistance/friction of latching hardware devices every time the doors return to the closed position. Some door closers do

Exhibit 12.7

Pair of swing fire doors with vertical clearance between the doors in excess of ⅛ in. (3.18 mm). (Courtesy of the Door Security & Safety Foundation, Door and Hardware Institute)

Exhibit 12.8

Pair of swing fire doors with noncompliant vertical clearance.

not have sufficient closing power to reliably close fire doors, due to their reduced-opening force designs to meet accessibility standards.

Door coordinators are required on pairs of swinging fire doors when there is an overlapping astragal or an extended latch bolt that prevents one of the doors from closing completely. In some cases, an auxiliary item referred to as a carry-open bar is needed to ensure that both doors reliably close. Carry-open bars mount to the push side of the inactive door leaf and force (e.g., stiff-arm) open the active leaf, engaging the coordinator. When the inactive leaf closes it releases the coordinator, allowing the active leaf to close, thereby ensuring that both door leaves are completely closed.

Auxiliary items, as referenced in 12.4.6.8.3.5.2(10), include kickstops, wooden wedges, chains, ropes, and other items that would interfere with the operation of the door. Kickstops are not permitted to be installed on fire doors. Even if the door is self-closing or automatic closing while the kickstop is disengaged, human intervention cannot be relied upon to release the kickstop and close the door. All fire doors must be self-closing or automatic closing, and kickstops not only interfere with the operation of the door, they also do not allow the door to be the required self-closing or automatic closing.

According to 12.4.6.8.3.5.2(12), gasketing materials (including intumescent materials) that are required by code (in this case, a building code) must be inspected. If the edges of the doors become damaged to the point that the damage compromises the intumescent material, most likely the door leaf will need to be replaced. While auxiliary surface-mounted intumescent gasketing could be installed, if the construction of the door leaf is compromised, the door leaf will need to be replaced. Smoke and intumescent gasketing products mounted to door frames need to form a continuous (unbroken) seal along the vertical and horizontal jambs. Because the gasketing is one of the last items installed, installers frequently cut and notch gasketing materials to fit around soffit-mounted hardware (e.g., parallel arm closer brackets and strikes for rim/surface vertical rod fire exit hardware devices). Gaps and notches in gasketing compromise its ability to resist the passage of smoke and gases around the assemblies.

Signage attached to doors is permitted, provided the total area of the signage is no more than 5 percent of the nominal area of the faces of the doors. Signage is not permitted to be attached to doors by fasteners that penetrate the doors (see 4.1.4 of NFPA 80). Classroom doors in schools and patient room doors in hospitals are frequently covered with papers, posters, and other decorations. While these decorations are not necessarily signage, they can pose a problem on fire-rated doors.

12.4.6.8.3.6 Horizontally Sliding, Vertically Sliding, and Rolling Doors.

12.4.6.8.3.6.1 Fire door assemblies shall be visually inspected from both sides to assess the overall condition of door assembly. [**80:**5.2.3.6.1]

12.4.6.8.3.6.2 At a minimum, the following items shall be verified:

(1) Labels are clearly visible and legible.
(2) No open holes or breaks exist in surfaces of either the door or frame.
(3) Slats, endlocks, bottom bar, guide assembly, curtain entry hood, and flame baffle are correctly installed and intact for rolling steel fire doors.
(4) Glazing, vision light frames, and glazing beads are intact and securely fastened in place, if so equipped.
(5) Curtain, barrel, and guides are aligned, level, plumb, and true for rolling steel fire doors.
(6) Expansion clearance is maintained in accordance with manufacturer's listing.
(7) Drop release arms and weights are not blocked or wedged.
(8) Mounting and assembly bolts are intact and secured.
(9) Attachment to jambs are with bolts, expansion anchors, or as otherwise required by the listing.
(10) Smoke detectors, if equipped, are installed and operational.
(11) No parts are missing or broken.
(12)* Fusible links, if equipped, are in the location; chain/cable, s-hooks, eyes, and so forth, are in good condition; the cable or chain are not kinked, pinched, twisted, or inflexible; and links are not painted or coated with dust or grease.
(13) Auxiliary hardware items that interfere or prohibit operation are not installed on the door or frame.

(14) No field modifications to the door assembly have been performed that void the label.
(15) Doors have an average closing speed of not less than 6 in./sec (152 mm/sec) or more than 24 in./sec (610 mm/sec).
[**80:**5.2.3.6.2]

A.12.4.6.8.3.6.2(12) Fusible links should not be coated with any materials such as fireproofing, drywall compound, or spray texturing. [**80:**A.5.2.3.6.2(12)]

The list in 12.4.6.8.3.6.2 includes many of the items that were listed for swinging doors but also contains items that are specific to sliding and rolling doors. Slats, endlocks, bars and guides, and hoods are some of the main components of a rolling steel fire door assembly. It must be verified that these components are installed correctly and are intact to ensure proper operation of the door assembly.

Much like kickstops for swinging doors, blocking the release arms or counterweights for sliding and rolling doors could mean that the door will not close and protect the opening during fire conditions. According to 12.4.6.8.3.6.2(7), it is critical that no obstructions interfere with the proper closing mechanisms that are part of the door assembly.

The use of fusible link hold-open door closers, as referenced in 12.4.6.8.3.6.2(12), has been restricted to a very few specific applications. Paragraph 12.4.6.8.3.8 specifically prohibits the painting of fusible links on all types of fire door assemblies, which means that painted fusible links will need to be replaced. When the fusible links are replaced, the manufacturer must be consulted to ensure that the replacement fusible link is the correct type and has the correct melting point. See also Section 4.7 of NFPA 80 for additional information on the installation of fusible links and sleeves.

12.4.6.8.3.7 Closing Devices.

12.4.6.8.3.7.1 All fire doors, fire shutters, and fire window assemblies shall be inspected and tested to check for proper operation and full closure. [**80:**5.2.3.7.1]

12.4.6.8.3.7.2 Resetting of the automatic-closing device shall be done in accordance with the manufacturer's instructions. [**80:**5.2.3.7.2]

12.4.6.8.3.7.3 Rolling Steel Fire Doors.

12.4.6.8.3.7.3.1 Rolling steel fire doors shall be drop-tested twice. [**80:**5.2.3.7.3.1]

12.4.6.8.3.7.3.2 The first test shall be to check for proper operation and full closure. [**80:**5.2.3.7.3.2]

12.4.6.8.3.7.3.3 A second test shall be done to verify that the automatic-closing device has been reset correctly. [**80:**5.2.3.7.3.3]

12.4.6.8.3.8* Fusible links, release devices, and any other movable parts shall not be painted or coated with other materials that could interfere with the operation of the assembly. [**80:**5.2.3.8]

A.12.4.6.8.3.8 Movable parts of the door assembly can include, but are not limited to, stay rollers, gears, and closing mechanisms. [**80:**A.5.2.3.8]

12.4.6.8.4 Periodic Inspection and Testing.

12.4.6.8.4.1* Periodic inspections and testing shall be performed not less than annually. [**80:**5.2.4.1]

A.12.4.6.8.4.1 Doors subject to high-volume use and abuse might warrant an increased frequency of inspection. Components including, but not limited to, hinges, catches, closers, latches, and stay rollers are especially subject to wear. [**80:**A.5.2.4.1]

12.4.6.8.4.2 As a minimum, the provisions of 12.4.6.8.3 shall be included in the periodic inspection and testing procedure. [**80:**5.2.4.2]

12.4.6.8.4.3 Inspection shall include an operational test for automatic-closing doors and windows to verify that the assembly will close under fire conditions. [**80:**5.2.4.3]

12.4.6.8.4.4 The assembly shall be reset after a successful test. [**80:**5.2.4.4]

12.4.6.8.4.5 Resetting of the release mechanism shall be done in accordance with the manufacturer's instructions. [**80:**5.2.4.5]

12.4.6.8.4.6* Hardware shall be examined, and inoperative hardware, parts, or other defective items shall be replaced without delay. [**80:**5.2.4.6]

A.12.4.6.8.4.6 The determination of the time required for corrective action should be based on a risk analysis and availability of replacement materials. [**80:**A.5.2.4.6]

12.4.6.8.4.7 Tin-clad and kalamein doors shall be inspected for dry rot of the wood core. [**80:**5.2.4.7]

12.4.6.8.4.8 Chains or cables employed shall be inspected for excessive wear, stretching, and binding. [**80:**5.2.4.8]

12.4.6.9 Retrofit Operators.

12.4.6.9.1 The operator, governor, and automatic-closing device on rolling steel fire doors shall be permitted to be retrofitted with a labeled retrofit operator under the conditions specified in 12.4.6.9.2 through 12.4.6.9.5. [**80:**5.3.1]

12.4.6.9.2 The retrofit operator shall be labeled as such. [**80:**5.3.2]

12.4.6.9.3 The retrofit operator shall be installed in accordance with its installation instructions and listing. [**80:**5.3.3]

12.4.6.9.4 The installation shall be acceptable to the AHJ. [**80:**5.3.4]

12.4.6.9.5 The retrofit operator shall be permitted to be provided by a manufacturer other than the original manufacturer of the rolling steel fire door on which it is retrofitted, provided its listing allows it to be retrofitted on that manufacturer's doors. [**80:**5.3.5]

12.4.6.10* Performance-Based Option.

Δ **A.12.4.6.10** See Annex J of NFPA 80 for information regarding performance-based inspection, testing, and maintenance options for fire door assemblies. [**80:**A.5.4]

12.4.6.10.1 As an alternate means of compliance with 12.4.6.8.4, subject to the AHJ, fire door assemblies shall be permitted to be inspected, tested, and maintained under a written performance-based program. [**80:**5.4.1]

12.4.6.10.2 Goals established under a performance-based program shall provide assurance that the fire door assembly will perform its intended function when exposed to fire conditions. [**80:**5.4.2]

12.4.6.10.3 Technical justification for inspection, testing, and maintenance intervals shall be documented in writing. [**80:**5.4.3]

12.4.6.10.4 The performance-based option shall include historical data acceptable to the AHJ. [**80:**5.4.4]

Using the performance-based option detailed in 12.4.6.10 is an alternative means for complying with the prescriptive requirements mandating the annual inspection of fire doors and fire windows. The concept of a performance-based program is to establish the type and frequency of inspection to demonstrate that the assembly is operational. The goal is to balance the inspection frequency with the proven reliability of the assembly. The goal is also to adjust the test and inspection frequencies corresponding with the documented history of equipment performance and desired reliability. See Annex J of NFPA 80 for additional information regarding the performance-based option for the inspection, testing, and maintenance of fire door assemblies.

12.4.6.11 Maintenance.

12.4.6.11.1* Repairs shall be made, and defects that could interfere with operation shall be corrected without delay. [**80:**5.5.1]

A.12.4.6.11.1 The determination of the time required for corrective action should be based on a risk analysis and availability of replacement materials. [**80:**A.5.5.1]

NFPA 80 requires the corrective actions to be made "without delay." It is up to the AHJ to decide what constitutes a reasonable time frame, because there needs to be some allowance for the time it takes to place orders, receive the materials, and perform the work. It is likely that owners could demonstrate compliance to the AHJ if they could show that the process has started and that the corrective actions will be completed in a reasonable time frame. The time it takes the corrective actions to be made should be commensurate with the size and complexity of the needed repairs.

Δ **12.4.6.11.2** Damaged glazing material shall be replaced with labeled glazing. [**80:**5.5.2]

12.4.6.11.3 Replacement glazing materials shall be installed in accordance with their individual listing. [**80:**5.5.3]

12.4.6.11.4 Any breaks in the face covering of doors shall be repaired without delay. [**80:**5.5.4]

Δ **12.4.6.11.5** Where a fire door, frame, or any part of its appurtenances is damaged to the extent that it could impair the door's proper emergency function, the following actions shall be performed:

(1) The fire door, frame, door assembly, or any part of its appurtenances shall be repaired with labeled parts or parts obtained from the original manufacturer.
(2) The door shall be tested to ensure emergency operation and closing upon completion of the repairs.

[**80:**5.5.5]

12.4.6.11.6 If repairs cannot be made with labeled components or parts obtained from the original manufacturer or retrofitted in accordance with Section 5.3 of NFPA 80, the fire door frame, fire door assembly, or appurtenances shall be replaced. [**80:**5.5.6]

12.4.6.11.7 When fastener holes are left in a door or frame due to changes or removal of hardware or plant-ons, the holes shall be repaired by the following methods:

(1) Install steel fasteners that completely fill the holes
(2) Fill the screw or bolt holes with the same material as the door or frame
(3) Fill holes with material listed for this use and installed in accordance with the manufacturer's procedures

[**80:**5.5.7]

This paragraph covers the repairing of round holes left in doors and door frames due to reinstallation and replacement of hardware components. Paragraph 4.1.3.2 of NFPA 80 describes the types and sizes of holes that are permitted to be made during the installation process; these are the types of holes covered by 12.4.6.11.7. Repairing round holes larger than 1 in. (25.4 mm) in diameter or holes of other shapes (of any size) falls under the category of field modification.

If the door leaves are hollow metal, any holes and cutouts will need to be filled with the same material as the door leaf. This type of work might not be permitted to be completed in the field since it would fall into the category of field modification. At a minimum, the laboratory whose label is attached to the door leaf will need to be contacted for more specific instruction, but most likely the actual door manufacturer will need to be consulted for direction. Depending on the number of door leaves that are left with open holes or cutouts, it might be less expensive to replace the door leaves. Note that the frame will need to be repaired if open holes or cutouts are in it as well — this might be as simple as installing a solid steel filler plate attached with steel screws.

If the door leaves are wood, most likely the best way to resolve the issue is to replace the door. It may be difficult to determine a satisfactory method for making such a substantial repair/modification. The AHJ must determine if the repair to the wood door is in compliance with the *Code*.

The use of fire caulk or other such putties or fillers is not an acceptable method for repairing fire doors, and neither places a protection plate over the holes in doors and frames. This type of work could easily fall under the field modification category, which requires the test laboratory to be contacted. It is important to research the construction of the door in question and seek direction as to how to correctly repair it before attempting to repair a damaged fire door.

New products designed to repair fire door assemblies have been labeled and listed by the testing laboratories. In most cases, these new products have specific limitations as to what types of doors they can be used on. For example, some products are limited for use on fire-rated wood composite doors with ratings up to 1½ hours.

Other such products can be used on doors rated up to ⅓ hour. Some products can be used to fill in round holes only up to ¾ in. (19 mm) in diameter in wood fire doors. It is likely that more products designed to repair fire doors will be on the market in the future. Accordingly, item (3) in 12.4.6.11.7 provides for the application of these new products when they are used in accordance with the manufacturer's procedures.

N **12.4.6.11.8** Holes, other than those as described by 12.4.6.9.7, shall be treated as a field modification in accordance with 12.4.6.4. [**80:**5.5.8]

N **12.4.6.11.9*** Upon completion of maintenance work, fire door assemblies shall be inspected and tested in accordance with 12.4.6.6.3. A record of these inspections and testing shall be made in accordance with 12.4.6.6.2. A record of maintenance performed on existing fire door assemblies shall be provided that includes the following information:

(1) Date of maintenance
(2) Name of facility
(3) Address of facility
(4) Name of person(s) performing maintenance
(5) Company name and address of maintenance personnel
(6) Signature of maintenance personnel performing the work
(7) Individual listings of each inspected and tested fire door assembly
(8) Opening identifier and location of each repaired fire door assembly
(9) Type and description of each repaired fire door assembly
(10) Description or listing of the work performed on each fire door assembly

[**80:**5.5.9]

N **A.12.4.6.11.9** Existing fire door assemblies that have been repaired should be inspected and tested immediately upon completion of the repair work to ensure that they are in compliance with this standard. Records of maintenance work should be maintained with the periodic inspections and testing records for the facility. [**80:**A.5.5.9]

The text in 12.4.6.11.9 is new to the 2016 edition of NFPA 80, from which it is extracted. Like acceptance testing and periodic inspection reports, maintenance reports must include the information listed in 12.4.6.11.9. When the work performed corrects deficiencies recorded during acceptance testing or periodic inspection and testing, the maintenance records should reference the corresponding inspection and testing records. Ideally, the maintenance records documenting corrective work should be kept with the inspection and testing records.

12.5* Interior Finish

A.12.5 The requirements pertaining to interior finish are intended to restrict the spread of fire over the continuous surface forming the interior portions of a building. [***101:***A.10.2]

The requirements are based on fire testing to NFPA 286 (with the criteria of 12.5.4.2), which apply to all interior finish materials. Many interior finish materials are permitted to be tested based on other fire tests, such as ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, or NFPA 265 as provided in the relevant subsection of Section 10.2. [***101:***A.10.2]

12.5.1 Interior finish in buildings and structures shall meet the requirements of NFPA *101* and this *Code*.

12.5.2* General.

A.12.5.2 The requirements pertaining to interior finish are intended to restrict the spread of fire over the continuous surface forming the interior portions of a building. The presence of multiple paint layers has the potential for paint delamination and bubbling or blistering of paint. Testing (NFPA Fire Technology, August 1974, "Fire Tests of Building Interior Covering Systems," David Waksman and John Ferguson, Institute for Applied Technology, National Bureau of Standards) has shown that adding up to two layers of paint with a dry film thickness of about 0.007 in. (0.18 mm) will not change the fire properties of surface-covering systems. Testing has shown that the fire properties of the surface-covering systems are highly substrate dependent and that thin coatings generally take on the characteristics of the substrate. When exposed to fire, the delamination, bubbling, and blistering of paint can result in an accelerated rate of flame spread. [***101:***A.10.2.1]

Δ **12.5.2.1** Classification of interior finish materials shall be in accordance with tests made under conditions simulating actual installations, provided that the authority having jurisdiction is permitted to establish the classification of any material for which classification by a standard test is not available. [***101:***10.2.1.1]

Paragraph 12.5.2.1 presents two concepts. First, for interior finish materials to be classified properly based on performance under a standardized test, the test needs to be indicative of the conditions under which the material will actually be installed. For example, thin wood paneling applied directly to wall framing studs can be expected to spread flame differently than does thin wood paneling applied to gypsum wallboard. This concept is explained, in part, in A.12.5.2.

Second, the AHJ is responsible for classifying interior finish materials for which standardized test data are not available. The AHJ is free to use whatever tools are available (such as experience, intuition, comparative field testing) and will generally take the conservative approach of banning the use of suspect materials for which there are no supporting data. The regulation of interior finish materials is an important part of the total package of life safety offered by compliance with the *Code*.

12.5.2.2 Fixed or movable walls and partitions, paneling, wall pads, and crash pads applied structurally or for decoration, acoustical correction, surface insulation, or other purposes shall be considered interior finish and shall not be considered decorations or furnishings. [***101:***10.2.1.2]

Prior to the 2006 edition of NFPA *101,* there was significant confusion among users on how to address materials placed on walls after construction and occupancy of the building. Often when materials were brought into an occupied building and attached to the walls, the AHJ was petitioned to treat such materials as decorations or furnishings. If the AHJ agreed to the classifying of such materials as decorations or furnishings, the materials might go unregulated or, at best, would be tested per NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films* (see 12.6.1), which is not the appropriate test for interior finish materials. The criteria in 12.5.2.2 provide the needed clarification.

Pads are often attached to walls in school gymnasiums to cushion the impact if a student collides with the wall. Such pads applied to or placed against walls need to be treated as interior wall finish. Similar pads placed on the floor should be considered contents and furnishings.

Δ **12.5.2.3** Lockers shall be considered interior finish. [***101:***10.2.1.3]

Historically, lockers in occupancies such as schools have been constructed of metal and have not posed a significant fire hazard. More recently, however, lockers constructed of wood and plastic have been made available. It is typical for lockers to line the walls of corridors; therefore, where they are constructed of combustible materials, they need to be regulated as interior wall finish materials in accordance with 12.5.2.3. See 12.6.7 for further details on lockers.

Δ **12.5.2.4** Washroom water closet partitions shall be considered interior finish. [***101:***10.2.1.4]

12.5.2.5 Fire-retardant coatings shall be in accordance with 12.5.7. [***101:***10.2.1.5]

• **12.5.3* Use of Interior Finishes.**

Δ **A.12.5.3** Table A.12.5.3 provides a compilation of the interior finish requirements of 7.1.4 of *NFPA 101* and the occupancy chapters (Chapters 12 through 42) of *NFPA 101*. [***101:***A.10.2.2]

Δ **12.5.3.1** Requirements for interior wall and ceiling finish shall apply as follows:

(1) Where specified elsewhere in this *Code* for specific occupancies *(see Chapter 7 and Chapters 11 through 43 of NFPA 101)*
(2) As specified in 12.5.4 through 12.5.7

[***101:***10.2.2.1]

12.5.3.2* Interior floor finish shall comply with 12.5.8 under any of the following conditions:

(1) Where floor finish requirements are specified elsewhere in this *Code*
(2) Where the fire performance of the floor finish cannot be demonstrated to be equivalent to floor finishes with a critical radiant flux of at least 0.1 W/cm²

[***101:***10.2.2.2]

A.12.5.3.2 This paragraph recognizes that traditional finish floors and floor coverings, such as wood flooring and resilient floor coverings, have not proved to present an unusual hazard. [***101:***A.10.2.2.2]

Traditional floor coverings, such as wood flooring and resilient tile, do not contribute to the early growth of fire. Paragraph 12.5.3.2 has the effect of exempting traditional floor coverings from the restrictions that would otherwise be applicable. However, the AHJ can require substantiation of the performance of any unfamiliar floor covering. For example, imitation wood floors made of plastic, artificial turf, artificial surfaces of athletic fields, and certain types of carpeting are products that might merit substantiation. If the AHJ judges that a floor covering warrants testing and substantiation, or if an occupancy chapter imposes restrictions, the floor covering must be treated as interior floor finish. It would, therefore, be regulated on the basis of tests conducted in accordance with the flooring radiant panel test required in 12.5.8.

Δ **12.5.4* Interior Wall or Ceiling Finish Testing and Classification.** Where interior wall or ceiling finish is required elsewhere in this *Code* to be classified for fire performance and smoke development, it shall be classified in accordance with 12.5.4.1 or 12.5.4.3, except as indicated in 12.5.5. [***101:***10.2.3]

A.12.5.4 ASTM E84, *Standard Test Method of Surface Burning Characteristics of Building Materials*, and UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, are considered nationally recognized consensus standard test methods for determining the flame spread index and smoke developed index of building materials and are likely to yield equivalent test results. *(See also A.12.5.5.4.1.)* [***101:***A.10.2.3]

The provisions of 12.5.4 were reorganized for the 2018 edition of the *Code* for user friendliness. Any interior wall or ceiling finish material is permitted to be tested in accordance with NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth,* as indicated in 12.5.4.1.1. Materials meeting the acceptance criteria in 12.5.4.2 are permitted to be used wherever a Class A, Class B, or Class C material is required as described in 12.5.4.1.2. Alternatively, flame spread and smoke development characteristics can be both quantified and recorded in the results of a test conducted in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building*

N *TABLE A.12.5.3 Interior Finish Classification Limitations*

Occupancy	Exits	Exit Access Corridors	Other Spaces
Assembly — new			
>300 occupant load	A	A or B	A or B
	I or II	I or II	NA
≤300 occupant load	A	A or B	A, B, or C
	I or II	I or II	NA
Assembly — existing			
>300 occupant load	A	A or B	A or B
≤300 occupant load	A	A or B	A, B, or C
Educational — new	A	A or B	A or B; C on low partitions*
	I or II	I or II	NA
Educational — existing	A	A or B	A, B, or C
Day-care centers — new	A	A	A or B
	I or II	I or II	NA
Day-care centers — existing	A or B	A or B	A or B
Day-care homes — new	A or B	A or B	A, B, or C
	I or II		NA
Day-care homes — existing	A or B	A, B, or C	A, B, or C
Health care — new	A	A	A
	NA	B on lower portion of corridor wall*	B in small individual rooms*
	I or II	I or II	NA
Health care — existing	A or B	A or B	A or B
Detention and correctional — new (sprinklers mandatory)	A or B	A or B	A, B, or C
	I or II	I or II	NA
Detention and correctional — existing	A or B	A or B	A, B, or C
	I or II	I or II	NA
One- and two-family dwellings and lodging or rooming houses	A, B, or C	A, B, or C	A, B, or C
Hotels and dormitories — new	A	A or B	A, B, or C
	I or II	I or II	NA
Hotels and dormitories — existing	A or B	A or B	A, B, or C
	I or II*	I or II*	NA
Apartment buildings — new	A	A or B	A, B, or C
	I or II	I or II	NA
Apartment buildings — existing	A or B	A or B	A, B, or C
	I or II*	I or II*	NA
Residential board and care — (See Chapters 32 and 33.)			
Mercantile — new	A or B	A or B	A or B
	I or II		NA
Mercantile — existing			
Class A or class B stores	A or B	A or B	Ceilings — A or B; walls — A, B, or C
Class C stores	A, B, or C	A, B, or C	A, B, or C
Business and ambulatory health care — new	A or B	A or B	A, B, or C
	I or II		NA
Business and ambulatory health care — existing	A or B	A or B	A, B, or C
Industrial	A or B	A, B, or C	A, B, or C
	I or II	I or II	NA
Storage	A or B	A, B, or C	A, B, or C
	I or II		NA

*See corresponding chapters for details.

NA: Not applicable.

Notes:

(1) Class A interior wall and ceiling finish — flame spread index, 0–25 (new applications); smoke developed index, 0–450.

(2) Class B interior wall and ceiling finish — flame spread index, 26–75 (new applications); smoke developed index, 0–450.

(3) Class C interior wall and ceiling finish — flame spread index, 76–200 (new applications); smoke developed index, 0–450.

(4) Class I interior floor finish — critical radiant flux, not less than 0.45 W/cm^2.

(5) Class II interior floor finish — critical radiant flux, not more than 0.22 W/cm^2, but less than 0.45 W/cm^2.

(6) Automatic sprinklers — where a complete standard system of automatic sprinklers is installed, interior wall and ceiling finish with a flame spread rating not exceeding Class C is permitted to be used in any location where Class B is required, and Class B interior wall and ceiling finish is permitted to be used in any location where Class A is required; similarly, Class II interior floor finish is permitted to be used in any location where Class I is required, and no interior floor finish classification is required where Class II is required. These provisions do not apply to new detention and correctional occupancies.

(7) Exposed portions of structural members complying with the requirements for heavy timber construction are permitted.

Materials, as described in 12.5.4.3. The test is also commonly referred to as the "Steiner tunnel test" (named after its inventor, Al Steiner, who developed the test at Underwriters Laboratories in 1944) and, generically, as the "tunnel test."

12.5.4.1 Interior Wall and Ceiling Finish Materials Tested in Accordance with NFPA 286.

N **12.5.4.1.1** Interior wall and ceiling finish materials shall be classified in accordance with NFPA 286 and comply with 12.5.4.2. [***101:***10.2.3.1.1]

N **12.5.4.1.2** Materials tested in accordance with 12.5.4.1.1 and complying with 12.5.4.2 shall be considered also to comply with the requirements of a Class A, Class B, or Class C in accordance with 12.5.4.3. [***101:***10.2.3.1.2]

Paragraph 12.5.4.1.2 permits materials that meet the criteria specified in 12.5.4.2, where tested in accordance with NFPA 286, to be used as both interior wall finish and interior ceiling finish, even where other *Code* provisions require interior wall and ceiling finish to be Class A in accordance with 12.5.4.3. Testing in accordance with NFPA 286, combined with performance criteria specified by 12.5.4.2, represents an improvement over testing in accordance with ASTM E84 or ANSI/UL 723 and classification in accordance with 12.5.4.3. ASTM E84 and ANSI/UL 723 test a sample that is mounted in a horizontal orientation to cover the 18 in. (455 mm) wide by 24 ft (7.3 m) long ceiling of the test tunnel. NFPA 286 tests a sample that fully covers three walls of the 8 ft (2440 mm) wide by 12 ft (3660 mm) long by 8 ft (2440 mm) high test chamber — and the ceiling as well if the results are to be applied to interior ceiling finish. See the commentary following 12.5.4.2.

Note that 12.5.4.1.2 does not require testing per NFPA 286; rather, it offers that test procedure as an alternative to meeting the Class A classification criteria of 12.5.4.3, based on results from the more traditional ASTM E84 or ANSI/UL 723 test protocol.

12.5.4.2 Acceptance Criteria for NFPA 286. The interior finish shall comply with the following:

(1) During the 40 kW exposure, flames shall not spread to the ceiling.
(2) The flame shall not spread to the outer extremity of the sample on any wall or ceiling.
(3) Flashover, as described in NFPA 286, shall not occur.
(4) The peak heat release rate throughout the test shall not exceed 800 kW.
(5) For new installations, the total smoke released throughout the test shall not exceed 1000 m^2.

[***101:***10.2.3.2]

NFPA 286 was developed specifically to measure the following:

1. Extent of flame spread and burning relative to the realistically sized and mounted sample
2. Whether flashover occurs
3. Peak rate of heat release
4. Total smoke released throughout the test

The peak heat release rate of 800 kW, as specified by 12.5.4.2(4), was new to the 2006 edition of NFPA *101*. It was added because 12.5.4.1.2 permits materials that meet the criteria specified in 12.5.4.2, where tested in accordance with NFPA 286, to be used as both interior wall finish and interior ceiling finish, even where other *Code* provisions require interior wall and ceiling finish to be Class A in accordance with 12.5.4.3. Some interior finish materials can be produced less expensively, albeit somewhat less fire safe, if they need to meet only the criteria of 12.5.4.2 (based on testing per NFPA 286) without a peak heat release rate criterion, instead of having to pass the flame spread criteria for Class A required by 12.5.4.3 (based on testing per ASTM E84 or ANSI/UL 723). The peak heat release rate criterion associated with testing per NFPA 286 helps equalize the anomaly in the test methods.

Materials that meet the criteria for Class A interior finish when tested per ASTM E84 or ANSI/UL 723 and that do not flashover the test room when tested per NFPA 286, typically have a peak heat release rate of less than 400 kW. The 800 kW peak heat release rate criterion of 12.5.4.2(4) was chosen to help ensure that materials that have already been tested are not unnecessarily penalized.

The test room used for NFPA 286 testing is the same size as that used for NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls,* testing. If the test results are to be applied only to interior wall finish, then the test specimens are mounted to cover fully both 8 ft × 12 ft (2440 mm × 3660 mm) walls and the 8 ft × 8 ft (2440 mm × 2440 mm) rear wall. If the test results are to be applied both to interior wall finish and to interior ceiling finish, then the test specimen also is mounted to cover the ceiling. If the test results are to be applied only to interior ceiling finish, the test specimen is mounted to cover the ceiling only.

12.5.4.3* Interior Wall and Ceiling Finish Materials Tested in Accordance with ASTM E84 or ANSI/UL 723. Interior wall and ceiling finish materials shall be classified in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard Test Method for Surface Burning Characteristics of Building Materials*, except as indicated in 12.5.4.4 and 12.5.4.5, and shall be grouped in the following classes in accordance with their flame spread and smoke developed indexes:

(1) Class A: Flame spread index 0–25; smoke developed index 0–450.
(2) Class B: Flame spread index 26–75; smoke developed index 0–450.
(3) Class C: Flame spread index 76–200; smoke developed index 0–450.

[***101:***10.2.3.3]

N **A.12.5.4.3** It has been shown that the method of mounting interior finish materials usually affects actual performance. The use of standard mounting methods will be helpful in determining appropriate fire test results. Where materials are tested in intimate contact with a substrate to determine a classification, such materials should be installed in intimate contact with a similar substrate. Such details are especially important for "thermally thin" materials. For further information, see ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*. [***101:***A.10.2.3.3]

Some interior wall and ceiling finish materials, such as fabrics not applied to a solid backing, do not lend themselves to a test made in accordance with ASTM E84. In such cases, the large-scale test outlined in NFPA 701 is permitted to be used. In 1989 the NFPA Technical Committee on Fire Tests eliminated the so-called "small-scale test" from NFPA 701 because the results had been shown not to represent a fire performance that corresponded to what happened in real scale. Since then, NFPA 701 no longer contains a "small-scale test" but it now contains two tests (Test 1 and Test 2), which apply to materials as a function of their areal density. Thus NFPA 701 Test 1 applies to fabrics (other than vinyl-coated fabric blackout linings) having an areal density less than or equal to 21 oz/yd^2 (700 g/m^2), while NFPA 701 Test 2 applies to fabrics with an areal density greater than 21 oz/yd^2 (700 g/m^2), vinyl-coated fabric blackout linings, decorative objects, and films. Representations that materials or products have been tested to the small-scale test in NFPA 701 normally refer to the pre-1989 small-scale test, which no longer exists and which does not represent acceptable fire performance. [***101:***A.10.2.3.3]

Prior to 1978, the test report described by ASTM E84 included an evaluation of the fuel contribution as well as the flame spread index and the smoke developed index. However, it is now recognized that the measurement on which the fuel contribution is based does not provide a valid measure. Therefore, although the data are recorded during the test, the information is no longer normally reported. Classification of interior wall and ceiling finish thus relies only on the flame spread index and smoke developed index. [***101:***A.10.2.3.3]

The 450 smoke developed index limit is based solely on obscuration. (*See A.10.2.4.4 of NFPA 101)* [***101:***A.10.2.3.3]

N **12.5.4.3.1** Existing interior finish shall be exempt from the smoke developed index criteria of 12.5.4.3. [***101:***10.2.3.3.1]

Samples are tested in accordance with ASTM E84 or ANSI/UL 723, as mandated by 12.5.4.3, using a noncombustible, fiber cement board backing. Specimens are tested with adhesives and joints and under other conditions that simulate the actual installation of a product in a building. These fire test standards provide a general indication of product performance only if the product is installed in a fashion similar to that which has been tested. Available data demonstrate that the performance of interior finish materials varies, depending on mounting conditions. For example, a product installed over a combustible substrate tends to propagate fire more readily than would be typical of the same product installed over a noncombustible substrate.

Further, a wall covering installed with air space behind the covering tends to spread flame more readily than one installed in contact with a noncombustible substrate. Therefore, mounting techniques must be carefully considered in the evaluation of probable product performance.

Exhibit 12.9

ASTM E84 tunnel test apparatus. (Photo courtesy of Herbert Blenstein)

Exhibit 12.9 illustrates the ASTM E84 tunnel test apparatus. The same apparatus is required for testing per ANSI/UL 723.

Interior wall and ceiling finish classifications in accordance with 12.5.4.3 are based mainly on flame spread indices, with an additional requirement that the smoke developed index not exceed a common value of 450, regardless of the class into which the material falls based on flame spread. Flame spread classifications offer a general indication of the speed with which fire might spread across the surface of a material. In assessing the hazard posed by a material on the basis of flame spread, it is assumed that a person might be close to the fire and would be directly exposed to the energy associated with the actual flames. By contrast, the purpose of the smoke developed index is to address visual obscuration of the egress path by smoke. Thus, an interior wall and ceiling finish material with a low smoke developed index should provide better visibility in a given egress route than a material with a relatively high smoke developed index. Given that the smoke developed index is a cumulative measurement over the prescribed test duration, it is based on both quantity and rate of smoke liberation.

The *Code* requires the use of specific classes of interior wall and ceiling finish materials, which are differentiated by their allowable flame spread index, based on consideration of their installed location within the building, the building's egress paths, and the occupancy in question. Different classes of interior finish materials are specified for an office area, for example, as opposed to an exit stair enclosure or exit access corridor. The different classes recognize that, when escaping a building, people must move away from the flames while traveling through the means of egress toward an exit. The classes of interior finishes that are considered acceptable within an open office, therefore, are different from those that are required for exit enclosures. Similarly, occupancies used by those who have decreased capabilities of self-preservation have stricter interior finish requirements than occupancies used by fully ambulatory occupants. For example, although both hospitals and hotels provide sleeping accommodations, interior finish requirements for hospitals are more stringent, because hospital patients are less capable of self-preservation.

The same smoke developed index limit is used for all three flame spread classifications. This limit recognizes that smoke generated during a fire might affect visibility both in the vicinity of and remote from the fire. Large buildings can quickly fill with smoke as a result of a fire. An upper limit has been established, therefore, that applies to new interior finish materials, regardless of their location.

According to 12.5.4.3.1, existing wall and ceiling finish materials are exempt from the smoke development limitation. In existing buildings, existing interior finish materials are restricted only on the basis of flame spread. Prior to the 1976 edition, the *Code* did not regulate interior finish materials based on smoke development. As a general rule, the replacement of existing materials only because they were previously approved exclusively on the basis of flame spread is not warranted.

The smoke developed index limit of 450 was determined on the basis of research conducted by Underwriters Laboratories Inc. A 5000 ft^3 (140 m^3) room equipped with illuminated exit signs was filled with smoke from the tunnel test chamber. The time required to reach various stages of exit sign obscuration was recorded and compared to the smoke developed indices for the different materials involved. The report states that "materials having smoke developed ratings above 325 showed 'good' to 'marginal' visibility — scale readings of 3 to 4.8 — in a few cases; other materials produced conditions of 'marginal' to obscuration in the six-minute period."

Considering both time and smoke levels, the limit of 450 on smoke development as used in the *Code* has been judged to be reasonable. There is no direct relationship between flame spread and smoke development. For example, in the report referenced in the preceding paragraph, one material had a flame spread index of 490 and a smoke developed index of 57, while another had a flame spread index of 44 and a smoke developed index of 1387.

The smoke development limit of 450 is based solely on the level of visual obscuration. Although not addressed by the requirements for interior finishes, other important factors used in evaluating materials on the basis of smoke generation are the effects of irritability and toxicity caused by gases. Smoke might also act as an irritant, further reducing visibility, and might, in addition, have a debilitating physiological effect on people attempting to escape from a building. Such effects are not evaluated by the current smoke development limit. The adverse physiological effects on the human body caused by exposure to heat and the effects of inhaling hot gases also should be considered as part of an overall hazard risk assessment and should be considered separately from the interior finish requirements of Section 12.5.

N **12.5.4.3.2** The classification of interior finish specified in 12.5.4.3 shall be that of the basic material used by itself or in combination with other materials. [***101:***10.2.3.3.2]

N **12.5.4.3.3** Wherever the use of Class C interior wall and ceiling finish is required, Class A or Class B shall be permitted, and where Class B interior wall and ceiling finish is required, Class A shall be permitted. [***101:***10.2.3.3.3]

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Paragraph 12.5.4.3.3 recognizes that the *Code* sets minimum criteria. An interior finish material that performs better than that specifically prescribed by the *Code* is always permitted.

N **12.5.4.4** Materials complying with the requirements of 12.5.4.1 shall not be required to be tested in accordance with 12.5.4.3. [***101:***10.2.3.4]

N **12.5.4.5** Materials described in 12.5.5 shall be tested as described in the corresponding sections. [***101:***10.2.3.5]

N **12.5.5* Interior Wall and Ceiling Finish Materials with Special Requirements.** The materials indicated in 12.5.5.1 through 12.5.5.16 shall be tested as indicated in the corresponding sections. [***101:***10.2.4]

N **A.12.5.5** Surface nonmetallic raceway products, as permitted by *NFPA 70* are not interior finishes and are not subject to the provisions of Chapter 10 of *NFPA 101*. [***101:***A.10.2.4]

N **12.5.5.1 Thickness Exemption.** The provisions of 12.5.2.1 shall not apply to materials having a total thickness of less than 1⁄28 in. (0.9 mm) that are applied directly to the surface of walls and ceilings where both of the following conditions are met:

(1) The wall or ceiling surface is a noncombustible or limited combustible material.
(2) The materials applied meet the requirements of Class A interior wall or ceiling finish when tested in accordance with 12.5.4, using fiber cement board as the substrate material.

[***101:***10.2.4.1]

Paragraph 12.5.5.1 addresses the issue of thin coverings, which was covered in earlier editions of the *Code* by a simply worded, performance-based criterion that was difficult to use and enforce. The *Code* recognized that thin coverings [those less than 1⁄28 in. (0.9 mm) in thickness] with surface-burning characteristics not greater than that of paper would not significantly affect the fire performance of the basic wall or ceiling material. If assurance was provided that such a thin covering had surface-burning characteristics not greater than those of paper, the thin material would not be subject to regulation as an interior finish. Therefore, the material's flame spread rating was not needed, which, in turn, meant that no fire testing was required. The problem was that, without running fire tests, it was impossible to determine whether a thin material had surface-burning characteristics that were greater than those of paper.

The wording of 12.5.5.1 does not exempt newly installed thin materials from testing, but it does exempt thin materials from testing with the actual substrate or backing material that will be used in the final installed state, provided that the material is installed on a noncombustible or limited-combustible surface (e.g., gypsum wallboard). If there were no exemption, thin materials, such as paint (whose liquid suspension state dries to become a thin layer of material) and wallpaper, would be required to be fire tested in combination with numerous backing materials. A complete set of test results, representative of the many forms of substrates in common use, would be prohibitively expensive to collect. Paragraph 12.5.5.1 permits the material to be tested only with fiber cement board as the substrate material. If the material, where tested in that configuration, meets the requirements for Class A interior finish (see 12.5.4.3), no further regulation by Section 12.5 is required.

Thermally thin coverings, such as paint and wallpaper coverings, where secured to a noncombustible substrate such as fiber cement board, will not significantly alter the performance of the substrate during a fire. However, thicker coverings, such as multiple layers of wallpaper, can contribute to rapid fire growth.

The provision of 12.5.5.1 has the effect of requiring any wall or ceiling covering (or multiple layers of such covering) of more than 1⁄28 in. (0.9 mm) in thickness to undergo the full test series required of other interior finish materials so as to be representative of actual installations. Painted surfaces might be evaluated using the following steps:

1. Determine the classification of the interior finish material (e.g., wood wainscoting) in its unpainted configuration and verify that it complies with the applicable limits.
2. Obtain a paint product for which the manufacturer has documented that it achieves a Class A rating when applied to a substrate of cement fiber board and tested in accordance with ASTM E84 or ANSI/UL 723.
3. Apply the paint to the substrate described in step 1 such that the thickness is less than 1⁄28 in. (0.9 mm).
4. Where steps 1 through 3 are followed, the paint is exempt from being tested on the substrate on which it is actually installed.

Where the thickness of an interior finish material is 1⁄28 in. (0.9 mm) or greater, it must be tested as it will actually be installed. For example, according to research presented in "Fire Tests of Building Interior Covering Systems" from the journal *Fire Technology,* the performance of thermally thin coverings is altered by the nature of the substrate over which they are installed. Adhesives might also be an important factor in performance. In the case of composites (such as textile wall coverings over gypsum board), the adhesive should be sufficient to maintain a bond between the "finish" and the substrate. However, excess adhesive might contribute to a fire. According to research from the Fire Research Laboratory, University of California, tests of textile wall coverings have shown that changing adhesives or simply changing the application rate for the same adhesive might significantly alter product performance. Tests to qualify assemblies should use adhesives and application rates similar to actual installations.

Similarly, a product that undergoes testing in intimate contact with a mineral board should be installed in contact with a mineral board or similar substrate. Also, where products are tested in intimate contact with a substrate, results might be altered if the product is installed with air space behind the covering.

N **12.5.5.1.1** If a material having a total thickness of less than 1⁄28 in. (0.9 mm) is applied to a surface that is not noncombustible or not limited-combustible, the provisions of 12.5.4 shall apply. [***101:***10.2.4.1.1]

N **12.5.5.1.2** Approved existing installations of materials applied directly to the surface of walls and ceilings in a total thickness of less than 1⁄28 in. (0.9 mm) shall be permitted to remain in use, and the provisions of 12.5.4 shall not apply. [***101:***10.2.4.1.2]

The provision of 12.5.5.1.2 exempts existing interior wall and ceiling finish materials having a thickness of less than 1⁄28 in. (0.9 mm) from the testing requirements of 12.5.4, provided that they are acceptable to the AHJ. See the definition of *approved existing* in 3.3.84.1 of NFPA *101.* The intent of the exemption is to permit existing finishes such as a single layer of paint or wallpaper to remain in place without documentation of their flame spread characteristics, since determination of their classification might be impractical. It is expected that such finish materials have a finite service life, and, upon replacement, tested products can be applied or installed. Where the AHJ determines that the finish material is of such character that regulation is necessary, use of the exemption provided by 12.5.5.1.2 can be denied.

N **12.5.5.2* Exposed Portions of Structural Members.** In other than new interior exit stairways, new interior exit ramps, and new exit passageways, exposed portions of structural members complying with the requirements for Type IV (2HH) construction in accordance with NFPA 220 or with the building code shall be exempt from testing and classification in accordance with 12.5.4. [***101:***10.2.4.2]

N **A.12.5.5.2** Paragraph 12.5.5.2 does not require Type IV (2HH), heavy timber, other than that used in interior exit stairs, interior exit ramps, and exit passageways be tested by either ASTM E84 or ANSI/UL 723 to determine a flame spread rating. Taller wood buildings and new technology, primarily new "mass timber," make taller buildings of Type IV possible. To that end, the requirements for Type IV have been changed to require the testing for components in the egress system such that they too need to be tested and meet the appropriate classification required in this section. This means that Type IV is "presumed" to comply with the finish requirements in this section for the purpose of meeting the requirements of this section for any wall or ceiling finish of elements other than interior exit stairways, interior exit ramps, and exit passageways. [***101:***A.10.2.4.2]

Paragraph 12.5.5.2 recognizes that exposed surfaces of heavy timber structural members can be safely used where Class A, Class B, or Class C interior wall and ceiling finish is required in other than exit enclosures, as explained in A.12.5.5.2, the text of which is new to the 2018 edition of NFPA *101*. Such wood members often have flame spread indices in the range of 76 to 200 and, therefore, are typically classified as Class C interior finish. The exemption is based on the fact that the structural members are located at intervals and do not constitute a continuous surface that allows flame to spread, for example, across a ceiling.

N **12.5.5.3 Cellular or Foamed Plastic.**

N **12.5.5.3.1** Cellular or foamed plastic materials shall not be used as interior wall and ceiling finish unless specifically permitted by 12.5.5.3.2 or 12.5.5.3.4. [***101:***10.2.4.3.1]

N **12.5.5.3.2** The requirements of 12.5.5.3 shall apply both to exposed foamed plastics and to foamed plastics used in conjunction with a textile or vinyl facing or cover. [***101:***10.2.4.3.2]

N **12.5.5.3.3*** Cellular or foamed plastic materials shall be permitted where subjected to large-scale fire tests that substantiate their combustibility and smoke release characteristics for the use intended under actual fire conditions. [***101:***10.2.4.3.3]

N **A.12.5.5.3.3** See A.12.5.5.3.3.2. [***101:***A.10.2.4.3.3]

N **12.5.5.3.3.1** One of the following fire tests shall be used for assessing the combustibility of cellular or foamed plastic materials as interior finish:

(1) NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, with the acceptance criteria of 12.5.4.2
(2) ANSI/UL 1715, *Standard for Fire Test of Interior Finish Material* (including smoke measurements, with total smoke release not to exceed 1000 m^2)
(3) ANSI/UL 1040, *Standard for Fire Test of Insulated Wall Construction*
(4) ANSI/FM Approval 4880, *Approval Standard for Class 1 Rating of Insulated Wall or Wall and Roof/Ceiling Panels, Interior Finish Materials or Coatings, and Exterior Wall Systems*

[***101:***10.2.4.3.3.1]

N **12.5.5.3.3.2*** The tests shall be performed on a finished foamed plastic assembly related to the actual end-use configuration, including any cover or facing, and at the maximum thickness intended for use. [***101:***10.2.4.3.3.2]

N **A.12.5.5.3.3.2** Both NFPA 286 and ANSI/UL 1715, *Standard for Fire Test of Interior Finish Material*, contain smoke obscuration criteria. ANSI/UL 1040, *Standard for Fire Test of Insulated Wall Construction*, and FM 4880, *Approval Standard for Class I Insulated Wall or Wall and Roof/Ceiling Panels; Plastic Interior Finish Materials; Plastic Exterior Building Panels; Wall/Ceiling Coating Systems; Interior or Exterior Finish Systems*, do not. Smoke obscuration is an important component of the fire performance of cellular or foamed plastic materials. [***101:***A. 10.2.4.3.3.2]

N **12.5.5.3.4** Cellular or foamed plastic shall be permitted for trim not in excess of 10 percent of the specific wall or ceiling area to which it is applied, provided that it is not less than 20 lb/ft³ (320 kg/m³) in density, is limited to ½ in. (13 mm) in thickness and 4 in. (100 mm) in width, and complies with the requirements for Class A or Class B interior wall and ceiling finish as described in 12.5.4.3; however, the smoke developed index shall not be limited. [***101:***10.2.4.3.4]

The prohibition of 12.5.5.3.1 on the use of foamed plastics within buildings is based on actual fire experience in which foamed plastics have contributed to very rapid fire development, as presented in "Foamed Plastic Fire: Fire Spreads 430 Feet in Eight Minutes," from *Fire Journal*. It also acknowledges that tunnel testing per ASTM E84 (see 12.5.4.4) might not accurately assess the potential hazard of plastics in general. Therefore, if cellular or foamed plastics are to be used within a building, their use needs to be substantiated on the basis of large-scale fire tests that simulate conditions of actual use. Four such tests are offered in 12.5.5.3.3.1(1) through (4).

Note that the provisions of 12.5.5.3 apply not only to exposed foamed plastics but also to foamed plastics used as backings for textile or vinyl facings or cover materials. An assembly comprising foamed plastic backings in conjunction with a textile or vinyl facing or cover is expected to behave differently under fire tests than if just the textile or vinyl facing were tested alone.

Paragraph 12.5.5.3.4 permits the limited use of cellular or foamed plastics as a substitute for traditional wood trim, assuming their performance under fire exposure will be comparable to that of wood. To control the mass of the material that can be used, limits have been established on width and thickness. The intent in establishing a minimum density of 20 lb/ft³ (320 kg/m³) is to prohibit the use of lightweight [1 lb/ft³ to 3 lb/ft³ (16 kg/m³ to 48 kg/m³)], readily available, foamed plastics as trim.

Limiting plastic trim to Class A or Class B materials, in combination with the 10 percent area limit for walls and ceilings, imposes a greater restriction than that which applies to wood. This limitation ensures that the performance of the plastic trim will be equivalent or superior to that of more traditional materials.

In establishing the 10 percent limit, it is intended that the trim will be used around doors and windows or at the junction of walls and ceilings. Therefore, the trim will be somewhat uniformly distributed throughout the room. There would be a significant difference in the probable performance of wall and ceiling finish if the 10 percent limit were concentrated in one area.

N **12.5.5.4* Textile Wall Coverings.** Where used as interior wall finish materials, textile materials shall be tested in the manner intended for use, using the product mounting system, including adhesive, and shall comply with the requirements of either, 12.5.4.1, 12.5.5.4.1, or 12.5.5.4.3. [***101:***10.2.4.4]

N **A.12.5.5.4** Previous editions of the *Code* have regulated textile materials on walls and ceilings using ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. Full-scale room/corner fire test research has shown that flame spread indices produced by ASTM E84 or ANSI/UL 723 might not reliably predict all aspects of the fire behavior of textile wall and ceiling coverings. [***101:***A.10.2.4.4]

NFPA 265 and NFPA 286, both known as room/corner tests, were developed for assessing the fire and smoke obscuration performance of textile wall coverings and interior wall and ceiling finish materials, respectively. As long as an interior wall or ceiling finish material is tested by NFPA 265 or NFPA 286, as appropriate, using a mounting system, substrate, and adhesive (if appropriate) that are representative of actual use, the room/corner test provides an adequate evaluation of a product's flammability and smoke obscuration behavior. Manufacturers, installers, and specifiers should be encouraged to use NFPA 265 or NFPA 286, as appropriate (but not both), because each of these standard fire tests has the ability to characterize actual product behavior, as opposed to data generated by tests using ASTM E84 or ANSI/UL 723, which only allow comparisons of one product's performance with another. If a manufacturer or installer chooses to test a wall finish in accordance with NFPA 286, additional testing in accordance with ASTM E84 or ANSI/UL 723 is not necessary. [***101:***A.10.2.4.4]

The test results from ASTM E84 or ANSI/UL 723 are suitable for classification purposes but should not be used as input into fire models, because they are not generated in units suitable for engineering calculations. Actual test results for heat, smoke, and combustion product release from NFPA 265, and from NFPA 286, are suitable for use as input into fire models for performance-based design. [***101:***A.10.2.4.4]

N **12.5.5.4.1*** Products tested in accordance with NFPA 265 shall comply with the criteria of 12.5.5.4.2. [**101:**10.2.4.4.1]

N **A.12.5.5.4.1** The methodology specified in NFPA 265 includes provisions for measuring smoke obscuration. [***101:***A.10.2.4.4.1]

N **12.5.5.4.2*** The interior finish shall comply with all of the following when tested using method B of the test protocol of NFPA 265:

(1) During the 40 kW exposure, flames shall not spread to the ceiling.
(2) The flame shall not spread to the outer extremities of the samples on the 8 ft × 12 ft (2440 mm × 3660 mm) walls.
(3) Flashover, as described in NFPA 265, shall not occur.
(4) For new installations, the total smoke released throughout the test shall not exceed 1000 m^2.

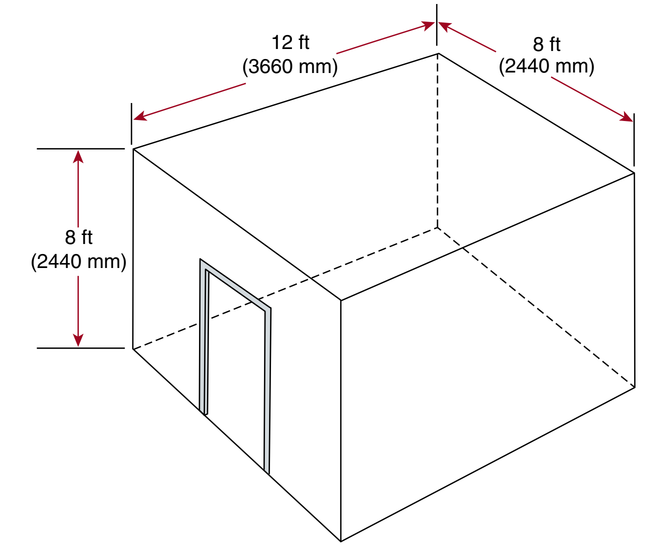
[***101:***10.2.4.4.2]

N **A.12.5.5.4.2** See A.12.5.5.4.1 and A.12.5.5.4. [***101:***A.10.2.4.4.2]

The *Code* recognizes the use of Method B of NFPA 265, but not Method A. Method B is the more rigorous test and requires that the test specimens be mounted to cover fully both 8 ft × 12 ft (2440 mm × 3660 mm) walls and the 8 ft × 8 ft (2440 mm × 2440 mm) rear wall. Method A is a screening test for which the test specimen is mounted as 24 in. (610 mm) wide strips at the intersection of two adjacent walls and along the tops of those two walls where they meet the ceiling.

The NFPA 265 test compartment is depicted in Exhibit 12.10.

Exhibit 12.10



Test compartment required by NFPA 265.

N **12.5.5.4.3** Textile materials meeting the requirements of Class A when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard Test Method for Surface Burning Characteristics of Building Materials*, using the specimen preparation and mounting method of ASTM E2404, *Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Polymeric (Including Vinyl) and Wood Wall or Ceiling Coverings, Facings and Veneers, to Assess Surface Burning Characteristics*, shall be permitted as follows:

(1) On the walls of rooms or areas protected by an approved automatic sprinkler system.
(2) On partitions that do not exceed three-quarters of the floor-to-ceiling height or do not exceed 8 ft (2440 mm) in height, whichever is less.
(3) On the lower 48 in. (1220 mm) above the finished floor on ceiling-height walls and ceiling-height partitions.
(4) Previously approved existing installations of textile material meeting the requirements of Class A when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials* or ANSI/UL 723, *Standard Test Method for Surface Burning Characteristics of Building Materials*, shall be permitted to be continued to be used.

[***101:***10.2.4.4.3]

The provisions addressing textile wall coverings were editorially reorganized for the 2018 edition of the *Code* to be more user friendly; no technical changes were intended. Textile materials are permitted to be used as interior wall finish only where such materials meet 12.5.4.1, 12.5.5.4.1, or 12.5.5.4.3. See the *Life Safety Code® Handbook* for further details on the use of textile wall and ceiling coverings.

N **12.5.5.5* Expanded Vinyl Wall Coverings.** Where used as interior wall finish materials, expanded vinyl wall coverings shall be tested in the manner intended for use, using the product mounting system, including adhesive, and shall comply with the requirements of either 12.5.4.1, 12.5.5.4.1, or 12.5.5.4.3. [***101:***10.2.4.5]

N **A.12.5.5.5** Expanded vinyl wall covering consists of a woven textile backing, an expanded vinyl base coat layer, and a nonexpanded vinyl skin coat. The expanded base coat layer is a homogeneous vinyl layer that contains a blowing agent. During processing, the blowing agent decomposes, which causes this layer to expand by forming closed cells. The total thickness of the wall covering is approximately 0.055 in. to 0.070 in. (1.4 mm to 1.8 mm). [***101:***A.10.2.4.5]

The provisions of 12.5.5.5, which address expanded vinyl wall coverings, are similar to those of 12.5.5.4, which are applicable to textile wall coverings. It is the intent of the *Code* to require compliance with 12.5.5.5 wherever expanded vinyl wall finish materials are installed, regardless of occupancy classification.

N **12.5.5.6 Textile Ceiling Coverings.** Where used as interior ceiling finish materials, textile materials shall be tested in the manner intended for use, using the product mounting system, including adhesive, and shall meet one of the following:

(1) Comply with the requirements of 12.5.4.1
(2) Meet the requirements of Class A when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials* or ANSI/UL 723, *Standard Test Method for Surface Burning Characteristics of Building Materials* using the specimen preparation and mounting method of ASTM E2404, *Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Polymeric (Including Vinyl) and Wood Wall or Ceiling Coverings, Facings and Veneers, to Assess Surface Burning Characteristics*, and used on the ceilings of rooms or areas protected by an approved automatic sprinkler system

[**101:**10.2.4.6]

N **12.5.5.7 Expanded Vinyl Ceiling Coverings.** Where used as interior ceiling finish materials, expanded vinyl materials shall be tested in the manner intended for use, using the product mounting system, including adhesive, and shall meet one of the following:

(1) Comply with the requirements of 12.5.4.1
(2) Meet the requirements of Class A when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials* or ANSI/UL 723, *Standard Test Method for Surface Burning Characteristics of Building Materials*, using the specimen preparation and mounting method of ASTM E2404, *Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Polymeric (Including Vinyl) and Wood Wall or Ceiling Coverings, Facings and Veneers, to Assess Surface Burning Characteristics*, and used on the ceilings of rooms or areas protected by an approved automatic sprinkler system

[***101:***10.2.4.7]

N **12.5.5.8 Lockers.**

N **12.5.5.8.1 Combustible Lockers.** Where lockers constructed of combustible materials other than wood are used, the lockers shall be considered interior finish and shall comply with 12.5.4, except as permitted by 12.5.5.8.2. [***101:***10.2.4.8.1]

N **12.5.5.8.2 Wood Lockers.** Lockers constructed entirely of wood and of noncombustible materials shall be permitted to be used in any location where interior finish materials are required to meet a Class C classification in accordance with 12.5.4. [***101:***10.2.4.8.2]

N **12.5.5.9 Solid Thermoplastics.**

N **12.5.5.9.1** Solid thermoplastics including, but not limited to, polypropylene, high-density polyethylene (HDPE), solid polycarbonate, solid polystyrene, and solid acrylic materials that melt and drip when exposed to flame shall not be permitted as interior wall or ceiling finish unless the material complies with the requirements of 12.5.4.1. [***101:***10.2.4.9.1]

N **12.5.5.9.2** The tests shall be performed on a finished assembly and on the maximum thickness intended for use. [***101:***10.2.4.9.2]

Polypropylene (PP) and high-density polyethylene (HDPE) are thermoplastic materials that, when exposed to fire, have a tendency to melt and form pool fires that can potentially burn vigorously. The requirement of 12.5.5.9.1 specifies that products, such as toilet room privacy dividers constructed of PP or HDPE, are considered interior finish materials and must comply with the performance criteria of 12.5.4.1 when tested in accordance with NFPA 286. Testing such materials for their flame spread and smoke development characteristics using the tunnel test of ASTM E84 or ANSI/UL 723 does not sufficiently characterize their fire performance. The NFPA 286 room-corner test provides a more realistic determination of their contribution to fire development in a room.

N **12.5.5.10 Site-Fabricated Stretch Systems.**

N **12.5.5.10.1** For new installations, site-fabricated stretch systems containing all three components described in the definition in Chapter 3 shall be tested in the manner intended for use and shall comply with the requirements of 12.5.4.1 or 12.6.7. [***101:***10.2.4.10.1]

N **12.5.5.10.2** If the materials are tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, specimen preparation and mounting shall be in accordance with ASTM E2573, *Standard Practice for Specimen Preparation and Mounting of Site-Fabricated Stretch Systems to Assess Surface Burning Characteristics*. [***101:***10.2.4.10.2]

Site-fabricated stretch systems comprise the following three components, as described in the definition of the term in 3.3.284.2 of NFPA *101*:

1. A frame (constructed of plastic, wood, metal, or other material) used to hold fabric in place
2. A core material (infill, with the correct properties for the application)
3. An outside layer, comprising a textile, fabric, or vinyl, that is stretched taut and held in place by tension or mechanical fasteners via the frame

Although many AHJs might have previously regulated site-fabricated stretch systems as interior finish, the requirements of 12.5.5.10 make it clear that such systems are, in fact, interior finish and must be tested accordingly. Additionally, where such systems are tested using the Steiner tunnel test in accordance with ASTM E84 or ANSI/UL 723, they must be mounted in the tunnel using the procedure specified by ASTM E2573, *Standard Practice for Specimen Preparation and Mounting of Site-Fabricated Stretch Systems to Assess Surface Burning Characteristics.*

N **12.5.5.11 Reflective Insulation Materials.**

N **12.5.5.11.1** Reflective insulation materials shall be tested in the manner intended for use and shall comply with the requirements of 12.5.4 or 12.5.4.3. [***101:***10.2.4.11.1]

N **12.5.5.11.2** If the materials are tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, specimen preparation and mounting shall be in accordance with ASTM E2599, *Standard Practice for Specimen Preparation and Mounting of Reflective Insulation, Radiant Barrier, and Vinyl Stretch Ceiling Materials for Building Applications to Assess Surface Burning Characteristics*. [***101:***10.2.4.11.2]

N **12.5.5.12 Metal Ceiling and Wall Panels.**

N **12.5.5.12.1** Listed factory finished metal ceiling and wall panels meeting the requirements of Class A in accordance with 12.5.4, shall be permitted to be finished with one additional application of paint. [***101:***10.2.4.12.1]

N **12.5.5.12.2** Such painted panels shall be permitted for use in areas where Class A interior finishes are required. The total paint thickness shall not exceed 1⁄28 in. (0.9 mm). [***101:***10.2.4.12.2]

N **12.5.5.13 Laminated Products Factory Produced with a Wood Substrate.**

N **12.5.5.13.1** Laminated products factory produced with a wood substrate shall be tested in the manner intended for use and shall comply with the requirements of 12.5.4.1 or 12.5.4.3. [***101:***10.2.4.13.1]

N **12.5.5.13.2** If the materials are tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, specimen preparation and mounting shall be in accordance with ASTM E2579, *Standard Practice for Specimen Preparation and Mounting of Wood Products to Assess Surface Burning Characteristics*, using the product-mounting system, including adhesive, of actual use. [***101:***10.2.4.13.2]

N **12.5.5.14 Facings or Wood Veneers Intended to be Applied on Site over a Wood Substrate.**

N **12.5.5.14.1** Facings or veneers intended to be applied on site over a wood substrate shall be tested in the manner intended for use and shall comply with the requirements of 12.5.4.1 or 12.5.4.3. [***101:***10.2.4.14.1]

N **12.5.5.14.2** If the materials are tested in accordance with NFPA 286 they shall use the product-mounting system, including adhesive, described in Section 5.8.9 of NFPA 286. [***101:***10.2.4.14.2]

N **12.5.5.14.3** If the materials are tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, specimen preparation and mounting shall be in accordance with ASTM E2404, *Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Polymeric (Including Vinyl) and Wood Wall or Ceiling Coverings, Facings and Veneers, to Assess Surface Burning Characteristics*. [***101:***10.2.4.14.3]

N **12.5.5.15* Light-Transmitting Plastics.** Light-transmitting plastics shall be permitted to be used as interior wall and ceiling finish shall be permitted based on large-scale fire tests per 12.5.5.3.3.1, which substantiate the combustibility characteristics of the plastics for the use intended under actual fire conditions. [***101:***10.2.4.15]

N **A.12.5.5.15** Light-transmitting plastics are used for a variety of purposes, including light diffusers, exterior wall panels, skylights, canopies, glazing, and the like. Previous editions of the *Code* have not addressed the use of light-transmitting plastics. Light-transmitting plastics will not normally be used in applications representative of interior finishes. Accordingly, ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials,* can produce test results that might or might not apply. [***101:***A.10.2.4.15]

Light-transmitting plastics are regulated by model building codes such as *NFPA 5000*. Model building codes provide adequate regulation for most applications of light-transmitting plastics. Where an authority having jurisdiction determines that a use is contemplated that differs from uses regulated by model building codes, light-transmitting plastics in such applications can be substantiated by fire tests that demonstrate the combustibility characteristics of the light-transmitting plastics for the use intended under actual fire conditions. [***101:***A.10.2.4.15]

For additional information on light transmitting plastics, see Section 48.7 of *NFPA 5000*. [***101:***A.10.2.4.15]

N **12.5.5.16 Decorations and Furnishings.** Decorations and furnishings that do not meet the definition of interior finish, as defined in 3.3.116.2, shall be regulated by the provisions of Section 12.6. [***101:***10.2.4.16]

N **12.5.6 Trim and Incidental Finish.**

N **12.5.6.1 General.** Interior wall and ceiling trim and incidental finish, other than wall base in accordance with 12.5.6.2 and bulletin boards, posters, and paper in accordance with 12.5.6.3, not in excess of 10 percent of the specific wall and ceiling areas of any room or space to which it is applied shall be permitted to be Class C materials in occupancies where interior wall and ceiling finish of Class A or Class B is required. [***101:***10.2.5.1]

N **12.5.6.2 Wall Base.** Interior floor trim material used at the junction of the wall and the floor to provide a functional or decorative border, and not exceeding 6 in. (150 mm) in height, shall meet the requirements for interior wall finish for its location or the requirements for Class II interior floor finish as described in 12.5.8.4 using the test described in 12.5.8.3. [***101:***10.2.5.2]

N **12.5.6.2.1** If a Class I floor finish is required, the interior floor trim shall be Class I. [***101:***10.2.5.2.1]

N **12.5.6.3 Bulletin Boards, Posters, and Paper.**

N **12.5.6.3.1** Bulletin boards, posters, and paper attached directly to the wall shall not exceed 20 percent of the aggregate wall area to which they are applied. [***101:***10.2.5.3.1]

N **12.5.6.3.2** The provision of 12.5.6.3.1 shall not apply to artwork and teaching materials in sprinklered educational or day-care occupancies in accordance with 20.2.4.4.3 and 20.3.4.2.3.5.3. [***101:***10.2.5.3.2]

Subsection 12.5.6 is intended to permit the use of wood trim around doors and windows as a decoration or as functional molding (such as for chair rails). Wood trim must meet the criteria for Class C materials. See 12.5.5.3.4 for restrictions applicable to plastic trim. Where such trim is used in rooms or spaces requiring the use of Class A or Class B materials, the trim is permitted to constitute not more than 10 percent of the aggregate wall or ceiling area to ensure that the trim will be more or less uniformly distributed throughout the room or space. If the trim is concentrated in a single, sizable, continuous pattern (e.g., on one wall of a room), the materials could contribute to rapid fire growth.

The wall base provisions of 12.5.6.2 regulate the common practice of running flooring up onto the lowest portion of a wall where it meets the floor. The 6 in. (150 mm) maximum height criterion recognizes the limitations of judging an interior wall finish material based on a test method developed to evaluate flame spread for interior floor finish materials exposed to a flaming radiant heat source. Note that, even where the interior floor finish of a room or space is not required to be Class I or Class II in accordance with 12.5.8.4, the flooring material wrapped up onto the wall is required to be tested and classified per 12.5.8.3 and 12.5.8.4.

The educational and day-care occupancies regulate artwork and teaching materials that are attached directly to walls for many editions of that *Code* — see 20.2.4.4.3 and 20.3.4.2.3.5.3. The provisions of 12.5.6.3 codify the subject for all other occupancies. Bulletin boards, posters, and paper attached directly to a wall serve as de facto interior finish materials with the potential for spreading flame. The 20 percent maximum aggregate wall area criterion of 12.5.6.3.1 helps ensure that there are not sufficient expanses of such materials, for which classification per 12.5.4.3 is unfeasible and unenforceable, that could spread flame more quickly than would occur with wall finish materials complying with applicable interior finish requirements based on testing per ASTM E84 or ANSI/UL 723.

N **12.5.7* Fire-Retardant Coatings.**

N **A.12.5.7** Fire-retardant coatings need to be applied to surfaces properly prepared for the material, and application needs to be consistent with the product listing. Deterioration of coatings applied to interior finishes can occur due to repeated cleaning of the surface or painting over applied coatings. [***101:***A.10.2.6]

N **12.5.7.1*** The required flame spread index or smoke developed index of existing surfaces of walls, partitions, columns, and ceilings shall be permitted to be secured by applying approved fire-retardant coatings to surfaces having higher flame spread index values than permitted. [***101:***10.2.6.1]

N **A.12.5.7.1** It is the intent of NFPA 1 to mandate interior wall and ceiling finish materials that obtain their fire performance and smoke developed characteristics in their original form. However, in renovations, particularly those involving historic buildings, and in changes of occupancy, the required fire performance or smoke developed characteristics of existing surfaces of walls, partitions, columns, and ceilings might have to be secured by applying approved fire-retardant coatings to surfaces having higher flame spread ratings than permitted. Such treatments should comply with the requirements of NFPA 703. When fire-retardant coatings are used, they need to be applied to surfaces properly prepared for the material, and application needs to be consistent with the product listing. Deterioration of coatings applied to interior finishes can occur due to repeated cleaning of the surface or painting over applied coatings, but permanency must be assured in some appropriate fashion. Fire-retardant coatings must possess the desired degree of permanency and be maintained so as to retain the effectiveness of the treatment under the service conditions encountered in actual use. [***101:***A.10.2.6.1]

N **12.5.7.1.1** Such treatments shall be tested, or shall be listed and labeled for application to the material to which they are applied, and shall comply with the requirements of NFPA 703. [***101:***10.2.6.1.1]

N **12.5.7.2*** Surfaces of walls, partitions, columns, and ceilings shall be permitted to be finished with factory-applied fire-retardant-coated products that have been listed and labeled to demonstrate compliance with the requirements of ASTM E2768, *Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials,* on the coated surface. [***101:***10.2.6.2]

N **A.12.5.7.2** The intent of this section is that factory-applied fire-retardant-coated products, such as panels or tiles applied to walls or ceilings, replace the existing finish and are not applied on top of the existing finish. [***101:***A.10.2.6.2]

N **12.5.7.3** Fire-retardant coatings or factory-applied fire-retardant-coated assemblies shall possess the desired degree of permanency and shall be maintained so as to retain the effectiveness of the treatment under the service conditions encountered in actual use. [***101:***10.2.6.3]

Fire-retardant paints, coatings, and penetrants are sometimes used to improve the flame spread ratings of materials or assemblies used as interior finishes within buildings. Fire-retardant treatments are permitted to be used to satisfy the flame spread requirements only for existing interior finish materials within existing buildings.

Fire retardants are generally surface treatments that — through intumescence or other chemical reaction — delay the ignition and slow the flame spread of a material. The nature of the material to which the treatment has been applied is not changed. Fire exposures of sufficient duration or intensity can ultimately cause a treated material to burn. Therefore, as a rule, materials with favorable intrinsic performance characteristics are preferred over those that achieve a satisfactory level of performance through the use of externally applied treatments. However, external treatments, where properly applied and maintained, can be effective in achieving reasonable fire performance.

Note that 12.5.7.1.1 permits fire-retardant coatings to be either tested or listed, since the product might have been tested with adequate results but not yet listed when being considered for application. Additionally, such products must comply with NFPA 703, *Standard for Fire-Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials* which contains criteria related to testing.

Fire-retardant paints, coatings, and penetrants must be applied in strict accordance with the manufacturer's instructions. Most fire-retardant coatings require an application rate that is three to four times greater than that of ordinary paints. Application is usually done by brush, spray, immersion, or pressure treatment. The treatment should be reapplied or renewed at regular intervals. Treatments that might be removed by regular maintenance, washing, or cleaning procedures will require periodic examination and reapplication to maintain the required level of performance.

The use of fire retardants can improve the performance of some materials from Class C to Class B; similarly, Class B materials can, in some cases, be upgraded to Class A. Likewise, materials having flame spread ratings in excess of 200 can sometimes be upgraded to Class C.

In approving fire-retardant treatments, the AHJ should take into consideration the fact that, in reducing flame spread, some fire-retardant treatments increase a material's capacity for smoke generation.

The provision of 12.5.7.2 is intended to permit assemblies with factory-applied coatings, provided that they are listed and labeled by an approved testing laboratory to indicate compliance with the noted test standard.

N 12.5.8* Interior Floor Finish Testing and Classification.

N **A.12.5.8** The flooring radiant panel provides a measure of a floor covering's tendency to spread flames when located in a corridor and exposed to the flame and hot gases from a room fire. The flooring radiant panel test method is to be used as a basis for estimating the fire performance of a floor covering installed in the building corridor. Floor coverings in open building spaces and in rooms within buildings merit no further regulation, provided that it can be shown that the floor covering is at least as resistant to spread of flame as a material that meets the U.S. federal flammability standard 16 CFR 1630, "Standard for the Surface Flammability of Carpets and Rugs" (FF 1-70). All carpeting sold in the United States since 1971 is required to meet this standard and, therefore, is not likely to become involved in a fire until a room reaches or approaches flashover. Therefore, no further regulations are necessary for carpet, other than carpet in exitways and corridors. [***101:***A.10.2.7]

It has not been found necessary or practical to regulate interior floor finishes on the basis of smoke development. [***101:***A.10.2.7]

Full-scale fire tests and fire experience have shown that floor coverings in open building spaces merit no regulation beyond the U.S. federally mandated DOC FF 1-70 "pill test." This is because floor coverings meeting the pill test will not spread flame significantly until a room fire approaches flashover. At flashover, the spread of flame across a floor covering will have minimal impact on the already existing hazard. The minimum critical radiant flux of a floor covering that will pass the FF 1-70 test has been determined to be approximately 0.04 W/cm^2 (Tu, King-Mon and Davis, Sanford, "Flame Spread of Carpet Systems Involved in Room Fires," NFSIR 76-1013, Center for Fire Research, National Bureau of Standards, June 1976). The flooring radiant panel is only able to determine critical radiant flux values to 0.1 W/cm^2. This provision will prevent use of a noncomplying material, which can create a problem, especially when the *Code* is used outside the United States where U.S. federal regulation FF 1-70 (16 CFR 1630) is not mandated. [***101:***A.10.2.7]

N **12.5.8.1*** Carpet and carpet-like interior floor finishes shall comply with ASTM D2859, *Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials.* [***101:***10.2.7.1]

N **A.12.5.8.1** Compliance with 16 CFR 1630, "Standard for the Surface Flammability of Carpets and Rugs" (FFI-70), is considered equivalent to compliance with ASTM D2859, *Standard Test Method for Ignition Characteristic of Finished Textile Floor Covering Materials.* [***101:***A.10.2.7.1]

N **12.5.8.2** Floor coverings, other than carpet for which 12.5.3.2 establishes requirements for fire performance, shall have a minimum critical radiant flux of 0.1 W/cm^2. [***101:***10.2.7.2]

N **12.5.8.3*** Interior floor finishes shall be classified in accordance with 12.5.8.4, based on test results from NFPA 253 or ASTM E648, *Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.* [***101:***10.2.7.3]

N **A.12.5.8.3** ASTM E648, *Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, and NFPA 253 are considered nationally recognized consensus standard test methods for determining the critical radiant flux from floor covering systems and are likely to yield equivalent test results. [***101:***A.10.2.7.3]

Experience and full-scale fire test data have shown that floor coverings of modest resistance to flame spread are unlikely to become involved in the early growth of a fire. The testing of flooring materials in accordance with 12.5.8.1 and 12.5.8.2 is relatively easy to accomplish. The testing helps to identify floor finish materials that have a modest resistance to flame spread.

Where floor coverings are regulated by the occupancy chapters in NFPA *101*, the evaluation is based on tests conducted in accordance with NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, or ASTM E648, *Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*. The flooring radiant panel test was specifically developed to evaluate the tendency of a floor covering to propagate flame. It measures a floor covering's tendency to spread flames where located in a corridor and exposed to flame and hot gases from a room fire.

Interior floor finishes must be tested as proposed for use. For example, if a carpet is to be used with a separate underlayment, the carpet must be tested as such. The flooring radiant panel test specifies that a carpet is permitted to be tested using either the standard underlayment specified in NFPA 253 or ASTM E648 or the actual underlayment proposed for use. Data generated using the standard underlayment is intended to permit the tested carpet to be used over any other underlayment. Where assembly tests are conducted with other than the standard underlayment, the results of such tests are valid only for the specific combination tested.

Floor coverings are not regulated on the basis of smoke generation. Smoke development limits are not believed to be practical or necessary, because floor coverings generally will not contribute to a fire until the fire has grown to large proportions. The minimal benefits achieved by imposing smoke development limits do not usually warrant such regulation. In addition, it is not considered practical to regulate on the basis of smoke development, because no regulatory test method that exists has been shown to be capable of producing data that correlate with the performance of products in actual fires.

N **12.5.8.4** Interior floor finishes shall be grouped in the classes specified in 12.5.8.4.1 and 12.5.8.4.2 in accordance with the critical radiant flux requirements. [***101:***10.2.7.4]

N **12.5.8.4.1 Class I Interior Floor Finish.** Class I interior floor finish shall have a critical radiant flux of not less than 0.45 W/cm^2, as determined by the test described in 12.5.8.3. [***101:***10.2.7.4.1]

N **12.5.8.4.2 Class II Interior Floor Finish.** Class II interior floor finish shall have a critical radiant flux of not less than 0.22 W/cm^2, but less than 0.45 W/cm^2, as determined by the test described in 12.5.8.3. [***101:***10.2.7.4.2]

The greater its critical radiant flux value, the greater the resistance of a floor finish to flame propagation. Thus, a Class I interior floor finish with a critical radiant flux of 0.45 W/cm^2 or greater should perform better under fire conditions than a Class II interior floor finish material with its lesser critical radiant flux value range of 0.22 W/cm^2 to less than 0.45 W/cm^2. Compare this classification with that of interior wall and ceiling interior finish materials in 12.5.4.3, in which higher flame spread indices generally denote poorer performance under fire conditions.

N **12.5.8.5** Wherever the use of Class II interior floor finish is required, Class I interior floor finish shall be permitted. [***101:***10.2.7.5]

N **12.5.9 Automatic Sprinklers.**

N **12.5.9.1** Other than as required in 12.5.5, where an approved automatic sprinkler system is installed in accordance with Section 13.3, Class C interior wall and ceiling finish materials shall be permitted in any location where Class B is required, and Class B interior wall and ceiling finish materials shall be permitted in any location where Class A is required. [***101:***10.2.8.1]

N **12.5.9.2** Where an approved automatic sprinkler system is installed in accordance with Section 13.3, throughout the fire compartment or smoke compartment containing the interior floor finish, Class II interior floor finish shall be permitted in any location where Class I interior floor finish is required, and where Class II is required, the provisions of 12.5.8.2 shall apply. [***101:***10.2.8.2]

Fire testing and actual fire experience have shown that automatic sprinklers prevent flame spread across the surface of a wall, ceiling, or floor covering so as to prevent flashover. Flame spread limits (applicable to interior wall and ceiling finishes) and critical radiant flux limits (applicable to interior floor finishes) are more lenient in areas protected by an automatic sprinkler system. However, there is a value beyond which the potential for flame spread becomes unacceptably high. For example, in occupancies with the most lenient interior finish requirements, which include fully sprinklered buildings, interior wall and ceiling finishes must meet the criteria for Class C materials. Note that the provisions of 12.5.9.1 and 12.5.9.2 apply unless specifically prohibited elsewhere in the *Code*. New detention and correctional occupancies are an example of an occupancy prohibiting the interior finish requirements from being further relaxed based on sprinkler protection, see 20.7.3.2. All new detention and correctional occupancies are required to be sprinklered (see 13.3.2.13.1). The interior finish limitations established in 20.7.3.2 and 20.7.3.4.2 are based on the presence of sprinklers. The prohibition on use of 12.5.9.1 and 12.5.9.2 keeps the user from taking a second, unjustified credit for the sprinklers.

N 12.6 Contents and Furnishings

N **12.6.1*** Where required by the applicable provisions of this *Code*, draperies, curtains, and other similar loosely hanging furnishings and decorations shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701. [***101:***10.3.1]

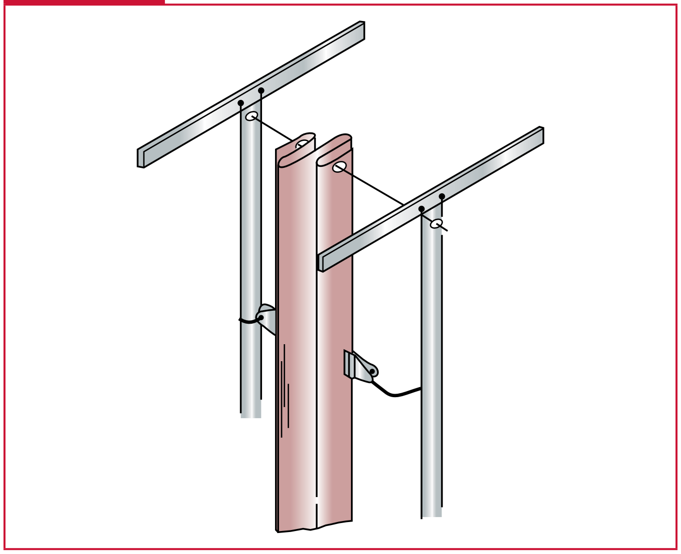
N **A.12.6.1** Testing per NFPA 701 applies to textiles and films used in a hanging configuration. If the textiles are to be applied to surfaces of buildings or backing materials as interior finishes for use in buildings, they should be treated as interior wall and ceiling finishes in accordance with Section 12.5.2 of this *Code*, and they should then be tested for flame spread index and smoke developed index values in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, or for flame spread and flashover in accordance with NFPA 265. Films and other materials used as interior finish applied to surfaces of buildings should be tested for flame spread index and smoke developed index values in accordance with ASTM E84 or ANSI/UL 723 or for heat and smoke release and flashover in accordance with NFPA 286. [***101:***A.10.3.1]

The test results from NFPA 701 are suitable for classification purposes but should not be used as input into fire models, because they are not generated in units suitable for engineering calculations. [***101:***A.10.3.1]

The testing requirements of NFPA 701 measure the level of hazard posed by draperies and other loosely hanging fabrics and films. NFPA 701 describes procedures for an intermediate-scale test (referred to as Test Method 1) and a large-scale test (referred to as Test Method 2). The applicable test method is determined, in part, by the weight of the material per unit area (i.e., areal density). Both tests involve applying a flame to a vertically positioned sample for a specified time. Upon removal of the flame-producing burner, the sample must self-extinguish and must not have charred beyond a specified distance in order to pass the test. Additionally, with the intermediate-scale test, a specified maximum percent weight loss must not be exceeded.

Exhibit 12.11 illustrates a representative setup for a folded test sample for the large-scale test (Test Method 2) from NFPA 701. The hanging textile sample is approximately 47 in. (1200 mm) long.

Exhibit 12.11



NFPA 701 test sample in folds.

N 12.6.2 Smoldering Ignition of Upholstered Furniture and Mattresses.

N **12.6.2.1* Upholstered Furniture.** Newly introduced upholstered furniture, except as otherwise permitted by Chapters 11 through 43 of NFPA *101*, shall be resistant to a cigarette ignition (i.e., smoldering) in accordance with one of the following:

(1) The components of the upholstered furniture shall meet the requirements for Class I when tested in accordance with NFPA 260.
(2) Mocked-up composites of the upholstered furniture shall have a char length not exceeding 1½ in. (38 mm) when tested in accordance with NFPA 261.

[***101:***10.3.2.1]

N **A.12.6.2.1** The Class I requirement associated with testing in accordance with NFPA 260 and the char length of not more than 1½ in. (38 mm) required with testing in accordance with NFPA 261 are indicators that the furniture item or mattress is resistant to a cigarette ignition. A fire that smolders for an excessive period of time without flaming can reduce the tenability within the room or area of fire origin without developing the temperatures necessary to operate automatic sprinklers. [***101:***A.10.3.2.1]

The test results from NFPA 260 and from NFPA 261 are suitable for classification purposes but should not be used as input into fire models because they are not generated in units suitable for engineering calculations. [***101:***A.10.3.2.1]

Until recently, NFPA 260 was equivalent to ASTM E1353, *Standard Test Methods for Cigarette Ignition Resistance of Components of Upholstered Furniture*, and NFPA 261 was equivalent to ASTM E1352, *Standard Test Method for Cigarette Ignition Resistance of Mock-Up Upholstered Furniture Assemblies*. However, that changed when NFPA 260 and NFPA 261 adopted the new NIST standard reference material (SRM 1196) as the igniting cigarette and ASTM E1352 and ASTM E1353 did not, meaning that ASTM E1352 and ASTM E1353 use commercial cigarettes that are low-ignition propensity and have a low likelihood of properly assessing smoldering potential. [***101:***A.10.3.2.1]

N **12.6.2.2* Mattresses.** Newly introduced mattresses, except as otherwise permitted by Chapters 11 through 43 of *NFPA 101*, shall have a char length not exceeding 2 in. (51 mm) when tested in accordance with 16 CFR 1632, “Standard for the Flammability of Mattresses and Mattress Pads” (FF 4-72). [**101:**10.3.2.2]

N **A.12.6.2.2** The char length of not more than 2 in. (51 mm) required in 16 CFR 1632, “Standard for the Flammability of Mattresses and Mattress Pads” (FF 4-72), is an indicator that the mattress is resistant to a cigarette ignition. United States federal regulations require mattresses in this country to comply with 16 CFR 1632. [***101:***A.10.3.2.2]

The provisions of 12.6.2 address ignition by cigarettes or other smoldering sources in an attempt to reduce the incidence of fires involving upholstered furniture and mattresses. Such ignition sources can smolder for considerable periods before producing flaming ignition.

Note that the provisions of 12.6.2.1 and 12.6.2.2 require cigarette ignition testing of newly introduced upholstered furniture and newly introduced mattresses for all occupancies unless "otherwise permitted by Chapters 11 through 43 of NFPA *101*."

The following fire test methods address the cigarette ignition resistance of upholstered furniture:

1. NFPA 260, *Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture*
2. NFPA 261, *Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes*

NFPA 260 tests individual components of upholstered furniture, such as cover fabric, interior fabric, welt cord, filling/padding, decking materials, and barrier materials. Specimens of the component to be tested are assembled with specimens of standardized materials to create a miniature horizontal base panel and vertical panel tester, a mocked-up arrangement that simulates the junction and surrounding area of a seat cushion and back cushion in a piece of upholstered furniture. Standardizing all the components of the mocked-up tester, except the component being tested, allows the test to measure the ignition resistance of the test component. Components that meet the test criteria are designated as Class I materials. Components that do not meet the test criteria are designated as Class II materials. Upholstered furniture constructed from components that individually received a Class I designation is judged to be resistant to cigarette ignition without testing of the actual combination of materials. Cigarette ignition–resistant upholstered furniture can also be constructed using Class II cover fabric materials over conventional polyurethane foam cushions if a Class I barrier material is used between the Class II fabric and the conventional foam cushion.

NFPA 261 tests a mocked-up assembly consisting of all the actual components that will be used to construct the piece of upholstered furniture, rather than testing the components individually. The test procedure specifies that a char length is to be measured and reported. There are no pass/fail criteria within the document, so 12.6.2.1(2) specifies that the char length not exceed 1½ in. (38 mm) if the mocked-up assembly is to be considered resistant to cigarette ignition.

NFPA 260 and NFPA 261 address the cigarette ignition resistance of upholstered furniture; 16 CFR 1632, "Standard for the Flammability of Mattresses and Mattress Pads," addresses the cigarette ignition resistance of mattresses. For this test method, 12.6.2.2 establishes that a char length not exceeding 2 in. (51 mm) qualifies the mattress as resistant to cigarette ignition.

N **12.6.3* Rate of Heat Release Testing of Upholstered Furniture and Mattresses.**

N **A.12.6.3** The intent of the provisions of 12.6.3 is as follows:

(1) The peak heat release rate of not more than 80 kW by a single upholstered furniture item was chosen based on maintaining a tenable environment within the room of fire origin, and the sprinkler exception was developed because the sprinkler system helps to maintain tenable conditions, even if the single upholstered furniture item were to have a peak rate of heat release in excess of 80 kW.
(2) The total heat release of not more than 25 MJ by the single upholstered furniture item during the first 10 minutes of the test was established as an additional safeguard to protect against the adverse conditions that would be created by an upholstered furniture item that released its heat in other than the usual measured scenario, and the following should also be noted:
    (a) During the test for measurement of rate of heat release, the instantaneous heat release value usually peaks quickly and then quickly falls off, so as to create a triangle-shaped curve.
    (b) In the atypical case, if the heat release were to peak and remain steady at that elevated level, as opposed to quickly falling off, the 80 kW limit would not ensure safety.
    (c) Only a sprinkler exception is permitted in lieu of the test because of the ability of the sprinkler system to control the fire.

Actual test results for heat, smoke, and combustion product release from ASTM E1537, *Standard Test Method for Fire Testing of Upholstered Furniture*, might be suitable for use as input into fire models for performance-based design. Furthermore, California Technical Bulletin 133, "Flammability Test Procedure for Seating Furniture for Use in Public Occupancies," includes pass/fail criteria for a single upholstered furniture item of 80 kW peak heat release rate and 25 MJ total heat release over the first 10 minutes of the test.

[***101:***A.10.3.3]

N **12.6.3.1** Where required by the applicable provisions of this *Code*, upholstered furniture and other seating furniture, unless the furniture is located in a building protected throughout by an approved automatic sprinkler system, shall have limited rates of heat release when tested in accordance with ASTM E1537, *Standard Test Method for Fire Testing of Upholstered Furniture*, as follows:

(1) The peak rate of heat release for the single furniture item shall not exceed 80 kW.
(2) The total heat released by the single furniture item during the first 10 minutes of the test shall not exceed 25 MJ.

[***101:***10.3.3.1]

N **12.6.3.2*** Where required by the applicable provisions of this *Code*, mattresses shall comply with 12.6.3.2.1 or 12.6.3.2.2, unless the mattress is located in a building protected throughout by an approved automatic sprinkler system. [***101:***10.3.3.2]

N **A.12.6.3.2** The intent of the provisions of 12.6.3.2 is as follows:

(1) The peak heat release rate of not more than 100 kW by a single mattress was chosen based on maintaining a tenable environment within the room of fire origin, and the sprinkler exception was developed because the sprinkler system helps to maintain tenable conditions, even if the single mattress were to have a peak rate of heat release in excess of 100 kW.
(2) The total heat release of not more than 25 MJ by the single mattress during the first 10 minutes of the test was established as an additional safeguard to protect against the adverse conditions that would be created by a mattress that released its heat in other than the usual measured scenario, and the following should also be noted:
   (a) During the test for measurement of rate of heat release, the instantaneous heat release value usually peaks quickly and then quickly falls off, so as to create a triangle-shaped curve.
   (b) In the atypical case, if the heat release were to peak and remain steady at that elevated level, as opposed to quickly falling off, the 100 kW limit would not ensure safety.
   (c) Only a sprinkler exception is permitted in lieu of the test because of the ability of the sprinkler system to control the fire.

Actual test results for heat, smoke, and combustion product release from ASTM E1590, *Standard Test Method for Fire Testing of Mattresses*, might be suitable for use as input into fire models for performance-based design. Furthermore, California Technical Bulletin 129, "Flammability Test Procedure for Mattresses for Use in Public Buildings," includes pass/fail criteria for a single mattress of 100 kW peak heat release rate and 25 MJ total heat release over the first 10 minutes of test.

[***101:***A.10.3.3.2]

N **12.6.3.2.1** The mattress shall have limited rates of heat release when tested in accordance with ASTM E1590, *Standard Test Method for Fire Testing of Mattresses*, as follows:

(1) The peak rate of heat release for the mattress shall not exceed 100 kW.
(2) The total heat released by the mattress during the first 10 minutes of the test shall not exceed 25 MJ.

[***101:***10.3.3.2.1]

N **12.6.3.2.2** The mattress shall have a mass loss not exceeding 15 percent when tested in accordance with the fire test in Appendix A3 of ASTM F1085, *Standard Specification for Mattress and Box Springs for Use in Berths and Marine Vessels*. [***101:***10.3.3.2.2]

Paragraph 12.6.3.2.2, which is new to the 2018 edition, offers an alternative to the ASTM E1590, *Standard Test Method for Fire Testing of Mattresses,* test. This test is relatively simple and does not require the use of an instrumented fire test lab. It involves rolling up a mattress, placing it at an angle (e.g., by holding it with a brick), introducing newspaper into the volume surrounding the rolled-up mattress and igniting the newspaper with a match. One of the advantages of using the test noted in 12.6.3.2.2 is that if the mattress materials melt away from the flame with flaming drips, they might "pass" the ASTM E1590 test, but melting will not allow a mattress to pass this test. In this test, flaming material on the floor will keep burning the mattress itself.

N **12.6.4*** Furnishings or decorations of an explosive or highly flammable character shall not be used. [***101:***10.3.4]

N **A.12.6.4** Christmas trees that are not effectively flame-retardant treated, ordinary crepe paper decorations, and pyroxylin plastic decorations might be classified as highly flammable. [***101:***A.10.3.4]

The *Code* relies on the AHJ to exercise judgment in determining whether materials are of an explosive or highly flammable nature.

N **12.6.5** Fire-retardant coatings shall be maintained to retain the effectiveness of the treatment under service conditions encountered in actual use. [***101:***10.3.5]

See NFPA 703.

N **12.6.6*** Where required by the applicable provisions of this *Code*, furnishings and contents made with foamed plastic materials that are unprotected from ignition shall have a heat release rate not exceeding 100 kW when tested in accordance with ANSI/UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, or when tested in accordance with NFPA 289 using the 20 kW ignition source. [***101:***10.3.6]

N **A.12.6.6** Neither UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, nor NFPA 289 is intended for evaluating interior wall and ceiling finish materials. Actual test results for heat, smoke, and combustion product release from UL 1975 or from NFPA 289 might be suitable for use as input into fire models intended for performance-based design. [***101:***A.10.3.6]

N **12.6.7 Lockers.**

N **12.6.7.1 Combustible Lockers.** Where lockers constructed of combustible materials other than wood are used, the lockers shall be considered interior finish and shall comply with Section 12.5, except as permitted by 12.6.7.2. [***101:***10.3.7.1]

N **12.6.7.2 Wood Lockers.** Lockers constructed entirely of wood and of noncombustible materials shall be permitted to be used in any location where interior finish materials are required to meet a Class C classification in accordance with 12.5.3. [***101:***10.3.7.2]

The provisions of 12.6.7 correspond with the provision of 12.5.2.3, which specifies that lockers are considered interior finish. Where lockers comprise combustible materials other than wood, they must be tested as required by 12.5.4. Where lockers are made of wood or a combination of wood and noncombustible materials, they are permitted to be installed wherever the *Code* permits Class C wall and ceiling finish materials with no additional testing.

N **12.6.8 Containers for Waste, or Linen.**

N **12.6.8.1** Where required by Chapters 11 through 43 of NFPA *101*, newly introduced containers for waste or linen, with a capacity of 20 gal (75.7 L) or more, shall meet both of the following:

(1) Such containers shall be provided with lids.
(2) Such containers and their lids shall be constructed of noncombustible materials or of materials that meet a peak rate of heat release not exceeding 300 kW/m^2 when tested at an incident heat flux of 50 kW/m^2 in the horizontal orientation and at a thickness as used in the container but not less than ¼ in. (6.3 mm), in accordance with ASTM E1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*.

[***101:***10.3.8.1]

N **12.6.8.2** Where required by Chapters 11 through 43 of NFPA *101*, newly introduced metal wastebaskets and other metal waste, or linen containers with a capacity of 20 gal (75.7 L) or more shall be listed in accordance with ANSI/UL 1315, *Standard for Safety for Metal Waste Paper Containers*, and shall be provided with a noncombustible lid. [***101:***10.3.8.2]

12.7 Fire Barriers

Δ **12.7.1 General.** Fire barriers used to provide enclosure, subdivision, or protection under NFPA *101* and this *Code* shall be classified in accordance with one of the following fire resistance ratings:

(1) 3-hour fire resistance rating
(2) 2-hour fire resistance rating
(3) 1-hour fire resistance rating
(4) ½-hour fire resistance rating

[***101:***8.3.1.1]

N **12.7.2*** Fire barriers shall comply with one of the following:

(1) The fire barriers are continuous from outside wall to outside wall or from one fire barrier to another, or a combination thereof, including continuity through all concealed spaces, such as those found above a ceiling, including interstitial spaces.
(2) The fire barriers are continuous from outside wall to outside wall or from one fire barrier to another, and from the floor to the bottom of the interstitial space, provided that the construction assembly forming the bottom of the interstitial space has a fire resistance rating not less than that of the fire barrier.

[***101:***8.3.1.2]

N **A.12.7.2** To ensure that a fire barrier is continuous, it is necessary to seal completely all openings where the fire barrier abuts other fire barriers, the exterior walls, the floor below, and the floor or ceiling above. In 12.7.2(2), the fire resistance rating of the bottom of the interstitial space is provided by that membrane alone. Ceilings of rated floor/ceiling and roof/ceiling assemblies do not necessarily provide the required fire resistance. [***101:***A.8.3.1.2]

N **12.7.3** Walls used as fire barriers shall comply with Chapter 7 of NFPA 221. The NFPA 221 limitation on percentage width of openings shall not apply. [***101:***8.3.1.3]

N **12.7.4 Smoke Barrier Used as a Fire Barrier.** A smoke barrier shall be permitted to be used as a fire barrier, provided that it meets the requirements of Section 8.3 of NFPA *101*. [***101:***8.3.1.4]

Subsection 12.7.4 is new to the 2018 edition of the *Code*, and it reminds users that smoke barriers that are also required to be constructed as fire barriers must also meet the fire barrier provisions of Section 12.7. Conversely, Section 12.9 currently contains similar text for fire barriers used as smoke barriers. Many occupancies that require smoke barriers with a fire-resistance rating also contain their own criteria for the construction and protection of the smoke barriers. Users should consult the occupancy chapter provisions where smoke barriers are required prior to following all the requirements in Section 12.7.

12.7.5 Walls.

12.7.5.1 The fire-resistive materials, assemblies, and systems used shall be limited to those permitted in this *Code* and this subsection. [***101:***8.3.2.1]

12.7.5.1.1* Fire resistance–rated glazing tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, shall be permitted. [***101:***8.3.2.1.1]

A.12.7.5.1.1 Fire resistance–rated glazing complying with 12.7.5, where not installed in a door, is considered a wall, not an opening protective. [***101:***A.8.3.2.1.1]

12.7.5.2 The construction materials and details for fire-resistive assemblies and systems for walls described shall comply with all other provisions of this *Code*, except as modified herein. [***101:***8.3.2.2]

12.7.5.3 Interior walls and partitions of nonsymmetrical construction shall be evaluated from both directions and assigned a fire resistance rating based on the shorter duration obtained in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials* or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*. When the wall is tested with the least fire-resistive side exposed to the furnace, the wall shall not be required to be subjected to tests from the opposite side. [***101:***8.3.2.3]

12.7.6 Opening Protectives.

Subsection 12.7.6 was completely revised and reorganized for the 2018 edition of the *Code*. In previous editions, requirements for fire doors and windows and other opening protectives in fire barriers were presented in a manner that was not logical to users of the *Code*. Most provisions were retained and relocated, while other provisions were updated to reflect consistent terminology. Some sections from previous editions were deleted because they were repeated elsewhere or addressed by other provisions in the *Code*, but minimal significant technical changes were made.

Δ **12.7.6.1 General.** Every opening in a fire barrier shall be protected to limit the spread of fire from one side of the fire barrier to the other. [***101:***8.3.3.1]

12.7.6.2 Minimum Fire Protection Rating.

N **12.7.6.2.1** Fire protection ratings for products required to comply with 12.7.6 shall be as determined and reported by a nationally recognized testing agency in accordance with NFPA 252; ANSI/UL 10B, *Standard for Fire Tests of Door Assemblies*; or ANSI/UL 10C, *Standard for Positive Pressure Fire Tests of Door Assemblies*; NFPA 257; or ANSI/UL 9, *Standard for Fire Tests of Window Assemblies*. [***101:***8.3.3.2.1]

Δ **12.7.6.2.2*** The fire rating for opening protectives in fire barriers, fire-rated smoke barriers, and fire-rated smoke partitions shall be in accordance with Table 12.7.6.2.2, except as otherwise permitted in 12.7.6.2.3 or 12.7.6.2.4. [***101:***8.3.3.2.2].

Table 12.7.6.2.2 does not mandate fire resistance ratings for the components listed; rather, it specifies the fire protection rating needed for openings where the listed components are required to be rated by another section of the *Code*. For example, not all exit access corridors are required to be rated. However, where corridor walls are required by another section of the *Code* to have a 1-hour rating, the doors therein must have a ⅓-hour (or 20-minute) fire protection rating. The table also specifies the maximum sizes of fire-rated door vision panels and glazing markings for various applications; the minimum fire protection or fire resistance rating for doorway sidelights or transoms and glazing markings for various applications; and the minimum fire protection ratings for fire window assemblies and associated markings for various applications. Table 12.7.6.2.2 was revised for the 2015 edition; however, no technical changes were intended. The revisions were intended to clarify its application to fire protection–rated glazing and fire resistance–rated glazing used in rated window assemblies.

Table 12.7.6.2.2 was further revised for the 2018 edition of the *Code*. The row for fire barriers within the table was relocated to the end of the table, before the entry for smoke barriers. This change helps clarify that this row addresses only fire barriers not otherwise addressed within the table. The table also contains a new row for 1-hour smoke partitions and 1-hour smoke barriers that previously were not included within the table.

Δ **A.12.7.6.2.2** Longer ratings might be required where opening protectives are provided for property protection as well as life safety. NFPA 80 should be consulted for standard practice in the selection and installation of fire door assemblies and fire window assemblies.

A vision panel in a fire door is not a fire window, and, thus, it is not the intent of the "NP" notations in the "Fire Window Assemblies" column of Table 12.7.6.2.2 to prohibit vision panels in fire doors. [***101:***A.8.3.3.2.2]

12.7.6.2.3 Existing fire door assemblies having a minimum 1¾-hour fire protection rating shall be permitted to continue to be used in vertical openings and in exit enclosures in lieu of the minimum 1-hour fire protection rating required by Table 12.7.6.2.2. [***101:***8.3.3.2.3]

12.7.6.2.4 Where a 20-minute fire protection–rated door is required in existing buildings, an existing 1¾ in. (44 mm) solid-bonded wood-core door, an existing steel-clad (tin-clad) wood door, or an existing solid-core steel door with positive latch and closer shall be permitted, unless otherwise specified by Chapters 11 through 43 of NFPA *101*. [***101:***8.3.3.2.4]

Fire barriers have fire *resistance* ratings, as addressed in 12.7.1; opening protectives, such as fire doors, have fire *protection* ratings, as discussed in 12.7.6.

In general, 1-hour fire barriers for the protection of vertical openings (e.g., the walls enclosing maximum three-story exit stairs) require doors with a 1-hour fire protection rating. One-hour fire barriers for other than vertical opening protection, such as those used to isolate a hazardous contents room, require doors with a ¾-hour fire protection rating.

In some cases, other sections of the *Code* modify the general rules stated in the preceding paragraph. Table 12.7.6.2.2 permits a 1-hour or ½-hour fire resistance–rated corridor wall or 1-hour fire resistance–rated smoke barrier to have a door with a 20-minute fire protection rating. Health care and ambulatory health care occupancies permit the omission of the self-closing devices on patient room doors installed in corridor walls. This provision recognizes the functional needs for open doors in these facilities, and a true fire protection–rated patient room door assembly is not required.

The fire protection ratings of the opening protectives are sometimes permitted to be of a lower rating than the fire resistance rating of the fire barrier openings to be protected. For example, a 2-hour fire barrier is permitted to have its openings protected by 1½-hour fire protection–rated door assemblies. The perceived mismatch of ratings actually accomplishes a reasonable, practical match — as explained in the paragraphs that follow.

The test procedures on which the ratings are based, that is, ASTM E119 and ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials,* for fire barriers and NFPA 252, *Standard Methods of Fire Tests of Door* Assemblies; ANSI/UL 10B, *Standard for Fire Tests of Door* Assemblies; and ANSI/UL 10C, *Standard for Positive Pressure Fire Tests of Door Assemblies*, for fire doors, are different.

Although combustibles placed against a fire resistance–rated wall expose the wall to a considerable fire challenge, a fire protection–rated door assembly does not usually have combustibles placed against it, because the opening must be clear to use the door and kept free of obstructions for proper operation of the door. Such a scenario suggests that if a door — for example, a second door to a storage room that is no longer needed — is not to be used and combustible storage is to be placed at the door opening, the door should be removed and the opening replaced with solid construction to restore the wall to its required fire resistance rating.

Δ ***TABLE 12.7.6.2.2*** *Minimum Fire Protection Ratings for Opening Protectives in Fire Resistance–Rated Assemblies and Fire-Rated Glazing Markings*

Component	Walls and Partitions (hr)	Fire Door Assemblies (hr)	Door Vision Panel Maximum Size (in.^{2})	Fire-Rated Glazing Marking Door Vision Panel	Minimum Side Light/Transom Assembly Rating (hr)		Fire-Rated Glazing Marking Side Light/Transom Panel		Minimum Fire-Rated Windows Rating[a,b] (hr)		Fire Window Marking	
					Fire Protection	Fire Resistance	Fire Protection	Fire Resistance	Fire Protection	Fire Resistance	Fire Protection	Fire Resistance
Elevator hoistways	2	1½	155 in.^{2}[c,e]	D-H-90 or D-H-W-90	NP	2	NP	D-H-W-120	NP	2	NP	W-120
	1	1	155 in.^{2}[c,e]	D-H-60 or D-H-W-60	NP	1	NP	D-H-W-60	NP	1	NP	W-60
	½	⅓	85 in.^{2}[d]	D-20 or D-W-20	⅓	⅓	D-H-20	D-W-20	⅓	⅓	OH-20	W-30
Elevator lobby (per 7.2.13.4 of NFPA ***101***)	1	1	100 in.^{2}[a]	$\leq$100 in.^{2}, D-H-T-60 or D-H-W-60[a] $>$100 in.^{2}, D-H-W-60	NP	1	NP	D-H-W-60			NP	W-60
Vertical shafts, including stairways, exits, and refuse chutes	2	1½	Maximum size tested	D-H-90 or D-H-W-90	NP	2	NP	D-H-W-120	NP	2	NP	W-120
	1	1	Maximum size tested	D-H-60 or D-H-W-60	NP	1	NP	D-H-W-60	NP	1	NP	W-60
Replacement panels in existing vertical shafts	½	⅓	Maximum size tested	D-20 or D-W-20	⅓	⅓	D-H-20	D-W-20	⅓	⅓	OH-20	W-30
Fire barriers	3	3	100 in.^{2}[a]	$\leq$100 in.^{2}, D-H-180 or D-H-W-180 $>$100 in.^{2}, D-H-W-180	NP	3	NP	D-H-W-180	NP	3	NP	W-180
	2	1½	Maximum size tested	D-H-90 or D-H-W-90	NP	2	NP	D-H-W-120	NP	2	NP	W-120
	1	¾	Maximum size tested[e]	D-H-45 or D-H-W-45	¾[e]	¾[e]	D-H-45	D-H-W-45	¾	¾	OH-45	W-60
	½	⅓	Maximum size tested	D-20 or D-W-20	⅓	⅓	D-H-20	D-W-20	⅓	⅓	OH-20	W-30
Horizontal exits	2	1½	Maximum size tested	D-H-90 or D-H-W-90	NP	2	NP	D-H-W-120	NP	2	NP	W-120
Horizontal exits served by bridges between buildings	2	¾	Maximum size tested[e]	D-H-45 or D-H-W-45	¾[e]	¾[e]	D-H-45	D-H-W-45	¾	¾	OH-45	W-120
Exit access corridors[f]	1	⅓	Maximum size tested	D-20 or D-W-20	¾	¾	D-H-45	D-H-W-20	¾	¾	OH-45	W-60
	½	⅓	Maximum size tested	D-20 or D-W-20	⅓	⅓	D-H-20	D-H-W-20	⅓	⅓	OH-20	W-30
Smoke barriers[f]	1	⅓	Maximum size tested	D-20 or D-W-20	¾	¾	D-H-45	D-H-W-20	¾	¾	OH-45	W-60
Smoke partitions[f,g]	½	⅓	Maximum size tested	D-20 or D-W-20	⅓	⅓	D-H-20	D-H-W-20	⅓	⅓	OH-20	W-30

For SI units, 1 in.^{2} = .00064516 m^2.

NP: Not permitted.

[a]Fire resistance–rated glazing tested to ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, shall be permitted in the maximum size tested. *(See 12.7.6.6.8.)*

[b]Fire-rated glazing in exterior windows shall be marked in accordance with Table 12.7.6.6.3.

[c]See ASME A17.1, *Safety Code for Elevators and Escalators*, for additional information.

[d]See ASME A17.3, *Safety Code for Existing Elevators and Escalators*, for additional information.

[e]Maximum area of individual exposed lights shall be 1296 in.^{2} (0.84 m^2) with no dimension exceeding 54 in. (1.37 m) unless otherwise tested. [**80:** Table 4.4.5, Note b, and **80:**4.4.5.1]

[f]Fire doors are not required to have a hose stream test per ANSI/UL 10B, *Standard for Fire Tests of Door Assemblies*; or ANSI/UL 10C, *Standard for Positive Pressure Fire Tests of Door Assemblies*.

[g]For residential board and care, see 32.2.3.1 and 33.2.3.1 of NFPA *101*.

[***101:***Table 8.3.3.2.2]

N **12.7.6.2.5** Openings required to have a fire protection rating by Table 12.7.6.2.2 shall be protected by approved, listed and labeled fire door assemblies and fire window assemblies and their accompanying hardware, including all frames, closing devices, anchorage, and sills in accordance with the requirements of NFPA 80, except as otherwise specified in NFPA *101*. [***101:***8.3.3.2.5]

12.7.6.3* Fire Doors.

Fire protection–rated door assemblies are tested in accordance with NFPA 252. Such assemblies must be installed in accordance with the requirements of NFPA 80. Where the *Code* uses the term *door*, it refers to the fire door assembly, which includes not only the door leaf or slab but also the doorway, frame, and necessary hardware, including hinges. Where describing a fire door, the applicable standards similarly define a fire protection–rated assembly as including all these components, as well as a listed door closer and positive latching.

If they are to be effective, fire doors must be not only closed but also held closed. Building fires are capable of generating pressures sufficient to force fire doors open if they are not held closed with positive latching, thereby rendering the doors incapable of protecting the opening in which they are installed and potentially allowing the fire to spread to an adjacent space and beyond the compartment of origin.

The acceptance criteria for fire protection–rated assemblies, such as fire doors, differ from those for fire resistance–rated construction, such as a wall or floor/ceiling assembly. The limitation of temperature rise through the fire door is not normally a measure of acceptance, although it is a measure of acceptance for a fire resistance–rated assembly such as a wall. In addition, during the course of the fire test, fire doors will expand on the exposed side and, as a result, will warp — sometimes expanding through the door opening at the top of the door. This expansion and warping can result in some flaming through the top of the door openings. The test standards recognize this phenomenon, and a certain amount of such flaming is permitted under the acceptance criteria. This does not adversely affect safety, given that fire protection–rated assemblies are intended to protect relatively small openings in larger fire resistance–rated barriers. Also, to maintain the door as usable, combustible materials are not typically stored in front of the door opening. Exhibit 12.12 shows the effects of a successful fire door assembly installation from the non-fire side. Exhibit 12.13 shows the same fire door assembly from the fire side.

N **A.12.7.6.3** Some door assemblies have been tested to meet the conditions of acceptance of ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*. Where such assemblies are used, the provisions of 12.7.5 should be applied instead of those of 12.7.6.3.

In existing installations, steel door frames that are well set in the wall might be judged as acceptable even if the frame label is not legible. [***101:***A.8.3.3.3]

Exhibit 12.12

Fire door assembly from non-fire side.

Exhibit 12.13

Fire door assembly from fire side.

N **12.7.6.3.1** Fire door assemblies shall be installed, inspected, tested, and maintained in accordance with NFPA 80. [***101:***8.3.3.3.1]

Δ **12.7.6.3.2** All fire door assemblies shall be labeled. [***101:***8.3.3.3.2]

• **12.7.6.3.3** Labels on fire door assemblies shall be maintained in a legible condition. [***101:***8.3.3.3.3]

NFPA 80 mandates that fire door assemblies be tested and inspected not less than annually by a qualified person. Annual inspections and testing should be documented and retained for review by the local AHJ. Any deficiencies found during inspection and testing should be documented and a corrective action plan developed to fix the deficiencies. Annual testing of the fire door assembly should verify proper operation of the door by closing the door by all means of activation. This verifies that there are no obstructions to door operation that would interfere with its ability to be self-closing and positive latching and that any device connected to the door, such as smoke detectors, are integrated properly and will close the door during an emergency.

The provisions for the annual inspection of fire doors were new to the 2007 edition of NFPA 80; thus, they became applicable to this *Code*, by reference, in the 2009 edition. Since then, as more jurisdictions move to adopting newer editions of this *Code*, they are becoming more aware for the need to properly care for and maintain fire door assemblies, a fire protection system that was often overlooked in earlier editions. Occupancies such as health care modify the application of NFPA 80 in certain conditions such as corridor fire door assemblies. The extent to which NFPA 80 is applied should be verified through the occupancy chapter.

Paragraphs 12.7.6.3.2 and 12.7.6.3.3 require that all fire door assemblies be labeled and that the label must be maintained in legible condition, as shown in Exhibit 12.14. A label is the identifier that a door is fire protection rated and that it has met the applicable testing criteria and has been certified by an accredited testing laboratory. Without the presence of a label on a fire door assembly, it is extremely difficult, if not impossible, to identify the door as a fire protection–rated door and the necessary criteria cannot be confirmed. The labeling requirement is a repetition of the provision from NFPA 80. Because it is such an important and fundamental concept for fire door assemblies, it is being repeated in this *Code* for emphasis and as a reminder to the users of the importance of labels on these products. Labels are permitted to be of metal, paper, or plastic or to be stamped onto or diecast into the item; the labels should not be removed, defaced, or made illegible while the door is in service. If the label on an existing fire door has been removed or is no longer legible, it might be acceptable to have the rating of the fire door verified by other means acceptable to the AHJ, such as an inspection or certification service that provides acceptable documentation.

Exhibit 12.14

Fire door label.

12.7.6.3.4* In existing installations, steel door frames without a label shall be permitted where approved by the AHJ. [***101:***8.3.3.3.4]

A.12.7.6.3.4 In existing installations, it is important to be able to determine the fire protection rating of the fire door. However, steel door frames that are well set in the wall might be judged as acceptable even if the frame label is not legible. [***101:***A.8.3.3.3.4]

12.7.6.3.5 Unless otherwise specified, fire doors shall be self-closing or automatic-closing in accordance with 14.5.4. [***101:***8.3.3.3.6]

12.7.6.4 Floor Fire Door Assemblies.

N **12.7.6.4.1** Floor fire door assemblies used to protect openings in fire resistance-rated floors shall be tested in accordance with NFPA 288 and shall achieve a fire resistance rating not less than the assembly being penetrated. [***101:***8.3.3.4.1]

N **12.7.6.4.2** Floor fire doors assemblies shall be listed and labeled. [***101:***8.3.3.4.2]

N **12.7.6.5 Fire Windows.**

N **12.7.6.5.1** Fire window assemblies shall be installed, inspected, tested, and maintained in accordance with NFPA 80. [***101:***8.3.3.5.1]

N **12.7.6.5.2** All fire window assemblies be labeled. [***101:***8.3.3.5.2]

12.7.6.5.3* Fire window assemblies shall be permitted in fire barriers having a required fire resistance rating of 1 hour or less and shall be of an approved type with the appropriate fire protection rating for the location in which they are installed. [***101:***8.3.3.5.3]

N **A.12.7.6.5.3** Some doors and glazing assemblies have been tested to meet the conditions of acceptance of ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*. Where such assemblies are used, the provisions of 12.7.5 should be applied instead of those of 12.7.6.6.6. [***101:***A.8.3.3.5.3]

N **12.7.6.6 Glazing.**

N **12.7.6.6.1** Glazing materials that have been tested, listed, and labeled to indicate the type of opening to be protected for fire protection purposes shall be permitted to be used in approved opening protectives in accordance with Table 12.7.6.2.2 and NFPA 80. [***101:***8.3.3.6.1]

N **12.7.6.6.2** Fire-rated glazing assemblies shall be permitted as follows:

(1) Those marked as complying with hose stream requirements (H) shall be permitted in applications that do not require compliance with hose stream requirements.
(2) Those marked as complying with temperature rise requirements (T) shall be permitted in applications that do not require compliance with temperature rise requirements.
(3) Those marked with ratings that exceed the ratings required by NFPA *101* shall be permitted.

[***101:***8.3.3.6.2]

TABLE 12.7.6.6.3 Marking Fire-Rated Glazing Assemblies

Fire Test Standard	Marking	Definition of Marking
ASTM E119 or ANSI/UL 263	W	Meets wall assembly criteria
NFPA 257	OH	Meets fire window assembly criteria, including the hose stream test
NFPA 252	D	Meets fire door assembly criteria
	H	Meets fire door assembly hose stream test
	T	Meets 450°F (232°C) temperature rise criteria for 30 minutes
	XXX	The time, in minutes, of fire resistance or fire protection rating of the glazing assembly

N **12.7.6.6.3** New fire protection-rated glazing shall be marked in accordance with Table 12.7.6.6.3 and Table 12.7.6.2.2, and such marking shall be permanently affixed. [***101:***8.3.3.6.3]

New glazing for use in fire barriers and fire doors is regulated by performance-oriented criteria, which refer to fire-rated glazing, in lieu of the more traditional but prescriptive requirements previously applicable to wired glass.

N **12.7.6.6.4** New fire resistance–rated glazing shall be marked in accordance with Table 12.7.6.6.3 and Table 12.7.6.2.2, and such marking shall be permanently affixed. [***101:***8.3.3.6.4]

N **12.7.6.6.5** Fire protection–rated glazing shall be permitted in fire barriers having a required fire resistance rating of 1 hour or less and shall be of an approved type with the appropriate fire protection rating for the location in which the barriers are installed. [***101:***8.3.3.6.5]

N **12.7.6.6.6*** Glazing in fire window assemblies, other than in existing fire window installations of wired glass and other fire-rated glazing material, shall be of a design that has been tested to meet the conditions of acceptance of NFPA 257 or ANSI/UL 9, *Standard for Fire Tests of Window Assemblies*. [***101:***8.3.3.6.6]

N **A.12.7.6.6.6** Some window assemblies have been tested to meet the conditions of acceptance of ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*. Where such assemblies are used, the provisions of 12.7.5 should be applied instead of those of 12.7.6.6.6. [***101:***A.8.3.3.6.6]

N **12.7.6.6.7** Fire protection–rated glazing in fire door assemblies, other than in existing fire-rated door assemblies, shall be of a design that has been tested to meet the conditions of acceptance of NFPA 252, ANSI/UL 10B, *Standard for Fire Tests of Door Assemblies*, or ANSI/UL 10C, *Standard for Positive Pressure Fire Tests of Door Assemblies*. [***101:***8.3.3.6.7]

N **12.7.6.6.8** Fire resistance–rated glazing tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, shall be permitted in fire doors and fire window assemblies in accordance with their listings. [***101:***8.3.3.6.8]

The provisions of 12.7.6.6.4 and 12.7.6.6.8 recognize that glazing material that has been tested as a wall assembly in accordance with ASTM E119 or ANSI/UL 263 is permitted to be used in fire barrier walls with no limitations other than those imposed by the product's listing. New glazing material tested and used as such must be appropriately labeled as specified in 12.7.6.6.3.

N **12.7.6.6.9** Nonsymmetrical fire protection–rated glazing systems shall be tested with each face exposed to the furnace, and the assigned fire protection rating shall be that of the shortest duration obtained from the two tests conducted in compliance with NFPA 257; or ANSI/UL 9, *Standard for Fire Tests of Window Assemblies*. [***101:***8.3.3.6.9]

N **12.7.6.6.10** The total combined area of glazing in fire-rated window assemblies and fire-rated door assemblies used in fire barriers shall not exceed 25 percent of the area of the fire barrier that is common with any room, unless the installation meets one of the following criteria:

(1) The installation is an existing fire window installation of wired glass and other fire-rated glazing materials in approved frames.
(2) The fire protection–rated glazing material is installed in approved existing frames.

[***101:***8.3.3.10]

N **12.7.6.6.11** Existing installations of wired glass of ¼ in. (6.3 mm) thickness and labeled for fire protection purposes shall be permitted to be used in approved opening protectives, provided that the maximum size specified by the listing is not exceeded. [***101:***8.3.3.6.11]

The requirements of 12.7.6.6.10 limit the installation of fire windows used in fire barriers to not more than 25 percent of the area of the fire barrier that is common with any room. However, 12.7.6.6.10 continues to recognize the current practice of using greater percentages of wired glass for existing fire windows if the material is installed in approved frames. Paragraph 12.7.6.6.11 recognizes the use of any existing installations of wired glass of ¼ in (6.3 mm) thickness and labeled for fire protection purposes in approved opening protectives if the maximum size specified in the listing is not exceeded. This recognizes a common application of wired glass used in vision panels in door assemblies. The language of 12.7.6.6.11 does not permit new installations of wired glazing in opening protectives; it simply permits existing installations to remain in use. Per the installation requirements in

NFPA 80, newer glazing installations require the glazing materials used in fire doors, windows, sidelights, and commercial lights to also meet applicable safety standards if they are subject to human impact.

The marking requirements for fire protection–rated glazing in 12.7.6.6.3 and Table 12.7.6.6.3 vary, depending on whether the glazing is installed in a door or a wall, and the table provides details on the test criteria at a glance. The prescribed marking scheme is consistent with the requirements of *NFPA 5000* and other model building codes.

N **12.7.6.7 Sidelights and Transoms.** Glazing used in sidelights and transoms adjacent to 20-minute doors in 1-hour corridor fire barriers shall be tested in accordance with 12.7.6.2, including hose stream, and shall attain a minimum 45-minute fire protection rating. [***101:***8.3.3.7]

12.7.7 Opening Protectives.

12.7.7.1 Every opening in a fire barrier shall be protected to limit the spread of fire and restrict the movement of smoke from one side of the fire barrier to the other. [***101:***8.3.4.1]

12.7.8 Penetrations.

N **12.7.8.1 General.**

N **12.7.8.1.1** The provisions of 12.7.8 shall govern the materials and methods of construction used to protect through-penetrations and membrane penetrations in fire walls, fire barrier walls, and fire resistance–rated horizontal assemblies. [***101:***8.3.4.1.1]

N **12.7.8.1.2** The provisions of 12.7.8 shall not apply to approved existing materials and methods of construction used to protect existing through-penetrations and existing membrane penetrations in fire walls, fire barrier walls, or fire resistance–rated horizontal assemblies, unless otherwise required by Chapter 11 through 43 of NFPA *101*. [***101:***8.3.4.1.2]

N **12.7.8.1.3** Penetrations shall be protected in accordance with a tested system, and installed and maintained in accordance with the manufacturer's instructions. [***101:***8.3.4.1.3]

12.7.8.2* Firestop Systems and Devices Required.

A.12.7.8.2 Firestop materials become systems when installed to the listed firestop system design from an accredited testing laboratory. Installation of firestop materials to the listed system should meet all limitations of the system. [***101:***A.8.3.4.2]

There are management system–based contractor approval or qualification programs offered by third-party, independent companies that quantifiably qualify a company to install firestop materials that become systems after proper installation. In each program, there is an industry firestop exam that gives the company a basis to appoint a "Designated Responsible Individual." [***101:***A.8.3.4.2]

Then, the third party firm audits the firestop company's product and systems documentation records in conjunction with the company's management system operational policies and procedures to verify company compliance does as it says it does. An audit also takes place on a project site to verify that the management system is working. [***101:***A.8.3.4.2]

Where the configuration of a penetrating item or group of items is such that a listed system is determined to be nonexistent and reconfiguration of the penetrations or fire resistance–rated assembly is determined to be impractical or impossible, alternative methods for maintaining the integrity of the required fire resistance rating of the assembly should be permitted to be established using an engineering analysis based on a comparison of listed systems prepared by a manufacturer's technical representative of the systems specified, by the laboratory that conducted the original test, or by a professional engineer. [***101:***A.8.3.4.2]

ASTM E2174, *Standard Practice for On-Site Inspection of Installed Fire Stops*, provides guidance for the inspection of through-penetration firestop systems tested in accordance with ASTM E814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops*, and ANSI/UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*. [***101:***A.8.3.4.2]

Independent inspection paid for by owner is in many specifications and referenced in this appendix using ASTM E2174 and ASTM E2393, *Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers*. As a result, there is an accreditation program available for firestop special inspection agencies. [***101:***A.8.3.4.2]

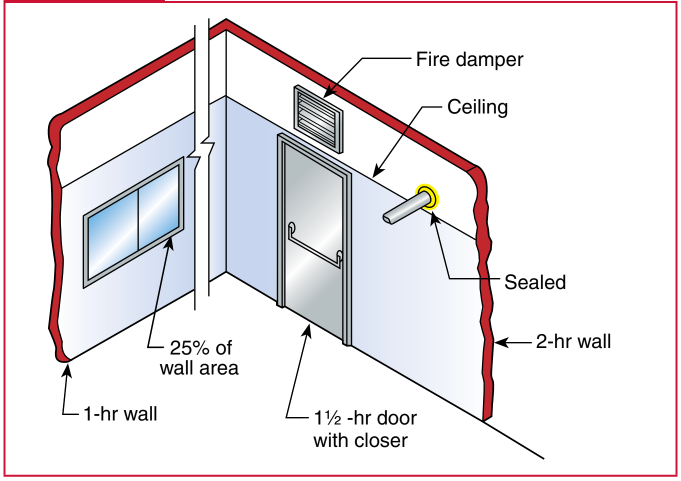
One source of information on tested materials, devices, and systems for protecting through-penetrations of fire resistance–rated barriers is Volume 2 of the UL *Fire Resistance Directory*. Such devices and systems are designed to resist the spread of fire through openings in fire resistance–rated floor or wall barriers that accommodate penetrating items, such as electrical cables, cable trays, conduits, and pipes. Underwriters Laboratories classifies such devices and systems with respect to installation in a wall only, installation in a floor only, or installation in a wall or floor. The basic standard used by UL to investigate products in this category is ANSI/UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*, which is similar to ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops. A sampling of the currently classified devices includes the use of the following:

1. Ceramic fibers
2. Foamed silicones
3. Mineral wool batts
4. Intumescent sheets
5. Sealing blankets and plugs
6. Fittings and couplings
7. Various caulks, putties, and mastics
8. Spring-loaded guillotine blades

Over the life of a building, it is important to maintain the integrity of barriers to protect against fire penetration. Renovations or any changes to building utilities tend to violate the compartmentation provided when a building is first occupied.

Exhibit 12.15 illustrates some of the typical fire barrier penetrations addressed by 12.7.8.

Exhibit 12.15



Typical penetrations of a fire barrier.

N **12.7.8.2.1** Penetrations for cables, cable trays, conduits, pipes, tubes, combustion vents and exhaust vents, wires, and similar items to accommodate electrical, mechanical, plumbing, and communications systems that pass through a wall, floor, or floor/ceiling assembly constructed as a fire barrier shall be protected by a firestop system or device. [***101:***8.3.4.2.1]

N **12.7.8.2.2 Testing.** The firestop system or device shall be tested in accordance with ASTM E814, *Standard Test Method for Fire Tests of Through Penetration Fire Stops*, or ANSI/UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*, at a minimum positive pressure differential of 0.01 in. water column (2.5 Pa) between the exposed and the unexposed surface of the test assembly. [***101:***8.3.4.2.2]

12.7.8.2.3 F Ratings. Firestop systems and devices shall have a minimum 1-hour F rating, but not less than the required fire resistance rating of the fire barrier penetrated. [***101:***8.3.4.2.3]

12.7.8.2.4 T Ratings.

N **12.7.8.2.4.1** Penetrations in fire resistance–rated horizontal assemblies shall have a T rating of not less than 1 hour, and not less than the fire resistance rating of the horizontal assembly. [***101:***8.3.4.2.4.1]

N **12.7.8.2.4.2** A T rating shall not be required for either of the following:

(1) Floor penetrations contained within the cavity of a wall assembly
(2) Penetrations through floors or floor assemblies where the penetration is not in direct contact with combustible material [***101:***8.3.4.2.4.2]

12.7.8.2.5 Alternative Firestop Requirements.

N **12.7.8.2.5.1** The requirements of 12.7.8.2 shall not apply where otherwise permitted by any one of the following:

(1) Where penetrations are tested and installed as part of an assembly tested and rated in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials* or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*
(2) Where penetrations through floors are enclosed in a shaft enclosure designed as a fire barrier
(3) Where concrete, grout, or mortar has been used to fill the annular spaces around cast-iron, copper, or steel piping, conduit or tubing that penetrates one or more concrete or masonry fire resistance–rated assemblies and all of the following applies:
   (a) The nominal diameter of each penetrating item does not exceed 6 in. (150 mm),
   (b) The opening size does not exceed 1 ft² (0.09 m²).
   (c) The thickness of the concrete, grout, or mortar is the full thickness of the assembly.
(4) Where penetration is limited to one floor, the firestopping material is capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time–temperature fire conditions of ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Materials* under a minimum positive pressure differential of 0.01 in. water column (2.5 Pa) at the location of the penetration for the time period equivalent to the required fire resistance rating of the assembly penetrated, and the firestopping materials are used with the following penetrating items:
   (a) Steel, ferrous, or copper cables
   (b) Cable or wire with steel jackets
   (c) Cast-iron, steel, or copper pipes
   (d) Steel conduit or tubing

[***101:***8.3.4.2.5.1]

Δ **12.7.8.2.5.2** The maximum nominal diameter of the penetrating item, as indicated in 12.7.8.2.5.1(4)(a) through (d), shall not be greater than 4 in. (100 mm) and shall not exceed an aggregate 100 in.² (64,520 mm²) opening in any 100 ft² (9.3 m²) of floor or wall area. [***101:***8.3.4.2.5.2]

12.7.8.3 Sleeves. Where the penetrating item uses a sleeve to penetrate the wall or floor, the sleeve shall be securely set in the wall or floor, and the space between the item and the sleeve shall be filled with a material that complies with 12.7.8.2. [***101:***8.3.4.3]

12.7.8.4 Insulation and Coverings. Insulation and coverings for penetrating items shall not pass through the wall or floor unless the insulation or covering has been tested as part of the firestop system or device. [***101:***8.3.4.4]

12.7.8.5 Vibration Isolation Equipment or Systems. Where vibration isolation of equipment or systems is employed, the vibration restraint(s) shall be located outside of the partition, wall, or floor assembly for which the equipment or systems pass through. [***101:***8.3.4.5]

12.7.8.6 Transitions.

12.7.8.6.1 Where piping penetrates a fire resistance–rated wall or floor assembly, combustible piping shall not connect to noncombustible piping within 36 in. (915 mm) of the firestop system or device unless it can be demonstrated that the transition will not reduce the fire resistance rating, except in the case of previously approved installations. [*101:*8.3.4.6.1]

12.7.8.6.2 Unshielded couplings shall not be used to connect noncombustible piping to combustible piping unless it can be demonstrated that the transition complies with the fire-resistive requirements of 12.7.8.2. [*101:*8.3.4.6.2]

12.7.8.7 Membrane Penetrations.

The term *membrane penetration* refers to openings for penetrations made through one side only of a fire resistance–rated assembly, as defined in *NFPA 5000*. The provisions of 12.7.8.7 address such penetrations, which, if not properly protected, would compromise the fire-resistive integrity of the barrier. The term *through-penetration*, on the other hand, refers to openings for penetrations that pass through both sides of a fire barrier.

12.7.8.7.1 Membrane penetrations for cables, cable trays, conduits, pipes, tubes, combustion vents and exhaust vents, wires, and similar items to accommodate electrical, mechanical, plumbing, and communications systems that pass through a membrane of a wall, floor, or floor/ceiling assembly constructed as a fire barrier shall be protected by a firestop system or device and shall comply with 12.7.8.2 through 12.7.8.6.2. [*101:*8.3.4.7.1]

Δ **12.7.8.7.2** The firestop system or device shall be tested in accordance with ASTM E814, *Standard Test Method for Fire Tests of Through Penetration Fire Stops*, or ANSI/UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*, at a minimum positive pressure differential of 0.01 in. water column (2.5 Pa) between the exposed and the unexposed surface of the test assembly, unless one of the following conditions applies:

(1) Membrane penetrations of ceilings that are not an integral part of a fire resistance–rated floor/ceiling or roof/ceiling assembly.
(2) Membrane penetrations of steel, ferrous, or copper conduits, piping, or tubing, and steel electrical outlet boxes and wires, or combustion vents or exhaust vents where the annular space is protected with an approved material, and the aggregate area of the openings does not exceed 100 in.^{2} (64,520 mm^2) in any 100 ft^2 (9.3 m^2) of ceiling area.
(3) Electrical outlet boxes and fittings, provided that such devices are listed for use in fire resistance–rated assemblies and are installed in accordance with their listing.
(4) The annular space created by the membrane penetration of a fire sprinkler shall be permitted, provided that the space is covered by a metal escutcheon plate.

[*101:*8.3.4.7.2]

Δ **12.7.8.7.3** Where walls or partitions are required to have a minimum 1-hour fire resistance rating, recessed fixtures shall be installed in the wall or partition in such a manner that the required fire resistance is not reduced, unless one of the following criteria is met:

(1) Any steel electrical box not exceeding 16 in.^{2} (10,300 mm^2) in area shall be permitted where the aggregate area of the openings provided for the boxes does not exceed 100 in.^{2} (64,520 mm^2) in any 100 ft^2 (9.3 m^2) of wall area, and, where outlet boxes are installed on opposite sides of the wall, the boxes shall be separated by one of the following means:
   (a) Horizontal distance of not less than 24 in. (610 mm)
   (b) Horizontal distance of not less than the depth of the wall cavity, where the wall cavity is filled with cellulose loose-fill, rock wool, or slag wool insulation
   (c)* Solid fireblocking
   (d) Other listed materials and methods
(2) Membrane penetrations for any listed electrical outlet box made of any material shall be permitted, provided that such boxes have been tested for use in fire resistance–rated assemblies and are installed in accordance with the instructions included in the listing.
(3) The annular space created by the membrane penetration of a fire sprinkler shall be permitted, provided that the space is covered by a metal escutcheon plate.
(4) Membrane penetrations by electrical boxes of any size or type, which have been listed as part of a wall opening protective material system for use in fire-resistance-rated assemblies and are installed in accordance with the instructions included in the listing shall be permitted.

[*101:*8.3.4.7.3]

A.12.7.8.7.3(1)(c) Criteria associated with fireblocking can be found in the building code. [*101:*A.8.3.4.7.3(1)(c)]

12.7.8.8 Ducts and Air-Transfer Openings. Openings in fire barriers for air-handling ductwork or air movement shall be protected in accordance with 11.2.1. [*101:*8.3.4.8]

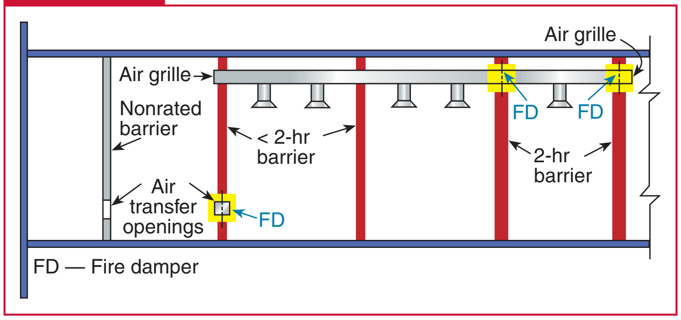
In referencing 11.2.1 for the protection of openings in fire barriers for air-handling ductwork or air movement, 12.7.8.8 mandates that the requirements of NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, and not the usual *Life Safety Code* requirements for opening protectives (contained in 12.7.6), apply to heating, ventilating, and air-conditioning (HVAC) system penetrations of fire barriers. NFPA 90A requires that approved fire dampers be provided in all air-transfer openings in barriers that are required to have a fire resistance rating. It also requires that approved fire dampers be provided where ducts penetrate barriers that are required to have a fire resistance rating of 2 hours or more. Thus, although any air-transfer opening would have to be provided with a fire damper in a required fire barrier of any rating, penetrations by ducts would not have to be provided with fire dampers if the required rating of the fire barrier is less than 2 hours. These requirements are depicted in Exhibit 12.16.

12.7.9 Joints.

12.7.9.1 General.

N **12.7.9.1.1** The provisions of 12.7.9 shall govern the materials and methods of construction used to protect joints in between and at the perimeter of fire barriers or, where fire barriers meet other

Exhibit 12.16



Fire damper requirements of NFPA 90A for HVAC penetrations of fire barriers.

fire barriers, the floor or roof deck above, or the outside walls. [***101:***8.3.5.1.1]

N **12.7.9.1.2** The provisions of 12.7.9 shall not apply to approved existing materials and methods of construction used to protect existing joints in fire barriers, unless otherwise required by Chapters 11 through 43 of NFPA *101*. [***101:***8.5.1.2]

12.7.9.2* **Joint System Requirements.**

N **A.12.7.9.2** Materials used to protect joints become systems when installed to the listed joint system design from an accredited testing laboratory. Installation of joint materials to the listed system should meet all limitations of the system. [***101:***A.8.3.5.2.1]

There are management system–based contractor approval or qualification programs offered by third-party, independent companies that quantifiably qualify a company to install firestop materials that become systems after proper installation. In each program, there is an industry firestop exam that gives the company a basis to appoint a "Designated Responsible Individual." [***101:***A.8.3.5.2.1]

Then, the third-party firm audits the firestop company's product and systems documentation records in conjunction with the company's management system operational policies and procedures to verify company compliance. An audit also takes place on a project site to verify that the management system is working. [***101:***A.8.3.5.2.1]

Where the configuration of a joint is such that a listed system is determined to be nonexistent and reconfiguration of the joint or fire resistance–rated assembly is determined to be impractical or impossible, alternative methods for maintaining the integrity of the required fire resistance rating of the assembly should be permitted to be established using an engineering analysis based on a comparison of listed systems prepared by a manufacturer's technical representative of the systems specified, by the laboratory that conducted the original test, or by a professional engineer. [***101:***A.8.3.5.2.1]

On-site inspection of firestopping is important in maintaining the integrity of any vertical or horizontal fire barrier. Two standard practice documents were developed with the ASTM process to allow inspections of through-penetration firestops, joints, and perimeter fire barrier systems. ASTM E2393, *Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers*, provides guidance for the inspection of fire-resistive joints and perimeter fire barrier joint systems tested in accordance with the requirements of ASTM E1966, *Standard Test Method for Fire-Resistive Joint Systems*, or with ANSI/UL 2079, *Standard for Tests for Fire Resistance of Building Joint Systems*. ASTM E2393 contains a standardized report format, which would lead to greater consistency for inspections. [***101:***A.8.3.5.2.1]

Independent inspection paid for by the owner is in many specifications and referenced in this annex using ASTM E2393. As a result, there is an accreditation program available for firestop special inspection agencies. [***101:***A.8.3.5.2.1]

N **12.7.9.2.1** Joints made within or at the perimeter of fire barriers, between fire resistance–rated assemblies, or where fire barriers meet other fire barriers, the floor or roof deck above, or the outside walls shall be protected with a joint system that is designed and tested to prevent the spread of fire for a time period equal to that of the assembly in which the joint is located. [***101:***8.3.5.2.1]

12.7.9.2.2 Joints made within or at the perimeter of fire barriers used as smoke barriers shall be capable of restricting the transfer of smoke in accordance with 8.5.7.4 of NFPA *101*. [***101:***8.3.5.2.2]

N **12.7.9.2.3** Joints shall be installed in accordance with a tested system, and installed and maintained in accordance with the manufacturer's instructions. [***101:***8.3.5.2.3]

12.7.9.2.4 Testing of the joint system in a fire barrier shall be representative of the actual installation suitable for the required engineering demand without compromising the fire resistance rating of the assembly or the structural integrity of the assembly. [***101:***8.3.5.2.4]

Δ **12.7.9.2.5** Such materials, systems, or devices shall be tested as part of the assembly in accordance with the requirements of ASTM E1966, *Standard Test Method for Fire-Resistive Joint Systems*, or ANSI/UL 2079, *Standard for Tests for Fire Resistance of Building Joint Systems*. [***101:***8.3.5.2.5]

Δ **12.7.9.2.6** All joint systems shall be tested at their maximum joint width in accordance with the requirements of ASTM E1966 or ANSI/UL 2079, under a minimum positive pressure differential of 0.01 in. water column (2.5 N/m^2) for a time period equal to that of the assembly. [***101:***8.3.5.2.6]

N **12.7.9.2.7** All test specimens shall comply with the minimum height or length required by the standard. [***101:***8.3.5.2.7]

N **12.7.9.2.8** Wall assemblies shall be subjected to a hose stream test in accordance with ASTM E119 or ANSI/UL 263. [***101:***8.3.5.2.8]

N **12.7.9.3** Joints made between a fire barrier and a non-fire-resistance-rated floor or roof sheathing, slab, or deck above shall be protected by an approved continuity head of wall joint system installed as tested in accordance with ASTM E2837, *Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies*, and the system shall have an F rating and T rating of not less than the required fire resistance rating of the fire barrier. [***101:***8.3.5.3]

The extension of the fire barrier to the next horizontal assembly needs to be tested as the assembly itself. ASTM E2387, *Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies,* measures the performance of the system and provides the continuity to protect the system consistent with the barrier. Joints between and within fire barriers must be protected by materials tested to ensure the integrity of the barrier. Like a weak link in a chain, an improperly protected joint in a fire barrier is likely to be the point of failure when exposed to fire.

12.7.9.4* Exterior Curtain Walls and Perimeter Joints.

N **A.12.7.9.4** The provisions of 12.7.9.4 are intended to restrict the interior vertical passage of flame and hot gases from one floor to another at the location where the floor intersects the exterior wall assembly. The requirements of 8.3.5.4 mandate sealing the opening between a floor and an exterior wall assembly to provide the same fire performance as that required for the floor. ASTM E2307, *Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-Story Test Apparatus*, is a test method for evaluating the performance of perimeter fire barrier systems. Some laboratories have tested and listed perimeter fire barrier systems essentially in accordance with the ASTM method. The ASTM test method evaluates the performance of perimeter fire barrier systems in terms of heat transfer and fire spread inside a building through the floor/exterior wall intersection. The current test method does not assess the ability of perimeter fire barrier systems to prevent the spread of fire from story to story via the exterior. However, some laboratories have included additional temperature measurement criteria in their evaluation of the exterior wall and evaluation of vision glass breakage as additional pass/fail criteria in an attempt to at least partially address this "leapfrog" effect. [***101:***A.8.3.5.4]

12.7.9.4.1 Voids created between the fire resistance–rated floor assembly and the exterior curtain wall shall be protected with a perimeter joint system that is designed and tested in accordance with ASTM E2307, *Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Apparatus*. [***101:***8.3.5.4.1]

12.7.9.4.2 The perimeter joint system shall have an F rating equal to the fire resistance rating of the floor assembly. [***101:***8.3.5.4.2]

12.8 Smoke Partitions

12.8.1* General. Where required elsewhere in this *Code*, smoke partitions shall be provided to limit the transfer of smoke. [***101:***8.4.1]

A.12.8.1 The provision for terminating the smoke partition at the ceiling is not intended to prevent the wall from extending above the ceiling.

Although a smoke partition is intended to limit the free movement of smoke, it is not intended to provide an area that would be free of smoke. [***101:***A.8.4.1]

Chapter 12 does not require the installation of smoke partitions but does provide detailed criteria for smoke partitions where required by other sections of the *Code*. A smoke partition is a continuous membrane designed to form a barrier to limit the transfer of smoke.

The smoke partition provisions offer options not available prior to the 2000 edition of the *Code* under the provisions for fire barriers and smoke barriers. For example, a smoke partition is not always required to have a fire resistance rating, but all fire barriers must have a rating. Also, a smoke partition is not required to have a smoke damper where ductwork penetrates the partition, but a duct penetration of a smoke barrier typically is required to do so.

Δ **12.8.2 Continuity.** Smoke partitions shall comply with the following:

(1) They shall extend from the floor to the underside of the floor or roof deck above, through any concealed spaces, such as those above suspended ceilings, and through interstitial structural and mechanical spaces.
(2)* They shall be permitted to extend from the floor to the underside of a monolithic or suspended ceiling system where all of the following conditions are met:
  (a) The ceiling system forms a continuous membrane.
  (b) A smoke-tight joint is provided between the top of the smoke partition and the bottom of the suspended ceiling.
  (c) The space above the ceiling is not used as a plenum.
(3) Smoke partitions enclosing hazardous areas shall be permitted to terminate at the underside of a monolithic or suspended ceiling system where all of the following conditions are met:
  (a) The ceiling system forms a continuous membrane.
  (b) A smoke-tight joint is provided between the top of the smoke partition and the bottom of the suspended ceiling.
  (c) Where the space above the ceiling is used as a plenum, return grilles from the hazardous area into the plenums are not permitted.

[***101:***8.4.2]

A.12.8.2(2) An architectural, exposed, suspended-grid acoustical tile ceiling with penetrations for sprinklers, ducted HVAC supply and return-air diffusers, speakers, and recessed light fixtures is capable of limiting the transfer of smoke. [***101:***A.8.4.2(2)]

A smoke partition should be thought of as a barrier that reasonably limits, but does not necessarily prevent, smoke transfer. As such, there are suspended ceiling systems and monolithic surfaced ceilings that provide resistance to smoke transfer that is approximately equal to that of the traditional, nonrated corridor wall or partition. Smoke partitions are permitted to terminate tightly against the underside of such ceilings in accordance with 12.8.2(2). The concept is further described in A.12.8.2(2). The provision for terminating the smoke partition at the ceiling is not intended to prevent the wall from extending above the ceiling.

The list of acceptable penetrating items (e.g., speakers, recessed light fixtures, and ducted HVAC air diffusers) makes it clear that a smoke partition is not intended to prevent all smoke transfer; rather, it limits the transfer of smoke to an acceptable level to provide for occupant life safety.

12.8.3 Opening Protectives.

12.8.3.1 Doors in smoke partitions shall comply with 12.8.3.2 through 12.8.3.6. [***101:***8.4.3.1]

12.8.3.2 Doors shall comply with the provisions of 7.2.1 of NFPA *101*. [***101:***8.4.3.2]

12.8.3.3 Doors shall not include louvers. [***101:***8.4.3.3]

12.8.3.4* Door clearances shall be in accordance with NFPA 80. [***101:***8.4.3.4]

A.12.8.3.4 Gasketing of doors should not be necessary, as the clearances in NFPA 80 effectively achieve resistance to the passage of smoke if the door is relatively tight-fitting. [***101:***A.8.4.3.4]

For swinging doors with builders hardware, NFPA 80 permits clearances of not more than ⅛ in. (3.2 mm) [±1⁄16 in. (±1.6 mm) for steel doors] between the top and the vertical edges of the door and the frame and between the meeting edges of doors in swinging pairs. The clearance under the bottom of a fire door is permitted to be not more than ¾ in. (19 mm).

With the permitted clearances, some smoke will pass to the opposite side of a closed door. It is important to remember that the intent of the smoke partition is not to prevent all smoke transfer but, rather, to limit the transfer of smoke to an acceptable level.

12.8.3.5 Doors shall be self-closing or automatic-closing in accordance with 14.5.4. [***101:***8.4.3.5]

12.8.4 Penetrations. The provisions of 12.8.4 shall govern the materials and methods of construction used to protect through-penetrations and membrane penetrations of smoke partitions. [***101:***8.4.4]

12.8.4.1 Penetrations for cables, cable trays, conduits, pipes, tubes, vents, wires, and similar items to accommodate electrical, mechanical, plumbing, and communications systems that pass through a smoke partition shall be protected by a system or material that is capable of limiting the transfer of smoke. [***101:***8.4.4.1]

12.8.4.2 Vibration Isolation Equipment or Systems. Where vibration isloation of equipment or systems is employed, the vibration restraint(s) shall be located outside of the partition, wall or floor assembly for which the equipment or systems pass through. [***101:***8.4.4.2]

12.8.5 Joints.

12.8.5.1 The provisions of 12.8.5 shall govern the materials and methods of construction used to protect joints in between and at the perimeter of smoke partitions or, where smoke partitions meet other smoke partitions, the floor or roof deck above, or the outside walls. The provisions of 12.8.5 shall not apply to approved existing materials and methods of construction used to protect existing joints in smoke partitions, unless otherwise required by Chapters 11 through 43 of NFPA *101*. [***101:***8.4.5.1]

12.8.5.2 Joints made within or at the perimeter of smoke partitions shall be protected with a joint system that is capable of limiting the transfer of smoke. [***101:***8.4.5.2]

12.8.6 Air-Transfer Openings.

12.8.6.1 General. The provisions of 12.8.6 shall govern the materials and methods of construction used to protect air-transfer openings in smoke partitions. [***101:***8.4.6.1]

12.8.6.2* Smoke Dampers. Air-transfer openings in smoke partitions shall be provided with approved smoke dampers designed and tested in accordance with the requirements of ANSI/UL 555S, *Standard for Smoke Dampers*, to limit the transfer of smoke. [***101:***8.4.6.2]

A.12.8.6.2 An air-transfer opening, as defined in NFPA 90A, is an opening designed to allow the movement of environmental air between two contiguous spaces. [***101:***A.8.4.6.2]

12.8.6.3 Smoke Damper Ratings. Smoke damper leakage ratings shall be not less than Class II. Elevated temperature ratings shall be not less than 250°F (140°C). [***101:***8.4.6.3]

Δ **12.8.6.4 Smoke Detectors.** Dampers in air-transfer openings shall close upon detection of smoke by approved smoke detectors installed in accordance with *NFPA 72*. [***101:***8.4.6.4]

Where ductwork extends to a smoke partition, pierces the partition, and continues its run on the other side of the partition, no transfer opening exists. Given that no transfer opening is present, there is no requirement for a smoke damper. If such ducted HVAC systems without dampers are to spread smoke, such smoke spread will occur due to the buoyant forces of the hot fire gases, because the provisions of NFPA 90A require the automatic shutdown of most of the fans that would otherwise circulate smoke through the ductwork.

12.9 Smoke Barriers

12.9.1* General. Where required by Chapters 11 through 43 of NFPA *101*, smoke barriers shall be provided to subdivide building spaces for the purpose of restricting the movement of smoke. [***101:***8.5.1]

A.12.9.1 Wherever smoke barriers and doors therein require a degree of fire resistance, as specified by requirements in the various occupancy chapters (Chapter 12 through Chapter 42 of NFPA *101*), the construction should be a fire barrier that has been specified to limit the spread of fire and restrict the movement of smoke. [***101:***A.8.5.1]

Although a smoke barrier is intended to restrict the movement of smoke, it might not result in tenability throughout the adjacent smoke compartment. The adjacent smoke compartment should be safer than the area on the fire side, thus allowing building occupants to move to that area. Eventually, evacuation from the adjacent smoke compartment might be required. [***101:***A.8.5.1]

It is imprecise to refer to a "1-hour smoke barrier," because smoke barriers are not classified based on the duration for which they resist the transfer of smoke. It is more accurate to refer to a "smoke barrier that additionally has a 1-hour fire resistance rating." A barrier with only a fire resistance rating does not necessarily make an effective smoke barrier. For example, a fire barrier, if rated at less than 2 hours, would not be required to have either a fire damper or a smoke damper where ductwork penetrates the barrier. A smoke barrier, in accordance with Section 12.9, would generally have ducted penetrations protected by smoke dampers per 12.9.5.2.

12.9.2* Continuity.

A.12.9.2 To ensure that a smoke barrier is continuous, it is necessary to seal completely all openings where the smoke barrier abuts other smoke barriers, fire barriers, exterior walls, the floor below, and the floor or ceiling above. It is not the intent to prohibit a smoke barrier from stopping at a fire barrier if the fire barrier meets the requirements of a smoke barrier (that is, the fire barrier is a combination smoke barrier/fire barrier). [***101:***A.8.5.2]

12.9.2.1 Smoke barriers required by NFPA *101* shall be continuous from an outside wall to an outside wall, from a floor to a floor, or from a smoke barrier to a smoke barrier, or by use of a combination thereof. [***101:***8.5.2.1]

12.9.2.2 Smoke barriers required by NFPA *101* shall be continuous through all concealed spaces, such as those found above a ceiling, including interstitial spaces. [***101:***8.5.2.2]

12.9.2.3 A smoke barrier required for an occupied space below an interstitial space shall not be required to extend through the interstitial space, provided that the construction assembly forming the bottom of the interstitial space provides resistance to the passage of smoke equal to that provided by the smoke barrier. [***101:***8.5.2.3]

In occupancies where evacuation is a last resort or is expected to be otherwise delayed, smoke barriers and doors require a degree of fire resistance, as specified by the requirements found in the occupancy sections (Chapter 20).

Other openings in smoke and fire barriers must be protected as well. HVAC ducts provide a ready path for smoke and fire to travel from one area to another unless appropriately protected. Penetrations in walls and ceiling construction for utilities and other building services must be firestopped to prevent fire spread. The hidden spaces above suspended ceilings and attic spaces are out of sight and can be easily overlooked.

The provision of 12.9.2.3 must be used with care. Several occupancy chapters require smoke barriers to be fire resistance rated and, therefore, the smoke barrier is permitted to terminate at the ceiling only if the ceiling is of the same rating. Also, even where no fire resistance rating is required, it is difficult to ensure that a ceiling is smoketight, unless it is of monolithic construction without air-handling penetrations. This kind of construction is often found in apartment buildings, hotels, and dormitories; consequently, the provision of 12.9.2.3 can be useful.

12.9.3 Fire Barrier Used as Smoke Barrier. A fire barrier shall be permitted to be used as a smoke barrier, provided that it meets the requirements of Section 12.9. [***101:***8.5.3]

12.9.4 Opening Protectives.

12.9.4.1* Doors in smoke barriers shall close the opening, leaving only the minimum clearance necessary for proper operation, and shall be without louvers or grilles. For other than previously approved existing doors, the clearance under the bottom of the doors shall be a maximum of ¾ in. (19 mm). [***101:***8.5.4.1]

A.12.9.4.1 For additional information on the installation of smoke-control door assemblies, see NFPA 105. [***101:***A.8.5.4.1]

NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*, acknowledges that no nationally recognized test standard for the measurement of hot smoke temperature leakage exists. However, NFPA 105 notes that ANSI/UL 1784, *Standard for Air Leakage Tests of Door Assemblies*, can be used to measure ambient and warm air leakage rates of door assemblies.

ANSI/UL 1784, which is also referenced in 8.2.2.4 of NFPA *101*, should determine satisfactory performance if recognized design features are also taken into account, such as close-fitting assemblies, limited deflections, and the use of gasketing and sealing materials. ANSI/UL 1784 then provides performance criteria for determining maximum air leakage rates expressed in air volume per time per area of door opening.

12.9.4.2 Where required by Chapters 11 through 43 of NFPA *101*, doors in smoke barriers that are required to be smoke leakage–rated shall comply with the requirements of 8.2.2.4 of NFPA *101*. [***101:***8.5.4.2]

12.9.4.3 Latching hardware shall be required on doors in smoke barriers unless specifically exempted by Chapters 11 through 43 of NFPA *101*. [***101:***8.5.4.3]

12.9.4.4* Doors in smoke barriers shall be self-closing or automatic-closing in accordance with 14.5.4 and shall comply with the provisions of 7.2.1 of NFPA *101*. [***101:***8.5.4.4]

A.12.9.4.4 Where, because of operational necessity, it is desired to have smoke barrier doors that are usually open, such doors should be provided with hold-open devices that are activated to close the doors by means of the operation of smoke detectors and other alarm functions. [***101:***A.8.5.4.4]

Doors in smoke barriers are not generally required to have a fire protection rating, unless the applicable occupancy chapter in NFPA *101* requires the smoke barrier itself to have a fire resistance rating. Therefore, any door that resists the passage of smoke, even a hollow-core wood door or a glass door, is acceptable, provided that it is tight-fitting, unless the door is required to be smoke leakage–rated as specified by 12.9.4.2. Stops at the head and sides of the door help resist the passage of smoke. Where a pair of doors is used, it is recommended (and required for cross-corridor door assemblies in new health care occupancies) that they open in opposite directions from each other so that rabbets, bevels, or astragals can be provided at the meeting edges without the use of coordinators. See 18.3.7.6 through 18.3.7.10 of NFPA *101* for details on smoke barrier doors in new health care occupancies.

Doors in smoke barriers, although not the equivalent of fire doors and not completely smoketight, are effective in restricting the spread of smoke and reducing drafts, which might otherwise spread fire rapidly. Where an occupancy chapter in NFPA *101* requires the smoke barrier to have a fire resistance rating, a 20-minute fire protection–rated door assembly should provide a reasonable degree of protection. It has been shown through tests presented in *"The 20-Minute Door and Other Considerations"* from the journal *Building Standards* that the commonly used 1¾ in. (44 mm) thick solid-bonded wood-core door assembly can be expected to fail in fire tests in 22 minutes to 24 minutes, but it has performed well in actual fires when closed. The maximum clearance under the bottom of new smoke barrier doors is limited to ¾ in. (19 mm) as indicated in 12.9.4.1; this limit is intended to be consistent with the clearance permitted by NFPA 80 for fire doors.

Doors in a fire barrier, horizontal exit, or smoke barrier should be closed at all times to impede the spread of smoke and fire gases. Functionally, however, keeping the doors closed can decrease the operational efficiency of the occupancy. In a health care occupancy, for example, closed doors limit patient observation by staff. To accommodate such situations, it is practical to presume that the door will be kept open, even with the use of wood chocks or other makeshift devices. Where operational necessity dictates that smoke barrier doors normally are to be kept open, such doors should be provided with hold-open devices that release by the operation of smoke detectors (see Exhibit 12.17). Smoke detectors for door releasing service are not necessarily required to activate a building evacuation alarm — see 13.7.1.9.2.3 for details.

12.9.4.5 Fire window assemblies shall comply with 12.7.6. [***101:***8.5.4.5]

12.9.5 Ducts and Air-Transfer Openings.

12.9.5.1 General. The provisions of 12.9.5 shall govern the materials and methods of construction used to protect ducts and air-transfer openings in smoke barriers. [***101:***8.5.5.1]

12.9.5.2 Smoke Dampers.

12.9.5.2.1 Where a smoke barrier is penetrated by a duct or air-transfer opening, a smoke damper designed and tested in accordance with the requirements of ANSI/UL 555S shall be installed. [***101:***8.5.5.2.1]

12.9.5.2.2 Where a smoke barrier is also constructed as a fire barrier, a combination fire/smoke damper designed and tested in accordance with the requirements of ANSI/UL 555 and ANSI/UL 555S shall be installed. [***101:***8.5.5.2.2]

Exhibit 12.17

Hold-open mechanism on automatic-closing door.

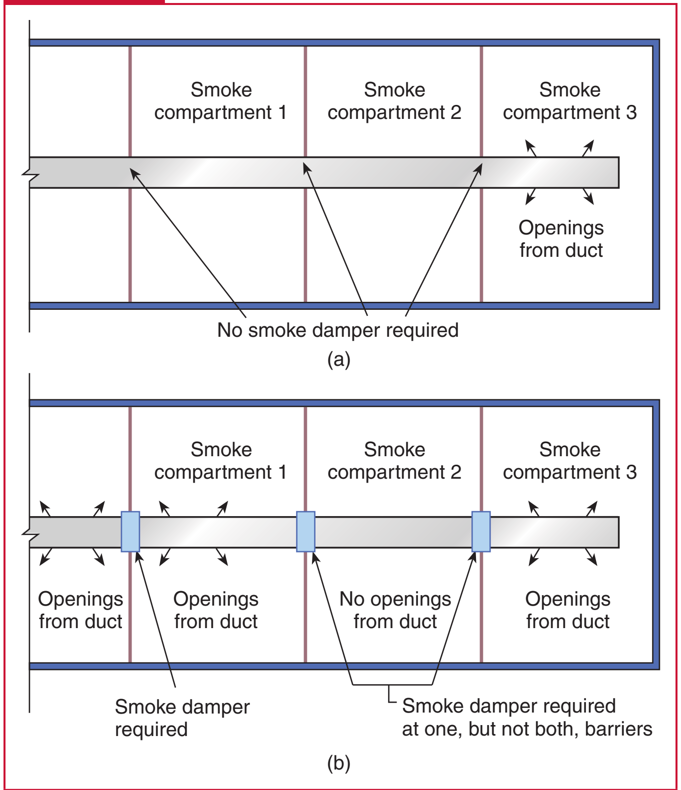
12.9.5.3 Smoke Damper Exemptions. Smoke dampers shall not be required under any of the following conditions:

(1) Where specifically exempted by provisions in Chapters 11 through 43 of NFPA *101*
(2) Where ducts or air-transfer openings are part of an engineered smoke control system and the smoke damper will interfere with the operation of a smoke control system
(3) Where the air in ducts continues to move and the air-handling system installed is arranged to prevent recirculation of exhaust or return air under fire emergency conditions

Item (2) of 12.9.5.3 addresses the omission of dampers in ducts that must remain open so that an engineered smoke control system can operate. The provision of item (3) applies only in very limited cases. It can be used only on small ventilation systems, because NFPA 90A requires that systems with an air-handling capacity over 15,000 ft^3/min (7080 L/s) that are not part of a smoke control system shut down upon detection of smoke.

Even without the restriction of NFPA 90A, it is difficult to ensure that the air-handling system will be in continuous operation. Because of increased awareness of energy conservation, many systems are cycled or shut down during parts of the day. The cycling or shutdown feature might be added later without recognizing its potential detriment to occupant life safety. However, the provisions of 12.9.5.3(3) can be useful for ductwork for small ventilation systems, such as those for toilet rooms or small suites.

Exhibit 12.18



Position of smoke dampers in air-handling ductwork.

(4) Where the air inlet or outlet openings in ducts are limited to a single smoke compartment

Item (4) of 12.9.5.3 addresses situations where an "express" duct has no openings other than in a single smoke compartment. This provision can reasonably be extended to situations illustrated in Exhibit 12.18. According to the requirements of NFPA 90A, only a single floor can be penetrated by ductwork not enclosed within a rated shaft, and such an installation requires a fire damper at the plane of the floor where the penetration is located. Ducts penetrating more than one floor must be enclosed within an appropriately fire-rated shaft. Thus, where a smoke damper is exempted by 12.9.5.3(5), the resulting openings can potentially act as a minor route for smoke migration from one floor to another before the actuation of a fire damper. The floor, as a whole, serves as an adequate smoke barrier in accordance with the requirements of 8.6.1 of NFPA *101*.

(5) Where ducts penetrate floors that serve as smoke barriers
(6) Where ducts penetrate smoke barriers forming a communicating space separation in accordance with 8.6.6(4)(a) of NFPA *101* [***101:***8.5.5.3]

12.9.5.4 Installation, Testing, and Maintenance.

Δ **12.9.5.4.1** Air-conditioning, heating, ventilating ductwork, and related equipment, including smoke dampers and combination fire and smoke dampers, shall be installed in accordance with NFPA 90A, NFPA 90B, NFPA 105, or NFPA 80, as applicable. [***101:***8.5.5.4.1]

12.9.5.4.2 Smoke dampers and combination fire and smoke dampers required by this code shall be inspected, tested, and maintained in accordance with NFPA 105. [***101:***8.5.5.4.2]

12.9.5.4.3 The equipment specified in 12.9.5.4.1 shall be installed in accordance with the requirements of 12.9.5, the manufacturer's installation instructions, and the equipment listing. [***101:***8.5.5.4.3]

12.9.5.5 Access and Identification.

12.9.5.5.1 Access to the dampers shall be provided for inspection, testing, and maintenance. [***101:***8.5.5.5.1]

12.9.5.5.2 Smoke and combination fire and smoke dampers in new construction shall be provided with an approved means of access, as follows:

(1) The means of access shall be large enough to allow inspection and maintenance of the damper and its operating parts.
(2) The access shall not affect the integrity of fire resistance–rated assemblies or smoke barrier continuity.
(3) The access openings shall not reduce the fire resistance rating of the assembly.
(4) Access doors in ducts shall be tight-fitting and suitable for the required duct construction.
(5) Access and maintenance shall comply with the requirements of the mechanical code. [***101:***8.5.5.5.2]

12.9.5.5.3 Identification. Access points to fire and smoke dampers in new construction shall be permanently identified by one of the following:

(1) A label having letters not less than ½ in. (13 mm) in height and reading as one of the following:
 (1) FIRE/SMOKE DAMPER
 (2) SMOKE DAMPER
 (3) FIRE DAMPER
(2) Symbols as approved by the AHJ [***101:***8.5.5.5.3]

Requirements for access to, and identification of, fire dampers, smoke dampers, and combination fire and smoke dampers were revised for the 2015 edition of NFPA *101*, to be consistent with the requirements of *NFPA 5000*. In new construction, access locations must be labeled to facilitate the required inspection, testing, and maintenance of dampers.

12.9.5.6 Smoke Damper Ratings. Smoke damper leakage ratings shall be not less than Class II. Elevated temperature ratings shall be not less than 250°F (140°C). [***101:***8.5.5.6]

12.9.5.7 Smoke Detectors.

12.9.5.7.1 Required smoke dampers in ducts penetrating smoke barriers shall close upon detection of smoke by approved smoke detectors in accordance with *NFPA 72*, unless one of the following conditions exists:

(1) The ducts penetrate smoke barriers above the smoke barrier doors, and the door release detector actuates the damper.

(2) Approved smoke detector installations are located within the ducts in existing installations. [***101:***8.5.5.7.1]

12.9.5.7.2 Where a duct is provided on one side of the smoke barrier, the smoke detectors on the duct side shall be in accordance with 12.9.5.7.1. [***101:***8.5.5.7.2]

12.9.5.7.3 Required smoke dampers in air-transfer openings shall close upon detection of smoke by approved smoke detectors in accordance with *NFPA 72*. [***101:***8.5.5.7.3]

NFPA 72®, National Fire Alarm and Signaling Code®, provides information on the installation of smoke detectors that close smoke dampers. The damper is permitted to be closed by the same detector that closes the door in a smoke barrier if the duct penetrates the wall above the door. Existing installations of detectors installed within ducts, which might not be in total compliance with *NFPA 72*, continue to be recognized.

12.9.6 Penetrations.

12.9.6.1 The provisions of 12.9.6 shall govern the materials and methods of construction used to protect through-penetrations and membrane penetrations of smoke barriers. [***101:***8.5.6.1]

12.9.6.2 Penetrations for cables, cable trays, conduits, pipes, tubes, vents, wires, and similar items to accommodate electrical, mechanical, plumbing, and communications systems that pass through a wall, floor, or floor/ceiling assembly constructed as a smoke barrier, or through the ceiling membrane of the roof/ceiling of a smoke barrier assembly, shall be protected by a system or material capable of restricting the transfer of smoke. [***101:***8.5.6.2]

12.9.6.3 Where a smoke barrier is also constructed as a fire barrier, the penetrations shall be protected in accordance with the requirements of 12.7.8 to limit the spread of fire for a time period equal to the fire resistance rating of the assembly and the requirements of 12.9.6 to restrict the transfer of smoke, unless the requirements of 12.9.6.4 are met. [***101:***8.5.6.3]

12.9.6.4 Where sprinklers penetrate a single membrane of a fire resistance–rated assembly in buildings equipped throughout with an approved automatic fire sprinkler system, noncombustible escutcheon plates shall be permitted, provided that the space around each sprinkler penetration does not exceed ½ in. (13 mm), measured between the edge of the membrane and the sprinkler. [***101:***8.5.6.4]

12.9.6.5 Where the penetrating item uses a sleeve to penetrate the smoke barrier, the sleeve shall be securely set in the smoke barrier, and the space between the item and the sleeve shall be filled with a listed system or with a material capable of restricting the transfer of smoke. [***101:***8.5.6.5]

12.9.6.6 Vibration Isolation Equipment or Systems. Where vibration isloation of equipment or systems is employed, the vibration restraint(s) shall be located outside of the partition, wall or floor assembly for which the equipment or systems pass through. [***101:***8.5.6.7]

12.9.7 Joints.

12.9.7.1 The provisions of 12.9.7 shall govern the materials and methods of construction used to protect joints in between and at the perimeter of smoke barriers or, where smoke barriers meet other smoke barriers, the floor or roof deck above, or the outside walls. The provisions of 12.9.7 shall not apply to approved existing materials and methods of construction used to protect existing joints in smoke barriers, unless otherwise required by Chapters 11 through 43 of NFPA *101*. [***101:***8.5.7.1]

12.9.7.2 Joints made within or at the perimeter of smoke barriers shall be protected with a joint system that is capable of limiting the transfer of smoke. [***101:***8.5.7.2]

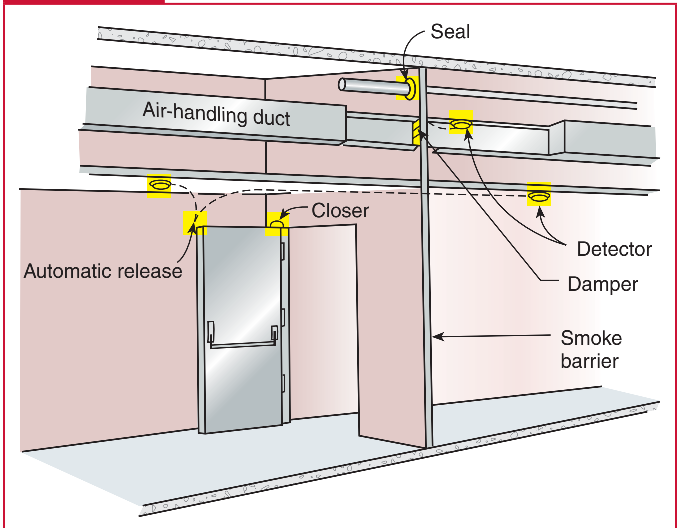
12.9.7.3 Joints made within or between smoke barriers shall be protected with a smoke-tight joint system that is capable of limiting the transfer of smoke. [***101:***8.5.7.3]

12.9.7.4 Smoke barriers that are also constructed as fire barriers shall be protected with a joint system that is designed and tested to resist the spread of fire for a time period equal to the required fire resistance rating of the assembly and restrict the transfer of smoke. [***101:***8.5.7.3]

12.9.7.5 Testing of the joint system in a smoke barrier that also serves as fire barrier shall be representative of the actual installation. [***101:***8.5.7.4]

As in the case of fire barriers, it is important to maintain the integrity of smoke barriers over the life of a building. Exhibit 12.19 illustrates some of the key items regarding smoke barrier penetrations discussed in 12.9.3 through 12.9.7.

Exhibit 12.19



Typical penetrations of a smoke barrier.

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Fire Protection Systems

13

Chapter 13 addresses fire protection systems, including requirements for standpipe systems, automatic sprinklers, fire pumps, water supply, portable fire extinguishers, and fire alarms.

13.1 General

13.1.1 The AHJ shall have the authority to require that construction documents for all fire protection systems be submitted for review and approval and a permit be issued prior to the installation, rehabilitation, or modification. *(For additional information concerning construction documents, see Section 1.14.)* Further, the AHJ shall have the authority to require that full acceptance tests of the systems be performed in the AHJ's presence prior to final system certification.

It is recommended that the authority having jurisdiction (AHJ) review plans for fire protection systems to ensure compliance with this *Code* and applicable referenced standards. The approval process ensures that systems are complete and fully functional. The presence of the AHJ during final testing is highly recommended to ensure that, in the event of a fire, fire protection systems operate as intended.

13.1.1.1 Permits. Permits, where required, shall comply with Section 1.12.

13.1.2 The property owner shall be responsible for the proper testing and maintenance of the equipment and systems.

N **13.1.3* Integrated Fire Protection and Life Safety System Test.** Where required by Chapters 11 through 43 of NFPA *101*, and where two or more fire protection or life safety systems are integrated, the integrated system shall be tested to verify the proper operation and function of such systems in accordance with NFPA 4. [***101:***9.11.4]

N **A.13.1.3** NFPA 4 requires that integrated fire protection and life safety systems be periodically retested as specified in the integrated system test plan. In addition, for existing systems, an integrated system test plan must be developed within 5 years of adoption of NFPA 4. [***101:***A.9.11.4]

The provisions of 13.1.3, which are new to the 2018 edition of the *Code*, address the testing of integrated fire protection and life safety systems and mandate compliance with NFPA 4, *Standard for Integrated Fire Protection and Life Safety System Testing*, where required by another section of the *Code*. The integrated systems test addressed by NFPA 4 verifies and documents the operation and function of all interconnected fire protection and life safety systems, including performance in accordance with applicable codes and standards, sequence of operation, performance in accordance with manufacturers' published instructions, and accuracy of record documents.

Where individual systems are needed to function together to provide the intended level of protection, it is important to test the systems together. For example, an engineered smoke control system might depend on the signals from a fire alarm system to activate; the fire alarm system might depend on the activation of an automatic sprinkler system waterflow to initiate an alarm condition. Traditionally, the fire alarm contractor would test only the fire alarm system. The sprinkler system contractor would test only the sprinkler system; and the HVAC contractor would test only the operation of the ventilation system. The provisions of NFPA 4 ensure that the integrated system is tested as whole, with representatives of all the applicable contractors present, to ensure that, for example, a water flow condition initiates an alarm condition on the fire alarm system, which in turn initiates the proper smoke control system operating mode based on the location of the sprinkler activation.

Occupancies and special structures that require the testing of integrated fire protection and life safety systems in accordance with NFPA 4 include the following:

1. High-rise buildings (11.8.9.1 of NFPA *101*)
2. Assembly occupancies (20.1.5.13)
3. New educational occupancies (20.2.4.6)
4. New day-care occupancies (20.3.4.2.3.7)
5. Health care occupancies (20.4.2.7)
6. Ambulatory health care occupancies (20.6.2.7)
7. Detention and correctional occupancies (20.7.2.8)
8. New hotels and dormitories (20.8.2.7)
9. New apartment buildings (20.9.2.4)
10. Mercantile occupancies (20.12.2.6)
11. Industrial occupancies (20.14.3.2)
12. Storage occupancies (20.15.3.2)

Exhibit 13.1

Example of an obstructed fire hydrant. (Source: Abra Staffin Wiebe/ photos.com)

13.1.4 Obstructions shall not be placed or kept near fire hydrants, fire department inlet connections, or fire protection system control valves in a manner that would prevent such equipment or fire hydrants from being immediately visible and accessible.

Obstructions are a common problem and require extra vigilance on the part of the fire inspector and building owner. The AHJ should review site plans to ensure that no obstructions exist. In addition, contacting the local water authority and providing a policy for installation can prevent some common obstruction issues.

See Exhibit 13.1 for an example of an obstructed fire hydrant. Adequate space needs to be provided to gain access and for proper setup and use of fire protection systems and equipment. Where the fire department is not the AHJ, it should be consulted for guidance, because it will require access to the equipment during a fire incident.

13.1.5 A minimum 36 in. (915 mm) of clear space shall be maintained to permit access to and operation of fire protection equipment, fire department inlet connections, or fire protection system control valves. The fire department shall not be deterred or hindered from gaining immediate access to fire protection equipment.

A clear space should be maintained around all fire alarm panels, hose connections, and portable fire extinguishers and any other fire protection equipment. Building and fire department personnel should be able to easily locate and gain access to fire protection equipment at all times. It might be necessary to provide signs indicating the location of fire protection equipment and mark those areas to prevent materials from being placed where they will obstruct access to such equipment.

13.1.5.1 An approved clear and unobstructed path shall be provided and maintained for access to the fire department inlet connections.

13.1.6 Detailed records documenting all systems and equipment testing and maintenance shall be kept by the property owner and shall be made available upon request for review by the AHJ.

Where the AHJ requires documentation regarding fire protection systems to be maintained for review during inspections, the property owner should be notified as part of the approval process. Such notification ensures that the property owner is aware of the documentation requirements.

13.1.7 Existing systems shall be in accordance with 1.3.6.2 and 10.3.2.

13.1.8 All fire protection systems and devices shall be maintained in a reliable operating condition and shall be replaced or repaired where defective or recalled.

N **13.1.9** Whenever impairments, critical deficiencies, or non-critical deficiencies are identified in water-based fire protection systems maintained in accordance with NFPA 25, they shall be corrected in a time frame approved by the AHJ.

13.1.10 The AHJ shall be notified when any fire protection system is out of service and on restoration of service.

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The AHJ must be notified when a fire protection system is out of service for any reason. The fire department should also be notified so it can respond accordingly to a particular incident. For example, fire-fighting tactics might vary significantly in a building with a fully operational automatic sprinkler system from those in a building in which the automatic sprinkler system is impaired.

13.1.11 In the event of a failure of a fire protection system or an excessive number of accidental activations, the AHJ shall be permitted to require an approved fire watch until the system is repaired.

13.1.12* For occupancies of an especially hazardous nature or where special hazards exist in addition to the normal hazard of the occupancy, or where access for fire apparatus is unduly difficult, or where the size or configuration of the building or contents limits normal fire suppression efforts, the AHJ shall have the authority to require additional safeguards consisting of additional fire safety equipment, more than one type of fire safety equipment, or special systems suitable for the protection of the hazard involved.

A.13.1.12 Such safeguards or fire safety equipment can include, but should not be limited to, automatic fire alarm systems, automatic sprinkler or water spray systems, standpipe and hose, fixed or portable fire extinguishers, breathing apparatus, manual or automatic covers, smoke and heat vents, and carbon dioxide, foam, halogenated, dry chemical, or other special fire-extinguishing systems.

13.1.13 The AHJ shall have the authority to require locking fire department connection (FDC) plugs or caps on all water-based fire protection systems.

13.2 Standpipe Systems

13.2.1 General. The design and installation of standpipe systems shall be in accordance with Section 13.2 and NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*.

13.2.2 Where Required.

13.2.2.1 Where required by this *Code* or the referenced codes and standards listed in Chapter 2, standpipe systems shall be installed in accordance with 13.2.1.

13.2.2.2 New buildings shall be equipped with a Class I standpipe system installed in accordance with the provisions of Section 13.2 where any of the following conditions exist:

(1) More than three stories above grade where the building is protected by an approved automatic sprinkler system
(2) More than two stories above grade where the building is not protected by an approved automatic sprinkler system
(3)* More than 50 ft (15 m) above grade and containing intermediate stories or balconies

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N **A.13.2.2.2(3)** Building height should be measured in accordance with the building code adopted in the jurisdiction.

(4) More than one story below grade
(5) More than 20 ft (6.1 m) below grade

13.2.2.3 High-rise buildings shall be protected throughout by a Class I standpipe system in accordance with 13.2.2. [***101:***11.8.3.2]

Standpipes in high-rise buildings can serve to increase life safety, as well as property protection, because of the lengthy evacuation times associated with tall buildings. In many cases, fire emergency plans advise occupants who are not in immediate danger of exposure to fire to remain within the building to allow responding fire service personnel better access to the standpipes within the exit stair enclosures (staged evacuation). Use of standpipes at such times supplements the operation of the required automatic sprinkler system. Exhibit 13.2 shows a typical combination sprinkler/standpipe system.

13.2.2.4 In new assembly occupancies, regular stages over 1000 ft^2 (93 m^2) in area and all legitimate stages shall be equipped with 1½ in. (38 mm) hose lines for first aid fire fighting at each side of the stage. [***101:***12.4.6.12.1]

13.2.2.4.1 In existing assembly occupancies, stages over 1000 ft^2 (93 m^2) in area shall be equipped with 1½ in. (38 mm) hose lines for first aid fire fighting at each side of the stage. [***101:***13.4.6.12.1]

Δ **13.2.2.4.2** Hose connections shall be in accordance with NFPA 13, unless Class II or Class III standpipes in accordance with NFPA 14 are used. [***101:***12.4.6.12.2; ***101:***13.4.6.12.2]

Regardless of whether a stage has automatic sprinkler protection, 1½ in. (38 mm) hose lines are required on each side of stages as specified in 13.2.2.4 through 13.2.2.4.2 to provide stagehands with first aid fire-fighting capability in the area of a theater where a fire is most likely to occur. See 3.3.274, 3.3.274.1, and 3.3.274.2 of NFPA *101*®, *Life Safety Code*®, for definitions of the terms *stage, legitimate stage,* and *regular stage.*

Exhibit 13.2

Typical combination sprinkler/standpipe system with a 2½ in. (64 mm) fire department valve.

Δ **13.2.2.5 New and Existing Detention and Correctional Facilities.** Standpipe and hose systems shall be provided in accordance with Section 9.10 of NFPA *101* as follows, unless otherwise permitted by 13.2.2.5.1:

(1) Class I standpipe systems shall be provided for any building three or more stories in height.
(2) Class III standpipe and hose systems shall be provided for all nonsprinklered buildings three or more stories in height.

[***101:***22.3.5.5; ***101:***23.3.5.5]

The requirements of 13.2.2.5 for standpipes intend that 2½ in. (64 mm) hose connections be available for fire department use in any detention and correctional occupancy more than two stories in height. In addition, if such buildings are nonsprinklered, 1½ in. (38 mm) connections and hose for staff and resident use are required.

Δ **13.2.2.5.1** The requirements of 13.2.2.5 shall not apply where otherwise permitted by the following:

(1) Formed hose, 1 in. (25 mm) in diameter, on hose reels shall be permitted to provide Class II service.
(2) Separate Class I and Class II systems shall be permitted in lieu of a Class III system.

[***101:***22.3.5.6; ***101:***23.3.5.6]

Item (1) in 13.2.2.5.1 permits the use of 1 in. (25 mm) formed rubber hose in place of the fabric-jacketed, rubber-lined hose normally required in standpipe systems. Rubber hose is normally stored on reels and is easier to use.

13.2.2.6* The AHJ shall be authorized to permit the removal of existing occupant-use hose lines where all of the following are met:

(1) This *Code* does not require their installation.
(2) The current building code does not require their installation.
(3) The AHJ determines that the occupant-use hose line will not be utilized by trained personnel or the fire department.

A.13.2.2.6 It is not the intent of 13.2.2.6 to permit the removal of portions of the existing standpipe system other than hose lines, and that such remaining system components be maintained and available for use by the fire department or other appropriate fire suppression personnel.

The provisions of 13.2.2.6, which was new to the 2015 edition of the *Code*, are intended to explicitly allow the removal of nonrequired, occupant-use standpipe hose from buildings. Prior to the 2015 edition, some AHJs might have been wary of permitting the removal of occupant-use hose, lacking any *Code* language stating its removal was permitted. Provided that the hose is not required by NFPA 1 or the applicable building code, and no trained on-site fire suppression personnel would be expected to utilize it, the hose can be removed. It is preferable for untrained building occupants to evacuate rather than attempt to extinguish a fire using hose lines.

13.2.3 Inspection, Testing, and Maintenance.

13.2.3.1 A standpipe system installed in accordance with this *Code* shall be properly maintained to provide at least the same level of performance and protection as designed.

13.2.3.2 The owner shall be responsible for maintaining the standpipe system and keeping it in good working condition.

Δ **13.2.3.3** A standpipe system installed in accordance with this *Code* shall be inspected, tested, and maintained in accordance with NFPA 25.

13.2.3.4 Existing Systems.

13.2.3.4.1 Where an existing standpipe system, including yard piping and fire department connection, is modified, the new piping shall be independently tested in accordance with 11.4.1 of NFPA 14. [**14:**11.4.7.1]

13.2.3.4.2 Modifications that cannot be isolated, such as new valves or the point of connection for new piping, shall not require testing in excess of system static pressure. [**14:**11.4.7.2]

Testing in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* is the only way to ensure piping integrity. The new section of piping might be isolated from the existing piping by test blanks or an isolation valve. However, if possible, it is always good practice to retest existing systems for weakness. The provision of 13.2.3.4.2 clarifies that, where modifications are not able to be isolated due to their configuration, they are subject only to testing at the normal system static pressure.

13.3 Automatic Sprinklers

13.3.1 General.

13.3.1.1* Automatic sprinklers shall be installed and maintained in full operating condition in the occupancies specified in this *Code* or in the codes or standards referenced in Chapter 2.

A.13.3.1.1 This *Code* contains requirements for automatic sprinkler protection that might not be required by other NFPA codes. These requirements are included in this *Code* from a property protection standpoint in an effort to reduce property damage due to fires as well as to reduce the costs of manual fire suppression in years to come.

Δ **13.3.1.2** Installations shall be in accordance with NFPA 13, NFPA 13R, or NFPA 13D as appropriate.

13.3.1.3 Existing systems shall be in accordance with 1.3.6.2 and 10.3.2.

13.3.1.4 Sprinkler piping serving not more than six sprinklers for any hazardous area shall be permitted to be connected directly to a domestic water supply system having a capacity sufficient to provide 0.15 gpm/ft^2 (6.1 mm/min) throughout the entire enclosed area. [***101:***9.7.1.2]

Δ **13.3.1.5** Sprinkler piping serving hazardous areas as described in 13.3.1.4 shall be provided with an indicating shutoff valve, supervised in accordance with 13.3.1.8 or NFPA 13 and installed in an accessible, visible location between the sprinklers and the connection to the domestic water supply. [***101:***9.7.1.3]

The general provisions of Section 8.7 of NFPA *101* for special hazard protection — in combination with the specific requirements for protection from hazards of the X.3.2 subsection of each occupancy chapter of NFPA *101* — make extensive use of sprinklering hazardous contents rooms in otherwise nonsprinklered buildings. Such sprinklers are permitted by 13.3.1.4 to be supplied by the domestic water supply and its associated distribution piping. The domestic water supply must provide a sufficient volume of water at the appropriate pressure to deliver a sprinkler discharge density of 0.15 gpm/ft^2 (6.1 mm/min) within the hazardous contents room. For a 100 ft^2 (9.3 m^2) room, the water supply would have to provide at least 15 gpm (57 L/min) at the pressure appropriate to such a discharge from a specific size and model of sprinkler. Additionally, the provisions of 13.3.1.4 can be used (in lieu of a devoted sprinkler system piping network and water supply) only if any given room requires six or fewer sprinklers for adequate protection, based on the spacing and location rules of the applicable installation standards referenced in 13.3.1.2.

Another hazardous contents room on the same floor or in some other part of the building can obtain its protection by repeating a similar maximum six-sprinkler installation in accordance with 13.3.1.4 and 13.3.1.5.

Δ **13.3.1.6*** In areas protected by automatic sprinklers, automatic heat-detection devices required by other sections of this *Code* shall not be required. [***101:***9.7.1.4]

A.13.3.1.6 Properly designed automatic sprinkler systems provide the dual function of both automatic alarms and automatic extinguishment. Dual function is not provided in those cases where early detection of incipient fire and early notification of occupants are needed to initiate actions in behalf of life safety earlier than can be expected from heat-sensitive fire detectors. [***101:***A.9.7.1.4]

Because the operation of an automatic sprinkler system is initiated by a heat-sensing element and works on the same principle as an automatic heat detection and alarm system, a sprinkler system is judged to be capable of serving the same purpose. Even though some sprinkler systems do not sound an alarm on activation, many do. Furthermore, although a particular sprinkler system might not sound an alarm, it does immediately initiate extinguishment, a feature that is at least as valuable, if not more so, than a system that sounds an alarm only.

Detection of smoke, on the other hand, can be accomplished at the incipient stages of a fire and can give rise to an earlier warning than that provided by heat detection, so smoke detection is considered in a somewhat different light. One school of thought is that a system that starts suppression of a fire immediately upon detection is better than one that simply detects the fire and sounds an alarm, even though the latter can be quicker to initiate an alarm signal. An alternative belief, however, is that an early alarm is more advantageous. The first strategy is concerned with the immediate suppression or containment of fire, since it might take considerable time for fire fighters to arrive. The second approach stresses immediate notification of occupants. The *Code* recognizes the value of both strategies and strives for a balanced approach to occupant protection by requiring, in some occupancies, both early warning and automatic suppression systems, depending on the characteristics of the occupants. The extent of protection provided should be commensurate with the ability of the occupants, as a group, to evacuate or relocate to a safe location within the building before the egress routes are compromised by the effects of a fire.

13.3.1.7 Automatic sprinkler systems installed to make use of an alternative permitted by this *Code* shall be considered required systems and shall meet the provisions of this *Code* that apply to required systems. [***101:***9.7.1.5]

The provisions of 13.3.1.7 specify that an automatic sprinkler system voluntarily installed as a *Code* alternative is considered a required system; therefore, it is subject to the same requirements (including maintenance) that apply to a sprinkler system specifically mandated by the *Code*. For example, if an occupancy that does not require a sprinkler system permits the use of the delayed-egress electrical locking system addressed by 14.5.3.1, and if the designer or building operator meets one of the unlocking provisions of 14.5.3.1 via the installation of an approved, supervised automatic sprinkler system, the sprinkler system is considered a required system. Therefore, the system must meet all requirements that apply to a similar system installed to comply with the *Code* in addition to those of the alternative system, such as delayed-egress door locking.

13.3.1.8 Supervision.

Automatic sprinkler system supervision is not required by 13.3.1.8. Rather, the requirements of 13.3.1.8 apply where a supervised automatic sprinkler system is mandated by another section of the *Code*. Most of the occupancy chapters of NFPA *101* that require an automatic sprinkler system for life safety purposes also require the system to be electrically supervised in accordance with 13.3.1.8.

13.3.1.8.1* Supervisory Signals.

Δ **A.13.3.1.8.1** *NFPA 72* provides details of standard practice in sprinkler supervision. Subject to the approval of the AHJ, sprinkler supervision is also permitted to be provided by direct connection to municipal fire departments or, in the case of very large establishments, to a private headquarters providing similar functions. *NFPA 72* covers such matters. System components and parameters that are required to be monitored should include, but should not be limited to, control valves, water tank levels and temperatures, tank pressure, and air pressure on dry-pipe valves. [***101:***A.9.7.2.1]

Where municipal fire alarm systems are involved, reference should also be made to NFPA 1221. [***101:***A.9.7.2.1]

13.3.1.8.1.1 Where supervised automatic sprinkler systems are required by another section of this *Code*, supervisory attachments shall be installed and monitored for integrity in accordance with *NFPA 72* and a distinctive supervisory signal shall be provided to indicate a condition that would impair the satisfactory operation of the sprinkler system. [***101:***9.7.2.1.1]

13.3.1.8.1.2 Supervisory signals shall sound and shall be displayed either at a location within the protected building that is constantly attended by qualified personnel or at an approved, remotely located receiving facility. [***101:***9.7.2.1.2]

One reason the automatic sprinkler system has attained a high level of satisfactory performance and response to fire conditions is that, through supervision, it can be kept in operative condition. Of course, keeping the system operative depends on routine maintenance and the owner's willingness to repair the system when there are indications of impairment. Features of the system, such as the following, can be automatically monitored:

1. Opening and closing of water control valves
2. Power supplies for required fire pumps
3. Water tank level

If an undesirable situation develops, a signal is annunciated in the protected building or relayed to a monitoring facility.

A supervisory system will also indicate or activate a waterflow alarm. In addition to being transmitted to an alarm-monitoring agency, the waterflow alarm can be transmitted directly to the fire department. The signals for electrical and mechanical problems need not burden the fire department unnecessarily, yet those signals indicating a fire can be received directly.

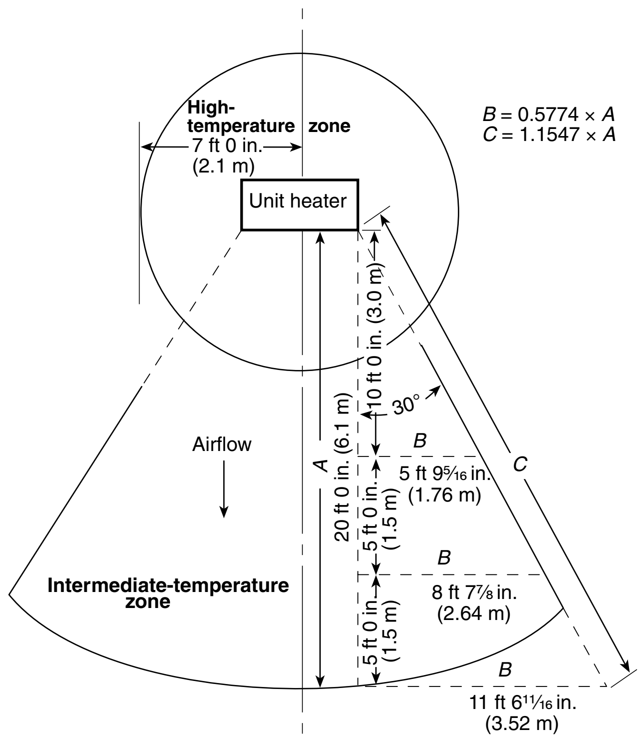
13.3.1.8.2 Alarm Signal Transmission.

13.3.1.8.2.1 Where supervision of automatic sprinkler systems is required by another section of this *Code*, waterflow alarms shall be transmitted to an approved, proprietary alarm-receiving facility, a remote station, a central station, or the fire department. [***101:***9.7.2.2.1]

13.3.1.8.2.2 The connection described in 13.3.1.8.2.1 shall be in accordance with 13.7.1.1. [***101:***9.7.2.2.2]

13.3.1.9 The following practices shall be observed to provide sprinklers of other than ordinary-temperature classification unless other temperatures are determined or unless high-temperature sprinklers are used throughout, and temperature selection shall be in accordance with Table 13.3.1.9(a), Table 13.3.1.9(b), and Figure 13.3.1.9:

(1) Sprinklers in the high-temperature zone shall be of the high-temperature classification, and sprinklers in the intermediate-temperature zone shall be of the intermediate-temperature classification.



Δ *FIGURE 13.3.1.9 High-Temperature and Intermediate-Temperature Zones at Unit Heaters. [**13:**Figure 8.3.2.5]*

(2) Sprinklers located within 12 in. (300 mm) to one side or 30 in. (750 mm) above an uncovered steam main, heating coil, or radiator shall be of the intermediate-temperature classification.

(3) Sprinklers within 7 ft (2.1 m) of a low-pressure blowoff valve that discharges free in a large room shall be of the high-temperature classification.

(4) Sprinklers under glass or plastic skylights exposed to the direct rays of the sun shall be of the intermediate-temperature classification.

(5) Sprinklers in an unventilated, concealed space, under an uninsulated roof, or in an unventilated attic shall be of the intermediate-temperature classification.

(6) Sprinklers in unventilated show windows having high-powered electric lights near the ceiling shall be of the intermediate-temperature classification.

(7) Sprinklers protecting commercial-type cooking equipment and ventilation systems shall be of the high- or extra high-temperature classification as determined by use of a temperature-measuring device. *(See 7.9.6 of NFPA 13.)*

(8) Sprinklers protecting residential areas installed near specific heat sources identified in Table 13.3.1.9(c) shall be installed in accordance with Table 13.3.1.9(c).

(9) Ordinary-temperature sprinklers located adjacent to a heating duct that discharges air that is less than 100°F (38°C) are not required to be separated in accordance with Table 13.3.1.9(a).

(10) Sprinklers in walk-in type coolers and freezers with automatic defrosting shall be of the intermediate-temperature classification or higher.

[**13:**8.3.2.5]

A.13.3.1.9 A diffuser in ceiling sheathing labeled by the manufacturer as "horizontal discharge" has directional vanes to move air further along the ceiling, and sprinklers located within the 2 ft 6 in. (750 mm) radius should have an intermediate-temperature rating. [**13:**A.8.3.2.5]

The requirements specified in 13.3.1.9 relate to the use of sprinklers covered in Table 6.2.5.1 of NFPA 13. The temperature rating criteria allow the sprinklers to operate in response to a fire rather than to high ambient temperatures.

13.3.2 Where Required.

13.3.2.1 Where required by this *Code* or the referenced codes and standards listed in Chapter 2, automatic sprinkler systems shall be installed in accordance with 13.3.1.

13.3.2.2 Basements exceeding 2500 ft^2 (232 m^2) in new buildings shall be protected throughout by an approved automatic sprinkler system.

Fires in basement areas pose a significant hazard to fire fighters. Basement areas are often used for storage and can contain large quantities of combustibles and confusing stock arrangements. Access to utilities often requires entry to buildings through the basement. Access for fire fighting is generally limited to one or two stairways, which can quickly become filled with heat and

Δ ***TABLE 13.3.1.9(a)*** *Temperature Ratings of Sprinklers Based on Distance from Heat Sources*

Type of Heat Condition	Ordinary-Temperature Rating	Intermediate-Temperature Rating	High-Temperature Rating
(1) Heating ducts			
(a) Above	More than 2 ft 6 in. (750 mm)	2 ft 6 in. or less (750 mm)	
(b) Side and below	More than 1 ft 0 in. (300 mm)	1 ft 0 in. or less (300 mm)	
(c) Diffuser	Any distance except as shown under Intermediate-Temperature Rating column	*Downward discharge:* Cylinder with 1 ft 0 in. (300 mm) radius from edge extending 1 ft 0 in. below and 2 ft 6 in. (750 mm) above *Horizontal discharge:* Semicylinder or cylinder with 2 ft 6 in. (750 mm) radius in direction of flow extending 1 ft 0 in. (300 mm) below and 2 ft 6 in. (750 mm) above	
(2) Unit heater			
(a) Horizontal discharge		*Discharge side:* 7 ft 0 in. (2.1 m) to 20 ft 0 in. (6.1 m) radius pie-shaped cylinder *(see Figure 13.3.1.8)* extending 7 ft 0 in. (2.1 m) above and 2 ft 0 in. (600 mm) below heater; also 7 ft 0 in. (2.1 m) radius cylinder more than 7 ft 0 in. (2.1 m) above unit heater	7 ft 0 in. (2.1 m) radius cylinder extending 7 ft 0 in. (2.1 m) above and 2 ft 0 in. (600 mm) below unit heater
(b) Vertical downward discharge *(for sprinklers below unit heater, see Figure 13.3.1.9)*		7 ft 0 in. (2.1 m) radius cylinder extending upward from an elevation 7 ft 0 in. (2.1 m) above unit heater	7 ft 0 in. (2.1 m) radius cylinder extending from the top of the unit heater to an elevation 7 ft 0 in. (2.1 m) above unit heater
(3) Steam mains (uncovered)			
(a) Above	More than 2 ft 6 in. (750 mm)	2 ft 6 in. or less (750 mm)	
(b) Side and below	More than 1 ft 0 in. (300 mm)	1 ft 0 in. or less (300 mm)	
(c) Blowoff valve	More than 7 ft 0 in. (2.1 m)		7 ft 0 in. or less (2.1 m)

[**13:** Table 8.3.2.5(a)]

smoke. Fire fighters must advance downward with hose lines, approaching the top of a fire, as opposed to advancing from beside or below the fire. Ventilation means are often restricted to the same stairway used by fire fighters to attack the fire. Horizontal ventilation is generally impossible.

A serious fire in a basement can jeopardize the structural integrity of the building, which can lead to floor collapse or more serious structural collapse. Installation of an approved automatic sprinkler system limits fire development and allows fire fighters the opportunity to quickly extinguish a fire and complete overhaul activities.

13.3.2.3 New buildings housing emergency fire, rescue, or ambulance services shall be protected throughout by approved supervised automatic sprinkler systems.

The requirement of 13.3.2.3 for new public safety buildings to be protected by supervised automatic sprinkler systems not only protects the emergency services personnel occupying the facility but also diminishes the probability of disrupting the provision of emergency services to the community as a result of a fire. This requirement is consistent with the public welfare goal and objective of the *Code* — see 4.1.5 and its associated commentary.

13.3.2.4 New buildings three or more stories in height above grade shall be protected throughout by an approved automatic sprinkler system in accordance with Section 13.3 unless otherwise permitted by 13.3.2.5.

13.3.2.5 Stand-alone open parking structures that are detached from other occupancies shall not be required to be protected by an automatic sprinkler system.

TABLE 13.3.1.9(b) Temperature Ratings of Sprinklers in Specified Locations

Location	Ordinary-Temperature Rating	Intermediate-Temperature Rating	High-Temperature Rating
Skylights		Glass or plastic	
Attics	Do not use	Ventilated or unventilated	
Peaked roof: metal or thin boards, concealed or not concealed, insulated or uninsulated	Ventilated	Unventilated	
Flat roof: metal, not concealed	Ventilated or unventilated	Note: For uninsulated roof, climate and insulated or uninsulated occupancy can necessitate intermediate sprinklers. Check on job.	
Flat roof: metal, concealed, insulated, or uninsulated	Ventilated	Unventilated	
Show windows	Ventilated	Unventilated	

Note: A check of job condition by means of thermometers might be necessary.

[**13:** Table 8.3.2.5(b)]

Δ *TABLE 13.3.1.9(c) Ratings of Sprinklers in Specified Residential Areas*

	Minimum Distance from Edge of Source to Ordinary-Temperature Sprinkler		Minimum Distance from Edge of Source to Intermediate-Temperature Sprinkler	
Heat Source	in.	mm	in.	mm
Side of open or recessed fireplace	36	915	12	300
Front of recessed fireplace	60	1525	36	915
Coal- or wood-burning stove	42	1070	12	305
Kitchen range	18	460	9	230
Wall oven	18	460	9	230
Hot air flues	18	460	9	230
Uninsulated heat ducts	18	460	9	230
Uninsulated hot water pipes	12	305	6	155
Side of ceiling- or wall-mounted hot air diffusers	24	610	12	305
Front of wall-mounted hot air diffusers	36	915	18	460
Hot water heater or furnace	6	155	3	75
Light fixture:				
0 W–250 W	6	155	3	75
250 W–499 W	12	305	6	155

[**13:** Table 8.3.2.5(c)]

The requirement of 13.3.2.4, which requires automatic sprinklers in all new buildings three or more stories in height above grade, other than open parking structures as specified by 13.3.2.5, was new to the 2012 edition of the *Code*. It recognizes the challenges posed to the fire service when fighting a fire in a multistory building. Where a fire occurs on an upper floor of a multistory building, the fire department must first locate the fire and then stretch hose lines up stairs or carry hose packs up stairs and connect to the building standpipe system. In either case, the time required to apply water to the fire is increased, allowing the fire to continue to develop. In many cases, the room of fire origin in multistory buildings will reach flashover prior to the application of water by the fire service. The onset of flashover significantly increases the production of heat, smoke, and other toxic products of combustion and can also adversely impact the building's structural integrity. With the installation of automatic sprinklers, the risk of flashover is all but eliminated, greatly enhancing the protection of building occupants, emergency responders, the building itself, and the building's contents.

The *Code* does not prescribe a method for determining a building's number of stories in height above grade. For such determination, the AHJ might defer to the building code adopted by the jurisdiction. Where no building code is adopted, the AHJ might refer to the criteria specified by other recognized codes, such as NFPA *101* or *NFPA 5000®*, *Building Construction and Safety Code®*.

13.3.2.6* Exterior Roofs, Canopies, Porte-Cocheres, Balconies, Decks, or Similar Projections. In buildings protected throughout by automatic sprinklers in accordance with NFPA 13, automatic sprinkler protection shall be provided for the exterior spaces in accordance with 13.3.2.6.

A.13.3.2.6 Small loading docks, covered platforms, ducts, or similar small unheated areas can be protected by dry pendent sprinklers extending through the wall from wet sprinkler piping in an adjacent heated area. Where protecting covered platforms, loading docks, and similar areas, a dry pendent sprinkler should extend down at a 45 degree angle. The width of the area to be protected should not exceed 7½ ft (2.3 m). Sprinklers should be spaced not over 12 ft (3.7 m) apart. Exterior projections include, but are not limited to, exterior roofs, canopies, porte-cocheres, balconies, decks, or similar projections. *(See Figure A.13.3.2.6.)* [**13:**A.8.15.7]

13.3.2.6.1 Unless the requirements of 13.3.2.6.2, 13.3.2.6.3, or 13.3.2.6.4 are met, sprinklers shall be installed under exterior projections exceeding 4 ft (1.2 m) in width. [**13:**8.15.7.1]

Exterior canopies exceeding 4 ft (1.2 m) in width that are constructed of combustible materials must be sprinklered unless they meet the requirements of 13.3.2.6.4 and do not have combustible goods stored or handled underneath them. Canopies less than 4 ft (1.2 m) in width do not need to be sprinklered, regardless of construction type, provided that no combustibles are stored beneath them.

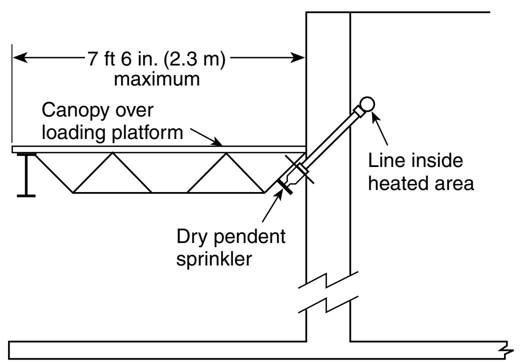


***FIGURE A.13.3.2.6** Dry Pendent Sprinklers for Protection of Covered Platforms, Loading Docks, and Similar Areas. [**13:** Figure A.8.15.7]*

Balconies under 4 ft (1.2 m) in width, such as those on many multistory apartment buildings, do not require sprinkler protection. Balconies more than 4 ft (1.2 m) in width are required to be sprinklered, unless the requirements of 13.3.2.6.1 are met.

13.3.2.6.2* Sprinklers shall be permitted to be omitted where the exterior canopies, roofs, porte-cocheres, balconies, decks, and similar projections are constructed with materials that are noncombustible, limited-combustible, or fire retardant–treated wood as defined in NFPA 703, or where the projections are constructed utilizing a noncombustible frame, limited-combustibles, or fire retardant-treated wood with an inherently flame-resistant fabric overlay as demonstrated by Test Method 2 in accordance with NFPA 701. [**13:**8.15.7.2]

Sprinklers can be omitted if the canopy construction assembly is composed entirely of noncombustible, limited-combustible, or fire-retardant materials and the area underneath is essentially restricted to pedestrian use. The reference to noncombustible and limited-combustible construction applies to the entire canopy assembly and not just to the exposed surface. Cases where the exterior roof or canopy is surfaced with noncombustible, limited-combustible, or fire-retardant-treated materials normally require sprinklers, but sprinklers may be omitted if the requirements of 13.3.2.6.2 are met.

The roof canopy typically found on strip shopping malls, where the area under the canopy is limited to pedestrians, is one example of this condition where pedestrian traffic is the primary use. Areas where automobiles stop briefly to pick up or drop off passengers are not considered storage areas. Areas located at drive-in bank windows or porte-cocheres at motels and hotels normally do not require sprinklers. However, the area under the exterior ceiling shown in Exhibit 13.3 would require sprinkler protection. The space is used primarily for parking vehicles, and the remainder of the building is sprinklered.

Exhibit 13.3

Parking area under exterior ceiling that is required to be sprinklered.

Figure A.13.3.2.6 shows one method of protecting areas under roofs or canopies up to 7 ft 6 in. (2.3 m) wide. Sprinklers are required under all such coverings where combustible goods are stored or handled.

A.13.3.2.6.2 Vehicles that are temporarily parked are not considered storage. Areas located at drive-in bank windows or porte-cocheres at hotels and motels normally do not require sprinklers where there is no occupancy above, where the area is entirely constructed of noncombustible or limited-combustible materials or fire retardant treated lumber, and where the area is not the only means of egress. However, areas under exterior ceilings where the building is sprinklered should be protected due to the occupancy above. [**13:**A.8.15.7.2]

13.3.2.6.3 Sprinklers shall be permitted to be omitted from below the exterior projections of combustible construction, provided the exposed finish material on the exterior projections are noncombustible, limited-combustible, or fire retardant–treated wood as defined in NFPA 703, and the exterior projections contain only sprinklered concealed spaces or any of the following unsprinklered combustible concealed spaces:

(1) Combustible concealed spaces filled entirely with noncombustible insulation
(2) Light or ordinary hazard occupancies where noncombustible or limited-combustible ceilings are directly attached to the bottom of solid wood joists so as to create enclosed joist spaces 160 ft^3 (4.5 m^3) or less in volume, including space below insulation that is laid directly on top or within the ceiling joists in an otherwise sprinklered attic *[see 11.2.3.1.4(4)(d) of NFPA 13]*
(3) Concealed spaces over isolated small exterior projections not exceeding 55 ft^2 (5.1 m^2) in area

[**13:**8.15.7.3]

Sprinklers are permitted to be omitted from a combustible roof, canopy, or porte-cochere where the exterior surfaces are of noncombustible, limited-combustible, or fire-retardant materials; where the roof, canopy, or porte-cochere contains only combustible concealed spaces that are completely filled with noncombustible insulation; where the concealed space is formed when the noncombustible surface is directly attached to joists so as to create spaces of 160 ft^3 (4.5 m^3) or less in volume; or where the area is less than 55 ft^2 (5.1 m^2). All these conditions do not require sprinklers per 8.15.1.2 of NFPA 13.

13.3.2.6.4 Sprinklers shall be permitted to be omitted from exterior exit corridors when the exterior walls of the corridor are at least 50 percent open and when the corridor is entirely of noncombustible construction. [**13:**8.15.7.4]

Exit corridors, such as those that might be found on the outside of a motel or similar structure, do not normally contain combustibles and do not require sprinklers, provided that the corridor is entirely constructed of noncombustible materials and the exterior walls are 50 percent open so that there is access for fire fighting if a fire occurs.

13.3.2.6.5* Sprinklers shall be installed under exterior projections greater than 2 ft (600 mm) wide over areas where combustibles are stored. [**13:**8.15.7.5]

A.13.3.2.6.5 Short-term transient storage, such as that for delivered packages, and the presence of planters, newspaper machines, and so forth, should not be considered for storage or handling of combustibles. The presence of combustible furniture on balconies for occupant use should not require sprinkler protection. [**13:**A.8.15.7.5]

Paragraph 13.3.2.6.5 requires sprinklers to be installed under exterior roofs, canopies, or porte-cocheres where combustibles are stored and handled, but it does not define the amount of combustibles that must be present. Paragraph A.13.3.2.6.5 clarifies that temporary "storage," such as newspaper vending machines and planters, is not sufficient to justify sprinklers. Another example of temporary storage that does not justify sprinklers is an automobile stopped at a bank's drive-up window or parked under a hotel's porte-cochere used for unloading luggage and checking in.

13.3.2.7 New Assembly Occupancies.

Δ **13.3.2.7.1** The following assembly occupancies shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.3.1.2:

(1) Dance halls
(2) Discotheques
(3) Nightclubs
(4) Assembly occupancies with festival seating

[***101:***12.3.5.1]

Δ **13.3.2.7.2** Any building containing one or more assembly occupancies where the aggregate occupant load of the assembly occupancies exceeds 300 shall be protected by an approved, supervised automatic sprinkler system in accordance with NFPA 13 as follows *(see also 12.1.6, 12.2.6, 12.3.2, and 12.3.6 of* NFPA *101):*

(1) Throughout the story containing the assembly occupancy
(2) Throughout all stories below the story containing the assembly occupancy
(3) In the case of an assembly occupancy located below the level of exit discharge, throughout all stories intervening between that story and the level of exit discharge, including the level of exit discharge

[***101:***12.3.5.2]

Δ **13.3.2.7.3** The requirements of 13.3.2.7.2 shall not apply to the following:

(1)* Assembly occupancies consisting of a single multipurpose room of less than 12,000 ft^2 (1115 m^2) that are not used for exhibition or display and are not part of a mixed occupancy

A.13.3.2.7.3(1) It is the intent to permit a single multipurpose room of less than 12,000 ft^2 (1115 m^2) to have certain small rooms as part of the single room. These rooms could be a kitchen, office, equipment room, and the like. It is also the intent that an addition could be made to an existing building without requiring that the existing building be sprinklered, where both the new and existing buildings have independent means of egress and a fire-rated separation is provided to isolate one building from the other. [*101:*A.12.3.5.3(1)]

A school gymnasium with egress independent of, and separated from, the school would be included in this exception, as would a function hall attached to a church with a similar egress arrangement. [*101:*A.12.3.5.3(1)]

(2) Gymnasiums, skating rinks, and swimming pools used exclusively for participant sports with no audience facilities for more than 300 persons

(3)* Locations in stadia and arenas as follows:
   (a) Over the floor areas used for contest, performance, or entertainment, provided that the roof construction is more than 50 ft (15 m) above the floor level, and use is restricted to low fire hazard uses
   (b) Over the seating areas, provided that use is restricted to low fire hazard uses
   (c) Over open-air concourses where an approved engineering analysis substantiates the ineffectiveness of the sprinkler protection due to building height and combustible loading

A.13.3.2.7.3(3) Examples of low fire hazard uses include spectator sporting events, concerts, and performances on platforms.

The following uses are not low fire hazard uses: concerts and performances on stages; tradeshows; exhibition and display of combustible items; displays of vehicles, boats, or similar items; or events using open flames or pyrotechnic effects. [*101:*A.12.3.5.3(3)]

•

(4) Locations in unenclosed stadia and arenas as follows:
   (a) Press boxes of less than 1000 ft^2 (93 m^2)
   (b) Storage facilities of less than 1000 ft^2 (93 m^2) if enclosed with not less than 1-hour fire resistance–rated construction
   (c) Enclosed areas underneath grandstands that comply with 25.3.4

[*101:*12.3.5.3]

13.3.2.7.4 Where another provision of Chapter 12 of NFPA *101* requires an automatic sprinkler system, the sprinkler system shall be installed in accordance with NFPA 13. [*101:*12.3.5.4]

The provisions of 13.3.2.7 and 13.3.2.8 specify two primary locations where automatic sprinkler protection might be required in new and existing assembly occupancies. The others are 12/13.1.6 and 12/13.4.4 of NFPA *101*, which apply to minimum construction requirements and high-rise buildings, respectively. Each of these subsections is to be applied independently to determine whether automatic sprinkler protection is required. For example, if the building is not high-rise and 12/13.1.6 of NFPA *101* does not require sprinklers for a particular assembly occupancy on the basis of building construction type and location within the building, 13.3.2.7 might require automatic sprinklers for that assembly occupancy based on use or occupant load, or 13.3.2.8 might require automatic sprinklers based on use or floor area that is capable of being used for exhibition purposes. If one subparagraph requires sprinklers and the other does not, sprinklers must be provided.

The requirements of 13.3.2.7.1 for new nightclub-type assembly occupancies to be sprinklered and of 13.3.2.8.1 for existing nightclub-type assembly occupancies with more than a 100-person occupant load to be sprinklered were added to the *Code* in 2006. The provisions were developed in response to the February 2003 fire at The Station nightclub in West Warwick, Rhode Island, which claimed the lives of 100 patrons.

The provisions of 13.3.2.7.1 and 13.3.2.8.1 were revised for the 2012 edition of the *Code*. Previously, an entry for "bars with live entertainment" was included in the list of nightclub-type assembly occupancies requiring sprinklers. Judgment of what constitutes a bar with live entertainment is difficult. Would the presence of a folk singer with a guitar sitting on a stool raise the danger level to that of a nightclub as learned from the fire at The Station nightclub so as to justify sprinklering? Questions like that convinced the technical committee to delete "bars with live entertainment" from the list.

The requirement of 13.3.2.7.2 for automatic sprinkler protection for new assembly occupancies with an occupant load in excess of 300 persons was prompted by the occurrence of fires involving assembly occupancies, most notably the Beverly Hills Supper Club fire in 1977 in Kentucky and the MGM Grand Hotel fire in 1980 in Las Vegas.

Paragraph 13.3.2.7.2 was revised for the 2009 edition of the *Code* to clarify that a 300-person occupant load threshold is to be applied to the aggregate occupant load of all the assembly occupancies in the building. For example, if two assembly occupancies are in the building, and each has an occupant load of 160 persons, the 300-person threshold of 13.3.2.7.2 is exceeded so as to require sprinklers. The extent of the sprinkler system is addressed by 13.3.2.7.2(1), (2), and (3).

The exemptions from the sprinkler requirement of 13.3.2.7.2, as contained in 13.3.2.7.3, are important in that they limit the areas or buildings requiring sprinkler protection. Two of the exemptions in 13.3.2.7.3, related to stadia and arenas, were revised for the 2012 edition of the *Code,* but similar exemptions in 13.3.2.8.3 for existing situations were left unchanged. The provision of 13.3.2.7.3(3)(a) was revised to add criteria for minimum clearance between floor and roof and a restriction to low fire hazard uses. The provision of 13.3.2.7.3(3)(b) was revised to add a restriction that the seating area have low fire hazard uses.

The concepts used in footnote a of Table 12.1.6 and Table 13.1.6 of NFPA *101* are also used with regard to which areas must be sprinklered — see 13.3.2.7.2(1), (2), and (3). If a five-story building has an assembly occupancy on the first floor, the floors above the assembly occupancy are not required to be sprinklered by the assembly occupancy provisions; however, the applicable occupancy chapter might require sprinklering of those floors. If the assembly occupancy were on the fifth floor, then the fifth floor and all floors below it would be required to be sprinklered.

Paragraph 13.3.2.7.3(1) exempts sprinkler protection for multipurpose assembly occupancies that are contained in one room, have an area of less than 12,000 ft² (1115 m²), and are not used as an exhibition hall or for a display room. Exhibit and display halls have been shown to be fire and life safety problems because of their high fuel load and potential for rapid fire spread.

The text of A.13.3.2.7.3(1) clarifies that it is not the intent of 13.3.2.7.3(1) to prohibit the presence of normal ancillary spaces. However, a number of assembly rooms or a mixed occupancy would not be permitted to use this exemption.

Paragraph 13.3.2.7.3(2) exempts gymnasiums, skating rinks (including ice and roller rinks), and swimming pools where there is an audience or spectator gallery with an occupant load of 300 or fewer persons. If the skating rink or swimming pool can be floored over and used for other purposes, then the multipurpose room requirements contained in 13.3.2.7.3(1) might apply. If the spectator gallery has an occupant load greater than 300, then an automatic sprinkler system is required. In effect, 13.3.2.7.3(2) exempts the participants on the gym floor, on the skating rink, or in the swimming pool from being counted as part of the 300-person threshold at which the provisions of 13.3.2.7.2 apply.

Two major questions that arise with regard to 13.3.2.7 deal with multiple occupancies (especially assembly/educational) and multiple assembly occupancies (especially religious halls with multipurpose rooms).

With regard to multiple occupancies, 6.1.14.3 states that, if mixed occupancies provisions are to be used to protect a multiple occupancy, the most stringent requirements applicable to any of the involved occupancies must be provided for all occupancies. Therefore, new schools with assembly occupancies with an occupant load in excess of 300 need to be fully sprinklered, unless the multiple occupancy is treated as separated occupancies in accordance with 6.1.14.4, which would require independent exit access systems and substantial fire-rated separating construction. If separated occupancies can be established, only the assembly occupancy with an occupant load in excess of 300 would need to be sprinklered. Also, multipurpose assembly rooms in a multiple occupancy assembly and educational occupancies building utilizing the separated occupancies provisions of 6.1.14.4 could potentially use 13.3.2.7.3(1) for exemption from the sprinkler requirement. Paragraph 13.3.2.7.3(1) emphasizes that the assembly occupancy is essentially a single room and, thus, cannot be part of a multiple occupancy building protected as mixed occupancies in accordance with 6.1.14.3.

Paragraph 13.3.2.7.3(1) was originally intended for a typical fellowship hall, such as a VFW, an American Legion, or a Grange hall. Some ancillary rooms, such as kitchens, restrooms, storage rooms, or minor offices, will exist, and it is not the intent that these ancillary spaces disqualify a facility from using this exemption [see A.13.3.2.7.3(1)]; however, it is the intent that the facility consist essentially of only one major room.

The provisions of 13.3.2.8.2 — which apply to existing assembly occupancies used or capable of being used for exhibition or display purposes — are not as stringent as those for new assembly occupancies. This requirement would apply to many facilities over 15,000 ft² (1400 m²), unless fixed seating or similar permanent obstruction to exhibition use is provided.

13.3.2.7.5 Fire Protection. Every stage shall be protected by an approved, supervised automatic sprinkler system in compliance with Section 13.3. [***101:***12.4.6.10]

13.3.2.7.5.1 Protection shall be provided throughout the stage and in storerooms, workshops, permanent dressing rooms, and other accessory spaces contiguous to stages. [***101:***12.4.6.10.1]

13.3.2.7.5.2 Sprinklers shall not be required for stages 1000 ft² (93 m²) or less in area and 50 ft (15 m) or less in height where the following criteria are met:

(1) Curtains, scenery, or other combustible hangings are not retractable vertically.
(2) Combustible hangings are limited to borders, legs, a single main curtain, and a single backdrop.

[***101:***12.4.6.10.2]

13.3.2.7.5.3 Sprinklers shall not be required under stage areas less than 48 in. (1220 mm) in clear height that are used exclusively for chair or table storage and lined on the inside with ⅝ in. (16 mm) Type X gypsum wallboard or the approved equivalent. [***101:***12.4.6.10.3]

Stages pose a host of life safety protection challenges. Scenery might be shifted horizontally, vertically, or both ways. The use of thrust stages and arena stages introduces new challenges.

The classic stage of the past rose high above the proscenium opening to accommodate the rigid asbestos curtain. The high void was a natural place to house combustible scenery for a performance, along with the rigging necessary for handling scene changes. This vertical storage area represented both a high fuel load and a space difficult to reach in case of fire. Many new theaters use a flexible, noncombustible curtain that does not require much height to accommodate it. Scenery on these stages is moved horizontally, thus reducing the distance necessary for storage between the top of the proscenium opening and the stage ceiling. Most combustible scenery is now stored in areas adjacent to the stage. All rigging and lighting is condensed in less vertical space.

13.3.2.8 Existing Assembly Occupancies.

See the commentary following 13.3.2.7.4.

Δ **13.3.2.8.1** Where the occupant load exceeds 100, the following assembly occupancies shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA 13:

(1) Dance halls
(2) Discotheques

(3) Nightclubs
(4) Assembly occupancies with festival seating
[***101:***13.3.5.1]

13.3.2.8.2 Any assembly occupancy used or capable of being used for exhibition or display purposes shall be protected throughout by an approved automatic sprinkler system in accordance with Section 13.3 where the exhibition or display area exceeds 15,000 ft^2 (1400 m^2). [***101:***13.3.5.2]

Δ **13.3.2.8.3** The sprinklers specified by 13.3.2.8.2 shall not be required where otherwise permitted in the following locations:

(1) Locations in stadia and arenas as follows:
  (a) Over the floor areas used for contest, performance, or entertainment
  (b) Over the seating areas
  (c) Over open-air concourses where an approved engineering analysis substantiates the ineffectiveness of the sprinkler protection due to building height and combustible loading
(2) Locations in unenclosed stadia and arenas as follows:
  (a) Press boxes of less than 1000 ft^2 (93 m^2)
  (b) Storage facilities of less than 1000 ft^2 (93 m^2) if enclosed with not less than 1-hour fire resistance–rated construction
  (c) Enclosed areas underneath grandstands that comply with 25.3.4

[***101:***13.3.5.3]

13.3.2.8.4 Where another provision of this chapter and Chapter 13 of NFPA *101* requires an automatic sprinkler system, the sprinkler system shall be installed in accordance with NFPA 13. [***101:***13.3.5.4]

13.3.2.8.5 Fire Protection. Every stage shall be protected by an approved automatic sprinkler system in compliance with Section 13.3. [***101:***13.4.6.10]

13.3.2.8.5.1 Protection shall be provided throughout the stage and in storerooms, workshops, permanent dressing rooms, and other accessory spaces contiguous to such stages. [***101:***13.4.6.10.1]

13.3.2.8.5.2 Sprinklers shall not be required for stages 1000 ft^2 (93 m^2) or less in area where the following criteria are met:

(1) Curtains, scenery, or other combustible hangings are not retractable vertically.
(2) Combustible hangings are limited to borders, legs, a single main curtain, and a single backdrop.

[***101:***13.4.6.10.2]

13.3.2.8.5.3 Sprinklers shall not be required under stage areas less than 48 in. (1220 mm) in clear height that are used exclusively for chair or table storage and lined on the inside with ⅝ in. (16 mm) Type X gypsum wallboard or the approved equivalent. [***101:***13.4.6.10.3]

13.3.2.9 New Educational Occupancies.

Δ **13.3.2.9.1** Educational occupancy buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***14.3.5.1]

• *N* **13.3.2.9.2** The requirement of 13.3.2.9.1 shall not apply to any of the following:

(1) Non-relocatable buildings having an area not exceeding 1000 ft^2 (93 m^2)
(2) Non-relocatable buildings containing a single classroom
(3) Relocatable buildings complying with all of the following:
  (a) Building area does not exceed 1000 ft^2 (93 m^2)
  (b) Building contains a single classroom
  (c) Building is located not less than 30 ft (9.1 m) from another building

[***101:***14.3.5.2]

13.3.2.9.3 Every portion of educational buildings below the level of exit discharge shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***14.3.5.3]

13.3.2.9.4 Buildings with unprotected openings in accordance with 8.6.6 of NFPA *101* shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***14.3.5.4]

13.3.2.9.5 Where another provision of Chapter 14 of NFPA *101* requires an automatic sprinkler system, the sprinkler system shall be installed in accordance with NFPA 13. [***101:***14.3.5.5]

The provision of 13.3.2.9.1 was revised for the 2018 edition of NFPA *101* and requires new educational occupancy buildings to be fully sprinklered, unless they can apply an exemption per 13.3.2.9.2. The previous 12,000 ft^2 (1120 m^2) building size and the four stories in height threshold for requiring sprinklers have been deleted. Fully sprinklered schools provide active fire protection regardless of any scenario for which they are used. Public schools are often used as public shelters, before or after a tornado, hurricane, flood, wild fire, and so forth. Some states require new schools be built as public shelters. In many emergencies, whether natural or man-made disasters, a school becomes the center for several temporary occupancies and agencies that provide emergency services, such as cooking, nursing, surgery, psychiatric, along with housing, to area residents. All these emergency uses, if built separately from a school, require sprinklers.

The NFPA document *Workshop on School Safety, Codes and Security: Final Report* makes several suggestions to improve school security. Several areas of the report suggest improving fire protection, such as fire sprinklers, to facilitate egress options. One example is delayed evacuation when lockdown procedures are implemented. A procedure that holds students and staff in an area, preventing egress after fire alarm activation, is a concept contrary to NFPA *101*. Only by mandating an active fire protection system is this even remotely possible.

Schools are a significant investment by the community, the state, and the federal government. Losing schools through fire is irresponsible planning, and the cost to rebuild places a heavy burden to the school district and local taxpayers. According to the abstract for the 2016 NFPA report *Structure Fires in Educational Properties*, "In 2009–2013, U.S. fire departments responded to an estimated average of 5,100 structure fires in educational properties, annually. These fires caused an annual average of one civilian death, 79 civilian fire injuries and $88 million in direct property damage." Where sprinklers are installed, fire damage is 62 percent less than damage to buildings without sprinklers.

Mandating sprinklers is only part of the emergency planning and by no means solves all the security aspects of schools. However, from experience, it is one of the more easily obtainable of all goals and provides a safe environment from fire.

Paragraph 13.3.2.9.2 has been updated to recognize three specific exemptions from the sprinkler requirement. Nonrelocatable buildings containing a single classroom or having an area not exceeding 1000 ft^2 (93 m^2) as well as relocatable buildings meeting the provisions of 13.3.2.9.2(3)(a) through (c) are exempt from the sprinkler provisions. These exemptions recognize modular-type classrooms that can be used as overflow classroom space during renovations, for example, or permanent buildings that are small enough in area and use that the sprinkler requirement is not justified. Paragraphs 13.3.2.9.3, 13.3.2.9.4, and 13.3.2.9.5 remain unchanged because not all new buildings will be required to be sprinklered. The non-sprinkler options must be retained because Chapter 43, Building Rehabilitation, of NFPA *101* requires compliance with Chapter 14 (new educational occupancies), but not Chapter 15 (existing educational occupancies) of NFPA *101*, for added or replaced elements and systems. The user who is performing the renovation in a nonsprinklered existing school building must not be misled into using provisions that apply only to new construction. The provision of 13.3.2.9.3 and the provisions of 13.3.2.10.1 through 13.3.2.10.3 address the need for sprinklers based on whether there are levels or floors below the level of exit discharge. For new construction, 13.3.2.9.3 will normally require basements of schools to be sprinklered; for existing educational occupancies, the basement will need to be sprinklered if it is used for student occupancy.

13.3.2.10 Existing Educational Occupancies.

See the commentary following 13.3.2.9.5.

13.3.2.10.1 Where student occupancy exists below the level of exit discharge, every portion of such floor shall be protected throughout by an approved automatic sprinkler system in accordance with Section 13.3. [***101:***15.3.5.1]

13.3.2.10.2 Where student occupancy does not exist on floors below the level of exit discharge, such floors shall be separated from the rest of the building by 1-hour fire resistance–rated construction or shall be protected throughout by an approved automatic sprinkler system in accordance with Section 13.3. [***101:***15.3.5.2]

Δ **13.3.2.10.3** Automatic sprinkler protection shall not be required where student occupancy exists below the level of exit discharge, provided that both of the following criteria are met:

(1) The approval of the AHJ shall be required.
(2) Windows for rescue and ventilation shall be provided in accordance with 15.2.11.1 of NFPA *101*.

[***101:***15.3.5.3]

13.3.2.10.4 Buildings with unprotected openings in accordance with 8.6.6 of NFPA *101* shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***15.3.5.4]

13.3.2.10.5 Where another provision of Chapter 15 of NFPA *101* requires an automatic sprinkler system, the sprinkler system shall be installed in accordance with NFPA 13. [***101:***15.3.5.5]

13.3.2.11 New Health Care Occupancies.

13.3.2.11.1* Buildings containing health care occupancies shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3, unless otherwise permitted by 13.3.2.11.3. [***101:***18.3.5.1]

A.13.3.2.11.1 In areas where the replenishment of water supplies is not immediately available from on-site sources, alternate provisions for the water-fill rate requirements of NFPA 13 and NFPA 22 that are acceptable to the AHJ should be provided. Appropriate means for the replenishment of these supplies from other sources, such as fire department tankers, public safety organizations, or other independent contractors should be incorporated into the overall fire safety plan of the facility. [***101:***A.18.3.5.1]

With automatic sprinkler protection required throughout new health care facilities and quick-response sprinklers required in smoke compartments containing patient sleeping rooms, a fire and its life-threatening byproducts can be reduced, thereby allowing the defend-in-place concept to continue. The difficulty in maintaining the proper integrity of life safety elements has been considered and it has been judged that the probability of a sprinkler system operating as designed is equal to or greater than other life safety features. [***101:***A.18.3.5.1]

13.3.2.11.2 The sprinkler system required by 13.3.2.11.1 shall be installed in accordance with NFPA 13. [***101:***18.3.5.4]

13.3.2.11.3 In Type I and Type II construction, alternative protection measures shall be permitted to be substituted for sprinkler protection, without causing a building to be classified as nonsprinklered, in specified areas where the AHJ has prohibited sprinklers. [***101:***18.3.5.5]

13.3.2.11.4* Listed quick-response or listed residential sprinklers shall be used throughout smoke compartments containing patient sleeping rooms. [***101:***18.3.5.6]

A.13.3.2.11.4 The requirements for use of quick-response sprinklers intend that quick-response sprinklers be the predominant type of sprinkler installed in the smoke compartment. It is recognized, however, that quick-response sprinklers might not be approved for installation in all areas such as those where NFPA 13 requires sprinklers of the intermediate- or high-temperature classification. It is not the intent of the 13.3.2.11.4 requirements to prohibit the use of standard sprinklers in limited areas of a smoke compartment where intermediate- or high-temperature sprinklers are required. [***101:***A.18.3.5.6]

Residential sprinklers are considered acceptable in patient sleeping rooms of all health care facilities, even though not specifically listed for this purpose in all cases. [***101:***A.18.3.5.6]

Where the installation of quick-response sprinklers is impracticable in patient sleeping room areas, appropriate equivalent protection features acceptable to the AHJ should be provided. It is recognized that the use of quick-response sprinklers might be limited in facilities housing certain types of patients or by the installation limitations of quick-response sprinklers. [***101:***A.18.3.5.6]

13.3.2.11.5* Sprinklers shall not be required in clothes closets of patient sleeping rooms in hospitals where the area of the closet does not exceed 6 ft^2 (0.55 m^2), provided that the distance from the sprinkler in the patient sleeping room to the back wall of the closet does not exceed the maximum distance permitted by NFPA 13. [***101:***18.3.5.10]

A.13.3.2.11.5 This exception is limited to hospitals, as nursing homes and many limited care facilities might have more combustibles within the closets. The limited amount of clothing found in the small clothes closets in hospital patient rooms is typically far less than the amount of combustibles in casework cabinets that do not require sprinkler protection, such as nurse servers. In many hospitals, especially new hospitals, it is difficult to make a distinction between clothes closets and cabinet work. The exception is far more restrictive than similar exceptions for hotels and apartment buildings. NFPA 13 already permits the omission of sprinklers in wardrobes *[see 8.1.1(7) of NFPA 13]*. It is not the intent of 13.3.2.11.5 to affect the wardrobe provisions of NFPA 13. It is the intent that the sprinkler protection in the room covers the closet as if there were no door on the closet. *(See 8.5.3.2.3 of NFPA 13.)* [***101:***A.18.3.5.10]

13.3.2.11.6* Sprinklers in areas where cubicle curtains are installed shall be in accordance with NFPA 13. [***101:***18.3.5.11]

A.13.3.2.11.6 For the proper operation of sprinkler systems, cubicle curtains and sprinkler locations need to be coordinated. Improperly designed systems might obstruct the sprinkler spray from reaching the fire or might shield the heat from the sprinkler. Many options are available to the designer including, but not limited to, hanging the cubicle curtains 18 in. (455 mm) below the sprinkler deflector; using a ½ in. (13 mm) diagonal mesh or a 70 percent open weave top panel that extends 18 in. (455 mm) below the sprinkler deflector; or designing the system to have a horizontal and minimum vertical distance that meets the requirements of NFPA 13. The test data that form the basis of the NFPA 13 requirements are from fire tests with sprinkler discharge that penetrated a single privacy curtain. [***101:***A.18.3.5.11]

Paragraph 13.3.2.11.1 requires automatic sprinkler protection throughout all new health care facilities; 13.3.2.11.4 requires the use of quick-response or residential sprinklers throughout all smoke compartments containing patient sleeping rooms.

Paragraph 13.3.2.12.1 requires automatic sprinkler protection throughout all existing nursing homes.

Paragraph 13.3.2.12.2 extracts the existing health care occupancies high-rise building sprinkler requirement in 19.4.2 of NFPA *101*. Without the extract, the user who consults 13.3.2.12 to identify the sprinkler requirements applicable to existing health care occupancies might miss the requirement that is located in the chapter subsection on high-rise buildings.

Where sprinkler protection is specified, complete building coverage in accordance with the provisions of NFPA 13 is required (see 13.3.2.11.2 and 13.3.2.12.6). The *Code* does not exempt any area of the building from sprinkler protection (see Section 13.3). However, where automatic sprinkler protection is omitted from certain spaces in Type I and Type II construction at the mandate of the AHJ, and the AHJ approves alternative protective measures, the building is still considered fully protected throughout in accordance with 13.3.2.11.3 and 13.3.2.12.7. Sprinklers are permitted to be omitted only from building areas of fire-rated, noncombustible construction, locations believed to have sufficient structural fire resistance to outlast most fires. Use of alternative protective measures should be carefully evaluated to ensure protection equivalent to that provided by automatic sprinklers. Where other automatic fire-extinguishing systems are used as an alternative to sprinklers for specific spaces, it is suggested that such spaces also be separated by fire resistance–rated construction from the remainder of the building that is protected by automatic sprinklers.

The word *supervised,* as used in 13.3.2.11.1 and 13.3.2.12.1, means that a distinct supervisory signal must be provided to a constantly attended location in the event of any malfunction or action that would impair sprinkler performance. Supervision must be provided, for example, for water supply and sprinkler control valves, fire pump power and running conditions, water tank levels and temperatures, pressure in pressure tanks, air pressure in dry-pipe systems, building temperature, and city water pressure. Supervision should include all sprinkler sectional control valves, in addition to main control valves. See also 13.3.1.8.

The intent of 13.3.2.12.8 is to permit the deletion of redundant features of fire protection within an individual smoke compartment that is sprinklered. Paragraph 13.3.2.12.8, for example, could be used to permit higher flame spread for interior wall/ceiling finish or nonrated corridor partitions within the sprinklered smoke compartment. In a limited care facility, the corridor smoke detection could be eliminated within the sprinklered smoke compartment as detailed in 13.7.2.8.5.1(2). However, certain general building protection features must be maintained, unless the building is fully sprinklered. For example, no relaxation in exit features (see Section 19.2 of NFPA *101*) or building construction requirements (see 19.1.6 of NFPA *101*) should be granted, unless the building is fully protected by automatic sprinklers.

Paragraph 13.3.2.12.9 provides sprinkler system criteria, which other sections of NFPA *101* can require by reference, that permit exemptions from requirements where automatic sprinkler protection is provided that utilizes quick-response sprinklers throughout smoke compartments having sleeping rooms. For example, 19.3.7.3(2) of NFPA *101* permits elimination of dampers in ducts penetrating smoke barriers where compartments on both sides of the barriers are sprinkler protected under certain conditions. This paragraph permits the elimination of dampers where compartments not used for patient sleeping are sprinklered, using either standard-response or quick-response sprinklers, or where compartments having patient sleeping rooms use quick-response or residential sprinklers.

The exemption provided by 13.3.2.12.9(6), for use of standard-response sprinklers in lieu of quick-response or residential sprinklers, has been used for purposes not intended by NFPA *101*. When the exemption was written for the 1991 edition of NFPA *101*, it addressed the case in which quick-response or residential sprinklers were installed throughout the smoke compartment, except in locations where the listing of the sprinkler prohibited its use. For example, the earliest quick-response sprinklers were not listed for use under sloped ceilings, in skylights, or in high ambient temperature areas. The exemption has been editorially revised over multiple editions of NFPA *101* so as to become unclear and subject to misapplication. The exemption has been misapplied to situations where the smoke compartment is sprinklered with standard-response sprinklers that were installed prior to the advent of quick-response or residential sprinklers. The exemption is not intended to grandfather such existing systems. Where another provision of Chapter 19 of NFPA *101* references 19.3.5.8 of NFPA *101* (13.3.2.12.9 of this *Code*), such reference is made because the presence of quick-response or residential sprinklers is needed to afford the intended level of life safety.

The provisions of 13.3.2.11.5 and 13.3.2.12.11 exempt sprinklers from small clothes closets where the sprinkler protecting the room is positioned so as to be able to discharge water to the back wall of the closet. The concept is explained in A.13.3.2.11.5 and A.13.3.2.12.11.

13.3.2.12 Existing Health Care Occupancies.

See the commentary following A.13.3.2.11.6.

13.3.2.12.1 Buildings containing nursing homes shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3 and Section 9.7 of NFPA *101*, unless otherwise permitted by 13.3.2.12.7. [***101:***19.3.5.1]

13.3.2.12.2 All high-rise buildings containing health care occupancies shall be protected throughout by an approved, supervised automatic sprinkler system installed in accordance with Section 13.3 within 12 years of the adoption of this *Code*, except as otherwise provided in 13.3.2.12.3 or 13.3.2.12.4. [***101:***19.4.2.1]

13.3.2.12.3 Where a jurisdiction adopts this edition of the *Code* and previously adopted the 2015 edition, the sprinklering required by 13.3.2.12.2 shall be installed within 9 years of the adoption of this *Code*. [***101:***19.4.2.2]

13.3.2.12.4 Where a jurisdiction adopts this edition of the *Code* and previously adopted the 2012 edition, the sprinklering required by 13.3.2.12.2 shall be installed within 6 years of the adoption of this *Code*. [***101:***19.4.2.3]

13.3.2.12.5 Where required by 19.1.6 of NFPA *101*, buildings containing hospitals or limited care facilities shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3 and Section 9.7 of NFPA *101*, unless otherwise permitted by 13.3.2.12.7. [***101:***19.3.5.3]

13.3.2.12.6* The sprinkler system required by 13.3.2.12.1 or 13.3.2.12.5 shall be installed in accordance with NFPA 13. [***101:***19.3.5.4]

A.13.3.2.12.6 It is not the intent to require existing standard sprinklers in existing sprinkler systems to be replaced with listed quick-response or listed residential sprinklers. It is the intent that new sprinkler systems installed in existing buildings comply with the requirements of Chapter 18 of NFPA *101*, including 18.3.5.6. [***101:***A.19.3.5.4]

13.3.2.12.7 In Type I and Type II construction, alternative protection measures shall be permitted to be substituted for sprinkler protection in specified areas where the AHJ has prohibited sprinklers, without causing a building to be classified as nonsprinklered. [***101:***19.3.5.5]

13.3.2.12.8* Where this *Code* permits exceptions for fully sprinklered buildings or smoke compartments, the sprinkler system shall meet all of the following criteria:

(1) It shall be in accordance with Section 13.3.
(2) It shall be installed in accordance with NFPA 13, unless it is an approved existing system.
(3) It shall be electrically connected to the fire alarm system.
(4) It shall be fully supervised.
(5) In Type I and Type II construction, where the AHJ has prohibited sprinklers, approved alternative protection measures shall be permitted to be substituted for sprinkler protection in specified areas without causing a building to be classified as nonsprinklered.

[***101:***19.3.5.7]

A.13.3.2.12.8 It is intended that any valve that controls automatic sprinklers in the building or portions of the building, including sectional and floor control valves, be electrically supervised. Valves that control isolated sprinkler heads, such as in laundry and trash chutes, are not required to be electrically supervised. Appropriate means should be provided to ensure that valves that are not electrically supervised remain open. [***101:***A.19.3.5.7]

Δ **13.3.2.12.9*** Where this *Code* permits exceptions for fully sprinklered buildings or smoke compartments and specifically references this paragraph, the sprinkler system shall meet all of the following criteria:

(1) It shall be installed throughout the building or smoke compartment in accordance with Section 13.3.
(2) It shall be installed in accordance with NFPA 13, unless it is an approved existing system.
(3) It shall be electrically connected to the fire alarm system.
(4) It shall be fully supervised.
(5) It shall be equipped with listed quick-response or listed residential sprinklers throughout all smoke compartments containing patient sleeping rooms.
(6) Standard-response sprinklers shall be permitted to be continued to be used in approved existing sprinkler systems where quick-response and residential sprinklers were not listed for use in such locations at the time of installation.
(7) Standard-response sprinklers shall be permitted for use in hazardous areas protected in accordance with 19.3.2.1 of NFPA *101*.

[***101:***19.3.5.8]

A.13.3.2.12.9 The provisions of 13.3.2.12.9(6) and (7) are not intended to supplant NFPA 13, which requires that residential sprinklers with more than a 10°F (5.6°C) difference in temperature rating not be mixed within a room. Currently there are no additional prohibitions in NFPA 13 on the mixing of sprinklers having different thermal response characteristics. Conversely, there are no design parameters to make practical the mixing of residential and other types of sprinklers. [***101:***A.19.3.5.8]

Residential sprinklers are considered acceptable in patient sleeping rooms of all health care facilities, even through not specifically listed for this purpose in all cases. [***101:***A.19.3.5.8]

13.3.2.12.10 Isolated hazardous areas shall be permitted to be protected in accordance with 13.3.1.4. For new installations in existing health care occupancies, where more than two sprinklers are installed in a single area, waterflow detection shall be provided to sound the building fire alarm or to notify, by a signal, any constantly attended location, such as PBX, security, or emergency room, at which the necessary corrective action shall be taken. [***101:***19.3.5.9]

Δ **13.3.2.12.11*** Sprinklers shall not be required in clothes closets of patient sleeping rooms in hospitals where the area of the closet does not exceed 6 ft^2 (0.55 m^2), provided that the distance from the sprinkler in the patient sleeping room to the back wall of the closet does not exceed the maximum distance permitted by NFPA 13. [***101:***19.3.5.10]

A.13.3.2.12.11 This exception is limited to hospitals, as nursing homes and many limited care facilities might have more combustibles within the closets. The limited amount of clothing found in the small clothes closets in hospital patient rooms is typically far less than the amount of combustibles in casework cabinets that do not require sprinkler protection, such as nurse servers. In many hospitals, especially new hospitals, it is difficult to make a distinction between clothes closets and cabinet work. The exception is far more restrictive than similar exceptions for hotels and apartment buildings. NFPA 13 already permits the omission of sprinklers in wardrobes *[see 8.1.1(7) of NFPA 13]*. It is not the intent of 13.3.2.12.11 to affect the wardrobe provisions of NFPA 13. It is the intent that the sprinkler protection in the room covers the closet as if there were no door on the closet. *(See 8.5.3.2.3 of NFPA 13.)* [***101:***A.19.3.5.10]

13.3.2.12.12* Newly introduced cubicle curtains in sprinklered areas shall be installed in accordance with NFPA 13. [***101:***19.3.5.11]

A.13.3.2.12.12 For the proper operation of sprinkler systems, cubicle curtains and sprinkler locations need to be coordinated. Improperly designed systems might obstruct the sprinkler spray from reaching the fire or might shield the heat from the sprinkler. Many options are available to the designer including, but not limited to, hanging the cubicle curtains 18 in. (455 mm) below the sprinkler deflector; using ½ in. (13 mm) diagonal mesh or a 70 percent open weave top panel that extends 18 in. (455 mm) below the sprinkler deflector; or designing the system to have a horizontal and minimum vertical distance that meets the requirements of NFPA 13. The test data that forms the basis of the NFPA 13 requirements is from fire tests with sprinkler discharge that penetrated a single privacy curtain. [***101:***A.19.3.5.11]

13.3.2.13 New Detention and Correctional Facilities.

13.3.2.13.1 All buildings classified as Use Condition II, Use Condition III, Use Condition IV, or Use Condition V shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.3.2.13.2. [***101:***22.3.5.2]

Δ **13.3.2.13.2** The automatic sprinkler system required by 13.3.2.13.1 shall meet all of the following criteria:

(1) It shall be in accordance with Section 13.3.
(2) It shall be installed in accordance with NFPA 13.
(3) It shall be electrically connected to the fire alarm system.
(4) It shall be fully supervised.

[***101:***22.3.5.3]

Paragraph 13.3.2.13.1 requires that new detention and correctional occupancies — other than Use Condition I — be protected throughout by approved, supervised automatic sprinkler systems. However, in establishing the sprinkler requirement, the Technical Committee on Detention and Correctional Occupancies realized that rehabilitation, modernizations, and renovations might take place in nonsprinklered existing buildings. Thus, 22.4.4 of NFPA *101* provides additional criteria needed for the proper protection of nonsprinklered existing building renovations.

Where automatic sprinklers are installed to comply with the *Code*, the system must be a complete, approved automatic sprinkler system installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*. The use of manually operated sprinklers is not recognized by the *Code*. Informal surveys of detention and correctional occupancy staff indicate no significant problems with the installation, maintenance, and use of automatic sprinkler systems in detention and correctional

Exhibit 13.4

Typical institutional sprinkler.

facilities. The system must also be supervised in accordance with the requirements of 13.3.1.8 to comply with the *Code*.

Exhibit 13.4 illustrates a typical institutional sprinkler. The sprinkler body and frame are designed to prevent residents from hanging items or themselves from the sprinkler.

13.3.2.14 Existing Detention and Correctional Facilities.

13.3.2.14.1* Where required by Table 23.1.6.1 of NFPA *101*, facilities shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.3.2.14.2. [***101:***23.3.5.2]

A.13.3.2.14.1 Where the openings in ceilings or partitions are ¼ in. (6.3 mm) or larger in the smallest dimension, where the thickness or depth of the material does not exceed the smallest dimension of the openings, and where such openings constitute not less than 70 percent of the area of the ceiling or partition material, the disruption of sprinkler spray patterns is permitted to be disregarded. [***101:***A.23.3.5.2]

Δ **13.3.2.14.2** Where this *Code* permits exceptions for fully sprinklered detention and correctional occupancies or sprinklered smoke compartments, the sprinkler system shall meet all of the following criteria:

(1) It shall be in accordance with Section 13.3.
(2) It shall be installed in accordance with NFPA 13.
(3) It shall be electrically connected to the fire alarm system.
(4) It shall be fully supervised.
[***101:***23.3.5.3]

Existing detention and correctional occupancies must be sprinklered where required based on the building's construction type in accordance with 23.1.6 of NFPA *101*, as indicated in 13.3.2.14.1. Also, where this *Code* permits a modification to a requirement based on the installation of a complete automatic sprinkler system, the sprinkler system must meet the requirements of 13.3.2.14.2, which include electrical supervision.

13.3.2.15 New Hotels and Dormitories.

13.3.2.15.1 All buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.3.2.15.2. [***101:***28.3.5.1]

13.3.2.15.2 Where an automatic sprinkler system is installed, either for total or partial building coverage, the system shall be in accordance with Section 13.3, as modified by 13.3.2.15.3. In hotel or dormitory occupancies up to and including four stories in height, that are located in buildings not exceeding 60 ft (18.3 m) in height above grade plane, systems in accordance with NFPA 13R shall be permitted. [***101:***28.3.5.3]

N **13.3.2.15.2.1** Where located in a building of Type III, Type IV, or Type V construction designed in accordance with 4.6.3(5) of NFPA *101*, and where the roof assembly is located more than 55 ft (17 m) above the lowest level of required fire department vehicle access, attics shall comply with 13.3.2.15.2.1.1, 13.3.2.15.1.2, and one of the following:

(1) Attics shall be provided with sprinkler protection.
(2) Attics shall be constructed with noncombustible materials.
(3) Attics shall be constructed with fire-retardant-treated wood.
(4) Attics shall be filled with noncombustible insulation.
[***101:***28.3.5.3.1]

N **13.3.2.15.2.1.1** The height of the roof assembly shall be determined by measuring the distance from the lowest level of required fire department vehicle access adjacent to the building to the eave of the highest pitched roof, the intersection of the highest roof to the exterior wall, or the top of the highest parapet, whichever yields the greatest distance. [***101:***28.3.5.3.1.1]

N **13.3.2.15.2.1.2** Required fire department vehicle access roads used in 28.3.5.3.1.1 shall include only those roads that are necessary for required fire department vehicle access in accordance with Section 18.2. [***101:***28.3.5.3.1.2]

13.3.2.15.3 The provisions for draft stops and closely spaced sprinklers in NFPA 13 shall not be required for openings complying with 8.6.9.1 of NFPA *101* where the opening is within the guest room or guest suite. [***101:***28.3.5.4]

13.3.2.15.4 Listed quick-response or listed residential sprinklers shall be used throughout guest rooms and guest room suites. [***101:***28.3.5.6]

Δ **13.3.2.15.5** Open parking structures that comply with NFPA 88A and are contiguous with hotels or dormitories shall be exempt from the sprinkler requirements of 13.3.2.15.1. [***101:***28.3.5.7]

New hotels and dormitories must be protected throughout by an approved, supervised automatic sprinkler system. The disproportionate percentage of deaths associated with residential occupancies and the conditions precipitating fatalities in hotel and dormitory settings (the need to wake sleeping occupants and to escape in unfamiliar surroundings) prompted the *Code* to require new hotels and dormitories to be provided with automatic sprinkler systems.

One objective of the *Code* is to protect occupants who are not intimate with the initial fire development from loss of life and to improve the survivability of those who are intimate with the fire development, as stated in 4.1.3.1.2.1. Based on that objective, new hotels and dormitories are required to use quick-response or residential sprinklers throughout guest rooms and guest suites per 13.3.2.15.4. The technology associated with quick-response and residential sprinklers helps to maintain tenability within the room of fire origin.

Per 13.3.2.16.1, an automatic sprinkler system is required in existing high-rise hotels and dormitories, unless every guest room or guest suite has exterior exit access. The presence of exterior exit access eliminates the need to traverse a corridor where conditions might not remain tenable.

The provisions of 13.3.2.15.2.1 through 13.3.2.15.2.1.2 are new to the 2018 edition of NFPA *1*. They are intended to provide attic protection to pedestal-type buildings (e.g., a four-story hotel situated atop a one-story, above-grade parking structure) that are protected by residential sprinkler systems in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, which permits the omission of sprinklers from attics under most conditions. Where the roof is located more than 55 ft (17 m) above the fire department access roadway as determined by 13.3.2.15.2.1.1 and 13.3.2.15.2.1.2, access to the roof for fire suppression operations via ladders can be hindered. The protection mandated by the four options in 13.3.2.15.2.1 (1) through (4) will help to mitigate the fire-fighting challenge posed by such high roofs.

13.3.2.16 Existing Hotels and Dormitories.

See the commentary following 13.3.2.15.5.

13.3.2.16.1 All high-rise buildings, other than those where each guest room or guest suite has exterior exit access in accordance with 7.5.3 of NFPA *101*, shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.3.2.16.2. [***101:***29.3.5.1]

13.3.2.16.2* Where an automatic sprinkler system is installed, either for total or partial building coverage, the system shall be in accordance with Section 13.3, as modified by 13.3.2.16.3 and 13.3.2.16.4. In buildings four or fewer stories in height and not exceeding 60 ft (18.3 m) in height above grade plane, systems in accordance with NFPA 13R shall be permitted. [***101:***29.3.5.3]

A.13.3.2.16.2 Although not required by NFPA *101*, the use of residential sprinklers or quick-response sprinklers is encouraged for new installations of sprinkler systems within dwelling units, apartments, and guest rooms. Caution should be exercised, as the system needs to be designed for the sprinkler being used. [***101:***A.29.3.5.3]

13.3.2.16.3 The provisions for draft stops and closely spaced sprinklers in NFPA 13 shall not be required for openings complying with 8.6.9.1 of NFPA *101* where the opening is within the guest room or guest suite. [***101:***29.3.5.4]

13.3.2.16.4 In guest rooms and in guest room suites, sprinkler installations shall not be required in closets not exceeding 24 ft² (2.2 m²) and in bathrooms not exceeding 55 ft² (5.1 m²). [***101:***29.3.5.5]

13.3.2.17 New Apartment Buildings.

13.3.2.17.1 All buildings shall be protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 13.3.2.17.2. [***101:***30.3.5.1]

Δ **13.3.2.17.2** Where an automatic sprinkler system is installed, either for total or partial building coverage, the system shall be in accordance with Section 13.3, as modified by 13.3.2.17.3 and 13.3.2.17.5. In apartment buildings up to and including four stories in height, that are located in buildings not exceeding 60 ft (18.3 m) in height above grade plane, systems in accordance with NFPA 13R shall be permitted. [***101:***30.3.5.2]

N **13.3.2.17.2.1** Where located in a building of Type III, Type IV, or Type V construction designed in accordance with 4.6.3(5) of NFPA *101*, and where the roof assembly is located more than 55 ft (17 m) above the lowest level of required fire department vehicle access, attics shall comply with 13.3.2.17.2.1.1, 13.3.2.17.2.1.2, and one of the following:

(1) Attics shall be provided with sprinkler protection.
(2) Attics shall be constructed with noncombustible materials.
(3) Attics shall be constructed with fire-retardant-treated wood.
(4) Attics shall be filled with noncombustible insulation.

[***101:***30.3.5.2.1]

N **13.3.2.17.2.1.1** The height of the roof assembly shall be determined by measuring the distance from the lowest level of required fire department vehicle access adjacent to the building to the eave of the highest pitched roof, the intersection of the highest roof to the exterior wall, or the top of the highest parapet, whichever yields the greatest distance. [***101:***30.3.5.2.1.1]

N **13.3.2.17.2.1.2** Required fire department vehicle access roads used in 13.3.2.17.2.1.1 shall include only those roads that are necessary for required fire department vehicle access in accordance with Section 18.2. [***101:***30.3.5.2.1.2]

13.3.2.17.3 In buildings sprinklered in accordance with NFPA 13, closets less than 12 ft² (1.1 m²) in area in individual dwelling units shall not be required to be sprinklered. Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size. [***101:***30.3.5.3]

Paragraph 13.3.2.17.3 exempts small closets from being sprinklered because of the limited fuel load characteristic of apartment unit closets. The closets exempted are limited to those within a living unit; closets in common building areas are not exempted. Also, any closet that contains HVAC equipment or washers and dryers is not permitted to take advantage of the sprinkler exemption due to the inherent ignition sources and combustible fuel load.

Δ **13.3.2.17.4** In buildings sprinklered in accordance with NFPA 13 bathrooms not greater than 55 ft² (5.1 m²) in individual dwelling units shall not be required to be sprinklered. [***101:***30.3.5.4]

13.3.2.17.5 The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with 8.6.9.1 of NFPA *101* where the convenience opening is within the dwelling unit. [***101:***30.3.5.5]

13.3.2.17.6 Listed quick-response or listed residential sprinklers shall be used throughout all dwelling units. [***101:***30.3.5.6]

The *Code* permits NFPA 13R to be used, within its scope, in place of NFPA 13. However, the provision of 13.3.2.17.6, which requires the use of listed quick-response sprinklers or listed residential sprinklers within dwelling units of new apartment buildings, supersedes any sprinkler options permitted by NFPA 13R or NFPA 13.

Δ **13.3.2.17.7** Open parking structures complying with NFPA 88A that are contiguous with apartment buildings shall be exempt from the sprinkler requirements of 13.3.2.17.1. [***101:***30.3.5.7]

13.3.2.17.8 Buildings with unprotected openings in accordance with 8.6.6 of NFPA *101* shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.3.2.17.1. [***101:***30.3.5.8]

13.3.2.18 Existing Apartment Buildings.

13.3.2.18.1* Where an automatic sprinkler system is installed, either for total or partial building coverage, the system shall be installed in accordance with Section 13.3, as modified by 13.3.2.18.2 and 13.3.2.18.4. In buildings four or fewer stories in height and not exceeding 60 ft (18.3 m) in height above grade plane, systems in accordance with NFPA 13R shall be permitted. [***101:***31.3.5.2]

A.13.3.2.18.1 Although not required by NFPA *101*, the use of residential sprinklers or quick-response sprinklers is encouraged for new installations of sprinkler systems within dwelling units, apartments, and guest rooms. Caution should be exercised, because the system needs to be designed for the sprinkler being used. [***101:***A.31.3.5.2]

13.3.2.18.2 In individual dwelling units, sprinkler installation shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size. [***101:***31.3.5.3]

Δ **13.3.2.18.3*** In buildings sprinklered in accordance with NFPA 13 bathrooms not greater than 55 ft^2 (5.1 m^2) in individual dwelling units shall not be required to be sprinklered. [***101:***31.3.5.4]

Δ **A.13.3.2.18.3** The provision of 13.3.2.18.3 differs from NFPA 13 because fire data shows that in apartment fires where sprinklers were present, bathrooms were the area of origin in 1 percent of the total fires, and resulted in no civilian deaths, civilian injuries, or property loss. [***101:***A.31.3.5.4]

13.3.2.18.4 The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with 8.6.9.1 of NFPA *101* where the convenience opening is within the dwelling unit. [***101:***31.3.5.5]

13.3.2.18.5 Buildings using Option 3 in accordance with NFPA *101* shall be provided with automatic sprinkler protection installed in accordance with 13.3.2.18.5.1 through 13.3.2.18.5.4. [***101:***31.3.5.9]

13.3.2.18.5.1 Automatic sprinklers shall be installed in the corridor, along the corridor ceiling, utilizing the maximum spacing requirements of the standards referenced in 13.3.1.2. [***101:***31.3.5.9.1]

13.3.2.18.5.2 An automatic sprinkler shall be installed within every dwelling unit that has a door opening to the corridor, with such sprinkler positioned over the center of the door, unless the door to the dwelling unit has not less than a 20-minute fire protection rating and is self-closing. [***101:***31.3.5.9.2]

13.3.2.18.5.3 The workmanship and materials of the sprinkler installation specified in 13.3.2.18.5 shall meet the requirements of 13.3.1.2. [***101:***31.3.5.9.3]

13.3.2.18.5.4 Where Option 3 is being used to permit the use of 1¾ in. (44 mm) thick, solid-bonded wood-core doors in accordance with 31.2.2.1.3 of NFPA *101*, sprinklers shall be provided within the exit enclosures in accordance with NFPA 13. [***101:***31.3.5.9.4]

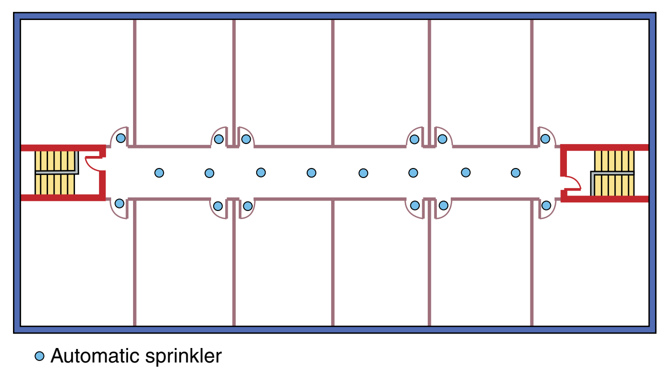
13.3.2.18.6 Buildings using Option 4 in accordance with NFPA *101* shall be protected throughout by an approved automatic sprinkler system in accordance with 13.3.2.18.1 and meeting the requirements of Section 13.3 for supervision for buildings seven or more stories in height. [***101:***31.3.5.10]

13.3.2.18.7* Where sprinklers are being used as an option to any requirement in this *Code*, the sprinklers shall be installed throughout the space in accordance with the requirements of that option. [***101:***31.3.5.11]

A.13.3.2.18.7 For example, if an Option 3 sprinkler system were being used to justify use of Class C wall finish in an exit enclosure, the sprinkler system would need to be extended into the exit enclosure, even if the rest of the requirements for Option 3 did not require the sprinklers in the exit enclosure. [***101:***A.31.3.5.11]

For existing apartment buildings, Option 3 and Option 4, as defined by 31.1.1.1 of NFPA *101*, require the installation of automatic sprinklers. Exhibit 13.5 illustrates the sprinkler location

Exhibit 13.5



Option 3 sprinkler protection for existing apartment buildings.

requirements for an Option 3 existing apartment building. A 20-minute fire protection–rated, self-closing corridor door is permitted by 13.3.2.18.5.2 to serve in lieu of the sprinklers positioned inside each apartment unit in the vicinity of the corridor door; however, the corridor sprinklers still must be provided.

13.3.2.19 Lodging or Rooming Houses.

13.3.2.19.1 All new lodging or rooming houses shall be protected throughout by an approved automatic sprinkler system in accordance with 13.3.2.19.2. [***101:***26.3.6.1]

If a new lodging or rooming house is part of a multiple occupancy and the occupancies are mixed, the entire mixed occupancy is required to be sprinklered. To waive this requirement, the occupancies would have to be arranged so that the lodging or rooming house is treated as a separate occupancy in accordance with 6.1.14.4. This arrangement would require the exit access for each occupancy to be separate. Doors that open directly to the outside from each of the occupancies usually achieve such independent exit access.

13.3.2.19.2 Where an automatic sprinkler system is required or is used as an alternative method of protection, either for total or partial building coverage, the system shall be in accordance with Section 13.3 and 13.3.2.19.2.1 through 13.3.2.19.2.6. [***101:***26.3.6.2]

13.3.2.19.2.1 Activation of the automatic sprinkler system shall actuate the fire alarm system in accordance with Section 13.7. [***101:***26.3.6.2.1]

13.3.2.19.2.2 In buildings four or fewer stories in height and not exceeding 60 ft (18.3 m) in height above grade plane, systems in accordance with NFPA 13R shall be permitted. [***101:***26.3.6.2.2]

13.3.2.19.2.3* Systems in accordance with NFPA 13D shall be permitted where all of the following requirements are met:

(1) The lodging or rooming house shall not be part of a mixed occupancy.
(2) Entrance foyers shall be sprinklered.
(3) Lodging or rooming houses with sleeping accommodations for more than eight occupants shall be treated as two-family dwellings with regard to the water supply.

[***101:***26.3.6.2.3]

A.13.3.2.19.2.3 The decision to permit the use of the criteria from NFPA 13D in these occupancies is based on the following:

(1) The desire to obtain a level of fire suppression and control that is approximately equivalent to that delivered by residential facilities protected by such systems (see A.1.1 in NFPA 13D)
(2) The fact that potential fire exposure and challenge to the suppression system in a small lodging and rooming occupancy is of the same nature and no more severe than that found in residences

[***101:***A.26.3.6.2.3]

Because there is such a wide variety of buildings that might fall into the classification of lodging or rooming houses, it is necessary to provide references to all three of the standards for the installation of automatic sprinkler systems.

The use of NFPA 13R is appropriate for many lodging or rooming houses.

In certain lodging or rooming house occupancies, the use of NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes,* is also appropriate. Some lodging or rooming houses are similar in physical configuration to a one- or two-family dwelling, whereas others are not. For example, an NFPA 13D system would be appropriate for a single-family dwelling that is used as a bed-and-breakfast (lodging or rooming house classification for purposes of applying this *Code*) but not for a fire station with a bunk room. The provision of 13.3.2.19.2.3(3) describes the provision of 6.5.2 of NFPA 13D, which specifies in multipurpose piping systems, where common water supply connections serve more than one dwelling unit, 5 gpm (19 L/min) must be added to the sprinkler system demand to determine the size of common piping and the size of the total water supply requirements where no provision is made to prevent flow into the domestic water system upon operation of a sprinkler.

13.3.2.19.2.4 In buildings sprinklered in accordance with NFPA 13, closets less than 12 ft^2 (1.1 m^2) in area in individual dwelling units shall not be required to be sprinklered. [***101:***26.3.6.2.4]

13.3.2.19.2.5 In buildings sprinklered in accordance with NFPA 13, closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size. [***101:***26.3.6.2.5]

13.3.2.19.2.6 In existing lodging or rooming houses, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101:***26.3.6.2.6]

13.3.2.20 One- and Two-Family Dwellings.

13.3.2.20.1 All new one- and two-family dwellings shall be protected throughout by an approved automatic sprinkler system in accordance with 13.3.2.20.2. [***101:***24.3.5.1]

Δ **13.3.2.20.2** Where an automatic sprinkler system is installed, either for total or partial building coverage, the system shall be in accordance with Section 13.3. [***101:***24.3.5.2]

In response to the unacceptable number of fire deaths occurring in one- and two-family dwellings on an annual basis (an average of 2570 civilian fire deaths per year in the United States for the period 2007–2011), the *Code*, starting with the 2006 edition, requires all new one- and two-family dwellings to be protected by automatic sprinkler systems. While the requirement for sprinkler systems in one- and two-family dwellings was new to the 2006 edition of the *Code*, the concept of residential sprinkler protection was not. As part of its decision to mandate sprinklers in new one- and two-family dwellings, the NFPA Technical Committee on Residential Occupancies evaluated economic and sprinkler success data from communities such as Scottsdale, Arizona, and Prince Georges County, Maryland, which have required sprinklers in new homes since 1986 and 1992, respectively. Data from the Scottsdale report have been updated to January 1, 2001, expanding its scope from 10 years to 15 years. Some of the highlights of the updated report (*Automatic Sprinklers: A 10 Year Study: A Detailed History of the Effects of the Automatic Sprinkler Code in Scottsdale, Arizona*) are as follows:

1. A total of 41,408 homes (more than 50 percent of the homes in Scottsdale) were protected by automatic sprinklers.
2. Since the sprinkler ordinance was implemented, 598 home fires occurred — 49 of which were in sprinklered homes.
   a. No fatalities occurred in the sprinklered homes.
   b. Thirteen people died in homes with no sprinklers.
3. There was less water damage in homes protected by sprinklers.
   a. Ninety-two percent of the fires in sprinklered homes were controlled by one or two sprinklers.
   b. Sprinkler systems discharged an average of 341 gal (1291 L) of water per fire.
   c. In nonsprinklered homes, fire fighter hose streams discharged an average of 2935 gal (11,110 L) of water per fire.
4. Fire damage was less in sprinklered homes.
   a. The average loss per fire in sprinklered homes was $2166 (1986–2001, 49 fires).
   b. The average loss per fire in nonsprinklered homes was $45,019 (1998–2001, 86 fires).
5. Technological advances have made residential sprinklers less costly and easier to install.
   a. On a national average, sprinkler systems add between 1 percent and 1.5 percent to the total cost of the construction of a home.
   b. In Scottsdale, the average installation cost was $0.80 per square foot ($8.61 per square meter) of floor area.

13.3.2.21 New Residential Board and Care Occupancies.

13.3.2.21.1 Large Facilities.

13.3.2.21.1.1 General. All buildings shall be protected throughout by an approved automatic sprinkler system installed in accordance with NFPA 13 and provided with quick-response or residential sprinklers throughout. [***101:***32.3.3.5.1]

13.3.2.21.1.2 Supervision. Automatic sprinkler systems shall be provided with electrical supervision in accordance with 13.3.1.8. [***101:***32.3.3.5.5]

13.3.2.21.2 Small Facilities.

13.3.2.21.2.1* All facilities, other than those meeting the requirement of 13.3.2.21.2.2, shall be protected throughout by an approved automatic sprinkler system, installed in accordance with 13.3.2.21.2.3, using quick-response or residential sprinklers. [***101:***32.2.3.5.1]

A.13.3.2.21.2.1 Where any provision requires the use of an automatic sprinkler system in accordance with 13.3.2.21.2, the provision of 13.3.2.21.2.2 is not permitted to be used. [***101:***A.32.2.3.5.1]

13.3.2.21.2.2* In conversions, sprinklers shall not be required in small board and care homes serving eight or fewer residents when all occupants have the ability as a group to move reliably to a point of safety within 3 minutes. [***101:***32.2.3.5.2]

A.13.3.2.21.2.2 Where a facility utilizing the provision of 13.3.2.21.2.2 contains residents who can no longer comply with the 3-minute evacuation response, 33.1.8 of NFPA *101* requires the facility to comply with the requirements for new construction, including automatic sprinkler protection. (See also A.33.1.8 of NFPA *101*.) [***101:***A.32.2.3.5.2]

Δ **13.3.2.21.2.3** Where an automatic sprinkler system is installed, for either total or partial building coverage, all of the following requirements shall be met:

(1) The system shall be in accordance with NFPA 13 and shall initiate the fire alarm system in accordance with 13.7.2.19.
(2) The adequacy of the water supply shall be documented to the AHJ.

[***101:***32.2.3.5.3]

13.3.2.21.2.3.1 In buildings four or fewer stories in height and not exceeding 60 ft (18.3 m) in height above grade plane, systems in accordance with NFPA 13R shall be permitted. All habitable areas, closets, roofed porches, roofed decks, and roofed balconies shall be sprinklered. [***101:***32.2.3.5.3.1]

Δ **13.3.2.21.2.3.2*** An automatic sprinkler system with a 30-minute water supply, and complying with all of the following requirements and with NFPA 13D, shall be permitted:

(1) All habitable areas, closets, roofed porches, roofed decks, and roofed balconies shall be sprinklered.
(2) Facilities with more than eight residents shall be treated as two-family dwellings with regard to water supply.

[***101:***32.2.3.5.3.2]

A.13.3.2.21.2.3.2 The decision to permit the use of the criteria from NFPA 13D in these occupancies is based on the following:

(1) The desire to obtain a level of fire suppression and control approximately equivalent to that delivered by residential facilities protected by such systems *(See A.1.1 in NFPA 13D.)*
(2) The fact that potential fire exposure and challenge to the suppression system in a small board and care facility are of the same nature and are no more severe than those found in residences

[***101:***A.32.2.3.5.3.2]

Chapter 13 permits the use of NFPA 13D and NFPA 13R outside of their scopes. This permission is based on a review of the occupancy and a recognition that the fires in board and care facilities are similar to those of other residential occupancies and that the level of protection is appropriate. The requirements of NFPA 13D and NFPA 13R have been supplemented with requirements for additional water supplies to compensate for the special needs of the board and care occupancy. [***101:***A.32.2.3.5.3.2]

NFPA 13D contains additional requirements for a piping system serving both sprinkler and domestic needs. [***101:***A.32.2.3.5.3.2]

13.3.2.21.2.4 Automatic sprinkler systems installed in accordance with NFPA 13 and NFPA 13R shall be provided with electrical supervision in accordance with 13.3.1.8. [***101:***32.2.3.5.4]

Δ **13.3.2.21.2.5** Automatic sprinkler systems installed in accordance with NFPA 13D shall be provided with valve supervision by one of the following methods:

(1) Single listed control valve that shuts off both domestic and sprinkler systems and separate shutoff for the domestic system only
(2) Electrical supervision in accordance with 13.3.1.8
(3) Valve closure that causes the sounding of an audible signal in the facility

[***101:***32.2.3.5.5]

Δ **13.3.2.21.2.6** Sprinkler piping serving not more than six sprinklers for any isolated hazardous area shall be permitted to be installed in accordance with 13.3.1.4 and shall meet all of the following requirements:

(1) In new installations, where more than two sprinklers are installed in a single area, waterflow detection shall be provided to initiate the fire alarm system required by 13.7.2.19.
(2) The duration of water supplies shall be as required by 13.3.2.21.2.3.2.

[***101:***32.2.3.5.6]

13.3.2.21.2.7 Attics shall be protected in accordance with 13.3.2.21.2.7.1 or 13.3.2.21.2.7.2. [***101:***32.2.3.5.7]

13.3.2.21.2.7.1 Where an automatic sprinkler system is required by 13.3.2.21.2, attics used for living purposes, storage, or fuel fired equipment shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 13.3.1.2. [***101:***32.2.3.5.7.1]

Δ **13.3.2.21.2.7.2** Where an automatic sprinkler system is required by 13.3.2.21.2, attics not used for living purposes, storage, or fuel-fired equipment shall meet one of the following criteria:

(1) Attics shall be protected throughout by a heat detection system arranged to activate the building fire alarm system in accordance with Section 13.7.
(2) Attics shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 13.3.1.2.
(3) Attics shall be of noncombustible or limited-combustible construction.
(4) Attics shall be constructed of fire-retardant-treated wood in accordance with NFPA 703.

[***101:***32.2.3.5.7.2]

13.3.2.22 Existing Residential Board and Care Facilities.

13.3.2.22.1 Large Facilities.

13.3.2.22.1.1* General. Where an automatic sprinkler system is installed, for either total or partial building coverage, the system shall be installed in accordance with Section 13.3, as modified by 13.3.2.22.1.1.1 through 13.3.2.22.1.1.3. [***101:***33.3.3.5.1]

A.13.3.2.22.1.1 It is intended that this requirement apply to existing small facilities that are converted to large facilities. [***101:***A.33.3.3.5.1]

Chapter 13 permits the use of NFPA 13D and NFPA 13R outside of their scopes. This permission is based on a review of the occupancy and a recognition that the fires in board and care facilities are similar to those of other residential occupancies and that the level of protection is appropriate. In some circumstances, such as those for impractical evacuation capabilities, the requirements of NFPA 13D and NFPA 13R have been supplemented with requirements for additional water supplies to compensate for the special needs of the board and care occupancy. [***101:***A.33.3.3.5.1]

13.3.2.22.1.1.1 In buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R shall be permitted. [***101:***33.3.3.5.1.1]

13.3.2.22.1.1.2 In facilities having prompt or slow evacuation capability, automatic sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with noncombustible or limited-combustible materials. [***101:***33.3.3.5.1.2]

13.3.2.22.1.1.3 Initiation of the fire alarm system shall not be required for existing installations in accordance with 13.3.2.22.1.6. [***101:***33.3.3.5.1.3]

13.3.2.22.1.2 Impractical Evacuation Capability. All facilities having impractical evacuation capability shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA 13. [***101:***33.3.3.5.2]

13.3.2.22.1.3 High-Rise Buildings. All high-rise buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.3.2.22.1. Such systems shall initiate the fire alarm system in accordance with 13.7.1.4. [***101:***33.3.3.5.3]

13.3.2.22.1.4 Attics shall be protected in accordance with 13.3.2.22.1.4.1 or 13.3.2.22.1.4.2. [***101:***33.3.3.5.4]

13.3.2.22.1.4.1 Where an automatic sprinkler system is installed, attics used for living purposes, storage, or fuel-fired equipment shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 13.3.1.2. [***101:***33.3.3.5.4.1]

Δ **13.3.2.22.1.4.2** Where an automatic sprinkler system is installed, attics not used for living purposes, storage, or fuel-fired equipment shall meet one of the following criteria:

(1) Attics shall be protected throughout by a heat detection system arranged to activate the building fire alarm system in accordance with Section 13.7.

(2) Attics shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 13.3.1.2.
(3) Attics shall be of noncombustible or limited-combustible construction.
(4) Attics shall be constructed of fire-retardant-treated wood in accordance with NFPA 703.

[***101:***33.3.3.5.4.2]

13.3.2.22.1.5 Supervision. Automatic sprinkler systems shall be supervised in accordance with Section 13.3; waterflow alarms shall not be required to be transmitted off-site. [***101:***33.3.3.5.5]

13.3.2.22.1.6 Domestic Water Supply Option. Sprinkler piping serving not more than six sprinklers for any isolated hazardous area in accordance with 13.3.1.4 shall be permitted; in new installations where more than two sprinklers are installed in a single area, waterflow detection shall be provided to initiate the fire alarm system required by 13.7.2.22. [***101:***33.3.3.5.6]

13.3.2.22.2 Small Facilities.

Δ **13.3.2.22.2.1** Where an automatic sprinkler system is installed, for either total or partial building coverage, all of the following requirements shall be met:

(1) The system shall be in accordance with Section 13.3 and shall initiate the fire alarm system in accordance with 13.7.2.21, as modified by 13.3.2.22.2.1.1 through 13.3.2.22.2.1.6.
(2) The adequacy of the water supply shall be documented to the AHJ.

[***101:***33.2.3.5.3]

Δ **13.3.2.22.2.1.1*** In prompt evacuation capability facilities, all of the following shall apply:

(1) An automatic sprinkler system in accordance with NFPA 13D shall be permitted.
(2) Automatic sprinklers shall not be required in closets not exceeding 24 ft² (2.2 m²) and in bathrooms not exceeding 55 ft² (5.1 m²), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier.

[***101:***33.2.3.5.3.1]

A.13.3.2.22.2.1.1 The decision to permit the use of the criteria from NFPA 13D in these occupancies is based on the following:

(1) The desire to obtain a level of fire suppression and control approximately equivalent to that delivered by residential facilities protected by such systems. *(See A.1.1 in NFPA 13D.)*
(2) The fact that potential fire exposure and challenge to the suppression system in a small board and care facility are of the same nature and are no more severe than those found in residences.

[***101:***A.32.2.3.5.3.1]

Chapter 13 permits the use of NFPA 13D and NFPA 13R outside of their scopes. This permission is based on a review of the occupancy and a recognition that the fires in board and care facilities are similar to those of other residential occupancies and that the level of protection is appropriate. In some circumstances, such as those for impractical evacuation capabilities, the requirements of NFPA 13D and NFPA 13R have been supplemented with requirements for additional water supplies to compensate for the special needs of the board and care occupancy.

[***101:***A.33.2.3.5.3.1]

Δ **13.3.2.22.2.1.2** In slow and impractical evacuation capability facilities, all of the following shall apply:

(1) An automatic sprinkler system in accordance with NFPA 13D, with a 30-minute water supply, shall be permitted.
(2) All habitable areas and closets shall be sprinklered.
(3) Automatic sprinklers shall not be required in bathrooms not exceeding 55 ft² (5.1 m²), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier.

[***101:***33.2.3.5.3.2]

13.3.2.22.2.1.3 In prompt and slow evacuation capability facilities, where an automatic sprinkler system is in accordance with NFPA 13, sprinklers shall not be required in closets not exceeding 24 ft² (2.2 m²) and in bathrooms not exceeding 55 ft² (5.1 m²), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier. [***101:***33.2.3.5.3.3]

13.3.2.22.2.1.4 In prompt and slow evacuation capability facilities in buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R shall be permitted. [***101:***33.2.3.5.3.4]

13.3.2.22.2.1.5 In impractical evacuation capability facilities in buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R shall be permitted. All habitable areas and closets shall be sprinklered. Automatic sprinklers shall not be required in bathrooms not exceeding 55 ft² (5.1 m²), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier. [***101:***33.2.3.5.3.5]

13.3.2.22.2.1.6 Initiation of the fire alarm system shall not be required for existing installations in accordance with 13.3.2.22.3. [***101:***33.2.3.5.3.6]

13.3.2.22.2.2 All impractical evacuation capability facilities shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.3.2.22.2.1. [***101:***33.2.3.5.3.7]

Δ **13.3.2.22.3** Sprinkler piping serving not more than six sprinklers for any isolated hazardous area shall be permitted to be installed in accordance with 13.3.1.4 and shall meet all of the following requirements:

(1) In new installations, where more than two sprinklers are installed in a single area, waterflow detection shall be provided to initiate the fire alarm system required by 13.7.2.21.
(2) The duration of water supplies shall be as required for the sprinkler systems addressed in 13.3.2.22.2.1.

[***101:***33.2.3.5.6]

13.3.2.22.4 Attics shall be protected in accordance with 13.3.2.22.4.1 or 13.3.2.22.4.2. [***101:***33.2.3.5.7]

13.3.2.22.4.1 Where an automatic sprinkler system is installed, attics used for living purposes, storage, or fuel-fired equipment shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 13.3.1.2. [***101:***33.2.3.5.7.1]

Δ **13.3.2.22.4.2** Where an automatic sprinkler system is installed, attics not used for living purposes, storage, or fuel-fired equipment shall meet one of the following criteria:

(1) Attics shall be protected throughout by a heat detection system arranged to activate the building fire alarm system in accordance with Section 13.7.
(2) Attics shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 13.3.1.2.
(3) Attics shall be of noncombustible or limited-combustible construction.
(4) Attics shall be constructed of fire-retardant-treated wood in accordance with NFPA 703.
(5) Attics shall be protected by heat alarms arranged to provide occupant notification in accordance with 33.2.3.4.2.

[***101:***33.2.3.5.7.2]

13.3.2.23 New Mercantile Occupancies.

Δ **13.3.2.23.1** Mercantile occupancies shall be protected by an approved automatic sprinkler system in accordance with NFPA 13 in any of the following specified locations:

(1) Throughout all mercantile occupancies three or more stories in height
(2) Throughout all mercantile occupancies exceeding 12,000 ft^2 (1115 m^2) in gross area
(3) Throughout stories below the level of exit discharge where such stories have an area exceeding 2500 ft^2 (232 m^2) and are used for the sale, storage, or handling of combustible goods and merchandise
(4) Throughout multiple occupancies protected as mixed occupancies in accordance with 6.1.14 where the conditions of 13.3.2.23.1(1), (2), or (3) apply to the mercantile occupancy

[***101:***36.3.5.1]

13.3.2.23.2 Automatic sprinkler systems in Class A mercantile occupancies shall be supervised in accordance with 13.3.1.8. [***101:***36.3.5.2]

All basement areas larger than 2500 ft^2 (232 m^2) and used for the sales, storage, or handling of combustible merchandise must be sprinklered per 13.3.2.23.1 and 13.3.2.24.1 to avoid the potential threat to occupants of the floors above. Studies have shown that there is a higher rate of fire incidence in basements than in other areas of stores. Because smoke and heat rise, a fire in a basement can quickly render exits and exit discharges located on the street floor unusable. This danger is especially acute in mercantile occupancies, where allowances for various vertical openings in accordance with the provisions of 36/37.3.1 of NFPA *101* are more lenient than those for many other occupancies.

13.3.2.23.3 Extinguishing Requirements. Bulk merchandising retail buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3 and the applicable provisions of the following:

(1) This *Code*
(2) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(3) NFPA 30, *Flammable and Combustible Liquids Code*
(4) NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*

[***101:***36.4.5.5]

Bulk merchandising retail buildings provide life safety challenges that differ from those of typical mercantile occupancies. Fires in bulk merchandising retail buildings demonstrate the need for specific requirements to help ensure the adequate life safety of building occupants. The provisions of 36/37.4.5 of NFPA *101* apply to new bulk merchandising retail buildings exceeding 12,000 ft^2 (1115 m^2) and existing facilities exceeding 15,000 ft^2 (1400 m^2).

The term *bulk merchandising retail building* (see definition in 3.3.192.4) refers to occupancies with storage height in excess of 12 ft (3660 mm), which differentiates such a building from typical mercantile occupancies. If the storage and display of combustible materials exceeds 12 ft (3660 mm) in height, the requirements of 36/37.4.5 of NFPA *101* are to be applied.

13.3.2.23.4 Mall Buildings.

13.3.2.23.4.1 Automatic Extinguishing Systems.

13.3.2.23.4.1.1 The mall structure and all anchor buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA 13 and 13.3.2.23.4.1.2. [***101:***36.4.4.13.1]

13.3.2.23.4.1.2 The system shall be installed in such a manner that any portion of the system serving tenant spaces can be taken out of service without affecting the operation of the portion of the system serving the mall concourse. [***101:***36.4.4.13.2]

The design practice described in 13.3.2.23.4.1.2 permits the installation, addition, or modification of automatic sprinkler protection within the individual tenant spaces without affecting the level of protection in other areas of the building, particularly in the mall. It is recognized that renovation projects are frequently conducted in mall buildings where tenant leases and other business considerations cause modifications to the design and arrangement of tenant spaces. When construction to modify these spaces occurs, the sprinkler systems are frequently taken out of service. The maintenance of sprinkler protection is of prime importance in the overall level of protection required for buildings of this nature, particularly where certain spaces, specifically the mall (pedestrian way), are used as a portion of a means of egress. The effect of this provision is to minimize the area and duration of interruption to sprinkler protection for the mall building.

13.3.2.23.4.2 Hose Connections.

13.3.2.23.4.2.1 There shall be a hose outlet connected to a system sized to deliver 250 gal/min (946 L/min) at the most hydraulically remote outlet. [**5000:**27.4.4.8.2.1]

13.3.2.23.4.2.2 The outlet shall be supplied from the mall concourse zone sprinkler system and shall be hydraulically calculated. [**5000:**27.4.4.8.2.2]

13.3.2.23.4.2.3 Hose outlets shall be provided at each of the following locations:

(1) Within the mall concourse at the entrance to each exit passage or corridor
(2) At each floor level landing within enclosed stairways opening directly onto the mall concourse
(3) At exterior public entrances to the mall concourse

[***5000:***27.4.4.8.2.3]

13.3.2.24 Existing Mercantile Occupancies.

See the commentary related to 13.3.2.23 and its subparagraphs.

Δ **13.3.2.24.1** Mercantile occupancies, other than one-story buildings that meet the requirements of a street floor, as defined in 3.3.192.19, shall be protected by an approved automatic sprinkler system in accordance with NFPA 13 in any of the following specified locations:

(1) Throughout all mercantile occupancies with a story over 15,000 ft^2 (1400 m^2) in area
(2) Throughout all mercantile occupancies exceeding 30,000 ft^2 (2800 m^2) in gross area
(3) Throughout stories below the level of exit discharge where such stories have an area exceeding 2500 ft^2 (232 m^2) and are used for the sale, storage, or handling of combustible goods and merchandise
(4) Throughout multiple occupancies protected as mixed occupancies in accordance with 6.1.14 where the conditions of 13.3.2.24.1(1), (2), or (3) apply to the mercantile occupancy

[***101:***37.3.5.1]

13.3.2.24.2 Bulk merchandising retail buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3 and the applicable provisions of the following:

(1) This *Code*
(2) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(3) NFPA 30, *Flammable and Combustible Liquids Code*
(4) NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*

[***101:***37.4.5.5]

13.3.2.25 Underground and Limited Access Structures. Underground and limited access structures, and all areas and floor levels traversed in traveling to the exit discharge, shall be protected by an approved, supervised automatic sprinkler system in accordance with Section 13.3, unless such structures meet one of the following criteria:

(1) They have an occupant load of 50 or fewer persons in new underground or limited access portions of the structure.
(2) They have an occupant load of 100 or fewer persons in existing underground or limited access portions of the structure.
(3) The structure is a one-story underground or limited access structure that is permitted to have a single exit, per Chapters 12 through 43 of NFPA *101*, with a common path of travel not greater than 50 ft (15 m).

[***101:***11.7.3.4]

Limited access and underground structures pose enhanced risks to life safety, because the buildings cannot be easily vented of products of combustion. In an area from which there is no direct access to the outside and where there are no windows to allow outside fire department rescue operations and ventilation, fire or smoke might cause occupants to panic. Therefore, additional corrective measures, such as complete automatic sprinkler protection and automatic smoke-venting systems (as required by NFPA *101*), must be provided where necessary to ensure an adequate level of life safety.

13.3.2.26 High-Rise Buildings.

13.3.2.26.1 New high-rise buildings shall be protected throughout by an approved automatic sprinkler system in accordance with Section 13.3.

Fires in high-rise buildings present unusual challenges to fire fighters. Fire-fighting equipment, including hose, tools, self-contained breathing apparatus, and spare air cylinders, often must be carried up many flights of stairs to the fire floor. The same stairways used by fire fighters to move equipment to the fire floor might also be used simultaneously by evacuating occupants.

Serious high-rise fires also usually require large numbers of fire fighters to search for and assist people evacuating the building. In other cases, fire fighters are required to assure occupants that they are safe in areas of the building not directly affected by the fire.

High-rise buildings are often subject to unusual air movement conditions, which can push fire from the compartment of origin into corridors. This situation makes it more difficult for occupants of the story of fire origin to evacuate and increases the danger to fire fighters trying to get onto the fire floor to rescue occupants or attack the fire. Ventilation of high-rise buildings is difficult, because breaking windows on upper stories can send broken glass onto fire fighters and others below. For these and other reasons, automatic sprinklers are required to contain and keep fires small, allowing fire fighters to effect extinguishment quickly.

13.3.2.26.2* Existing high-rise buildings shall be protected throughout by an approved automatic sprinkler system in accordance with this chapter and 13.3.2.26.2.1 through 13.3.2.26.2.3.

A.13.3.2.26.2 The enabling legislation adopting this *Code* should specify a specific date for compliance with 13.3.2.26.2. Building owners and managers should be notified of this requirement within 180 days of code adoption. The following items should be considered by the AHJ as guidance in evaluating compliance plans:

(1) Shortage of qualified contractors to install sprinkler systems
(2) Impact on owners and tenants as a result of existing conditions contained in lease agreements
(3) Environmental constraints resulting from contaminated material being removed from limited areas of the building during installation of sprinklers and attendant activity
(4) Available time to install sprinklers in the occupied spaces
(5) Financial constraints of owners being able to fund the cost of installing automatic sprinklers with associated costs
(6) Ability of the owner to coordinate general building remodeling with the actual sprinkler retrofit process

13.3.2.26.2.1 Each building owner shall, within 180 days of receiving notice, file an intent to comply with this regulation with the AHJ for approval.

13.3.2.26.2.2 The AHJ shall review and respond to the intent-to-comply submittal within 60 days of receipt.

13.3.2.26.2.3* The entire building shall be required to be protected by an approved automatic sprinkler system within 12 years of adoption of this *Code*.

A.13.3.2.26.2.3 Examples of retrofit schedules can include the following:

(1) Plan submitted and approved within 1 year; 33 percent of square footage completed within 4 years; 66 percent of square footage completed within 8 years; 100 percent of square footage completed within 12 years.
(2) Plans submitted and approved with 1 year; all common areas completed within 4 years; 50 percent of remaining area completed within 8 years; 100 percent of remaining area completed within 12 years.
(3) An alternative schedule can be approved by the AHJ that does not have any intermediary stages but has to be 100 percent complete within 8 years.

When notifying building owners of the need to comply with the requirement for automatic sprinkler systems in existing high-rise buildings, the AHJ should specify the information to be included in the owner's intent-to-comply notification. Existing buildings might contain asbestos, which necessitates the use of specific mitigation measures during the sprinkler system installation process. The intent-to-comply notification should contain a schedule to allow sufficient time for completion, as well as time for possible delays due to unforeseen circumstances. The building owner must also ensure that the schedule complies with the 12-year requirement of 13.3.2.26.2.3.

13.3.2.27* New Storage Occupancies.

A.13.3.2.27 For the purpose of the requirements in 13.3.2.27.1 through 13.3.2.27.3, combustibles include all combustible materials in storage as well as noncombustible materials that are enclosed, encapsulated, or packaged in combustible materials.

13.3.2.27.1 High-Piled Storage. An automatic sprinkler system shall be installed throughout all occupancies containing areas greater than 2500 ft^2 (232 m^2) for the high-piled storage of combustibles.

13.3.2.27.2* General Storage. An automatic sprinkler system shall be installed throughout all occupancies containing areas greater than 12,000 ft^2 (1115 m^2) for the storage of combustibles.

A.13.3.2.27.2 Portions of structures that are subdivided by fire walls can be considered to be separate buildings for the purpose of applying this *Code*. Fire walls by their definition have sufficient structural stability to maintain the integrity of the wall in the event of the collapse of the building construction on either side of the wall.

13.3.2.27.3 An automatic sprinkler system shall be installed throughout all occupancies containing storage commodities classified as Group A Plastics in excess of 5 ft (1.5 m) in height over an area exceeding 2500 ft^2 (232 m^2) in area.

13.3.2.27.4 Mini-Storage Building. An automatic sprinkler system shall be installed throughout all mini-storage buildings greater than 2500 ft^2 (232 m^2) and where any of the individual storage units are separated by less than a 1-hour fire resistance–rated barrier. [**5000:**30.3.5.3]

13.3.2.27.5 Bulk Storage of Tires. Buildings and structures where the volume for the storage of tires exceeds 20,000 ft^3 (566 m^3) shall be equipped throughout with an approved automatic fire sprinkler system. [**5000:**30.3.5.2]

13.3.2.28 Woodworking Operations. An approved automatic fire sprinkler system shall be installed in buildings containing woodworking operations exceeding 2500 ft^2 (232 m^2) that use equipment, machinery, or appliances; that generate finely divided combustible waste; or that use finely divided combustible materials. [**5000:**29.3.5.1.2]

13.3.2.29 New and Existing Day Care. Buildings with unprotected openings in accordance with 8.6.6 of NFPA *101* shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***16.3.5.3; ***101:***17.3.5.3]

13.3.2.30 New Industrial Occupancies. New industrial occupancies, other than low-hazard industrial occupancies, shall be protected by an approved automatic sprinkler system in accordance with NFPA 13 in any of the following locations:

(1) Throughout all industrial occupancies three or more stories in height
(2) Throughout all industrial occupancies exceeding 12,000 ft^2 (1115 m^2) in fire area
(3) Where the total area of all floors, including mezzanines, exceeds 24,000 ft^2 (2230 m^2)

[**5000:**29.3.5.1.1]

13.3.3 Inspection, Testing, and Maintenance.

13.3.3.1 A sprinkler system installed in accordance with this *Code* shall be properly maintained to provide at least the same level of performance and protection as designed. The owner shall be responsible for maintaining the system and keeping it in good working condition.

13.3.3.2 A sprinkler system installed in accordance with this *Code* shall be inspected, tested, and maintained in accordance with NFPA 25.

13.3.3.3 Ceiling Tiles and Ceiling Assemblies. Where automatic sprinklers are installed, ceilings necessary for the proper actuation of the fire protection device in accordance with NFPA 13 shall be maintained.

13.3.3.4 General Requirements.

13.3.3.4.1 Responsibility of the Property Owner or Designated Representative.

13.3.3.4.1.1* Responsibility for Inspection, Testing, Maintenance, and Impairment. The property owner or designated representative shall be responsible for properly maintaining a water-based fire protection system. [**25:**4.1.1]

In many jurisdictions, NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, is adopted through a model code or state law. However, due to a lack of manpower, AHJs often cannot actively enforce the standard in those jurisdictions. Even if the AHJ is not actively seeking the inspection, testing, and maintenance (ITM) inspection report, the owner still must follow the ITM program outlined by NFPA 25.

A.13.3.3.4.1.1 Any portion or all of the inspection, testing, and maintenance can be permitted to be contracted with an inspection, testing, and maintenance service. When an inspection, testing, and maintenance service company agrees to perform inspections and tests at a specific frequency required by this standard, the inspection, testing, and maintenance service company should perform all inspections and tests that are required more frequently than the specified frequency. For example, the ITM service provider agrees to perform required inspections and tests on an annual basis. Those inspections and tests required on a daily, weekly, quarterly, and semi-annual frequency should also be performed during the annual inspections and tests. [**25:**A.4.1.1]

13.3.3.4.1.1.1* Inspection, testing, maintenance, and impairment procedures shall be implemented in accordance those established in this document and in accordance with the manufacturer's instructions. [**25:**4.1.1.1]

As stated in Chapter 1 of NFPA 25, the requirements found in NFPA 25 are minimum requirements. Along with those minimum requirements, as indicated in this 13.3.3.4.1.1.1, ITM requirements found in manufacturers' instructions must be followed as well.

A.13.3.3.4.1.1.1 In order to ensure compliance, the owner should verify that windows, skylights, doors, ventilators, other openings and closures, concealed spaces, unused attics, stair towers, roof houses, and low spaces under buildings do not expose water-filled piping to freezing. This should occur prior to the onset of cold weather and periodically thereafter. [**25:**A.4.1.1.1]

13.3.3.4.1.1.2 Inspection, testing, and maintenance shall be performed by qualified personnel. [**25:**4.1.1.2]

The term *qualified* is defined in 3.3.34 of NFPA 25 and should not be confused with *licensed*. Qualification is the minimum level of training and expertise that NFPA 25 requires, whereas licensing is a governmental function. Regardless of whether the jurisdiction requires a license to perform ITM work, the person doing the work must be qualified. There are many levels of qualification as defined by NFPA 25. For example, building maintenance personnel might be qualified to inspect valves to ensure they remain in the correct position but might not be qualified to perform an internal inspection of some valves as required by Chapter 13 of this *Code*.

Although all ITM functions require at least some training, many of the individual tasks can be performed with minimal training and experience. Looking at a gauge to determine that it is still indicating normal pressure, for example, might be something that a trained building maintenance person can do.

As indicated earlier in this section, NFPA 25 assigns all ITM responsibilities to the owner. The owner can contract some or all of these functions out to a qualified contractor. Nothing in the standard is meant to prevent the owner from performing the tasks as long as the owner is qualified to do so. One important fact to keep in mind, however, is that the determination of qualification ultimately rests with the AHJ. The owner should verify any jurisdictional requirements before embarking on an in-house ITM program of any sort.

N **13.3.3.4.1.1.2.1*** The owner shall coordinate with the entity conducting the inspection, testing, and maintenance activities to minimize any water damage caused by the discharge of water. [**25:**4.1.1.2.1]

13.3.3.4.1.1.3* Where the property owner or designated representative is not the occupant, the property owner or designated representative shall be permitted to delegate the authority for inspecting, testing, maintenance, and the managing of impairments of the fire protection system to a designated representative. [**25:**4.1.1.3]

N **A.13.3.3.4.1.1.3** Water-based systems rely on the adequacy and ongoing maintenance of drainage systems such as roof drains storm drains and floor drains, during flowing water as part of testing systems. These systems are often used for other purposes than fire system testing and are not part of the fire protection system. They are often designed and maintained as part of building plumbing systems. [**25:**A.4.1.1.2.1]

Anytime water is released, consideration must be given to where that water might ultimately end up. This is not only a responsibility of the person performing the ITM, as required by 13.2.4 of NFPA 25, but must also involve the owner or designated representative. The owner or designated representative, such as maintenance personnel, is often more familiar with the condition of the plumbing system or the drainage characteristics of the surrounding area.

NOTE: The annex material was inadvertently misnumbered. Annex material A.13.3.3.4.1.1.3 should be associated with 13.3.3.4.1.1.2.1, and A.13.3.3.4.1.1.4 should be associated with 13.3.3.4.1.1.3. The text in 13.3.3.4.1.1.2.1 is new to the 2017 edition of NFPA 25.

13.3.3.4.1.1.4 Where a designated representative has received the authority for inspecting, testing, maintenance, and the managing of impairments, the designated representative shall comply with the requirements identified for the property owner or designated representative throughout this *Code*. [**25:**4.1.1.4]

A.13.3.3.4.1.1.4 Examples of designated representatives can include the occupant, management firm, or managing individual through specific provisions in the lease, written use agreement, or management contract. [**25:**A.4.1.1.3]

See the Note in the preceding commentary regarding Annex A material.

13.3.3.4.1.2* Freeze Protection. The property owner or designated representative shall ensure that water-filled piping is maintained at a minimum temperature of 40°F (4.0°C) unless an approved anti-freeze solution is utilized. [**25:**4.1.2]

Sprinkler system freeze-ups are a matter of simple physics. When untreated water reaches a temperature of 32°F (0°C), it begins to freeze. This is not a "failure" of the sprinkler system, but a matter of not preventing the system from being exposed to freezing temperatures. Section 1.1 of NFPA 25 states that the scope of that standard is to establish the ITM of water-based fire protection systems. Verifying the condition of the heating system in the building or identifying holes in walls that can let in cold weather is not part of the requirements of NFPA 25.

When a sprinkler system does freeze, it often requires expensive repairs to the system and to the building if water is discharged through broken pipe, fittings, or sprinklers. In addition, the sprinkler system is impaired, which creates a heightened risk of loss from a fire event. For those reasons, NFPA 25 establishes the requirement for maintaining building temperature and places the responsibility for this important task on the owner. Note that 13.3.3.4.1.2 specifically refers to an "approved" antifreeze solution.

The requirements for antifreeze systems have changed drastically since the 2011 edition of NFPA 25 was published. As outlined in Chapter 5 of NFPA 25, an acceptable antifreeze solution would be a solution with 30 percent propylene glycol or less or a solution with 38 percent glycerine or less. These solutions have been deemed acceptable for existing systems based on test data that have shown that solutions with this concentration of antifreeze do not increase the heat release rate of a fire when the solution is discharged.

Another design approach that might be acceptable would be an antifreeze solution that has been approved by the AHJ as described in a deterministic risk assessment. Refer to 5.3.3.4.1 of NFPA 25 for more information on deterministic risk assessments for antifreeze systems.

Δ **A.13.3.3.4.1.2** In areas that have the potential for freezing temperatures below the level that can be adequately protected by an allowable antifreeze solution, supplemental heat can be provided when temperatures fall below the level of the antifreeze solution. Other means of freeze protection for water-filled piping, including heated valve enclosures, heat tracing, insulation, or other methods are allowed by the applicable installation standard. Installation standards require heat tracing protecting fire protection piping against freezing to be supervised. [**25:**A.4.1.2]

13.3.3.4.1.2.1 All areas of the building containing water-filled piping that does not have another means of freeze protection shall be maintained at a minimum temperature of 40°F (4.0°C). [**25:**4.1.2.1]

13.3.3.4.1.2.2 Aboveground water-filled pipes that pass through open areas, cold rooms, passageways, or other areas exposed to temperatures below 40°F (4.0°C), protected against freezing by insulating coverings, frostproof casings, listed heat tracing systems, or other reliable means shall be maintained at temperatures between 40°F (4.0°C) and 120°F (48.9°C). [**25:**4.1.2.2]

13.3.3.4.1.2.3 Where other approved means of freeze protection for water-filled piping as described in 13.3.3.4.1.2.2 are utilized they shall be inspected, tested, and maintained in accordance with NFPA 25. [**25:**4.1.2.3]

This paragraph clarifies that when means other than running water-filled piping through heated areas are utilized, those means become an important part of the reliability of the fire protection system and must be maintained accordingly.

13.3.3.4.1.3* Accessibility. The property owner or designated representative shall provide ready accessibility to components of water-based fire protection systems that require inspection, testing, and maintenance. [**25:**4.1.3]

A.13.3.3.4.1.3 The components are not required to be open or exposed. Doors, removable panels, or valve pits can be permitted to satisfy the need for accessibility. Such equipment should not be obstructed by features such as walls, ducts, columns, direct burial, or stock storage. [**25:**A.4.1.3]

The requirement in 13.3.3.4.1.3 for accessibility is intended to address the all-too-common practice of placing objects such as file cabinets or stock in front of sprinkler risers and other control equipment. This requirement is not limited to the interior of the building. Exterior components of the system must be kept accessible as well. Exhibit 13.6 shows a fire department connection (FDC) that has been obstructed by shrubbery. Exterior components such as post indicator valves and FDCs might also be blocked by dumpsters and outdoor storage, as shown in Exhibit 13.7, and even snow piles as a result of plowing and shoveling, as shown in Exhibit 13.8.

Exhibit 13.6

FDC obstructed by shrubbery.

Exhibit 13.7

FDC obstructed and inaccessible due to exterior storage. (Courtesy of Byron Blake and SimplexGrinnell)

Exhibit 13.8

FDC obstructed by snow. (Courtesy of Byron Blake and SimplexGrinnell)

13.3.3.4.1.4 Notification of System Shutdown or Testing. The property owner or designated representative shall notify the AHJ, the fire department, if required, and the alarm-receiving facility before testing or shutting down a system or its supply. [**25:**4.1.4]

Paragraph 13.3.3.4.1.4 establishes the requirement for notification when systems are removed from service. Testing a system without proper notification might — and often does — result in a false alarm. False alarms must be avoided, since they remove emergency services personnel from service at a time when their might be needed for an actual emergency. In many jurisdictions, repeated false alarms can result in a fine or other penalty for property owners. When flowing an inspector's test connection, it may be obvious that an alarm is intended to sound upon waterflow and that the supervisory service must be notified as prescribed by 13.3.3.4.1.4. Perhaps not so obvious is the fact that other tests, such as a fire pump test, hydrant test, or main drain test, can also lead to the tripping of a waterflow switch, which will sound an alarm and, potentially, send a signal to the fire department. At the conclusion of such tests, the alarm-receiving facility should be notified that any alarms received from that point on are not test generated and should be responded to appropriately.

13.3.3.4.1.4.1 The notification of system shutdown or test shall include the purpose for the shutdown, the system or component involved, the estimated time of shutdown or test, and the expected duration of the shutdown or test. [**25:**4.1.4.1]

13.3.3.4.1.4.2 The AHJ, the fire department, and the alarm-receiving facility shall be notified when the system, supply, or component is returned to service or when the test is complete. [**25:**4.1.4.2]

The requirement in 13.3.3.4.1.4.2 assists the AHJ or alarm company in establishing a follow-up program to ensure that systems are properly returned to service.

13.3.3.4.1.5* Corrections and Repairs.

A.13.3.3.4.1.5 Recalled products should be replaced or remedied. Remedies include entrance into a program for scheduled replacement. Such replacement or remedial product should be installed in accordance with the manufacturer's instructions and the appropriate NFPA installation standards. A recalled product is a product subject to a statute or administrative regulation specifically requiring the manufacturer, importer, distributor, wholesaler, or retailer of a product, or any combination of such entities, to recall the product, or a product voluntarily recalled by a combination of such entities. [**25:**A.4.1.5]

Needed corrections and repairs should be classified as an impairment, critical deficiency, or noncritical deficiency according to the effect on the fire protection system and the nature of the hazard protected. [**25:**A.4.1.5]

Impairments are the highest priority problem found during inspection, testing, and maintenance and should be corrected as soon as possible. The fire protection system cannot provide an adequate response to a fire, and implementation of impairment procedures outlined in 13.3.3.6 is required until the impairment is corrected. [**25:**A.4.1.5]

Critical deficiencies need to be corrected in a timely fashion. The fire protection system is still capable of performing, but its performance can be impacted and the implementation of impairment procedures might not be needed. However, special consideration must be given to the hazard in the determination of the classification. A deficiency that is critical for one hazard might be an impairment in another. [**25:**A.4.1.5]

Noncritical deficiencies do not affect the performance of the fire protection system but should be corrected in a reasonable time period so that the system can be properly inspected, tested, and maintained. [**25:**A.4.1.5]

Assembly occupancies, health care facilities, prisons, high- rise buildings, other occupancies where the life safety exposure is significant, or facilities that cannot be evacuated in a timely manner require special consideration. As an example, a nonfunctioning waterflow alarm might be considered a critical deficiency in a storage warehouse but an impairment in a hospital. [**25:**A.4.1.5]

High hazard occupancies where early response to a fire is critical also require special consideration. A small number of painted sprinklers could be considered an impairment for a system protecting a high hazard occupancy but might be considered a critical deficiency in a metal working shop. [**25:**A.4.1.5]

Classifications of needed corrections and repairs are shown in Table A.3.3.7 of NFPA 25. [**25:**A.4.1.5]

One of the most common misapplications of NFPA 25 comes from not understanding the document scope completely. NFPA 25 is intended to confirm the functionality of the system components that are installed, not to ensure that the designer has designed the system correctly and observed the rules of the design and installation standard.

This misapplication of scope can often lead to arguments among owners, inspectors, and AHJs when certain conditions exist in a building. In some cases, the owner has the expectation that the hired inspector is not only looking for "wear and tear" items associated with the water-based systems but also giving the system a clean bill of health from a design perspective as well. The level of effort to produce this clean bill of health is significantly more than what the standard intends and requires an inspector to deliver.

Simply put, if a condition that is found in the field does not comply with the design standard, but the components observed are in good working condition, it would not be considered a deficiency or impairment per NFPA 25.

Δ **13.3.3.4.1.5.1*** The property owner or designated representative shall correct or repair deficiencies or impairments. [**25:**4.1.5.1]

A.13.3.3.4.1.5.1 System deficiencies not explained by normal wear and tear, such as hydraulic shock, can often be indicators of system problems and should be investigated and evaluated by a qualified person or engineer. Failure to address these issues could lead to catastrophic failure. Examples of deficiencies that can be caused by issues beyond normal wear and tear are as follows:

(1) Pressure gauge deficiencies as follows:
  (a) Gauge not returning to zero
  (b) Gauge off scale
  (c) Gauge with bent needle
(2) Support devices deficiencies as follows:
  (a) Bent hangers and/or rods
  (b) Hangers pulled out/off structure
  (c) Indication of pipe or hanger movement such as the following:
    i. Hanger scrape marks on pipe, exposed pipe surface where pipe and hangers are painted
    ii. Firestop material damaged at pipe penetration of fire-rated assembly
(3) Unexplained system damage as follows:
  (a) Unexplained system damage beyond normal wear and tear
  (b) Bent or broken shafts on valves
  (c) Bent or broken valve clappers
  (d) Unexplained leakage at branch lines, cross main, or feed main piping
  (e) Unexplained leakage at closed nipples
  (f) Loose bolts on flanges and couplings
(4) Fire pump deficiencies as follows:
  (a) Fire pump driver out of alignment
  (b) Vibration of fire pump and/or driver
  (c) Unusual sprinkler system piping noises (sharp report, loud bang)

[**25:**A.4.1.5.1]

It should be noted that many jurisdictions regulate who can perform corrections and repairs, along with regulating specific licensing or certification requirements. In the case of corrections that do not involve the fire protection contractor, special attention should be paid to how these corrections are documented.

13.3.3.4.1.5.2 Corrections and repairs shall be performed by qualified maintenance personnel or a qualified contractor. [**25:**4.1.5.2]

13.3.3.4.1.6* Changes in Occupancy, Use, Process, or Materials. The property owner or designated representative shall not make changes in the occupancy, the use or process, or the materials used or stored in the building without evaluation of the fire protection system(s) for its capability to protect the new occupancy, use, or materials. [**25:**4.1.6]

A.13.3.3.4.1.6 The inspections and tests specified in this *Code* do not address the adequacy of design criteria or the capability of the fire protection system to protect the building or its contents. It is assumed that the original system design and installation were appropriate for the occupancy and use of the building and were approved by all applicable AHJs. If no changes to the water supply or to the building or its use have transpired since it was originally occupied, no evaluation is required. If changes are contemplated, it is the owner's responsibility to arrange for the evaluation of the fire protection system(s). Where the inspections and tests specified in the *Code* have been contracted to a qualified inspection provider or contractor, it is not the role of the inspector or contractor to determine if any changes have been made or the subsequent evaluation of the fire protection system. The evaluation of any building changes should be conducted before any proposed change is incorporated and should utilize the appropriate installation standard and input from applicable AHJs. [**25:**A.4.1.6]

Fire protection systems should not be removed from service when the building is not in use; however, where a system that has been out of service for a prolonged period (such as in the case of idle or vacant properties) is returned to service, it is recommended that a responsible and experienced contractor be retained to perform all inspections and tests. [**25:**A.4.1.6]

Note that in the fire protection and life safety field, there are different uses of the term *occupancy*. NFPA 13 bases its design/density criteria for sprinkler systems on occupancy classifications based on the quantity and/or combustibility of contents expected within that space. NFPA *101*, on the other hand, bases the application of that code on occupancy classification defined by the purpose for which a building, structure, or part thereof is intended to be used. Either one of these occupancy types can change while the other remains the same, or a change can result in both types falling under different definitions.

Changes to the occupancy that affect the definition from an NFPA *101* perspective are much more likely to call for building permits and require evaluation of the fire protection systems. Changes to the use of individual spaces or contents within an area are less likely to draw such a stringent review but can change the occupancy classification from an NFPA 13 perspective and drastically limit the effectiveness of a system. Regardless of which occupancy classification is affected, 13.3.3.4.1.6 requires an evaluation of the fire protection system for its capability to protect the new occupancy.

13.3.3.4.1.6.1 The evaluation required by 13.3.3.4.1.6 shall not be considered part of the normal inspection, testing, and maintenance required by this *Code*. [**25:**4.1.6.1]

It is a common misconception that NFPA 25 does not address changes. As outlined in Chapter 1 of NFPA 25, the scope of NFPA 25 does not require the inspector to evaluate the design and layout of the systems covered in that standard. The standard presupposes that the system, as designed and installed, complies with the applicable standards at the time of construction and at the points where changes were made to the building that would necessitate system modifications. However, the requirements in 13.3.3.4.1.6 address this concept by identifying that is it the owner's responsibility to understand the impact of changes in occupancy, use, process, or material and to take certain steps before those changes are made. In the event that changes are made to the building and this evaluation does not take place, any noncompliant conditions created by the changes are not the responsibility of the inspector to identify.

In some cases, a condition that does not comply with the design standard is relatively easy to identify. It can be identified from the floor level without the need of a lift, ladder, tape measure, or any other equipment. Exhibit 13.9 shows a sprinkler that is several feet below the ceiling. In this instance, a drop ceiling was removed and the sprinkler was not relocated to within 12 in. (305 mm) of the ceiling as required by NFPA 13. A similar case would be a sprinkler located too close to a hot air diffuser, as shown in Exhibit 13.10. Although the sprinkler shown is too close to the hot air diffuser according to the spacing rules of NFPA 13, this is not a deficiency according to NFPA 25 and should not be called out in an NFPA 25 inspection report.

That is not to say that inspectors cannot inform building owners that there might be an issue with a system as it relates to a design standard such as NFPA 13. The problem with providing a client with more information, though, is that it can open the inspector to liability. If an inspector is identifying some, but not all, design deficiencies on an NFPA 25 inspection report, the line can become blurred as to the depth of the review and the

Exhibit 13.9

No drop ceiling. (Courtesy of Byron Blake and SimplexGrinnell)

Exhibit 13.10

Heat source. (Courtesy of Byron Blake and SimplexGrinnell)

Exhibit 13.11

Retrofitted cross-corridor door that affects sprinkler spacing.

inspector's contractual obligation to the owner. Many owners believe that NFPA 25 requires the inspector to conduct a hazard evaluation, so when an inspector includes a few design deficiencies with legitimate NFPA 25 deficiencies, it can further muddy the waters.

Many inspectors feel that they have a moral and ethical obligation, as members of the fire protection and life safety community, to inform their clients of all potential concerns. One way to comply with the requirements of NFPA 25 while still satisfying that moral obligation is to keep two deficiency reports: one dealing with NFPA 25 issues and another that could be called the "good Samaritan" list. The NFPA 25 report would catalog wear-and-tear issues while clearly identifying the scope of NFPA 25. The "good Samaritan" report would list all other items that are beyond the scope of NFPA 25, along with a disclaimer stating that these items are not considered part of an NFPA 25 inspection program. This way, the scope of NFPA 25 is acknowledged, as are any and all problems observed during the inspection.

The requirement in 13.3.3.4.1.6.1 states that the inspections and tests found in NFPA 25 do not include an evaluation of the capability of the system to adequately protect the property or its contents. The owner or designated representative is responsible for an evaluation of the adequacy (i.e., design criteria) of the fire protection systems when changes are proposed to the building or its use. However, most owners do not understand the significance of this requirement, nor do they know how to have the evaluation conducted. In addition, many users of NFPA 25 assume that the inspections and tests specified in that standard include an evaluation of the adequacy of the system to protect the hazard presented by the building, its use, and the contents. That assumption is incorrect. For example, an evaluation of the system design criteria would include an examination of the area of coverage and spacing of the sprinklers, and those tasks are not part of the annual inspection required in NFPA 25.

To further clarify this point, Exhibit 13.11 shows a retrofitted cross-corridor door. Prior to the retrofit, the spacing of the sprinklers in the corridor was according to the requirements of NFPA 13. However, after the retrofit, the sprinkler in the foreground must be evaluated against different criteria for spacing from a wall. In this case, the sprinkler is too far from the wall. This evaluation is required by 13.3.3.4.1.6.2, but the criteria for the evaluation are not within the scope of the inspections required by NFPA 25. The criteria for the evaluation of a sprinkler system are found in installation requirements specified by NFPA 13. This example of how the scopes of the two standards are interrelated is clarified further in 13.3.3.4.1.7.

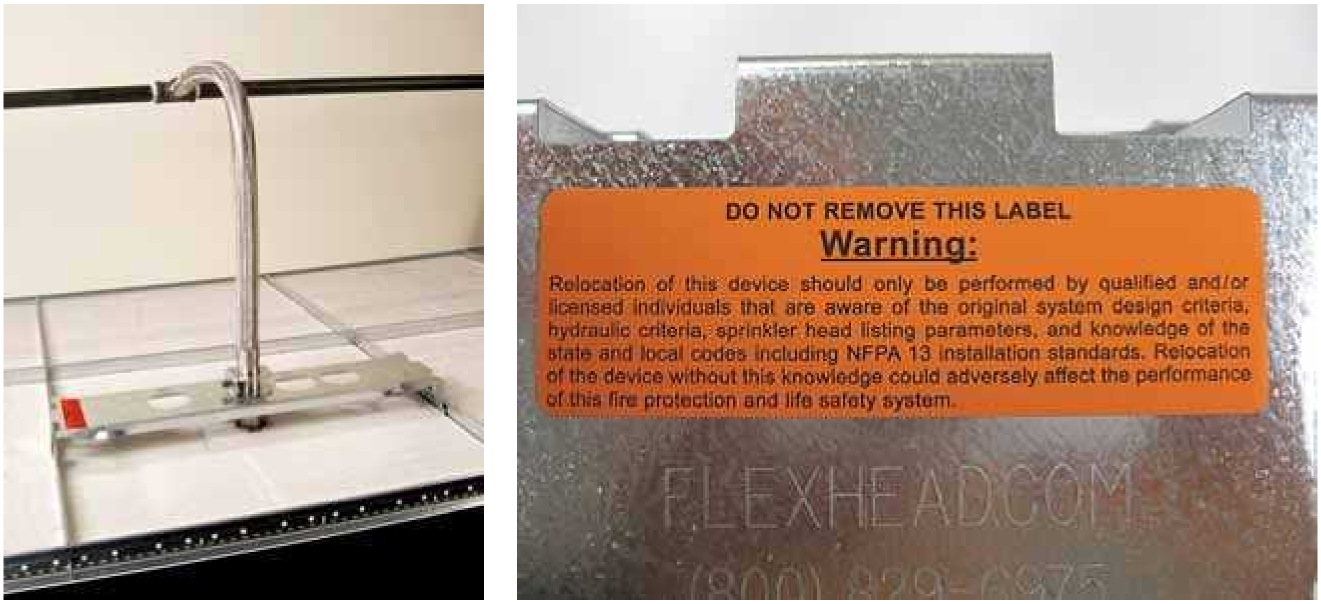
As stated in Chapter 1 of NFPA 25, the purpose of the inspections and tests required by that standard is to maintain the operational status of the system(s). Most inspectors are not trained to evaluate the design criteria of a system, and they should not attempt to do so. It is important that contractors or inspection providers are clear in explaining to the owner the scope of the work that they have been contracted to do. An owner might want to have the system evaluated for its adequacy — and it is certainly appropriate for contractors or inspection providers to conduct such evaluations if they are qualified to do so — but this evaluation is separate from the inspection and testing activities specified by NFPA 25.

Δ **13.3.3.4.1.6.2*** The evaluation shall consider factors that include, but are not limited to, the following:

(1) Occupancy changes such as converting office or production space into warehousing
(2) Process or material changes such as metal stamping to molded plastics
(3) Building revisions such as relocated walls, added mezzanines, and ceilings added below sprinklers
(4) Removal of heating systems in spaces with piping subject to freezing
(5) Changes to the storage method, arrangement, height, or commodities
(6) Changes in water supplies

[***25:***4.1.6.2]

Exhibit 13.12



Flexible sprinkler hose fitting (left) and warning label (right). (Courtesy of FlexHead Industries)

Occupancy changes usually involve a building permit and the subsequent review process by the AHJ. Yet, the more subtle changes listed in 13.3.3.4.1.6.2, items (3) and (4), might not always be reported. Moving walls and adding mezzanines and ceilings can severely affect the spray pattern of sprinklers. Sprinkler protection in unheated spaces frequently causes damage to systems and water damage to buildings and their contents. Monitoring of building alterations and performing inspections can help avoid costly damage to buildings and contents.

In recent years, a growing number of installations have included sprinklers attached to flexible sprinkler hose fittings. As a result, the relocation of sprinklers attached to flexible hose fittings and who should perform that work is an area of concern.

Flexible sprinkler hose fittings are recognized in NFPA 13. However, due to growing concern regarding the ability to move sprinklers without proper evaluation, NFPA 13 contains the following language in Chapter 9:

> **9.2.1.3.3.4*** Where flexible sprinkler hose fittings are used to connect sprinklers to branch lines in suspended ceilings, a label limiting relocation of the sprinkler shall be provided on the anchoring component.

The annex material for this requirement in NFPA 13 provides the following suggested language for the label:

> **CAUTION:** DO NOT REMOVE THIS LABEL.
>
> Relocation of this device should only be performed by qualified and/or licensed individuals that are aware of the original system design criteria, hydraulic criteria, sprinkler head listing parameters, and knowledge of the state and local codes including NFPA 13 installation standards. Relocation of the device without this knowledge could adversely affect the performance of this fire protection and life safety system.

Where flexible sprinkler hose fittings allow sprinklers to be adjusted and relocated, adjustments and relocations made by unqualified individuals could violate requirements, such as those for maximum or minimum sprinkler spacing or obstruction avoidance. For this reason, the committee has added a requirement for a label warning against relocation. To further discourage relocation, the length of flexible drops should be kept to the minimum required for adequate installation and proper performance.

Exhibit 13.12 shows a flexible sprinkler hose fitting along with its mounting and a warning label.

N **A.13.3.3.4.1.6.2** Fire protection systems are designed and installed based on a specific set of circumstances and building uses. For example, the volume of water needed for a sprinkler system to control a fire in the built environment is based upon the intended use of the facility known at the time the sprinkler system was designed and installed. Revisions to properties used for storage represent one of the most common scenarios that impact the ability of systems to provide adequate protection. Some of the most common changes include raising the storage height, changing the storage method arrangement such as adding racks, installing solid shelves in rack structures or decreasing the aisle widths between racks. Changes in product packaging with the use of foam inserts, bubble wrap, or other plastics or encapsulated storage can significantly increase the fire hazard. Changing from wood pallets to plastic pallets, converting to the use of plastic bin boxes, or revising or adding material handling systems such as conveyors could severely impact the effectiveness of the fire protection systems. [**25:**A.4.1.6.2]

13.3.3.4.1.7* Addressing Changes in Hazards.

A.13.3.3.4.1.7 See Annex E of NFPA 25 for an example of a hazard evaluation form. A hazard evaluation is not part of a system inspection. [**25:**A.4.1.7]

In addition to Annex E of NFPA 25, another tool for evaluating an existing system is NFPA 3, *Standard for Commissioning of Fire Protection and Life Safety Systems*. NFPA 3 provides requirements on the retro-commissioning of individual systems or integrated systems. The purpose of NFPA 3 is to provide a structure and reporting mechanism for the design and operation of a system. Properly documenting a system and its design at the same time as design decisions are being made and put on paper, which is what commissioning is intended to do, makes future assessments and evaluations easier and more cost effective to conduct.

13.3.3.4.1.7.1 Where changes in the occupancy, hazard, water supply, storage commodity, storage arrangement, building modification, or other condition that affects the installation criteria of the system are identified, the property owner or designated representative shall promptly take steps to evaluate the adequacy of the installed system in order to protect the building or hazard in question. [**25:**4.1.7.1]

13.3.3.4.1.7.2 Where the evaluation reveals that the installed system is inadequate to protect the building or hazard in question, the property owner or designated representative shall make the required corrections. [**25:**4.1.7.2]

13.3.3.4.1.7.3 Corrections shall be approved. [**25:**4.1.7.3]

The requirement in 13.3.3.4.1.7.3 clarifies the role of the AHJ in the evaluation of the adequacy of the system(s) when changes in the hazard are identified. The owner is not required to include the AHJ in evaluation of the buildings and its systems, but where a system is determined to be inadequate, the corrections must be acceptable to the AHJ. Annex E of NFPA 3 includes sample commissioning documentation. It is critical that whoever conducts the evaluation is qualified to do so.

13.3.3.4.1.8 Valve Location. The location of shutoff valves shall be identified at the system riser or other approved locations. [**25:**4.1.8]

13.3.3.4.1.9 Information Sign.

13.3.3.4.1.9.1 A permanently marked metal or rigid plastic information sign shall be placed at the system control riser supplying an antifreeze loop, dry system, preaction system, or auxiliary system control valve. [**25:**4.1.9.1]

13.3.3.4.1.9.2 Each sign shall be secured with a corrosion-resistant wire, chain, or other approved means and shall indicate at least the following information:

(1) Location of the design area or areas
(2) Discharge densities over the design area or areas
(3) Required flow and residual pressure demand at the base of riser
(4) Occupancy classification or commodity classification and maximum permitted storage height and configuration
(5) Hose stream allowance included in addition to the sprinkler demand
(6) The name of the installing contractor or person providing the information

[**25:**4.1.9.2]

The sign required by 13.3.3.4.1.9 is needed to provide vital information that might not otherwise be readily known to anyone maintaining a system. The sign is particularly useful in addressing freeze threats by identifying any locations with heat tape and acknowledging that auxiliary and low-point drains are installed on the system along with their number and location. If this information is not known, the system can be damaged due to freezing of water in the trapped sections of pipe. It is important to recognize that 13.3.3.4.1.9.2 is a retroactive requirement. For example, system information signs were not required by NFPA 13 prior to the 2007 edition, so many systems might not have them. This information is critical to the assessment of a building when certain ITM tasks are being performed, as evidenced by NFPA 13 requiring it in the last three editions of the standard. If this sign is not present, contractors and inspection providers should alert the owner to the need for the sign and the importance of the information. The required information could come from building records, which include the as-built sprinkler system drawing(s), the Contractor's Material and Test Certificate, or other documents. If these are not available, the owner might need to ask the contractor or other qualified entity or individual to survey the system and provide the information needed for the sign.

N **13.3.3.4.1.10 Antifreeze Information Sign.** An antifreeze information sign shall be placed on the antifreeze system main valve, which indicates the manufacture type and brand of the antifreeze solution, the concentration by volume of the antifreeze solution used, and the volume of the antifreeze solution used in the system. [**25:**4.1.10]

13.3.3.4.1.11 Impairments.

13.3.3.4.1.11.1 Where an impairment to a water-based fire protection system occurs or is identified during inspection, testing, or maintenance activities, the procedures outlined in Chapter 15 of NFPA 25 shall be followed, including the attachment of a tag to the impaired system. [**25:**4.1.11.1]

This paragraph clarifies that the requirements in Chapter 15 of NFPA 25 are to be implemented by the owner in the event that the system is impaired. Chapter 15 of NFPA 25 outlines the specific steps that must be taken. It is notable that although 3.3.21.1 and 3.3.21.2 of NFPA 25 define *emergency* and *preplanned impairment* separately, the actions that the owner must undertake are the same once the impairment occurs.

Exhibit 13.13 shows an impaired system that has been identified with an impairment tag by the AHJ. NFPA 25 does not mandate a certain style or color for the impairment tag; however, many

Exhibit 13.13

Example of an impaired system tag. (Courtesy of Byron Blake and SimplexGrinnell)

states have their own tagging system that should be consulted. Where a system impairment occurs in a location that is remote from the system control valve, the inspector will often provide a tag both at the system riser and at the impaired component. For instance, if a system has to be shut down due to a failed coupling in a section of feed main piping outside the sprinkler control room, it makes sense to tag both the coupling and the closed control valve. The tag on the control valve should note where the impairment is, leading the AHJ, owner, or inspector to the other tag.

13.3.3.4.1.11.2 Where a water-based fire protection system is returned to service following an impairment, the system shall be verified to be working properly by means of an appropriate inspection or test as described in the table, "Summary of Component Replacement [Action] Requirements" in the applicable chapters of NFPA 25. [**25:**4.1.11.2]

Component replacement and testing tables are included in NFPA 25 for each system type to assist the user in determining the type and extent of actions that are needed following a repair or adjustment. See the appropriate systems chapter in NFPA 25 for the pertinent component replacement and testing table. There are times when these actions are in accordance with the requirements of the appropriate installation standard. For example, the tests needed when an air maintenance device in a dry pipe sprinkler system is replaced would be performed in accordance with NFPA 13.

13.3.3.4.2 Manufacturer's Corrective Action. Manufacturers shall be permitted to make modifications to their own listed product in the field with listed devices that restore the original performance as intended by the listing, where acceptable to the AHJ. [**25:**4.2]

13.3.3.4.3 Records.

13.3.3.4.3.1* Records shall be made for all inspections, tests, and maintenance of the system and its components and shall be made available to the AHJ upon request. [**25:**4.3.1]

Although many local and some state jurisdictions require it, NFPA 25 does not mandate the transmittal of records to the AHJ. Some jurisdictions require that all ITM records be immediately sent to the AHJ upon completion of the inspection, test, or maintenance. Other jurisdictions require only that certain records, such as those indicating impairments, be forwarded. Still other jurisdictions only want the records to be maintained on site for review by fire inspectors or others, such as insurance companies. It is important that all stakeholders in the process are aware of any requirements to forward records to anyone other than the owner.

A.13.3.3.4.3.1 Inspection reports used for system inspections should contain an "Owner's Section" as shown in Figure A.13.3.3.4.3.1 that the property owner or designated representative should complete. Typical records include, but are not limited to, valve inspections; flow, drain, and pump tests; and trip tests of dry pipe, deluge, and preaction valves. [**25:**A.4.3.1]

Acceptance test records should be retained for the life of the system or its special components. Subsequent test records should be retained for a period of 1 year after the next test. The comparison determines deterioration of system performance or condition and the need for further testing or maintenance. [**25:**A.4.3.1]

13.3.3.4.3.1.1* Records shall be permitted to be stored and accessed electronically. [**25:**4.3.1.1]

A.13.3.3.4.3.1.1 Computer programs that file inspection and test results should provide a means of comparing current and past results and should indicate the need for corrective maintenance or further testing. [**25:**A.4.3.1.1]

The ITM records referred to in 13.3.3.4.3 provide written documentation of compliance with NFPA 25. These records also offer a service history of the installed systems by indicating their performance during testing and/or maintenance. The advances in electronic database software allow for complete and highly detailed histories of system maintenance. Many AHJs allow owners to use their own central database or that of a service provider to electronically file and maintain records, rather than to store traditional paper records on site. In some jurisdictions, the AHJ has contracted with a third-party records maintenance provider. These programs typically involve the ITM provider submitting the reports required by this chapter directly to the third party in addition to providing them to the owner. There may be a cost involved with these programs, so it is important that the owner and the ITM service provider both be familiar with the local requirements.

Δ **13.3.3.4.3.2** Records shall indicate the following:

(1) The procedure/activity performed (e.g., inspection, test, or maintenance)
(2) The organization that performed the activity
(3) The required frequency of the activity
(4) The results and date of the activity
(5) The name and contact information of the qualified contractor or owner, including lead person for activity

[**25:**4.3.2]

Owner's Section

A. Is the building occupied?	❏ Yes	❏ No
B. Has the occupancy and hazard of contents remained the same since the last inspection?	❏ Yes	❏ No
C. Are all fire protection systems in service?	❏ Yes	❏ No
D. Has the system remained in service without modification since the last inspection?	❏ Yes	❏ No
E. Was the system free of actuation of devices or alarms since the last inspection?	❏ Yes	❏ No

Explain any "no" answers:

Owner or Designated Representative (print)   Signature and Date

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Δ *FIGURE A.13.3.3.4.3.1 Owner's Section on Inspection Report. [**25:**Figure A.4.3.1]*

Any form, whether produced commercially or developed independently, can be used to document ITM activities, provided it details the activity sufficiently to verify compliance with NFPA 25. Many people assume that NFPA 25 requires a specific series of forms that need to be filled out; however, a review of the standard, will show that it is completely devoid of forms. This absence of forms in the standard is not intended to lessen the importance of recording ITM data, but rather it allows the owners and inspectors the flexibility to use their own project management programs, software, and ITM forms to track their ITM work. NFPA has developed a series of electronic forms specific to the ITM requirements throughout NFPA 25. These completely customizable forms are available at www.nfpa.org. Exhibit 13.14 shows an example of a form that can be used for recording system information or documenting an ITM task that has been completed.

One of the main concerns of property owners and facility managers who own or manage multiple properties is the many different ITM forms they receive. The same holds true for AHJs. For that reason, in the 2017 edition of NFPA 25, annex guidance was expanded regarding recommended minimum information for ITM reports. Although not required, the annex provides a framework for consistency for those who choose to follow it. For more information, see Section B.4 in Annex B of NFPA 25.

13.3.3.4.3.3* Records shall be maintained by the property owner. [**25:**4.3.3]

A.13.3.3.4.3.3 See Section B.2 of NFPA 25 for information regarding sample forms. [**25:**A.4.3.3]

13.3.3.4.3.4 As-built system installation drawings, hydraulic calculations, original acceptance test records, and device manufacturer's data sheets shall be retained for the life of the system. [**25:**4.3.4]

13.3.3.4.3.5 Subsequent records shall be retained for a period of 1 year after the next inspection, test, or maintenance of that type required by the *Code*. [**25:**4.3.5]

13.3.3.5 Sprinkler Systems.

13.3.3.5.1 Maintenance — Sprinklers.

13.3.3.5.1.1 Where a sprinkler has been removed for any reason, it shall not be reinstalled. [**25:**5.4.1.1]

Δ **13.3.3.5.1.2*** Replacement sprinklers shall have the proper characteristics for the application intended, which include the following:

(1) Style
(2) Orifice size and K-factor
(3) Temperature rating
(4) Coating, if any
(5) Deflector type (e.g., upright, pendent, sidewall)
(6) Design requirements

[**25:**5.4.1.2]

Exhibit 13.14

FIRE SPRINKLER SYSTEM HAZARD EVALUATION

Changes in building occupancy, use, or process, or material used or stored, create the need for evaluation of the installed fire protection systems. This form is intended to identify and evaluate such changes and should be completed only by an individual property qualified in the area of system design.

Owner: ____________ Owner's address: ____________

Property being evaluated: ____________

Property address: ____________

Date of work: ____________

(All responses refer to the current hazard evaluation performed on this date.)

Section 1. Identification of Sprinklered Occupancy and Storage Hazards
(Use additional pages as needed.)

Area of Property (List nonsprinklered areas separately in Section 3.)	Type of System and Sprinklers	Design Capability of System	Hazard Protected (Uses or storage arrangements, including commodity)	Improvements Needed to Address Hazard
1.				
2.				
3.				
4.				
5.				

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FIRE SPRINKLER SYSTEM HAZARD EVALUATION (Continued)

Section 2. Evaluation of Protection

For each area of the property evaluated in Section 1, please answer the following questions with a "yes," "no," "N/A," or "?" and explain all "no" and "?" responses below by row and column identification:

Answer the following for each identified property area:	1	2	3	4	5
a. Are all sprinklers the correct type for their application?					
b. Are the obstructions to sprinklers in all areas within acceptable limits for the specific types of sprinklers used?					
c. Are hazards associated with all occupancy areas consistent with hazards typical for that occupancy hazard classification?					
d. Are stockpiles of combustibles located within occupancy areas limited to appropriate heights?					
e. Are miscellaneous and dedicated storage areas properly identified and managed?					
f. Are all dedicated storage areas protected in accordance with the proper storage configuration and commodity classification?					
g. Is the storage or use of flammable liquids, combustible liquids, or aerosol products in any area properly addressed?					
h. Is all idle pallet storage properly protected?					
i. Is there any presence of nitrate film, pyroxylin plastic, compressed or liquefied gas cylinders, liquid or solid oxidizers, or organic peroxide formulations except where specifically addressed by appropriate protection measures?					
j. Are all sprinklers spaced appropriately for the hazard and the type of sprinkler?					
k. Do the available sources of heat and cooling appear adequate for the type of system and temperature rating of sprinklers?					

Explanation of "no" and "?" answers:

Examples:
b2 — no — Obstructions to ESFR sprinklers exceed currently accepted standards.
e3 — ? — ***Owner must provide information on type of plastic involved in product before evaluation can be finalized.***

 (p. 2 of 4)

FIRE SPRINKLER SYSTEM HAZARD EVALUATION (Continued)

Section 3. Evaluation of Unsprinklered Areas

Area of Property for Which Protection Is Not Provided	Basis of Lack of Protection (if known)	Basis for Omission Under Current Codes/Standards
1.		
2.		
3.		
4.		
5.		

Section 4. Water Supply Evaluation

If this hazard evaluation is the result of a reduction in the residual pressure during routine inspections, explain the results of the investigation made to determine the reasons for this change:

Explain the basis of continued acceptability of the water supply or proposed improvements:

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FIRE SPRINKLER SYSTEM HAZARD EVALUATION (Continued)

Section 5. Hazard Evaluator's Information and Certification

Evaluator: ____________

Company: ____________

Company address: ____________

I state that the information on this form is correct at the time and place of my review of my evaluation.

Is this hazard evaluation completed? (Note: All "?" must be resolved.) Yes ❑ No ❑

Explain if answer is not "yes":

Have deficiencies in protection been identified that should be improved or corrected? Yes ❑ No ❑

Summarize improvements of corrections needed:

Signature of Evaluator: ____________ Date: ______

License or Certification Number (if applicable): ____________

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Sample fire sprinkler hazard evaluation form.

There are many types of sprinklers, a number of which have similar appearances but different performance characteristics. Paragraph 13.3.3.5.1.2 identifies sprinkler characteristics that must be matched to the application.

Care must be taken to ensure that replacement sprinklers have the same characteristics as those they are replacing so that the design performance of the system is maintained. This is especially important for special sprinklers, as noted in 13.3.3.5.1.4. When the same make and model of a special sprinkler is no longer manufactured, persons with appropriate expertise and knowledge should be consulted for selection of a replacement sprinkler.

While replacement sprinklers must have the same characteristics, nothing in NFPA 25 or NFPA 13 requires that the replacement sprinkler be the same make and model. Sprinkler manufacturers may update or discontinue a particular model, but sprinklers with the same operating characteristics are almost always available.

The replacement sprinkler is not required to have the exact temperature rating of the sprinkler being replaced, but it should be of the temperature range appropriate for the environment installed, based on Table 6.2.5.1 of NFPA 13.

A.13.3.3.5.1.2 To help in the replacement of like sprinklers, unique sprinkler identification numbers (SINs) are provided on all sprinklers manufactured after January 1, 2001. The SIN accounts for differences in orifice size, deflector characteristics, pressure rating, and thermal sensitivity. [**25:**A.5.4.1.2]

13.3.3.5.1.2.1* Spray sprinklers shall be permitted to replace old-style sprinklers. [**25:**5.4.1.2.1]

A.13.3.3.5.1.2.1 Old-style sprinklers are permitted to replace existing old-style sprinklers. Old-style sprinklers should not be used to replace standard sprinklers without a complete engineering review of the system. The old-style sprinkler is the type manufactured before 1953. It discharges approximately 40 percent of the water upward to the ceiling, and it can be installed in either the upright or pendent position. [**25:**A.5.4.1.2.1]

N **13.3.3.5.1.2.2*** Where replacing residential sprinklers manufactured prior to 2003 that are no longer available from the manufacturer and are installed using a design density less than 0.05 gpm/ft^2 (204 mm/min), a residential sprinkler with an equivalent K-factor (± 5 percent) shall be permitted to be used provided the currently listed coverage area for the replacement sprinkler is not exceeded. [**25:**5.4.1.2.2]

N **A.13.3.3.5.1.2.2** It is recognized that the flow and pressure available to the replacement sprinkler might be less than its current flow and pressure requirement. [**25:**A.5.4.1.2.2]

The text of 13.3.3.5.1.2.2 is new to the 2018 edition of NFPA 1 and was added to correlate with NFPA 13 and NFPA 13R. Minimum design density requirements were added to the 2002 edition of NFPA 13. Since that change, many sprinkler manufacturers stopped making residential sprinklers listed for densities less than 0.05 gpm/ft^2 (204 mm/min). This paragraph gives owners NFPA 25–compliant options for replacing sprinklers installed prior to this change when sprinklers matching the exact characteristics are not available.

Δ **13.3.3.5.1.2.3** Replacement sprinklers for piers and wharves shall comply with NFPA 307. [**25:**5.4.1.2.3]

13.3.3.5.1.3 Only new, listed sprinklers shall be used to replace existing sprinklers. [**25:**5.4.1.3]

Δ **13.3.3.5.1.4*** Special and quick-response sprinklers as defined by NFPA 13 shall be replaced with sprinklers of the same orifice, size, temperature range and thermal response characteristics, and K-factor. [**25:**5.4.1.4]

A.13.3.3.5.1.4 It is imperative that any replacement sprinkler have the same characteristics as the sprinkler being replaced. If the same temperature range, response characteristics, spacing requirements, flow rates, and K-factors cannot be obtained, a sprinkler with similar characteristics should be used, and the system should be evaluated to verify the sprinkler is appropriate for the intended use. With regard to response characteristics, matching identical Response Time Index (RTI) and conductivity factors is not necessary unless special design considerations are given for those specific values. [**25:**A.5.4.1.4]

Prior to the 2008 edition of NFPA 25, the standard required that sprinklers be replaced by a sprinkler of the exact make and model, in addition to having the same performance characteristics. This is impractical, so NFPA 25 now simply requires that sprinklers be replaced with types having equal performance characteristics, such as orifice size, K-factor, temperature rating, and thermal response.

13.3.3.5.1.5* Stock of Spare Sprinklers. A supply of at least six spare sprinklers shall be maintained on the premises so that any sprinklers that have operated or been damaged in any way can be promptly replaced. [**25:**5.4.1.5]

A.13.3.3.5.1.5 A minimum of two sprinklers of each type and temperature rating installed should be provided. [**25:**A.5.4.1.5]

Following an incident in which a sprinkler has operated, either due to a fire or mechanical damage, it is important to minimize system impairments. Thus, 13.3.3.5.1.5 specifies that a supply of spare sprinklers must be available so that sprinklers can be replaced quickly following a small fire or accidental discharge. Note that the supply must be "on the premises" but need not be in each building of a complex or specifically at the sprinkler system riser. For example, a supply of spare sprinklers for a complex can be stored in a central location, provided that the supply is accessible and does not substantially delay the replacement of sprinklers following an incident.

13.3.3.5.1.5.1 The sprinklers shall correspond to the types and temperature ratings of the sprinklers in the property. [**25:**5.4.1.5.1]

13.3.3.5.1.5.2 The sprinklers shall be kept in a cabinet located where the temperature in which they are subjected will at no time exceed 100°F (38°C). [**25:**5.4.1.5.2]

13.3.3.5.1.5.3 Where dry sprinklers of different lengths are installed, spare dry sprinklers shall not be required, provided that a means of returning the system to service is furnished. [**25:**5.4.1.5.3]

Dry sprinklers are manufactured to specific lengths. Due to the pitching of pipe or various ceiling heights, the dry sprinklers on a system are often of varying lengths, so it is impractical to have spare sprinklers for each specific length. However, if all the dry sprinklers on a system are the same length, spare dry sprinklers should be kept in the sprinkler cabinet. For example, freezer boxes with dry sprinklers supplied by a wet system can all be the same length, and it is practical and reasonable to provide the spare dry sprinklers.

Δ **13.3.3.5.1.5.4** The stock of spare sprinklers shall include all types and ratings installed and shall be as follows:

(1) For protected facilities having under 300 sprinklers — no fewer than 6 sprinklers
(2) For protected facilities having 300 to 1000 sprinklers — no fewer than 12 sprinklers
(3) For protected facilities having over 1000 sprinklers — no fewer than 24 sprinklers

[**25:**5.4.1.5.4]

13.3.3.5.1.5.5* One sprinkler wrench as specified by the sprinkler manufacturer shall be provided in the cabinet for each type of sprinkler installed to be used for the removal and installation of sprinklers in the system. [**25:**5.4.1.5.5]

A.13.3.3.5.1.5.5 One sprinkler wrench design can be appropriate for many types of sprinklers, and multiple wrenches of the same design should not be required. [**25:**A.5.4.1.5.5]

Special wrenches as prescribed by the manufacturer must be kept in the sprinkler cabinet so that sprinklers can be properly replaced following an incident or in the event that inspection or testing indicates damage. There should be an appropriate wrench provided for each sprinkler type installed in the system.

13.3.3.5.1.5.6 A list of the sprinklers installed in the property shall be posted in the sprinkler cabinet. [**25:**5.4.1.5.6]

13.3.3.5.1.5.6.1* The list shall include the following:

(1) Sprinkler Identification Number (SIN) if equipped; or the manufacturer, model, orifice, deflector type, thermal sensitivity, and pressure rating
(2) General description

Sprinklers Contained in this Cabinet

Sprinkler Identification, SIN	General Description	Temperature Rating, °F	Sprinkler Quantity Maintained
TY9128	Extended Coverage, K-25, upright	155	6
VK425	Concealed pendent residential	145	6
Issued: 10/3/05	Revised:		

Δ ***FIGURE A.13.3.3.5.1.5.6.1*** *Sample List. [25:Figure A.5.4.1.5.6.1]*

(3) Quantity of each type to be contained in the cabinet
(4) Issue or revision date of the list

[**25:**5.4.1.5.6.1]

A.13.3.3.5.1.5.6.1 The minimum information in the list contained in the spare sprinkler cabinet should be marked with the following:

(1) General description of the sprinkler, including upright, pendent, residential, ESFR, and so forth
(2) Quantity of sprinklers that is to be maintained in the spare sprinkler cabinet. An example of the list is shown in Figure A.13.3.3.5.1.5.6.1.

[**25:**A.5.4.1.5.6.1]

13.3.3.5.1.6* Sprinklers shall not be altered in any respect or have any type of ornamentation, paint, or coatings applied after shipment from the place of manufacture. [**25:**5.4.1.6]

A.13.3.3.5.1.6 Corrosion-resistant or specially coated sprinklers should be installed in locations where chemicals, moisture, or other corrosive vapors exist. [**25:**A.5.4.1.6]

13.3.3.5.1.7 Sprinklers and automatic spray nozzles used for protecting commercial-type cooking equipment and ventilating systems shall be replaced annually. [**25:**5.4.1.7]

13.3.3.5.1.7.1 Where automatic bulb-type sprinklers or spray nozzles are used and annual examination shows no buildup of grease or other material on the sprinklers or spray nozzles, such sprinklers and spray nozzles shall not be required to be replaced. [**25:**5.4.1.7.1]

13.3.3.5.1.8 Protective Coverings.

13.3.3.5.1.8.1* Sprinklers protecting spray areas and mixing rooms in resin application areas installed with protective coverings shall continue to be protected against overspray residue so that they will operate in the event of fire. [**25:**5.4.1.8.1]

A.13.3.3.5.1.8.1 Typical sandwich bags purchased in a grocery store are generally plastic, not cellophane. Plastic bags have a tendency to shrink and adhere to the sprinkler prior to sprinkler activation, creating the potential for disruption of sprinkler spray patterns. Bags placed over sprinklers need to be true cellophane or paper. [**25:**A.5.4.1.8.1]

13.3.3.5.1.8.2 Sprinklers installed as described in 13.3.3.5.1.8.1 shall be protected using cellophane bags having a thickness of 0.003 in. (0.076 mm) or less or thin paper bags. [**25:**5.4.1.8.2]

Testing has shown that lightweight cellophane or paper bags will not adversely affect the operation of a sprinkler. However, sprinklers protected by lightweight cellophane or paper bags might require more frequent inspection than the annual inspection outlined in 5.2.1.1 of NFPA 25, to prevent excessive buildup on the bags. Depending on the use of the spray coating area, the inspection and subsequent replacement of the bags might need to be done daily. The use of plastic bags is not permitted due to concerns for the potential of a plastic bag to shrink prior to sprinkler activation and disrupt the discharge pattern. Exhibit 13.15 illustrates a sprinkler protected from overspray by a cellophane bag.

Exhibit 13.15

Sprinkler protected from overspray with a cellophane bag.

13.3.3.5.1.8.3 Coverings shall be replaced periodically so that heavy deposits of residue do not accumulate. [**25:**5.4.1.8.3]

13.3.3.5.2* Dry Pipe Systems. Dry pipe systems shall be kept dry at all times. [**25:**5.4.2]

A.13.3.3.5.2 Conversion of dry pipe systems to wet pipe systems on a seasonal basis causes corrosion and accumulation of foreign matter in the pipe system and loss of alarm service. [**25:**A.5.4.2]

Moisture is one of the main causes of corrosion in sprinkler piping. Alternating from a dry system to a wet system allows moisture to enter the system and can accelerate corrosion rates. In addition, the waterflow alarm on most dry systems will need to be removed from service if the system is left wet. To minimize corrosion and prevent freezing of sprinkler piping, it is required that these systems always remain dry, and it is recommended that they be reset and drained following operation to minimize moisture inside the system. Exhibit 13.16 shows rust and scale removed from a dry pipe system.

Exhibit 13.16

Rust and scale removed from dry pipe system.

13.3.3.5.2.1 During nonfreezing weather, a dry pipe system shall be permitted to be left wet if the only other option is to remove the system from service while waiting for parts or during repair activities. [**25:**5.4.2.1]

13.3.3.5.2.2 Refrigerated spaces or other areas within the building interior where temperatures are maintained at or below 40°F (4.4°C) shall not be permitted to be left wet. [**25:**5.4.2.2]

13.3.3.5.2.3 Air driers shall be maintained in accordance with the manufacturer's instructions. [**25:**5.4.2.3]

13.3.3.5.2.4 Compressors used in conjunction with dry pipe sprinkler systems shall be maintained in accordance with the manufacturer's instructions. [**25:**5.4.2.4]

13.3.3.6 Impairments.

The most common impairments involve closed water-control valves, but other examples can include conditions such as a nonfunctioning fire pump, painted sprinklers, heavily corroded sprinklers, or a broken hose valve.

The requirements in 13.3.3.6 deal primarily with preplanned impairments — those impairments in which the system or a portion thereof is out of service due to work, such as modifications to the water supply or sprinkler system piping, that has been planned in advance. But in reality, an effective impairment program is one that is established and understood well in advance of any impairment and can be implemented in the event of an emergency impairment as well. Note that the appointment of an impairment coordinator (see 13.3.3.6.2) does not necessarily coincide with the actual impairment. In fact, 13.3.3.4.1.11.1 directs the user to Chapter 15 of NFPA 25 whenever an impairment occurs or is identified.

Rarely is a facility more exposed to a potentially catastrophic fire loss than when a fire protection system or portion of a system is out of service. Many devastating fires could have been mitigated had a proper impairment program been in place and adhered to. Whether an impairment is preplanned or occurs in an emergency situation seems to have little bearing on its tendency to lead to catastrophe. A major factor in numerous large-loss fires included the failure to do the following:

- Recognize the risks created by the impairment
- Establish a fire watch and provide backup fire protection
- Control ignition sources and/or shut down hazardous processes
- Expedite repairs
- Ensure that the fire protection system is properly placed back into service

13.3.3.6.1 General.

13.3.3.6.1.1 Minimum Requirements.

13.3.3.6.1.1.1 Subsection 13.3.3.6 shall provide the minimum requirements for a water-based fire protection system impairment program. [**25:**15.1.1.1]

13.3.3.6.1.1.2 Measures shall be taken during the impairment to ensure that increased risks are minimized and the duration of the impairment is limited. [**25:**15.1.1.2]

13.3.3.6.2 Impairment Coordinator.

13.3.3.6.2.1 The property owner or designated representative shall assign an impairment coordinator to comply with the requirements of 13.3.3.6. [**25:**15.2.1]

Prior to removing a system from service, the impairment coordinator should ensure that the necessary tools, equipment, and replacement parts are on hand to minimize the duration of the impairment. This typically involves coordination with the contractor or service provider who is scheduled to perform the work that necessitates shutdown of the system. As stated earlier, the building and its occupants are at higher risk when fire protection systems are impaired. Thus, the role of the impairment coordinator in performing this important function should not be understated.

13.3.3.6.2.2 In the absence of a specific designee, the property owner or designated representative shall be considered the impairment coordinator. [**25:**15.2.2]

13.3.3.6.2.3 Where the lease, written use agreement, or management contract specifically grants the authority for inspection, testing, and maintenance of the fire protection system(s) to the tenant, management firm, or managing individual, the tenant, management firm, or managing individual shall assign a person as impairment coordinator. [**25:**15.2.3]

13.3.3.6.3 Tag Impairment System.

Many jurisdictions have requirements to identify the system's operational status. These often include tags that are placed at the system riser or other specified locations to indicate that ITM has been performed and whether any deficiencies or impairments were found. System status tagging programs often use color-coded tags for this purpose. For more information on color-coded system status tagging programs, see Annex G of NFPA 25. Those programs, and the tags they utilize, are not typically part of the requirements of Chapter 15 of NFPA 25. For example, a system that is found to have impairments during inspection or testing may be tagged as such by the qualified person conducting the ITM, but that simply triggers the implementation of the requirements found in Chapter 15 of NFPA 25. The impairment coordinator would then place the impairment tags as required by 13.3.3.6.3.

13.3.3.6.3.1* A tag shall be used to indicate that a system, or part thereof, has been removed from service. [**25:**15.3.1]

A.13.3.3.6.3.1 A clearly visible tag alerts building occupants and the fire department that all or part of the water-based fire protection system is out of service. The tag should be weather resistant, plainly visible, and of sufficient size [typically 4 in. × 6 in. (100 mm × 150 mm)]. The tag should identify which system is impaired, the date and time impairment began, and the person responsible. Figure A.13.3.3.6.3.1 illustrates a typical impairment tag. [**25:**A.15.3.1]

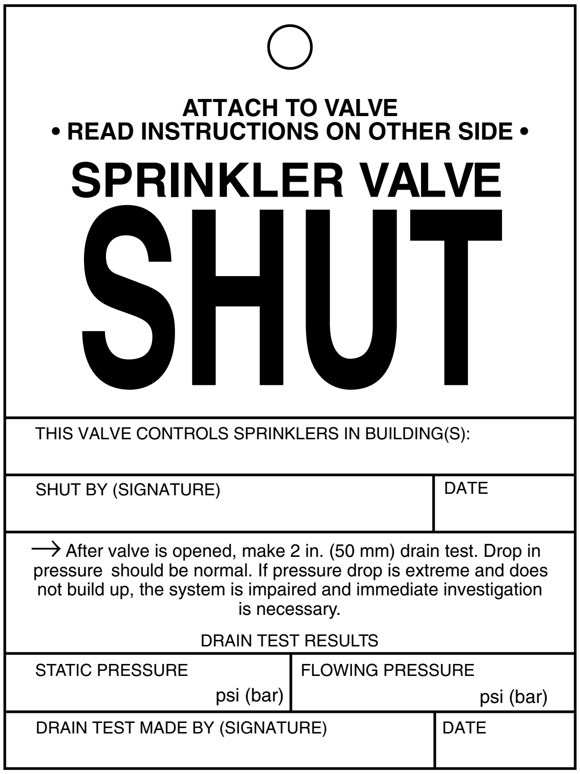


FIGURE A.13.3.3.6.3.1 *Sample Impairment Tag. [**25:**Figure A.15.3.1]*

13.3.3.6.3.2* The tag shall be posted at each fire department connection and the system control valve, and other locations required by the AHJ indicating which system, or part thereof, has been removed from service. [**25:**15.3.2]

A.13.3.3.6.3.2 An impairment tag should be placed on the fire department connection to alert responding fire fighters of an abnormal condition. An impairment tag that is located on the system riser only could go unnoticed for an extended period if fire fighters encounter difficulty in gaining access to the building or sprinkler control room. [**25:**A.15.3.2]

13.3.3.6.4 Impaired Equipment.

13.3.3.6.4.1 The impaired equipment shall be considered to be the water-based fire protection system, or part thereof, that is removed from service. [**25:**15.4.1]

Δ **13.3.3.6.4.2** The impaired equipment shall include, but shall not be limited to, the following:

(1) Sprinkler systems
(2) Standpipe systems
(3) Fire hose systems
(4) Underground fire service mains
(5) Fire pumps
(6) Water storage tanks
(7) Water spray fixed systems
(8) Foam-water sprinkler systems
(9) Water mist systems
(10) Fire service control valves
(11) Water supply

[**25:**15.4.2]

13.3.3.6.5* Preplanned Impairment Programs.

A.13.3.3.6.5 The need for temporary fire protection, termination of all hazardous operations, and frequency of inspections in the areas involved should be determined. All work possible should be done in advance to minimize the length of the impairment. Where possible, temporary feedlines should be used to maintain portions of systems while work is completed. [**25:**A.15.5]

Water-based fire protection systems should not be removed from service when the building is not in use. Where a system that has been out of service for a prolonged period, such as in the case of idle or vacant properties, is returned to service, qualified personnel should be retained to inspect and test the systems. [**25:**A.15.5]

13.3.3.6.5.1 All preplanned impairments shall be authorized by the impairment coordinator. [**25:**15.5.1]

Δ **13.3.3.6.5.2** Before authorization is given, the impairment coordinator shall be responsible for verifying that the following procedures have been implemented:

(1) The extent and expected duration of the impairment have been determined.
(2) The areas or buildings involved have been inspected and the increased risks determined.
(3) Recommendations to mitigate any increased risks have been submitted to management or the property owner or designated representative.
(4) Where a fire protection system is out of service for more than 10 hours in a 24-hour period, the impairment coordinator shall arrange for one of the following:
    (a) Evacuation of the building or portion of the building affected by the system out of service
    (b)* An approved fire watch

Fire watch personnel should be trained to understand the hazards at the job site and the nature of hot work where hot work operations are used. They should ensure that safe conditions are maintained during all hot work operations and should have the authority to stop work if unsafe conditions develop. Fire-extinguishing equipment should be readily available, and fire watch personnel should be trained in its use. The fire watch personnel should be familiar with the facilities and procedures for sounding an alarm in the event of a fire.

Fire watch personnel should be trained in proper incipient fire response procedures, such as notifying the fire department and persons in the fire area before attempting to extinguish a fire. They should attempt to extinguish a fire only if it is obviously within the capacity of the equipment available. It is important to note that many AHJs have specific requirements that fire watch personnel must meet. Fire watch personnel may be allowed to perform additional tasks, but those tasks should not distract them from their watch responsibilities. For additional guidance on fire watch operations, see NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*.

For torch-applied roofing operations, a fire watch must be posted for the duration of the work and for 60 minutes thereafter.

A.13.3.3.6.5.2(4)(b) A fire watch should consist of trained personnel who continuously patrol the affected area. Ready access to fire extinguishers and the ability to promptly notify the fire department are important items to consider. During the patrol of the area, the person should not only be looking for fire, but making sure that the other fire protection features of the building such as egress routes and alarm systems are available and functioning properly. [**25:**A.15.5.2(4)(b)]

    (c)* Establishment of a temporary water supply

A.13.3.3.6.5.2(4)(c) Temporary water supplies are possible from a number of sources, including use of a large-diameter hose from a fire hydrant to a fire department connection, use of a portable tank and a portable pump, or use of a standby fire department pumper and/or tanker. [**25:**A.15.5.2(4)(c)]

Temporary water supplies can be established through the use of existing systems or portions of systems that are not involved in the maintenance or repair activity. Exhibit 13.17 shows one type of temporary water supply in the form of portable bladder tanks. Exhibit 13.18 shows another type of temporary water supply in which a hard-piped connection was made to the fire department connection (FDC) in order to bypass work on the main water supply. The temporary water supply for fire protection

Exhibit 13.17

Portable storage tanks as an alternative source of water. (Courtesy of National Park Service)

Exhibit 13.18

Temporary water supply connection to FDC.

should be available as soon as existing fire protection systems are shut down for maintenance or repair.

In situations involving automatic sprinklers, the system should be returned to service as soon as possible. The operation of sprinkler control valves should be limited to properly authorized personnel only. Where the sprinkler protection is regularly turned off and on to facilitate connection of newly repaired segments, the sprinkler control valves should be checked at the end of each work shift and the impairment program followed to verify that protection is in service. If at all possible, sprinkler systems should be isolated from standpipes in order to keep the standpipe system in service and readily available for manual fire fighting.

(d)* Establishment and implementation of an approved program to eliminate potential ignition sources and limit the amount of fuel available to the fire

An approved fire prevention program, as referred to in 13.3.3.6.5.2(4)(d), should include the following:

1. Good housekeeping
2. On-site security
3. Immediate activation of new or repaired fire protection systems as construction and repairs allow
4. Preservation of existing fire protection systems during building construction or renovation
5. Development of a prefire plan with the local fire department
6. Accurate and rapid communication process
7. Consideration of any special hazards resulting from construction operations
8. Protection of existing structures and equipment from exposure fires resulting from construction, alteration, and demolition operations

Temporary fire extinguishers should be provided in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*. At least one approved fire extinguisher should be provided in plain sight on each floor at each usable stairway, and access to permanent, temporary, or portable fire equipment should be maintained at all times.

A.13.3.3.6.5.2(4)(d) Depending on the use and occupancy of the building, it could be enough in some circumstances to stop certain processes in the building or to cut off the flow of fuel to some machines. It is also helpful to implement “No Smoking” and “No Hot Work” (cutting, grinding, or welding) policies while the system is out of service because these activities are responsible for many fire ignitions. [**25:**A.15.5.2(4)(d)]

Although shop welding of pipe is preferred, welding of pipe and pipe supports is permitted by NFPA 13, provided that welding operations are conducted in accordance with NFPA 51B. In some areas, a permit issued by the local AHJ might be required.

(5) The fire department has been notified.

Although many fire departments might not require a permit for maintenance activities, notification to the department that a system or a portion of a system is out of service is still required. This notification of an impaired system serves two purposes:

1. It assists fire department pre-incident planning should an emergency response to the affected property be necessary.
2. It allows the fire department to monitor progress in repairs and avoid a system impairment that is longer than necessary.

(6) The insurance carrier, the alarm company, property owner or designated representative, and other AHJs have been notified.

Notifying the insurance carrier, the alarm company, the property owner or designated representative, and other AHJs is important for the following reasons:

1. In addition to ensuring that the alarm company does not inadvertently initiate a fire department response to an

alarm signal, alarm companies often require an estimated time period for the impairment and will respond if the system is not placed in service at the end of the specified time period.

2. Insurance companies might have requirements or recommendations for temporary protection during impairments and provide assistance in monitoring the impairment. Many insurance companies have specific tag impairment systems that must be used during impairments.
3. Water or health departments might have special requirements when systems are shut off and brought back on line, such as testing of backflow prevention devices.

(7) The supervisors in the areas to be affected have been notified.
(8) A tag impairment system has been implemented. *(See 13.3.3.6.3.)*

Prior to any scheduled inspection or testing that could impair the system, the contractor or service company should consult with the property owner or impairment coordinator. The following issues should be discussed and agreed upon by all parties prior to the start of any work:

1. Requirements for advance notification to the building occupants
2. Coordination of any business interruption
3. Procedures for the evacuation or for the restoration of protection
4. Additional related issues

(9) All necessary tools and materials have been assembled on the impairment site.

[**25:**15.5.2]

13.3.3.6.6* Emergency Impairments.

A.13.3.3.6.6 Emergency impairments include, but are not limited to, system leakage, interruption of water supply, frozen or ruptured piping, equipment failure, or other impairments found during inspection, testing, or maintenance activities. [**25:**A.15.6]

13.3.3.6.6.1 Emergency impairments shall include, but are not limited to, interruption of water supply, frozen or ruptured piping, and equipment failure, and includes impairments found during inspection, testing, or maintenance activities.
[**25:**15.6.1]

An emergency impairment is a condition in which the water-based fire protection system or a portion thereof is out of service due to an unexpected occurrence. Such an impairment might occur as the result of a successful system operation during a fire.

Following a fire, sprinklers that have operated must be replaced and the system must be returned to service. The replacement of sprinklers illustrates the importance of the sprinkler cabinet inspections required by 13.3.3.5.1, since the impairment time can be substantially reduced if replacement sprinklers are on site.

Exhibit 13.19

Emergency impairment notice. (Courtesy of Liberty Mutual Commercial Markets)

13.3.3.6.6.2* The coordinator shall implement the steps outlined in 13.3.3.6.5. [**25:**15.6.2]

The impairment coordinator can use an emergency impairment notice, such as the one shown in Exhibit 13.19, to coordinate emergency repairs of a fire protection system.

A.13.3.3.6.6.2 When one or more impairments are discovered during inspection, testing, and maintenance activities the owner or owner's authorized representative should be notified in writing. See Figure A.13.3.3.6.6.2 for an example of written notification. [**25:**A.15.6.2]

The impairment coordinator can use an emergency impairment notice (see Exhibit 13.19) to coordinate the emergency repairs of a fire protection system.

Δ **13.3.3.6.7* Restoring Systems to Service.** When all impaired equipment is restored to normal working order, the impairment coordinator shall verify that the following procedures have been implemented:

(1) Any necessary inspections and tests have been conducted to verify that affected systems are operational. The appropriate chapter of NFPA 25 shall be consulted for guidance on the type of inspection and test required.

The most common tests required following a system repair include the hydrostatic pressure test to verify that the piping system will not leak and the main drain test to verify that all water supply control valves have been returned to their full open

IMPAIRMENT NOTICE

DURING A RECENT INSPECTION OF YOUR FIRE PROTECTION SYSTEM(S), AN ***EMERGENCY IMPAIRMENT*** WAS DISCOVERED AND INDICATED ON THE INSPECTION REPORT. AS DEFINED BY NFPA 25, AN ***EMERGENCY IMPAIRMENT*** IS "A CONDITION WHERE A WATER-BASED FIRE PROTECTION SYSTEM OR PORTION THEREOF IS OUT OF ORDER DUE TO AN UNEXPECTED OCCURRENCE, SUCH AS A RUPTURED PIPE, OPERATED SPRINKLER, OR AN INTERRUPTION OF WATER SUPPLY TO THE SYSTEM." NFPA 25 FURTHER STATES, "EMERGENCY IMPAIRMENTS INCLUDE BUT ARE NOT LIMITED TO SYSTEM LEAKAGE, INTERRUPTION OF WATER SUPPLY, FROZEN OR RUPTURED PIPING, AND EQUIPMENT FAILURE."

WE RECOMMEND THAT IMMEDIATE STEPS BE TAKEN, AS DESCRIBED IN THE ATTACHED COPY OF CHAPTER 15 OF NFPA 25, TO CORRECT THE FOLLOWING IMPAIRMENT(S) TO YOUR FIRE PROTECTION SYSTEM(S):

[ ] CONTROL VALVE SHUT. SYSTEM OUT OF SERVICE.
[ ] LOW WATER PRESSURE DURING FLOW TEST. POSSIBLE OBSTRUCTION IN WATER SUPPLY OR PARTIALLY SHUT VALVE.
[ ] PIPE(S) FROZEN.
[ ] PIPE(S) LEAKING.
[ ] PIPE(S) ARE OBSTRUCTED.
[ ] SYSTEM PIPING OR PORTIONS OF SYSTEM PIPING ARE DISCONNECTED.
[ ] FIRE DEPT. CONNECTION MISSING OR DAMAGED OR OBSTRUCTED.
[ ] DRY PIPE VALVE CANNOT BE RESET.
[ ] DRY PIPE SYSTEM QUICK OPENING DEVICE IS OUT OF SERVICE.
[ ] SPRINKLERS ARE PAINTED, CORRODED, DAMAGED, OR LOADED.
[ ] FIRE PUMP IS OUT OF SERVICE.
[ ] DETECTION/ACTUATION SYSTEM IS OUT OF SERVICE.
[ ] OTHER: ______________________________

FIGURE A.13.3.3.6.6.2 Sample Impairment Notice.

positions. Other tests, such as a running test for fire pumps and flow or alarm tests to check the functioning of replaced components, are required when components are repaired or replaced. The specific actions required for placing a system or a system component in service following repair, replacement, or other corrective actions can be found in the appropriate chapter in NFPA 25.

(2) Supervisors have been advised that protection is restored.
(3) The fire department has been advised that protection is restored.
(4) The property owner or designated representative, insurance carrier, alarm company, and other AHJs have been advised that protection is restored.

All parties involved in the original impairment notification should be advised when protection is restored. See the commentary following 13.3.3.6.5.2(5) for further information.

(5) The impairment tag has been removed.
[**25:**15.7]

Impairment tags are required to be removed and should be accounted for. Counting these tags can be a means of verifying that all system control valves have been returned to their proper operating position and the system is fully operational.

A.13.3.3.6.7 Occasionally, fire protection systems in idle or vacant buildings are shut off and drained. When the equipment is eventually restored to service after a long period of not being maintained, it is recommended that a qualified person perform the work. The following is an example of a procedure:

(1) All piping should be traced from the extremities of the system to the main connections with a careful check for blank gaskets in flanges, closed valves, corroded or damaged sprinklers, nozzles or piping, insecure or missing hangers and insufficient support. Proper repairs or adjustments should be made and needed extensions or alterations for the equipment should be completed.
(2) An air test at low pressure (40 psi) should be conducted prior to allowing water to fill the system. When the piping has been proven tight by passing the air test, water can be introduced slowly into the system with proper precautions against damage by escape of water from previously undiscovered defects. When the system has been filled under normal service pressure, drain valve tests should be made to detect any closed valve that possible could have been overlooked. All available pipes should be flushed and an obstruction investigation completed to make sure that the system is clear of debris.
(3) Where the system was known to have been damaged by freezing or where other extensive damage may have occurred, a full hydrostatic test can be performed in accordance with NFPA 13 to determine whether the system integrity has been maintained.
(4) Dry-pipe valves, quick opening devices, alarm valves and all alarm connections should be examined, put in proper condition and tested.
(5) Fire pumps, pressure and gravity tanks, reservoirs and other water supply equipment should receive proper attention before being placed in service. Each supply should be tested separately; and then together if they are designed to work together.
(6) All control valves should be operated from the closed to fully open position and should be left sealed, locked or equipped with a tamper switch.

[**25:**A.15.7]

13.4 Fire Pumps

13.4.1 General.

Δ **13.4.1.1** Where provided, fire pumps shall be installed in accordance with NFPA 20 and Section 13.4.

13.4.1.2 Permits. Permits, where required, shall comply with Section 1.12.

13.4.1.3 Retroactivity. The provisions of this section reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this section at the time the section was issued. [**20:**1.4]

The retroactivity statement in 13.4.1.3 appears in most NFPA codes and standards. The purpose of the statement here is to reinforce the premise that any fire pump installed in accordance with the applicable edition of NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, is considered to be compliant with that standard for the lifetime of the fire pump, as long as the associated hazards remain unchanged and the pump is properly inspected, tested, and maintained. Therefore, an existing installation is not required to be reviewed for compliance with every new edition of NFPA 20.

Omission of the retroactivity statement would require the never-ending task of updating and revising a fire pump installation every time a new edition of NFPA 20 is published. Although newer editions contain information that may provide a greater level of safety or a more effective means of accomplishing a certain objective than that prescribed by older editions, the provisions of older editions should not necessarily be interpreted as unsafe. In those instances where a severe deficiency is discovered, 13.4.1.3 allows latitude for any AHJ to require an upgrade.

13.4.1.3.1 Unless otherwise specified, the provisions of this section shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the section. Where specified, the provisions of this section shall be retroactive. [**20:**1.4.1]

13.4.1.3.2 In those cases where the AHJ determines that the existing situation presents an unacceptable degree of risk, the AHJ shall be permitted to apply retroactively any portion of this section deemed appropriate. [**20:**1.4.2]

13.4.1.3.3 The retroactive requirements of this section shall be permitted to be modified if their application clearly would be impractical in the judgment of the AHJ, and only where it is clearly evident that a reasonable degree of safety is provided. [**20:**1.4.3]

13.4.1.4* Approval Required.

A.13.4.1.4 Because of the unique nature of fire pump units, the approval should be obtained prior to the assembly of any specific component. [**20:**A.4.2]

Fire pumps are typically long-lead items. Making changes to the fire pump after the pump is ordered can lead to project delay and additional costs.

13.4.1.4.1 Stationary pumps shall be selected based on the conditions under which they are to be installed and used. [**20:**4.2.1]

The fire protection system designer should verify the fire pump suction and discharge pressures over the operating range of the fire pump. The fire pump should provide sufficient discharge pressure to supply the fire protection system demands, but the discharge pressure should not subject the fire protection system components to pressures in excess of their listed pressure rating.

Fire pumps should be located in a suitable environment. See 13.4.2 for further guidance.

13.4.1.4.2 The pump manufacturer or its authorized representative shall be given complete information concerning the liquid and power supply characteristics. [**20:**4.2.2]

Pump capacities are based on the calculated system demand. Pressure boost or output of the pump is determined by the difference between the pressures available from the attached water supply and the pressure required by the fire protection system. The characteristics of that water supply — whether positive pressure or static — must be determined in order to select the correct type of pump and its performance characteristics.

The available power supply for electric pumps must be suitable for the fire pump controller. The power supply must be analyzed for reliability, capacity, and suitability. This information must be made available to the pump manufacturer or manufacturer's representative for analysis.

While fire pumps are traditionally associated with water, they are also used for pumping foam concentrate, foam water, water with other water additives, seawater, and possibly other liquids. The characteristics of the liquid are part of the critical information needed by the pump manufacturer.

Using salt water in a fire protection system requires special considerations to minimize corrosion issues. Dissimilar materials should be avoided.

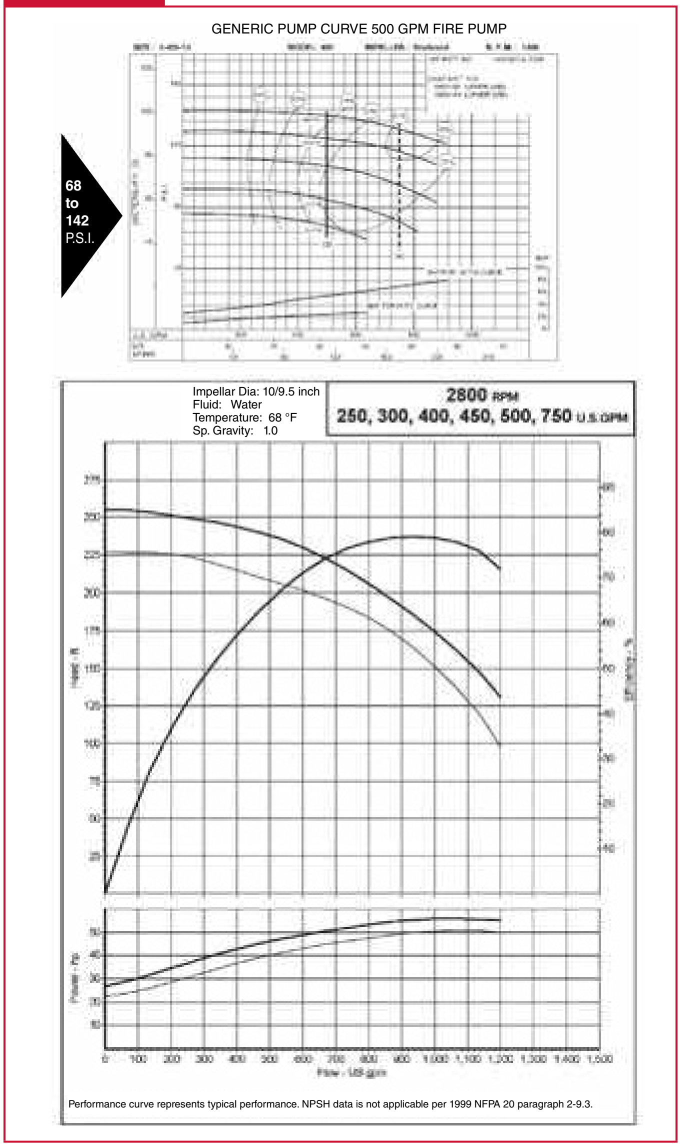
13.4.1.4.3 A complete plan and detailed data describing pump, driver, controller, power supply, fittings, suction and discharge connections, and liquid supply conditions shall be prepared for approval. [**20:**4.2.3]

Generic pump curves can be obtained from the pump manufacturer to determine the churn pressure and the pressure available at the required flow rate. See Exhibit 13.20. The certified pump curve is not available until the pump is manufactured, but it should be close to the generic curve. If system hydraulic calculations have been performed using a generic pump curve, they should be reconfirmed upon receipt of the certified pump curve to ensure that system demands will be met.

Ordinarily, upon purchase of a fire pump, the manufacturer or supplier provides the buyer with product data for the pump, the driver, the controller, and all accessories. This data package should include the pump's rated capacity and speed in addition to other performance characteristics. The data package should be submitted to the registered design professional (RDP) and the AHJ for approval before shipment of the pump and its accessories. The reviewing authority should be contacted prior to submittal to determine the number of plans, calculations, or product data needed for review. The submitter should include an additional number of copies of the package to be returned documenting the approval or comments from the AHJ.

In addition to the data package, a complete plan of the proposed installation, drawn to scale, should be submitted, indicating, at a minimum, the information outlined in Exhibit 13.21.

Exhibit 13.20



Sample generic fire pump curves. (Courtesy of Aon Fire Protection Engineering)

Δ **13.4.1.4.3.1** Plans shall be drawn to an indicated scale, on sheets of uniform size, and shall indicate, as a minimum, the items from the following list that pertain to the design of the system:

(1) Name(s) of owner and occupant
(2) Location, including street address
(3) Point of compass
(4) Name and address of installing contractor
(5) Pump make and model number
(6) Pump rating _______ gpm @ _____ psi ______ rpm
(7) Suction main size, length, location, type and class/schedule of material, and point of connection to water supply, as well as depth to top of pipe below grade
(8) Water storage tank, if applicable
(9) Size and type of valves, regulators, meters, and valve pits, if applicable
(10) Water supply information including the following flow test information, if applicable:
  (a) Location and elevation of static and residual test gauge with relation to the elevation reference point
  (b) Flow location
  (c) Static pressure, psi (bar)
  (d) Residual pressure, psi (bar)
  (e) Flow, gpm (L/min)
  (f) Date
  (g) Time
  (h) Name of person who conducted the test or supplied the information
  (i) Other sources of water supply, with pressure or elevation
(11) Pump driver details including manufacturer and horsepower
(12) Voltage for electric motor-driven pumps
(13) Fuel system details for diesel-driven pumps
(14) Controller manufacturer, type, and rating
(15) Suction and discharge pipe, fitting, and valve types
(16) Test connection piping and valves
(17) Flow meter details, if applicable
(18) Pressure maintenance pump and controller arrangement, including sensing line details, if applicable

[**20:**4.2.3.1]

13.4.1.4.4 Each pump, driver, controlling equipment, power supply and arrangement, and liquid supply shall be approved by the AHJ for the specific field conditions encountered. [**20:**4.2.4]

13.4.1.5 Pump Operation.

13.4.1.5.1 In the event of fire pump operation, qualified personnel shall respond to the fire pump location to determine that the fire pump is operating in a satisfactory manner. [**20:**4.3.1]

A qualified person is one who is familiar with the purpose and function of the fire pump and related equipment. This person does not need to be qualified to work on the pump but should be trained in the operation of the pump.

The regularly scheduled nonflow test required by NFPA 25 is an excellent training opportunity that can be used to demonstrate the proper operation of pumping equipment. One of the reasons for placing a fire pump in a protected enclosure, as required in 13.4.2, is to provide protection for both the pump operator and the pumping equipment. Consideration should be given to locating the fire pump room at grade level, with direct access to the exterior of the building, to afford quick and easy egress for the pump operator and access to the pumping equipment for fire department personnel.

13.4.1.5.2 System Designer.

13.4.1.5.2.1 The system designer shall be identified on the system design documents. [**20:**4.3.2.1]

13.4.1.5.2.2 Acceptable minimum evidence of qualifications or certification shall be provided when requested by the AHJ. [**20:**4.3.2.2]

Exhibit 13.21

PUMP INSTALLATION PLAN CHECKLIST

General
- ❑ Name of owner or occupant
- ❑ Location including street address
- ❑ Point of compass
- ❑ Name and address of designer and installing contractor
- ❑ Listed pump, make, model number, driver type, and rated capacity
- ❑ Type of system supplied by pump
- ❑ Design standard used including edition

Water Supply Characteristics
- ❑ Flow test data not more than 5 years old
- ❑ Underground main of adequate size
- ❑ Water storage tank of adequate capacity with automatic refill connection

Suction Piping
- ❑ Proper size
- ❑ Galvanized or painted on the inside for corrosion protection
- ❑ Isolation valve (OS&Y) in the proper location
- ❑ Backflow prevention or other device in proper location
- ❑ Elbows in the proper orientation or more than 10 pipe diameters away from suction flange of pump
- ❑ Eccentric reducer (if needed) installed correctly
- ❑ Pump bypass
- ❑ Suction and discharge pressure gauges
- ❑ Circulation relief valve

Discharge Piping
- ❑ Proper size
- ❑ Check valve
- ❑ Discharge isolation valve

Fire Pump Controller
- ❑ Listed for type of pump served
- ❑ If electric, type and arrangement of power supply

Water Flow Test Devices
- ❑ Test header or flowmeter
- ❑ Proper number of 2½ in. hose valves on test header
- ❑ Test header piping of proper size
- ❑ Proper size of flowmeter (if provided)

Jockey Pump
- ❑ Jockey pump bypasses fire pump
- ❑ Separate and dedicated sensing line for jockey pump
- ❑ Sensing lines ½ in. diameter and of brass, copper, or stainless steel piping
- ❑ No shutoff valves in sensing lines

Isolation Valves
- ❑ All isolation valves supervised in the open position
- ❑ Test header and flowmeter valves supervised in the closed position

Diesel Fire Pump
- ❑ Relief valve (if provided) with no isolation valves
- ❑ Two storage batteries provided with charger
- ❑ Cooling system from heat exchanger or cooling water supply from pump discharge
- ❑ Diesel tank located above ground
- ❑ Diesel tank of sufficient capacity 1 gallon per horsepower (gal/hp) plus 10 percent

Notes:
1. For all types of pumping equipment, a complete bill of material should be provided. This list should include the make, model, and part numbers of all components.
2. For all electrically operated pumps, provide an electrical schematic drawing that depicts which components are proposed for the power supply from the utility connection to the pump motor controller.
3. Ratings of all equipment and components and settings of breakers, fuses, switches, and transformers should be indicated. Size and length of all circuit conductors should also be noted.

Checklist for plan of proposed installation.

Δ **13.4.1.5.2.3** Qualified personnel shall include, but not be limited to, one or more of the following:

(1) Personnel who are factory trained and certified for fire pump system design of the specific type and brand of system being designed
(2) Personnel who are certified by a nationally recognized fire protection certification organization acceptable to the AHJ
(3) Personnel who are registered, licensed, or certified by a state or local authority

[**20:**4.3.2.3]

13.4.1.5.2.4 Additional evidence of qualification or certification shall be permitted to be required by the AHJ. [**20:**4.3.2.4]

13.4.1.5.3 System Installer.

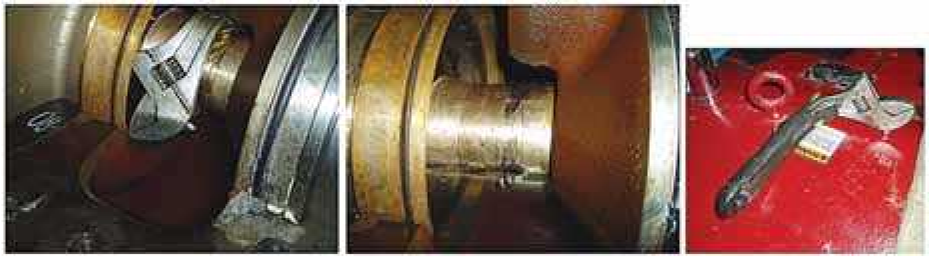
13.4.1.5.3.1 Installation personnel shall be qualified or shall be supervised by persons who are qualified in the installation, inspection, and testing of fire protection systems [**20:**4.3.3.1].

13.4.1.5.3.2 Minimum evidence of qualifications or certification shall be provided when requested by the AHJ. [**20:**4.3.3.2]

Δ **13.4.1.5.3.3** Qualified personnel shall include, but not be limited to, one or more of the following:

(1) Personnel who are factory trained and certified for fire pump system installation of the specific type and brand of system being designed

Exhibit 13.22



Fire pump damage from careless installation and maintenance procedures. (Courtesy of Aon Fire Protection Engineering)

(2) Personnel who are certified by a nationally recognized fire protection certification organization acceptable to the AHJ
(3) Personnel who are registered, licensed, or certified by a state or local authority

[**20:**4.3.3.3]

13.4.1.5.3.4 Additional evidence of qualification or certification shall be permitted to be required by the AHJ. [**20:**4.3.3.4]

13.4.1.5.4 Service Personnel Qualifications and Experience.

13.4.1.5.4.1 Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire protection systems. [**20:**4.3.4.1]

Δ **13.4.1.5.4.2** Qualified personnel shall include, but not be limited to, one or more of the following:

(1) Personnel who are factory trained and certified for fire pump system servicing of the specific type and brand of system being designed
(2) Personnel who are certified by a nationally recognized fire protection certification organization acceptable to the AHJ
(3) Personnel who are registered, licensed, or certified by a state or local authority
(4) Personnel who are employed and qualified by an organization listed by a nationally recognized testing laboratory for the servicing of fire protection systems

[**20:**4.3.4.2]

13.4.1.5.4.3 Additional evidence of qualification or certification shall be permitted to be required by the AHJ. [**20:**4.3.4.3]

13.4.2* Equipment Protection.

Subsection 13.4.2 provides requirements and guidance on the proper placement of a fire pump and related equipment. It is also intended to provide a relatively safe environment for the equipment operator. In accordance with 13.4.1.5, a qualified fire pump operator will report to the fire pump room to confirm that the equipment is operating properly in the event of operation of the pump. By locating the fire pump room near an exterior wall and enclosing the equipment in a fire-rated room, the operator is provided with a means of egress, and both the operator and the equipment are protected from fire exposure.

Although not specifically addressed in this subsection, damage to fire pump systems can occur from careless installation and maintenance procedures. Exhibit 13.22 shows the effect of one such incident.

Multiple fire pumps can be located in one fire pump room. Although not required by this *Code*, separate rooms might be required by the insuring authority where redundant pumps are not required by this *Code* but are installed because of risk management considerations.

The intent of this subsection, by requiring fire separation, is to locate a fire pump and its related equipment in a dedicated fire pump room. For installations with multiple pumps, a single fire pump room is needed. Fire pumps must not be located in mechanical equipment spaces, which would expose the equipment and the operator to damage and potential injury.

A.13.4.2 Special consideration needs to be given to fire pump installations installed belowgrade. Light, heat, drainage, ventilation, and potential flooding are several of the variables that need to be addressed. Some locations or installations might not require a pump house. Where a pump room or pump house is required, it should be of ample size and located to permit short and properly arranged piping. The suction piping should receive first consideration. The pump house should preferably be a detached building of noncombustible construction. A one-story pump room with a combustible roof, either detached or well protected from an adjoining one-story building, is acceptable if sprinklered. Where a detached building is not feasible, the pump room should be located and constructed to protect the pump unit and controls from falling floors or machinery, and from fire that could drive away the pump operator or damage the pump unit or controls. Access to the pump room should be provided from outside the building. Where the use of brick or reinforced concrete is not feasible, metal lath and plaster is recommended for the construction of the pump room. The pump room or pump house should not be used for storage purposes. Vertical shaft turbine–type pumps might necessitate a removable panel in the pump house roof to permit the pump to be removed for inspection or repair. Proper clearances to equipment should be provided as recommended by the manufacturer's drawings. [**20:**A.4.13]

13.4.2.1* General Requirements. The fire pump, driver, controller, water supply, and power supply shall be protected against possible interruption of service through damage caused by explosion, fire, flood, earthquake, rodents, insects, windstorm, freezing, vandalism, and other adverse conditions. [**20:**4.13.1]

A.13.4.2.1 A fire pump that is inoperative for any reason at any time constitutes an impairment to the fire protection system. It should be returned to service without delay. [**20:**A.4.12.1]

Rain and intense heat from the sun are adverse conditions to equipment not installed in a completely protective enclosure. At a minimum, equipment installed outdoors should be shielded by a roof or deck. [**20:**A.4.12.1]

13.4.2.1.1* Indoor Fire Pump Units.

A.13.4.2.1.1 Most fire departments have procedures requiring operation of a fire pump unit during an incident. Building designers should locate the fire pump room to be easily accessible during an incident. [**20:**A.4.12.1.1]

13.4.2.1.1.1 Except as permitted in 13.4.2.1.1.3, fire pump units serving high-rise buildings shall be protected from surrounding occupancies by a minimum of 2-hour fire-rated construction or physically separated from the protected building by a minimum of 50 ft (15.3 m). [**20:**4.13.1.1.1]

A minimum of 50 ft (15.3 m) of separation or a 2-hour fire-rated enclosure will protect the building's fire pump and personnel from an exposure fire.

13.4.2.1.1.2* Except as permitted in 13.4.2.1.1.3, indoor fire pump rooms in non-high-rise buildings or in separate fire pump buildings shall be physically separated or protected by fire-rated construction in accordance with Table 13.4.2.1.1.2. [**20:**4.13.1.1.2]

A.13.4.2.1.1.2 The purpose for the "Not Sprinklered" column in Table 13.4.2.1.1.2 is to provide guidance for unsprinklered buildings. This does not permit sprinklers to be omitted from pump rooms in fully sprinklered buildings. [**20:**A.4.12.1.1.2]

For the purposes of Table 13.4.2.1.1.2, a building with a fire protection system(s) supplied from the fire pump is considered to be a building exposing the pump room/house. There may also be other buildings or hazards that expose the pump room/house.

TABLE 13.4.2.1.1.2 *Equipment Protection*

Pump Room/House	Building(s) Exposing Pump Room/House	Required Separation
Not sprinklered Not sprinklered Fully sprinklered	Not sprinklered Fully sprinklered Not sprinklered	2 hour fire-rated or 50 ft (15.3 m)
Fully sprinklered	Fully sprinklered	1 hour fire-rated or 50 ft (15.3 m)

[**20:** Table 4.13.1.1.2]

The purpose of Table 13.4.2.1.1.2 is to prevent a fire in the protected building from impairing the fire pump that provides protection to the protected building. A fire pump located a minimum of 50 ft (15.3 m) from a protected building is adequately protected from a fire in that building. A fire in the fire pump enclosure could still impair the fire pump; however, a fire in the fire pump enclosure is unlikely to occur simultaneously with a fire in the protected building.

N **13.4.2.1.1.3** Fire pump units supplying a local application fire protection system(s) shall be physically separated from the hazard being protected in a manner that will prevent a fire associated with the hazard from directly exposing the pumping unit. [**20:**4.12.1.1.3]

13.4.2.1.1.4 The location of and access to the fire pump room shall be preplanned with the fire department. [**20:**4.13.1.1.3]

13.4.2.1.1.5* Except as permitted in 13.4.2.1.1.6, rooms containing fire pumps shall be free from storage, equipment, and penetrations not essential to the operation of the pump and related components. [**20:**4.13.1.1.4]

It is the intent of this *Code* to prohibit the use of a fire pump room for the purposes of storage. It is not the intent of this *Code* to prohibit the installation of other types of equipment such as domestic water distribution equipment, as indicated in 13.4.2.1.1.6. No materials or equipment that add to the combustibility of the space should be placed in the fire pump room. This provision is intended to provide protection to equipment as well as operating personnel.

A.13.4.2.1.1.5 Equipment that increases the fire hazard (such as boilers) and is not related to fire protection systems should not be in a fire pump room. [**20:**A.4.12.1.1.4]

13.4.2.1.1.6 Equipment related to domestic water distribution shall be permitted to be located within the same room as the fire pump equipment. [**20:**4.13.1.1.5]

Δ **13.4.2.1.1.7** The pump room or pump house shall be sized to fit all of the components necessary for the operation of the fire pump and to accommodate the following:

(1) Clearance between components for installation and maintenance
(2) Clearance between a component and the wall for installation and maintenance
(3) Clearance between energized electrical equipment and other equipment in accordance with *NFPA 70*
(4) Orientation of the pump to the suction piping to allow compliance with 4.15.6.3 of NFPA 20

[**20:**4.13.1.1.6]

13.4.2.1.2 Outdoor Fire Pump Units.

Exhibit 13.23 shows an outdoor fire pump unit.

13.4.2.1.2.1 Fire pump units that are outdoors shall be located at least 50 ft (15.3 m) away from any buildings and other fire exposures exposing the building. [**20:**4.13.1.2.1]

Exhibit 13.23

Outdoor fire pump installation. (Courtesy of Aon Fire Protection Engineering)

13.4.2.1.2.2 Outdoor installations shall be required to be provided with protection against possible interruption, in accordance with 13.4.2.1. [**20:**4.13.1.2.2]

13.4.2.2 Equipment Access.

13.4.2.2.1 The location of and access to the fire pump room(s) shall be pre-planned with the fire department. [**20:**4.13.2.1]

A properly operating fire pump is essential to fire department fire-fighting operations. Coordinating the location and access with the fire department is necessary to allow monitoring by the fire department.

13.4.2.2.1.1 Except as provided in 13.4.2.2.1.1.1 fire pump rooms not directly accessible from the outside shall be accessible through an enclosed passageway from an enclosed stairway or exterior exit. [**20:**4.13.2.1.1]

N **13.4.2.2.1.1.1** Fire pump units supplying only local application fire protection systems shall be accessible by a path that is not subject to exposure from a fire in any hazard protected by the fire pump. [**20:**4.13.2.1.1.1]

13.4.2.2.1.2 The enclosed passageway shall have a fire-resistance rating not less than the fire-resistance rating of the fire pump room. [**20:**4.13.2.1.2]

A properly operating fire pump is essential to fire department operations. Fire pump rooms should be accessible under fire conditions to allow the fire department to monitor the fire pump to provide early warning and modifications to the fire-fighting operations should a fire pump not operate satisfactorily. Where a fire pump room cannot be located on grade with direct access from outside the building, a protected space with a fire rating in accordance with Table 13.4.2.1.1.2 must be provided. The space must be accessible through an enclosed passageway from an exterior exit or from an enclosed stairway.

13.4.2.3 Heat.

13.4.2.3.1 An approved or listed source of heat shall be provided for maintaining the temperature of a pump room or pump house, where required, above 40°F (4°C). [**20:**4.13.3.1]

Although maintaining the water temperature above 32°F (0°C) will prevent freezing, maintaining a minimum temperature of 40°F (4°C) provides a safety factor to account for isolated temperature variations and the accuracy of the temperature control equipment.

13.4.2.3.2 The requirements of 13.4.4.5 shall be followed for higher temperature requirements for internal combustion engines. [**20:**4.13.3.2]

Temperatures above 40°F (4°C) may be necessary to ensure starting of diesel engines.

13.4.2.4 Normal Lighting. Artificial light shall be provided in a pump room or pump house. [**20:**4.13.4]

13.4.2.5 Emergency Lighting.

Δ **13.4.2.5.1** Emergency lighting shall be provided in accordance with NFPA *101*.

13.4.2.5.2 Emergency lights shall not be connected to an engine-starting battery. [**20:**4.13.5.2]

13.4.2.6 Ventilation. Provision shall be made for ventilation of a pump room or pump house. [**20:**4.13.6]

For an engine drive pump, the ventilation must be adequate to provide combustion air. See 11.3.2 of NFPA 20.

13.4.2.7* Drainage.

A.13.4.2.7 Pump rooms and pump houses should be dry and free of condensate. To accomplish a dry environment, heat might be necessary. [**20:**A.4.12.7]

13.4.2.7.1 Floors shall be pitched for adequate drainage of escaping water away from critical equipment such as the pump, driver, controller, and so forth. [**20:**4.13.7.1]

13.4.2.7.2 The pump room or pump house shall be provided with a floor drain that will discharge to a frost-free location. [**20:**4.13.7.2]

Where a reduced pressure zone (RPZ) backflow prevention device is installed in a fire pump room, the discharge from the middle chamber should be piped outside, or the floor drain should be sized to accommodate the full discharge from the RPZ. An RPZ is shown in Exhibit 13.24

Δ **13.4.2.8 Guards.** Couplings and flexible connecting shafts shall be installed with a coupling guard in accordance with Section 7 of ANSI B11.19, *Performance Requirements for Safeguarding*. [**20:**4.13.8]

Exhibit 13.24

RPZ backflow prevention device. (Courtesy of Aon Fire Protection Engineering)

13.4.3* Valve Supervision.

A.13.4.3 Isolation valves and control valves are considered to be identical when used in conjunction with a backflow prevention assembly. [**20:**A.4.16]

Δ **13.4.3.1 Supervised Open.** Where provided, the suction valve, discharge valve, bypass valves, and isolation valves on the backflow prevention device or assembly shall be supervised open by one of the following methods:

(1) Central station, proprietary, or remote station signaling service
(2) Local signaling service that will cause the sounding of an audible signal at a constantly attended point
(3) Locking valves open
(4) Sealing of valves and approved weekly recorded inspection where valves are located within fenced enclosures under the control of the owner

[**20:**4.17.1]

The four methods of supervision represented in 13.4.3.1 help to ensure that a common mode of sprinkler system failure is reduced to a minimum. Approximately one-third of system failures are attributable to closed or partially closed sprinkler system control valves. The methods listed are in descending order of preference.

Central station, proprietary, or remote station supervision methods are preferred over the other methods listed. Supervisory signals received at such alarm facilities are usually forwarded to maintenance staff responsible for the protected property. This method also allows for much more efficient notification of the responding fire department (the signal is not considered a fire alarm signal and, therefore, does not require an immediate response). Early notification that a control valve has been closed for any reason might alter the fire department's response and fire-fighting tactics. However, central station, proprietary, or remote station supervision methods are not mandated by NFPA 20.

All bypass valves are required to be supervised open. Where a bypass is installed, water is expected to flow through the bypass into the fire protection system automatically — that is, without human intervention — in the event that the fire pump does not start. When the control valves are open, water can flow through the bypass automatically. A check valve, therefore, needs to be installed in the bypass line so that, when the pump is running, water does not circulate through the bypass back to the pump.

13.4.3.2 Supervised Closed. Control valves located in the pipeline to the hose valve header shall be supervised closed by one of the methods allowed in 13.4.3.1. [**20:**4.17.2]

For test headers that are installed outside or where freezing is a danger, an isolation valve as required by 4.21.3.3.1 of NFPA 20 must be installed. This valve is normally closed and is opened only for testing purposes. The valve is required to be supervised in the closed position to prevent accidental freezing of the test header. The hose header is required to have an automatic drain valve (typically a ball drip valve) where it is subject to freezing conditions.

13.4.4* Diesel Engine Driver System Operation.

A.13.4.4 Internal combustion engines necessarily embody moving parts of such design and in such number that the engines cannot give reliable service unless given diligent care. The manufacturer's instruction book covering care and operation should be readily available, and pump operators should be familiar with its contents. All of its provisions should be observed in detail. [**20:**A.11.6]

13.4.4.1 Weekly Run.

13.4.4.1.1 Engines shall be designed and installed so that they can be started no less than once a week and run for no less than 30 minutes to attain normal running temperature. [**20:**11.6.1.1]

Running the engine for a minimum of 30 minutes provides sufficient time for the engine to reach its full operating temperature and for condensation to evaporate from the crankcase. Any irregularities in the engine operation should be investigated and repaired immediately. Running the engine for this length of time also gives the operator sufficient time to check out the pump operations, the cooling loop operation, the battery chargers, and all other pump room components requiring an inspection. Subsection 8.1.2 and Table 8.1.1.2 of NFPA 25 describe the schedules and the specific requirements for periodically required maintenance items. Additionally, 8.6.1 of NFPA 25 provides the necessary testing required after repairs or upgrades are completed on any pump room component.

13.4.4.1.2 Engines shall run smoothly at rated speed, except for engines addressed in 13.4.4.1.3. [**20:**11.6.1.2]

13.4.4.1.3 Engines equipped with variable speed pressure limiting control shall be permitted to run at reduced speeds provided factory-set pressure is maintained and they run smoothly. [**20:**11.6.1.3]

13.4.4.2* Engine Maintenance. Engines shall be designed and installed so that they can be kept clean, dry, and well lubricated to ensure adequate performance. [**20:**11.6.2]

A.13.4.4.2 See NFPA 25, for proper maintenance of engine(s), batteries, fuel supply, and environmental conditions. [**20:**A.11.6.2]

13.4.4.3 Battery Maintenance.

13.4.4.3.1 Storage batteries shall be designed and installed so that they can be kept charged at all times. [**20:**11.6.3.1]

13.4.4.3.2 Storage batteries shall be designed and installed so that they can be tested frequently to determine the condition of the battery cells and the amount of charge in the battery. [**20:**11.6.3.2]

Lead-acid batteries last between 24 months and 30 months of service. When replacements of batteries are required, it is best to replace both units where two batteries are required to make a starting set. This is particularly true in a system requiring two batteries to make a set (24 V dc). See NFPA 25 for the recommended replacement schedule.

13.4.4.3.3 Only distilled water shall be used in battery cells. [**20:**11.6.3.3]

13.4.4.3.4 Battery plates shall be kept submerged at all times. [**20:**11.6.3.4]

If the battery requires an excessive amount of replacement water, the battery should be checked to make sure it is not overcharging. Also, the battery plates need to be covered with water to help eliminate the possibility of battery explosions. Exposed plates can create an arc or a spark, which can ignite the hydrogen gases present during the starting and charging cycles.

13.4.4.3.5 The automatic feature of a battery charger shall not be a substitute for proper maintenance of battery and charger. [**20:**11.6.3.5]

13.4.4.3.6 The battery and charger shall be designed and installed so that periodic inspection of both battery and charger is physically possible. [**20:**11.6.3.6]

13.4.4.3.6.1 This inspection shall determine that the charger is operating correctly, the water level in the battery is correct, and the battery is holding its proper charge. [**20:**11.6.3.6.1]

13.4.4.4* Fuel Supply Maintenance.

Δ **A.13.4.4.4** Active systems that are permanently added to fuel tanks for removing water and particulates from the fuel can be acceptable, provided the following apply:

(1) All connections are made directly to the tank and are not interconnected with the engine or its fuel supply and return piping in any way.
(2) There are no valves or other devices added to the engine or its fuel supply and return piping in any way.

13.4.4.4.1 The fuel storage tanks shall be designed and installed so that they can be kept as full and maintained as practical at all times but never below 66 percent (two-thirds) of tank capacity. [**20:**11.6.4.1]

13.4.4.4.2 The tanks shall be designed and installed so that they can always be filled by means that will ensure removal of all water and foreign material. [**20:**11.6.4.2]

13.4.4.5* Temperature Maintenance.

A.13.4.4.5 Proper engine temperature, in accordance with 11.2.8.2 of NFPA 20 and 13.4.4.5.1, maintained through the use of a supplemental heater has many benefits, as follows:

(1) Quick starting (a fire pump engine might have to carry a full load as soon as it is started)
(2) Reduced engine wear
(3) Reduced drain on batteries
(4) Reduced oil dilution
(5) Reduced carbon deposits, so that the engine is far more likely to start every time

[**20:**A.11.6.5]

13.4.4.5.1 The temperature of the pump room, pump house, or area where engines are installed shall be designed so that the temperature is maintained at the minimum recommended by the engine manufacturer and is never less than the minimum recommended by the engine manufacturer. [**20:**11.6.5.1]

Fuel tanks installed outdoors generate a greater volume of water from condensation than do tanks installed inside the fire pump room.

If possible, diesel fuel tanks should be located inside the pump room, where they will be subjected to fewer temperature variances. If a diesel fuel tank is placed outside, fuel maintenance intervals should be increased because the fuel tank is likely to have additional condensate buildup inside the tank. Tank drain valves should be added to the end of the tank opposite the fuel line that feeds the fuel pump to allow for removal of sediment and water. The valves should be closed at all times except annually, when 5 gal (20 L) of diesel fuel should be removed from the bottom of the tank. This will minimize the amount of debris that could enter the fuel pump.

13.4.4.6 Emergency Starting and Stopping.

13.4.4.6.1 The sequence for emergency manual operation, arranged in a step-by-step manner, shall be posted on the fire pump engine. [**20:**11.6.6.1]

13.4.4.6.2 It shall be the engine manufacturer's responsibility to list any specific instructions pertaining to the operation of this equipment during the emergency operation. [**20:**11.6.6.2]

The manufacturer's instructions and the sequence of steps for emergency manual operation must be clearly posted, typically on the engine near the instrument panel, since it is possible that a person not strictly qualified in accordance with 13.4.1.5 will be the responder in an emergency.

13.4.5 Components.

13.4.5.1 Indicators on Controller.

13.4.5.1.1 All visible indicators shall be plainly visible. [**20:**12.4.1.1]

13.4.5.1.2* Visible indication shall be provided to indicate that the controller is in the automatic position. If the visible indicator is a pilot lamp, it shall be accessible for replacement. [**20:**12.4.1.2]

Visible indication is necessary whether the controller is located in a dark room, in a brightly lit pump house, or outdoors. This requirement applies to alarm, trouble, and status indicators, as well as digital displays.

Legacy, or traditional, controllers commonly used incandescent lamp–type or pilot light–type indicators. Some modern controllers make use of LED-type indicators and/or digital displays in one form or another. Most now make use of touch-sensitive display screens. All controllers make use of multiple menu screens for accessing additional data and for entering parametric data such as enabling or disabling options, setting timer values, start and stop pressure settings, alarm set-points, and so on.

A.13.4.5.1.2 It is recommended that the pilot lamp for signal service have operating voltage less than the rated voltage of the lamp to ensure long operating life. When necessary, a suitable resistor should be used to reduce the voltage for operating the lamp. [**20:**A.12.4.1.2]

This recommendation was important for legacy controllers, which made use of filament-type pilot lights. Other controllers use 14 V and 28 V rated lamps for 12 V dc and 24 V dc rated systems, respectively. This is one reason why replacement lamps should be what the controller manufacturer recommends.

The life of filament (incandescent) lamps is inversely proportional to the 12th power of the voltage. Hence, operating a 14 V lamp at 13.2 V dc (typical battery charger float voltage) is a 9.1 percent reduction in voltage, which results in approximately a 314 percent increase in lamp life.

Δ **13.4.5.1.3** Separate visible indicators and a common audible fire pump alarm capable of being heard while the engine is running and operable in all positions of the main switch except the off position shall be provided to immediately indicate the following conditions:

The audible device must be capable of being heard. Traditionally, controllers used alarm bells or horns that could usually be heard over the noise of a running engine. The exception was 3000 rpm engines, which are not as prevalent as they once were. It is important to note that solid-state devices, such as piezoelectric beepers, are sometimes used and are sometimes not audible over the sound of a running engine.

(1) Critically low oil pressure in the lubrication system.

The oil pressure referred to is lube oil pressure, not fuel oil pressure. In most, if not all, cases the testing is accomplished by switching the controller to the manual mode or one of the two manual modes (MAN1 or MAN2), not by cranking the engine. The low oil pressure switch should be closed in manual mode, and the controller visible indicator should be lit. However, the audible device and remote failure contacts should remain in their "normal" (non-alarm) state. Typically, there is a delay time of a few seconds after the controller receives the cranking terminating (engine running) signal from the engine speed switch prior to actuating the audible device and alarm contacts. This delay is intended to prevent false alarms. See also 12.7.2.7.4 and 12.7.2.7.5 of NFPA 20.

(2) High engine temperature.

Similar to the low lube oil pressure alarm, the controller will not shut down the engine due to a high water alarm condition if it is running under a true demand, such as pressure loss, remote start, and so forth. The controller will shut down the engine if it is running under test. Note that some engines add an oil pressure switch in series with the high temperature switch to avoid false alarms after a high horsepower demand running. See also 12.7.2.7.4 and 12.7.2.7.5 of NFPA 20 for further requirements and information.

(3) Failure of engine to start automatically.

This condition occurs if the engine fails to start after six cranking attempts or if the engine (speed switch) fails to notify the controller that the engine is running. See 12.7.4 of NFPA 20 for more information. The controller treats this condition as a shutdown requirement, even though the engine might not be running. The reason for this shutdown is to kill the water and fuel solenoids to avoid further battery drain and also to avoid cooling water drain, which can be significant over an extended period, such as a 3-day weekend.

(4) Shutdown from overspeed.

Typically, the engine overspeed switch is set to trip at approximately 20 percent of the engine's rated running speed.

Although the general philosophy is that the fire pump and the engine are sacrificial if an overspeed condition is detected by the engine speed switch and transmitted to the controller, the controller will immediately shut down the engine. The reason is that a true engine overspeed condition is considered an imminent destruction condition. It is also a personnel safety consideration, since engines sometimes throw parts in the process of overspeed destruction. By shutting down the engine, there may also be a possibility of manual intervention to correct or temporarily remedy the situation.

(5) High cooling water temperature
[**20:**12.4.1.3]

This condition was added in the 2016 edition of NFPA 20 to correlate with the requirements of 13.4.5.1.4(11). By way of background, some field cases were found where the temperature of the "cooling" water for the diesel engine was too high to enable adequate cooling of the diesel engine when fully loaded. This is another signal that requires a switch closure on the diesel engine to notify the fire pump controller of the alarm condition. See 13.4.5.1.4(11) for more information on this alarm.

13.4.5.1.3.1 The controller shall provide means for testing the low oil pressure alarms and circuit in conjunction with the engine circuit testing method. [**20**:12.4.1.3.1]

The usual method for checking this alarm signal is to set the controller control switch to the manual position (or MAN1 or MAN2 on controllers with two manual switch positions) but not crank or start the engine. In this condition, the engine pressure switch should be closed (no oil pressure) and, consequently, the controller's low oil pressure alarm signal should be active.

13.4.5.1.3.2 Instructions shall be provided on how to test the operation of the signals in 13.4.5.1.3. [**20:**12.4.1.3.2]

Paragraph 13.4.5.1.3.2 mandates that instructions be provided for testing the alarm circuits specified in 13.4.5.1.3 because the test method for a specific engine controller was not always evident, which resulted in inadequate or no testing of alarm circuits.

Δ **13.4.5.1.4** Separate visible indicators and a common audible signal capable of being heard while the engine is running and operable in all positions of the main switch except the off position shall be provided to immediately indicate the following conditions:

(1)* Battery failure or missing battery. Each controller shall be provided with a separate visible indicator for each battery. The battery failure signal shall initiate at no lower than two-thirds of battery nominal voltage rating (8.0 V dc on a 12 V dc system). Sensing shall be delayed to prevent nuisance signals.

The battery failure signal initiates when the engine cranking voltage is too low to effectively crank (turn over) the engine. In addition to initiating the signal, the controller must also switch to the other battery set. This provision quantifies the initiation of the battery failure signal by setting a voltage limit at which initiation must commence.

As batteries age, their actual capacity (amp-hours) increases somewhat, then declines over the life of the battery. Once a battery's actual capacity returns to its initial capacity, the capacity curve will indicate that the capacity is declining rapidly and will soon be inadequate. Battery replacement is advised at this time. Note that this could also be an indication of a failed battery charger function on the newer battery or an actual failure of the newer battery.

A.13.4.5.1.4(1) The controller can set the signal trip point above the two-thirds level. But, higher than ¾ of nominal is not recommended to avoid false signals during normal battery aging. [**20:**A.12.4.1.4(1)]

Cranking voltage under normal conditions (nominal batteries fully charged and nominal engine cranking current) typically will be 80 percent of nominal, or around 9.5 volts on a 12 V dc nominal system or around 19 volts on a 24 V dc system. Cranking voltage of 75 percent of nominal is still acceptable; however, it indicates that the system needs attention. This is because cranking voltages this low indicate either excessive starter motor draw, inadequately charged batteries, or batteries that are approaching end of life. End of life means that the battery capacity has dropped, or is dropping, below nominal rated capacity (ampere hour or A-H capacity or, alternatively, the battery's reserve capacity rating).

(2) Battery charger failure. Each controller shall be provided with a separate visible indicator for battery charger failure and shall not require the audible signal for battery charger failure.

The controller is required to actuate a signal if the battery charger either fails to maintain the charge in the battery or fails to recharge the battery as required. Some controllers trip the charger failure alarm *before* the batteries lose their charge. This is done by setting the alarm trip voltage around halfway between the nominal charger float voltage and the battery's full charge open circuit voltage. For typical SAE 8D truck-type starting batteries, the trip voltage would be around 12.75 (halfway between 13.2 and 12.5 V dc) for a 12 V dc nominal system. Equipment with lower trip set-points will result in either a partially discharged or a fully discharged battery before tripping the charger failure alarm. See Sections 12.5 and 12.6 of NFPA 20 for more requirements.

(3) Low air or hydraulic pressure. Where air or hydraulic starting is provided *(see 11.2.7 and 11.2.7.4 of NFPA 20)*, each pressure tank shall provide to the controller separate visible indicators to indicate low pressure.

A low air or low hydraulic pressure condition is analogous to the battery failure alarm and its need for a signal. Note that while not commonly used, a controller for either hydraulically or pneumatically started engines will usually make use of two batteries for controller power, although these batteries may be fairly small. In any event, the controller usually will still be provided with the battery failure and charger failure alarms, since both the battery and the charger remain critical to the operation of the fire pump.

(4) System overpressure, for engines equipped with variable speed pressure limiting controls, to actuate at 115 percent of set pressure.

Pressure limiting diesel drivers use feedback from the pump discharge pressure to modulate the speed governor setting. The system overpressure signal is used to indicate a problem or manual intervention resulting in pressure higher than the desired set-point value. This signal also indicates that the main pressure relief valve might be open and flowing large quantities of water or that it might not be working at all. See Section 4.19 of NFPA 20 for more information on relief valves.

(5) ECM selector switch in alternate ECM position (only for engines with ECM controls).

Note that this position should also indicate when the alternate electronic control module (ECM) is selected automatically by the engine.

(6) Common alarm for fuel injection malfunction (only for engines with ECM).

This signal from the engine occurs when the ECM detects an internal failure.

(7) Low fuel level. Signal at two-thirds tank capacity.

The low fuel alarm alerts those responsible for maintaining the fire pump in good operating condition. NFPA 20 requires that a diesel fuel tank be capable of containing enough fuel for 8 hours of pump run time. The standard also allows the fuel tank level to drop as low as two-thirds capacity, which equates to 6 hours run time. It is important that the fuel level not drop below the two-thirds level because it is not uncommon for fire pumps to run for long durations during a fire event. Exhibit 13.25 shows a low fuel level switch.

(8) Low air pressure (air-starting engine controllers only). The air supply container shall be provided with a separate visible indicator to indicate low air pressure.
(9) Low engine temperature.

The low engine temperature alarm picks up the low engine temperature sensor. This signal indicates that there is a loss of ac (mains) power to the engine heater or a malfunction of the heater, that the heater is unplugged or disconnected, or that the heater has a kinked or plugged hose(s).

(10) Supervisory signal for interstitial space liquid intrusion.
(11) High cooling water temperature.
(12) Fuel maintenance needed if automatic fuel maintenance system is provided.
[**20:**12.4.1.4]

Traditionally, diesel fuels of the type used for diesel fire pump engines had a certain amount of sulfur content. This was beneficial to the engines since it not only added a certain amount of upper cylinder lubrication but also acted as a biocide — that is, it retarded or prevented the growth of biologicals, namely bacteria (algae) and fungi. Modern fuels are of the low-sulfur type. As a result, biological growth poses a problem, especially with fuel tanks that store the fuel for extended periods of time. Note that biological growth is not usually a problem for vehicles because their fuel is used at a faster rate and hence is a deterrent to biological growth.

Growth of biologicals can clog fuel filters and create other problems for fire pump engines. As a result, it is now common for fire pump fuel tanks to be equipped with some sort of maintenance program or device to prevent or retard such growth. This maintenance could be periodic service from a fuel supplier or other vendor or be an automatic fuel treatment system such as is common with boiler feed water. The automatic systems themselves might require periodic maintenance. If an automatic device is used, the controller must provide a signal (e.g., contact closure) when the system needs attention or maintenance.

Exhibit 13.25

Low fuel level switch. (Courtesy of Master Control Systems, Inc.)

13.4.5.1.5 A separate signal silencing switch or valve, other than the controller main switch, shall be provided for the conditions reflected in 13.4.5.1.3 and 13.4.5.1.4. [**20:**12.4.1.5]

Field experience has demonstrated situations in which audible alarms were disabled, resulting in no audible alarm for a new alarm condition and situations in which the fire pump failed to respond when needed. Paragraphs 13.4.5.1.5.1, 13.4.5.1.5.2, and 13.4.5.1.5.3 specify the conditions under which any of the audible alarms in 13.4.5.1.3 or signals in 13.4.5.1.4 may be silenced.

Audible alarm and signal silencing requirements address situations in which conditions that are alarmed cannot be corrected immediately (such as low engine temperature or fuel injection malfunction alarms). In such situations, it could take 24 hours or longer to correct the condition. Under such circumstances, it is not necessary to acknowledge the alarm until the condition is corrected. In addition, the alarm is unavailable for additional alarm conditions during that period. The words "or valve" address controllers that operate pneumatically or use fluidic logic rather than traditional electrical circuitry.

13.4.5.1.5.1 The switch or valve shall allow the audible device to be silenced for up to 4 hours and then re-sound repeatedly for the conditions in 13.4.5.1.3, [**20:**12.4.1.5.1.]

The trouble conditions specified in 13.4.5.1.3 could exist for extended periods. Silencing these alarms is needed in the case of attended pump rooms. Silencing is also needed to avoid unnecessary battery drain during power outages and to avoid the controller being taken out of service to quiet the alarm.

13.4.5.1.5.2 The switch or valve shall allow the audible device to be silenced for up to 24 hours and then re-sound repeatedly for the conditions in 13.4.5.1.4. [**20:**12.4.1.5.2]

The trouble conditions specified in 13.4.5.1.4 could exist for extended periods. Silencing these alarms is needed in the case of attended pump rooms. Silencing is also needed to avoid unnecessary battery drain during power outages and to avoid the controller being taken out of service to quiet the alarm.

13.4.5.1.5.3 The audible device shall re-sound until the condition is corrected or the main switch is placed in the off position. [**20:**12.4.1.5.3]

13.4.5.1.6* The controller shall automatically return to the nonsilenced state when the alarm(s) have cleared (returned to normal). [**20:**12.4.1.6]

A.13.4.5.1.6 This automatic reset function can be accomplished by the use of a silence switch of the automatic reset type or of the self-supervising type. [**20:**A.12.4.1.6]

13.4.5.1.6.1 This switch shall be clearly marked as to its function. [**20:**12.4.1.6.1]

13.4.5.2 Signal Devices Remote from Controller.

13.4.5.2.1 Where the pump room is not constantly attended, audible or visible signals powered by a source other than the engine starting batteries and not exceeding 125 V shall be provided at a point of constant attendance. [**20:**12.4.2.1]

Paragraph 13.4.5.2.1 requires the fire pump controller to be constantly monitored or supervised. This is not a requirement of the controller, although the controller is required to provide the contacts necessary to fulfill this requirement.

A boiler room where operating personnel are required 24 hours a day is one type of a constantly attended location. Because most new installations are not able to satisfy the provisions for a constantly attended location, a remote alarm panel often is installed at a place of constant attendance, such as a guard house or a 24-hour phone switchboard. Although these units are termed *alarm sets* or *alarm panels*, they are usually not built or sold as alarm equipment in accordance with *NFPA 72®, National Fire Alarm and Signaling Code.*

As an alternative, the AHJ may require an off-site fire alarm monitoring station or alarm service. Note that a fire alarm monitoring station is often preferred. These signals are not considered a fire alarm as defined in *NFPA 72*. They would instead be considered supervisory or trouble signals. The monitoring station would normally notify the plant personnel, rather than the fire department, when these signals occur. A notable exception can be the engine running signal. This signal is often used to meet the required weekly line test function of *NFPA 72*, since this signal will — or should — occur during the weekly ½-hour engine test run. When an engine running signal occurs during any time other than during the expected weekly test run, the alarm company may signal the fire department of a potential fire.

The 125 V maximum requirement is to avoid imposing higher voltages on the controller remote alarm contacts of 13.4.5.3. This voltage is often the maximum voltage rating of these contacts.

13.4.5.2.2 Remote Indication. Controllers shall be equipped to operate circuits for remote indication of the conditions covered in 13.4.5.1.3, 13.4.5.1.4, and 13.4.5.2.3. [**20:**12.4.2.2]

The controller is required to have at least three sets of contacts for engine running, switch-off, and engine (or controller) failure. Many controllers have more than these three sets as a standard, and all controllers are available with additional or individual alarm contacts for the various conditions supervised by the controller.

Δ **13.4.5.2.3** The remote panel shall indicate the following:

(1) The engine is running (separate signal).

It is good practice for the weekly test run to be attended to monitor the starting and running conditions of the engine and the controller. It is imperative that appropriate personnel be immediately dispatched to the pump room at any other time the engine is running to determine the cause and to monitor the engine and controller operation, because it is highly likely that the engine and the controller are supplying, or attempting to supply, water for fire fighting. Note that with building alarm systems, the fire pump running signal may be programmed either as a fire alarm signal or as a trouble signal. In the case of the latter, it is up to the remote monitoring facility to determine whether to call the fire department to the building. This sometimes includes calling the building in question.

(2) The controller main switch has been turned to the off or manual position (separate signal).

If the controller control or selector switch is not in the auto (automatic) mode position, the controller, the engine, and thus the fire pump are out of service. For a sole source pump installation, which is a common situation, that means the protected premises (building, plant, etc.) has no fire protection. This condition may require a fire watch or even that a fire pump truck to be connected to the building until fire protection is restored.

(3)* There is trouble on the controller or engine (separate or common signals). *(See 13.4.5.1.4 and 13.4.5.1.5.)*

[**20:**12.4.2.3]

Δ **A.13.4.5.2.3(3)** The following signals should be monitored remotely from the controller:

(1) A common signal can be used for the following trouble indications: the items in 13.4.5.1.4(1) through 13.4.5.1.4(7) and loss of output of battery charger on the load side of the dc overcurrent protective device.
(2) The arrangement specified in A.13.4.5.2.3(3) is permitted only where approved by the AHJ in accordance with Section 1.5 of NFPA 20 and allows, upon loss of the ac power supply, the batteries to maintain their charge, activates ventilation in case conditions require cooling the engine, and/or maintains engine temperature in case conditions require heating the engine. *(See also A.4.6.4 and A.11.4.1.3.1 of NFPA 20.)*

[**20:**A.12.4.2.3(3)]

It is suggested that, when the engine is allowed by the AHJ to be run to charge the batteries or keep the pump room temperature above freezing, it should not be run any longer than necessary. The AHJ may require the controller to be set up for automatic stop operation after a minimum running period, typically 30 minutes.

In some cases, the AHJ requires power failure pump starting where hot processes are involved, such as with furnaces and molten salt baths. The purpose is to bring the fire water supply on-line because plantwide power loss will result in the loss of cooling fans, blowers, and/or pumps, which presents an increased likelihood of a fire.

13.4.5.3 Controller Contacts for Remote Indication. Controllers shall be equipped with open or closed contacts to operate circuits for the conditions covered in 13.4.5.2. [**20:**12.4.3]

These contacts are part of the fire pump controller. Modern controllers employ contacts rated for 1.0 amp or less at 125 V ac or 28 V dc. See also the commentary to 13.4.5.2.1 of this *Code* and 12.4.4 of NFPA 20.

13.4.6 Field Acceptance Tests.

The field acceptance test evaluates the pump performance over a range of conditions to assess the performance of the installation and to ensure that the pump will perform as needed during an actual fire. The acceptance should be completely documented to serve as a baseline for subsequent performance testing required by NFPA 25.

13.4.6.1* The pump manufacturer, the engine manufacturer (when supplied), the controller manufacturer, and the transfer switch manufacturer (when supplied) or their factory-authorized representatives shall be present for the field acceptance test. *(See Section 4.4 of NFPA 20.)* [**20:**14.2.1]

NFPA 20 requires a single entity to have the responsibility for ensuring a properly completed, tested, and accepted fire pump installation. To that end, 13.4.6.1 requires that all key component manufacturers or their representatives be present at the field acceptance test. The presence of the manufacturer's representatives allows any problems with the quality of the installation, the equipment, and the performance of the completed fire pump installation to be effectively identified and corrected to the satisfaction of the owner, the design entity, the AHJ, the installing contractor, and any other involved parties.

A.13.4.6.1 In addition, representatives of the installing contractor, insurance company, and owner should be present. [**20:**A.14.2.1]

13.4.6.2 The date, time, and location of the field acceptance test shall be coordinated with the AHJ. [**20:**14.2.2]

The requirement of 13.4.6.1 can be met by the presence of a single factory-authorized representative.

In many cases, the local fire/building official ultimately has legal jurisdictional responsibility and may be needed to approve an installation or even issue a valid Certificate of Occupancy. As such, adequate notice needs to be given to arrange the testing. See Exhibit 13.26 for a sample Certificate of Occupancy.

Exhibit 13.26

CERTIFICATE OF OCCUPANCY

Building Permit Number ______ **Date** ______

The undersigned hereby applies for a permit of occupancy in accordance with 780 CMR 120, sixth edition:

1. Location of building ______ *Street Address* ______ *Unit Number*
2. Applicant ______
3. Owner ______
   Address ______
4. Occupant ______
5. Use group ______ Occupancy ______
6. Construction type ______ Occupant load ______
7. Special stipulations or conditions ______

Plumbing/gas ______ Fire ______

Electrical ______ Water and sewer ______

Health ______ Public works ______

I hereby certify that the work specified by the above named building permit has been completed and is ready for occupancy.

Building Inspector ______

Inspection Director ______

Date ______

Sample Certificate of Occupancy.

While the AHJ can represent a number of different individuals, such as various code enforcement officers, it is best to have all involved parties, such as the owner, tenant, or insurance companies, notified and present rather than to have to repeat the acceptance test multiple times. Sometimes, the owner or owner's representative can assist in notifying other interested parties. The owner may also be needed to provide access to other important areas, such as electrical rooms.

13.4.6.3 Pump Room Electrical Wiring. All electric wiring to the fire pump motor(s), including control (multiple pumps) interwiring, normal power supply, alternate power supply where provided, and jockey pump, shall be completed and checked by the electrical contractor prior to the initial startup and acceptance test. [**20:**14.2.3]

It is important to verify that all wiring and connections are completed and tested prior to acceptance testing and the pump rotation direction verified so that any problems associated with incorrect or incomplete connections, unacceptable quality, incompatibilities due to mismatched components, or any other performance problems can be readily identified and corrected. Acceptance should not be granted on the assumption that an incomplete installation will be completed correctly at some future time.

Most instances of driver failures during the acceptance testing of electric motor–driven fire pumps are usually traced back to noncompliant wiring methods, materials, or practices. By checking the entire installation prior to the acceptance test, unnecessary and time-consuming troubleshooting efforts can be avoided.

13.4.6.4* Certified Pump Curve.

The manufacturer's certified pump test characteristic curve provides a graphical representation of the pump's performance under controlled conditions, prior to any damage that might occur in transit and prior to the completion of the installation. The curve provides a benchmark to which installed pumps can be compared (see Section 4.5 of NFPA 20).

A.13.4.6.4 If a complete fire pump submittal package is available, it should provide for comparison of the equipment specified. Such a package should include an approved copy of the fire pump room general arrangement drawings, including the electrical layout, the layout of the pump and water source, the layout of the pump room drainage details, the pump foundation layout, and the mechanical layout for heat and ventilation. [**20:**A.14.2.4]

Δ **13.4.6.4.1** A copy of the manufacturer's certified pump test curve shall be available for comparison of the results of the field acceptance test. [**20:**14.2.4.1]

13.4.6.4.1.1 For water mist positive displacement pumping units, a copy of the manufacturer's certified shop test data for both variable speed and non-variable speed operation shall be available for comparison of the results of the field acceptance test. [**20:**14.2.4.1.1]

The manufacturer must provide separate certified pump curves for water mist positive displacement pumping units with the variable speed features both active and deactivated. The manufacturer also provides certified pump curves for each individual pump, with the variable speed features both active and deactivated. The individual curves are intended to assist in the evaluation of underperforming units and do not need to be verified during the acceptance test.

13.4.6.4.2 At all flow conditions, including those required to be tested in 14.2.6.2 of NFPA 20, the fire pump as installed shall equal the performance as indicated on the manufacturer's certified shop test curve within the accuracy limits of the test equipment. [**20:**14.2.4.2]

Exhibit 13.27 shows fire pump test data obtained from a fire pump acceptance test, and Exhibit 13.28 shows the plots of the test data with respect to the manufacturer's certified test curve.

13.4.6.4.2.1 For water mist positive displacement pumping units with variable speed features, the pump unit as installed shall equal the performance as indicated on the fire pump unit manufacturer's certified shop test data, with variable speed features deactivated within the accuracy limits of the test equipment. [**20:**14.2.4.2.1]

Testing a water mist positive displacement pumping unit with variable speed features deactivated provides verification of the pumping unit performance. The pumps do not need to be tested individually unless it is necessary to investigate an underperforming unit. The unit test results are compared to the pump unit manufacturer's certified shop test data with variable speed features deactivated.

13.4.6.4.2.2 For water mist positive displacement pumping units, the pump unit as installed shall equal the performance as indicated on the fire pump unit manufacturer's certified shop test data, with variable speed features activated within the accuracy limits of the test equipment. [**20:**14.2.4.2.2]

Testing water mist positive displacement pumping units with variable speed features active allows verification of the operation of the unit under simulated fire flow demand. The pumps do not need to be tested individually unless it is necessary to investigate an underperforming unit. The unit test results for variable speed operation are compared to the pump unit manufacturer's certified shop test data with variable speed features active. The unit test results with variable speed deactivated are compared to the pump unit manufacturer's certified shop test data with variable speed features deactivated.

13.4.6.5 System Demand. The actual unadjusted fire pump discharge flows and pressures installed shall meet or exceed the fire protection system's demand. [**20:**14.2.5]

It is possible for a fire pump to perform satisfactorily but still not deliver the system demand. This situation can occur if the residual pressures in the water supply have decreased or if the pump is operating below rated speed. It is important to apply speed adjustment as necessary to verify the fire pump performance. It is equally important to verify that the actual discharge pressure from the fire pump will meet the system demand.

13.4.7* Record Drawings, Test Reports, Manuals, Special Tools, and Spare Parts.

A.13.4.7 It is the intent to retain the record drawing, equipment manual, and completed test report for the life of the fire pump system. [**20:**A.14.3]

13.4.7.1 One set of record drawings shall be provided to the building owner. [**20:**14.3.1]

13.4.7.2 One copy of the completed test report shall be provided to the building owner. [**20:**14.3.2]

13.4.7.3* One set of instruction manuals for all major components of the fire pump system shall be supplied by the manufacturer of each major component. [**20:**14.3.3]

A.13.4.7.3 Consideration should be given to stocking spare parts for critical items not readily available. [**20:**A.14.3.3]

Δ **13.4.7.4** The manual shall contain the following:

(1) A detailed explanation of the operation of the component
(2) Instructions for routine maintenance
(3) Detailed instructions concerning repairs
(4) Parts list and parts identification

Exhibit 13.27

Test Date	September 11, 2014	Test Type	Acceptance
Previous Test Date			
Location	Big City	State	MI
Fire Pump Information			
Fire Pump Description	Electric 1500 gpm at 100 psi Fire Pump in Fire Pump House		
Fire Pump Type	Horizontal Centrifugal	Description if Other	
Pump Mfg	USA	Pump Approved (UL or FM)	Yes
Model	8x6MI	Rated Flow	1500
Serial No	66439	Rated Pressure	90
Horsepower		Factory Test Pressure	
Year Manufactured	2014	Net Churn Pressure	103
Pump Start Pressure	145	Net 150% Pressure	72
Pump Shutoff Pressure	Manual	Rated Speed	1775
Fire Pump Controller Information		**Jockey Pump Information**	
Controller Mfg	JC USA	Manufacturer	JC USA
Controller Type	Across The Line	Model	MC-2
Transfer Switch	No	Serial No.	JP8976678
Model	FTA-5000	Horsepower	2
Serial No	FTA-879456		
Fire Pump Driver		**Jockey Pump Controller Information**	
Type	Electric Motor	Controller Mfg	JC USA
Description if other		Model	MX-A
Motor / Engine Manufacture	USA Motors	Serial No.	543789E
Engine / Motor Horsepower	100	Jockey Pump Sart Pressure	150
Model	Squirel Cage	Jockey Pump Shutoff Pressure	162
Serial No	M958769943	Sample Fire Pump Test	
Rated Speed	1775		

Electric 1500 gpm at 100 psi Fire Pump in Fire Pump House 1500 gpm @ 90 psi @ 1775 rpm

	Phase/VOLTS			Phase/AMPS			PRESSURE (psi)			Nozzle Coefficient/Nozzle Size (inches) /Pitot Pressure (psi)						Flow (gpm)	Adjusted to 1775 rpm		
										1.75	1.75	1.75	1.75	1.75	1.75		Press	Flow	% of
RPM	1	2	3	1	2	3	Suct	Disc	Net	0.98	0.98	0.98	0.98	0.98	0.98		Net	(gpm)	Factory
1,793	481	482	482	66	63	66	46	149	103	0						0	101	0	98%
1786	480	481	481	80	78	82	47	147	100	73						761	99	756	99%
1783	477	478	478	106	102	107	41	134	93	71	72					1506	92	1500	102%
1774	475	477	477	122	116	123	30	102	72	73	73	72				2278	72	2279	101%
																0			
																0			
																0			
																0			

Comments:

Maximum System Demand (at pump discharge)	1463	gpm	105	psi
Available Pressure @ 1463 gpm			118	Psi
Pump passed initial test	Yes			
Pump could supply maximum system demand	Yes			
Pump was significantly impaired	No			
Pump was partially impaired	N/A			
Pump passed after adjustments	N/A			
Repairs Initiated	N/A			
Failure Mode	**0 Not Applicable - Satisfactory Performance**			
Explanation of Failure				
Part Replaced				
Description of Part Replacement or Non Routine Maintenance or Repair				

Fire pump test data. (Courtesy of Aon Fire Protection Engineering)

(5) Schematic electrical drawings of controller, transfer switch, and fire pump control panels

(6)* List of recommended spare parts and lubricants

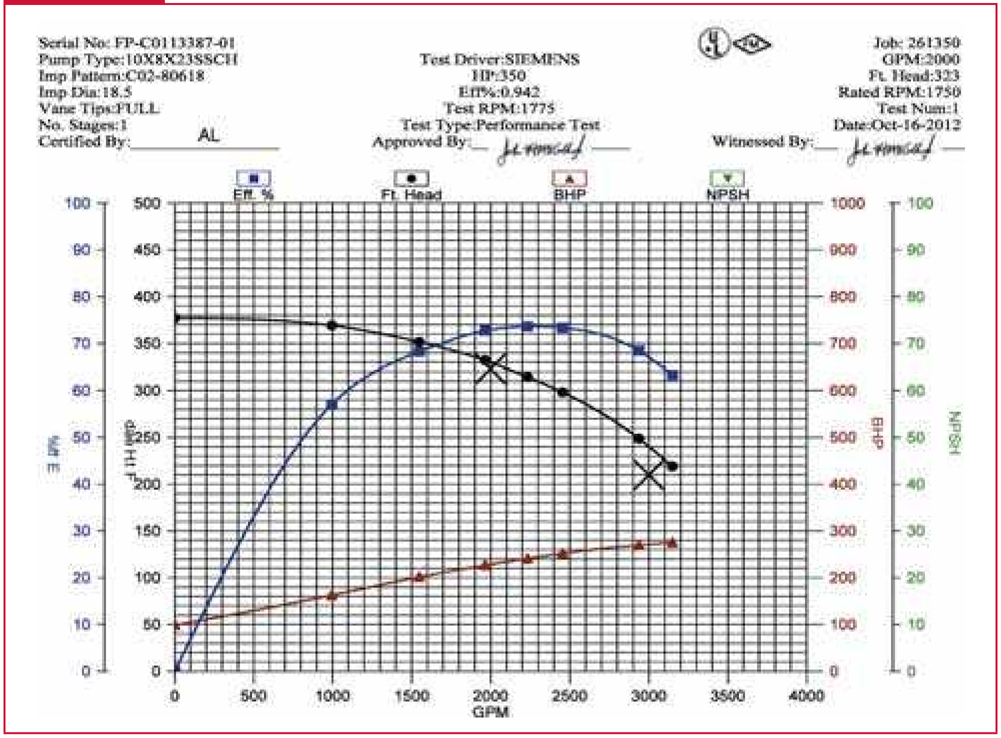
[**20:**14.3.4]

Ordinarily, the operation and maintenance manual is submitted by the installing contractor for review and approval by the building owner or his or her representative, usually the project engineer. Multiple copies of the manual need to be maintained on file for future reference. The manual should be made available at the time of the acceptance test for review of systems and components. Prior to final acceptance, the manual should be used for training operating personnel.

A.13.4.7.4(6) Recommended spare parts and lubricants should be stored on-site to minimize system impairment. [**20:**A.14.3.4(6)]

13.4.7.5 Any special tools and testing devices required for routine maintenance shall be available for inspection by the AHJ at the time of the field acceptance test. [**20:**14.3.5]

Exhibit 13.28



Manufacturer certified test curve. (Courtesy of Aon Fire Protection Engineering)

Δ **13.4.8 Periodic Inspection, Testing, and Maintenance.** Fire pumps shall be inspected, tested, and maintained in accordance with NFPA 25. [**20:**14.4]

Following are a few requirements and recommendations based on the ITM requirements from NFPA 25 as they relate to NFPA 20.

1. **Test frequencies.** Nonflow testing, which consists of starting the pump and running it at full speed at the regular intervals as required by NFPA 25, helps to ensure that the pump installation is always ready for service. The 2014 edition of NFPA 25 requires weekly nonflow testing for the following fire pumps:

   - Diesel engine–driven fire pumps
   - Electric motor fire pumps with limited service controllers
   - Electric motor fire pumps supplied from a tank
   - Electric motor fire pumps in a high-rise building

   Monthly nonflow testing is required for electric motor–driven fire pumps not identified above. In editions of NFPA 25 prior to the 2014 edition, weekly testing was required for electric motor–driven fire pumps.
2. **Five-percent degradation investigation.** NFPA 25 requires an investigation whenever the net pump pressure is less than 95 percent of the original pump curve at 100 percent of rated flow. A more pronounced reduction in capacity could be due to one or more causes, as shown in Annex B of NFPA 20. A plugged impeller, worn wear rings, and obstructed suction are among the most common causes. In some cases, the reading of the suction gauge indicates whether the trouble is due to an obstruction in the water supply or in the suction pipe. In other cases, the difference between the reading of the suction gauge and that of the discharge gauge is the indicator of a plugged impeller or overly worn wear rings.
3. **Flowmeter testing.** When testing a pump by discharging through a listed meter back to the pump suction, a hydraulic imbalance within the pump is possible. Additionally, this test method is not able to check the suction supply and piping upstream of the connection to the pump suction. If possible, the flowmeter should not be piped to the pump suction. Piping the flow back to the water storage tank (with an air gap) or to the pump house exterior results in accurate measurements.
4. **Diesel fire pumps.** At least once a year, diesel engine–driven pumps should be checked for overheating by running them with the pump discharging at 150 percent or more of its rated capacity. Once the engine temperature has stabilized, the engine should be run for at least an additional 15 minutes. If the engine overheats, a blockage of the cooling system is probably the cause, such as an inadequate cooling waterflow caused by an obstruction in the cooling water system, a plugged strainer, or a partly closed valve.

In addition to the requirements of NFPA 25 for engine-driven pumps, the engine should be kept clean and dry. The fuel tank should be kept at a level at least capable of running the engine for 6 hours at peak load. The crankcase oil should be checked to verify that it is at the proper level, that it has not become fouled, and that it has not lost its viscosity. Additionally, the strainers in the cooling water system should be cleaned, and the specific gravity of the battery electrolyte should be checked monthly.

5. **Records.** Even though NFPA 25 specifies the records that should be kept, it is also beneficial to maintain a specific record of the temperature and tightness of the glands, the readings of the suction and discharge gauges, and the condition of the suction supply.

13.4.9 Component Replacement.

13.4.9.1 Positive Displacement Pumps.

13.4.9.1.1 Whenever a critical path component in a positive displacement fire pump is replaced, as defined in 14.5.2.5 of NFPA 20, a field test of the pump shall be performed. [**20:**14.5.1.1]

13.4.9.1.2 If components that do not affect performance are replaced, such as shafts, then only a functional test shall be required to ensure proper installation and reassembly. [**20:**14.5.1.2]

13.4.9.1.3 If components that affect performance are replaced, such as rotors, plungers, and so forth, then a retest shall be conducted by the pump manufacturer or designated representative or qualified persons acceptable to the AHJ. [**20:**14.5.1.3]

13.4.9.1.3.1 For water mist positive displacement pumping units, the retest shall include the pump unit as a whole. [**20:**14.5.1.3.1]

13.4.9.1.4 Field Retest Results.

13.4.9.1.4.1 The field retest results shall be compared to the original pump performance as indicated by the fire pump manufacturer's original factory-certified test curve, whenever it is available. [**20:**14.5.1.4.1]

13.4.9.1.4.2 The field retest results shall meet or exceed the performance characteristics as indicated on the pump nameplate, and the results shall be within the accuracy limits of field testing as stated elsewhere in NFPA 20. [**20:**14.5.1.4.2]

13.5 Water Supply

Δ **13.5.1** Private fire service mains shall be installed in accordance with NFPA 13 and NFPA 24.

Δ **13.5.2** Where no adequate and reliable water supply exists for fire-fighting purposes, the requirements of NFPA 1142 shall apply.

NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting*, identifies minimum requirements for water supplies for fire-fighting purposes in areas in which adequate and reliable water supply systems for fire-fighting purposes do not exist. The water typically must be transported from a river, lake, canal, bay, stream, pond, well, cistern, or other similar source that is available as a suction supply for fire department use.

In some areas, water supply systems have been installed for domestic water purposes only. These systems can be equipped with hydrants that might not be standard fire hydrants, with available volume, pressure, and duration of flow being inadequate for fire-fighting purposes. Where such conditions exist, the requirements of NFPA 1142 should be applied.

Δ **13.5.3*** The installation of devices to protect the public water supply from contamination shall comply with the provisions of NFPA 13, NFPA 13D, NFPA 13R, NFPA 24, and the plumbing code.

A.13.5.3 The installation of backflow prevention devices on services supplying water to existing fire protection systems can result in excessive pressure losses. Therefore, installation of backflow prevention devices to protect public health has to be accomplished with due regard for the implications on fire protection. The provisions of AWWA M14, *Backflow Prevention and Cross-Connection Control: Recommended Practices*, should be used as a guide for determining the appropriate protection for public health. Hydraulic calculations and water supply analysis should be conducted prior to installation to determine the impact on fire protection.

Δ **13.5.3.1** Backflow prevention devices shall be inspected, tested, and maintained in accordance with the requirements of NFPA 25.

13.5.4 Inspection, Testing, and Maintenance.

13.5.4.1 A private fire service main installed in accordance with this *Code* shall be properly maintained to provide at least the same level of performance and protection as designed. The owner shall be responsible for maintaining the system and keeping it in good working condition.

13.5.4.2 A private fire service main installed in accordance with this *Code* shall be inspected, tested, and maintained in accordance with NFPA 25.

13.6 Portable Fire Extinguishers

13.6.1 General Requirements.

13.6.1.1 Scope. The selection, installation, inspection, maintenance, recharging, and testing of portable fire extinguishers shall be in accordance with NFPA 10 and Section 13.6.

13.6.1.1.1 The requirements given herein are minimum. [**10:**1.1.1]

13.6.1.1.2 The requirements shall not apply to permanently installed systems for fire extinguishment, even where portions of such systems are portable (such as hose and nozzles attached to a fixed supply of extinguishing agent). [**10:**1.1.2]

13.6.1.2* Where Required. Fire extinguishers shall be provided where required by this *Code* as specified in Table 13.6.1.2 and the referenced codes and standards listed in Chapter 2.

Portable fire extinguishers are required by this *Code* to be installed in the occupancies specified by Table 13.6.1.2. It is noted that this

TABLE 13.6.1.2 Portable Fire Extinguishers Required

Occupancy Use	Where Required
Ambulatory health care occupancies	Yes
Apartment occupancies[a]	Yes
Assembly occupancies[b]	Yes
Business occupancies	Yes
Day-care occupancies	Yes
Detention and correctional occupancies[c,d]	Yes
Educational occupancies	Yes
Health care occupancies	Yes
Hotel and dormitory occupancies	Yes
Industrial occupancies	Yes
Lodging and rooming house occupancies	Yes
Mercantile occupancies	Yes
Occupancies in special structures	Yes
One- and two-family dwelling occupancies	No
Residential board and care occupancies	Yes
Storage occupancies[e]	Yes

[a]Portable fire extinguishers shall be permitted to be located at exterior locations or interior locations so that all portions of the buildings are within 75 ft (22.8 m) of travel distance to an extinguishing unit.

[b]Portable fire extinguishers are not required in seating or outdoor performance areas.

[c]Access to portable fire extinguishers shall be permitted to be locked.

[d]Portable fire extinguishers shall be permitted to be located at staff locations only.

[e]In storage areas where forklift, powered industrial truck, or cart operators are the primary occupants, fixed extinguishers, as specified in NFPA 10, need not be provided when:

(1) Use of vehicle-mounted extinguishers is approved by the AHJ.

(2) Each vehicle is equipped with a 10 lb, 40-A:80-B:C extinguisher affixed to the vehicle using a mounting bracket approved by the extinguisher manufacturer or the AHJ for vehicular use.

(3) Not less than two spare extinguishers of equal or greater rating are available onsite to replace a discharged extinguisher.

(4) Vehicle operators are trained in the proper operation and use of the extinguisher.

(5) Inspections of vehicle-mounted extinguishers are performed daily.

Code requires portable fire extinguishers in buildings of every occupancy classification other than one- and two-family dwellings, whereas NFPA *101* requires portable fire extinguishers in far fewer occupancies. The different requirements of NFPA 1 and NFPA *101* are sometimes, incorrectly, perceived as a conflict — there is none. The scope of this *Code* includes occupant safety, emergency responder safety, and property protection; the scope of NFPA *101* is limited to occupant life safety. The broader scope of NFPA 1 warrants different protection requirements — in this case, more stringent requirements than those of NFPA *101* for the installation of portable fire extinguishers. By meeting the more stringent requirements for portable fire extinguishers of NFPA 1, the requirements of NFPA *101* are also met. A conflict would exist only if one code required portable fire extinguishers and another code prohibited them. Exhibit 13.29 depicts examples of portable fire extinguishers.

Exhibit 13.29

Portable fire extinguishers.

A.13.6.1.2 Employees expected or anticipated to use fire extinguishers should be instructed on the hazards of fighting fire, how to properly operate the fire extinguishers available, and what procedures to follow in alerting others to the fire emergency.

The intended application of footnote e in Table 13.6.1.2 is for warehouse areas that are generally unoccupied except by operators on forklifts or similar vehicles or occasional workers or maintenance personnel. The footnote is not intended to apply to office or process areas. Office and process areas have to be provided with fixed extinguishers in accordance with NFPA 10 and applicable provisions in this *Code*.

13.6.1.3 Listing and Labeling.

Δ **13.6.1.3.1*** Portable fire extinguishers used to comply with Section 13.6 shall be listed and labeled and shall meet or exceed all the requirements of ANSI/UL 711, CAN/ULC-S508, *Standard for Rating and Fire Testing of Fire Extinguishers*, and one of the following applicable performance standards:

(1) Carbon dioxide types: ANSI/UL 154, CAN/ULC-S503, *Standard for Carbon-Dioxide Fire Extinguishers*
(2) Dry chemical types: ANSI/UL 299, CAN/ULC-S504, *Standard for Dry Chemical Fire Extinguishers*
(3) Water types: ANSI/UL 626, CAN/ULC-S507, *Standard for Water Fire Extinguishers*
(4) Halon types: CAN/ULC-S512, *Standard for Halogenated Agent Hand and Wheeled Fire Extinguishers*
(5) Film-forming foam types: ANSI/UL 8, CAN/ULC-S554, *Water Based Agent Fire Extinguishers*
(6) Halocarbon types: ANSI/UL 2129, CAN/ULC-S566, *Standard for Halocarbon Clean Agent Fire Extinguishers*

[**10:**4.1.1]

A.13.6.1.3.1 Listed and labeled halon portable fire extinguishers currently comply with Section 13.6 and have demonstrated compliance with the requirements of UL-1093, *Standard for Halogenated Agent Fire Extinguishers*, which also includes fire testing and rating criteria. As a result of the Montreal Protocol on Substances that Deplete the Ozone Layer, UL has withdrawn UL-1093. This does not imply that extinguishers that are listed and labeled to the requirements of UL-1093 are unsafe for use as fire extinguishers, nor does it mean that UL or the EPA is requiring that halon extinguishers be removed from service. It does mean that UL will not accept new designs of halon extinguishers for testing or UL listing. It also means that no changes or updates are allowed to models that are currently listed and that had previously demonstrated compliance with UL 1093. [**10:**A.4.1.1]

Extinguisher manufacturers are allowed to manufacture their current design of UL -listed halon extinguishers with the UL listing mark until October 2025. Halon extinguishers currently in use will continue to be listed beyond the 2025 date and should be permitted to be used to comply with the requirements of NFPA 10 and this *Code* when installed, inspected, and maintained in accordance with NFPA 10 and this *Code*. [**10:**A.4.1.1]

13.6.1.3.2* Each fire extinguisher shall be marked with the following:

(1) Identification of the listing and labeling organization
(2) Product category indicating the type of extinguisher
(3) Extinguisher classification as indicated in Section 5.3 of NFPA 10
(4) Performance and fire test standards that the extinguisher meets or exceeds

[**10:**4.1.2]

A.13.6.1.3.2 AHJs should determine the acceptability and credibility of the organization listing or labeling fire extinguishers. Authorities should determine if the organization tests to all the requirements of NFPA 10. Factors such as the structure of the organization, its principal fields of endeavor, its reputation and established expertise, its involvement in the standards-writing process, and the extent of its follow-up service programs should all be assessed before recognition is given. [**10:**A.4.1.2]

The listing and labeling organization identification marking might be in the form of a symbol of the organization. The product category marking should identify the extinguisher, for example, “Carbon Dioxide Fire Extinguisher,” “Dry Chemical Fire Extinguisher,” or “Clean Agent Fire Extinguisher.” Extinguisher ratings should indicate the classification of fire type, such as A, B, or C, and the associated fire size. An example of an extinguisher rating is 1-A: 5-B:C, which designates a Class A fire (wood) rating with an associated fire size of 1, as described in ANSI/UL711, CAN/ULC-S508, *Standard for Rating and Testing of Fire Extinguishers*; a Class B fire (flammable liquid) rating with an associated fire size of 5, as described in ANSI/UL711, CAN/ULC-S508; and a Class C compatible rating as described in ANSI/UL711, CAN/ULC-S508. [**10:**A.4.1.2]

A fire extinguisher label includes the identification of the listing and labeling organization, and the fire test and performance standards it meets or exceeds. The label also includes which classifications (A:B:C:D:K) and rating (size of fire) the extinguisher meets, the agent weight, the suitable use temperature range, and the operating instructions. Also included on the label are maintenance and field inspection instructions, the correct charged pressure, the extinguisher gross weight, and any necessary cautions and warnings. The labels on some extinguishers manufactured before 1986 were not required to provide all the information described.

13.6.1.3.2.1 Fire extinguishers manufactured prior to January 1, 1986, shall not be required to comply with 13.6.1.3.2. [**10:**4.1.2.1]

13.6.1.3.2.2 Halon extinguishers listed and labeled to UL 1093, *Standard for Halogenated Agent Fire Extinguishers*, shall be permitted to be used to comply with the requirements of Section 13.6 when installed, inspected and maintained in accordance with Section 13.6. [**10:**4.1.2.2]

13.6.1.3.3* An organization listing fire extinguishers used to comply with the requirements of Section 13.6 shall utilize a third-party certification program for portable fire extinguishers that meets or exceeds UL 1803, *Standard for Factory Follow-Up on Third Party Certified Portable Fire Extinguishers*. [**10:**4.1.3]

A.13.6.1.3.3 AHJs should determine the thoroughness of the factory follow-up quality assurance program exercised by third-party certification organizations listing and labeling portable fire extinguishers. The specified factory follow-up standard provides a minimum basis for that determination. Application of the factory follow-up standard provides a reasonable assurance that portable fire extinguishers sold to the public continue to have the same structural reliability and performance as the fire extinguishers the manufacturer originally submitted to the listing and labeling organization for evaluation. [**10:**A.4.1.3]

13.6.1.3.3.1 Fire extinguishers manufactured prior to January 1, 1989, shall not be required to comply with 13.6.1.3.3. [**10:**4.1.3.1]

13.6.1.3.3.2 Certification organizations accredited by the Standards Council of Canada shall not be required to comply with 13.6.1.3.3. [**10:**4.1.3.2]

13.6.1.3.3.3 Listed and labeled Class D extinguishing agents intended to be manually applied to combustible metal fires shall comply with the fire test requirements specified in ANSI/UL 711, CAN/ULC-S508, *Standard for Rating and Fire Testing of Fire Extinguishers*. [**10:**4.1.3.3]

13.6.1.3.4 Electrical Conductivity. Extinguishers listed for the Class C rating shall not contain an agent that is a conductor of electricity. [**10:**4.1.4]

13.6.1.3.4.1 In addition to successfully meeting the requirements of ANSI/UL 711, CAN/ULC-S508, *Standard for Rating and Fire Testing of Fire Extinguishers*, water-based agents that are listed for the Class C rating shall be tested in accordance with ASTM D5391, *Standard Test for Electrical Conductivity and Resistivity of a Flowing High Purity Water Sample*. [**10:**4.1.4.1]

13.6.1.3.4.2 Fire extinguishers containing water-based agents that have a conductivity higher than 1.00 µS/cm at 77°F (25°C) shall be considered a conductor of electricity and therefore shall not be rated Class C. [**10:**4.1.4.2]

13.6.1.3.4.3 Paragraphs 13.6.1.3.4.1 and 13.6.1.3.4.2 shall apply only to water-based extinguishers manufactured after August 15, 2002. [**10:**4.1.4.3]

Δ **13.6.1.4* Identification of Contents.** A fire extinguisher shall have a label, tag, or stencil attached to it providing the following information:

(1) The content's product name as it appears on the manufacturer's Material Safety Data Sheet (MSDS)
(2) Listing of the hazardous material identification in accordance with *Hazardous Materials Identification System (HMIS), Implementation Manual* [in Canada, *Globally Harmonized System of Classification and Labeling of Chemicals (GHS)*] developed by the National Paint and Coatings Association
(3) List of any hazardous materials that are in excess of 1.0 percent of the contents
(4) List of each chemical in excess of 5.0 percent of the contents
(5) Information as to what is hazardous about the agent in accordance with the MSDS
(6) Manufacturer's or service agency's name, mailing address, and phone number

[**10:**4.2]

Δ **A.13.6.1.4** Federal OSHA regulations require that manufacturers communicate information as to the type of chemicals in a product that can be hazardous and the level of hazard. This information is contained in the MSDS created for each chemical or mixture of chemicals and is summarized on labels or tags attached to the product. Additionally, state and local authorities have enacted similar acts and regulations requiring identification of chemicals and hazardous ingredients in products. MSDSs for fire extinguisher agents are available on request from fire equipment dealers or distributors or the fire equipment manufacturer. [**10:**A.4.2]

The identification of contents information enables determination of the type of chemicals contained in the fire extinguisher and helps to resolve complications arising from an unusual use of the agent. The *Hazardous Materials Identification System (HMIS)*, developed by the American Coatings Association uses a three-place format with numerical indexes from 0 to 4. The first place is for "toxic properties," the second place is for "flammability," and the third place is for "reactivity" with other chemicals. Most fire extinguishers have a 0 numerical index in the second and third places because they are nonflammable and relatively inert. [**10:**A.4.2]

Information on the HMIS can be obtained from Label Master, Inc., in Chicago, IL, or from the American Coatings Association in Washington, DC. Extinguisher contents information can be integrated into the standard fire extinguisher label in some form, or it can be on a separate label or tag. The following example is a typical chemical contents identification marking:

CONTENTS: ABC DRY CHEMICAL/HMIS 1-0-0 MUSCOVITE MICA, MONOAMMONIUM PHOSPHATE AMMONIUM SULFATE/NUISANCE DUST IRRITANT/CONTENTS UNDER PRESSURE [Manufacturer's Name, Mailing Address, Phone Number]
[**10:**A.4.2]

13.6.1.5* Instruction Manual.

A.13.6.1.5 The manual can be specific to the fire extinguisher involved, or it can cover many types. [**10:**A.4.3]

The fire extinguisher instruction manual should cover the required inspection, maintenance, and recharging frequencies and requirements as specified by Chapter 7 of NFPA 10.

13.6.1.5.1 The owner or the owner's agent shall be provided with a fire extinguisher instruction manual that details condensed instructions and cautions necessary to the installation, operation, inspection, and maintenance of the fire extinguisher(s). [**10:**4.3.1]

13.6.1.5.2 The manual shall refer to NFPA 10 as a source of detailed instruction. [**10:**4.3.2]

Δ **13.6.1.6 Obsolete Fire Extinguishers.** The following types of fire extinguishers are considered obsolete and shall be removed from service:

(1) Soda acid
(2) Chemical foam (excluding film-forming agents)
(3) Carbon tetrachloride, methyl bromide, and chlorobromomethane (CBM)
(4) Cartridge-operated water
(5) Cartridge-operated loaded stream
(6) Copper or brass shell (excluding pump tanks) joined by soft solder or rivets
(7) Carbon dioxide extinguishers with metal horns
(8) Solid charge–type AFFF extinguishers (paper cartridge)
(9) Pressurized water fire extinguishers manufactured prior to 1971
(10) Any extinguisher that needs to be inverted to operate
(11) Any extinguisher manufactured prior to 1955
(12) Any extinguishers with 4B, 6B, 8B, 12B, and 16B fire ratings
(13) Stored-pressure water extinguishers with fiberglass shells (pre-1976)

[**10:**4.4]

Δ **13.6.1.6.1*** Dry chemical stored-pressure extinguishers with an indicated manufacturing date of 1984 or prior shall be removed from service. [**10:**4.4.1]

Δ **A.13.6.1.6.1** The requirement in 13.6.1.6.1 brings the standard into line with the 1984 changes to ANSI/UL 299, CAN/ULC-S504, *Standard for Dry Chemical Fire Extinguishers*, and to ANSI/UL 711, *Rating and Fire Testing of Fire Extinguishers*.

(1) *Hose*. The 1984 edition of UL 299 requires extinguishers rated 2A or higher or 20-B or higher to be equipped with a discharge hose. Before this change, almost all 5 lb (2.3 kg) extinguishers and many 10 lb (4.5 kg) extinguishers were equipped with a fixed nozzle on the outlet of the extinguisher valve and without hoses. These extinguishers, rated 2-A to 4-A and 10-B to 60-B are used to comply with the installation requirements now

contained in Chapter 6 of NFPA 10. To properly use one of these extinguishers, the user must keep it in the upright position, apply the dry chemical to the base of the fire, and sweep the discharge back and forth. The requirement for the addition of a hose to these extinguishers came out of the novice fire tests sponsored by Underwriters Laboratories (UL) and the Fire Equipment Manufacturers Association. The film footage of these tests shows that those who had never used a fire extinguisher before often used both hands to operate these extinguishers, turning the extinguisher cylinder in a horizontal position while squeezing the handle and lever to open the valve. Sometimes they even inverted the extinguisher. The result of such actions is a partial discharge of the extinguisher contents or possibly only the expellant gas and, therefore, no extinguishment of the fire can be achieved. The addition of a hose also makes it much easier to direct the discharge at the base of the flames and to sweep the discharge from side to side. The requirement to add a hose makes it more likely that the extinguisher will be used in an upright position. In fact, it is almost impossible to do otherwise, since one hand opens the valve and the other hand, which holds the hose, directs the discharge stream to the fire. It is important to note that field modification of an extinguisher is generally not allowed since the modification might not have been evaluated to comply with the test requirements in the applicable UL extinguisher standards, and the extinguisher might not operate as intended. Thus, a fixed nozzle cannot simply be removed from an extinguisher and replaced with a hose and nozzle.

(2) *Minimum Discharge Time.* This requirement, found in the 1984 edition of UL 711, requires a minimum 13-second discharge duration for an extinguisher rated 2-A or higher. The 13-second minimum requirement was the result of recommendations from the novice fire tests mentioned in A.13.6.1.6.1(1). Before 1984, almost all 2-A-rated dry chemical extinguishers had discharge durations of only 8 seconds to 10 seconds. The novice fire tests clearly showed that longer discharge duration resulted in an increased likelihood of extinguishment. The revision to UL 711 mandated a 50 percent to 60 percent increase in the minimum discharge duration for a 2-A-rated dry chemical extinguisher. Modification of extinguishers with a nozzle/hose that gives different or longer discharge duration is not allowed. Such modification would not have been evaluated to comply with the test requirements in the applicable UL extinguisher standards, and the extinguisher might not operate as intended.

(3) *Pull Pins.* A revision to the extinguisher standards, including UL 299, required a maximum 30 lb (133 N) of force to remove a safety pin or pull pin from an extinguisher. This again came from the novice testing, in which some individuals could not physically remove the pin and actuate the extinguisher. The UL extinguisher standards also included a design requirement so that the pin is visible from the front of the extinguisher unless noted by the operating instructions.

(4) *Operating Instructions/Marking.* The extinguisher standards, including the 1984 revision of UL 299, mandated the use of pictographic operating instructions and code symbols on all but Class D extinguishers and wheeled extinguishers. These requirements also came out of the novice fire tests, which showed many individuals taking too long to read and understand the written operating instructions. The novice tests actually developed the pictographic operating instructions and tested them on novice operators for effectiveness. The details of the number of instructions per pictogram came from the test program. The novice fire tests were also the impetus for making the use code symbols for the various classes of fires more understandable. The new pictographic use code symbols were also mandated in 1984 as well as a uniform method of applying A, B, and C symbols to extinguishers with ABC or BC only ratings. The result was a uniform, consistent set of easily understood symbols that made the extinguisher more user friendly.

(5) *Service Manuals.* The extinguisher standards, including UL 299, for the first time mandated that extinguisher manufacturers have a service manual for their products. In addition, the 1984 edition of UL 299 required a reference to the service/maintenance manual on the extinguisher nameplate. Prior to 1984, service manuals were not required.[**10:**A.4.4.1]

13.6.1.6.1.1 Paragraph 13.6.1.6.1 shall not apply to wheeled-type dry chemical stored-pressure fire extinguishers. [**10:**4.4.1.1]

13.6.1.6.2* Any fire extinguisher that can no longer be serviced in accordance with the manufacturer's maintenance manual is considered obsolete and shall be removed from service. [**10:**4.4.2]

A.13.6.1.6.2 Fire extinguishers manufactured by companies that are no longer in business can remain in use if they meet the requirements of NFPA 10 and this *Code*, and are maintained in accordance with the manufacturer's service manual. When these extinguishers require recharging or maintenance and the required extinguishing agent or necessary repair parts are not available, the extinguishers should be removed from service. [**10:**A.4.4.2]

Extinguishers that can still be serviced in accordance with the manufacturer's service manual are not obsolete, even if the manufacturer is no longer in business. However, to maintain an extinguisher in accordance with the manufacturer's manual, the service company must use the replacement parts specified in the manual. This usually becomes difficult when the original manufacturer no longer exists; therefore, such extinguishers often are removed from service anyway. However, it is still important to understand that the standard does not require their removal as long as they can be maintained.

13.6.2 Selection of Portable Fire Extinguishers.

13.6.2.1 General Requirements. The selection of fire extinguishers for a given situation shall be determined by the applicable requirements of Sections 5.2 through 5.6 of NFPA 10 and the following factors:

(1) Type of fire most likely to occur
(2) Size of fire most likely to occur
(3) Hazards in the area where the fire is most likely to occur
(4) Energized electrical equipment in the vicinity of the fire
(5) Ambient temperature conditions
(6) Other factors *(see Section H.2 of NFPA 10)*

[**10:**5.1]

13.6.2.1.1 Portable fire extinguishers shall be installed as a first line of defense to cope with fires of limited size, except as required by 5.5.5 of NFPA 10. [**10:**5.1.1]

13.6.2.1.2 The selection of extinguishers shall be independent of whether the building is equipped with automatic sprinklers, standpipe and hose, or other fixed protection equipment. [**10:**5.1.2]

13.6.2.2 Classification of Fires. See 3.3.110.

13.6.2.3 Extinguisher Classification System.

For an explanation of the extinguisher classification per ANSI/UL 711, see G.1.1 of NFPA 10.

13.6.2.3.1 The classification of fire extinguishers shall consist of a letter that indicates the class of fire on which a fire extinguisher has been found to be effective. [**10:**5.3.1]

13.6.2.3.1.1 Fire extinguishers classified for use on Class A or Class B hazards shall be required to have a rating number preceding the classification letter that indicates the relative extinguishing effectiveness. [**10:**5.3.1.1]

13.6.2.3.1.2 Fire extinguishers classified for use on Class C, Class D, or Class K hazards shall not be required to have a number preceding the classification letter. [**10:**5.3.1.2]

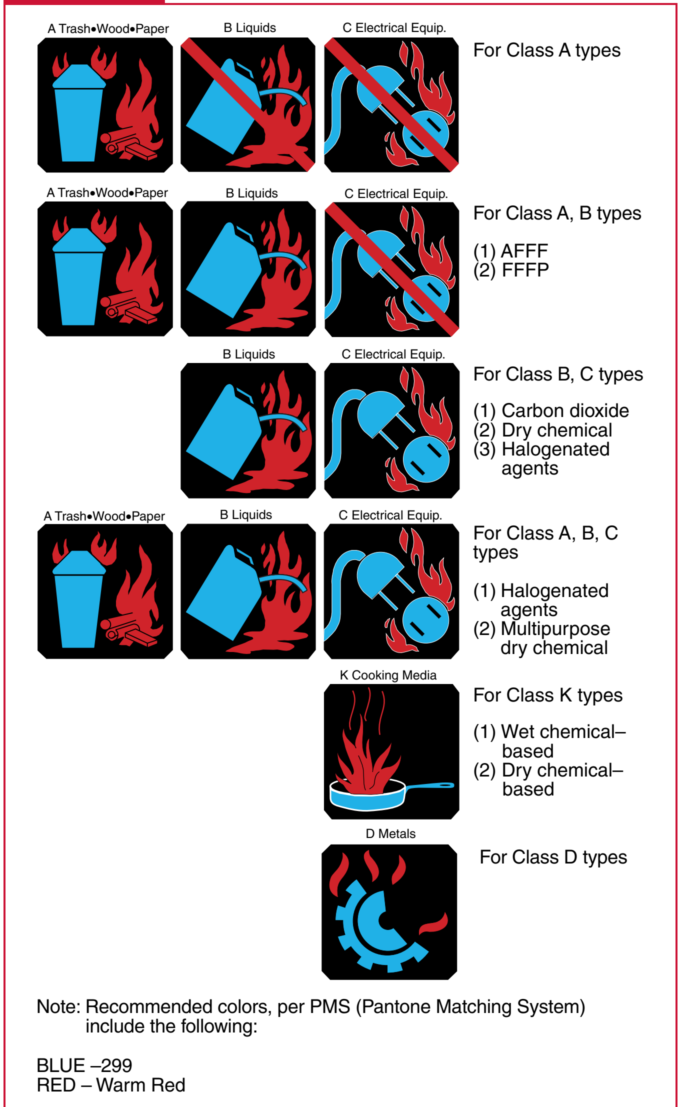
A typical fire extinguisher rated 4-A:20-B:C indicates the unit should extinguish approximately twice as much Class A fire as a 2-A–rated fire extinguisher. It should extinguish approximately four times as much fire as a 5-B–rated fire extinguisher, and the C classification indicates it is suitable to use on energized electrical equipment. The classes of fire are shown by pictographic code symbols. (See Exhibit 13.30 and Exhibit 13.31.) If a fire extinguisher is not large enough to obtain a rating for a minimum class test fire, the pictographic symbol is not shown on the label.

A 10-B:C–rated dry chemical extinguisher with an agent weight of 2.5 lb (1.13 kg), for example, is safe to use on a Class A fire but does not include a Class A pictographic use code symbol on the label. If an extinguisher is unsafe for use on a class of fire, the pictographic use code symbol includes a red diagonal line that passes through the symbol that signals the user that the extinguisher is not for use on that type of fire. For example, water units show the red line passing through the Class B flammable liquids and Class C energized electrical equipment symbols.

13.6.2.3.2 Fire extinguishers shall be selected for the class(es) of hazards to be protected in accordance with 13.6.2.3.2.1 through 13.6.2.3.2.5. *(For specific hazards, see Section 5.5 of NFPA 10.)* [**10:**5.3.2]

13.6.2.3.2.1* Fire extinguishers for the protection of Class A hazards shall be selected from types that are specifically listed and labeled for use on Class A fires. *(For halon agent–type extinguishers, see 13.6.2.3.2.6.)* [**10:**5.3.2.1]

Exhibit 13.30



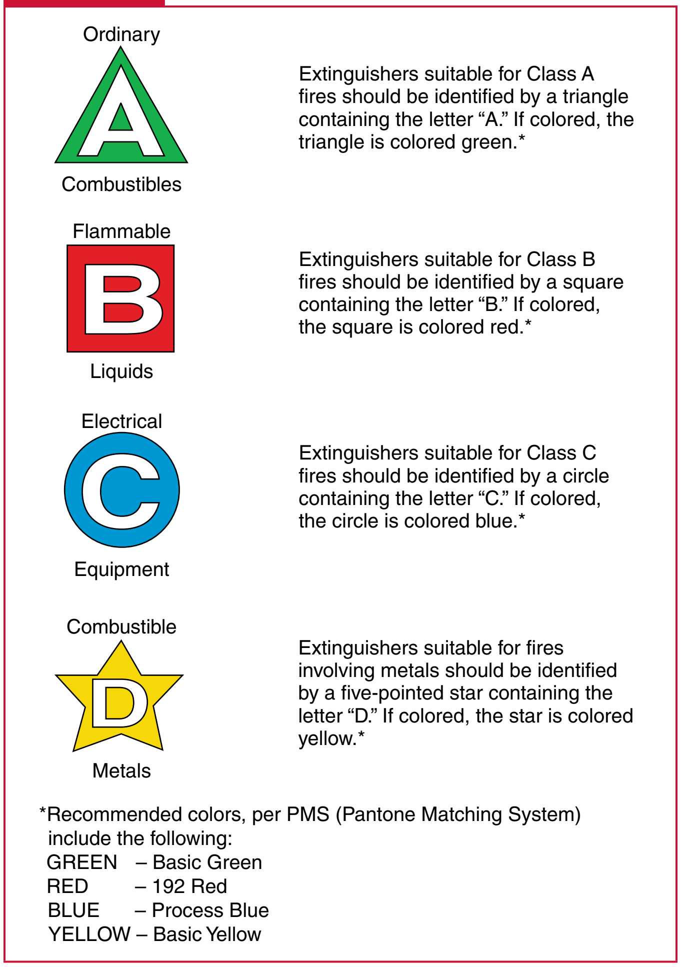
Recommended marking system for fire extinguishers.

A.13.6.2.3.2.1 Examples of extinguishers for protecting Class A hazards are as follows:

(1) Water type
(2) Halogenated agent type *(For halogenated agent–type fire extinguishers, see 13.6.2.3.2.6.)*
(3) Multipurpose dry chemical type
(4) Wet chemical type
[**10:**A.5.3.2.1]

13.6.2.3.2.2* Fire extinguishers for the protection of Class B hazards shall be selected from types that are specifically listed and labeled for use on Class B fires. *(For halon agent–type extinguishers, see 13.6.2.3.2.6.)* [**10:**5.3.2.2]

Exhibit 13.31



Letter-shaped symbol markings for fire extinguishers.

A.13.6.2.3.2.2 Examples of extinguishers for protecting Class B hazards are as follows:

(1) Aqueous film-forming foam (AFFF)
(2) Film-forming fluoroprotein foam (FFFP)
(3) Carbon dioxide
(4) Dry chemical type
(5) Halogenated agent type *(For halogenated agent–type fire extinguishers, see 13.6.2.3.2.6.)*

[**10:**A.5.3.2.2]

13.6.2.3.2.3* Fire extinguishers for the protection of Class C hazards shall be selected from types that are specifically listed and labeled for use on Class C hazards. *(For halon agent–type fire extinguishers, see 13.6.2.3.2.6.)* [**10:**5.3.2.3]

A.13.6.2.3.2.3 The use of dry chemical fire extinguishers on wet energized electrical equipment (such as rain-soaked utility poles, high-voltage switch gear, and transformers) could aggravate electrical leakage problems. The dry chemical in combination with moisture provides an electrical path that can reduce the effectiveness of insulation protection. The removal of all traces of dry chemical from such equipment after extinguishment is recommended. [**10:**A.5.3.2.3]

Pound for pound, dry chemical agent is far more effective on fires than carbon dioxide agent, particularly outdoors in windy conditions. For many applications, such as fires in electric motors, enclosed electrical panels, and other electrical equipment that is semiconfined or housed in cabinets, properly sized carbon dioxide agent extinguishers are effective and clean. The carbon dioxide evaporates after use, leaving no residue.

13.6.2.3.2.4* Fire extinguishers and extinguishing agents for the protection of Class D hazards shall be of the types specifically listed and labeled for use on the specific combustible metal hazard. [**10:**5.3.2.4]

Δ **A.13.6.2.3.2.4** The following information pertains to Class D hazards:

(1) Chemical reaction between burning metals and many extinguishing agents (including water) can range from explosive to inconsequential, depending in part on the type, form, and quantity of metal involved. In general, the hazards from a metal fire are significantly increased when such extinguishing agents are applied. The advantages and limitations of a wide variety of commercially available metal fire extinguishing agents are discussed in NFPA 484 and in Section 6, Chapter 9, of the NFPA *Fire Protection Handbook*. The MSDS of the Class D hazard being protected or the extinguisher manufacturer should be consulted.
(2) The agents and fire extinguishers discussed in this section are of specialized types, and their use often involves special techniques peculiar to a particular combustible metal. A given agent will not necessarily control or extinguish all metal fires. Some agents are valuable in working with several metals; others are useful in combating only one type of metal fire. The AHJs should be consulted in each case to determine the desired protection for the particular hazard involved.
(3) Certain combustible metals require special extinguishing agents or techniques. See NFPA 484 for additional information. If there is doubt, NFPA 484 or the NFPA *Fire Protection Guide to Hazardous Materials* should be consulted. (NFPA 49 and NFPA 325 have been officially withdrawn from the *National Fire Codes*, but the information is contained in the NFPA *Fire Protection Guide to Hazardous Materials.*)
(4) Reference should be made to the manufacturer's recommendations for use and special techniques for extinguishing fires in various combustible metals.
(5) Fire of high intensity can occur in certain metals. Ignition is generally the result of frictional heating, exposure to moisture, or exposure from a fire in other combustible materials. The greatest hazard exists when these metals are in the molten state or in finely divided forms of dust, turnings, or shavings. [**10:**A.5.3.2.4]

The properties of a wide variety of combustible metals and the agents available for extinguishing fires in these metals are discussed in NFPA 484 and the NFPA *Fire Protection Handbook*. [**10:**A.5.3.2.4]

A given agent does not necessarily control or extinguish all metal fires. Some agents work well for the extinguishment of several types of metal fires; others are useful in combating only one type of metal fire. The properties of a wide variety of combustible metals and the agents available for extinguishing fires involving those metals are discussed in the *NFPA Fire Protection Handbook®*. The AHJ should be consulted to determine the required protection for the particular hazard involved.

13.6.2.3.2.5 Fire extinguishers for the protection of Class K hazards shall be selected from types that are specifically listed and labeled for use on Class K fires. [**10:**5.3.2.5]

Prior to the early 1990s, fire extinguishers for cooking media (vegetable or animal oils and fats) traditionally followed Table 13.6.3.3.1.1 for extra (high) hazard, requiring a minimum 40-B–rated sodium bicarbonate or potassium bicarbonate dry chemical extinguisher. The evolution of high-efficiency cooking appliances and the transition of the cooking medium from animal fats to vegetable oils (which have a higher auto-ignition temperature) have created a more severe fire hazard. Testing has shown that wet chemical extinguishers have several times the fire-extinguishing capability of a minimum 40-B–rated sodium bicarbonate or potassium bicarbonate dry chemical extinguisher; this finding prompted the creation of a new classification and a new listing test protocol in 1994.

For fires within cooking appliances protected by a fixed automatic fire extinguishing system, the system should be actuated before a portable fire extinguisher is used, since the fixed fire extinguishing system will automatically shut off the fuel source to the cooking appliance. In such an instance, the portable fire extinguisher provides supplemental protection.

See NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, and Chapter 50 of this *Code* for further information.

13.6.2.3.2.6* Use of halon agent fire extinguishers shall be limited to applications where a clean agent is necessary to extinguish fire efficiently without damaging the equipment or area being protected, or where the use of alternative agents has the potential to cause a hazard to personnel in the area. [**10:**5.3.2.6]

A.13.6.2.3.2.6 Halon agent is highly effective for extinguishing fire and evaporates after use, leaving no residue. Halon agent is, however, included in the Montreal Protocol list of controlled substances developed under the United Nations Environment Program. Where agents other than halon can satisfactorily protect the hazard, they should be used instead of halon. Halon use should be limited to extinguishment of unwanted fire; it should not be used for routine training of personnel. [**10:**A.5.3.2.6]

13.6.2.3.2.6.1* Placement of portable fire extinguishers containing halogenated agents shall conform to minimum confined space volume requirement warnings contained on the fire extinguisher nameplates. [**10:**5.3.2.6.1]

A.13.6.2.3.2.6.1 ANSI/UL 2129, CAN/ULC-S566, *Standard for Halocarbon Clean Agent Fire Extinguishers*, and CAN/ULC-S512, *Standard for Halogenated Agent Hand and Wheeled Fire Extinguishers*, require halocarbon and halogenated agent nameplates to provide safety guidelines for avoiding overexposure to agent vapors when the agents are discharged into confined spaces. The UL minimum volume requirement for confined spaces is based on exposure to the agent in the absence of a fire and does not include considerations of fire or agent decomposition products. [**10:**A.5.3.2.6.1]

Δ **13.6.2.3.2.7*** Wheeled fire extinguishers shall be considered for hazard protection in areas in which a fire risk assessment has shown the following:

(1) High hazard areas are present
(2) Limited available personnel are present, thereby requiring an extinguisher that has the following features:
    (a) High agent flow rate
    (b) Increased agent stream range
    (c) Increased agent capacity

[**10:**5.3.2.7]

A.13.6.2.3.2.7 Wheeled fire extinguishers are available in capacities of 33 gal (125 L) for foam units and range from 30 lb to 350 lb (13.6 kg to 158.8 kg) for other types of extinguishers. These fire extinguishers are capable of delivering higher agent flow rates and greater agent stream range than normal portable-type fire extinguishers. Wheeled fire extinguishers are capable of furnishing increased fire-extinguishing effectiveness for high hazard areas and have added importance where a limited number of people are available. [**10:**A.5.3.2.7]

13.6.2.4 Classification of Hazards.

13.6.2.4.1 Classifying Occupancy Hazard. Rooms or areas shall be classified as being light hazard, ordinary hazard, or extra hazard. [**10:**5.4.1]

13.6.2.4.1.1* Light Hazard. Light hazard occupancies shall be classified as locations where the quantity and combustibility of Class A combustibles and Class B flammables are low and fires with relatively low rates of heat release are expected. These occupancies consist of fire hazards having normally expected quantities of Class A combustible furnishings, and/or the total quantity of Class B flammables typically expected to be present is less than 1 gal (3.8 L) in any room or area. [**10:**5.4.1.1]

A.13.6.2.4.1.1 Light hazard occupancies can include some buildings or rooms occupied as offices, classrooms, churches, assembly halls, guest room areas of hotels or motels, and so forth. This classification anticipates that the majority of content items are either noncombustible or so arranged that a fire is not likely to spread rapidly. Small amounts of Class B flammables used for duplicating machines, art departments, and so forth, are included, provided that they are kept in closed containers and safely stored. [**10:**A.5.4.1.1]

13.6.2.4.1.2* Ordinary Hazard. Ordinary hazard occupancies shall be classified as locations where the quantity and combustibility of Class A combustible materials and Class B flammables are moderate and fires with moderate rates of heat release are expected.

These occupancies consist of fire hazards that only occasionally contain Class A combustible materials beyond normal anticipated furnishings, and/or the total quantity of Class B flammables typically expected to be present is from 1 gal to 5 gal (3.8 L to 18.9 L) in any room or area. [**10:**5.4.1.2]

A.13.6.2.4.1.2 Ordinary hazard occupancies could consist of dining areas, mercantile shops and allied storage, light manufacturing, research operations, auto showrooms, parking garages, workshop or support service areas of light hazard occupancies, and warehouses containing Class I or Class II commodities as defined by NFPA 13. [**10:**A.5.4.1.2]

A Class I commodity is defined by NFPA 13 as a noncombustible product that meets one of the following criteria:

(1) It is placed directly on wooden pallets.
(2) It is placed in single-layer corrugated cartons, with or without single-thickness cardboard dividers, with or without pallets.
(3) It is shrink-wrapped or paper-wrapped as a unit load, with or without pallets.

[**10:**A.5.4.1.2]

A Class II commodity is defined by NFPA 13 as a noncombustible product that is in slatted wooden crates, solid wood boxes, multiple-layered corrugated cartons, or equivalent combustible packaging material, with or without pallets. [**10:**A.5.4.1.2]

13.6.2.4.1.3* Extra Hazard. Extra hazard occupancies shall be classified as locations where the quantity and combustibility of Class A combustible material are high or where high amounts of Class B flammables are present and rapidly developing fires with high rates of heat release are expected. These occupancies consist of fire hazards involved with the storage, packaging, handling, or manufacture of Class A combustibles, and/or the total quantity of Class B flammables expected to be present is more than 5 gal (18.9 L) in any room or area. [**10:**5.4.1.3]

A.13.6.2.4.1.3 Extra hazard occupancies could consist of woodworking; vehicle repair; aircraft and boat servicing; cooking areas; individual product display showrooms; product convention center displays; and storage and manufacturing processes such as painting, dipping, and coating, including flammable liquid handling. Also included is warehousing or in-process storage of other than Class I and Class II commodities. [**10:**A.5.4.1.3]

13.6.2.4.1.4 Limited areas of greater or lesser hazard shall be protected as required. [**10:**5.4.1.4]

13.6.2.4.2* Selection by Occupancy. Fire extinguishers shall be provided for the protection of both the building structure and the occupancy hazards contained therein regardless of the presence of any fixed fire suppression systems. [**10:**5.4.2]

A.13.6.2.4.2 All buildings have Class A fire hazards. In any occupancy, there could be a predominant hazard as well as special hazard areas requiring extinguishers with ratings to match those hazards. For example, a hospital will generally have need for Class A fire extinguishers covering patient rooms, corridors, offices, and so forth, but will need Class B fire extinguishers in laboratories and where flammable anesthetics are stored or handled, Class C fire extinguishers in electrical switch gear or generator rooms, and Class K extinguishers in kitchens. [**10:**A.5.4.2]

13.6.2.4.2.1 Required building protection shall be provided by fire extinguishers for Class A fires. [**10:**5.4.2.1]

Most buildings include Class A fire hazards. In any occupancy, there might be a predominant hazard and special hazard areas that require supplemental protection. For example, a hospital generally requires Class A fire extinguishers to cover patient rooms, corridors, offices, and so forth. However, a hospital also requires Class B fire extinguishers in laboratories and areas where flammable anesthetics are stored or handled, Class C fire extinguishers in electrical switch gear or generator rooms, and Class K fire extinguishers in kitchens.

13.6.2.4.2.2* Occupancy hazard protection shall be provided by fire extinguishers for such Class A, B, C, D, or K fire potentials as might be present. [**10:**5.4.2.2]

A.13.6.2.4.2.2 If fire extinguishers intended for different classes of fires are grouped, their intended use should be marked conspicuously to aid in the choice of the proper fire extinguisher at the time of a fire. In an emergency, the tendency is to reach for the closest fire extinguisher. If this fire extinguisher is of the wrong type, users could endanger themselves and the property they are endeavoring to protect. Wherever possible, it is preferable to have only those fire extinguishers available that can be safely used on any type of fire in the immediate vicinity. [**10:**A.5.4.2.2]

13.6.2.4.2.3 Fire extinguishers provided for building protection shall be permitted to also be considered for the protection of occupancies having a Class A fire potential. [**10:**5.4.2.3]

Where a code or standard requires portable extinguishers to be installed for general building protection, extinguishers rated for Class A fires are used, since the purpose of the extinguisher is to provide a first line of defense against a structure fire. Where the building contents are also a Class A fire risk, this paragraph permits the same extinguishers to be used for both purposes. Without this requirement, 13.6.2.4.2 might be interpreted to require a full complement of extinguishers for the building structure protection and additional extinguishers for the occupancy hazards.

13.6.2.4.2.4 Buildings having an occupancy hazard subject to Class B or Class C fires, or both, shall have a standard complement of Class A fire extinguishers for building protection, plus additional Class B or Class C fire extinguishers, or both. [**10:**5.4.2.4]

13.6.2.4.2.5 Where fire extinguishers have more than one letter classification (such as 2-A:20-B:C), they shall be permitted to satisfy the requirements of each letter class. [**10:**5.4.2.5]

13.6.2.5 Selection for Specific Hazards.

13.6.2.5.1 Class B Fires.

13.6.2.5.1.1* Extinguishers for Pressurized Flammable Liquids and Pressurized Gas Fires.

A.13.6.2.5.1.1 Pressurized flammable liquids and pressurized gas fires are considered to be a special hazard. Class B fire extinguishers containing agents other than dry chemical are relatively ineffective on this type of hazard due to stream and agent characteristics. The system used to rate the effectiveness of fire extinguishers on Class B fires (flammable liquids in depth) is not applicable to these types of hazards. It has been determined that special nozzle design and rates of agent application are required to cope with such hazards. [**10:**A.5.5.1.1]

13.6.2.5.1.1.1* Extinguishers for Pressurized Flammable Liquids and Pressurized Gas Fires. Large-capacity dry chemical extinguishers of 10 lb (4.54 kg) or greater and a discharge rate of 1 lb/sec (0.45 kg/sec) or more shall be used to protect these hazards. [**10:**5.5.1.1]

A.13.6.2.5.1.1.1 A three-dimensional Class B fire involves Class B materials in motion, such as pouring, running, or dripping flammable liquids, and generally includes vertical as well as one or more, horizontal surfaces. Fires of this nature are considered to be a special hazard. The system used to rate fire extinguishers on Class B fires (flammable liquids in depth) is not directly applicable to this type of hazard. The installation of fixed systems should be considered where applicable. [**10:**A.5.5.2]

• **13.6.2.5.2 Three-Dimensional Fires.** Large capacity dry chemical extinguishers of 10 lb (4.54 kg) or greater and having a discharge rate of 1 lb/sec (0.45 kg/sec) or more shall be used to protect these hazards. [**10:**5.5.2]

Δ **13.6.2.5.3 Obstacle Fires.** Selection of a fire extinguisher for this type of hazard shall be based on one of the following:

(1) Extinguisher containing a vapor-suppressing foam agent
(2)* Multiple extinguishers containing non-vapor-suppressing Class B agents intended for simultaneous application

A.13.6.2.5.3(2) Where multiple extinguishers are utilized, simultaneous discharge from multiple locations to eliminate any blind spots created by an obstacle should be employed. [**10:**A.5.5.3(2)]

(3) Larger capacity extinguishers of 10 lb (4.54 kg) or greater and a minimum discharge rate of 1 lb/sec (0.45 kg/sec)

[**10:**5.5.3]

13.6.2.5.4 Water-Soluble Flammable Liquid Fires (Polar Solvents). Aqueous film-forming foam (AFFF) and film-forming fluoroprotein foam (FFFP) types of fire extinguishers shall not be used for the protection of water-soluble flammable liquids, such as alcohols, acetone, esters, ketones, and so forth, unless specifically referenced on the fire extinguisher nameplate. [**10:**5.5.4]

13.6.2.5.5* Class K Cooking Media Fires. Fire extinguishers provided for the protection of cooking appliances that use combustible cooking media (vegetable or animal oils and fats) shall be listed and labeled for Class K fires. [**10:**5.5.5]

A.13.6.2.5.5 Fire extinguishers for cooking media (vegetable or animal oils and fats) traditionally followed Table 6.3.1.1 of NFPA 10 for extra hazard, requiring a minimum 40-B -rated sodium bicarbonate or potassium bicarbonate dry chemical extinguisher. The evolution of high-efficiency cooking appliances and the change to hotter-burning vegetable shortening has created a more severe fire hazard. Testing has shown that wet chemical extinguishers have several times the cooking fire–extinguishing capability of a minimum 40-B rated sodium bicarbonate or potassium bicarbonate dry chemical extinguisher, which has prompted the creation of a new classification and a new listing test protocol. The test protocol is found in ANSI/UL 711, CAN/ULC-S508. [**10:**A.5.5.5]

See NFPA 96 for further information. Persons in cooking areas need specific training on the use of extinguishers as an essential step for personal safety. Class K fire extinguishers equipped with extended wand–type discharge devices should not be used in a manner that results in subsurface injection of wet chemical extinguishing agents into hot cooking media. Subsurface injection causes a thermodynamic reaction comparable to an explosion. Class K fire extinguishers are no longer manufactured with extended wand–type discharge devices. [**10:**A.5.5.5]

13.6.2.5.5.1 Class K fire extinguishers manufactured after January 1, 2002, shall not be equipped with extended wand–type discharge devices. [**10:**5.5.5.1]

As described in D.4.7 of NFPA 10, Class K wet chemical extinguishers have replaced dry chemical extinguishers in commercial kitchens.

Wet chemical agents are salt-based agents, such as potassium carbonate, dissolved in water. When discharged onto a burning fryer, the salt combines with the oil to create a foamy soap-like layer, which is capable of maintaining a vapor barrier over the surface of the oil. Simultaneously, the large quantity of water absorbs heat from the oil, cooling it significantly. For those reasons, wet chemical agents quickly became the standard agent for fixed commercial kitchen systems once ANSI/UL 300, *Standard for Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas*, was adopted.

With this change, manufacturers also began to offer wet chemical portable extinguishers to avoid compatibility issues between agents and to ensure the effectiveness of the portable extinguisher when used on a deep-fat fryer. Some of the initial designs included an extended wand-type discharge device, which were intended to allow the user to discharge into the fryer from a safe distance. However, there was concern that people would submerge the wand and inject the water-based agent below the oil surface. The high temperature of the oil could cause the water to vaporize at an explosive rate and cause burning oil to splash out of the fryer. For that reason, NFPA 10 specifically forbids manufacture of Class K extinguishers with wands. Because the listing for Class K extinguishers was developed after this prohibition was added to NFPA 10, listed Class K extinguishers should not have a wand.

13.6.2.5.5.2 Fire extinguishers installed specifically for the protection of cooking appliances that use combustible cooking media (animal or vegetable oils and fats) without a Class K rating shall be removed from service. [**10:**5.5.5.2]

13.6.2.5.5.3* Where a hazard is protected by an automatic fire protection system, a placard shall be conspicuously placed near the extinguisher that states that the fire protection system shall be actuated prior to using the fire extinguisher. [**10:**5.5.5.3]

A.13.6.2.5.5.3 Figure A.13.6.2.5.5.3(a) and Figure A.13.6.2.5.5.3(b) show the recommended wording for the Class K placard. Recommended size is 7⅝ in. × 11 in. (194 mm × 279 mm). [**10:**A.5.5.5.3]

13.6.2.5.6* Electronic Equipment Fires. Fire extinguishers for the protection of delicate electronic equipment shall be selected

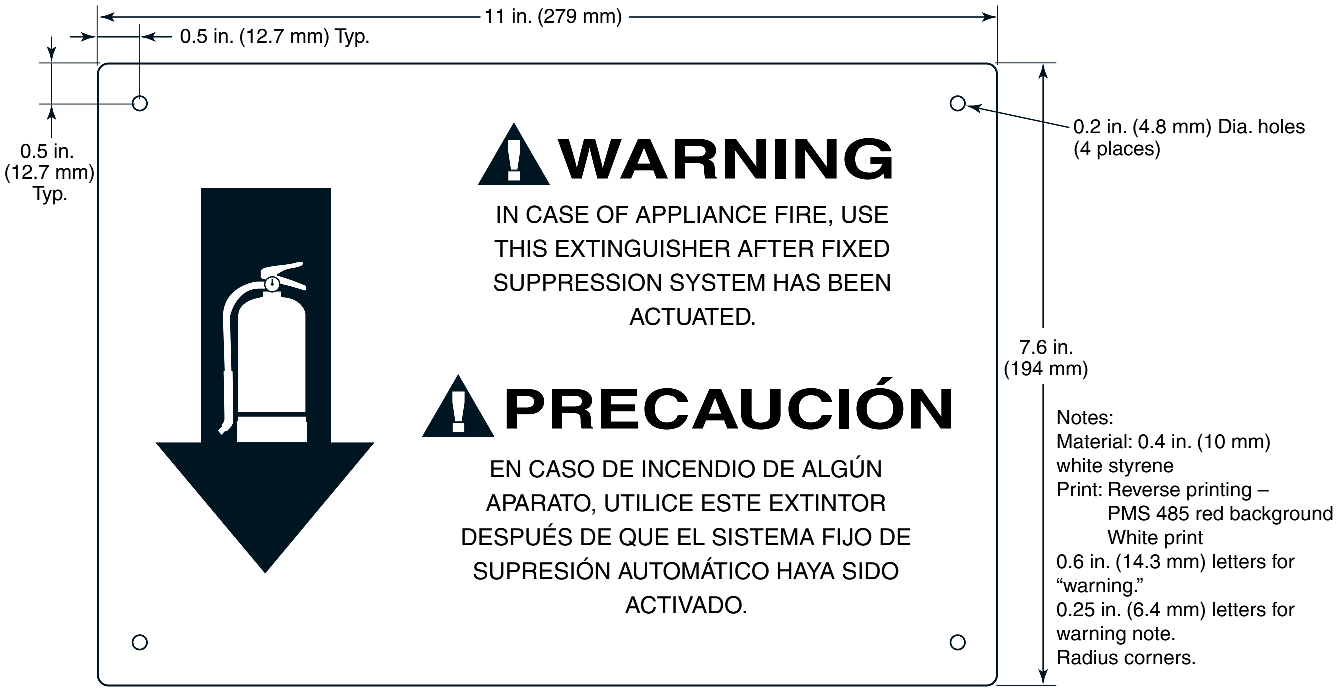


***FIGURE A.13.6.2.5.5.3(a)** Typical Class K Placard in English and Spanish. [**10:**Figure A.5.5.5.3(a)]*

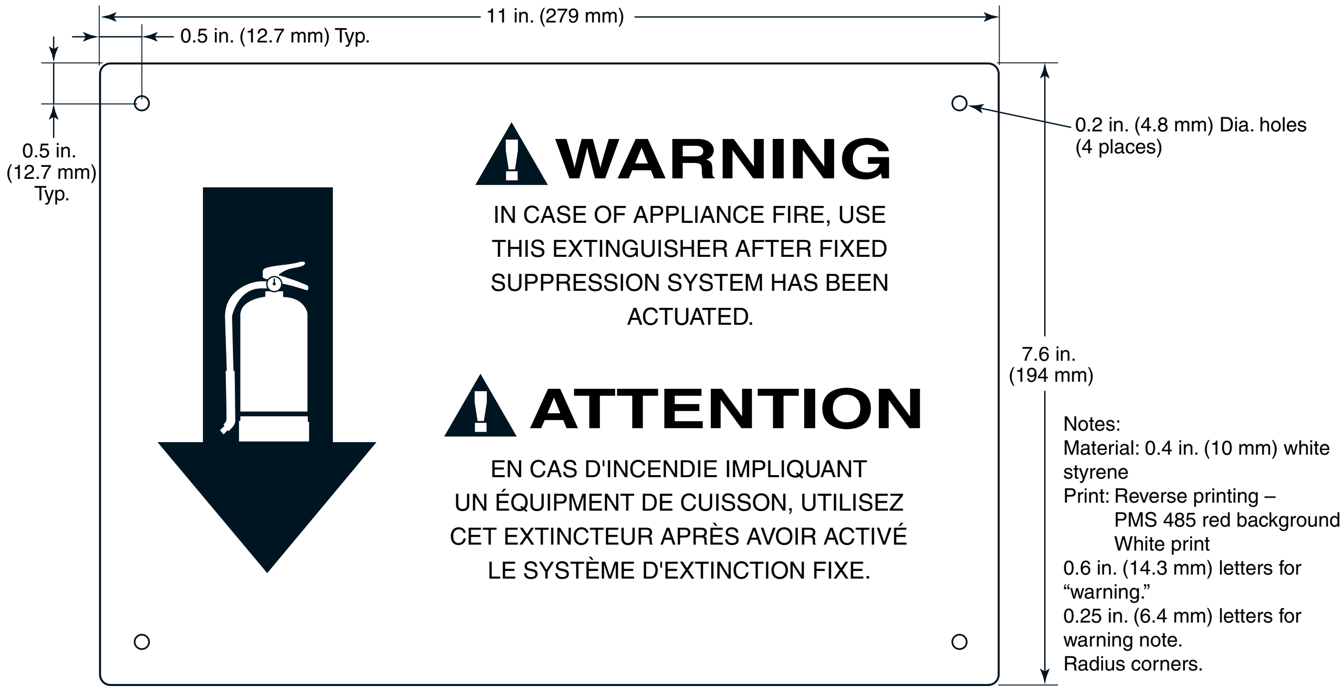


***FIGURE A.13.6.2.5.5.3(b)** Typical Class K Placard in English and French. [**10:**Figure A.5.5.5.3(b)]* from types specifically listed and labeled for Class C hazards. *(See 13.6.2.3.2.3.)* [**10:**5.5.6]

Δ **A.13.6.2.5.6** Where occupancies are required to have extinguishers installed, this section is applicable to areas where the electronic equipment is located. Delicate electronic equipment includes, but is not limited to, telecommunications, computers, servers, robotics, and reproduction equipment. [**10:**A.5.5.6]

It is up to the equipment owner to determine whether electronic equipment is considered "delicate." In modern terminology, it is more common to refer to such equipment as "mission critical." With the advent of comparatively cheap replacement parts, multiple-site processing, and distributed data storage, very few computer and server rooms would be considered to be delicate, despite the antiquated language in A.13.6.2.5.6. However, one-of-a-kind machines or other irreplaceable systems should be considered "delicate" and thus should not be protected with or located within areas containing portable extinguishers that use corrosive or damaging agents.

13.6.2.5.6.1* Dry chemical fire extinguishers shall not be installed for the protection of delicate electronic equipment. [**10:**5.5.6.1]

A.13.6.2.5.6.1 Dry chemical residue will probably not be able to be completely and immediately removed, and, in addition, multipurpose dry chemical exposed to temperatures in excess of 250°F (121°C) or relative humidity in excess of 50 percent can cause corrosion. [**10:**A.5.5.6.1]

13.6.2.5.7 Areas Containing Oxidizers.

13.6.2.5.7.1 Only water or foam extinguishers shall be installed in areas where pool chemicals containing chlorine or bromine are stored. [**10:**5.5.7.1]

13.6.2.5.7.2 Multipurpose dry chemical fire extinguishers shall not be installed in areas where pool chemicals containing chlorine or bromine are stored. [**10:**5.5.7.2]

N **13.6.2.5.7.3** Fire extinguishers intended for use on oxidizer fires where oxidizers are stored or used shall be selected and installed based on the specific recommendations contained within the material's safety data sheet (SDS) for the oxidizer, surrounding conditions, and NFPA 400. [**10:**5.5.7.3]

13.6.2.5.8 Class D Combustible Metal Fires. Fire extinguishers or containers of Class D extinguishing agents provided for the protection of Class D fires shall be listed and labeled for Class D fires. [**10:**5.5.8]

13.6.2.5.8.1* Class D fire extinguishers and agents shall be compatible with the specific metal for which protection is provided. [**10:**5.5.8.1]

A.13.6.2.5.8.1 Other nonlisted agents can be used if acceptable to the AHJ. Other nonlisted agents include specially dried sand, dolomite, soda ash, lithium chloride, talc, foundry flux, and zirconium silicate or other agents shown to be effective. Consult NFPA 484 for use and limitations of these agents and other nonlisted alternatives. [**10:**A.5.5.8.1]

13.6.2.6 Selection for Specific Locations.

Δ **13.6.2.6.1*** Where portable fire extinguishers are required to be installed, the following documents shall be reviewed for the occupancies outlined in their respective scopes:

(1) This *Code*
(2) NFPA 2, *Hydrogen Technologies Code*
(3) NFPA 22, *Standard for Water Tanks for Private Fire Protection*
(4) NFPA 30, *Flammable and Combustible Liquids Code*
(5) NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*
(6) NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
(7) NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*
(8) NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*
(9) NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes*
(10) NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*
(11) NFPA 52, *Vehicular Natural Gas Fuel Systems Code*
(12) NFPA 58, *Liquefied Petroleum Gas Code*
(13) NFPA 59, *Utility LP-Gas Plant Code*
(14) NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*
(15) NFPA 72, *National Fire Alarm and Signaling Code*
(16) NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*
(17) NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities*
(18) NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*
(19) NFPA 99, *Health Care Facilities Code*
(20) NFPA 99B, *Standard for Hypobaric Facilities*
(21) NFPA *101*, *Life Safety Code*
(22) NFPA 102, *Standard for Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures*
(23) NFPA 115, *Standard for Laser Fire Protection*
(24) NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*
(25) NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities*
(26) NFPA 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems*
(27) NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations*
(28) NFPA 150, *Standard on Fire and Life Safety in Animal Housing Facilities*
(29) NFPA 160, *Standard for the Use of Flame Effects Before an Audience*
(30) NFPA 232, *Standard for the Protection of Records*
(31) NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*

(32) NFPA 301, *Code for Safety to Life from Fire on Merchant Vessels*
(33) NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*
(34) NFPA 303, *Fire Protection Standard for Marinas and Boatyards*
(35) NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*
(36) NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*
(37) NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids*
(38) NFPA 400, *Hazardous Materials Code*
(39) NFPA 403, *Standard for Aircraft Rescue and Fire-Fighting Services at Airports*
(40) NFPA 407, *Standard for Aircraft Fuel Servicing*
(41) NFPA 408, *Standard for Aircraft Hand Portable Fire Extinguishers*
(42) NFPA 409, *Standard on Aircraft Hangars*
(43) NFPA 410, *Standard on Aircraft Maintenance*
(44) NFPA 418, *Standard for Heliports*
(45) NFPA 423, *Standard for Construction and Protection of Aircraft Engine Test Facilities*
(46) NFPA 484, *Standard for Combustible Metals*
(47) NFPA 495, *Explosive Materials Code*
(48) NFPA 498, *Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives*
(49) NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities*
(50) NFPA 502, *Standard for Road Tunnels, Bridges, and Other Limited Access Highways*
(51) NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*
(52) NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*
(53) NFPA 731, *Standard for the Installation of Electronic Premises Security Systems*
(54) NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*
(55) NFPA 804, *Standard for Fire Protection for Advanced Light Water Reactor Electric Generating Plants*
(56) NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants*
(57) NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*
(58) NFPA 909, *Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship*
(59) NFPA 914, *Code for Fire Protection of Historic Structures*
(60) NFPA 1123, *Code for Fireworks Display*
(61) NFPA 1125, *Code for the Manufacture of Model Rocket and High Power Rocket Motors*
(62) NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*
(63) NFPA 1141, *Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas*
(64) NFPA 1192, *Standard on Recreational Vehicles*
(65) NFPA 1194, *Standard for Recreational Vehicle Parks and Campgrounds*
(66) NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*
(67) NFPA 1901, *Standard for Automotive Fire Apparatus*
(68) NFPA 1906, *Standard for Wildland Fire Apparatus*
(69) NFPA 1925, *Standard on Marine Fire-Fighting Vessels*
(70) *NFPA 5000, Building Construction and Safety Code*

[**10:**5.6.1]

A.13.6.2.6.1 Where portable fire extinguishers are required to be installed, the following documents should be reviewed for the occupancies outlined in their respective scopes:

(1) NFPA 77, *Recommended Practice on Static Electricity*
(2) NFPA 402, *Guide for Aircraft Rescue and Fire-Fighting Operations*
(3) NFPA 610, *Guide for Emergency and Safety Operations at Motorsports Venues*
(4) NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*
(5) NFPA 921, *Guide for Fire and Explosion Investigations*
(6) NFPA 1452, *Guide for Training Fire Service Personnel to Conduct Community Risk Reduction*

[**10:**A.5.6.1]

Many building codes, fire codes, and specific occupancy standards simply refer to NFPA 10 to provide all the requirements for the selection, installation, and maintenance of extinguishers. However, there are also many standards that include more stringent requirements based on the nature of the occupancy. It is important to be aware of such exceptions. The list in 13.6.2.6.1 provides some guidance on other standards that should be consulted in specific situations. The list, however, is not exhaustive. Whether it appears on this list or not, the appropriate standard, if one exists, should always be consulted to ensure that adequate protection is provided.

13.6.2.6.2 In no case shall the requirements of the documents in 13.6.2.6.1 be less than those specified in Section 13.6 and Chapter 2. [**10:**5.6.2]

13.6.3 Installation of Portable Fire Extinguishers.

13.6.3.1 General.

13.6.3.1.1* Number of Extinguishers. The minimum number of fire extinguishers needed to protect a property shall be determined as outlined in 13.6.3. [**10:**6.1.1]

A.13.6.3.1.1 The following items affect distribution of portable fire extinguishers:

(1) Area and arrangement of the building occupancy conditions
(2) Severity of the hazard
(3) Anticipated classes of fire
(4) Other protective systems or devices
(5) Distances to be traveled to reach fire extinguishers

[**10:**A.6.1.1]

In addition, the following factors should be considered:

(1) Anticipated rate of fire spread
(2) Intensity and rate of heat development
(3) Smoke contributed by the burning materials

[**10:**A.6.1.1]

Wheeled fire extinguishers have additional agent and range and should be considered for areas where the additional protection is needed. Portable fire extinguishers offer the occupant a means to assist in evacuation of a building or occupancy. They are useful to knock down the fire if it occurs along the evacuation route. If possible, the individual property should be surveyed for actual protection requirements. [**10:**A.6.1.1]

13.6.3.1.1.1 The installation of extinguishers shall be independent of whether the building is equipped with automatic sprinklers, standpipe and hose, or other fixed protection equipment. [**10:**6.1.1.1]

13.6.3.1.1.2 Additional extinguishers shall be permitted to be installed to provide more protection as necessary. [**10:**6.1.1.2]

As with all NFPA standards, the requirements of NFPA 10 are designed to provide the minimum level of protection. It is always acceptable to provide protection that is above and beyond the requirements of NFPA 10, including the installation of additional or higher-rated extinguishers, when deemed appropriate.

13.6.3.1.1.3 Fire extinguishers having ratings less than those specified in Table 13.6.3.2.1.1 and Table 13.6.3.3.1.1 shall be permitted to be installed, provided they are not used in fulfilling the minimum protective requirements of this subsection, except as modified in 13.6.3.2.1.4, 13.6.3.2.1.5, and 13.6.3.3.1.1.1. [**10:**6.1.1.3]

13.6.3.1.2 Extinguisher Readiness. Portable fire extinguishers shall be maintained in a fully charged and operable condition and shall be kept in their designated places at all times when they are not being used. [**10:**6.1.2]

13.6.3.1.3 Placement.

13.6.3.1.3.1 Fire extinguishers shall be conspicuously located where they are readily accessible and immediately available in the event of fire. [**10:**6.1.3.1]

13.6.3.1.3.2 Fire extinguishers shall be located along normal paths of travel, including exits from areas. [**10:**6.1.3.2]

Locating portable fire extinguishers along normal paths of travel helps to ensure that occupants are able to easily find an obviously placed extinguisher and that they will not put themselves in danger while retrieving the extinguisher.

13.6.3.1.3.3 Visual Obstructions.

13.6.3.1.3.3.1 Fire extinguishers shall be installed in locations where they are visible except as permitted by 13.6.3.1.3.3.2. [**10:**6.1.3.3.1]

Δ **13.6.3.1.3.3.2*** In rooms and in locations where visual obstructions cannot be completely avoided, signs or other means shall be provided to indicate the extinguisher location. [**10:**6.1.3.3.2]

NFPA 10 does not specify a means of identifying the locations of extinguishers to occupants, nor does it provide design specifications, such as color, font size, and so forth, for signs or other identifiers. It is within the purview of the AHJ to determine whether the extinguisher locations are conspicuous and/or identifiable.

Δ **A.13.6.3.1.3.3.2** The primary means for identifying locations of fire extinguishers should be by the installation of the fire extinguisher signs that are specifically designed for that purpose. Examples of other means of identifying the fire extinguisher locations include arrows, lights, or coding of the wall or column. [**10:**A.6.1.3.3.2]

N **13.6.3.1.3.3.3** Signs or other means used to indicate fire extinguisher location shall be located in close proximity to the extinguisher. [**10:**6.1.3.3.3]

N **13.6.3.1.3.3.4** Signs or other means used to indicate fire extinguisher location shall be visible from the normal path of travel. [**10:**6.1.3.3.4]

Δ **13.6.3.1.3.4*** Portable fire extinguishers other than wheeled extinguishers shall be installed using any of the following means:

(1) Securely on a hanger intended for the extinguisher
(2) In a bracket incorporating releasing straps or bands supplied by the extinguisher manufacturer
(3) In a listed bracket incorporating releasing straps or bands approved for such purpose
(4) In approved cabinets or wall recesses

[**10:**6.1.3.4]

Δ **A.13.6.3.1.3.4** In situations where it is necessary that fire extinguishers be provided temporarily, a good practice is to provide portable stands on uprights with feet, on which the fire extinguishers can be installed. Portable stands should be designed to comply with the mounting heights for extinguishers. [**10:**A.6.1.3.4]

13.6.3.1.3.5 Wheeled fire extinguishers shall be located in designated locations. [**10:**6.1.3.5]

13.6.3.1.3.6 Fire extinguishers installed in vehicles or under other conditions where they are subject to dislodgement shall be installed in approved strap-type brackets specifically designed for this application. [**10:**6.1.3.6]

Fire extinguishers that are installed in narrow corridors with two-way traffic are subject to people bumping into and dislodging them. Extinguishers are also sometimes mounted in areas where children might reach up and dislodge them. Extinguishers accidentally dislodged from their brackets can fall and cause injury. In such situations, extinguishers should be secured in strap brackets or mounted in properly marked recesses or cabinets to protect them from accidental dislodgment.

13.6.3.1.3.7 Fire extinguishers installed under conditions or in locations where they are subject to physical damage (e.g., from impact, vibration, the environment) shall be protected against such damage. [**10:**6.1.3.7]

If an extinguisher is located where it could be susceptible to damage, consult with the extinguisher manufacturer to determine whether special mounting brackets or protective coverings are available

13.6.3.1.3.8 Installation Height.

13.6.3.1.3.8.1 Fire extinguishers having a gross weight not exceeding 40 lb (18.14 kg) shall be installed so that the top of the fire extinguisher is not more than 5 ft (1.53 m) above the floor. [**10:**6.1.3.8.1]

13.6.3.1.3.8.2 Fire extinguishers having a gross weight greater than 40 lb (18.14 kg) (except wheeled types) shall be installed so that the top of the fire extinguisher is not more than 3½ ft (1.07 m) above the floor. [**10:**6.1.3.8.2]

13.6.3.1.3.8.3 In no case shall the clearance between the bottom of the hand portable fire extinguisher and the floor be less than 4 in. (102 mm). [**10:**6.1.3.8.3]

13.6.3.1.3.9 Label Visibility.

13.6.3.1.3.9.1 Fire extinguishers shall be installed so that the fire extinguisher's operating instructions face outward. [**10:**6.1.3.9.1]

Operating instructions that face outward are immediately visible at all times. They should not be covered by inspection tags, mounting straps, or other materials. This remains true even where the extinguisher is installed inside a cabinet, as shown in Exhibit 13.32

13.6.3.1.3.9.2 Hazardous materials identification systems (HMIS) labels, 6-year maintenance labels, hydrostatic test labels, or other labels shall not be located or placed on the front of the extinguisher. [**10:**6.1.3.9.2]

Exhibit 13.32

Inspection and maintenance tags on a cabinet-mounted extinguisher.

13.6.3.1.3.9.3 The restrictions of 13.6.3.1.3.9.2 shall not apply to the original manufacturer's labels, labels that specifically relate to the extinguisher's operation or fire classification, or inventory control labels specific to that extinguisher. [**10:**6.1.3.9.3]

In an emergency situation, information other than an extinguisher's operating instructions can confuse or distract the user, causing a delay in putting the extinguisher into operation. The pictographic operating instructions cover a minimum 120-degree arc of the extinguisher label on the front of the extinguisher.

Extensive live fire testing with novice operators proved that pictographic instructions and the elimination of unnecessary information from the front of the extinguisher significantly improved fire extinguishment. Inspection tags, hydrostatic test labels, service agency identification labels, and any other markings that are not necessary for understanding how to properly operate the extinguisher should be kept out of the 120-degree arc operating instruction area on the front of the extinguisher.

13.6.3.1.3.10 Cabinets.

13.6.3.1.3.10.1 Cabinets housing fire extinguishers shall not be locked, except where fire extinguishers are subject to malicious use and cabinets include a means of emergency access. [**10:**6.1.3.10.1]

13.6.3.1.3.10.2 The location of fire extinguishers as described in 13.6.3.1.3.3.2 shall be marked conspicuously. [**10:**6.1.3.10.2]

13.6.3.1.3.10.3 Fire extinguishers mounted in cabinets or wall recesses shall be placed so that the fire extinguisher's operating instructions face outward. [**10:**6.1.3.10.3]

13.6.3.1.3.10.4* Where fire extinguishers are installed in closed cabinets that are exposed to elevated temperatures, the cabinets shall be provided with screened openings and drains. [**10:**6.1.3.10.4]

A.13.6.3.1.3.10.4 Vented fire extinguisher cabinets should utilize tinted glass and should be constructed to prevent the entrance of insects and the accumulation of water. Vented fire extinguisher cabinets constructed in this manner lower the maximum internal temperature by 10°F to 15°F (5.6°C to 8.3°C). [**10:**A.6.1.3.10.4]

Extinguishers installed in unventilated outside cabinets in areas exposed to direct sunlight can be subject to significant heat buildup (greenhouse effect) and can be too hot to handle [approximately 140°F (60°C)]. Louvered cabinets, which allow air to circulate into and out of the cabinet, should be used. Screened openings should be provided to prevent insects from nesting in the cabinet. Drains should be provided to prevent the accumulation of water and, in winter, the formation of ice. Cabinets suitable for installation in outdoor locations are readily available and should be used.

13.6.3.1.3.10.5 Cabinets or wall recesses for fire extinguishers shall be installed such that the extinguisher mounting heights specified in 13.6.3.1.3.8.1 and 13.6.3.1.3.8.2 are met. [**10:**6.1.3.10.5]

N 13.6.3.1.3.10.6* For fire resistance–rated walls, only surface-mounted cabinets or listed fire-rated cabinets shall be installed. [**10:**6.1.3.10.6]

N A.13.6.3.1.3.10.6 Certain fire resistance–rated cabinets are intended for installation into fire resistance–rated walls. Cabinets that are not fire resistance–rated make the entire fire resistance–rated wall noncompliant, so only surface-mounted cabinets or fire resistance–rated cabinets are appropriate for installation in fire resistance–rated walls. [**10:**A.6.1.3.10.6]

13.6.3.1.3.11* Fire extinguishers shall not be exposed to temperatures outside of the listed temperature range shown on the fire extinguisher label. [**10:**6.1.3.11]

A.13.6.3.1.3.11 The following precautions should be noted where fire extinguishers are located in areas that have temperatures outside the range of 40°F to 120°F (4°C to 49°C):

(1) AFFF and FFFP fire extinguishers cannot be protected against temperatures below 40°F (4°C) by adding an antifreeze charge, because it tends to destroy the effectiveness of the extinguishing agent.
(2) Plain water fire extinguishers should not be protected against temperatures below 40°F (4°C) with ethylene glycol antifreeze. Calcium chloride solutions should not be used in stainless steel fire extinguishers.
(3) Fire extinguishers installed in machinery compartments, diesel locomotives, automotive equipment, marine engine compartments, and hot processing facilities can easily be subjected to temperatures above 120°F (49°C). Selection of fire extinguishers for hazard areas with temperatures above the listed limits should be made on the basis of recommendations by manufacturers of this equipment.

[**10:**A.6.1.3.11]

13.6.3.1.4 Antifreeze.

13.6.3.1.4.1 Fire extinguishers containing only plain water shall be protected to temperatures as low as −40°F (−40°C) by the addition of an antifreeze that is stipulated on the fire extinguisher nameplate. [**10:**6.1.4.1]

13.6.3.1.4.2 Calcium chloride solutions shall not be used in stainless steel fire extinguishers. [**10:**6.1.4.2]

13.6.3.1.5 Electronic Monitoring and Alarm System.

13.6.3.1.5.1 The connection to the electronic monitoring device shall be continuously supervised for integrity. [**10:**6.1.5.1]

13.6.3.1.5.2 The power source for the electronic monitoring device shall be supervised for continuity of power. [**10:**6.1.5.2]

13.6.3.2 Installations for Class A Hazards.

13.6.3.2.1 Fire Extinguisher Size and Placement for Class A Hazards.

13.6.3.2.1.1 Minimal sizes of fire extinguishers for the listed grades of hazards shall be provided on the basis of Table 13.6.3.2.1.1, except as modified by 13.6.3.2.1.4 and 13.6.3.2.1.5. [**10:**6.2.1.1]

Δ ***TABLE 13.6.3.2.1.1*** *Fire Extinguisher Size and Placement for Class A Hazards*

Criteria	Light Hazard Occupancy	Ordinary Hazard Occupancy	Extra Hazard Occupancy
Minimum rated single extinguisher	2-A	2-A	4-A
Maximum floor area per unit of A	3000 ft^2	1500 ft^2	1000 ft^2
Maximum floor area per extinguisher	11,250 ft^2	11,250 ft^2	11,250 ft^2
Maximum travel distance to extinguisher	75 ft	75 ft	75 ft

For SI units, 1 ft = 0.305 m; 1 ft^2 = 0.0929 m^2.
Note: For maximum floor area explanations, see E.3.3 of NFPA 10. [**10:** Table 6.2.1.1]

13.6.3.2.1.2 The minimum number of extinguishers for Class A hazards shall be sufficient to meet the requirements of 13.6.3.2.1.2.1 through 13.6.3.2.1.2.3. [**10:**6.2.1.2]

13.6.3.2.1.2.1 The minimum number of fire extinguishers for Class A hazards for each floor of a building shall be determined by dividing the total floor area by the maximum area to be protected per extinguisher as determined by Table 13.6.3.2.1.1. *(See Annex E of NFPA 10.)* [**10:**6.2.1.2.1]

13.6.3.2.1.2.2 Fire extinguishers shall be located so that the maximum travel distances shall not exceed 75 ft(22.9 m), except as modified by 13.6.3.2.1.4. [**10:**6.2.1.2.2]

The requirement of 13.6.3.2.1.2.2 is intended to limit the time required to reach the extinguisher and then reach the fire and begin extinguishment. Locating extinguishers to meet the travel distance requirements must take into account the presence of obstacles in the area.

It is ineffective to distribute extinguishers in an empty warehouse and then fill it with pallets of stock. The true travel distance from the extinguisher to a potential fire location could significantly increase where pallets are in place. Extinguisher placement with respect to travel distance should be practical with respect to the intent, which is to limit the time required to put the extinguisher into operation. Annex E of NFPA 10 offers a comprehensive discussion on determining the effective distribution of portable fire extinguishers.

13.6.3.2.1.2.3 Where the quantity of extinguishers required to satisfy 13.6.3.2.1.2.2 exceeds the number calculated in 13.6.3.2.1.2.1, additional extinguishers shall be installed. [**10:**6.2.1.2.3]

13.6.3.2.1.3 Smaller fire extinguishers that are rated on Class B and Class C fires but do not have a minimum 1-A rating shall not be used to meet the requirements of 13.6.3.2.1. [**10:**6.2.1.3]

13.6.3.2.1.4 Fire extinguishers of lesser rating shall be permitted to be installed but shall not be considered as fulfilling any part of the requirements of Table 13.6.3.2.1.1, except as permitted in 13.6.3.2.1.4(A) and 13.6.3.2.1.4(B). [**10:**6.2.1.3.1]

13.6.3.2.1.4.1 Up to two water-type extinguishers, each with 1-A rating, shall be permitted to be used to fulfill the requirements of one 2-A rated extinguisher. [**10:**6.2.1.3.1.1]

13.6.3.2.1.4.2 Two 2½ gal (9.46 L) water-type extinguishers shall be permitted to be used to fulfill the requirements of one 4-A rated extinguisher. [**10:**6.2.1.3.1.2]

13.6.3.2.1.5 Up to one-half of the complement of fire extinguishers specified in Table 13.6.3.2.1.1 shall be permitted to be replaced by uniformly spaced 1½ in. (38 mm) hose stations for use by the occupants of the building. [**10:**6.2.1.4]

Δ **13.6.3.2.1.5.1** Where hose stations are so provided, they shall conform to NFPA 14. [**10:**6.2.1.4.1]

13.6.3.2.1.5.2 The location of hose stations and the placement of fire extinguishers shall be such that the hose stations do not replace more than every other fire extinguisher. [**10:**6.2.1.4.2]

13.6.3.2.1.6 Where the area of the floor of a building is less than that specified in Table 13.6.3.2.1.1, at least one fire extinguisher of the minimum size required shall be provided. [**10:**6.2.1.5]

13.6.3.2.1.7 The protection requirements shall be permitted to be fulfilled with fire extinguishers of higher rating, provided the travel distance to such larger fire extinguishers does not exceed 75 ft (22.9 m) and the maximum floor area per unit of A is not exceeded. [**10:**6.2.1.6]

13.6.3.3 Installations for Class B Hazards.

13.6.3.3.1 Spill Fires.

Δ **13.6.3.3.1.1** Minimum ratings of fire extinguishers for the listed grades of hazard shall be provided in accordance with Table 13.6.3.3.1.1 [**10:**6.3.1.1].

13.6.3.3.1.1.1 Two or more fire extinguishers of lower rating shall not be used to fulfill the protection requirements of Table 13.6.3.3.1.1 except as permitted by 13.6.3.3.1.1.2 and 13.6.3.3.1.1.3. [**10:**6.3.1.1.1]

13.6.3.3.1.1.2 Up to three AFFF or FFFP fire extinguishers of at least 2½ gal (9.46 L) capacity shall be permitted to be used to fulfill extra hazard requirements. [**10:**6.3.1.1.2]

13.6.3.3.1.1.3 Two AFFF or FFFP fire extinguishers of at least 1.6 gal (6 L) capacity shall be permitted to be used to fulfill ordinary hazard requirements. [**10:**6.3.1.1.3]

13.6.3.3.1.2 Fire extinguishers of lesser rating, designed for small specific hazards within the general hazard area, shall be permitted to be installed but shall not be considered as fulfilling any part of the requirements of Table 13.6.3.3.1.1, unless permitted by 13.6.3.3.1.1.1 or 13.6.3.3.1.1.2. [**10:**6.3.1.2]

13.6.3.3.1.3 Fire extinguishers shall be located so that the maximum travel distances do not exceed those specified in Table 13.6.3.3.1.1. [**10:**6.3.1.3]

Δ ***TABLE 13.6.3.3.1.1*** *Fire Extinguisher Size and Placement for Class B Hazards*

Type of Hazard	Basic Minimum Extinguisher Rating	Maximum Travel Distance to Extinguishers: ft	m
Light	5-B	30	9.14
	10-B	50	15.25
Ordinary	10-B	30	9.14
	20-B	50	15.25
Extra	40-B	30	9.14
	80-B	50	15.25

Note: The specified ratings do not imply that fires of the magnitudes indicated by these ratings will occur, but rather they are provided to give the operators more time and agent to handle difficult spill fires that have the potential to occur.

[**10:** Table 6.3.1.1]

13.6.3.3.1.4 The protection requirements shall be permitted to be fulfilled with fire extinguishers of higher ratings, provided the travel distance to such larger fire extinguishers does not exceed 50 ft (15.25 m). [**10:**6.3.1.4]

13.6.3.3.2 Flammable Liquids of Appreciable Depth.

13.6.3.3.2.1 Portable fire extinguishers shall not be installed as the sole protection for flammable liquid hazards of appreciable depth where the surface area exceeds 10 ft^2 (0.93 m^2.) [**10:**6.3.2.1]

13.6.3.3.2.2* Where personnel who are trained in extinguishing fires in the protected hazards are located on the premises and capable of responding immediately, the maximum surface area shall not exceed 20 ft^2 (1.86 m^2). [**10:**6.3.2.2]

A.13.6.3.3.2.2 Where such personnel are not available, the hazard should be protected by fixed systems. [**10:**A.6.3.2.2]

13.6.3.3.2.3 For flammable liquid hazards of appreciable depth, a Class B fire extinguisher shall be provided on the basis of at least 2 numerical units of Class B extinguishing potential per 1 ft^2 (0.09 m^2) of flammable liquid surface of the largest hazard area. [**10:**6.3.2.3]

13.6.3.3.2.4 AFFF- or FFFP-type fire extinguishers shall be permitted to be provided on the basis of 1-B of protection per 1 ft^2 (0.09 m^2) of hazard. *(For fires involving water-soluble flammable liquids, see 5.5.3 of NFPA 10.)* [**10:**6.3.2.4]

13.6.3.3.2.5 Two or more fire extinguishers of lower ratings, other than AFFF- or FFFP-type fire extinguishers, shall not be used in lieu of the fire extinguisher required for the largest hazard area. [**10:**6.3.2.5]

13.6.3.3.2.6 Up to three AFFF- or FFFP-type fire extinguishers shall be permitted to fulfill the requirements, provided the sum of the Class B ratings meets or exceeds the value required for the largest hazard area. [**10:**6.3.2.6]

13.6.3.3.2.7 Travel distances for portable fire extinguishers shall not exceed 50 ft (15.25 m). *(See Annex E of NFPA 10.)* [**10:**6.3.2.7]

13.6.3.3.2.7.1 Scattered or widely separated hazards shall be individually protected. [**10:**6.3.2.7.1]

13.6.3.3.2.7.2 A fire extinguisher in the proximity of a hazard shall be located to be accessible in the presence of a fire without undue danger to the operator. [**10:**6.3.2.7.2]

Fires in flammable liquids of appreciable depth can grow quickly, radiate significant heat, and be difficult to approach. Fire extinguishers should be located so that, in the case of a fully involved fire, an extinguisher is available without hazard to the operator and so that, if the fire spreads, the operator has a means of escape. Keeping this goal in mind, the fire extinguisher selected to protect the hazard should be the most obvious and convenient to use. For example, a 5 lb (2.27 kg) halogenated agent extinguisher used to protect a shop floor computer terminal should not be hung next to a 2.5 gal (9.46 L) film-forming fluoroprotein foam (FFFP) unit placed to protect a flammable liquid degreaser tank. In the event of a tank fire, the incorrect extinguisher might accidentally be selected.

13.6.3.3.3 Obstacle, Gravity/Three-Dimensional, and Pressure Fire Hazards.

13.6.3.3.3.1 Where hand portable fire extinguishers are installed or positioned for obstacle, gravity/three-dimensional, or pressure fire hazards, the actual travel distance to hazard shall not exceed 30 ft (9 m) unless otherwise specified *(See 5.6.1 of NFPA 10.)* [**10:**6.3.3.1]

13.6.3.3.3.2 Where wheeled fire extinguishers of 125 lb (56.7 kg) agent capacity or larger are installed or positioned for obstacle, gravity/three-dimensional, or pressure fire hazards, the actual travel distance to hazard shall not exceed 100 ft (30.5 m) unless otherwise specified. *(See 5.6.1 of NFPA 10.)* [**10:**6.3.3.2]

The provisions of 13.6.3.3.3 address the travel distances to extinguishers for obstacle, gravity/three-dimensional, and pressure fire hazards, which are described as follows:

1. Obstacle fires: fuel situations completely surrounding a sizable object
2. Gravity/three-dimensional fires: pouring, running, or dripping fuel situations
3. Pressure fires: forced, pumped, or sprayed fuel situations

13.6.3.4* Installations for Class C Hazards.

A.13.6.3.4 Electrical equipment should be de-energized as soon as possible to prevent reignition. [**10:**A.6.4]

13.6.3.4.1 Fire extinguishers with Class C ratings shall be required where energized electrical equipment can be encountered. [**10:**6.4.1]

13.6.3.4.2 The requirement in 13.6.3.4.1 shall include situations where fire either directly involves or surrounds electrical equipment. [**10:**6.4.2]

13.6.3.4.3 Because fire is a Class A or Class B hazard, the fire extinguishers shall be sized and located on the basis of the anticipated Class A or Class B hazard. [**10:**6.4.3]

13.6.3.5 Installations for Class D Hazards.

13.6.3.5.1* Fire extinguishers or extinguishing agents with Class D ratings shall be provided for fires involving combustible metals. [**10:**6.5.1]

A.13.6.3.5.1 Where Class D fire hazards exist, it is common practice to place bulk quantities of extinguishing agent near the potential Class D hazard. Depending on the type of metal present, the Class D agent selected for the protection of the hazard might not be a listed fire-extinguishing agent. In the case of the production of lithium metal, the agent of choice is lithium chloride, which is feed stock to the electrolytic cell where the lithium metal is manufactured. The use of lithium chloride on a lithium fire will not poison the electrolytic cell so the cell would not have to be drained and relined with fire brick. There are several Class D agents that have been shown to be effective on specific Class D fires. Additional information on Class D agents is provided in NFPA 484. [**10:**A.6.5.1]

The operation of Class D fire extinguishers is much different from that of dry chemical extinguishers rated for Class A, B, or C. The extinguishing agent from a Class D extinguisher should be applied to avoid spreading the combustible metal material and/or suspending the metal product in the air, which can result in an explosion, by slowly applying the agent. The application of a Class D agent on burning metals is intended to control the fire and assist in the formation of oxide crust that limits combustion. This is accomplished by first encircling the combustible metal material with the agent and then covering the burning metal in a smothering action. It is important to note that metal fires involving large quantities of metal beyond the incipient stage are nearly impossible to control or extinguish with a Class D agent. In most cases, the metal will continue to burn in a controlled fashion after application of the agent until it is completely oxidized. Disturbing the oxide crust can result in reignition and open burning if complete extinguishment, oxidation of the metal, or exclusion of oxygen has not occurred. Fires involving alkali earth metal and transitional metals will begin to form an oxide crust as they burn, which will limit open burning without the application of an extinguishing agent. Application of water or other extinguishing agents can result in an adverse reaction, including the potential for an explosion. Burning metals can also draw moisture from concrete or asphalt, which also maintains the potential for explosion. Large amounts of combustible metal materials involved in a fire can remain hot for some time and vigorously reignite if disturbed prior to complete extinguishment of the combustible metal materials. *(See A.13.6.2.3.2.4.)* [**10:**A.6.5.1]

Work areas that generate combustible metals in powder, flakes, shavings, chips, or similarly sized products must have Class D fire extinguishers available. The extinguisher should be specifically listed for the particular metal hazard or hazards involved. Listed hand portable fire extinguishers and wheeled-type fire extinguishers are available for metal fires involving magnesium, sodium, potassium, sodium potassium alloys, uranium, powdered aluminum, and lithium. The Class D agents accomplish fire extinguishment by coating and caking over the burning metal, absorbing heat and excluding oxygen.

13.6.3.5.2 Fire extinguishers or extinguishing agents (media) shall be located not more than 75 ft (22.9 m) of travel distance from the Class D hazard. *(See Section E.6 of NFPA 10.)* [**10:**6.5.2]

13.6.3.5.3* Portable fire extinguishers or extinguishing agents (media) for Class D hazards shall be provided in those work areas where combustible metal powders, flakes, shavings, chips, or similarly sized products are generated. [**10:**6.5.3]

A.13.6.3.5.3 See NFPA 484 for additional information. [**10:**A.6.5.3]

13.6.3.5.4* Size determination shall be on the basis of the specific combustible metal, its physical particle size, area to be covered, and recommendations by the fire extinguisher manufacturer based on data from control tests. [**10:**6.5.4]

A.13.6.3.5.4 See NFPA 484 for additional information. [**10:**A.6.5.4]

13.6.3.6 Installations for Class K Hazards.

13.6.3.6.1 Class K fire extinguishers shall be provided for hazards where there is a potential for fires involving combustible cooking media (vegetable or animal oils and fats). [**10:**6.6.1]

13.6.3.6.2 Maximum travel distance shall not exceed 30 ft (9.1 m) from the hazard to the extinguishers. [**10:**6.6.2]

13.6.3.6.3 All solid fuel cooking appliances (whether or not under a hood) with fire boxes of 5 ft^3 (0.14 m^3) volume or less shall have at least a listed 2-A rated water-type fire extinguisher or a 1.6 gal (6 L) wet chemical fire extinguisher that is listed for Class K fires. [**10:**6.6.3]

13.6.4 Inspection, Maintenance, and Recharging.

13.6.4.1* General.

A.13.6.4.1 Subsection 13.6.4 is concerned with the rules governing inspection, maintenance, and recharging of fire extinguishers. These factors are of prime importance in ensuring operation at the time of a fire. The procedure for inspection and maintenance of fire extinguishers varies considerably. Minimal knowledge is necessary to perform a monthly "quick check" or inspection in order to follow the inspection procedure as outlined in 13.6.4.2. [**10:**A.7.1]

13.6.4.1.1 Responsibility. The owner or designated agent or occupant of a property in which fire extinguishers are located shall be responsible for inspection, maintenance, and recharging. *(See 13.6.4.1.2.)* [**10:**7.1.1]

13.6.4.1.2 Personnel.

13.6.4.1.2.1* Persons performing maintenance and recharging of extinguishers shall be certified. [**10:**7.1.2.1]

It is up to the AHJ to adopt and enforce the certification requirements for persons performing maintenance on portable fire extinguishers. The AHJ is also responsible for identifying which certification programs are accepted.

A.13.6.4.1.2.1 Persons performing maintenance and recharging of extinguishers should meet one of the following criteria:

(1) Factory training and certification for the specific type and brand of portable fire extinguisher being serviced
(2) Certification by an organization acceptable to the AHJ
(3) Registration, licensure, or certification by a state or a local AHJ

[**10:**A.7.1.2.1]

Certification confirms that a person has fulfilled specific requirements as a fire extinguisher service technician and has earned the certification. For the purpose of Section 13.6, certification is the process of an organization issuing a document confirming that an applicant has passed a test based on the chapters and annexes of NFPA 10. The organization administering the test issues an official document that is relied upon as proof of passing the test. Ultimately, the document issued by the organization administering the test must be acceptable to the AHJ. Some AHJs do not rely on outside organizations and establish their own local licensing programs that include a test. [**10:**A.7.1.2.1]

13.6.4.1.2.1.1 Persons training to become certified shall be permitted to perform maintenance and recharging of extinguishers under the direct supervision and in the immediate presence of a certified person. [**10:**7.1.2.1.1]

13.6.4.1.2.1.2 Certification requires that a person pass a test administered by an organization acceptable to the AHJ. [**10:**7.1.2.1.2]

13.6.4.1.2.1.3 The test shall, at a minimum, be based upon knowledge of the chapters and annexes of NFPA 10. [**10:**7.1.2.1.3]

13.6.4.1.2.1.4 The testing process shall permit persons to use NFPA 10 during the test. [**10:**7.1.2.1.4]

13.6.4.1.2.1.5 Persons passing the test required in 13.6.4.1.2.1.2 shall be issued a document or a certificate. [**10:**7.1.2.1.5]

13.6.4.1.2.1.6 The document or certificate shall be made available when requested by the AHJ. [**10:**7.1.2.1.6]

13.6.4.1.2.2* Persons performing maintenance and recharging of extinguishers shall be trained and shall have available the appropriate manufacturer's servicing manual(s), the correct tools, recharge materials, lubricants, and manufacturer's replacement parts or parts specifically listed for use in the fire extinguisher. [**10:**7.1.2.2]

A.13.6.4.1.2.2 Industrial facilities that establish their own maintenance and recharge facilities and that provide training to personnel who perform these functions are considered to be in compliance with this requirement. Examples include power generation, petrochemical, and telecommunications facilities. A letter from the facility management can be used as the certification document. [**10:**A.7.1.2.1.2]

13.6.4.1.2.3* Persons performing inspections shall not be required to be certified. [**10:**7.1.2.3]

A.13.6.4.1.2.3 This requirement is not intended to prevent service technicians from performing the inspections. [**10:**A.7.1.2.3]

13.6.4.1.3 Replacement While Servicing. Fire extinguishers removed from service for maintenance or recharging shall be replaced by a fire extinguisher suitable for the type of hazard being protected and shall be of at least equal rating. [**10:**7.1.3]

The type of agent used in the replacement extinguisher should be compatible with the type of hazard being protected. A dry chemical type is not acceptable in a computer facility, because the extinguishing agent could cause damage to the equipment intended to be protected. An A:B:C type might not be suitable for use in a kitchen cooking unit, because it is unable to saponify flaming grease and permanently extinguish the fire.

Replacement extinguishers with ratings equal to, or larger in size than, the replaced extinguisher or extinguishers that have additional class ratings are acceptable. For example, a 40-B:C–rated sodium bicarbonate extinguisher used to protect against a flammable liquid fire could be replaced by a 2-A:40-B:C ammonium phosphate unit. Both are equally effective on a Class B fire hazard.

13.6.4.1.4 Tags or Labels.

13.6.4.1.4.1 Tags or labels intended for recording inspections, maintenance, or recharging shall be affixed so as not to obstruct the fire extinguisher use, fire extinguisher classification, or manufacturer's labels. [**10:**7.1.4.1]

13.6.4.1.4.2 Labels indicating fire extinguisher use or classification or both shall be permitted to be placed on the front of the fire extinguisher. [**10:**7.1.4.2]

13.6.4.2 Inspection.

13.6.4.2.1 Inspection Frequency.

13.6.4.2.1.1* Fire extinguishers shall be manually inspected when initially placed in service. [**10:**7.2.1.1]

A.13.6.4.2.1.1 Frequency of fire extinguisher inspections should be based on the need of the area in which fire extinguishers are located. The required monthly inspection is a minimum. [**10:**A.7.2.1.1]

13.6.4.2.1.2* Fire extinguishers and Class D extinguishing agents shall be inspected either manually or by means of an electronic monitoring device/system at intervals not exceeding 31 days. [**10:**7.2.1.2]

A.13.6.4.2.1.2 Inspections should be performed on extinguishers 12 times per year, at regular intervals not exceeding 31 days. [**10:**A.7.2.1.2]

13.6.4.2.1.2.1 Fire extinguishers and Class D extinguishing agents shall be inspected at least once per calendar month. [**10:**7.2.1.2.1]

13.6.4.2.1.3* Fire extinguishers and Class D extinguishing agents shall be manually inspected daily or weekly when conditions exist that indicate the need for more frequent inspections. [**10:**7.2.1.3]

A.13.6.4.2.1.3 Inspections should be more frequent if any of the following conditions exist:

(1) High frequency of fires in the past
(2) Severe hazards
(3) Susceptibility to tampering, vandalism, or malicious mischief
(4) Possibility of, or history of, theft of fire extinguishers
(5) Locations that make fire extinguishers susceptible to mechanical injury
(6) Possibility of visible or physical obstructions
(7) Exposure to abnormal temperatures or corrosive atmospheres
(8) Characteristics of fire extinguishers, such as susceptibility to leakage

[**10:**A.7.2.1.3]

More frequent inspections could be enhanced through electronic monitoring of the fire extinguisher. [**10:**A.7.2.1.3]

13.6.4.2.1.4 Extinguishers that are electronically monitored for location only, such as those monitored by means of a switch to indicate when the extinguisher is removed from its bracket or cabinet, shall be manually inspected in accordance with 13.6.4.2.2. [**10:**7.2.1.4]

Δ **13.6.4.2.2 Inspection Procedures.** Periodic inspection or electronic monitoring of fire extinguishers shall include a check of at least the following items:

(1) Location in designated place
(2) Visibility of the extinguisher or means of indicating the extinguisher location
(3) Access to the extinguisher
(4) Pressure gauge reading or indicator in the operable range or position
(5) Fullness determined by weighing or hefting
(6) Condition of tires, wheels, carriage, hose, and nozzle for wheeled extinguishers

A record of the inspection should be noted on the extinguisher service tag. Many fire equipment dealers and distributors use bar code identification on the extinguishers they inspect, service, and test. The bar code readout provides a convenient, accurate, up-to-date record of the inspections, maintenance, recharging, and hydrotesting performed on each extinguisher, which can be maintained in their files. If an inspection reveals a problem, full maintenance should be performed.

(7) Indicator for nonrechargeable extinguishers using push-to-test pressure indicators

[**10:**7.2.2]

N **13.6.4.2.2.1** The owner or the owner's agent shall determine the method of extinguisher inspection such as manual inspection, electronic monitoring, or any combination of the two. [**10:**7.2.2.1]

N **13.6.4.2.2.2** Any method(s) of inspection other than manual inspection shall require the approval of the authority having jurisdiction. [**10:**7.2.2.2]

Paragraphs 13.6.4.2.2.1 and 13.6.4.2.2.2 are new to the *Code*. The type of inspection service provided should be at the discretion of the building owner or designated agent. The owner or agent should also be the party that determines one method or another or a combination of methods. Any alternative method to visual inspection should be reviewed and approved by the AHJ.

Δ **13.6.4.2.2.3*** In addition to 13.6.4.2.2, fire extinguishers shall be visually inspected in accordance with 13.6.4.2.2.4 if they are located where any of the following conditions exists:

(1) High frequency of fires in the past
(2) Severe hazards
(3) Locations that make fire extinguishers susceptible to mechanical injury or physical damage
(4) Exposure to abnormal temperatures or corrosive atmospheres

[**10:**7.2.2.3]

A.13.6.4.2.2.3 Fire extinguishers in vehicles should be inspected at the beginning of a shift or whenever the vehicle is used. The inspection should ensure that the extinguisher is charged and ready for use. Extinguishers in compartments or trunks can become damaged or otherwise compromised because of weather exposure, other items in the compartment that are not secured, or other factors. [**10:**A.7.2.2.3]

13.6.4.2.2.4 Where required by 13.6.4.2.2.3, the following inspection procedures shall be in addition to those addressed in 13.6.4.2.2:

(1) Verify that operating instructions on nameplates are legible and face outward
(2) Check for broken or missing safety seals and tamper indicators
(3) Examine for obvious physical damage, corrosion, leakage, or clogged nozzle

[**10:**7.2.2.4]

13.6.4.2.2.5 Inspection Procedure for Containers of Class D Extinguishing Agent. Periodic inspection of containers of Class D extinguishing agent used to protect Class D hazards shall include verification of at least the following:

(1) Located in designated place
(2) Visibility of the container or means of indicating the container location
(3) Access to the container
(4) Lid is sealed
(5) Fullness by hefting or weighing
(6) No obvious physical damage to container

[**10:**7.2.2.5]

13.6.4.2.3 Corrective Action. When an inspection of any fire extinguisher reveals a deficiency in any of the conditions in 13.6.4.2.2 or 13.6.4.2.2.4, immediate corrective action shall be taken. [**10:**7.2.3]

13.6.4.2.3.1 Rechargeable Fire Extinguishers. When an inspection of any rechargeable fire extinguisher reveals a deficiency in any of the conditions in 13.6.4.2.2(3), 13.6.4.2.2(4), 13.6.4.2.2(5),or 13.6.4.2.2(1) through 13.6.4.2.2(3), the extinguisher shall be subjected to applicable maintenance procedures. [**10:**7.2.3.1]

13.6.4.2.3.2 Nonrechargeable Dry Chemical Fire Extinguisher. When an inspection of any nonrechargeable dry chemical fire extinguisher reveals a deficiency in any of the conditions listed in 13.6.4.2.2(3), 13.6.4.2.2(4),13.6.4.2.2(6), or 13.6.4.2.2.4(1) through 13.6.4.2.2.4(3), the extinguisher shall be removed from further use, discharged, and destroyed at the direction of the owner or returned to the manufacturer. [**10:**7.2.3.2]

13.6.4.2.3.3 Nonrechargeable Halon Agent Fire Extinguisher. When an inspection of any nonrechargeable fire extinguisher containing a halon agent reveals a deficiency in any of the conditions listed in 13.6.4.2.2(3), 13.6.4.2.2(4), 13.6.4.2.2(6), or 13.6.4.2.2.4(1) through 13.6.4.2.2.4(3), the extinguisher shall be removed from service, shall not be discharged, and shall be returned to the manufacturer, a fire equipment dealer, or a distributor to permit recovery of the halon. [**10:**7.2.3.3]

13.6.4.2.4 Inspection Record Keeping.

13.6.4.2.4.1 Manual Inspection Records.

13.6.4.2.4.1.1 Where manual inspections are conducted, records for manual inspections shall be kept on a tag or label attached to the fire extinguisher, on an inspection checklist maintained on file, or by an electronic method. [**10:**7.2.4.1.1]

13.6.4.2.4.1.2 Where manual inspections are conducted, the month and year the manual inspection was performed and the initials of the person performing the inspection shall be recorded. [**10:**7.2.4.1.2]

13.6.4.2.4.1.3 Personnel making manual inspections shall keep records of all fire extinguishers inspected, including those found to require corrective action. [**10:**7.2.4.1.3]

13.6.4.2.4.1.4 Records for manual inspection shall be kept to demonstrate that at least the last 12 monthly inspections have been performed. [**10:**7.2.4.1.4]

13.6.4.2.4.2 Electronic Inspection Records.

13.6.4.2.4.2.1 Where electronically monitored systems are employed for inspections, records shall be kept for fire extinguishers found to require corrective action. [**10:**7.2.4.2.1]

13.6.4.2.4.2.2 Records for electronic monitoring shall be kept to demonstrate that at least the last 12 monthly inspections have been performed. [**10:**7.2.4.2.2]

13.6.4.2.4.2.3 For electronically monitored fire extinguishers, where the extinguisher causes a signal at a control unit when a deficiency in any of the conditions listed in 13.6.4.2.2 occurs, record keeping shall be provided in the form of an electronic event log at the control panel. [**10:**7.2.4.2.3]

13.6.4.3 Extinguisher Maintenance.

Fire extinguisher maintenance includes a thorough examination of the mechanical parts, the extinguishing agent, and the expelling means. Different types of extinguishers require different maintenance schedules. For example, rechargeable water-type extinguishers are disassembled for complete maintenance and recharge annually. Stored-pressure extinguishers, which require a 12-year hydrostatic test, are not disassembled for annual maintenance. They are disassembled and undergo full maintenance every 6 years, and complete external/internal maintenance is performed every 12 years. Careful examination during full (disassembly) maintenance reveals whether the cylinder should be subjected to hydrostatic testing.

13.6.4.3.1* Maintenance Procedures. Where required by another section of this *Code* or NFPA 10, maintenance procedures shall include the procedures detailed in the manufacturer's service manual and a thorough examination of the basic elements of the fire extinguisher, including the following:

(1) Mechanical parts of all fire extinguishers
(2) Extinguishing agent
(3) Expelling means
(4) Physical condition

[**10:**7.3.1]

Δ **A.13.6.4.3.1** The annual maintenance of a fire extinguisher requires the services of a trained and certified technician who has the proper tools, listed parts, and appropriate manufacturer's service manual. Maintenance of fire extinguishers should not be confused with inspection, which is a quick check of the extinguishers that is performed at least every 30 days. Because the detailed maintenance procedures for various extinguisher types and models differ, the procedures specified within service manuals need to be followed. [**10:**A.7.3.1]

The following list is a sample of maintenance procedures that should be followed to determine deficiencies that require additional attention to remediate the condition of the extinguisher as appropriate for rechargeable, stored-pressure, dry chemical, and halogenated agent hand portable fire extinguishers:

(1) Visually examine the extinguisher for damage by removing the extinguisher from the hanger, bracket, or cabinet, and visually examine the extinguisher for damage, including pressure gauge, cylinder dents, repairs, general corrosion, hose or nozzle threads, handles, and levers.
(2) Verify that the hanger, bracket, or cabinet is the proper one for the extinguisher.
(3) Verify that the hanger, bracket, or cabinet is secure, undamaged, and properly mounted.
(4) Verify that the nameplate operating instructions are legible and facing outward.
(5) Confirm that the extinguisher model is not subject to recall and is not obsolete.
(6) Verify the extinguisher records to determine internal examination and hydrostatic test intervals. Thoroughly examine the cylinder for dents, damage, repairs, or corrosion.
(7) Verify the pull pin functions properly and examine for damage or corrosion by removing the pull pin.
(8) Verify that the handle and levers are undamaged and operable.
(9) Verify that the valve stem is correctly extended and not corroded or damaged.
(10) Verify that the pressure gauge or indicator is in the operable range.
(11) Verify that the gauge operating pressure corresponds with the nameplate instructions.
(12) Verify that the gauge face corresponds with the proper agent type.
(13) Verify that the gauge threads are compatible with the valve body material.
(14) Verify that the nozzle or hose assembly, or both, is unobstructed by removing and examining the nozzle.
(15) Confirm that the nozzle and hose assembly are correct for the model of extinguisher.
(16) Verify that the hose and couplings are not cut, cracked, damaged, or deformed.
(17) Examine internal valve port surfaces and threads for signs of leakage or corrosion by removing the nozzle or hose assembly and reinstalling the nozzle and hose assembly securely after examination.
(18) Verify that the hose retention band is secure and properly adjusted.
(19) Weigh the extinguisher and verify that it corresponds to the weight listed on the nameplate.
(20) Reinstall the ring pin and install a new tamper seal.
(21) Clean exposed extinguisher surfaces to remove any foreign material.
(22) Record the maintenance on the extinguisher tag or label.
(23) Return the extinguisher to the hanger, bracket, or cabinet.

[**10:**A.7.3.1]

The following list is a sample of maintenance procedures that should be followed to determine deficiencies that require additional attention to remediate the condition of the extinguisher as appropriate for carbon dioxide hand portable fire extinguishers:

(1) Visually examine the extinguisher for damage by removing the extinguisher from the hanger or cabinet, and visually examine the extinguisher for damage, including cylinder dents, repairs, general corrosion, hose or nozzle threads, handles, and levers.
(2) Verify that the bracket or cabinet is the proper one for the extinguisher.
(3) Verify that the bracket or cabinet is secure, undamaged, and properly mounted.
(4) Verify that the nameplate operating instructions are legible and facing outward.
(5) Confirm that the extinguisher model is not subject to recall and is not obsolete.
(6) Verify the extinguisher records to determine hydrostatic test intervals.
(7) Verify the pull pin functions properly and examine for damage or corrosion by removing the pull pin.

(8) Examine the handle and levers to ensure that they are undamaged and operable.
(9) Verify that the valve stem is correctly extended and not corroded or damaged.
(10) Verify that the nozzle or hose assembly, or both, is unobstructed, by removing and examining the nozzle.
(11) Confirm that the nozzle and hose assembly are correct for the model of extinguisher.
(12) Verify that the hose and couplings are not cut, cracked, damaged, or deformed.
(13) Examine the discharge port for signs of leakage or corrosion by removing the nozzle or hose assembly and reinstalling the nozzle and hose assembly securely after examination.
(14) Conduct a conductivity test on the hose assembly.
(15) Affix the conductivity test label to hose assemblies that pass the conductivity test and replace hoses that fail the conductivity test.
(16) Verify that the safety assembly is not damaged or blocked.
(17) Verify that the hose retention band is secure and properly adjusted.
(18) Weigh the extinguisher to verify that it corresponds to the weight listed on the nameplate.
(19) Reinstall the ring pin and install a new tamper seal.
(20) Clean exposed extinguisher surfaces to remove any foreign material.
(21) Record the maintenance on the extinguisher tag or label.
(22) Return the extinguisher to the hanger, bracket, or cabinet.

[**10:**A.7.3.1]

The following list is a sample of maintenance procedures and checks that are commonly associated with pressurized-water-type hand portable fire extinguishers:

(1) Visually examine the extinguisher for damage by removing the extinguisher from the hanger, bracket, or cabinet, and visually examine the extinguisher for damage, including pressure gauge, cylinder dents, repairs, general corrosion, hose or nozzle threads, handles, and levers.
(2) Verify that the hanger, bracket, or cabinet is the proper one for the extinguisher.
(3) Verify that the hanger, bracket, or cabinet is secure, undamaged, and properly mounted.
(4) Verify that the nameplate operating instructions are legible and facing outward.
(5) Confirm that the extinguisher model is not subject to recall and is not obsolete.
(6) Check the extinguisher records to determine hydrostatic test intervals.
(7) Verify that the pull pin functions properly and examine for damage or corrosion by removing the pull pin.
(8) Examine the handle and levers to ensure that they are undamaged and operable.
(9) Verify that the valve stem is correctly extended and not corroded or damaged.
(10) Verify that the pressure gauge is in the operable range.
(11) Verify that the gauge operating pressure corresponds with the nameplate instructions.
(12) Verify that the gauge face corresponds with the proper agent type.
(13) Verify that the gauge threads are compatible with the valve body material.
(14) Verify that the nozzle or hose assembly, or both, is unobstructed, by removing and examining the nozzle.
(15) Confirm that the nozzle and hose assembly are correct for the model of extinguisher.
(16) Verify that the hose and couplings are not cut, cracked, damaged, or deformed.
(17) Examine the internal valve port surfaces and threads for signs of leakage or corrosion by removing the nozzle or hose assembly and reinstalling the nozzle and hose assembly securely after examination.
(18) Verify that the hose retention band is secure and properly adjusted.
(19) Weigh the extinguisher to verify that it corresponds to the weight listed on the nameplate.
(20) Reinstall the ring pin and install a new tamper seal.
(21) Clean exposed extinguisher surfaces to remove any foreign material.
(22) Record the maintenance on the extinguisher tag or label.
(23) Return the extinguisher to the hanger, bracket, or cabinet.

[**10:**A.7.3.1]

The following list is a sample of maintenance procedures and checks that are commonly associated with cartridge-operated dry chemical and dry powder hand portable fire extinguishers:

(1) Visually examine the extinguisher for damage by removing the extinguisher from the hanger, bracket, or cabinet, and visually examine the extinguisher for damage, including pressure gauge, cylinder dents, repairs, general corrosion, hose or nozzle threads, handles, and levers.
(2) Verify that the hanger, bracket, or cabinet is the proper one for the extinguisher.
(3) Verify that the hanger, bracket, or cabinet is secure, undamaged, and properly mounted.
(4) Verify that the nameplate operating instructions are legible and facing outward.
(5) Confirm that the extinguisher model is not subject to recall and is not obsolete.
(6) Verify the extinguisher hydrostatic test records to determine the hydrostatic test interval.
(7) Invert the extinguisher and open the nozzle to ensure any pressure is relieved from the shell.
(8) Remove the cartridge guard and check the integral components for damage or corrosion.
(9) Unscrew the cartridge to examine the seal. (Replace the cartridge if the seal is punctured, damaged, or corroded.) Verify that the seal is not punctured, that it is the proper cartridge for that extinguisher, and that it has the proper manufacturer's seal.
(10) Install the shipping cap on the cartridge.
(11) Weigh the cartridge on a scale and verify the weight is within the tolerance specified in the manufacturer's service manual.

(12) Remove the discharge nozzle from its holder and lift the hose, breaking the tamper seal.
(13) Operate the puncture lever to verify proper operation.
(14) Check and clean the pressure relief vent in the cartridge receiver in accordance with manufacturer's service manual.
(15) Remove and examine the cartridge receiver gasket. Replace the gasket if brittle, compression set, cracked, cut, or missing.
(16) Lubricate the gasket in accordance with the manufacturer's manual and install.
(17) Slowly loosen the fill cap to relieve any trapped pressure and reinstall hand tight.
(18) Examine the hose, nozzle, and couplings for any damage.
(19) Operate the discharge nozzle to verify proper operation.
(20) Remove the nozzle tip in accordance with the manufacturer's service manual and verify the proper tip is installed and that it is not damaged. Install the nozzle tip in accordance with manufacturer's manual.
(21) Remove the discharge hose from the extinguisher and ensure that the hose is not obstructed.
(22) Examine the hose o-ring and replace if necessary.
(23) Verify that the hose connection is clean and not damaged.
(24) Install the hose on the extinguisher.
(25) Remove the fill cap and examine the threads and seating surfaces for any damage or corrosion.
(26) Verify that the pressure relief vent is not obstructed.
(27) Verify that the dry chemical agent is the correct type and that there are no foreign materials or caking.
(28) Examine and clean the fill cap, gasket, and indicator in accordance with manufacturer's manual.
(29) Lubricate and install the fill cap and gasket in accordance with manufacturer's manual.
(30) Secure the discharge hose in place and install the proper cartridge.
(31) Replace the cartridge guard and install new tamper seals.
(32) Record the maintenance on the extinguisher tag or label.
(33) Return the extinguisher to the hanger, bracket, or cabinet.

[**10:**A.7.3.1]

N **13.6.4.3.1.1** Fire extinguishers shall be subjected to maintenance at intervals of not more than 1 year, at the time of hydrostatic test, or when specifically indicated by an inspection discrepancy or electronic notification. [**10:**7.3.1.1]

13.6.4.3.2 Annual External Examination of All Extinguishers.

13.6.4.3.2.1 Physical Condition. An annual external visual examination of all fire extinguishers shall be made to detect obvious physical damage, corrosion, or nozzle blockage; to verify that the operating instructions are present, legible, and facing forward, and that the HMIS information is present and legible, and to determine if a 6-year interval examination or hydrostatic test is due. [**10:**7.3.2.1]

13.6.4.3.2.2* Seals or Tamper Indicators. At the time of the maintenance, the tamper seal of a rechargeable fire extinguisher shall be removed by operating the pull pin or locking device. [**10:**7.3.2.2]

A.13.6.4.3.2.2 Where a safety seal or tamper indicator is missing, it can be evidence that the fire extinguisher has been used. If a tamper seal is found to be missing from a nonrechargeable extinguisher, it should be removed from service. [**10:**A.7.3.2.2]

13.6.4.3.2.2.1 After the applicable maintenance procedures are completed, a new listed tamper seal shall be installed. [**10:**7.3.2.2.1]

13.6.4.3.2.2.2 Seals or tamper indicators on nonrechargeable-type extinguishers shall not be removed. [**10:**7.3.2.2.2]

13.6.4.3.2.3* Boots, Foot Rings, and Attachments. All removable extinguisher boots, foot rings, and attachments shall be removed to accommodate thorough annual cylinder examinations. [**10:**7.3.2.3]

A.13.6.4.3.2.3 Removable extinguisher boots and foot rings are those that are not put on by the extinguisher manufacturer with glue or welded. [**10:**A.7.3.2.3]

13.6.4.3.2.4 When subjected to temperatures at or above their listed rating, stored-pressure fire extinguishers that require a 12-year hydrostatic test shall be emptied and subjected to the applicable maintenance and recharge procedures on an annual basis. [**10:**7.3.2.4]

13.6.4.3.2.5 Corrective Action. When an external examination of any fire extinguisher reveals a deficiency, immediate corrective action shall be taken. [**10:**7.3.2.5]

13.6.4.3.3 Annual Internal Examination of Certain Types of Extinguishers.

13.6.4.3.3.1* Maintenance Intervals. Fire extinguishers shall be internally examined at intervals not exceeding those specified in Table 13.6.4.3.3.1. [**10:**7.3.3.1]

Δ **A.13.6.4.3.3.1** Persons performing maintenance operations usually come from two major groups:

(1) Fire extinguisher service agencies
(2) Trained industrial safety or maintenance personnel [**10:**A.7.3.3.1]

Fire extinguishers owned by individuals are often neglected because a periodic follow-up program is not planned. It is recommended that such owners become familiar with their fire extinguishers so they can detect telltale warnings during inspection that suggest the need for maintenance. When maintenance is indicated, it should be performed by trained persons having proper equipment. *(See 13.6.4.1.2.2.)* [**10:**A.7.3.3.1]

The purpose of a well-planned and well-executed maintenance program for a fire extinguisher is to maximize the following probabilities:

(1) That the extinguisher will operate properly between the time intervals established for maintenance examinations in the environment to which it is exposed
(2) That the extinguisher will not constitute a potential hazard to persons in its vicinity or to operators or rechargers of fire extinguishers [**10:**A.7.3.3.1]

Any replacement parts needed should be obtained from the manufacturer or a representative. [**10:**A.7.3.3.1]

TABLE 13.6.4.3.3.1 Maintenance Involving Internal Examination

Extinguisher Type	Internal Examination Interval (years)
Stored-pressure loaded stream and antifreeze	1
Pump tank water and pump tank calcium chloride–based	1
Dry chemical, cartridge- and cylinder-operated, with mild steel shells	1*
Dry powder, cartridge- and cylinder-operated, with mild steel shells	1*
Wetting agent	1
Stored-pressure water	5
AFFF (aqueous film-forming foam)	3†
FFFP (film-forming fluoroprotein foam)	3†
Stored-pressure dry chemical, with stainless steel shells	5
Carbon dioxide	5
Wet chemical	5
Dry chemical stored-pressure, with mild steel shells, brazed brass shells, and aluminum shells	6
Halogenated agents	6
Dry powder, stored-pressure, with mild steel shells	6

*Dry chemical and dry powder in cartridge- or cylinder-operated extinguishers are examined annually.

†The extinguishing agent in liquid charge-type AFFF and FFFP extinguishers is replaced every 3 years, and an internal examination (teardown) is normally conducted at that time.

[**10:** Table 7.3.3]

13.6.4.3.3.2 Loaded Stream Charge. Stored-pressure types of fire extinguishers containing a loaded stream agent shall be disassembled on an annual basis and subjected to complete maintenance. [**10:**7.3.3.2]

13.6.4.3.3.2.1 The loaded stream charge shall be permitted to be recovered and re-used, provided it is subjected to agent analysis in accordance with the extinguisher manufacturer's instructions. [**10:**7.3.3.2.1]

13.6.4.3.3.2.2 When the internal maintenance procedures are performed during periodic recharging or hydrostatic testing, the 1-year requirement shall begin from that date. [**10:**7.3.3.2.2]

13.6.4.3.3.3 Cartridge- or Cylinder-Operated Extinguishers. The extinguishing agent of cartridge- or cylinder-operated extinguishers shall be internally examined annually. [**10:**7.3.3.3]

13.6.4.3.3.4 Wetting Agent Extinguishers. Wetting agent extinguishers shall be disassembled on an annual basis and subjected to complete maintenance. [**10:**7.3.3.4]

13.6.4.3.3.5 Pump Tank Extinguishers. Pump tank extinguishers shall be internally examined annually. [**10:**7.3.3.5]

13.6.4.3.3.6 Annual internal examination shall not be required for nonrechargeable fire extinguishers, carbon dioxide fire extinguishers, or stored-pressure fire extinguishers, except for those types specified in 13.6.4.3.3.2. [**10:**7.3.3.6]

13.6.4.3.4* Annual Maintenance Record Keeping.

A.13.6.4.3.4 In addition to the required tag or label, a permanent file record should be kept for each fire extinguisher. This file record should include the following information, as applicable:

(1) Maintenance date and the name of the person and the agency performing the maintenance
(2) Date of the last recharge and the name of the person and the agency performing the recharge
(3) Hydrostatic retest date and the name of the person and the agency performing the hydrostatic test
(4) Description of dents remaining after passing of the hydrostatic test
(5) Date of the 6-year maintenance for stored-pressure dry chemical and halogenated agent types (*See 13.6.4.3.6.)*

[**10:**A.7.3.4]

It is recognized that an electronic bar coding system is often acceptable to the AHJ in lieu of a tag or label for maintenance record keeping. [**10:**A.7.3.4]

Under special circumstances, or when local requirements are in effect, additional information can be desirable or required. [**10:**A.7.3.4]

13.6.4.3.4.1 Each fire extinguisher shall have a tag or label securely attached that indicates that maintenance was performed. [**10:**7.3.4.1]

Δ **13.6.4.3.4.1.1** The tag or label, as a minimum, shall identify the following:

(1) Month and year maintenance was performed
(2) Person performing the work
(3) Name of the agency performing the work

[**10:**7.3.4.1.1]

Δ **13.6.4.3.4.2** Each extinguisher that has undergone maintenance that includes internal examination, except extinguishers identified in 13.6.4.3.3.3 and 13.6.4.3.3.5, shall have a verification-of-service collar located around the neck of the container. [**10:**7.3.4.2]

13.6.4.3.4.3 Verification-of-Service Collar (Maintenance or Recharging).

13.6.4.3.5 Corrective Action. When maintenance of any fire extinguisher reveals a deficiency, immediate corrective action shall be taken. [**10:**7.3.5]

Δ **13.6.4.3.6 Six-Year Internal Examination of Certain Types of Extinguishers.** Every 6 years, stored-pressure fire extinguishers that require a 12-year hydrostatic test shall be emptied and subjected to the applicable internal and external examination procedures as detailed in the manufacturer's service manual and NFPA 10. [**10:**7.3.6]

13.6.4.3.6.1 When the applicable maintenance procedures are performed during periodic recharging or hydrostatic testing, the 6-year requirement shall begin from that date. [**10:**7.3.6.1]

13.6.4.3.6.2* The removal of agent from halon agent fire extinguishers shall only be done using a listed halon closed recovery system. [**10:**7.3.6.2]

A.13.6.4.3.6.2 Halon removed from a fire extinguisher is kept in a closed recovery/recharge system until disposition can be made as to whether to recharge the halon back into a fire extinguisher or return unsatisfactory halon to a manufacturer for proper disposal. A listed Halon 1211 closed recovery/recharge system has the following:

(1) Clear sight glass for monitoring the cleanliness of the Halon 1211
(2) A means of determining if the acceptable water content of the halon has been exceeded
(3) A means of mechanically filtering the Halon 1211 and removing excess water

[**10:**A.7.3.6.2]

Such a recovery system also has a motor-driven pump system that permits the transfer of halon into a fire extinguisher or supply container without the need to vent the receiving container to reduce its pressure before halon transfer. Closed recovery/recharge systems also include the plumbing, valves, regulators, and safety relief devices to permit convenient, quick transfer of the Halon 1211. [**10:**A.7.3.6.2]

13.6.4.3.6.3 Nonrechargeable fire extinguishers shall not be required to have a 6-year internal examination and shall not be hydrostatically tested but shall be removed from service at a maximum interval of 12 years from the date of manufacture. [**10:**7.3.6.3]

Δ **13.6.4.3.6.3.1** Nonrechargeable halon agent fire extinguishers shall be disposed of in accordance with 13.6.4.2.3.3. [**10:**7.3.6.3.1]

13.6.4.3.6.4 Corrective Action. When an internal examination of any fire extinguisher reveals a deficiency, immediate corrective action shall be taken. [**10:**7.3.6.4]

13.6.4.3.6.5* Six-Year Internal Examination Label. Fire extinguishers that pass the applicable 6-year requirement of 13.6.4.3.6 shall have the maintenance information recorded on a durable weatherproof label that is a minimum of 2 in. × 3½ in. (51 mm × 89 mm). [**10:**7.3.6.5]

A.13.6.4.3.6.5 Labels should be printed in black with a light blue background. [**10:**A.7.3.6.5]

13.6.4.3.6.5.1 The new label shall be affixed to the shell by a heatless process, and any previous 6-year internal examination labels shall be removed. [**10:**7.3.6.5.1]

13.6.4.3.6.5.2 These labels shall be of the self-destructive type when their removal from a fire extinguisher is attempted. [**10:**7.3.6.5.2]

13.6.4.3.6.5.3 The 6-year internal examination label shall, as a minimum, identify the following:

(1) Month and year the 6-year internal examination was performed
(2) Person performing the work
(3) Name of the agency performing the work

[**10:**7.3.6.5.3]

13.6.4.4* Carbon Dioxide Hose Assembly Conductivity Test. A conductivity test shall be conducted annually on all carbon dioxide hose assemblies. [**10:**7.4]

A.13.6.4.4 Carbon dioxide hose assemblies have a continuous metal braid that connects to both couplings to minimize the static shock hazard. The reason for the conductivity test is to determine that the hose is conductive from the inlet coupling to the outlet orifice. A basic conductivity tester consists of a flashlight having an open circuit and a set of two wires with a conductor (clamps or probe) at each end. [**10:**A.7.4]

Figure A.13.6.4.4 provides a guide to the design of a conductivity test label. [**10:**A.7.4]

13.6.4.4.1 Carbon dioxide hose assemblies that fail the conductivity test shall be replaced. [**10:**7.4.1]

13.6.4.4.2 Record Keeping for Conductivity Testing of Carbon Dioxide Hose Assemblies.

13.6.4.4.2.1 Carbon dioxide hose assemblies that pass a conductivity test shall have the test information recorded on a durable weatherproof label that is a minimum of ½ in. × 3 in. (13 mm × 76 mm). [**10:**7.4.2.1]

13.6.4.4.2.2 The label shall be affixed to the hose by means of a heatless process. [**10:**7.4.2.2]

Δ **13.6.4.4.2.3** The label shall include the following information:

(1) Month and year the test was performed, indicated by perforation such as is done by a hand punch
(2) Name or initials of person performing the test and the name of the agency performing the test

[**10:**7.4.2.3]

N **13.6.4.5 Hose Station Maintenance.** Where hose stations are installed to comply with 13.6.3.2.1.5, they shall be maintained in accordance with NFPA 1962. [**10:**7.5]

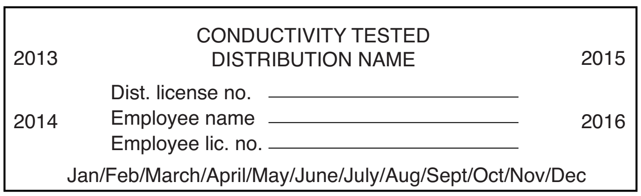


FIGURE A.13.6.4.4 *Conductivity Test Label. [**10:**Figure A.7.4]*

Paragraph 13.6.4.5 is new to the *Code*. Previous editions of the *Code* failed to emphasize the need for regular maintenance of fire hoses that are installed in lieu of fire extinguishers. NFPA 10 requires fire extinguishers to be regularly maintained. As long as fire hoses are recognized in 13.6.3.2.1.5 as an acceptable alternative for up to half of the required complement of Class A–rated fire extinguishers, it is important that NFPA 10 also require that those fire hoses be properly maintained. NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*, details the maintenance requirements for fire hoses.

13.6.4.6 Electronic Monitoring System Maintenance.

13.6.4.6.1 Electronic Monitoring. The components of the monitoring device/system shall be tested and maintained annually in accordance with the manufacturer's listed maintenance manual, with the following items included as a minimum:

(1) Power supply inspection/battery change
(2) Obstruction sensor inspection
(3) Location sensor inspection
(4) Pressure indication inspection
(5) Connection continuity inspection *(see 13.6.4.6.1.1 and 13.6.4.6.1.2)*

[**10:**7.6.1]

13.6.4.6.1.1 One hundred percent of all units shall be tested upon initial installation or reacceptance with verification of receipt of signal at the control panel or a local alarm. [**10:**7.6.1.1]

13.6.4.6.1.2 Twenty percent of units shall be tested annually on a rotating basis so that all units are tested within a 5-year period. [**10:**7.6.1.2]

13.6.4.6.2 When used in conjunction with fire alarm systems, fire extinguisher electronic monitoring devices shall be inspected and maintained in accordance with *NFPA 72* and 13.6.4.6.1. [**10:**7.6.2]

13.6.4.6.3 Corrective Action. When maintenance of any monitoring system reveals a deficiency, immediate corrective action shall be taken. [**10:**7.6.3]

13.6.4.7 Maintenance of Wheeled Extinguisher Hoses and Regulators.

13.6.4.7.1 Wheeled Unit Hoses. Discharge hoses on wheeled-type fire extinguishers shall be completely uncoiled and examined for damage annually. [**10:**7.7.1]

13.6.4.7.2* Discharge hoses on wheeled extinguishers shall be coiled in a manner to prevent kinks and to allow rapid deployment in accordance with the manufacturer's instructions. [**10:**7.7.1.1]

A.13.6.4.7.2 The following procedure permits rapid removal of the hose by one person without kinking of the hose and without obstruction of flow of the extinguishing agent:

(1) Form a standard loop over the hose supports *[see Figure A.13.6.4.7.2(a)]*.
(2) Follow with a reverse loop over the hose supports so that the hose passes behind the loop *[see Figure A.13.6.4.7.2(b)]*.
(3) Repeat steps (1) and (2), alternating standard loops and reverse loops, until all hose is coiled on the support *[see Figure A.13.6.4.7.2(c)]*.

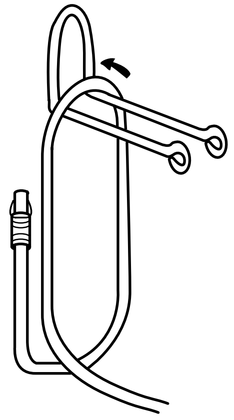


FIGURE A.13.6.4.7.2(a) *Counterclockwise Loop. [**10:**Figure A.7.7.1.1(a)]*

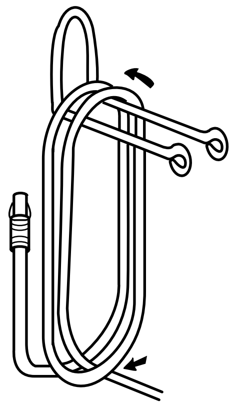


FIGURE A.13.6.4.7.2(b) *Reverse Loop. [**10:**Figure A.7.7.1.1(b)]*

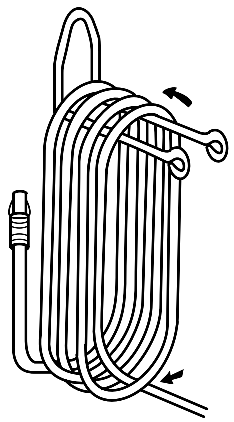


FIGURE A.13.6.4.7.2(c) *Procedures in Figure A.13.6.4.7.2(a) and Figure A.13.6.4.7.2(b) Continued. [**10:**Figure A.7.7.1.1(c)]*

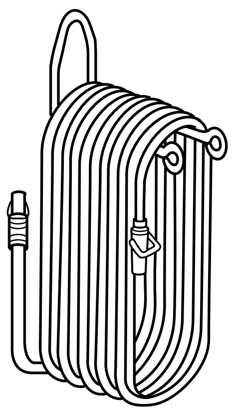


FIGURE A.13.6.4.7.2(d) *Nozzle in Downward Position. [**10:**Figure A.7.7.1.1(d)]*

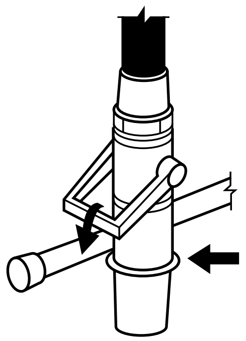


FIGURE A.13.6.4.7.2(e) *Nozzle in Holder. [**10:**Figure A.7.7.1.1(e)]*

(4) Adjust the coil so that the nozzle is in the downward position *[see Figure A.13.6.4.7.2(d)]*. Hose coiled in this manner pulls off free of twists.
(5) Place the nozzle in the holder with the handle forward in the closed position *[see Figure A.13.6.4.7.2(e)]*.

[**10:**A.7.7.1.1]

13.6.4.7.3 Pressure Regulators. Pressure regulators provided with wheeled-type fire extinguishers shall be tested annually for outlet static pressure and flow rate in accordance with the manufacturer's instructions. [**10:**7.7.2]

13.6.4.7.4 Corrective Action. When maintenance of any fire extinguisher hose or pressure regulator reveals a deficiency, immediate corrective action shall be taken. [**10:**7.7.3]

13.6.4.8 Extinguisher Recharging and Extinguishing Agents.

13.6.4.8.1* General.

A.13.6.4.8.1 General safety guidelines for recharging include the following:

(1) Make sure all pressure is vented from the fire extinguisher before attempting to remove the valve body or to fill the closure. (**Warning:** Do not depend on pressure-indicating devices to tell if the container is under pressure, because the devices could malfunction.)
(2) Use proper recharge materials when refilling a fire extinguisher. Mixing of some extinguishing agents can cause a chemical reaction, resulting in a dangerous pressure buildup in the container.
(3) The weight of agent as specified on the nameplate is critical. Overfilling could render the fire extinguisher dangerous or ineffective.
(4) Clean and properly lubricate all sealing components to prevent leakage after recharge.
(5) Check the pressure-indicating device to ascertain that it is reading properly.
(6) Most manufacturers recommend the use of dry nitrogen as an expellant gas for stored-pressure fire extinguishers. Limiting the charging pressure regulator setting to 25 psi (172 kPa) above service pressure, as 13.6.4.8.4, prevents gauge damage and loss of calibration. (**Warning:** Never connect the fire extinguisher to be charged directly to the high-pressure source. Connecting directly to the high-pressure source could cause the container to rupture, resulting in injury. Never leave a fire extinguisher connected to the regulator of a high-pressure source for an extended period of time. A defective regulator could cause the container to rupture due to excess pressure.)
(7) Use the manufacturer's recommended charging adapter to prevent damage to a valve and its components.
(8) When recharging separate expellant source fire extinguishers, make sure the filled enclosure is in place and tightened down. Replace all safety devices prior to installing replacement cartridges.
(9) Use only gas cartridges recommended by the manufacturer. Cartridge features such as pressure relief, puncturing capabilities, fill density, and thread compatibility are designed and approved to specific functional requirements.
(10) Use proper safety seals; other types, such as meter seals, could fail to break at the prescribed requirements.
(11) Regulators utilized on wheeled fire extinguishers are factory pinned at the operating pressure and should not be field adjusted.

[**10:**A.7.8.1]

The term *maintenance*, as it relates to fire extinguishers, means complete disassembly and examination. Recharging is not required in the annual maintenance of some types of extinguishers where disassembly and internal examination are not performed. Some jurisdictions require complete (internal/external) annual maintenance of a number of types of extinguishers; therefore, recharging of those types is required annually. Recharging is required after any use in order to remove any dry chemical from the sealing surfaces and hoses so the unit retains pressure. Recharging is also performed to remove water, foam, or antifreeze from internal areas of the valve to avoid corrosion. Most important, recharging must be performed to restore the extinguisher to its full fire-extinguishing potential.

13.6.4.8.1.1 All rechargeable-type fire extinguishers shall be recharged after any use or when the need is indicated by an inspection or servicing. [**10:**7.8.1.1]

13.6.4.8.1.2* When recharging is performed, the manufacturer's service manual shall be followed. *(For recharge agents, see 13.6.4.8.3.)* [**10:**7.8.1.2]

A.13.6.4.8.1.2 Some manufacturers require that their fire extinguishers be returned to the factory for recharging. [**10:**A.7.8.1.2]

13.6.4.8.1.3* The amount of recharge agent shall be verified by weighing. [**10:**7.8.1.3]

A.13.6.4.8.1.3 To determine the gross weight, the entire fire extinguisher should be weighed empty. The weight of the specified recharge agent should be added to that amount. [**10:**A.7.8.1.3]

13.6.4.8.1.3.1 For those fire extinguishers that do not have the gross weight marked on the nameplate or valve, a permanent label that indicates the gross weight shall be affixed to the cylinder. [**10:**7.8.1.3.1]

13.6.4.8.1.3.2 The added label containing the gross weight shall be a durable material of a pressure-sensitive, self-destruct type. *(For stored-pressure water-type extinguishers, see 13.6.4.8.3.10.)* [**10:**7.8.1.3.2]

13.6.4.8.1.3.3 Pump tank water and pump tank calcium chloride–based antifreeze types shall not be required to have weight marked. [**10:**7.8.1.3.3]

13.6.4.8.1.3.4* After recharging, a leak test shall be performed on stored-pressure and self-expelling types of fire extinguishers. [**10:**7.8.1.3.4]

A.13.6.4.8.1.3.4 The leak test required for stored-pressure and self-expelling types should be sufficiently sensitive to ensure that the fire extinguisher remains operable for at least 1 year. Any tamper indicators or seals need to be replaced after recharging. [**10:**A.7.8.1.3.4]

13.6.4.8.1.3.5 In no case shall an extinguisher be recharged without hydrostatic testing if it is beyond its specified hydrostatic test date. [**10:**7.8.1.3.5]

13.6.4.8.2 Extinguisher Recharging Frequency for Certain Types of Extinguishers.

13.6.4.8.2.1 Pump Tank. Every 12 months, pump tank water and pump tank calcium chloride–based antifreeze types of fire extinguishers shall be recharged with new chemicals or water as applicable. [**10:**7.8.2.1]

13.6.4.8.2.2 Wetting Agent. The agent in stored-pressure wetting agent fire extinguishers shall be replaced annually. [**10:**7.8.2.2]

13.6.4.8.2.2.1 Only the agent specified on the nameplate shall be used for recharging. [**10:**7.8.2.2.1]

13.6.4.8.2.2.2 The use of water or any other additives shall be prohibited. [**10:**7.8.2.2.2]

13.6.4.8.2.3 AFFF and FFFP.

13.6.4.8.2.3.1 The premixed agent in liquid charge–type AFFF and FFFP fire extinguishers shall be replaced at least once every 3 years. [**10:**7.8.2.3.1]

13.6.4.8.2.3.2 Only the foam agent specified on the extinguisher nameplate shall be used for recharge. [**10:**7.8.2.3.2]

13.6.4.8.2.3.3 The agent in nonpressurized AFFF and FFFP fire extinguishers that is subjected to agent analysis in accordance with manufacturer's instructions shall not be required to comply with 13.6.4.8.2.3.1. [**10:**7.8.2.3.3]

13.6.4.8.3* Recharge Agents.

A.13.6.4.8.3 On properties where fire extinguishers are maintained by the occupant, a supply of recharging agents should be kept on hand. These agents should meet the requirements of 13.6.4.8.3. [**10:**A.7.8.3]

The intent of this provision is to maintain the efficiency of each fire extinguisher as produced by the manufacturer and as labeled by one or more of the fire testing laboratories. For example, the extinguishing agent and the additives used in the various types of dry chemical fire extinguishers vary in chemical composition and in particle size and, thus, in flow characteristics. Each fire extinguisher is designed to secure maximum efficiency with the particular formulation used. Changing the agent from that specified on the fire extinguisher nameplate could affect flow rates, nozzle discharge characteristics, and the quantity of available agent (as influenced by density) and would void the label of the testing laboratory. [**10:**A.7.8.3]

Certain recharging materials deteriorate with age, exposure to excessive temperature, and exposure to moisture. Storage of recharge agents for long periods of time should be avoided. [**10:**A.7.8.3]

Dry powder used for combustible metal fires (Class D) should not become damp, because the powder will not be free flowing. In addition, when dry powder contains sufficient moisture, a hazardous reaction could result when applied to a metal fire. [**10:**A.7.8.3]

13.6.4.8.3.1 Only those agents specified on the nameplate or agents proven to have equal chemical composition, physical characteristics, and fire-extinguishing capabilities shall be used. [**10:**7.8.3.1]

13.6.4.8.3.1.1 Agents listed specifically for use with that fire extinguisher shall be considered to meet these requirements. [**10:**7.8.3.1.1]

13.6.4.8.3.2* Mixing of Dry Chemicals. Multipurpose dry chemicals shall not be mixed with alkaline-based dry chemicals. [**10:**7.8.3.2]

A.13.6.4.8.3.2 Mixing multipurpose dry chemicals with alkaline-based dry chemicals could result in a chemical reaction capable of developing sufficient pressures to rupture a fire extinguisher. Substituting a different formulation for the one originally employed could cause malfunctioning of the fire extinguisher or result in substandard performance. [**10:**A.7.8.3.2]

13.6.4.8.3.3 Topping Off.

13.6.4.8.3.3.1 The remaining dry chemical in a discharged fire extinguisher shall be permitted to be re-used, provided that it is thoroughly checked for the proper type, contamination, and condition. [**10:**7.8.3.3.1]

13.6.4.8.3.3.2 Dry chemical found to be of the wrong type or contaminated shall not be re-used. [**10:**7.8.3.3.2]

13.6.4.8.3.4 Dry Chemical Agent Re-Use.

13.6.4.8.3.4.1 The dry chemical agent shall be permitted to be re-used, provided a closed recovery system is used and the agent is stored in a sealed container to prevent contamination. [**10:**7.8.3.4.1]

13.6.4.8.3.4.2 Prior to re-use, the dry chemical shall be thoroughly checked for the proper type, contamination, and condition. [**10:**7.8.3.4.2]

13.6.4.8.3.4.3 Where doubt exists with respect to the type, contamination, or condition of the dry chemical, the dry chemical shall be discarded. [**10:**7.8.3.4.3]

13.6.4.8.3.4.4 Dry Chemical Closed Recovery System.

(A) The system shall be constructed in a manner that does not introduce foreign material into the agent being recovered. [**10:**7.8.3.4.4.1]

(B) The system shall have a means for visual inspection of the recovered agent for contaminants. [**10:**7.8.3.4.4.2]

13.6.4.8.3.5 Dry Powder.

13.6.4.8.3.5.1 Pails or drums containing dry powder agents for scoop or shovel application for use on metal fires shall be kept full and sealed with the lid provided with the container. [**10:**7.8.3.5.1]

13.6.4.8.3.5.2 The dry powder shall be replaced if found damp. *(See A.13.6.4.8.3.)* [**10:**7.8.3.5.2]

13.6.4.8.3.6* Removal of Moisture. For all non-water types of fire extinguishers, any moisture shall be removed before recharging. [**10:**7.8.3.6]

A.13.6.4.8.3.6 Moisture within a non-water-type fire extinguisher creates a serious corrosion hazard to the fire extinguisher shell and also indicates that the extinguisher is probably inoperative. Moisture could possibly enter under the following conditions:

(1) After a hydrostatic test
(2) When recharging is being performed
(3) When the valve has been removed from the cylinder
(4) Where compressed air and a moisture trap are used for pressurizing non-water types

[**10:**A.7.8.3.6]

It is extremely important to remove any water or moisture from any fire extinguisher before recharging. Excess moisture in a dry chemical fire extinguisher causes the agent to cake and lump and become unusable. It also causes corrosion to the fire extinguisher shell and valve. In carbon dioxide and halogenated fire extinguishers, excess moisture combined with the extinguishing agent causes extremely corrosive acids to form. These acids can corrode the fire extinguisher shell and valve. [**10:**A.7.8.3.6]

13.6.4.8.3.7* Halogenated Agent. Halogenated agent fire extinguishers shall be charged with only the type and weight of agent specified on the nameplate. [**10:**7.8.3.7]

A.13.6.4.8.3.7 If the fire extinguisher valve is removed for servicing, it is recommended that the fire extinguisher be purged with nitrogen or argon (as appropriate) or that a vacuum be drawn on the fire extinguisher cylinder prior to recharging. [**10:**A.7.8.3.7]

13.6.4.8.3.8 Halogenated Agent Re-Use.

13.6.4.8.3.8.1 The removal of Halon 1211 from fire extinguishers shall be done using only a listed halon closed recovery system. [**10:**7.8.3.8.1]

13.6.4.8.3.8.2 The removal of agent from other halogenated agent fire extinguishers shall be done using only a closed recovery system. [**10:**7.8.3.8.2]

13.6.4.8.3.8.3 The fire extinguisher shall be examined internally for contamination or corrosion or both. [**10:**7.8.3.8.3]

13.6.4.8.3.8.4 The halogenated agent retained in the system recovery cylinder shall be re-used only if no evidence of internal contamination is observed in the fire extinguisher cylinder. [**10:**7.8.3.8.4]

13.6.4.8.3.8.5 Halogenated agent removed from fire extinguishers that exhibits evidence of internal contamination or corrosion shall be processed in accordance with the fire extinguisher manufacturer's instructions. [**10:**7.8.3.8.5]

13.6.4.8.3.9* Carbon Dioxide.

A.13.6.4.8.3.9 The preferred source of carbon dioxide for recharging fire extinguishers is from a low-pressure [300 psi at 0°F (2068 kPa at −17.8°C)] supply, supplied either directly or via dry cylinders used as an intermediary means. Dry ice converters should not be used to recharge carbon dioxide portable fire extinguishers. [**10:**A.7.8.3.9]

13.6.4.8.3.9.1 The vapor phase of carbon dioxide shall be not less than 99.5 percent carbon dioxide. [**10:**7.8.3.9.1]

13.6.4.8.3.9.2 The water content shall be not more than 60 parts per million (ppm) by weight at –52°F (–47°C) dew point. [**10:**7.8.3.9.2]

13.6.4.8.3.9.3 Oil content shall not exceed 10 ppm by weight. [**10:**7.8.3.9.3]

13.6.4.8.3.10* Water Types. The amount of liquid agent shall be determined by using one of the following:

(1) Exact measurement by weight
(2) Exact measurement by volume
(3) Anti-overfill tube, if provided
(4) Fill mark on fire extinguisher shell, if provided

[**10:**7.8.3.10]

A.13.6.4.8.3.10 When stored-pressure fire extinguishers are recharged, overfilling results in improper discharge. [**10:**A.7.8.3.10]

13.6.4.8.3.10.1 Only the agent specified on the extinguisher nameplate shall be used for recharge. [**10:**7.8.3.10.1]

13.6.4.8.3.10.2 Only additives identified on the original nameplate shall be permitted to be added to water type extinguishers. [**10:**7.8.3.10.2]

13.6.4.8.3.11 Wet Chemical and Water Mist Agent Re-Use.

13.6.4.8.3.11.1 Wet chemical and water mist agents shall not be re-used. [**10:**7.8.3.11.1]

13.6.4.8.3.11.2 If a wet chemical or water mist extinguisher is partially discharged, all remaining wet chemical or water mist shall be discarded. [**10:**7.8.3.11.2]

13.6.4.8.3.11.3 Wet chemical or water mist agent shall be discarded and replaced at the hydrostatic test interval. [**10:**7.8.3.11.3]

(A) Only the agent specified on the extinguisher nameplate shall be used for recharge. [**10:**7.8.3.11.3.1]

13.6.4.8.4 Recharging Expellant Gas for Stored-Pressure Fire Extinguishers.

13.6.4.8.4.1 Only standard industrial-grade nitrogen with a maximum dew point of −60°F (−51°C), in accordance with CGA G-10.1. *Commodity Specification for Nitrogen*, shall be used to pressurize stored-pressure dry chemical and halogenated-type fire extinguishers that use nitrogen as a propellant. [**10:**7.8.4.8.1]

13.6.4.8.4.2 Halogenated-type fire extinguishers that require argon shall be pressurized with argon with a dew point of −65°F (−54°C) or lower. [**10:**7.8.4.8.2]

13.6.4.8.4.3 Compressed air shall be permitted to be used from special compressor systems capable of delivering air with a dew point of −60°F (−51°C) or lower. *(See Annex J of NFPA 10.)* [**10:**7.8.4.3]

13.6.4.8.4.3.1 The special compressor system shall be equipped with an automatic monitoring and alarm system to ensure that the dew point remains at or below −60°F (−51°C) at all times. [**10:**7.8.4.3.1]

13.6.4.8.4.3.2 Compressed air through moisture traps shall not be used for pressurizing even though so stated in the instructions on older fire extinguishers. [**10:**7.8.4.3.2]

13.6.4.8.4.3.3 Compressed air without moisture removal devices shall be permitted for pressurizing water extinguishers and foam hand extinguishers only. [**10:**7.8.4.3.3]

13.6.4.8.4.4* Class D, wet chemical, water mist, and halogenated agent fire extinguishers shall be repressurized only with the type of expellant gas referred to on the fire extinguisher label. [**10:**7.8.4.4]

A.13.6.4.8.4.4 Some Class D fire extinguishers are required to be pressurized with argon. [**10:**A.7.8.4.4]

13.6.4.8.4.5 A rechargeable stored-pressure-type fire extinguisher shall be pressurized only to the charging pressure specified on the fire extinguisher nameplate. [**10:**7.8.4.5]

13.6.4.8.4.5.1 The manufacturer's pressurizing adapter shall be connected to the valve assembly before the fire extinguisher is pressurized. [**10:**7.8.4.5.1]

13.6.4.8.4.5.2 A regulated source of pressure, set no higher than 25 psi (172 kPa) above the operating (service) pressure, shall be used to pressurize fire extinguishers. [**10:**7.8.4.5.2]

13.6.4.8.4.5.3 The gauge used to set the regulated source of pressure shall be calibrated at least annually. [**10:**7.8.4.5.3]

13.6.4.8.4.6* An unregulated source of pressure, such as a nitrogen cylinder without a pressure regulator, shall not be used. [**10:**7.8.4.6]

A.13.6.4.8.4.6 The reason an unregulated source of pressure is not to be used is because the fire extinguisher has the potential to be overpressurized and possibly rupture. [**10:**A.7.8.4.6]

13.6.4.8.4.7* A fire extinguisher shall not be left connected to the regulator of a high-pressure source for an extended period of time. [**10:**7.8.4.7]

A.13.6.4.8.4.7 A defective regulator could cause the container to rupture due to excess pressure. [**10:**A.7.8.4.7]

13.6.4.8.4.8 Recharge Record Keeping.

13.6.4.8.4.8.1 Each fire extinguisher shall have a tag or label attached that indicates the month and year recharging was performed, identifies the person performing the service, and identifies the name of the agency performing the work. [**10:**7.8.4.8.1]

13.6.4.8.4.8.2 Each extinguisher that has been recharged shall have a verification-of-service collar located around the neck of the container, except as identified in 13.6.4.11.4. [**10:**7.8.4.8.2]

13.6.4.9* Pressure Gauges.

A.13.6.4.9 If it becomes necessary to replace a pressure gauge on a fire extinguisher, in addition to knowing the charging pressure, it is important to know the type of extinguishing agent for which the gauge is suitable, as well as the valve body with which the gauge is compatible. This information often is available in the form of markings on the dial face. Where the marking is provided, the extinguishing agent is indicated by instructions such as "Use Dry Chemicals Only," while the valve body compatibility is indicated as follows:

(1) Gauges intended for use with aluminum or plastic valve bodies are marked with a line above the gauge manufacturer's code letter.
(2) Gauges intended for use with brass or plastic valve bodies are marked with a line below the manufacturer's code letter.
(3) Universal gauges that can be used with aluminum, brass, or plastic valve bodies are marked with lines above and below the manufacturer's code letter or by the absence of any line above or below the manufacturer's code letter.

[**10:**A.7.9]

Using the proper replacement gauge as to pressure range, extinguishing agent, and valve body compatibility is recommended to avoid or to reduce gauge-related problems. [**10:**A.7.9]

13.6.4.9.1 Replacement pressure gauges shall have the correct indicated charging (service) pressure. [**10:**7.9.1]

13.6.4.9.2 Replacement pressure gauges shall be marked for use with the agent in the fire extinguisher. [**10:**7.9.2]

13.6.4.9.3 Replacement pressure gauges shall be compatible with the fire extinguisher valve body material. [**10:**7.9.3]

13.6.4.10 Prohibition on Uses of Extinguishers and Conversion of Fire Extinguisher Types.

13.6.4.10.1 Fire extinguishers shall not be used for any purpose other than that of a fire extinguisher. [**10:**7.10.1]

13.6.4.10.2 Fire extinguishers shall not be converted from one type to another, modified, or altered. [**10:**7.10.2]

13.6.4.10.3 Fire extinguishers shall not be converted for the use of a different type of extinguishing agent. [**10:**7.10.3]

13.6.4.11* Maintenance and Recharge Service Collar. Each extinguisher that has undergone maintenance that included internal examination or that has been recharged requiring the removal of the valve assembly shall have a verification-of-service collar located around the neck of the container. [**10:**7.11]

Δ **A.13.6.4.11** A verification-of-service collar is installed to show that an extinguisher has been depressurized, the valve has been removed, and a complete maintenance has been performed. The verification-of-service collar design also requires that the valve be removed before the collar can be attached to the extinguisher. The collar provides the AHJs with a convenient visual proof that the extinguisher has been disassembled and that maintenance most likely has been performed. [**10:**A.7.11]

All extinguishers are to have the valve removed for hydrostatic testing and are to be subsequently recharged before they are returned to service. To be valid, the date on the verification-of-service collar should always be the same as or more recent than the date on the hydrostatic test label. [**10:**A.7.11]

Figure A.13.6.4.11 provides a guide to the design of a verification-of-service collar. [**10:**A.7.11]

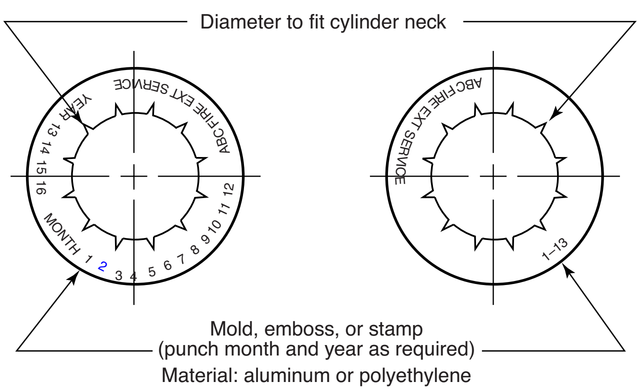


***FIGURE A.13.6.4.11** Design of a Verification-of-Service Collar. [**10:**A.7.11]*

13.6.4.11.1 The collar shall be a single circular piece of uninterrupted material forming a hole of a size that does not permit the collar assembly to move over the neck of the container unless the valve is completely removed. [**10:**7.11.1]

13.6.4.11.2 The collar shall not interfere with the operation of the fire extinguisher. [**10:**7.11.2]

13.6.4.11.3 The verification-of-service collar shall, as a minimum, identify the following:

(1) Month and year the recharging or internal examination was performed
(2) Name of the agency performing the work

[**10:**7.11.3]

13.6.4.11.4 Service Collar Exemptions.

13.6.4.11.4.1 New extinguishers requiring an initial charge in the field (such as pressurized water, AFFF, FFFP, or wet chemical extinguishers) shall not be required to have a verification-of-service collar installed. [**10:**7.11.4.1]

13.6.4.11.4.2 Liquefied gas, halogenated agent, and carbon dioxide extinguishers that have been recharged without valve removal shall not be required to have a verification-of-service collar installed following recharge. [**10:**7.11.4.2]

13.6.4.11.4.3 Cartridge- and cylinder-operated extinguishers shall not be required to have a verification-of-service collar installed. [**10:**7.11.4.3]

13.6.4.12* Weight Scales. Weight scales used for the maintenance and recharge of fire extinguishers shall have the reading increments and the accuracy necessary to verify the charge weights required in the service manuals and on the nameplates. [**10:**7.12]

Δ **A.13.6.4.12** Weight scales used for weighing a fire extinguisher with a gross weight of 60 lb (27.2 kg) or less should permit readings to 0.25 lb (0.10 kg). Weight scales used for weighing extinguishers and cartridges should permit readings consistent with the tolerances identified on the nameplate of the extinguisher or cartridge. All scales should be calibrated (tested) for accuracy. Accuracy of weight scales should be demonstrated at least daily by the use of a test weight(s) having a verified weight. The test method involves placing a test weight on the scale and reading the results. The following method should be used to calibrate weight scales daily or more frequently as needed:

(1) With nothing on the scale, "zero out" the weight scale by adjusting the weight scale calibration knob or wheel or tare/zero button so that it reads zero. A digital scale should be powered and allowed to stabilize before adjusting to read zero.
(2) Place the test weight(s) on the scale.
(3) Read the weight that is registered on the scale, and, if needed, adjust the scale by turning the calibration knob or wheel to show the weight of the test weight that is being tested. Some digital scales have an electronic push-button calibration feature to calibrate the weight during a test.

(4) Repeat the testing procedure twice after any adjustment. The weight that is registered should be exactly the same.

[**10:**A.7.12]

Weight scales that do not provide repeatable results within the tolerances specified in the manufacturer's literature should be repaired or replaced. [**10:**A.7.12]

13.6.5 Hydrostatic Testing. For hydrostatic testing of portable fire extinguishers, see Chapter 8 of NFPA 10.

13.6.5.1 Condemning Extinguishers.

13.6.5.1.1 Fails Test or Examination. When a fire extinguisher cylinder, shell, or cartridge fails a hydrostatic pressure test or fails to pass a visual examination as specified in 8.4.2 of NFPA 10, it shall be condemned or destroyed by the owner or the owner's agent. [**10:**8.8.1]

13.6.5.1.1.1 When a cylinder is required to be condemned, the retester shall notify the owner in writing that the cylinder is condemned and that it cannot be reused. [**10:**8.8.1.1]

13.6.5.1.1.2 A condemned cylinder shall not be repaired. [**10:**8.8.1.2]

13.6.5.1.2 Marking Condemned Extinguishers.

13.6.5.1.2.1 Condemned cylinders shall be stamped "CONDEMNED" on the top, head, shoulder, or neck with a steel stamp. [**10:**8.8.2.1]

13.6.5.1.2.2 No person shall remove or obliterate the "CONDEMNED" marking. [**10:**8.8.2.2]

13.6.5.1.2.3 Minimum letter height shall be ⅛ in. (3 mm). [**10:**8.8.2.3]

13.7 Detection, Alarm, and Communications Systems

13.7.1 General.

13.7.1.1 Where building fire alarm systems or automatic fire detectors are required by other sections of this *Code*, they shall be provided and installed in accordance with NFPA 70, *NFPA 72*, and Section 13.7.

Δ **13.7.1.2* Building Fire Alarm Systems.** Protected premises fire alarm systems that serve the general fire alarm needs of a building or buildings shall include one or more of the following systems or functions:

(1) Manual fire alarm signal initiation
(2) Automatic fire alarm and supervisory signal initiation
(3) Monitoring of abnormal conditions in fire suppression systems
(4) Activation of fire suppression systems
(5) Activation of emergency control functions
(6) Activation of fire alarm notification appliances
(7) In-building fire emergency voice/alarm communications
(8) Guard's tour supervisory service
(9) Process monitoring supervisory systems
(10) Activation of off-premises signals
(11) Combination systems

[**72:**23.3.3.1]

Δ **A.13.7.1.2** The following functions are included in Annex A to provide guidelines for utilizing building systems and equipment in addition to proprietary fire alarm equipment in order to provide life safety and property protection. Building functions that should be initiated or controlled during a fire alarm condition include, but should not be limited to, the following:

(1) Elevator operation consistent with ANSI/ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*
(2) Unlocking of stairwell and exit doors (see NFPA 80 and NFPA *101*)
(3) Release of fire and smoke dampers (see NFPA 90A and NFPA 90B)
(4) Monitoring and initiating of self-contained automatic fire extinguishing system(s) or suppression system(s) and equipment (see NFPA 11, NFPA 12, NFPA 12A, NFPA 13, NFPA 14, NFPA 15, NFPA 17, NFPA 17A, and NFPA 750)

[**72:**A.23.3.3.1]

13.7.1.3 All apparatus requiring rewinding or resetting to maintain normal operation shall be rewound or reset as promptly as possible after each test and alarm. [**72:**14.5.4]

13.7.1.4 The provisions of Section 13.7 shall apply only where specifically required by another section of this *Code*. [***101:***9.6.1.1]

13.7.1.4.1 Fire detection, alarm, and communications systems installed to make use of an alternative permitted by this *Code* shall be considered required systems and shall meet the provisions of this *Code* applicable to required systems. [***101:***9.6.1.2]

The provisions of 13.7.1.4.1 remind the user that a fire detection system, an alarm system, or an associated communications system that is installed to take advantage of a *Code* alternative becomes a required system and is subject to the same requirements as any other required system, including maintenance. An example of this provision is a new business occupancy that is not required to have a fire alarm system on the basis of the thresholds established in 13.7.2.25. If, for security reasons, delayed-egress electrical locking systems were to be installed, they would have to meet the provisions of 14.5.3.1. Paragraph 14.5.3.1.1(1) requires that the locks automatically release upon the activation of an approved, supervised automatic sprinkler system in accordance with Section 13.3; the activation of any heat detector; or the activation of not more than two smoke detectors of an approved, supervised automatic fire detection system installed in accordance with Section 13.7 of this *Code* and Section 9.6 of NFPA *101*. If a fire alarm system is utilized to automatically release a delayed-egress electrical locking system, it becomes a required system and must be installed and maintained in accordance with Section 13.7 of this *Code* and Section 9.6 of NFPA *101*.

Δ **13.7.1.4.2*** To ensure operational integrity, the fire alarm system shall have an approved maintenance and testing program complying with the applicable requirements of *NFPA 70* and *NFPA 72*. [***101:***9.6.1.4]

A.13.7.1.4.2 Records of conducted maintenance and testing and a copy of the certificate of compliance should be maintained. [***101:***A.9.6.1.4]

The operational integrity of a fire alarm system cannot be ensured without proper maintenance and testing. Thus, the *Code* requires that an approved — that is, acceptable to the AHJ — maintenance and testing program be operational on an ongoing basis. An important part of the program is retention of system acceptance records and subsequent operational test records, so that comparisons can be made to initial system specifications.

Δ **13.7.1.4.3** Fire alarm system impairment procedures shall comply with NFPA 72. [***101:***9.6.1.5]

A fire alarm system might be shut down or otherwise impaired for any number of reasons during the life of a building. Some impairments are preplanned, controlled, and of short duration, such as during periodic testing and maintenance. Others might be preplanned and of longer duration, such as during times of building or system rehabilitation. Emergency shutdown of the system can be the result of power failure, fire, or other physical damage and might result in a short or lengthy shutdown to repair the system. Advance planning should help ensure that the system, or most of the system, can be restored to service despite the scope of the renovation or the extent of an unexpected impairment. If the alarm system is required by the *Code* or if it was installed to make use of one of the alternatives offered by the *Code*, it must be in operable condition for the building to be considered *Code* compliant.

Instead of designating a building with an inoperative alarm system as noncompliant and prohibiting occupancy under all conditions in accordance with the provisions of 4.5.4 and 4.5.6.1, 13.7.1.4.3 mandates compliance with the fire alarm system impairment procedures specified by *NFPA 72*. In addition to notifying the building owner any time an alarm system or portion thereof is impaired, the service provider is required to notify the AHJ when an alarm system is out of service for more than 8 hours. The 8-hour criterion specified by *NFPA 72* is intended to correspond with a typical work shift, such that if the alarm system remains impaired at the end of the work day, the AHJ will be notified. If the AHJ determines the alarm system will be impaired for an extended period of time, means to mitigate the associated life safety risk can be implemented. Such means might include the establishment of a fire watch.

It is the intent of the *Code* that a fire watch result in a heightened awareness of the building's operations and environment. Individuals assigned to the fire watch should be able to recognize fire hazards and understand the procedures for occupant and fire department notification and occupant evacuation in an emergency.

When a plan to address system impairment is being developed, it is important to consider the nature of the impairment, the location, the increased hazards that are involved, and the actions necessary to mitigate the hazards. The AHJ should be involved in the development of such a plan.

See 13.3.3.6 for requirements relating to automatic sprinkler system impairments.

13.7.1.5* Impaired and Nuisance Alarm Prone Systems.

A.13.7.1.5 Requirements to address impaired fire alarm systems, and fire alarm systems prone to chronic nuisance alarms are provided in 13.7.1.5. In many situations, the problems can be corrected by ensuring the systems are maintained, serviced, and tested by an approved fire alarm service company. However, in some cases, the system problems may be attributed to aging for which suitable replacement parts are no longer available.

13.7.1.5.1 Impaired fire alarm systems shall include, but shall not be limited to, required systems that are not fully operational, are no longer monitored as required by the AHJ, or are under renovation or repair.

13.7.1.5.2 The system owner or designated representative shall immediately notify the AHJ in an approved manner when a fire alarm system is impaired.

13.7.1.5.3 The AHJ shall be authorized to require standby fire personnel or an approved fire watch in accordance with 1.7.16 at premises in which required fire alarm systems are impaired or classified as chronic nuisance alarm prone systems.

13.7.1.5.4 Fire alarm systems that have produced five or more nuisance alarms in a 365-day period shall be classified as chronic nuisance alarm prone systems.

13.7.1.5.5* The AHJ shall be authorized to require central station service be provided for chronic nuisance alarm prone systems.

A.13.7.1.5.5 This paragraph allows the AHJ to require chronic nuisance alarm prone systems to comply with the *NFPA 72*, Section 26.3 requirements for central station service. Central station service, as compared to other supervising service, requires the system to be covered by a systematic follow-up program under the control of the organization that has listed the prime contractor. This will ensure that not only is the system being maintained, serviced, and periodically tested by an approved alarm service company, but it is also under an ongoing audit program by the company that listed the central station. Many jurisdictions that require central station service on fire alarm systems also communicate directly with the listing organization concerning the systems monitored in their jurisdiction.

13.7.1.5.6* Fire alarm supervising stations and fire alarm service companies shall immediately notify the AHJ when any of the following conditions exists:

(1) A fire alarm system is impaired.
(2) Required system monitoring is no longer being provided.
(3) Required testing, service, and maintenance is no longer being provided.

(4) A fire alarm system cannot be serviced or repaired to make it fully operational.
(5) A fire alarm system cannot be serviced or repaired to eliminate chronic nuisance alarms.

A.13.7.1.5.6 It is not always practical for the AHJ to continually verify that required monitoring, testing, service, and maintenance are provided. It is also difficult for the AHJ to determine if older systems are no longer able to be serviced or repaired to keep them operational and resistant to nuisance alarms, particularly if spare parts are no longer available. Paragraph 13.7.1.5.6 requires the fire alarm companies to notify the AHJ when required services have been discontinued, or when systems can no longer be serviced and maintained in an operational condition, free from chronic nuisance alarms. It is not the intent of this paragraph to prevent system owners from getting a second opinion on the system status from another approved fire alarm service provider.

13.7.1.5.7 The system owner shall replace required fire alarm systems that cannot be serviced or repaired to eliminate system impairments or chronic nuisance alarms.

13.7.1.6* Nonrequired Coverage.

The term *nonrequired* is not the same as the terms *supplementary*, *partial*, or *selective* (see 17.5.3.2 of *NFPA 72*). Refer to the definitions of the terms *nonrequired* and *supplementary* found in 3.3.170, A.3.3.170, and 3.3.286 of *NFPA 72*.

The subparagraphs of 13.7.1.6 address circumstances in which fire detection serves purposes or achieves objectives not established by a locally adopted, minimum-compliance building code or fire code. Often, a user has specific fire protection goals or objectives that can be achieved only by using automatic fire detection. For example, a building operator might have a mission continuity objective and intends to use a special extinguishing system, actuated by automatic detection, to achieve that objective. Such a system is a nonrequired system because it is installed at the option of the operator and not because of a building or fire code requirement.

The language of the subparagraphs provides the necessary latitude in design for systems that are being installed to meet an objective other than the minimum requirements for property protection and life safety provided in the local building code. Although the requirements in 13.7.1.6.1 and 13.7.1.6.2 are specified in prescriptive terms, designs for some objectives might be best achieved through the use of the performance-based design option. The process of performance-based design involves a documented formal analysis that serves as the basis for design decisions.

A.13.7.1.6 The requirement of 13.7.1.6 recognizes there will be instances where, for example, a facility owner would want to apply detection to meet certain performance goals and to address a particular hazard or need, but that detection is not required. Once installed, of course, acceptance testing, annual testing, and ongoing maintenance in accordance with this *Code* is expected. The intent of this section is to allow the use of a single detector, or multiple detectors provided for specific protection, with spacing to meet specific fire safety objectives as determined in accordance with 17.6.1.1 and 17.7.1.1 of *NFPA 72*. [**72:**A.17.5.3.3]

13.7.1.6.1 Detection installed for reasons of achieving specific fire safety objectives, but not required by any laws, codes, or standards, shall meet all of the requirements of this *Code*, with the exception of prescriptive spacing criteria of Chapter 17 of *NFPA 72*. [**72:**17.5.3.3.1]

Even where detection is not required by some applicable law, code, or standard, detection must still comply with all the requirements of *NFPA 72*, including the specific detector location, installation, operation, and maintenance requirements for the type of detector being used. This requirement helps to ensure that purchasers of nonrequired systems receive systems that work. Decades of experience in fire alarm system design, installation, and maintenance have demonstrated that compliance with the criteria in this *Code* results in systems that have a high probability of providing consistent, reliable service. The exception permits the use of detector spacing that is different from the spacing specified in the prescriptive sections of this *Code*. With some system objectives, using the prescriptive spacings is not necessary in order to attain the performance intended for the nonrequired system.

Whenever any system is designed, 17.6.1.1, 17.7.1.1, and 17.8.1.1 of *NFPA 72* require that the objectives for the system be stipulated in the design documentation. Consequently, these paragraphs apply to nonrequired systems. The detection spacing selected must be substantiated in the design documentation to show that design objectives for the system will be satisfied when the detectors are selected and installed on the spacing selected.

13.7.1.6.2 Where nonrequired detectors are installed for achieving specific fire safety objectives, additional detectors not necessary to achieve the objectives shall not be required. [**72:**17.5.3.3.2]

Generally, the objective of nonrequired coverage is to attain an early warning of a fire involving a valuable asset but not necessarily some other portion of the compartment. Under these circumstances, providing detection for the portion of the compartment where the asset is actually located, rather than throughout the entire compartment or building, might be sufficient. Exhibit 13.33 and Exhibit 13.34 represent special application detection devices.

13.7.1.7 Signal Initiation.

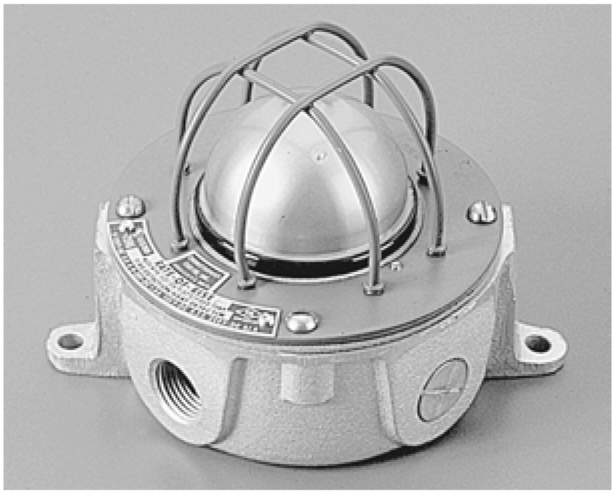
Δ **13.7.1.7.1** Where required by other sections of this *Code*, actuation of the fire alarm system shall occur by any or all of the following means of initiation, but shall not be limited to such means:

(1) Manual fire alarm initiation
(2) Automatic detection
(3) Extinguishing system operation

[***101:***9.6.2.1]

The capability for manual fire alarm initiation is a requirement common to all occupancies that require the installation of a fire

Exhibit 13.33



Explosionproof spot-type heat detector. (Source: Kidde-Fenwal, Ashland, MA)

Exhibit 13.34

Line-type heat detector installed in a cable tray application. (Source: The Protectowire Co., Inc., Pembroke, MA)

alarm system. Initiation by automatic detection or extinguishing system operation is permitted to serve in lieu of manual initiation for some occupancies. In some cases, an occupancy chapter might require initiation by automatic detection or extinguishing system operation. For example, new educational occupancies are not always required to have an automatic sprinkler system, depending on their size; however, if such a system is installed, 13.7.2.3.2.2 requires automatic alarm system initiation by operation of the sprinkler system in addition to the manual means. In new health care occupancies, automatic sprinklers are required, and 13.7.2.7.2.1 states that initiation of the alarm system is to be by manual means and by sprinkler system waterflow alarms. In new Class A mercantile occupancies, a fire alarm system and an automatic sprinkler system are required. However, 13.7.2.23.2(1) requires only alarm initiation by manual means. Alarm initiation by means of sprinkler system activation is permitted by 13.7.2.23.2(3) to serve in lieu of manual initiation, but it is not required.

Where both manual and automatic means for alarm system initiation are used, they should be complementary. If one system becomes inoperative — for example, failure of the manual initiation circuit — the second should continue to function properly and initiate the alarm upon automatic detection of fire or smoke.

13.7.1.7.2 Manual fire alarm boxes shall be used only for fire-protective signaling purposes. Combination fire alarm and guard's tour stations shall be permitted. [***101***:9.6.2.2]

13.7.1.7.3 A manual fire alarm box shall be provided as follows, unless modified by another section of this *Code*:

(1) For new alarm system installations, the manual fire alarm box shall be located within 60 in. (1525 mm) of exit doorways.
(2) For existing alarm system installations, the manual fire alarm box either shall be provided in the natural exit access path near each required exit or within 60 in. (1525 mm) of exit doorways.

[***101***:9.6.2.3]

13.7.1.7.4 Manual fire alarm boxes shall be mounted on both sides of grouped openings over 40 ft (12.2 m) in width, and within 60 in. (1525 mm) of each side of the opening. [***101***:9.6.2.4]

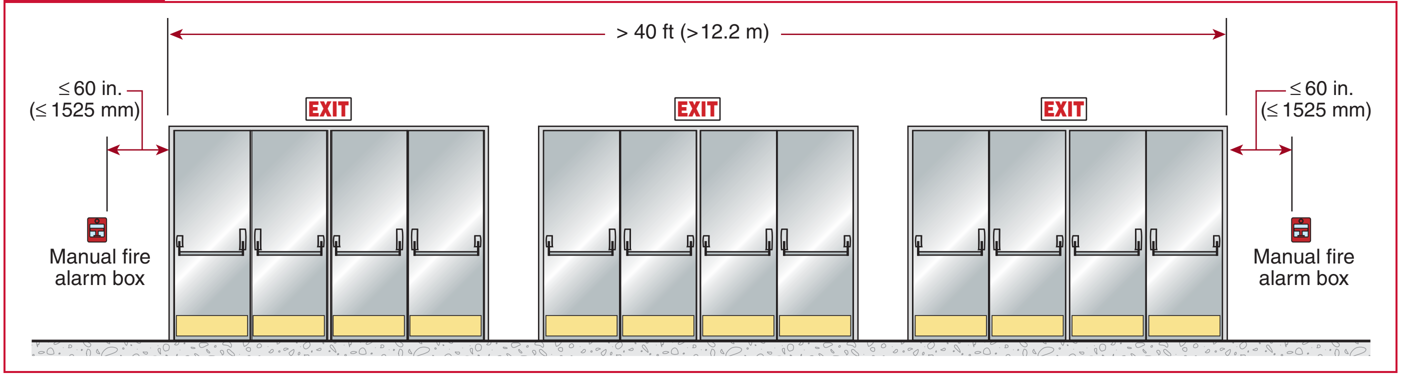
Prior to the 2009 edition of the *Code,* manual fire alarm boxes were only required to be located near each required exit in the natural exit access path; such arrangement is still permitted by 13.7.1.7.3(2) for existing installations. For new installations, manual fire alarm boxes must be located within 60 in. (1525 mm) of exit doors, which includes doors directly to the outside and doors to exit stair enclosures and exit passageways. See Exhibit 13.35 for an example of the application of 13.7.1.7.4 to manual fire alarm boxes at grouped openings.

13.7.1.7.5* Additional manual fire alarm boxes shall be located so that, on any given floor in any part of the building, no horizontal distance on that floor exceeding 200 ft (61 m) shall need to be traversed to reach a manual fire alarm box. [***101***:9.6.2.5]

A.13.7.1.7.5 It is not the intent of 13.7.1.7.5 to require manual fire alarm boxes to be attached to movable partitions or to equipment, nor is it the intent to require the installation of permanent structures for mounting purposes only. [***101***:A.9.6.2.5]

In a large open area, such as an exhibit hall, it would be impractical to require the installation of manual fire alarm boxes on

Exhibit 13.35



Locations of manual fire alarm boxes at grouped openings.

mounting posts in the middle of the floor. However, it would be reasonable to apply the maximum spacing requirements to boxes located on the perimeter wall of the space.

13.7.1.7.6* For fire alarm systems using automatic fire detection or waterflow detection devices to initiate the fire alarm system in accordance with Chapters 11 through 43 of NFPA *101*, not less than one manual fire alarm box, located as required by the AHJ, shall be provided to initiate a fire alarm signal. [***101:***9.6.2.6]

A.13.7.1.7.6 The manual fire alarm box required by 13.7.1.7.6 is intended to provide a means to manually activate the fire alarm system when the automatic fire detection system or waterflow devices are out of service due to maintenance or testing, or where human discovery of the fire precedes automatic sprinkler system or automatic detection system activation. Where the fire alarm system is connected to a monitoring facility, the manual fire alarm box required by 13.7.1.7.6 should be connected to a separate circuit that is not placed "on test" when the detection or sprinkler system is placed on test. The manual fire alarm box should be located in an area that is accessible to occupants of the building and should not be locked. [***101:***A.9.6.2.6]

13.7.1.7.7* Manual fire alarm boxes shall be accessible, unobstructed, and visible. [***101:***9.6.2.7]

A.13.7.1.7.7 Manual fire alarm boxes can include those with key-operated locks for detention areas or psychiatric hospitals, manual fire alarm boxes in areas where explosive vapors or dusts might be a hazard, or manual fire alarm boxes in areas with corrosive atmospheres. The appearance of manual fire alarm boxes for special uses often differs from those used in areas of normal occupancy. Manual fire alarm boxes, such as those with locks, that are located in areas where the general public has limited access might need to have signage advising persons to seek assistance from staff in the event a fire is noted. [***101:***A.9.6.2.7]

Paragraphs 13.7.1.7.3 through 13.7.1.7.7 establish the criteria for the placement of manual fire alarm boxes. The intent is to provide maximum visibility and easy access to increase the probability that building occupants will initiate an alarm as they exit the building. If alarm boxes are not located conveniently or are obstructed from view, it is unlikely that an occupant will look for one. A manual fire alarm box is shown in Exhibit 13.36.

The requirement of 13.7.1.7.6 is also found in *NFPA 72*. This requirement affects initiation arrangement for occupancies that permit alarm initiation by automatic detection or extinguishing system operation in lieu of manual initiation. For example, a business occupancy using either 13.7.2.25.2(2) or (3) for alarm initiation would still be required to have one manual fire alarm box in the building at a location approved by the AHJ. The single required fire alarm box is intended to be utilized to initiate the required fire alarm to provide occupant notification in the event the automatic initiation circuit is out of service for testing, maintenance, or repair. It is not necessarily intended to be accessible to the general public, although it might be if so required by the AHJ.

13.7.1.7.8 Where a sprinkler system provides automatic detection and alarm system initiation, it shall be provided with an approved

Exhibit 13.36

Manual fire alarm box. (Courtesy of The Protectowire Co., Inc., Pembroke, MA) alarm initiation device that operates when the flow of water is equal to or greater than that from a single automatic sprinkler. [*101:*9.6.2.8]

13.7.1.7.9 Where a total (complete) coverage smoke detection system is required by another section of this *Code*, automatic detection of smoke in accordance with *NFPA 72* shall be provided in all occupiable areas in environments that are suitable for proper smoke detector operation. [*101:*9.6.2.9]

13.7.1.8 Smoke Alarms.

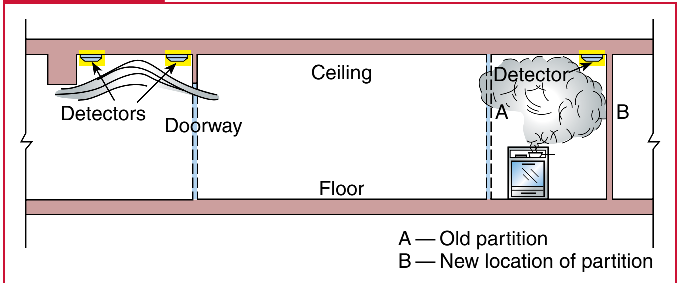
Smoke alarms need to be positioned correctly. If they are too close to a wall/ceiling intersection, particularly over a door, air currents might cause heat and smoke to bypass the unit completely. Likewise, the location of the alarms with respect to a dropped beam or other construction can have a similar nullifying effect. Problems can arise where partitions are moved without regard to the location of existing detectors. These problems are illustrated in Exhibit 13.37. *NFPA 72* provides extensive guidance in this area.

The terms *smoke alarm* and *smoke detector* are frequently, and incorrectly, used interchangeably. A smoke alarm is a device that, upon the presence of smoke, sounds an integral alarm. Smoke alarms are typically powered by the building electrical system and might be provided with battery backup; in some cases, such as in existing one- and two-family dwellings, they are permitted to be powered solely by batteries. Smoke alarms are typically found within dwelling units and within sleeping rooms of lodging or rooming houses and hotels and dormitories, among other occupancy locations.

Smoke alarms can be of either the single-station type or the multiple-station type. The term *single station* means that, when a particular smoke alarm senses smoke, only that device sounds its integral sounding alarm. The term *multiple-station* refers to smoke alarms that are interconnected such that, when one alarm senses smoke, all the interconnected devices sound their integral alarms. Multiple-station smoke alarms are typically interconnected within individual dwelling units to alert sleeping occupants located in different rooms to a fire in the dwelling.

A smoke detector is a component of a fire alarm system. In the presence of smoke, a smoke detector sends an electronic signal to the fire alarm control unit, which, in turn, initiates a predetermined action (such as activating the building evacuation alarm). Smoke detectors usually receive their power from the fire alarm system and contain no integral sounding devices.

Exhibit 13.37



Detector location problems to be avoided.

In an occupancy such as a hotel, it might be desirable to protect the guest rooms with system smoke detectors rather than single-station smoke alarms. The *Code*, however, prohibits the guest room smoke detectors from sounding the general building evacuation alarm (see 13.7.1.8.9). Provided that the system smoke detectors are arranged to function like single- or multiple-station smoke alarms by sounding an alarm only within the protected guest room or suite, and to perhaps annunciate a supervisory signal at the front desk, 13.7.1.8.6 permits system smoke detectors to be used in the guest rooms in lieu of single- or multiple-station smoke alarms. The use of such system smoke detectors might provide an enhanced level of reliability, since the wiring connecting the detectors to the fire alarm control unit will be supervised for integrity in accordance with *NFPA 72*.

13.7.1.8.1 Where required by another section of this *Code*, single-station and multiple-station smoke alarms shall be in accordance with *NFPA 72* unless otherwise provided in 13.7.1.8.3, 13.7.1.8.4, 13.7.1.8.5, or 13.7.1.8.6. [*101:*9.6.2.10.1]

13.7.1.8.2 Where automatic smoke detection is required by Chapters 11 through 43 of NFPA *101*, smoke alarms shall not be used as a substitute. [*101:*9.6.2.10.2]

13.7.1.8.3* The interconnection of smoke alarms shall apply only to new construction as provided in 13.7.1.8.8. [*101:*9.6.2.10.3]

Δ **A.13.7.1.8.3** *NFPA 72* mandates smoke alarms in all sleeping rooms, and interconnection of smoke alarms is required for both new and existing installations. Per 13.7.1.8.1, the residential occupancy requirements determine whether smoke alarms are needed within sleeping rooms. Paragraph 13.7.1.8.3 limits the requirement for interconnection of smoke alarms to those in new construction. This *Code* does not intend to require compliant, existing smoke alarm installations to be interconnected. This *Code* is periodically revised to add retrospective requirements only where the need is clearly substantiated. [*101:*A.9.6.2.10.3]

Δ **13.7.1.8.4** Smoke alarms and smoke detectors shall not be installed within an area of exclusion determined by a 10 ft (3.0 m) radial distance along a horizontal flow path from a stationary or fixed cooking appliance, unless listed for installation in close proximity to cooking appliances. Smoke alarms and smoke detectors installed between 10 ft (3.0 m) and 20 ft (6.1 m) along a horizontal flow path from a stationary or fixed cooking appliance shall be equipped with an alarm-silencing means or use photoelectric detection.

Exception: Smoke alarms or smoke detectors that use photoelectric detection shall be permitted for installation at a radial distance greater than 6 ft (1.8 m) from any stationary or fixed cooking appliance when the following conditions are met:

(1) The kitchen or cooking area and adjacent spaces have no clear interior partitions or headers and
(2) The 10 ft (3.0 m) area of exclusion would prohibit the placement of a smoke alarm or smoke detector required by other sections of NFPA 72.

*[**72:**29.8.3.4(4)]*

13.7.1.8.5 Smoke alarms and smoke detectors shall not be installed within a 36 in. (910 mm) horizontal path from a door to a bathroom containing a shower or tub unless listed for installation in close proximity to such locations. [**72:**29.8.3.4(6)]

Paragraph 13.7.1.8.5 clarifies that devices listed for installation in close proximity of bathroom doors are permitted within the 36 in. (910 mm) exclusion distance. This language is consistent with the general provisions for equivalency in Section 1.4, which permits for the application of technologies that can meet the intended performance goals without being overly restrictive and inadvertently barring the use of capable equipment.

13.7.1.8.6 System smoke detectors in accordance with *NFPA 72* and arranged to function in the same manner as single-station or multiple-station smoke alarms shall be permitted in lieu of smoke alarms. [***101:***9.6.2.10.7]

13.7.1.8.7 Smoke alarms, other than battery-operated smoke alarms as permitted by other sections of this *Code*, shall be powered in accordance with the requirements of *NFPA 72*. [***101:***9.6.2.10.8]

Single-station and multiple-station smoke alarms, unless exempted by 13.7.1.8.7, must be powered as required by *NFPA 72*. In general, they must be powered by the building electrical system; they must not rely solely on battery power. This provision is based on the experience that battery-operated smoke alarms do not provide the reliability with respect to uninterrupted power supply that building electrical system power provides. Batteries are often removed to avoid nuisance alarms caused by cooking or steam from showers, or they may be removed for use in other devices such as radios and electronic toys; dead batteries often are not replaced. However, 13.7.1.8.7 allows other sections of the *Code* to permit battery-operated, single-station smoke alarms. The use of battery-operated smoke alarms is permitted in existing one- and two-family dwellings; in existing lodging or rooming houses; and, under certain conditions, in existing residential board and care facilities.

It is not the intent of 13.7.1.8.7 to prohibit low-power wireless technology where a battery-operated alarm reports by radio transmission to a fire alarm control unit if such a system complies with *NFPA 72*. In turn, *NFPA 72* requires such systems to indicate a missing battery or low battery power condition at the remotely located alarm system panel. Compliance with the provisions of *NFPA 72* applicable to low-power wireless systems increases the power source reliability to a level comparable to that provided by connection to the building electrical service.

Δ **13.7.1.8.8*** In new construction, where two or more smoke alarms are required within a dwelling unit, suite of rooms, or similar area, they shall be arranged so that operation of any smoke alarm shall cause the alarm in all smoke alarms within the dwelling unit, suite of rooms, or similar area to sound, unless otherwise permitted by one of the following:

(1) The requirement of 13.7.1.8.8 shall not apply where permitted by another section of this *Code*.

(2) The requirement of 13.7.1.8.8 shall not apply to configurations that provide equivalent distribution of the alarm signal. [***101:***9.6.2.10.9]

A.13.7.1.8.8 A dwelling unit is that structure, area, room, or combination of rooms, including hotel rooms/suites, in which a family or individual lives. A dwelling unit includes living areas only and not common usage areas in multifamily buildings, such as corridors, lobbies, and basements. [***101:***A.9.6.2.10.8]

13.7.1.8.9 The alarms described in 13.7.1.8.8 shall sound only within an individual dwelling unit, suite of rooms, or similar area and shall not actuate the building fire alarm system, unless otherwise permitted by the AHJ. [***101:***9.6.2.10.10]

13.7.1.8.10 Smoke alarms shall be permitted to be connected to the building fire alarm system for the purpose of annunciation in accordance with *NFPA 72*. [***101:***9.6.2.10.11]

The intent behind requiring smoke alarms within individual living units without requiring connection to the building fire alarm system is to provide notification of a smoke condition within a guest room, guest suite, or dwelling unit to its occupants. Once the occupants escape from their unit to the building's common areas, they can use the manual fire alarm boxes to sound the building alarm to notify the remaining building occupants of the emergency.

Interconnection of dwelling unit smoke detectors to the building fire alarm system can result in numerous nuisance alarms due to the detection of cooking vapors or steam from showers. Nuisance alarms can lead to complacency or, worse, the deliberate disablement of the system and the resulting lack of early warning. Thus, where a complete fire detection (versus smoke detection) system is required, it usually includes system smoke detection within building common areas and system heat detection within individual dwelling units. Single- or multiple-station smoke alarms are then still necessary within each dwelling unit to afford the occupants of each unit early warning of smoke conditions within their unit.

13.7.1.9 Occupant Notification.

13.7.1.9.1 Occupant notification shall be provided to alert occupants of a fire or other emergency where required by other sections of this *Code*. [***101:***9.6.3.1]

13.7.1.9.2 Occupant notification shall be in accordance with 13.7.1.9.3 through 13.7.1.9.10.2, unless otherwise provided in 13.7.1.9.2.1 through 13.7.1.9.2.4. [***101:***9.6.3.2]

Note that 13.7.1.9.5 requires occupant notification to be provided by audible and visible signals. Thus, where an occupancy chapter requires an alarm system that provides occupant notification in accordance with 13.7.1.9, visible signals, as well as the traditional audible signals, must be provided. Several exemptions to the requirement for visible signals are provided in 13.7.1.9.5.1 through 13.7.1.9.5.8. For example, existing alarm systems are exempt from the requirement for visible signals per 13.7.1.9.5.3.

13.7.1.9.2.1* Elevator lobby, hoistway, and associated machine room smoke detectors used solely for elevator recall, and heat detectors used solely for elevator power shutdown, shall not be required to activate the building evacuation alarm if the power supply and installation wiring to such detectors are monitored by the building fire alarm system, and if the activation of such detectors initiates a supervisory signal at a constantly attended location. [***101:***9.6.3.2.1]

A.13.7.1.9.2.1 Elevator lobbies have been considered areas subject to unwanted alarms due to factors such as low ceilings and smoking. In the past several years, new features have become available to reduce this problem. These features are, however, not necessarily included in any specific installation. [***101:***A.9.6.3.2.1]

13.7.1.9.2.2* Smoke detectors used solely for closing dampers or heating, ventilating, and air-conditioning system shutdown shall not be required to activate the building evacuation alarm, provided that the power supply and installation wiring to the detectors are monitored by the building fire alarm system, and the activation of the detectors initiates a supervisory signal at a constantly attended location. [***101:***9.6.3.2.2]

A.13.7.1.9.2.2 The concept addressed is that detectors used for releasing service, such as door or damper closing and fan shutdown, are not required to sound the building alarm. [***101:***A.9.6.3.2.2]

13.7.1.9.2.3* Smoke detectors located at doors for the exclusive operation of automatic door release shall not be required to activate the building evacuation alarm, provided that the power supply and installation wiring to the detectors are monitored by the building fire alarm system, and the activation of the detectors initiates a supervisory signal at a constantly attended location. [***101:***9.6.3.2.3]

A.13.7.1.9.2.3 The concept addressed is that detectors used for releasing service, such as door or damper closing and fan shutdown, are not required to sound the building alarm. [***101:***A.9.6.3.2.3]

13.7.1.9.2.4 Detectors in accordance with 22.3.4.3.1(2) and 23.3.4.3.1(2) of NFPA *101* shall not be required to activate the building evacuation alarm. [***101:***9.6.3.2.4]

The provisions of 13.7.1.9.2.1 through 13.7.1.9.2.4 reaffirm that not all detectors are required to sound the building alarm simply because they are installed on the premises. Detectors used for releasing service, such as for the release of an automatic door hold-open device that allows a door to be self-closing in the presence of smoke, need only perform their intended function as long as the detector wiring is monitored and a supervisory signal is annunciated at a constantly attended location when the detectors activate. In areas where smoke detection — complete with occupant notification via the building alarm system — is needed to provide the intended level of life safety, the *Code* specifically requires either a complete or a partial smoke detection system. Interconnection with the building alarm should not be mandated in the hope of receiving additional detection coverage; such a detector might have been installed for another purpose, such as releasing service.

New health care occupancies, as specified in 13.7.2.7.3.1, are prohibited from using 13.7.1.9.2.3. Thus, if a smoke detector is installed as part of an automatic door release system (see 14.5.4.2), the activation of the detector must result in occupant notification through the building fire alarm system.

13.7.1.9.3 Where permitted by Chapters 11 through 43 of NFPA *101*, a presignal system shall be permitted where the initial fire alarm signal is automatically transmitted without delay to a municipal fire department, to a fire brigade (if provided), and to an on-site staff person trained to respond to a fire emergency. [***101:***9.6.3.3]

Instead of immediately and automatically sounding a general alarm throughout the building, a presignal system delays the general alarm by sounding an alarm only at an approved and constantly attended area. This area could be, for example, a fire brigade station, a guard station, or similar location with staff trained to investigate the signal's origin and subsequently activate a general alarm if necessary.

A delay in sounding the general alarm is inherent in a presignal system, but the delay might do more harm than good in those occupancies with populations that are difficult to evacuate or protect. Therefore, the *Code* requires an occupancy to specifically recognize a presignal system to permit its use.

A presignal system used in accordance with the provisions of 13.7.1.9.3 is permitted to delay only the general occupant notification and must, at time of initiation, achieve immediate and automatic notification of emergency forces.

13.7.1.9.4 Where permitted by Chapters 11 through 43 of NFPA *101*, a positive alarm sequence shall be permitted, provided that it is in accordance with *NFPA 72*. [***101:***9.6.3.4]

Positive alarm sequence offers relief from nuisance alarms in buildings equipped with detection technology by permitting a delay in occupant notification. The detector senses smoke and automatically, without delay, sends an alarm signal to a constantly attended location, so that trained staff can investigate the origin of the signal. Positive alarm sequence includes the following features:

1. The signal received at the attended location must be acknowledged within 15 seconds, or immediate activation of notification signals in accordance with the building evacuation or relocation plan and remote signals must occur.
2. Trained personnel have up to 180 seconds during the alarm investigation phase to evaluate the fire condition and reset the system; if the system is not reset within 180 seconds, immediate activation of notification signals in accordance with the building evacuation or relocation plan and remote signals must occur.
3. If a second automatic fire detector is actuated during the investigation phase, immediate activation of notification signals in accordance with the building evacuation or relocation plan and remote signals must occur.

4. If any other initiating device, such as a manual fire alarm box, is actuated during the investigation phase, immediate activation of notification signals in accordance with the building evacuation or relocation plan and remote signals must occur.
5. The system must provide a means to bypass the positive alarm sequence.

Positive alarm sequence is permitted where another section of this *Code* or NFPA *101* specifically allows it. The only occupancies that do not permit occupant notification by positive alarm sequence are new and existing residential board and care occupancies.

13.7.1.9.5 Unless otherwise provided in 13.7.1.9.5.1 through 13.7.1.9.5.8, notification signals for occupants to evacuate shall be by audible and visible signals in accordance with *NFPA 72* and ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*, or other means of notification acceptable to the AHJ. [***101:***9.6.3.5]

13.7.1.9.5.1 Areas not subject to occupancy by persons who are hearing impaired shall not be required to comply with the provisions for visible signals. [***101:***9.6.3.5.1]

In addition to audible alarms, visible alarm devices are needed in buildings occupied by persons who are hearing impaired. The provision of 13.7.1.9.5.1 recognizes that not all buildings are subject to occupancy by those who are hearing impaired. For example, in a high hazard industrial occupancy where, due to employee safety concerns, an adequate hearing level has been judged to be a legitimate condition of employment, there should be no life safety need for visible signals in addition to the audible signals. As the provisions of the *Americans with Disabilities Act and Architectural Barriers Act Accessibility Guidelines for Buildings and Facilities* receive wider implementation or are expanded in scope, few locations will exist where it is certain that persons with hearing impairments will not be present.

13.7.1.9.5.2 Visible-only signals shall be provided where specifically permitted in health care occupancies in accordance with Chapters 18 and 19 of NFPA *101*. [***101:***9.6.3.5.2]

13.7.1.9.5.3 Existing alarm systems shall not be required to comply with the provision for visible signals. [***101:***9.6.3.5.3]

Δ **13.7.1.9.5.4** Visible signals shall not be required in lodging or rooming houses in accordance with Chapter 26 of NFPA *101*. [***101:***9.6.3.5.4]

13.7.1.9.5.5 Visible signals shall not be required in exit stair enclosures. [***101:***9.6.3.5.5]

13.7.1.9.5.6 Visible signals shall not be required in elevator cars. [***101:***9.6.3.5.6]

Visible occupant notification appliances are not required to be installed in exit stairs or elevator cars as noted in 13.7.1.9.5.5 and 13.7.1.9.5.6, respectively. These provisions recognize that, upon entering an exit stair, occupants have reached a safe location and are in the process of egressing the building. Notification appliances in exit stair enclosures can create confusion and slow down the evacuation process. Likewise, if occupants are in an elevator and the building alarm activates, they will become aware of the alarm condition when the doors open and will proceed to egress the building. See also 13.7.1.9.6.4 and 13.7.1.9.6.5 for parallel provisions addressing audible notification appliances.

13.7.1.9.5.7* Public mode visual notification appliances in accordance with *NFPA 72* shall not be required in designated areas as permitted by Chapters 11 through 43 of NFPA *101*, provided that they are replaced with approved alternative visible means. [***101:***9.6.3.5.7]

A.13.7.1.9.5.7 Visual notification appliances installed in large volume spaces, such as arenas, stadiums, mall concourses and atriums, can be alternative devices which are not listed as visible notification appliances for fire alarm systems provided that the notification objective of the visual signal is reasonably achieved. Examples of alternative devices include, but are not limited to, scoreboards, message boards, and other electronic devices that meet the performance objectives of visible fire alarm appliances in large volume spaces. [***101:***A.9.6.3.5.7]

It is the intent to permit the omission of visible notification appliances as identified in 13.7.1.9.5.7 provided that the adjacent areas that have not been specifically designated as exempt are provided with visible notification as required by 13.7.1.9.5. [***101:***A.9.6.3.5.7]

13.7.1.9.5.8* Where visible signals are not required, as permitted by 13.7.1.9.5.7, documentation of such omission shall be maintained in accordance with 9.7.7 of NFPA *101*. [***101:***9.6.3.5.8]

A.13.7.1.9.5.8 Documentation should be maintained with the as-built drawings so that inspection and testing personnel understand that the visible appliances have been exempted from certain areas and, therefore, can note the deviation on the acceptance test documentation and ongoing inspection reports. This will provide inspection and testing personnel with necessary details regarding the omission of visible notification appliances. [***101:***A.9.6.3.5.8]

In large-volume spaces, such as stadiums, standard visual alarm notification appliances (strobes) might not prove to be effective for hearing-impaired occupants. The provisions of 13.7.1.9.5.7 and 13.7.1.9.5.8 permit alternative means of visual notification, provided that permission is granted by the applicable occupancy. Such alternative means of visual notification might be provided by electronic signage or video displays strategically located throughout the space or by the electronic scoreboards provided within a stadium or arena. It is anticipated that, in such occupancies, hearing-impaired occupants not only will see the messages but will take cues from other occupants responding to the audible alarm notification.

13.7.1.9.6 The general evacuation alarm signal shall operate in accordance with one of the methods prescribed by 13.7.1.9.6.1 through 13.7.1.9.6.3. [***101:***9.6.3.6]

13.7.1.9.6.1 The general evacuation alarm signal shall operate throughout the entire building other than the locations described in 13.7.1.9.6.4 and 13.7.1.9.6.5. [***101:***9.6.3.6.1]

13.7.1.9.6.2* Where total evacuation of occupants is impractical due to building configuration, only the occupants in the affected zones shall be initially notified, and provisions shall be made to selectively notify occupants in other zones to afford orderly evacuation of the entire building, provided that such arrangement is approved by the AHJ. [***101:***9.6.3.6.2]

A.13.7.1.9.6.2 To approve an evacuation plan to selectively notify building occupants, the AHJ should consider several building parameters, including building compartmentation, detection and suppression system zones, occupant loads, and the number and arrangement of the means of egress.

In high-rise buildings, it is typical to evacuate the fire floor, the floor(s) above, and the floor immediately below. Other areas are then evacuated as the fire develops. [***101:***A.9.6.3.6.2]

The provision of 13.7.1.9.6.2 typically applies to high-rise buildings. It provides for zoned, staged evacuation. This provision anticipates that the portions of the building that do not receive the initial alarm are separated from the areas of immediate emergency by adequate fire resistance–rated construction, such as the 2-hour fire separation that is usually provided between floors of high-rise buildings.

The use of staged evacuation requires occupants to be regularly trained and to have a basic understanding of the building's life safety systems and features. After having witnessed the collapse of the World Trade Center on September 11, 2001, many building occupants might not be comfortable remaining in a high-rise building under any fire condition. By conducting routine training, their comfort level can be increased by raising their awareness of how buildings are designed to limit the spread of fire from the area of origin through compartmentation and the installation of automatic sprinkler systems. This training becomes very important, since the exit stairs in most existing high-rise buildings are not designed to accommodate the simultaneous evacuation of the entire building population.

13.7.1.9.6.3 Where occupants are incapable of evacuating themselves because of age, physical or mental disabilities, or physical restraint, all of the following shall apply:

(1) The private operating mode as described in *NFPA 72* shall be permitted to be used.
(2) Only the attendants and other personnel required to evacuate occupants from a zone, area, floor, or building shall be required to be notified.
(3) Notification of personnel as specified in 13.7.1.9.6.3(2) shall include means to readily identify the zone, area, floor, or building in need of evacuation.

[***101:***9.6.3.6.3]

The provisions of 13.7.1.9.6.3, which address the private operating mode for occupant notification, frequently apply to health care occupancies and detention and correctional occupancies. It is common in these occupancies to use coded messages or a similar method to announce the occurrence and location of a fire emergency throughout the facility. This allows all members of the emergency response team, regardless of current location within a potentially sprawling facility, to respond to their assigned emergency duties.

NFPA 72 modifies the requirements for the placement of visible notification appliances where the private operating mode is utilized. For example, it might not be necessary to locate visible notification appliances in the patient rooms of a hospital or nursing home, since notification is intended to be provided via a coded message to staff, who will initiate the emergency plan. In such a case, visible signals might be limited to those areas subject to occupancy by the general public (such as lobbies, corridors, cafeterias, public restrooms, and other similar spaces). The AHJ ultimately determines where visible notification appliances must be located.

Δ **13.7.1.9.6.4** The general evacuation signal shall not be required in exit stair enclosures. [***101:***9.6.3.6.4]

Δ **13.7.1.9.6.5** The general evacuation signal shall not be required in elevator cars. [***101:***9.6.3.6.5]

13.7.1.9.7 Audible alarm notification appliances shall be of such character and so distributed as to be effectively heard above the average ambient sound level that exists under normal conditions of occupancy. [***101:***9.6.3.7]

The AHJ should review carefully the types and locations of fire alarm notification appliances. Given that audibility above ambient sound level is of primary importance and that each additional sounding device adds cost to a system, a balance should be maintained so that excessive costs are not incurred, while the installation of sufficient devices for adequate audibility is ensured. The provision of sufficient devices is extremely important in hotels and apartment buildings. Sounding devices located in corridors might not be audible within living units or guest rooms, especially in newer construction, due to the increased use of acoustical insulation for sound isolation.

In newer hotels, it has become common to install alarm notification appliances within each guest room to meet the audibility requirements of *NFPA 72*. With water running in the bathroom, the television operating on high volume, and the air-conditioning system in use, the horn or speaker within the room achieves the required occupant notification, whereas a similar device located in the corridor alone might not. Additionally, the alarm device often used is a speaker that can produce an alarm tone or deliver a specific voice message. A speaker device is particularly useful in a high-rise building; although it is important to get an initial message to all rooms, there could be a need to send different messages to different parts of the building as part of a zoned or staged evacuation plan. See the commentary following A.13.7.1.9.6.2 for additional information on staged evacuation.

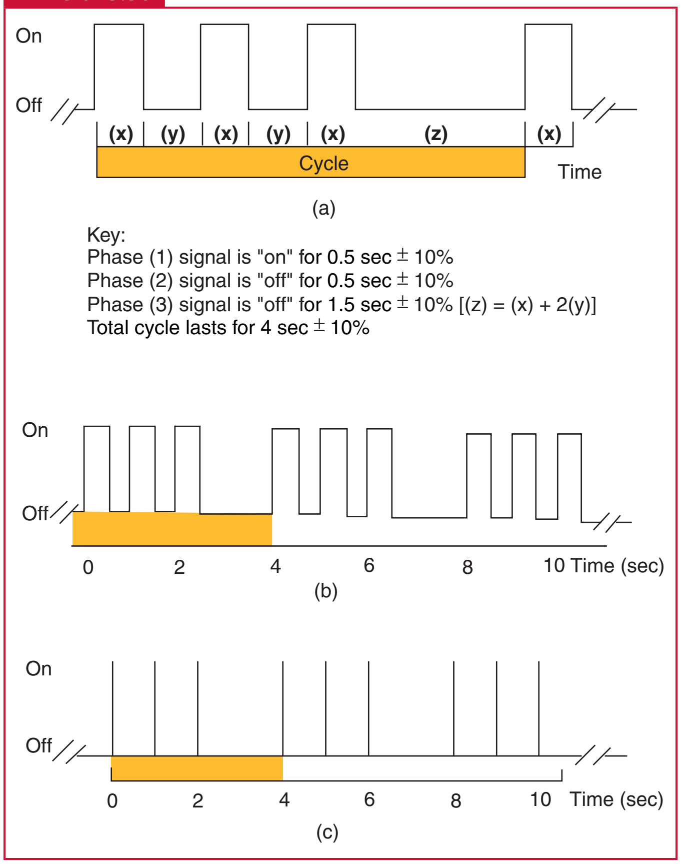
13.7.1.9.8 Audible alarm notification appliances shall produce signals that are distinctive from audible signals used for other purposes in a given building. [***101:***9.6.3.8]

Where an evacuation alarm signal is required by this *Code* or NFPA *101*, the standard fire alarm evacuation signal described in *NFPA 72* should be used. The standard fire alarm evacuation signal is a three-pulse temporal pattern using any appropriate sound. This signal is illustrated in Exhibit 13.38. The pattern consists of an "on" phase (1) lasting 0.5 second followed by an "off" phase (2) lasting 0.5 second, for three successive "on" periods; these are followed by an "off" phase (3) lasting 1.5 seconds. The signal should be repeated for a period appropriate for the purposes of evacuation of the building, but for not less than 180 seconds. A single-stroke bell or chime sounded at "on" intervals lasting 1 second, with a 2-second "off" interval after each third "on" stroke, is permitted.

13.7.1.9.9 Automatically transmitted or live voice evacuation or relocation instructions shall be permitted to be used to notify occupants and shall comply with either 13.7.1.9.9.1 or 13.7.1.9.9.2. [***101:***9.6.3.9]

13.7.1.9.9.1 Automatically transmitted or live voice evacuation or relocation instructions shall be in accordance with *NFPA 72*. [***101:***9.6.3.9.1]

Exhibit 13.38



Standard fire alarm evacuation signal.

13.7.1.9.9.2 Where permitted by Chapters 11 through 43 of NFPA *101*, automatically transmitted or live voice announcements shall be permitted to be made via a voice communication or public address system that complies with all of the following:

(1) Occupant notification, either live or recorded, shall be initiated at a constantly attended receiving station by personnel trained to respond to an emergency.
(2) An approved secondary power supply shall be provided for other than existing, previously approved systems.
(3) The system shall be audible above the expected ambient noise level.
(4) Emergency announcements shall take precedence over any other use.

[***101:***9.6.3.9.2]

13.7.1.9.10 Unless otherwise permitted by another section of this *Code*, audible and visible fire alarm notification appliances shall comply with either 13.7.1.9.10.1 or 13.7.1.9.10.2. [***101:***9.6.3.10]

13.7.1.9.10.1 Audible and visible fire alarm notification appliances shall be used only for fire alarm system or other emergency purposes. [***101:***9.6.3.10.1]

13.7.1.9.10.2 Emergency voice/alarm communication systems shall be permitted to be used for other purposes in accordance with *NFPA 72*. [***101:***9.6.3.10.2]

The provision of 13.7.1.9.10.2 permits a voice communication system to be used for some other purpose in accordance with *NFPA 72*. The system designer or building operator and the AHJ should determine how susceptible the system is to deliberate tampering. For example, in a business occupancy where a combination emergency voice communication and daily background music system is installed with a speaker located in the ceiling directly over an employee's desk, it should be predicted that the constant background music might irritate the employee to the point that the employee might muffle or otherwise disable the speaker. Therefore, the requirement that the fire alarm system take precedence over all other signals becomes futile; a disabled speaker cannot deliver the required emergency message.

13.7.1.10 Emergency Forces Notification.

13.7.1.10.1 Where required by another section of this *Code*, emergency forces notification shall be provided to alert the municipal fire department and fire brigade (if provided) of fire or other emergency. [***101:***9.6.4.1]

Δ **13.7.1.10.2** Where emergency forces notification is required by another section of this *Code*, the fire alarm system shall be arranged to transmit the alarm automatically via any of the following means acceptable to the AHJ and shall be in accordance with *NFPA 72*:

(1) Auxiliary fire alarm system
(2) Central station fire alarm system
(3) Proprietary supervising station fire alarm system
(4) Remote supervising station fire alarm system

[***101:***9.6.4.2]

The following paragraphs help differentiate among the four alarm transmission methods for fire department notification specified in 13.7.1.10.2.

1. *Auxiliary fire alarm system.* An auxiliary fire alarm system is a system connected to a municipal fire alarm system for transmitting a fire alarm to the public fire service communications center. Fire alarms from an auxiliary alarm system are received at the public fire service communications center on the same equipment and by the same methods as alarms transmitted manually from municipal fire alarm boxes located on streets.

2. *Central station fire alarm system.* A central station fire alarm system is a system or group of systems in which the operations of circuits and devices are signaled automatically to, recorded in, maintained by, and supervised from a listed central station staffed by competent and experienced servers and operators. Upon receipt of a signal, the staff takes such action as is required. Such service is controlled and operated by a person or firm whose business is the furnishing, maintaining, and monitoring of supervised fire alarm systems.

3. *Proprietary supervising station fire alarm system.* A proprietary supervising station fire alarm system is an installation of fire alarm systems that serves contiguous or noncontiguous properties, under one ownership, from a proprietary supervising station located at the protected property where trained, competent personnel are in constant attendance. This system includes the proprietary supervising station; power supplies; signal initiating devices; initiating device circuits (IDCs); signal notification appliances; equipment for the automatic, permanent, visual recording of signals; and equipment for initiating the operation of emergency building control services.

4. *Remote supervising station fire alarm system.* A remote supervising station fire alarm system is a system installed to transmit alarm, supervisory, and trouble signals from one or more protected premises to a remote supervising station location at which appropriate action is taken.

Δ **13.7.1.10.3** For existing installations where none of the means of notification specified in 13.7.1.10.2(1) through 13.7.1.10.2(4) are available, an approved plan for notification of the municipal fire department shall be permitted. [***101:***9.6.4.3]

The extensive availability of reliable communications systems has limited the necessity for the provision of 13.7.1.10.3 (formerly permitted for all occupancies) to existing installations only.

13.7.1.10.4 For other than existing installations, where fire alarm systems are required to provide emergency forces notification, supervisory signals and trouble signals shall sound and be visibly displayed either at an approved, remotely located receiving facility or at a location within the protected building that is constantly attended by qualified personnel. [***101:***9.6.4.4]

13.7.1.11 Fire Safety Functions.

13.7.1.11.1 Emergency control functions shall be installed in accordance with the requirements of *NFPA 72*. [***101:***9.6.5.1]

13.7.1.11.2 Where required by another section of this *Code*, the following functions shall be actuated:

(1) Release of hold-open devices for doors or other opening protectives

Doors are permitted by 14.5.4.2 to be automatic-closing if (among other requirements) the detection of smoke automatically releases the device holding the door open, thus allowing the door to become self-closing. The provisions of 14.5.4.2 do not require the building alarm system to release the doors. The health care occupancy chapters of NFPA *101* are more stringent on the subject and require that the automatic closing of doors must also occur upon initiation of the building's required fire alarm system (see 18.2.2.2.8 and 19.2.2.2.8 of NFPA *101*). This is an example of an occupancy chapter of NFPA *101* mandating the application of 13.7.1.11.2(1) as a requirement that is needed in addition to the provisions of 14.5.4.2.

(2) Stairwell or elevator shaft pressurization
(3) Smoke management or smoke control systems

Manual fire alarm boxes generally should not be used to activate smoke control systems, other than stair tower pressurization systems, due to the likelihood of a person signaling an alarm from a location outside the smoke zone of fire origin. Such alarm initiation could put the smoke management system in an undesirable mode of operation and cause it to spread smoke from one zone to another, rather than restrict it. The installation of smoke control systems is addressed by NFPA 92, *Standard for Smoke Control Systems*.

(4) Unlocking of doors

For an example of a *Code* requirement for the activation of the alarm system to unlock a door, see the provisions for delayed-egress electrical locking systems addressed by 14.5.3.1.

(5) Elevator recall and shutdown

ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, and ASME A17.3, *Safety Code for Existing Elevators and Escalators* (which are referenced mandatorily by Section 11.3), prohibit the recall of elevators by detectors, other than those installed in elevator lobbies, hoistways, and associated elevator machine rooms. Recall by other detectors can lead to numerous nuisance recalls under conditions where it would be safe to operate elevators. To avoid taking elevators out of service every time any building smoke detector activates, the recall feature is sometimes deliberately disabled. ASME A17.1/CSA B44 and ASME A17.3 impose the recall restriction to ensure that the elevator recall feature remains operational. The elevator lobby, hoistway, and machine room detectors are permitted to be part of the building fire alarm system, provided that only the activation of those detectors initiates elevator recall.

(6) HVAC shutdown
[***101:***9.6.5.2]

13.7.1.12 Location of Controls. Operator controls, alarm indicators, and manual communications capability shall be installed at a convenient location acceptable to the AHJ. [***101:***9.6.6]

At times it is not practical, either physically or from a security standpoint, to locate fire alarm system controls adjacent to an entrance. For example, controls for proprietary fire alarm systems designed in accordance with *NFPA 72,* for reasons of security, often need to be located away from public areas. Thus, the *Code* does not require that controls be located adjacent to an entrance. However, because the controls are intended to be used by the fire department, they need to be located as approved by the AHJ. Where the fire department does not serve as the AHJ, it should be consulted to determine an acceptable location.

13.7.1.13 Annunciation and Annunciation Zoning.

The provisions of 13.7.1.13 establish requirements for fire alarm annunciation, which are then referenced by other sections of the *Code* as part of the overall life safety package needed for specific occupancies. Alarm annunciation allows trained individuals — such as building engineers, security and safety officers, and responding fire service personnel — to read the indicator lamps or alphanumeric displays of an annunciator panel to identify circuits, associated building locations, and conditions that warrant attention or investigation.

13.7.1.13.1 Where alarm annunciation is required by another section of this *Code*, it shall comply with 13.7.1.13.2 through 13.7.1.13.13. [***101:***9.6.7.1]

13.7.1.13.2 Alarm Annunciation. Where required by other governing laws, codes, or standards, the location of an operated initiating device shall be annunciated by visible means. [**72:**10.17.1.1]

13.7.1.13.2.1 Visible annunciation of the location of an operated initiating device shall be by an indicator lamp, alphanumeric display, printout, or other approved means. [**72:**10.17.1.1.1]

13.7.1.13.2.2 The visible annunciation of the location of operated initiating devices shall not be canceled by the means used to deactivate alarm notification appliances. [**72:**10.17.1.1.2]

13.7.1.13.3 Supervisory and Trouble Annunciation. Where required by other governing laws, codes, or standards, supervisory and/or trouble conditions shall be annunciated by visible means. [**72:**10.17.2.1]

13.7.1.13.3.1 Visible annunciation shall be by an indicator lamp, an alphanumeric display, a printout, or other means. [**72:**10.17.2.1.1]

13.7.1.13.3.2 The visible annunciation of supervisory and/or trouble conditions shall not be canceled by the means used to deactivate supervisory or trouble notification appliances. [**72:**10.17.2.1.2]

13.7.1.13.4* Annunciator Access and Location.

A.13.7.1.13.4 The primary purpose of annunciation is to enable responding personnel to quickly and accurately determine the status of equipment or emergency control functions that might affect the safety of occupants. [**72:**A.10.17.3]

The AHJ determines the type and location of any required annunciation. Common locations for annunciation are lobbies, guards' desks, and fire command centers. *NFPA 72* does not prescribe requirements for the location of the fire alarm control unit. However, if annunciation is required and the fire alarm control unit is being used as the means for annunciation, it must be located in accordance with 13.7.1.13.4.1 and 13.7.1.13.4.2.

13.7.1.13.4.1 All required annunciation means shall be readily accessible to responding personnel. [**72:**10.17.3.1]

13.7.1.13.4.2 All required annunciation means shall be located as required by the AHJ to facilitate an efficient response to the situation. [**72:**10.17.3.2]

13.7.1.13.5 Alarm Annunciation Display. Visible annunciators shall be capable of displaying all zones in alarm. [**72:**10.17.4]

13.7.1.13.5.1 If all zones in alarm are not displayed simultaneously, the zone of origin shall be displayed. [**72:**10.17.4.1]

13.7.1.13.5.2 If all zones in alarm are not displayed simultaneously, there shall be an indication that other zones are in alarm. [**72:**10.17.4.2]

The requirement in 13.7.1.13.5 ensures that where systems require scrolling to view all the zones in alarm, the system will display the zone of origin and provide an indication that more alarms can be viewed than are currently displayed. The intent is to aid emergency responders in quickly obtaining complete information from the system. The zone of origin must always be displayed. Although the arrangement of the display is not prescribed, *Code* users should be aware of the standard emergency service interface requirements of Section 18.11 of *NFPA* 72 and the related guidance in A.18.11.

13.7.1.13.6* Annunciation Zoning.

A.13.7.1.13.6 Fire alarm system annunciation should, as a minimum, be sufficiently specific to identify a fire alarm signal in accordance with the following:

(1) If a floor exceeds 22,500 ft^2 (2090 m^2) in area, the floor should be subdivided into detection zones of 22,500 ft^2 (2090 m^2) or less, consistent with the existing smoke and fire barriers on the floor.
(2) If a floor exceeds 22,500 ft^2 (2090 m^2) in area and is undivided by smoke or fire barriers, detection zoning should be determined on a case-by-case basis in consultation with the AHJ.
(3) Waterflow switches on sprinkler systems that serve multiple floors, areas exceeding 22,500 ft^2 (2090 m^2), or areas inconsistent with the established detection system zoning should be annunciated individually.
(4) In-duct smoke detectors on air-handling systems that serve multiple floors, areas exceeding 22,500 ft^2 (2090 m^2), or areas inconsistent with the established detection system zoning should be annunciated individually.
(5) If a floor area exceeds 22,500 ft^2 (2090 m^2), additional zoning should be provided. The length of any zone should not exceed 300 ft (91 m) in any direction. If the building is provided with

automatic sprinklers throughout, the area of the alarm zone should be permitted to coincide with the allowable area of the sprinkler zone.
[**72:**A.10.17.5]

The provisions of 13.7.1.13.6 specify the minimum zoning required. Fire alarm system notification zones, which are addressed by these requirements, should correlate with building smoke and fire zones. This correlation is especially important if an in-building fire emergency voice/alarm communications system is used to selectively or partially evacuate occupants or to relocate occupants to areas of refuge during a fire. Definitions for the terms *zone*, *notification zone,* and *signaling zone* can be found in Chapter 3 of *NFPA 72*. In addition, refer to the requirements in 23.8.6.3 of *NFPA 72* for notification zones and the requirements in 24.4.9 of *NFPA 72* for signaling zones.

Additional zoning requirements may exist in the governing building codes, NFPA *101*, *NFPA 5000*®, and local ordinances. These higher-level documents often require each floor of a building to be zoned separately for smoke detectors, waterflow switches, manual fire alarm boxes, and other initiating devices. The zoning recommendations found in A.13.7.1.13.6 parallel the annunciation zoning requirements found in NFPA *101* and the model building codes. *NFPA 72*, as a minimum installation standard, does not require that an addressable system control unit be used. Conventional (zone or nonaddressable) alarm control units are often adequate to meet the annunciation zoning requirements. Local codes or ordinances might be more specific.

13.7.1.13.6.1 For the purpose of alarm annunciation, each floor of the building shall be considered as a separate zone. [**72:**10.19.5.1]

13.7.1.13.6.2 For the purposes of alarm annunciation, if a floor of the building is subdivided into multiple zones by fire or smoke barriers and the fire plan for the protected premises allows relocation of occupants from the zone of origin to another zone on the same floor, each zone on the floor shall be annunciated separately. [**72:**10.17.5.2]

13.7.1.13.6.3 Where the system serves more than one building, each building shall be annunciated separately. [**72:**10.17.5.3]

13.7.1.13.7 Alarm annunciation at the control center shall be by means of audible and visible indicators. [***101:***9.6.7.2]

Alarm annunciation at the control center, as specified in 13.7.1.13.7, must be by means of audible as well as visible indicators to capture the attention of the trained attendant, who might have numerous job functions within or near the control center that might distract attention from the annunciator panel.

Where a control center is not required or otherwise provided, the annunciator panel should be located in or near a public space, such as an entrance lobby, so that trouble and supervisory signals will get the attention of a passerby, who can then notify the building's maintenance staff.

13.7.1.13.8 For the purposes of alarm annunciation, each floor of the building, other than floors of existing buildings, shall be considered as not less than one zone, unless otherwise permitted by 13.7.1.13.9.4, 13.7.1.13.9.5, 13.7.1.13.9.6 or as another section of this *Code*. [***101:***9.6.7.3]

13.7.1.13.9 Where a floor area exceeds 22,500 ft^2 (2090 m^2), additional fire alarm zoning shall be provided, and the length of any single fire alarm zone shall not exceed 300 ft (91 m) in any direction, except as provided in 13.7.1.13.9.1 through 13.7.1.13.9.6 or otherwise modified by another section of this *Code*. [***101:***9.6.7.4]

13.7.1.13.9.1 Where permitted by another section of this *Code*, fire alarm zones shall be permitted to exceed 22,500 ft^2 (2090 m^2), and the length of a zone shall be permitted to exceed 300 ft (91 m) in any direction. [***101:***9.6.7.4.1]

13.7.1.13.9.2 Where the building is protected by an automatic sprinkler system in accordance with NFPA 13, the area of the fire alarm zone shall be permitted to coincide with the allowable area of the sprinkler system. [***101:***9.6.7.4.2]

13.7.1.13.9.3 Where the building is protected by a water mist system in accordance with 9.8.1 and Table 9.8.1 of NFPA *101*, the area of the fire alarm zone shall be permitted to coincide with the allowable area of the water mist system. [***101:***9.6.7.4.3]

13.7.1.13.9.4 Unless otherwise prohibited by another section of this *Code*, where a building not exceeding four stories in height is protected by an automatic water mist system in accordance with 9.7.3 of NFPA *101*, the water mist system shall be permitted to be annunciated on the fire alarm system as a single zone. [***101:***9.6.7.4.4]

13.7.1.13.9.5 Unless otherwise prohibited by another section of this *Code*, where a building not exceeding four stories in height is protected by an automatic sprinkler system in accordance with NFPA 13, the sprinkler system shall be permitted to be annunciated on the fire alarm system as a single zone. [***101:***9.6.7.4.5]

The provision of 13.7.1.13.9.5 permits the waterflow from a sprinkler system that meets the requirements of NFPA 13 to be annunciated as a single zone in buildings up to four stories in height, unless the applicable occupancy chapters prohibit such arrangement. Lacking this provision, sprinkler systems would have to be arranged so that every floor would be provided with a waterflow switch to permit each floor to be annunciated as separate zones. Such a requirement would limit the sprinkler system design flexibility and would prohibit the use of the so-called birdcage design in which multiple vertical risers act as loops for hydraulic efficiency. The only occupancy chapter of NFPA *101* that prohibits the use of this provision is Chapter 18, New Health Care Occupancies).

13.7.1.13.9.6 Where the building is protected by an automatic sprinkler system in accordance with NFPA 13D or NFPA 13R, the sprinkler system shall be permitted to be annunciated on the fire alarm system as a single zone. [***101:***9.6.7.4.6]

Paragraphs 13.7.1.13.9.1 through 13.7.1.13.9.6 provide a choice of zone locations and zone sizes for meaningful annunciation. In a new, multiple-story building required to have alarm annunciation by another section of the *Code*, 13.7.1.13.8 would not permit two or more floors to be considered as a single zone, unless the building were a residential occupancy sprinklered in accordance with NFPA 13R, NFPA 13D, or as otherwise permitted by 13.7.1.13.9.5, in which case the sprinkler system would be permitted to be annunciated as a single zone. In buildings other than those sprinklered in accordance with NFPA 13 (up to four stories, other than new health care), NFPA 13R, or NFPA 13D, floors must be annunciated separately; otherwise an alarm condition would be annunciated as originating in a zone that includes multiple floors and, thus, would not identify the specific location of the fire. Such a situation might delay the investigation and associated emergency response effort. Existing alarm annunciation systems are exempted from the requirement of 13.7.1.13.8, so as not to unfairly render existing *Code*-complying installations abruptly noncompliant, thereby avoiding the need for major alterations or a complete replacement of the alarm system.

Residential sprinkler systems in accordance with NFPA 13R and NFPA 13D commonly utilize a birdcage piping configuration, in which the sprinkler branch lines are run vertically through the building, rather than horizontally, providing an economical design alternative. (The resulting piping network resembles a birdcage, thus the name.) With such a configuration, however, it is not practical to provide waterflow devices for every floor, since each branch line typically serves multiple floors. Therefore, a single waterflow device is provided on the supply piping ahead of the branch lines, resulting in the sprinkler system being annunciated as a single zone. Although such an arrangement might increase the time required for emergency responders to locate the fire, it is considered a reasonable alternative for residential occupancies not exceeding four stories in height utilizing sprinkler systems compliant with NFPA 13R or NFPA 13D.

It is further specified in 13.7.1.13.9 that no one zone, for alarm annunciation purposes, even if located entirely on one floor of the building, is permitted to be so large that it delays identification of the location from which the alarm was initiated. The permitted zone size, 22,500 ft^2 (2090 m^2), is intended to coordinate with the maximum permitted smoke compartment size in health care and detention and correctional occupancies. The maximum zone area and zone dimensional criteria are modified by 13.7.1.13.9.2 for fully sprinklered buildings, allowing the alarm system zoning to coincide with the area of the sprinkler system zone. Depending on the sprinkler system's design, this might result in a zone as large as 52,000 ft^2 (4831 m^2). This requirement helps to achieve consistency in reporting alarms from signaling system devices and from sprinkler system waterflow to the alarm annunciator. Although a sprinkler system might be designed and installed by parties other than those who design and install fire alarm systems, the coordination of these two systems is needed during the design phase to ensure that they complement each other.

13.7.1.13.10 A system trouble signal shall be annunciated by means of audible and visible indicators. in accordance with *NFPA 72*. [***101:***9.6.7.5]

13.7.1.13.11 A system supervisory signal shall be annunciated by means of audible and visible indicators in accordance with *NFPA 72*. [***101:***9.6.7.6]

Alarm system trouble signals and supervisory signals must be annunciated by both audible and visible indicators in accordance with 13.7.1.13.10 and 13.7.1.13.11 to help ensure that personnel will respond to the indication. Trouble signals indicate such conditions as a circuit break or ground occurring in the fire alarm system wiring. Supervisory signals indicate conditions that would adversely affect the operation of a fire suppression system, such as a closed control valve on an automatic sprinkler system. Supervisory signals can also be associated with the supervision of other extinguishing systems and equipment.

13.7.1.13.12 Where the system serves more than one building, each building shall be annunciated separately. [***101:***9.6.7.7]

13.7.1.13.13 Where permitted by another section of this *Code*, the alarm zone shall be permitted to coincide with the permitted area for smoke compartments. [***101:***9.6.7.8]

Δ **13.7.1.14 Carbon Monoxide (CO) Detection and Warning Equipment.** Where required by another section of this *Code*, carbon monoxide (CO) detection and warning equipment shall be provided in accordance with NFPA 720. [***101:***9.12]

Paragraph 13.7.1.14 provides a reference to NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment,* where such equipment is mandated by another section of the *Code*. It is noted that not all occupancies are required to be provided with CO detection and warning equipment. Such equipment is not currently required by the *Code* to be installed in any existing occupancy; its use is generally limited to new occupancies in which occupants might be asleep or otherwise have decreased capability of self-preservation and where vehicles, combustion equipment, or appliances are present. The occupancies requiring CO detection and warning equipment are as follows:

1. New assembly occupancies (13.7.2.1.4)
2. New educational occupancies (13.7.2.3.4)
3. New day-care homes (13.7.2.5.6.4)
4. New and existing health care occupancies containing fireplaces (18.5.2.3 and 19.5.2.3 of NFPA *101*)
5. New one- and two-family dwellings (13.7.2.13.2)
6. New lodging or rooming houses (13.7.2.14.6)
7. New hotels and dormitories (13.7.2.15.6)
8. New apartment buildings (13.7.2.17.6)
9. New residential board and care occupancies (32.2.3.4.4 and 32.3.3.4.9 of NFPA *101*)

Exhibit 13.39 illustrates an example of a CO alarm. It is important to note that all CO detectors and alarms have a limited service life, typically about 5 to 10 years. CO detection equipment must be replaced at the end of its service life; the recommended replacement date is required by NFPA 720 to be marked on the device.

Exhibit 13.39

Carbon monoxide alarm. (© Danny Hooks, Dreamstime.com)

The requirements for CO detection and warning equipment are not based on safety to life from fire considerations. Rather, they are intended to mitigate the risk to building occupants posed by exposure to CO gas, which is a natural product of incomplete combustion of hydrocarbon fuels. Where combustion gases from equipment in a building (such as a fuel-fired furnace) are not properly vented, or where CO gas infiltrates a building from a space like an attached garage, occupants are at risk of CO poisoning. CO gas is sometimes referred to as the silent killer because it is colorless and odorless. Without CO detection and warning equipment, its presence is virtually impossible to detect.

According to the Centers for Disease Control and Prevention (CDC), approximately 15,200 people were treated annually during 2001–2003 in emergency departments for unintentional, non-fire–related CO exposure. During 2001–2002, an estimated 480 people died annually as a result of such exposure. In 2005, municipal fire departments responded to an estimated 61,100 non-fire CO incidents where CO was present. The cold weather months of December and January are the peak months for non-fire CO incidents, and 89 percent of non-fire CO incidents took place in the home.

NFPA 720 is formatted much like *NFPA 72* and contains requirements for CO detection systems (analogous to fire alarm systems) as well as single- and multiple-station CO alarms (analogous to smoke alarms). NFPA 720 was first published in 1998 and was titled *Recommended Practice for the Installation of Household Carbon Monoxide (CO) Warning Equipment.* In 2005, it was revised as a standard; however, its scope was still limited to dwelling units. For the 2009 edition, the scope of NFPA 720 was significantly expanded to include occupancies other than residential dwelling units. The expanded requirements were based on the Fire Protection Research Foundation report "Development of a Technical Basis for Carbon Monoxide Detector Siting." Where NFPA 720 is applied via adoption of this *Code*, and where the requirements of this *Code* differ from the requirements of NFPA 720, the requirements of this *Code* should apply. Where both this *Code* and NFPA 720 are separately adopted and enforced, the more stringent requirements should be followed so as to meet the minimum requirements of both documents.

N **13.7.1.15* Risk Analysis for Mass Notification Systems.**

N **A.13.7.1.15** This section does not require mass notification systems, it only provides direction for the risk analysis. Where the risk analysis and resulting action plan identifies a need for a mass notification system, *NFPA 72* should be used for design and installation requirements. [***101:***A.9.14]

Paragraphs 13.7.1.15 through 13.7.1.15.4, which are new to the 2018 edition of the *Code*, provide criteria for completing a risk analysis to determine whether a building or a collection of buildings, such as a university campus, requires a mass notification system (MNS) to warn individuals of an emergency, including, but not limited to, weather emergencies (e.g., floods and tornadoes), hazardous materials releases (e.g., an accident involving a tank truck containing a hazardous chemical), and acts of violence (e.g., an active-shooter or terrorist attack).

An in-building MNSs is a system used to provide information and instructions to people in a building(s) or other space using intelligible voice communications and including visible signals, text, graphics, tactile, or other communication methods, as defined in *NFPA 72*. An in-building MNS is similar in concept to a fire alarm system that includes an in-building fire emergency voice/alarm communications system. The only purpose of an in-building fire emergency voice/alarm communications system is for fire emergencies; the in-building MNS has a much broader set of potential applications and is likely to be subject to a much more complex set of potential design conditions and operation scenarios, which could also include fire emergencies.

A wide-area MNS is generally installed to provide real-time information to outdoor areas and could have the capability to communicate with other notification systems provided for a campus, military base, municipality, or similar single area or multiple contiguous areas, as defined in *NFPA 72*. A wide-area MNS is a one-way emergency communications system that is intended to communicate to outdoor areas such as those on a college or military campus. The primary means of communication is via high power speaker arrays.

The distributed-recipient MNS, or DRMNS, is a system meant to communicate directly to targeted individuals and groups that might not be in a contiguous area, as defined in *NFPA 72*. DRMNSs are normally one-way emergency communications systems that are intended to communicate with a wide range of targeted individuals and groups. Methods of communication include a variety of means such as reverse 911, SMS text messaging, and email.

N **13.7.1.15.1 Where Required.**

N **13.7.1.15.1.1** Where required by another section of this *Code*, a risk analysis for mass notification systems shall be provided in accordance with the requirements of Chapter 24 of *NFPA 72* and the provisions of 13.7.1.15.2 through 13.7.1.15.4. [***101:***9.14.1.1]

N **13.7.1.15.1.2** Where a mass notification system is required by the risk analysis in 13.7.1.15.1.1, the system shall be in accordance with the requirements of Chapter 24 of *NFPA 72*. [***101:***9.14.1.2]

A risk analysis to determine the need for an MNS is required where specified by the applicable occupancies. Occupancies and special structures that require an MNS risk analysis include the following:

- New high-rise buildings with a total occupant load of 5000 or more persons or where the floor of an occupiable story is greater than 420 ft (128 m) above the lowest level of fire department vehicle access (11.8.4.3 of NFPA *101*)
- New assembly occupancies with an occupant load of 500 or more (13.7.2.1.5)
- New educational occupancies (13.7.2.3.5)
- New grade K–12, college, and university dormitories with an occupant load of greater than 100 (13.7.2.15.7)
- New mall structures (36.4.4.7.5 of NFPA *101*)
- New business occupancies requiring a fire alarm system (see 13.7.2.25.5.1) and those containing a classroom where the building is owned, rented, leased, or operated by a college or university (13.7.2.25.5.2)
- Neither *NFPA 72* nor this *Code* requires the installation of an MNS. The decision to install an MNS is typically owner-driven based on the results of the risk analysis required by 13.7.1.15 and the occupancy chapters. If the owner determines an MNS is needed, it must meet the requirements of *NFPA 72*.

N **13.7.1.15.2 Purpose.**

N **13.7.1.15.2.1** The purpose of the mass notification system shall be to communicate information about emergencies including, but not limited to, fire, human-caused events (accidental and intentional), other dangerous situations, accidents, and natural disasters. [***101:***9.14.2.1]

N **13.7.1.15.2.2** The purpose of the emergency action plan for the mass notification system shall be to identify the mass notification system design and performance requirements in accordance with the results of the risk analysis. [***101:***9.14.2.2]

N **13.7.1.15.3 Documentation.**

N **13.7.1.15.3.1** The emergency action plan, risk assessment report, and accompanying documentation shall be submitted to the authority having jurisdiction by the registered design professional (RDP). The format and content of the documentation shall be acceptable to the authority having jurisdiction. [***101:***9.14.3.1]

N **13.7.1.15.3.2*** Where required by the authority having jurisdiction, an independent review of the emergency action plan, risk assessment, and the accompanying documentation by one or more individuals possessing expertise in risk characterization for accidental and intentional hazards shall be performed. [***101:***9.14.3.2]

N **A.13.7.1.15.3.2** These peer reviews should focus on the assumptions and methods of analysis used and on the findings. Peer reviewers should submit written assessment reports to the authority having jurisdiction. [***101:***A.9.14.3.2]

The independent, third-party review described in 13.7.1.15.3.2, if required by the AHJ, is performed at the owner's expense. See 1.15 for additional details on technical assistance.

N **13.7.1.15.4 Emergency Action Plan.** The completed emergency action plan in accordance with Section 4.8 of NFPA *101* shall be used for the design of the mass notification/emergency communications system. [***101:***9.14.4]

13.7.2 Where Required and Occupancy Requirements.

13.7.2.1 New Assembly Occupancies.

13.7.2.1.1 General.

13.7.2.1.1.1 New assembly occupancies with occupant loads of more than 300 and all theaters with more than one audience-viewing room shall be provided with an approved fire alarm system in accordance with Section 13.7 and 13.7.2.1, unless otherwise permitted by 13.7.2.1.1.2. [***101:***12.3.4.1.1]

13.7.2.1.1.2 New assembly occupancies that are a part of a multiple occupancy protected as a mixed occupancy *(see 6.1.14)* shall be permitted to be served by a common fire alarm system, provided that the individual requirements of each occupancy are met. [***101:***12.3.4.1.2]

13.7.2.1.2 Initiation.

13.7.2.1.2.1 Initiation of the required fire alarm system shall be by both of the following means:

(1) Manual means in accordance with 13.7.1.7.1(1), unless otherwise permitted by one of the following:
   (a) The requirement of 13.7.2.1.2.1(1) shall not apply where initiation is by means of an approved automatic fire detection system in accordance with 13.7.1.7.1(2) that provides fire detection throughout the building.
   (b) The requirement of 13.7.2.1.2.1(1) shall not apply where initiation is by means of an approved automatic sprinkler system in accordance with 13.7.1.7.1(3) that provides fire detection and protection throughout the building.

(2) Where automatic sprinklers are provided, initiation of the fire alarm system by sprinkler system waterflow, even where manual fire alarm boxes are provided in accordance with 13.7.2.1.2.1(1)

[***101:***12.3.4.2.1]

13.7.2.1.2.2 The initiating device shall be capable of transmitting an alarm to a receiving station, located within the building, that is constantly attended when the assembly occupancy is occupied. [***101:***12.3.4.2.2]

13.7.2.1.2.3* In new assembly occupancies with occupant loads of more than 300, automatic detection shall be provided in all hazardous areas that are not normally occupied, unless such areas are protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***12.3.4.2.3]

A.13.7.2.1.2.3 The intent is to require detectors only in nonsprinklered hazardous areas that are unoccupied. When the building is occupied, the detectors in the unoccupied, unsprinklered hazardous areas will initiate occupant notification. If the building is unoccupied, the fire in the nonsprinklered hazardous area is not a life safety issue, and the detectors, upon activation, are not required to notify anyone. The signal from a detector is permitted to be sent to a control panel in an area that is occupied when the building is occupied, but that is unoccupied when the building is unoccupied, without the need for central station monitoring or the equivalent. [***101:***A.12.3.4.2.3]

13.7.2.1.3 Notification. The required fire alarm system shall activate an audible and visible alarm in a constantly attended receiving station within the building when occupied for purposes of initiating emergency action. [***101:***12.3.4.3]

13.7.2.1.3.1 Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted. [***101:***12.3.4.3.1]

13.7.2.1.3.2 Reserved.

13.7.2.1.3.3 Occupant notification shall be by means of voice announcements in accordance with 13.7.1.9.9, initiated by the person in the constantly attended receiving station. [***101:***12.3.4.3.3]

13.7.2.1.3.4 Occupant notification shall be by means of visible signals in accordance with 13.7.1.9.5, initiated by the person in the constantly attended receiving station, unless otherwise permitted by 13.7.2.1.3.5. [***101:***12.3.4.3.4]

13.7.2.1.3.5* Visible signals shall not be required in the assembly seating area, or the floor area used for the contest, performance, or entertainment, where the occupant load exceeds 1000 and an approved, alternative visible means of occupant notification is provided. *(See 13.7.1.9.5.7.)* [***101:***12.3.4.3.5]

A.13.7.2.1.3.5 Examples of devices that might be used to provide alternative visible means include scoreboards, message boards, and other electronic devices. [***101:***A.12.3.4.3.5]

13.7.2.1.3.6 The announcement shall be permitted to be made via a voice communication or public address system in accordance with 13.7.1.9.9.2. [***101:***12.3.4.3.6]

Δ **13.7.2.1.3.7** Where the AHJ determines that a constantly attended receiving station is impractical, both of the following shall be provided:

(1) Automatically transmitted evacuation or relocation instructions shall be provided in accordance with *NFPA 72*.
(2) The system shall be monitored by a supervising station in accordance with *NFPA 72*.

[***101:***12.3.4.3.7]

N **13.7.2.1.4 Carbon Monoxide Detection.**

N **13.7.2.1.4.1** New assembly occupancies shall be provided with carbon monoxide detection and warning equipment in accordance with 13.7.1.14 in the locations specified as follows:

(1) On the ceilings of rooms containing permanently installed fuel-burning appliances or fuel-burning fireplaces
(2) Centrally located within occupiable spaces served by the first supply air register from permanently installed fuel-burning HVAC systems
(3)* Centrally located within occupiable spaces adjacent to an attached garage

[***101:***12.3.4.4.1]

N **A.13.7.2.1.4.1(3)** The intent is to require CO detectors in occupiable spaces immediately adjacent, vertically or horizontally, to attached garages, regardless of the presence of openings between the garage and the adjacent occupiable spaces. Other occupiable spaces that are not adjacent to the attached garage do not require CO detectors. [***101:***A.12.3.4.4.1]

N **13.7.2.1.4.2** Carbon monoxide detectors as specified in 13.7.2.1.4.1 shall not be required in the following locations:

(1) Garages
(2) Occupiable spaces with attached garages that are open parking structures as defined in 3.3.192.26.3.
(3) Occupiable spaces with attached garages that are mechanically ventilated in accordance with the mechanical code

[***101:***12.3.4.4.2]

N **13.7.2.1.5 Risk Analysis for Mass Notification Systems.** A risk analysis in accordance with 13.7.1.15 shall be performed for new assembly occupancies with an occupant load of 500 or more to determine if a mass notification system is required. [***101:***12.3.4.5]

13.7.2.2 Existing Assembly Occupancies.

13.7.2.2.1 General.

13.7.2.2.1.1 Existing assembly occupancies with occupant loads of more than 300 and all theaters with more than one audience-viewing room shall be provided with an approved fire alarm system in accordance with Section 13.7 and 13.7.2.2, unless otherwise permitted by 13.7.2.2.1.2, 13.7.2.2.1.3, or 13.7.2.2.1.4. [***101:***13.3.4.1.1]

13.7.2.2.1.2 Existing assembly occupancies that are a part of a multiple occupancy protected as a mixed occupancy *(see 6.1.14)* shall be permitted to be served by a common fire alarm system, provided that the individual requirements of each occupancy are met. [***101:***13.3.4.1.2]

13.7.2.2.1.3 Voice communication or public address systems complying with 13.7.2.2.3.6 shall not be required to comply with Section 13.7. [***101:***13.3.4.1.3]

13.7.2.2.1.4 The requirement of 13.7.2.2.1.1 shall not apply to existing assembly occupancies where, in the judgment of the AHJ, adequate alternative provisions exist or are provided for the discovery of a fire and for alerting the occupants promptly. [***101:***13.3.4.1.4]

13.7.2.2.2 Initiation.

13.7.2.2.2.1 Initiation of the required fire alarm system shall be by both of the following means, and the system shall be provided with an emergency power source:

(1) Manual means in accordance with 13.7.1.7.1(1), unless otherwise permitted by one of the following:
    (a) The requirement of 13.7.2.2.2.1(1) shall not apply where initiation is by means of an approved automatic fire

detection system in accordance with 13.7.1.7.1(2) that provides fire detection throughout the building.

(b) The requirement of 13.7.2.2.2.1(1) shall not apply where initiation is by means of an approved automatic sprinkler system in accordance with 13.7.1.7.1(3) that provides fire detection and protection throughout the building.

(2) Where automatic sprinklers are provided, initiation of the fire alarm system by sprinkler system waterflow, even where manual fire alarm boxes are provided in accordance with 13.7.2.2.2.1(1)

[***101:***13.3.4.2.1]

13.7.2.2.2.2 The initiating device shall be capable of transmitting an alarm to a receiving station, located within the building, that is constantly attended when the assembly occupancy is occupied. [***101:***13.3.4.2.2]

13.7.2.2.2.3* In existing assembly occupancies with occupant loads of more than 300, automatic detection shall be provided in all hazardous areas that are not normally occupied, unless such areas are protected throughout by an approved automatic sprinkler system in accordance with Section 13.3. [***101:***13.3.4.2.3]

A.13.7.2.2.2.3 The intent is to require detectors only in nonsprinklered hazardous areas that are unoccupied. Where the building is occupied, the detectors in the unoccupied, unsprinklered hazardous areas will initiate occupant notification. If the building is unoccupied, the fire in the nonsprinklered hazardous area is not a life safety issue, and the detectors, upon activation, are not required to notify anyone. The signal from a detector is permitted to be sent to a control panel in an area that is occupied when the building is occupied, but that is unoccupied when the building is unoccupied, without the need for central station monitoring or the equivalent. [***101:***A.13.3.4.2.3]

13.7.2.2.3 Notification. The required fire alarm system shall activate an audible alarm in a constantly attended receiving station within the building when occupied for purposes of initiating emergency action. [***101:***13.3.4.3]

13.7.2.2.3.1 Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted. [***101:***13.3.4.3.1]

13.7.2.2.3.2 A presignal system in accordance with 13.7.1.9.3 shall be permitted. [***101:***13.3.4.3.2]

13.7.2.2.3.3 Occupant notification shall be by means of voice announcements in accordance with 13.7.1.9.9 initiated by the person in the constantly attended receiving station. [***101:***13.3.4.3.3]

13.7.2.2.3.4 Reserved.

13.7.2.2.3.5 Reserved.

13.7.2.2.3.6 The announcement shall be permitted to be made via a voice communication or public address system in accordance with 13.7.1.9.9.2. [***101:***13.3.4.3.6]

Δ **13.7.2.2.3.7** Where the AHJ determines that a constantly attended receiving station is impractical, automatically transmitted evacuation or relocation instructions shall be provided in accordance with *NFPA 72*. [***101:***13.3.4.3.7]

Paragraphs 13.7.2.1.1.2 and 13.7.2.2.1.2 clarify that a common alarm system can be used within a building that houses occupancies in addition to an assembly occupancy, provided that the system meets the alarm requirements applicable to each of those occupancies. Those provisions permit an assembly occupancy in a school, hotel, hospital, mall structure, or another building to be served by the same fire alarm as the predominant occupancy, provided that it also meets the requirements applicable to alarm systems in an assembly occupancy.

Paragraph 13.7.2.2.1.3 permits an existing voice communication system or public address system installed to comply with 13.7.2.2.3.6 to be exempt from the installation requirements of *NFPA 72*, including electrical supervision and secondary power. In *Code* editions through 2006, alarm systems in new assembly occupancies were afforded the same exemption under the belief that the daily use of the voice communication system would provide adequate self-supervision and sufficient need to keep the system in good working order. Subsequent editions require new alarm systems in assembly occupancies to provide occupant notification by means of voice announcements in accordance with 13.7.1.9.9. The provisions of 13.7.1.9.9 permit automatically transmitted or live voice evacuation or relocation instructions, used to notify occupants, to comply with either *NFPA 72* or the criteria of 13.7.1.9.9.2, which require secondary power, among other features. Paragraph 13.7.1.9.9 is meant to be used for facilities such as large assembly venues in which the configuration (e.g., large-volume spaces), function, and human behavior (including elevated levels of occupant-generated noise) present challenges with respect to effective occupant notification by standard means in accordance with *NFPA 72*. Because the routine operation of large-venue assembly occupancies demands highly reliant, acoustically capable, and sufficiently audible public address systems, properly trained staff can be relied on to use these public address systems to effect occupant notification.

Paragraph 13.7.2.2.1.4, which applies only to existing assembly occupancies, specifically allows the AHJ to permit the continued use of existing alternative means for discovering fire and alerting occupants — even if such means do not meet the myriad requirements of *NFPA 72*.

13.7.2.3 New Educational Occupancies.

13.7.2.3.1 General.

13.7.2.3.1.1 New educational occupancies shall be provided with a fire alarm system in accordance with Section 13.7 and 13.7.2.3. [***101:***14.3.4.1.1]

13.7.2.3.1.2 The requirement of 13.7.2.3.1.1 shall not apply to buildings meeting all of the following criteria:

(1) Buildings having an area not exceeding 1000 ft^2 (93 m^2)
(2) Buildings containing a single classroom
(3) Buildings located not less than 30 ft (9.1 m) from another building

[***101:***14.3.4.1.2]

The limited-size, single-classroom building addressed by 13.7.2.3.1.2 and 13.7.2.4.1.2 does not need an alarm system, because the fire will be immediately obvious to the occupants. Emergency egress can begin upon first notice of fire. A fire within a building located at least 30 ft (9.1 m) from another building should not prove to be detrimental to the occupants of the other building if egress is delayed because no alarm system is provided.

13.7.2.3.2 Initiation.

Δ **13.7.2.3.2.1 General.** Initiation of the required fire alarm system, other than as permitted by 13.7.2.3.2.3, shall be by manual means in accordance with 13.7.1.7.1(1). [***101:***14.3.4.2.1]

13.7.2.3.2.2 Automatic Initiation. In buildings provided with automatic sprinkler protection, the operation of the sprinkler system shall automatically activate the fire alarm system in addition to the initiation means required in 13.7.2.3.2.1. [***101:***14.3.4.2.2]

13.7.2.3.2.3 Alternative Protection System. Manual fire alarm boxes shall be permitted to be eliminated in accordance with 13.7.2.3.2.3.1 or 13.7.2.3.2.3.2. [***101:***14.3.4.2.3]

13.7.2.3.2.3.1* Manual fire alarm boxes shall be permitted to be eliminated where all of the following conditions apply:

(1) Interior corridors are protected by smoke detectors in accordance with Section 13.7.
(2) Auditoriums, cafeterias, and gymnasiums are protected by heat-detection devices or other approved detection devices.
(3) Shops and laboratories involving dusts or vapors are protected by heat-detection devices or other approved detection devices.
(4) Provision is made at a central point to manually activate the evacuation signal or to evacuate only affected areas.

[***101:***14.3.4.2.3.1]

A.13.7.2.3.2.3.1 Occupied portions of the building should have access to a central point for manual activation of the evacuation signal. [***101:***A.14.3.4.2.3.1]

13.7.2.3.2.3.2* Manual fire alarm boxes shall be permitted to be eliminated where both of the following conditions apply:

(1) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3.
(2) Provision is made at a central point to manually activate the evacuation signal or to evacuate only affected areas.

[***101:***14.3.4.2.3.2]

A.13.7.2.3.2.3.2 Occupied portions of the building should have access to a central point for manual activation of the evacuation signal. [***101:***A.14.3.4.2.3.2]

Exhibit 13.40 shows a manual fire alarm box for initiation of the building fire alarm system. The cover is intended to help avoid accidental initiations due to unintended contact with the box. Where additional means of preventing unintended or nuisance alarms is needed, the provisions of 13.7.2.3.2.3 and 13.7.2.4.2.3 offer alternatives.

Exhibit 13.40

Manual fire alarm box with protective cover.

Paragraphs 13.7.2.3.2.3 and 13.7.2.4.2.3 provide alternatives to the manual fire alarm boxes required by 13.7.2.3.2.1 and 13.7.2.4.2.1. These alternatives are offered as a means to avoid the nuisance alarms initiated through unauthorized use of the building manual fire alarm boxes. By relying on the automatic initiation that is provided by the detection systems addressed in 13.7.2.3.2.3.1(1) and 13.7.2.4.23,1(1) through 13.7.2.3.2.3.1(3) and 13.7.2.4.2.3.1(3), equivalent protection is provided. By relying on the fire control that is provided by the automatic sprinkler system addressed in 13.7.2.3.2.3.2 and 13.7.2.4.2.3.2, equivalent protection is provided.

Paragraph 13.7.2.4.2.1(2) — which applies only to existing educational occupancies — recognizes an alternative to a dedicated fire alarm system. Where there is a two-way communication system between classrooms and a constantly attended location where a general alarm can be sounded, the requirement for an alarm system — and its requisite manual fire alarm boxes — is exempted. To use this exemption, the AHJ must designate those manual fire alarm boxes that are not required. For the purposes of this provision, a "constantly attended" location is a location that is attended while the school building is in use as a school. Compliance might involve providing personnel at this location during night classes, when the regular school office staff is not present. The exemption is not permitted for new construction due to reliability concerns.

13.7.2.3.3 Notification.

13.7.2.3.3.1 Occupant Notification.

13.7.2.3.3.1.1 Occupant notification shall be accomplished automatically in accordance with 13.7.1.9. [***101:***14.3.4.3.1.1]

13.7.2.3.3.1.2 The occupant notification required by 13.7.2.3.3.1.1 shall utilize an emergency voice/alarm communication system in accordance with 13.7.1.9 where the building has an occupant load of more than 100. [***101:***14.3.4.3.1.2]

13.7.2.3.3.1.3 Positive alarm sequence shall be permitted in accordance with 13.7.1.9.4. [***101:***14.3.4.3.1.3]

13.7.2.3.3.1.4 In accordance with 13.7.1.9.10.2, the emergency voice/alarm communication system shall be permitted to be used for other emergency signaling or for class changes. [***101:***14.3.4.3.1.4]

13.7.2.3.3.1.5 To prevent students from being returned to a building that is burning, the recall signal shall be separate and distinct from any other signals, and such signal shall be permitted to be given by use of distinctively colored flags or banners. [***101:***14.3.4.3.1.5]

13.7.2.3.3.1.6 If the recall signal required by 13.7.2.3.3.1.5 is electric, the push buttons or other controls shall be kept under lock, the key for which shall be in the possession of the principal or another designated person in order to prevent a recall at a time when there is an actual fire. [***101:***14.3.4.3.1.6]

13.7.2.3.3.1.7 Regardless of the method of recall signal, the means of giving the recall signal shall be kept under lock. [***101:***14.3.4.3.1.7]

13.7.2.3.3.2 Emergency Forces Notification. Emergency forces notification shall be accomplished in accordance with 13.7.1.10. [***101:***14.3.4.3.2]

13.7.2.3.4 Carbon Monoxide Alarms and Carbon Monoxide Detection Systems.

Δ **13.7.2.3.4.1** Carbon monoxide detectors in accordance with 13.7.1.14 shall be provided in new educational occupancies in the locations specified as follows:

(1) Carbon monoxide detectors shall be installed on the ceilings of rooms containing permanently installed fuel-burning appliances.
(2) Carbon monoxide detectors shall be installed centrally located within occupiable spaces served by the first supply air register from a permanently installed, fuel-burning HVAC system.
(3) Carbon monoxide detectors shall be installed centrally located within occupiable spaces adjacent to a communicating attached garage.
(4) Carbon monoxide detectors shall be installed centrally located within occupiable spaces adjacent to an attached garage with a separation wall constructed of gypsum wallboard.

[***101:***14.3.4.4.1]

13.7.2.3.4.2 Carbon monoxide alarms and carbon monoxide detectors as specified in 13.7.2.3.4.1 shall not be required in the following locations:

(1) Garages
(2) Occupiable spaces with communicating attached garages that are open parking structures as defined in 3.3.192.26.3
(3) Occupiable spaces with communicating attached garages that are mechanically ventilated in accordance with the applicable mechanical code
(4) Occupiable spaces that are separated from attached garages by walls constructed of gypsum wallboard where the garage is an open parking structure as defined in 3.3.192.26.3
(5) Occupiable spaces that are separated from attached garages by walls constructed of gypsum wallboard where the garage is mechanically ventilated in accordance with the mechanical code

[***101:***14.3.4.4.3]

N **13.7.2.3.5 Risk Analysis for Mass Notification Systems.** A risk analysis in accordance with 13.7.1.15 shall be performed to determine if a mass notification system is required. [***101:***14.3.4.5]

Paragraph 13.7.1.15 is new for the 2018 edition of the *Code*. By reference to this new paragraph, new educational occupancies require that a risk analysis be conducted in accordance with Chapter 24 of *NFPA 72* to determine if an MNS is necessary. See the commentary associated with 13.7.1.15 for more information.

13.7.2.4 Existing Educational Occupancies.

13.7.2.4.1 General.

13.7.2.4.1.1 Existing educational occupancies shall be provided with a fire alarm system in accordance with Section 13.7 and 13.7.2.4. [***101:***15.3.4.1.1]

13.7.2.4.1.2 The requirement of 13.7.2.4.1.1 shall not apply to buildings meeting all of the following criteria:

(1) Buildings having an area not exceeding 1000 ft^2 (93 m^2)
(2) Buildings containing a single classroom
(3) Buildings located not less than 30 ft (9.1 m) from another building

[***101:***15.3.4.1.2]

See the commentary following 13.7.2.3.1.2(3).

13.7.2.4.2 Initiation.

Δ **13.7.2.4.2.1 General.** Initiation of the required fire alarm system shall be by manual means in accordance with 13.7.1.7(1), unless otherwise permitted by one of the following:

(1) Manual fire alarm boxes shall not be required where permitted by 13.7.2.4.2.3.
(2) In buildings where all normally occupied spaces are provided with a two-way communication system between such spaces and a constantly attended receiving station from where a general evacuation alarm can be sounded, the manual fire alarm boxes shall not be required, except in locations specifically designated by the AHJ.

[***101:***15.3.4.2.1]

13.7.2.4.2.2 Automatic Initiation. In buildings provided with automatic sprinkler protection, the operation of the sprinkler system shall automatically activate the fire alarm system in addition to the initiation means required in 13.7.2.4.2.1. [***101:***15.3.4.2.2]

13.7.2.4.2.3 Alternative Protection System. Manual fire alarm boxes shall be permitted to be eliminated in accordance with 13.7.2.4.2.3.1 or 13.7.2.4.2.3.2. [***101:***15.3.4.2.3]

Δ **13.7.2.4.2.3.1*** Manual fire alarm boxes shall be permitted to be eliminated where all of the following conditions apply:

(1) Interior corridors are protected by smoke detectors using an alarm verification system as described in *NFPA 72*.
(2) Auditoriums, cafeterias, and gymnasiums are protected by heat-detection devices or other approved detection devices.
(3) Shops and laboratories involving dusts or vapors are protected by heat-detection devices or other approved detection devices.
(4) Provision is made at a central point to manually activate the evacuation signal or to evacuate only affected areas.

[***101:***15.3.4.2.3.1]

A.13.7.2.4.2.3.1 Occupied portions of the building should have access to a central point for manual activation of the evacuation signal. [***101:***A.15.3.4.2.3.1]

13.7.2.4.2.3.2* Manual fire alarm boxes shall be permitted to be eliminated where both of the following conditions apply:

(1) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3.
(2) Provision is made at a central point to manually activate the evacuation signal or to evacuate only affected areas.

[***101:***15.3.4.2.3.2]

A.13.7.2.4.2.3.2 Occupied portions of the building should have access to a central point for manual activation of the evacuation signal. [***101:***A.15.3.4.2.3.2]

13.7.2.4.3 Notification.

13.7.2.4.3.1 Occupant Notification.

13.7.2.4.3.1.1* Occupant notification shall be accomplished automatically in accordance with 13.7.1.9. [***101:***14.3.4.3.1.1]

Δ **A.13.7.2.4.3.1.1** The audible occupant notification signal for evacuation of an educational occupancy building should be the distinctive three-pulse temporal pattern fire alarm evacuation signal that is required of new systems by *NFPA 72*. The temporal pattern will help educate students to recognize the need to evacuate when they are in other occupancies. Existing fire alarm systems should be modified, as feasible, to sound the three-pulse temporal pattern. [***101:***A.15.3.4.3.1.1]

13.7.2.4.3.1.2 Reserved.

13.7.2.4.3.1.3 Positive alarm sequence shall be permitted in accordance with 13.7.1.9.4. [***101:***15.3.4.3.1.3]

13.7.2.4.3.1.4 Where acceptable to the AHJ, the fire alarm system shall be permitted to be used for other emergency signaling or for class changes, provided that the fire alarm is distinctive in signal and overrides all other use. [***101:***15.3.4.3.1.4]

13.7.2.4.3.1.5 To prevent students from being returned to a building that is burning, the recall signal shall be separate and distinct from any other signals, and such signal shall be permitted to be given by use of distinctively colored flags or banners. [***101:***15.3.4.3.1.5]

13.7.2.4.3.1.6 If the recall signal required by 13.7.2.4.3.1.5 is electric, the push buttons or other controls shall be kept under lock, the key for which shall be in the possession of the principal or another designated person in order to prevent a recall at a time when there is an actual fire. [***101:***15.3.4.3.1.6]

13.7.2.4.3.1.7 Regardless of the method of recall signal, the means of giving the recall signal shall be kept under lock. [***101:***15.3.4.3.1.7]

13.7.2.4.3.2 Emergency Forces Notification.

13.7.2.4.3.2.1 Wherever any of the school authorities determine that an actual fire exists, they shall immediately call the local fire department using the public fire alarm system or other available facilities. [***101:***15.3.4.3.2.1]

13.7.2.4.3.2.2 Emergency forces notification shall be accomplished in accordance with 13.7.1.10 where the existing fire alarm system is replaced. [***101:***15.3.4.3.2.2]

The provision of 13.7.2.4.3.2.2 imposes a requirement for emergency forces notification in accordance with 13.7.1.10 in existing buildings only where the fire alarm system is replaced.

13.7.2.5 New Day-Care Occupancies.

13.7.2.5.1 General. New day-care occupancies, other than day-care occupancies housed in one room having at least one door opening directly to the outside at grade plane or to an exterior exit access balcony in accordance with 14.10.3, shall be provided with a fire alarm system in accordance with Section 13.7 and 13.7.2.5. [***101:***16.3.4.1]

13.7.2.5.2 Initiation. Initiation of the required fire alarm system shall be by manual means and by operation of any required smoke detectors and required sprinkler systems. *(See 13.7.2.5.5.)* [***101:***16.3.4.2]

13.7.2.5.3 Occupant Notification.

13.7.2.5.3.1 Occupant notification shall be in accordance with 13.7.1.9. [***101:***16.3.4.3.1]

13.7.2.5.3.2 Positive alarm sequence shall be permitted in accordance with 13.7.1.9.4. [***101:***16.3.4.3.2]

13.7.2.5.3.3 Private operating mode in accordance with 13.7.1.9.6.3 shall be permitted. [***101:***16.3.4.3.3]

13.7.2.5.4 Emergency Forces Notification. Emergency forces notification shall be accomplished in accordance with 13.7.1.10. [***101:***16.3.4.4].

13.7.2.5.5 Detection. A smoke detection system in accordance with 13.7.1 shall be installed in new day-care occupancies, other than those housed in one room having at least one door opening directly to the outside at grade plane or to an exterior exit access balcony in accordance with 14.10.3, and such system shall comply with both of the following:

(1) Detectors shall be installed on each story in front of the doors to the stairways and in the corridors of all floors occupied by the day-care occupancy.
(2) Detectors shall be installed in lounges, recreation areas, and sleeping rooms in the day-care occupancy.

[***101:***16.3.4.5]

New day-care centers, other than those housed in a single room having a door opening directly to the outside at grade plane or to an exterior exit access balcony, are required to have a fire alarm system. Existing day-care centers, other than those housed in a single room, are required to have a fire alarm system. The alarm system is for purposes of occupant notification and fire department notification. Existing day-care centers are exempt from the fire department notification requirement if there are 100 or fewer clients.

Neither new nor existing day-care centers are permitted to use a presignal system (see 13.7.1.9.3). A delay in occupant notification is permitted only if positive alarm sequence in accordance with 13.7.1.9.4 is provided. Positive alarm sequence includes some fail-safe features not found in presignal systems. For example, if the person staffing the control panel does not acknowledge the signal, general occupant notification occurs automatically. Also, if a second initiation device reports a fire condition to the control panel, the delay ends and general occupant notification occurs immediately.

Some day-care centers include provisions for clients to nap. Also, parents who work at night might place their children in day-care centers for the purpose of sleeping through the night. Regardless of whether occupants sleep in the center, the smoke detectors required by 13.7.2.5.5 and 13.7.2.6.5 will provide critical extra time to evacuate clients. The requirement for smoke detection does not apply to new day-care centers housed in a single room having a door opening directly to the outside at grade plane or to an exterior exit access balcony, in which case a fire will be obvious to all occupants simultaneously. Similarly, the requirement for smoke detection does not apply to existing day-care centers housed in a single room or where the clients are capable of self-preservation and there are no sleeping facilities.

N **13.7.2.5.6 New Day-Care Homes.**

N **13.7.2.5.6.1** Smoke alarms shall be installed within day-care homes in accordance with 13.7.1.8. [***101:***16.6.3.4.1]

N **13.7.2.5.6.2** Where a day-care home is located within a building of another occupancy, such as in an apartment building or office building, any corridors serving the day-care home shall be provided with a smoke detection system in accordance with 13.7.1.4. [***101:***16.6.3.4.2]

N **13.7.2.5.6.3** Single-station or multiple-station smoke alarms or smoke detectors shall be provided in all rooms used for sleeping in accordance with 13.7.1.8. [***101:***16.6.3.4.4]

N **13.7.2.5.6.4** Single-station or multiple-station carbon monoxide alarms or detectors shall be provided in accordance with 13.7.1.14 in day-care homes where client sleeping occurs and one or both of the following conditions exist:

(1) Fuel-fired equipment is present.
(2) An enclosed parking structure is attached to the day-care home.

[***101:***16.6.3.4.6]

13.7.2.6 Existing Day-Care Occupancies.

13.7.2.6.1 General. Existing day-care occupancies, other than day-care occupancies housed in one room, shall be provided with a fire alarm system in accordance with Section 13.7 and 13.7.2.6. [***101:***17.3.4.1]

13.7.2.6.2 Initiation. Initiation of the required fire alarm system shall be by manual means and by operation of any required smoke detectors and required sprinkler systems. *(See 13.7.2.6.5.)* [***101:***17.3.4.2]

13.7.2.6.3 Occupant Notification.

13.7.2.6.3.1 Occupant notification shall be in accordance with 13.7.1.9. [***101:***17.3.4.3.1]

13.7.2.6.3.2 Positive alarm sequence shall be permitted in accordance with 13.7.1.9.4. [***101:***17.3.4.3.2]

13.7.2.6.3.3 Private operating mode in accordance with 13.7.1.9.6.3 shall be permitted. [***101:***17.3.4.3.3]

13.7.2.6.4 Emergency Forces Notification.

13.7.2.6.4.1 Emergency forces notification, other than for day-care occupancies with not more than 100 clients, shall be accomplished in accordance with 13.7.1.10. [***101:***17.3.4.4.1]

13.7.2.6.4.2 Emergency forces notification shall be accomplished in accordance with 13.7.1.10 where the existing fire alarm system is replaced. [***101:***17.3.4.4.2]

13.7.2.6.5 Detection. A smoke detection system in accordance with 13.7.1 shall be installed in existing day-care occupancies, other than those housed in one room or those housing clients capable of self-preservation where no sleeping facilities are provided, and such system shall comply with both of the following:

(1) Detectors shall be installed on each story in front of the doors to the stairways and in the corridors of all floors occupied by the day-care occupancy.
(2) Detectors shall be installed in lounges, recreation areas, and sleeping rooms in the day-care occupancy.

[***101:***17.3.4.5]

See the commentary following 13.7.2.5.5.

N **13.7.2.6.6 Existing Day-Care Homes.**

N **13.7.2.6.6.1** Smoke alarms shall be installed within day-care homes in accordance with 13.7.1.8. [***101:***17.6.3.4.1]

N **13.7.2.6.6.2** Where a day-care home is located within a building of another occupancy, such as in an apartment building or office building, any corridors serving the day-care home shall be provided with a smoke detection system in accordance with 13.7.1.7. [*101:*17.6.3.4.2]

N **13.7.2.6.6.3** Single-station or multiple-station smoke alarms or smoke detectors shall be provided in all rooms used for sleeping in accordance with 13.7.1.8, other than as permitted by 13.7.2.6.6.4. [*101:*17.6.3.4.4]

N **13.7.2.6.6.4** Approved existing battery-powered smoke alarms, rather than house electrical service–powered smoke alarms required by 13.7.2.6.6.3, shall be permitted where the facility has testing, maintenance, and battery replacement programs that ensure reliability of power to the smoke alarms. [*101:*17.6.3.4.5]

13.7.2.7 New Health Care Occupancies.

13.7.2.7.1 General. New health care occupancies shall be provided with a fire alarm system in accordance with Section 13.7 and 13.7.2.7. [*101:*18.3.4.1]

13.7.2.7.2* Initiation.

A.13.7.2.7.2 It is not the intent of this *Code* to require single-station smoke alarms that might be required by local codes to be connected to or to initiate the building fire alarm system. [*101:*A.18.3.4.2]

13.7.2.7.2.1 Initiation of the required fire alarm systems shall be by manual means in accordance with 13.7.1.7 and by means of any required sprinkler system waterflow alarms, detection devices, or detection systems, unless otherwise permitted by 13.7.2.7.2.2 and 13.7.2.7.2.3. [*101:*18.3.4.2.1]

13.7.2.7.2.2 Manual fire alarm boxes in patient sleeping areas shall not be required at exits if located at all nurses' control stations or other continuously attended staff location, provided that both of the following criteria are met:

(1) Such manual fire alarm boxes are visible and continuously accessible.
(2) Travel distances required by 13.7.1.7.5 are not exceeded.

[*101:*18.3.4.2.2]

13.7.2.7.2.3 The system smoke detector installed in accordance with 18.3.2.5.3(13) of NFPA *101* shall not be required to initiate the fire alarm system. [*101:*18.3.4.2.3]

13.7.2.7.3 Notification. Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted. [*101:*18.3.4.3]

13.7.2.7.3.1 Occupant Notification. Occupant notification shall be accomplished automatically in accordance with 13.7.1.9, unless otherwise modified by the following:

(1) Paragraph 13.7.1.9.2.3 shall not be permitted to be used.
(2)* In lieu of audible alarm signals, visible alarm-indicating appliances shall be permitted to be used in critical care areas.

A.13.7.2.7.3.1(2) It is the intent of this provision to permit a visible fire alarm signal instead of an audible signal to reduce interference between the fire alarm and medical equipment monitoring alarms. [*101:*A.18.3.4.3.1(2)]

(3) The provision of 18.3.2.5.3(13)(c) of NFPA *101* shall be permitted to be used.

[*101:*18.3.4.3.1]

13.7.2.7.3.2 Emergency Forces Notification.

13.7.2.7.3.2.1 Emergency forces notification shall be accomplished in accordance with 13.7.1.10, except that the provision of 18.3.2.5.3(13)(d) of NFPA *101* shall be permitted to be used. [*101:*18.3.4.3.2.1]

13.7.2.7.3.2.2 Reserved.

13.7.2.7.3.3 Annunciation and Annunciation Zoning.

13.7.2.7.3.3.1 Annunciation and annunciation zoning shall be provided in accordance with 13.7.1.13, unless otherwise permitted by 13.7.2.7.3.3.2 or 13.7.2.7.3.3.3. [*101:*18.3.4.3.3.1]

13.7.2.7.3.3.2 The alarm zone shall be permitted to coincide with the permitted area for smoke compartments. [*101:*18.3.4.3.3.2]

13.7.2.7.3.3.3 The provision of 13.7.1.13.9.2, which permits sprinkler system waterflow to be annunciated as a single building zone, shall be prohibited. [*101:*18.3.4.3.3.3]

13.7.2.7.4 Emergency Control Functions. Operation of any activating device in the required fire alarm system shall be arranged to accomplish automatically any control functions to be performed by that device. *(See 13.7.1.11.)* [*101:*18.3.4.4]

13.7.2.7.5 Detection.

13.7.2.7.5.1 General. Detection systems, where required, shall be in accordance with Section 13.7. [*101:*18.3.4.5.1]

13.7.2.7.5.2 Detection in Spaces Open to Corridors. See 18.3.6.1 of NFPA *101*. [*101:*18.3.4.5.2]

13.7.2.7.5.3* Nursing Homes. An approved automatic smoke detection system shall be installed in corridors throughout smoke compartments containing patient sleeping rooms and in spaces open to corridors as permitted in nursing homes by 18.3.6.1 of NFPA *101*, unless otherwise permitted by one of the following:

(1) Corridor systems shall not be required where each patient sleeping room is protected by an approved smoke detection system.
(2) Corridor systems shall not be required where patient room doors are equipped with automatic door-closing devices with integral smoke detectors on the room side installed in accordance with their listing, provided that the integral detectors provide occupant notification.

[*101:*18.3.4.5.3]

A.13.7.2.7.5.3 The requirement for smoke detectors in spaces open to the corridors eliminates the requirements of 18.3.6.1 (1)(c), (2)(b), and (5)(b) of NFPA *101* for direct supervision by the facility staff of nursing homes. [*101:*A.18.3.4.5.3]

13.7.2.8 Existing Health Care Occupancies.

13.7.2.8.1 General. Existing health care occupancies shall be provided with a fire alarm system in accordance with Section 13.7 and 13.7.2.8. [***101:***19.3.4.1]

13.7.2.8.2* Initiation.

A.13.7.2.8.2 It is not the intent of this *Code* to require single-station smoke alarms, which might be required by local codes, to be connected to or to initiate the building fire alarm system. [***101:***A.19.3.4.2]

13.7.2.8.2.1 Initiation of the required fire alarm systems shall be by manual means in accordance with 13.7.1.7 and by means of any required sprinkler system waterflow alarms, detection devices, or detection systems, unless otherwise permitted by 13.7.2.8.2.2 through 13.7.2.8.2.5. [***101:***19.3.4.2.1]

13.7.2.8.2.2 Manual fire alarm boxes in patient sleeping areas shall not be required at exits if located at all nurses' control stations or other continuously attended staff location, provided that both of the following criteria are met:

(1) Such manual fire alarm boxes are visible and continuously accessible.
(2) Travel distances required by 13.7.1.7.5 are not exceeded.

[***101:***19.3.4.2.2]

13.7.2.8.2.3 The system smoke detector installed in accordance with 19.3.2.5.3(13) of NFPA *101* shall not be required to initiate the fire alarm system. [***101:***19.3.4.2.3]

13.7.2.8.2.4 Fixed extinguishing systems protecting commercial cooking equipment in kitchens that are protected by a complete automatic sprinkler system shall not be required to initiate the fire alarm system. [***101:***19.3.4.2.4]

13.7.2.8.2.5 Detectors required by 19.7.5.3 and 19.7.5.5 of NFPA *101* shall not be required to initiate the fire alarm system. [***101:***19.3.4.2.5]

13.7.2.8.3 Notification. Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted in health care occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA 13. [***101:***19.3.4.3]

13.7.2.8.3.1 Occupant Notification. Occupant notification shall be accomplished automatically in accordance with 13.7.1.9, unless otherwise modified by the following:

(1)* In lieu of audible alarm signals, visible alarm-indicating appliances shall be permitted to be used in critical care areas

A.13.7.2.8.3.1(1) It is the intent of this provision to permit a visible fire alarm signal instead of an audible signal to reduce interference between the fire alarm and medical equipment monitoring alarms. [***101:***A.19.3.4.3.1(1)]

(2) Where visual devices have been installed in patient sleeping areas in place of an audible alarm, they shall be permitted where approved by the AHJ.
(3) The provision of 19.3.2.5.3(13)(c) of NFPA *101* shall be permitted to be used.

[***101:***19.3.4.3.1]

13.7.2.8.3.2 Emergency Forces Notification.

13.7.2.8.3.2.1 Emergency forces notification shall be accomplished in accordance with 13.7.1.10, except that the provision of 19.3.2.5.3(13)(d) of NFPA *101* shall be permitted to be used. [***101:***19.3.4.3.2.1]

13.7.2.8.3.2.2 Smoke detection devices or smoke detection systems equipped with reconfirmation features shall not be required to automatically notify the fire department, unless the alarm condition is reconfirmed after a period not exceeding 120 seconds. [***101:***19.3.4.3.2.2]

13.7.2.8.3.3 Reserved.

13.7.2.8.4 Emergency Control Functions. Operation of any activating device in the required fire alarm system shall be arranged to accomplish automatically any control functions to be performed by that device. *(See 13.7.1.11.)* [***101:***19.3.4.4]

13.7.2.8.5 Detection.

13.7.2.8.5.1 Corridors. An approved automatic smoke detection system in accordance with Section 13.7 shall be installed in all corridors of limited care facilities, unless otherwise permitted by one of the following:

(1) Where each patient sleeping room is protected by an approved smoke detection system, and a smoke detector is provided at smoke barriers and horizontal exits in accordance with Section 13.7, the corridor smoke detection system shall not be required on the patient sleeping room floors.
(2) Smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.3.2.12.8 shall be permitted.

[***101:***19.3.4.5.1]

13.7.2.8.5.2 Detection in Spaces Open to Corridors. See 19.3.6.1 of NFPA *101*. [***101***:19.3.4.5.2]

A manual fire alarm system is required in new and existing health care occupancies by 13.7.2.7.1, 13.7.2.7.2, 13.7.2.8.1, and 13.7.2.8.2. Manual fire alarm boxes are normally located along the natural routes of egress and are also located to cover all portions of the building. Paragraphs 13.7.2.7.2.2 and 13.7.2.8.2.2 permit manual fire alarm boxes, under certain conditions, to be located only at continuously attended staff positions in sleeping areas. This arrangement provides the opportunity for prompt notification of fire without requiring staff to leave their normal workstations. In new installations, it would normally be desirable to have manual fire alarm boxes at all attended staff locations and at entrances to exits, because the additional cost of the extra fire alarm boxes would be minimal. However, the exemptions recognize that the fire alarm boxes located near the exits might lead to nuisance alarms if patients misuse them.

Manual fire alarm boxes should be located so that those qualified to send an alarm can summon aid without having to leave their zone of ordinary activity or pass out of the sight and hearing of people immediately exposed to, or in direct view of, a fire. The operation of a manual fire alarm box should automatically summon attendants who can assist in removing physically helpless occupants and controlling mentally disabled occupants.

Paragraph 13.7.2.8.2.5 addresses smoke detectors installed for a special purpose — to provide an exemption to paragraphs 19.7.5.3 and 19.7.5.5 of NFPA *101*, which require that newly introduced upholstered furniture and mattresses be resistant to cigarette ignition and have limited rates of heat release. Paragraph 13.7.2.8.2.5 exempts such smoke detectors from having to initiate the building alarm system.

Paragraphs 13.7.2.7.3 and 13.7.2.8.3 permit positive alarm sequence in sprinklered health care occupancies. The criteria for positive alarm sequence are detailed in *NFPA 72*. See the commentary following 13.7.1.9.4 for details on positive alarm sequence.

Although 13.7.2.7.3.1 and 13.7.2.8.3.1 require occupant notification, coded messages are permitted to be used to notify staff and trained responders. As part of their emergency duties, staff will then keep patients and visitors informed of expected actions.

Paragraph 13.7.2.7.3.1(1) specifically prohibits new health care occupancies from using 13.7.1.9.2.3, which exempts detectors at doors used for the exclusive operation of automatic door release from the requirements for occupant notification. Note that the use of 13.7.1.9.2.1, which exempts detectors used for recalling elevators from initiating occupant notification, and 13.7.1.9.2.2, which exempts detectors used for closing dampers from initiating occupant notification, is permitted. Although such detectors must be arranged to initiate the health care occupancy alarm system in accordance with 13.7.2.7.2.1, subsequent automatic occupant notification is not required.

Emergency forces notification is addressed in 13.7.2.7.3.2 and 13.7.2.8.3.2. Paragraph 13.7.2.8.3.2.2 permits the continued use of an existing alarm system feature that delays fire department notification for up to 120 seconds where smoke detectors or smoke detection systems are equipped with a reconfirmation feature. However, staff notification, as required by 13.7.2.8.3.1, cannot be delayed by the existing smoke detection system with reconfirmation feature.

The alarm must automatically transmit to a point outside the facility. If the fire department legally committed to serve the facility does not permit automatic alarm transmission, arrangements must be made for the prompt notification of the fire department or such other assistance as may be available in the case of fire or other emergency. Paragraph 13.7.1.10.2 lists various acceptable methods for automatically notifying the fire department. The fire department should also be called manually to verify and confirm the automatic transmission of the alarm. In larger facilities, this might be the responsibility of the facility telephone operator; in smaller facilities, it might be the responsibility of the nursing staff.

Exhibit 13.41

Alarm system annunciator panel.

The provision of 13.7.2.7.3.3 requires annunciation and annunciation zoning for new fire alarm systems. Exhibit 13.41 shows an alarm system annunciator panel positioned on the wall of a minor entrance to a hospital. The minor entrance is the location by which the fire department enters the building when responding to a call for assistance. The hospital facility floor plan is attached to the wall in the vicinity of the annunciator panel so that the abbreviated zone identifiers displayed at the annunciator panel can be converted to visual cues as to the section of the building from which the alarm signal was received.

The provision of 13.7.2.7.3.3.3 prohibits sprinkler system waterflow from being annunciated as a single building zone. The prohibition was written in reaction to the addition of 13.7.1.13.9.2, which permits such single-zone annunciation so as not to prohibit a so-called sprinkler system birdcage piping configuration, in which the sprinkler branch lines are run vertically through the building, rather than horizontally, providing an economical installation alternative. (The resulting piping network resembles a birdcage, hence the name.) With such a piping configuration, it is not practical to provide waterflow devices for every floor, since each branch line typically serves multiple floors. Therefore, a single waterflow device is provided on the supply piping ahead of the branch lines, resulting in the sprinkler system being annunciated as a single zone. Such an arrangement has the potential to increase the time required for emergency responders to locate the fire and is inconsistent with the protection level mandated for health care occupancies.

Paragraph 13.7.2.8.5.1 requires smoke detectors in the corridors of existing limited care facilities. Staffing levels in hospitals and nursing homes reasonably ensure discovery of a fire at an early stage. In existing hospitals and nursing homes, it is considered reasonable to rely on staff to sound the alarm.

Paragraph 13.7.2.7.5.3 requires corridor smoke detection systems in new nursing homes. The justification for the creation of this requirement stated that corridor smoke detectors are needed for redundancy, since, in some fire scenarios, the corridor detector might be the first device to provide notification of fire, and the cost of installing a corridor smoke detection system as part of new construction is minor.

13.7.2.9 New Ambulatory Health Care Occupancies.

13.7.2.9.1 General. New ambulatory health care facilities shall be provided with fire alarm systems in accordance with Section 13.7 and 13.7.2.9, except as modified by 13.7.2.9.2 through 13.7.2.9.4. [***101:***20.3.4.1]

13.7.2.9.2 Initiation. Initiation of the required fire alarm systems shall be by manual means in accordance with 13.7.1.7 and by means of any detection devices or detection systems required. [***101:***20.3.4.2]

13.7.2.9.3 Notification. Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted. [***101:***20.3.4.3]

13.7.2.9.3.1 Occupant Notification. Occupant notification shall be accomplished automatically, without delay, in accordance with 13.7.1.9 upon operation of any fire alarm activating device. [***101:***20.3.4.3.1]

13.7.2.9.3.2 Emergency Forces Notification.

13.7.2.9.3.2.1 Emergency forces notification shall be accomplished in accordance with 13.7.1.10. [***101:***20.3.4.3.2.1]

13.7.2.9.3.2.2 Reserved.

13.7.2.9.4 Emergency Control Functions. Operation of any activating device in the required fire alarm system shall be arranged to accomplish automatically, without delay, any control functions required to be performed by that device. *(See 13.7.1.11.)* [***101:***20.3.4.4]

13.7.2.10 Existing Ambulatory Health Care Occupancies.

13.7.2.10.1 General. Existing ambulatory health care facilities shall be provided with fire alarm systems in accordance with Section 13.7 and 13.7.2.10, except as modified by 13.7.2.10.2 through 13.7.2.10.4. [***101:***21.3.4.1]

13.7.2.10.2 Initiation. Initiation of the required fire alarm systems shall be by manual means in accordance with 13.7.1.7 and by means of any detection devices or detection systems required. [***101:***21.3.4.2]

13.7.2.10.3 Notification. Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted. [***101:***21.3.4.3]

13.7.2.10.3.1 Occupant Notification. Occupant notification shall be accomplished automatically, without delay, in accordance with 13.7.1.9 upon operation of any fire alarm activating device. [***101:***21.3.4.3.1]

13.7.2.10.3.2 Emergency Forces Notification.

13.7.2.10.3.2.1 Emergency forces notification shall be accomplished in accordance with 13.7.1.10. [***101:***21.3.4.3.2.1]

13.7.2.10.3.2.2 Smoke detection devices or smoke detection systems equipped with reconfirmation features shall not be required to automatically notify the fire department, unless the alarm condition is reconfirmed after a period not exceeding 120 seconds. [***101:***21.3.4.3.2.2]

13.7.2.10.4 Emergency Control Functions. Operation of any activating device in the required fire alarm system shall be arranged to accomplish automatically, without delay, any control functions required to be performed by that device. *(See 13.7.1.11.)* [***101:***21.3.4.4]

Paragraphs 13.7.2.9.1 through 13.7.2.9.4 and 13.7.2.10.1 through and 13.7.2.10.4 address required fire alarm equipment. Reliability is of prime importance; therefore, electrical supervision of the system and system components is specified via the references to Section 13.7. In the event of circuit fault, component failure, or other trouble, a continuous trouble indication signal is required and should be provided at a constantly attended location.

Paragraphs 13.7.2.9.1, 13.7.2.9.2, 13.7.2.10.1, and 13.7.2.10.2 require a manual fire alarm system. Manual fire alarm boxes should be located along the natural routes of egress and cover all portions of the building (see 13.7.1.7.3 and 13.7.1.7.5). They should be located so that those qualified to send an alarm can summon aid without having to leave their zone of ordinary activities or pass beyond the view and hearing of people immediately exposed to, or in direct view of, a fire. The operation of a manual fire alarm box should automatically summon attendants to assist in moving occupants.

Actuation of any required fire or smoke detector, activation of a required sprinkler system, or operation of a manual fire alarm box must automatically, without delay, initiate the alarm system and sound audible alarm devices within the building. Presignal systems are not permitted (see 13.7.1.9.3); positive alarm sequence is permitted (see 13.7.1.9.4).

The criteria for positive alarm sequence are detailed in *NFPA 72* and include the following:

1. The signal from an automatic fire detection device selected for positive alarm sequence operation must be acknowledged at the control unit by trained personnel within 15 seconds of annunciation in order to initiate the alarm investigation phase.
2. If the signal is not acknowledged within 15 seconds, notification signals in accordance with the building evacuation or relocation plan and remote signals must be automatically and immediately activated (i.e., immediate occupant notification and emergency forces notification must occur).
3. If the signal is acknowledged within 15 seconds, trained personnel have up to 180 seconds during the alarm investigation phase to evaluate the fire condition and reset the system.

4. If the system is not reset during the investigation phase, notification signals in accordance with the building evacuation or relocation plan and remote signals must be automatically and immediately activated (i.e., immediate occupant notification and emergency forces notification must occur).
5. If a second automatic fire detector selected for positive alarm sequence is actuated during the alarm investigation phase, notification signals in accordance with the building evacuation or relocation plan and remote signals must be automatically and immediately activated (i.e., immediate occupant notification and emergency forces notification must occur).
6. If any other initiating device is actuated (e.g., a manual fire alarm box), notification signals in accordance with the building evacuation or relocation plan and remote signals must be automatically and immediately activated (i.e., immediate occupant notification and emergency forces notification must occur).

The alarm must automatically transmit to a point outside the facility. If automatic transmission of the alarm to the fire department legally committed to serve the facility is not permitted, arrangements must be made for the prompt notification of the fire department or such other assistance as is available in the case of fire or other emergency. Paragraph 13.7.1.10.2 lists various methods acceptable for automatically notifying the fire department. The fire department should also be called manually to verify and confirm the automatic transmission of the alarm. In larger facilities, this might be the responsibility of the facility telephone operator. In smaller facilities, it might be the responsibility of the medical staff. Actuation of the fire alarm must initiate the operation of audible alerting devices that sound throughout the affected zone or building.

13.7.2.11 New Detention and Correctional Occupancies.

Δ **13.7.2.11.1 General.** New detention and correctional occupancies shall be provided with a fire alarm system in accordance with Section 13.7 and 13.7.2.11, except as modified by 13.7.2.11.2 through 13.7.2.11.4.3. [***101:***22.3.4.1]

13.7.2.11.2 Initiation. Initiation of the required fire alarm system shall be by manual means in accordance with 13.7.1.7, by means of any required detection devices or detection systems, and by means of waterflow alarm in the sprinkler system required by 13.3.2.13.1, unless otherwise permitted by the following:

(1) Manual fire alarm boxes shall be permitted to be locked, provided that staff is present within the area when it is occupied and staff has keys readily available to unlock the boxes.
(2) Manual fire alarm boxes shall be permitted to be located in a staff location, provided that both of the following criteria are met:
    (a) The staff location is attended when the building is occupied.
    (b) The staff attendant has direct supervision of the sleeping area.

[***101:***22.3.4.2]

13.7.2.11.3 Notification.

13.7.2.11.3.1 Occupant Notification. Occupant notification shall be accomplished automatically in accordance with 13.7.1.9, and the following also shall apply:

(1) A positive alarm sequence shall be permitted in accordance with 13.7.1.9.4.
(2)* Any smoke detectors required by this chapter shall be permitted to be arranged to alarm at a constantly attended location only and shall not be required to accomplish general occupant notification.

[***101:***22.3.4.3.1]

A.13.7.2.11.3.1(2) The staff at the constantly attended location should have the capability to promptly initiate the general alarm function and contact the fire department or have direct communication with a control room or other location that can initiate the general alarm function and contact the fire department. [***101:***A.22.3.4.3.1(2)]

13.7.2.11.3.2 Emergency Forces Notification.

13.7.2.11.3.2.1 Fire department notification shall be accomplished in accordance with 13.7.1.10, unless otherwise permitted by one of the following:

(1) A positive alarm sequence shall be permitted in accordance with 13.7.1.9.4.
(2) Any smoke detectors required by this chapter shall not be required to transmit an alarm to the fire department.
(3) This requirement shall not apply where staff is provided at a constantly attended location that meets one of the following criteria:
    (a) It has the capability to promptly notify the fire department.
    (b) It has direct communication with a control room having direct access to the fire department.

[***101:***22.3.4.3.2.1]

13.7.2.11.3.2.2 Where the provision of 13.7.2.11.3.2.1(3) is utilized, the fire plan, as required by 20.7.2.1.3, shall include procedures for logging of alarms and immediate notification of the fire department. [***101:***22.3.4.3.2.2]

13.7.2.11.4* Detection. An approved automatic smoke detection system shall be in accordance with Section 13.7, as modified by 13.7.2.11.4.1 through 13.7.2.11.4.3, throughout all resident sleeping areas and adjacent day rooms, activity rooms, or contiguous common spaces. [***101:***22.3.4.4]

A.13.7.2.11.4 Examples of contiguous common spaces are galleries and corridors. [***101:***A.22.3.4.4]

13.7.2.11.4.1 Smoke detectors shall not be required in sleeping rooms with four or fewer occupants. [***101:***22.3.4.4.1]

13.7.2.11.4.2 Other arrangements and positioning of smoke detectors shall be permitted to prevent damage or tampering, or for other purposes. [***101:***22.3.4.4.2]

13.7.2.11.4.2.1 Other arrangements, as specified in 13.7.2.11.4.2, shall be capable of detecting any fire, and the placement of detectors shall be such that the speed of detection is equivalent to that provided by the spacing and arrangements required by the installation standards referenced in Section 13.7. [***101:***22.3.4.4.2.1]

13.7.2.11.4.2.2 Detectors shall be permitted to be located in exhaust ducts from cells, behind grilles, or in other locations. [***101***:22.3.4.4.2.2]

13.7.2.11.4.2.3 The equivalent performance of the design permitted by 13.7.2.11.4.2.2 shall be acceptable to the AHJ in accordance with the equivalency concepts specified in Section 1.4. [***101:***22.3.4.4.2.3]

13.7.2.11.4.3* Smoke detectors shall not be required in Use Condition II open dormitories where staff is present within the dormitory whenever the dormitory is occupied. [***101:***22.3.4.4.3]

A.13.7.2.11.4.3 An open dormitory is a dormitory that is arranged to allow staff to observe the entire dormitory area at one time. [***101:***A.22.3.4.4.3]

13.7.2.12 Existing Detention and Correctional Occupancies.

13.7.2.12.1 General. Existing detention and correctional occupancies shall be provided with a fire alarm system in accordance with Section 13.7 and 13.7.2.12, except as modified by 13.7.2.12.2 through 13.7.2.12.4.4. [***101:***23.3.4.1]

13.7.2.12.2 Initiation. Initiation of the required fire alarm system shall be by manual means in accordance with 13.7.1.7 and by means of any required detection devices or detection systems, unless otherwise permitted by the following:

(1) Manual fire alarm boxes shall be permitted to be locked, provided that staff is present within the area when it is occupied and staff has keys readily available to unlock the boxes.
(2) Manual fire alarm boxes shall be permitted to be located in a staff location, provided that both of the following criteria are met:
    (a) The staff location is attended when the building is occupied.
    (b) The staff attendant has direct supervision of the sleeping area.

[***101:***23.3.4.2]

13.7.2.12.3 Notification.

13.7.2.12.3.1 Occupant Notification. Occupant notification shall be accomplished automatically in accordance with 13.7.1.9, and the following also shall apply:

(1) A positive alarm sequence shall be permitted in accordance with 13.7.1.9.4.
(2)* Any smoke detectors required by this chapter shall be permitted to be arranged to alarm at a constantly attended location only and shall not be required to accomplish general occupant notification.

[***101:***23.3.4.3.1]

A.13.7.2.12.3.1(2) The staff at the constantly attended location should have the capability to promptly initiate the general alarm function and contact the fire department or have direct communication with a control room or other location that can initiate the general alarm function and contact the fire department. [***101:***A.23.3.4.3.1(2)]

13.7.2.12.3.2 Emergency Forces Notification.

13.7.2.12.3.2.1 Fire department notification shall be accomplished in accordance with 13.7.1.10, unless otherwise permitted by one of the following:

(1) A positive alarm sequence shall be permitted in accordance with 13.7.1.9.4.
(2) Any smoke detectors required by this chapter shall not be required to transmit an alarm to the fire department.
(3) This requirement shall not apply where staff is provided at a constantly attended location that meets one of the following criteria:
    (a) It has the capability to promptly notify the fire department.
    (b) It has direct communication with a control room having direct access to the fire department.

[***101:***23.3.4.3.2.1]

13.7.2.12.3.2.2 Where the provision of 13.7.2.12.3.2.1(3) is utilized, the fire plan, as required by 20.7.2.1.3, shall include procedures for logging of alarms and immediate notification of the fire department. [***101:***23.3.4.3.2.2]

13.7.2.12.4 Detection. An approved automatic smoke detection system shall be in accordance with Section 13.7, as modified by 13.7.2.12.4.1 through 13.7.2.12.4.4, throughout all resident housing areas. [***101:***23.3.4.4]

13.7.2.12.4.1 Smoke detectors shall not be required in sleeping rooms with four or fewer occupants in Use Condition II or Use Condition III. [***101:***23.3.4.4.1]

13.7.2.12.4.2 Other arrangements and positioning of smoke detectors shall be permitted to prevent damage or tampering, or for other purposes. [***101:***23.3.4.4.2]

13.7.2.12.4.2.1 Other arrangements, as specified in 13.7.2.12.4.2, shall be capable of detecting any fire, and the placement of detectors shall be such that the speed of detection is equivalent to that provided by the spacing and arrangements required by the installation standards referenced in Section 13.7. [***101:***23.3.4.4.2.1]

13.7.2.12.4.2.2 Detectors shall be permitted to be located in exhaust ducts from cells, behind grilles, or in other locations. [***101:***23.3.4.4.2.2]

Δ **13.7.2.12.4.2.3** The equivalent performance of the design permitted by 13.7.2.12.4.2.2 shall be acceptable to the AHJ in accordance with the equivalency concepts specified in Section 1.4. [***101:***23.3.4.4.2.3]

13.7.2.12.4.3* Smoke detectors shall not be required in Use Condition II open dormitories where staff is present within the dormitory whenever the dormitory is occupied and the building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.3.2.14.2. [***101:***23.3.4.4.3]

A.13.7.2.12.4.3 An open dormitory is a dormitory that is arranged to allow staff to observe the entire dormitory area at one time. [***101:***A.23.3.4.4.3]

13.7.2.12.4.4 In smoke compartments protected throughout by an approved automatic sprinkler system in accordance with 13.3.2.14.2, smoke detectors shall not be required, except in corridors, common spaces, and sleeping rooms with more than four occupants. [***101:***23.3.4.4.4]

Given that new detention and correctional facilities must be sprinklered, 13.7.2.12.2 requires a waterflow alarm as one of the means for initiating the fire alarm system.

Paragraph 13.7.1.9.3 requires specific occupancy chapter permission for a presignal system to be used. The provision of 13.7.2.11.3.1 and 13.7.2.12.3.1 has the effect of prohibiting the use of presignal systems by not specifically allowing them. Rather, notification must be provided without delay in accordance with 13.7.1.9, or the more reliable form of presignal — called positive alarm sequence — can be used if complying with 13.7.1.9.4. However, to avoid numerous nuisance alarms, smoke detectors are exempted from sounding a general alarm.

Where the fire department is not equipped to receive alarms or where direct transmission to the fire department is not permitted, the provisions of 13.7.2.11.3.2 and 13.7.2.12.3.2 require that arrangements be made for the prompt notification of the fire department. One means of notification is by an approved central station alarm system. The provisions of 13.7.1.10 provide several options for notifying the fire department automatically. Where smoke detectors are provided, they are not required to sound the fire alarm or to transmit a signal to the fire department, but they are required to sound an alarm at a constantly attended location, unless otherwise specified.

Paragraphs 13.7.2.11.4.3 and 13.7.2.12.3.4 are exemptions to the smoke detection system requirement. They apply to Use Condition II open dormitories where staff are present within the dormitory whenever the dormitory is occupied. Note that Use Condition II facilities must allow free movement from sleeping areas to another smoke compartment. The concept employed is one of relying on awake and alert staff within the dormitory to act as human fire detectors, providing early warning, and allowing residents to move into a safe smoke compartment.

13.7.2.13 New and Existing One- and Two-Family Dwellings.

13.7.2.13.1 Smoke alarms or a smoke detection system shall be provided in accordance with either 13.7.2.13.1.1 or 13.7.2.13.1.2, as modified by 13.7.2.13.1.3. [***101:***24.3.4.1]

13.7.2.13.1.1* Smoke alarms shall be installed in accordance with 13.7.1.8 in all of the following locations:

(1) All sleeping rooms
(2)* Outside of each separate sleeping area, in the immediate vicinity of the sleeping rooms

Δ **A.13.7.2.13.1.1** Paragraph 11.5.1.3 of *NFPA 72* contains related requirements. They specify that, where the interior floor area for a given level of a dwelling unit, excluding garage areas, is greater than 1000 ft² (93 m²), smoke alarms are to be installed as follows:

(1) All points on the ceiling are to have a smoke alarm within a distance of 30 ft (9.1 m), measured along a path of travel, or to have one smoke alarm per 500 ft² (46.5 m²) of floor area, which is calculated by dividing the total interior floor area per level by 500 ft² (46.5 m²).
(2) Where dwelling units include great rooms or vaulted/cathedral ceilings extending over multiple floors, smoke alarms located on the upper floor that are intended to protect the aforementioned area are permitted to be considered as part of the lower floor(s) protection scheme used to meet the requirements of A.13.7.2.13.1.1(1).

[***101:***A.24.3.4.1.1]

Δ **A.13.7.2.13.1.1(2)** Paragraphs 11.5.1.1(2) and 11.5.1.2 of *NFPA 72* contain related requirements. The requirement of 11.5.1.1(2) specifies that an alarm is to be installed outside of each separate dwelling unit sleeping area, within 21 ft (6.4 m) of any door to a sleeping room, with the distance measured along a path of travel. The requirement in 11.5.1.2 of *NFPA 72* specifies that, where the area addressed in 11.5.1.1(2) of *NFPA 72* is separated from the adjacent living areas by a door, a smoke alarm is to be installed in the area between the door and the sleeping rooms, and additional alarms are to be installed on the living area side of the door. [***101:***A.24.3.4.1.1(2)]

(3) On each level of the dwelling unit, including basements

[***101:***24.3.4.1.1]

13.7.2.13.1.2 Dwelling units shall be protected by an approved smoke detection system in accordance with Section 13.7 and equipped with an approved means of occupant notification. [***101:***24.3.4.1.2]

13.7.2.13.1.3 In existing one- and two-family dwellings, approved smoke alarms powered by batteries shall be permitted. [***101:***24.3.4.1.3]

The reference to 13.7.1.8 in 13.7.2.13.1.1 requires smoke alarms to be hardwired into the electrical system of the home, to be plug-in alarms, or to meet the other power requirements of *NFPA 72*. The provision of 13.7.2.13.1.3, which permits battery-powered smoke alarms in existing dwellings, gives dwelling occupants relief from retrofit requirements while providing needed protection. However, occupants of dwellings that use battery-operated smoke alarms must ensure that those alarms are tested and maintained properly. NFPA analysis has shown that 30 percent of smoke alarms were inoperative in homes with smoke alarms that had experienced fire. The primary reason for smoke alarm failure is that the battery was removed to avoid nuisance alarms. NFPA public education programs, such as the *Learn Not to Burn*® program, are effective tools for promoting the importance of working smoke alarms.

Note that the *Code* requires smoke alarms to be located in sleeping rooms of both new and existing one- and two-family dwellings. In existing dwellings, the smoke alarms are permitted to be powered by replaceable batteries as indicated in 13.7.2.13.1.3.

13.7.2.13.2 Carbon Monoxide and Carbon Monoxide Detection Systems.

13.7.2.13.2.1 Carbon monoxide alarms or carbon monoxide detectors in accordance with 13.7.1.14 and 13.7.2.13.2 shall be provided in new one- and two-family dwellings where either of the following conditions exists:

(1) Dwelling units with communicating attached garages, unless otherwise exempted by 13.7.2.13.2.3
(2) Dwelling units containing fuel-burning appliances or fuel-burning fireplaces

[***101:***24.3.4.2.1]

13.7.2.13.2.2* Where required by 13.7.2.13.2.1, carbon monoxide alarms or carbon monoxide detectors shall be installed in the following locations:

(1) Outside of each separate dwelling unit sleeping area in the immediate vicinity of the sleeping rooms
(2) On every occupiable level of a dwelling unit, including basements, and excluding attics and crawl spaces

[***101:***24.3.4.2.2]

Δ **A.13.7.2.13.2.2** The placement requirements of NFPA 720 are modified specifically for one- and two-family dwellings as required by this *Code* and do not affect other regulations within a jurisdiction. [***101:***A.24.3.4.2.2]

13.7.2.13.2.3 Carbon monoxide alarms and carbon monoxide detectors as specified in 13.7.2.13.2.1(1) shall not be required in the following locations:

(1) In garages
(2) Within dwelling units with communicating attached garages that are open parking structures as defined by the building code
(3) Within dwelling units with communicating attached garages that are mechanically ventilated in accordance with the mechanical code

[***101:***24.3.4.2.3]

The provisions of 13.7.2.13.2 mandate the installation of CO detectors or CO alarms in new dwellings where there is a potential for accidental CO poisoning from a vehicle in an attached, communicating garage (i.e., a garage with an opening to the dwelling unit) or from fuel-burning appliances, such as a gas- or an oil-fired furnace or a fuel-burning fireplace. The reference to 13.7.1.14 in 13.7.2.13.2.1 requires compliance with NFPA 720. NFPA 720, which is modeled after *NFPA 72*, contains the detailed installation requirements for CO alarms, including those for power supply. The required locations for CO alarms in dwellings are nearly identical to those for smoke alarms, except CO alarms are not required in sleeping rooms. Also, like smoke alarms, where more than one CO alarm is required in a dwelling, they must be interconnected so that, when one activates, all CO alarms in the dwelling sound their alarms.

Exhibit 13.42

Combination CO and smoke alarm.

Although not mandated in existing dwellings, the installation of CO alarms is recommended if CO poisoning is a possibility. See the commentary following 13.7.1.14 for additional details. Exhibit 13.42 depicts a typical battery-powered combination CO and smoke alarm on display for sale at a retail store.

It is important to note that the typical service life of a CO alarm varies from about 5 to 10 years. CO alarms must be replaced by the date indicated on the device to ensure proper operation.

13.7.2.14 New and Existing Lodging or Rooming Houses.

13.7.2.14.1 General.

13.7.2.14.1.1 New and existing lodging and rooming houses, other than those meeting 13.7.2.14.1.2, shall be provided with a fire alarm system in accordance with Section 13.7. [***101:***26.3.4.1.1]

13.7.2.14.1.2 A fire alarm system in accordance with Section 13.7 shall not be required in existing lodging and rooming houses that have an existing smoke detection system meeting or exceeding the requirements of 13.7.2.14.5.1 where that detection system includes not less than one manual fire alarm box per floor arranged to initiate the smoke detection alarm. [***101:***26.3.4.1.2]

In existing lodging or rooming houses, 13.7.2.14.1.2 permits existing multiple-station smoke alarms and a manual fire alarm box arranged as a system to substitute for a standard fire alarm system in accordance with *NFPA 72*.

Δ **13.7.2.14.2 Initiation.** Initiation of the required fire alarm system shall be by manual means in accordance with 13.7.1.7, or by alarm initiation in accordance with 13.7.1.7.1(3) in buildings protected throughout by an approved automatic sprinkler system in accordance with 13.3.2.19. [***101:***26.3.4.2]

13.7.2.14.3 Notification. Occupant notification shall be provided automatically in accordance with 13.7.1.9, as modified by 13.7.2.14.3.1 and 13.7.2.14.3.2. [***101:***26.3.4.3]

13.7.2.14.3.1* Visible signals for the hearing impaired shall not be required where the proprietor resides in the building and there are five or fewer rooms for rent. [*101:*26.3.4.3.1]

A.13.7.2.14.3.1 The proprietor is the owner or owner's agent with responsible charge. [*101:*A.26.3.4.3.1]

13.7.2.14.3.2 Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted. [*101:*26.3.4.3.2]

13.7.2.14.4 Detection. (Reserved)

13.7.2.14.5 Smoke Alarms.

Δ **13.7.2.14.5.1** Approved smoke alarms, other than existing smoke alarms meeting the requirements of 13.7.2.14.5.3, shall be installed in accordance with 13.7.1.8 in every sleeping room. [*101:*26.3.4.5.1]

13.7.2.14.5.2 In other than existing buildings, the smoke alarms required by 13.7.2.14.5.1 shall be interconnected in accordance with 13.7.1.8.3. [*101:*26.3.4.5.2]

13.7.2.14.5.3 Existing battery-powered smoke alarms, rather than house electric-powered smoke alarms, shall be permitted where the facility has demonstrated to the AHJ that the testing, maintenance, and battery replacement programs will ensure reliability of power to the smoke alarms. [*101:*26.3.4.5.3]

Paragraph 13.7.2.14.5.1 requires the installation of a smoke alarm in each sleeping room. This requirement applies retroactively to existing lodging or rooming houses, as well as to new construction.

While 13.7.2.14.5.3 permits existing battery-powered smoke alarms to remain in place if approved by the AHJ, newly installed smoke alarms must be powered by the building electrical service or in accordance with the other options specified by *NFPA 72*. This requirement applies to both new and existing lodging or rooming houses in accordance with 13.7.1.8.7.

13.7.2.14.6 Carbon Monoxide Alarms and Carbon Monoxide Detection Systems.

13.7.2.14.6.1 Carbon monoxide alarms or carbon monoxide detectors in accordance with 13.7.1.14 and 13.7.2.14.6 shall be provided in new lodging or rooming houses where either of the following conditions exists:

(1) Lodging or rooming houses with communicating attached garages, unless otherwise exempted by 13.7.2.14.6.3
(2) Lodging or rooming houses containing fuel-burning appliances or fuel-burning fireplaces

[*101:*26.3.4.6.1]

13.7.2.14.6.2* Where required by 13.7.2.14.6.1, carbon monoxide alarms or carbon monoxide detectors shall be installed in the following locations:

(1) Outside of each separate sleeping area in the immediate vicinity of the sleeping rooms
(2) On every occupiable level, including basements, and excluding attics and crawl spaces

[*101:*26.3.4.6.2]

Δ **A.13.7.2.14.6.2** The placement requirements of NFPA 720 are modified to accommodate lodging or rooming house occupancies that are part of multiple occupancy buildings (e.g., an on-call physicians' sleeping room in a hospital). The placement requirements of NFPA 720 are modified specifically for lodging or rooming houses as required by this *Code* and do not affect other regulations within a jurisdiction. [*101:*A.26.3.4.6.2]

13.7.2.14.6.3 Carbon monoxide alarms and carbon monoxide detectors as specified in 13.7.2.14.6.1(1) shall not be required in the following locations:

(1) In garages
(2) Within lodging or rooming houses with communicating attached garages that are open parking structures as defined by the building code
(3) Within lodging or rooming houses with communicating attached garages that are mechanically ventilated in accordance with the mechanical code

[*101:*26.3.4.6.3]

The provisions of 13.7.2.14.6 mandate the installation of CO detectors or CO alarms in new lodging or rooming houses where the potential for accidental CO poisoning from a vehicle in an attached, communicating garage (i.e., a garage with an opening to the lodging or rooming house) or from fuel-burning appliances, such as a gas- or an oil-fired furnace or a fuel-burning fireplace, exists. The reference to 13.7.1.14 in 13.7.2.14.6.1 requires compliance with NFPA 720. NFPA 720, which is modeled after *NFPA 72,* contains the detailed installation requirements for CO alarms, including those for power supply. The required locations for CO alarms in dwellings are nearly identical to those for smoke alarms, except CO alarms are not required in sleeping rooms. Also, like smoke alarms, where more than one CO alarm is required in a lodging or rooming house, they must be interconnected so that, when one activates, all CO alarms in the lodging or rooming house sound their alarms.

Although not mandated in existing lodging or rooming houses, the installation of CO alarms is recommended if CO poisoning is a possibility. It is important to note the typical service life of a CO alarm varies from about 5 to 10 years. CO alarms must be replaced by the date indicated on the device to ensure proper operation. See the commentary following 13.7.1.14 for additional details.

13.7.2.15 New Hotels and Dormitories.

13.7.2.15.1 General. A fire alarm system in accordance with Section 13.7, except as modified by 13.7.2.15.2 through 13.7.2.15.6, shall be provided. [*101:*28.3.4.1]

13.7.2.15.2 Initiation. The required fire alarm system shall be initiated by each of the following:

(1) Manual means in accordance with 13.7.1.7
(2) Manual fire alarm box located at the hotel desk or other convenient central control point under continuous supervision by responsible employees

(3) Required automatic sprinkler system
(4) Required automatic detection system other than sleeping room smoke detectors

[***101:***28.3.4.2]

13.7.2.15.3 Notification.

13.7.2.15.3.1* Occupant notification shall be provided automatically in accordance with 13.7.1.9. [***101:***28.3.4.3.1]

A.13.7.2.15.3.1 Visible signaling appliances might be governed by provisions of federal regulations in 28 CFR 36, Appendix A, "Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities," Section 4.28, Alarms. [***101:***A.28.3.4.3.1]

13.7.2.15.3.2 Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted. [***101:***28.3.4.3.2]

13.7.2.15.3.3* Guest rooms and guest suites specifically required and equipped to accommodate hearing-impaired individuals shall be provided with a visible notification appliance. [***101:***28.3.4.3.3]

A.13.7.2.15.3.3 A quantity of such rooms and suites might be required to be equipped to accommodate hearing-impaired individuals based on the total number of rooms in a transient lodging facility. *(See 28 CFR 36, Appendix A, "Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities.")* [***101:***A.28.3.4.3.3]

13.7.2.15.3.4 In occupiable areas, other than guest rooms and guest suites, visible notification appliances shall be provided. [***101:***28.3.4.3.4]

13.7.2.15.3.5 Annunciation and annunciation zoning in accordance with 13.7.1.13 shall be provided in buildings three or more stories in height or having more than 50 guest rooms or guest suites. Annunciation shall be provided at a location readily accessible from the primary point of entry for emergency response personnel. [***101:***28.3.4.3.5]

13.7.2.15.3.6 Emergency forces notification shall be provided in accordance with 13.7.1.10. [***101:***28.3.4.3.6]

13.7.2.15.4 Detection. A corridor smoke detection system in accordance with Section 13.7 shall be provided in buildings other than those protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.7.2.15. [***101:***28.3.4.5]

13.7.2.15.5* Smoke Alarms. Smoke alarms shall be installed in accordance with 13.7.1.8 in every guest room and every living area and sleeping room within a guest suite. [***101:***28.3.4.6]

A.13.7.2.15.5 Caution needs to be exercised in locating smoke alarms with regard to their proximity to bathrooms, cooking facilities, and HVAC outlets in order to prevent nuisance alarms. [***101:***A.28.3.4.5]

13.7.2.15.6 Carbon Monoxide Alarms and Carbon Monoxide Detection Systems.

13.7.2.15.6.1 Carbon monoxide alarms or carbon monoxide detectors in accordance with 13.7.1.14 and 13.7.2.15.6 shall be provided in new hotels and dormitories where either of the following conditions exists:

(1) Guest rooms or guest suites with communicating attached garages, unless otherwise exempted by 13.7.2.15.6.3
(2) Guest rooms or guest suites containing a permanently installed fuel-burning appliance or fuel-burning fireplace

[***101:***28.3.4.7.1]

13.7.2.15.6.2 Where required by 13.7.2.15.6.1, carbon monoxide alarms or carbon monoxide detectors shall be installed in the following locations:

(1) Outside of each separate guest room or guest suite sleeping area in the immediate vicinity of the sleeping rooms
(2) On every occupiable level of a guest room and guest suite

[***101:***28.3.4.7.2]

Δ **13.7.2.15.6.3** Carbon monoxide alarms and carbon monoxide detectors as specified in 13.7.2.15.6.1(1) shall not be required in the following locations:

(1) In garages
(2) Within guest rooms or guest suites with communicating attached garages that are open parking structures as defined by the building code
(3) Within guest rooms or guest suites with communicating attached garages that are mechanically ventilated in accordance with the mechanical code

[***101:***28.3.4.7.3]

Δ **13.7.2.15.6.4** Where fuel-burning appliances or fuel-burning fireplaces are installed outside guest rooms or guest suites, carbon monoxide detectors shall be installed in accordance with the manufacturer's published instructions in the locations specified as follows:

(1) On the ceilings of rooms containing permanently installed fuel-burning appliances or fuel-burning fireplaces
(2) Centrally located within occupiable spaces served by the first supply air register from a permanently installed, fuel-burning HVAC system
(3) Centrally located within occupiable spaces adjacent to a communicating attached garage

[***101:***28.3.4.7.4]

The provisions of 13.7.2.15.6 mandate the installation of CO detectors or CO alarms in new hotels and dormitories where the potential for accidental CO poisoning from a vehicle in an attached, communicating garage (i.e., a garage with an opening directly to the hotel or dormitory occupancy) or from fuel-burning appliances, such as a gas- or an oil-fired furnace or a fuel-burning fireplace, exists. The reference to 13.7.1.14 in 13.7.2.15.6.1 requires compliance with NFPA 720. NFPA 720, which is modeled after *NFPA 72,* contains the detailed installation requirements for CO alarms, including those for power supply. Like smoke alarms, where more than one CO alarm is required in a hotel or dormitory, they must be interconnected so that, when one activates, all CO alarms in the hotel or dormitory sound their alarms.

Although not mandated in existing hotels and dormitories, the installation of CO alarms is recommended if there is a potential for CO poisoning. It is important to note that the typical service life of a CO alarm varies from about 5 to 10 years. CO alarms must be replaced by the date indicated on the device to ensure proper operation. See the commentary following 13.7.1.14 for additional details.

N **13.7.2.15.6.5** Where carbon monoxide detectors are installed in accordance with 13.7.2.15.6.4(1), the alarm signal shall be automatically transmitted to an approved on-site location or to an off-premises location in accordance with NFPA 720. [***101:***28.3.4.7.5]

N **13.7.2.15.7 Risk Analysis for Mass Notification.**

N **13.7.2.15.7.1** A risk analysis in accordance with 13.7.1.15 shall be performed for grade K through 12, college, or university dormitories with an occupant load greater than 100 to determine if a mass notification system is required. [***101:***28.3.4.4.1]

N **13.7.2.15.7.2** Applicable portions of an existing risk analysis shall be permitted to be used when a new building is added to the campus. [***101:***28.3.4.4.2]

13.7.2.16 Existing Hotels and Dormitories.

13.7.2.16.1 General. A fire alarm system in accordance with Section 13.7, except as modified by 13.7.2.16.2 through 13.7.2.16.3.5, shall be provided in buildings, other than those where each guest room has exterior exit access in accordance with 14.10.3 and the building is three or fewer stories in height. [***101:***29.3.4.1]

13.7.2.16.2 Initiation. The required fire alarm system shall be initiated by each of the following:

(1) Manual means in accordance with 13.7.1.7, unless there are other effective means to activate the fire alarm system, such as complete automatic sprinkler or automatic detection systems, with manual fire alarm box in accordance with 13.7.2.16.2(2) required
(2) Manual fire alarm box located at the hotel desk or other convenient central control point under continuous supervision by responsible employees
(3) Required automatic sprinkler system
(4) Required automatic detection system other than sleeping room smoke detectors

[***101:***29.3.4.2]

13.7.2.16.3 Notification.

13.7.2.16.3.1 Occupant notification shall be provided automatically in accordance with 13.7.1.9. [***101:***29.3.4.3.1]

13.7.2.16.3.2 Positive alarm sequence in accordance with 13.7.1.9.4, and a presignal system in accordance with 13.7.1.9.3, shall be permitted. [***101:***29.3.4.3.2]

13.7.2.16.3.3 Reserved.

13.7.2.16.3.4 Reserved.

13.7.2.16.3.5 Reserved.

13.7.2.16.3.6* Where the existing fire alarm system does not provide for automatic emergency forces notification in accordance with 13.7.1.10, provisions shall be made for the immediate notification of the public fire department by telephone or other means in case of fire, and, where there is no public fire department, notification shall be made to the private fire brigade. [***101:***29.3.4.3.6]

A.13.7.2.16.3.6 The provision for immediate notification of the public fire department is intended to include, but is not limited to, all of the arrangements in 13.7.1.10.2. Other arrangements that depend on a clerk or other member of the staff to notify the fire department might also be permitted. In such cases, however, it is essential that a trained staff member and an immediately available means of calling the fire department are continuously available. If a telephone is to be used, it should not be of any type or arrangement that requires a coin or the unlocking of a device to contact the fire department. [***101:***A.29.3.4.3.6]

13.7.2.16.3.7 Where a new fire alarm system is installed or the existing fire alarm system is replaced, emergency forces notification shall be provided in accordance with 13.7.1.10. [***101:***29.3.4.3.7]

13.7.2.16.4 Detection. (Reserved)

13.7.2.16.5* Smoke Alarms. An approved single-station smoke alarm shall be installed in accordance with 13.7.1.8 in every guest room and every living area and sleeping room within a guest suite. [***101:***29.3.4.5]

A.13.7.2.16.5 Caution needs to be exercised in locating smoke alarms with regard to their proximity to bathrooms, cooking facilities, and HVAC outlets in order to prevent nuisance alarms. [***101***:A.29.3.4.5]

13.7.2.16.5.1 The smoke alarms shall not be required to be interconnected. [***101:***29.3.4.5.1]

13.7.2.16.5.2 Single-station smoke alarms without a secondary (standby) power source shall be permitted. [***101:***29.3.4.5.2]

13.7.2.17 New Apartment Buildings.

13.7.2.17.1 General.

13.7.2.17.1.1 New apartment buildings four or more stories in height or with more than 11 dwelling units, other than those meeting the requirements of 13.7.2.17.1.2, shall be provided with a fire alarm system in accordance with Section 13.7, except as modified by 13.7.2.17.2 through 13.7.2.17.5. [***101:***30.3.4.1.1]

13.7.2.17.1.2 A fire alarm system shall not be required in buildings where each dwelling unit is separated from other contiguous dwelling units by fire barriers *(see Section 12.7)* having a minimum 1-hour fire resistance rating, and where each dwelling unit has either its own independent exit or its own independent stairway or ramp discharging at the finished ground level. [***101:***30.3.4.1.2]

The intent of 13.7.2.17.1.2 is to exempt townhouse-type apartment buildings from the requirement for a fire alarm system, because, during a fire, each apartment unit retains safe egress routes for longer than is typical of apartment buildings with interior exit access corridors. The safe egress route helps to ensure that any delay in occupant notification resulting from the absence of an alarm system can be tolerated without undue risk.

13.7.2.17.2 Initiation.

13.7.2.17.2.1 Initiation of the required fire alarm system shall be by manual means in accordance with 13.7.1.7, unless the building complies with 13.7.2.17.2.2. [***101:***30.3.4.2.1]

13.7.2.17.2.2 Initiation of the required fire alarm system by manual means shall not be required in buildings four or fewer stories in height, containing not more than 16 dwelling units, and protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 13.3.2.17. [***101:***30.3.4.2.2]

13.7.2.17.2.3 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 13.3.2.17, required fire alarm systems shall be initiated upon operation of the automatic sprinkler system. [***101:***30.3.4.2.3]

13.7.2.17.3 Notification.

13.7.2.17.3.1 Occupant notification shall be provided automatically in accordance with Section 13.7, and both of the following shall also apply:

(1) Visible signals shall be installed in units designed for the hearing impaired.
(2) Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted.

[***101:***30.3.4.3.1]

13.7.2.17.3.2 Annunciation, and annunciation zoning, in accordance with 13.7.1.13 shall be provided, unless the building complies with either 13.7.2.17.3.3 or 13.7.2.17.3.4. Annunciation shall be provided at a location readily accessible from the primary point of entry for emergency response personnel. [***101:***30.3.4.3.2]

13.7.2.17.3.3 Annunciation, and annunciation zoning, shall not be required in buildings two or fewer stories in height and having not more than 50 dwelling units. [***101:***30.3.4.3.3]

13.7.2.17.3.4 Annunciation, and annunciation zoning, shall not be required in buildings four or fewer stories in height containing not more than 16 dwelling units and protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 13.3.2.17. [***101:***30.3.4.3.4]

13.7.2.17.3.5 Emergency forces notification shall be accomplished in accordance with 13.7.1.10. [***101:***30.3.4.3.5]

13.7.2.17.4 Detection. (Reserved)

13.7.2.17.5* Smoke Alarms. Smoke alarms shall be installed in accordance with 13.7.1.8 in every sleeping area, outside every sleeping area in the immediate vicinity of the bedrooms, and on all levels of the dwelling unit, including basements. [***101:***30.3.4.5]

A.13.7.2.17.5 Previous editions of NFPA *101* permitted the single-station smoke alarm required by 13.7.2.17.5 to be omitted from each apartment where a complete automatic smoke detection system was installed throughout the building. With such a system, when one detector is activated, an alarm is sounded throughout the building. Experience with complete smoke detection systems in apartment buildings has shown that numerous nuisance alarms are likely to occur. Where there is a problem with frequent nuisance alarms, occupants ignore the alarm, or the system is either disconnected or otherwise rendered inoperative. [***101:***A.30.3.4.5]

The smoke alarm(s) required by 13.7.2.17.5 should be located in the hall area(s) that provides access to rooms used for sleeping. In multilevel apartment units, the smoke alarm covering the upper level should normally be located at the top of the stairs. The smoke alarm(s) should be mounted on the ceiling or on the wall; *NFPA 72* provides detailed smoke alarm placement requirements. Smoke alarms should be remotely located from cooking areas. Where unusual factors such as room configuration, air movement, or stagnant air pockets must be considered, the AHJ and the designer should determine the placement of the smoke alarms.

In addition to requiring smoke alarms outside of sleeping rooms, the *Code* requires all new apartment buildings to be provided with smoke alarms within sleeping rooms as well, regardless of sprinkler protection. Note that 13.7.1.8.7 requires smoke alarms to be powered as required by *NFPA 72*; *NFPA 72* requires smoke alarms to be powered by the building's electrical system, which is achieved by using directly wired or plug-in-type smoke alarms. Alternatively, smoke alarms are permitted to be powered by a nonrechargeable, nonreplaceable battery capable of operating the device for 10 years under normal conditions, followed by 4 minutes of alarm, followed by 7 days of trouble alarm.

It is not the *Code's* intent to prohibit the interconnection of smoke alarms within individual apartments. Where an apartment unit requires more than one smoke alarm, interconnection will probably be required to meet the performance criterion for audibility detailed in 13.7.1.8.8.

13.7.2.17.6 Carbon Monoxide Alarms and Carbon Monoxide Detection Systems.

13.7.2.17.6.1 Carbon monoxide alarms or carbon monoxide detectors in accordance with 13.7.1.14 and 13.7.2.17.6 shall be provided in new apartment buildings where either of the following conditions exists:

(1) Dwelling units with communicating attached garages, unless otherwise exempted by 13.7.2.17.6.3
(2) Dwelling units containing a permanently installed fuel-burning appliance or fuel-burning fireplace

[***101:***30.3.4.6.1]

13.7.2.17.6.2 Where required by 13.7.2.17.6.1, carbon monoxide alarms or carbon monoxide detectors shall be installed in the following locations:

(1) Outside of each separate dwelling unit sleeping area in the immediate vicinity of the sleeping rooms
(2) On every occupiable level of a dwelling unit

[***101:***30.3.4.6.2]

Δ **13.7.2.17.6.3** Carbon monoxide alarms and carbon monoxide detectors as specified in 13.7.2.17.6.1(1) shall not be required in the following locations:

(1) In garages
(2) Within dwelling units with communicating attached garages that are open parking structures as defined by the building code
(3) Within dwelling units with communicating attached garages that are mechanically ventilated in accordance with the mechanical code

[***101:***30.3.4.6.3]

Δ **13.7.2.17.6.4*** Where fuel-burning appliances or fuel-burning fireplaces are installed outside dwelling units, carbon monoxide detectors shall be installed in accordance with the manufacturer's published instructions in the locations specified as follows:

(1) On the ceilings of rooms containing permanently installed fuel-burning appliances or fuel-burning fireplaces
(2) Centrally located position within occupiable spaces served by the first supply air register from a permanently installed, fuel-burning HVAC system
(3) Centrally located position within occupiable spaces adjacent to a communicating attached garage

[***101:***30.3.4.6.4]

N **A.13.7.2.17.6.4** Where fuel-burning appliances or fuel-burning fireplaces are located outside but attached to the dwelling unit, the area or room containing the fuel-burning appliance or fuel-burning fireplace could be considered part of the attached dwelling unit(s). In this application, either carbon monoxide alarms or carbon monoxide detectors are permitted to be installed in the attached dwelling unit(s) in accordance with 30.3.4.4. [***101:***A.30.3.4.6.4]

N **13.7.2.17.6.5** Where carbon monoxide detectors are installed in accordance with 13.7.2.17.6.4(1), the alarm signal shall be automatically transmitted to an approved on-site location or to an off-premises location in accordance with NFPA 720. [***101:***30.3.4.6.5]

The provisions of 13.7.2.17.6 mandate the installation of CO detectors or CO alarms in new apartment buildings where there is a potential for accidental CO poisoning from a vehicle in an attached, communicating garage or from fuel-burning appliances, such as a gas-fired or an oil-fired furnace or a fuel-burning fireplace. The reference to 13.7.1.14 in 13.7.2.17.6.1 requires compliance with NFPA 720. NFPA 720, which is modeled after *NFPA 72*, contains the detailed installation requirements for CO alarms, including those for power supply. Like smoke alarms, where more than one CO alarm is required in an apartment, they must be interconnected so that when one activates, all CO alarms in the apartment sound their alarms.

The provision of 13.7.2.17.6.5, which is new to the 2018 edition of the *Code*, requires CO detectors in rooms containing fuel-fired heating equipment, which are not normally occupied, to transmit their alarms to a location in the building approved by the AHJ or to an off-site location, such as an alarm monitoring company. This provision is intended to ensure that responsible building personnel will be promptly notified of a dangerous accumulation of CO in a space in which a local alarm might sound unheard for an extended period of time.

Although not mandated in existing apartment buildings, the installation of CO alarms is recommended if there is a potential for CO poisoning. It is important to note that the typical service life of a CO alarm varies from about 5 to 10 years. CO alarms must be replaced by the date indicated on the device to ensure proper operation. See the commentary following 13.7.1.14 for additional details.

13.7.2.18 Existing Apartment Buildings.

13.7.2.18.1 General.

13.7.2.18.1.1 Existing apartment buildings four or more stories in height or with more than 11 dwelling units, other than those meeting the requirements of 13.7.2.18.1.2, shall be provided with a fire alarm system in accordance with Section 13.7, except as modified by 13.7.2.18.1.2 through 13.7.2.18.5. [***101:***31.3.4.1.1]

13.7.2.18.1.2 A fire alarm system shall not be required where each dwelling unit is separated from other contiguous dwelling units by fire barriers *(see Section 12.7)* having a minimum ½-hour fire resistance rating, and where each dwelling unit has either its own independent exit or its own independent stairway or ramp discharging at the finished ground level. [***101:***31.3.4.1.2]

The intent of 13.7.2.18.1.2 is to exempt townhouse-type apartment buildings from the requirement for a fire alarm system, because, during a fire, each apartment unit retains safe egress routes for longer than is typical of apartment buildings with interior exit access corridors. The safe egress route helps to ensure that any delay in occupant notification resulting from the absence of an alarm system can be tolerated without undue risk.

See the commentary following 13.7.2.17.1.2.

13.7.2.18.2 Initiation.

13.7.2.18.2.1 Initiation of the required fire alarm system shall be by manual means in accordance with 13.7.1.7, unless the building complies with 13.7.2.18.2.2. [***101:***31.3.4.2.1]

13.7.2.18.2.2 Initiation of the required fire alarm system by manual means shall not be required in buildings four or fewer stories in height, containing not more than 16 dwelling units, and protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 13.7.2.18. [***101:***31.3.4.2.2]

13.7.2.18.2.3 In buildings using Option 2 as defined by NFPA *101*, the required fire alarm system shall be initiated by the automatic fire detection system in addition to the manual initiation means of 13.7.2.18.2.1. [***101:***31.3.4.2.3]

13.7.2.18.2.4 In buildings using Option 3 as defined by NFPA *101*, the required fire alarm system shall be initiated upon operation of the automatic sprinkler system in addition to the manual initiation means of 13.7.2.18.2.1. [***101:***31.3.4.2.4]

13.7.2.18.2.5 In buildings using Option 4 as defined by NFPA *101*, the required fire alarm system shall be initiated upon operation of the automatic sprinkler system in addition to the manual initiation means of 13.7.2.18.2.1. [*101:*31.3.4.2.5]

13.7.2.18.3 Notification.

13.7.2.18.3.1 Occupant notification shall be provided automatically in accordance with Section 13.7, and all of the following shall also apply:

(1) Visible signals shall be installed in units designed for the hearing impaired.
(2) Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted.
(3) Existing approved presignal systems shall be permitted in accordance with 13.7.1.9.3.

[*101:*31.3.4.3.1]

13.7.2.18.3.2 An annunciator panel, whose location shall be approved by the AHJ, connected with the required fire alarm system shall be provided, unless the building meets the requirements of 13.7.2.18.3.3 or 13.7.2.18.3.4. [*101:*31.3.4.3.2]

13.7.2.18.3.3 Annunciation shall not be required in buildings two or fewer stories in height and having not more than 50 rooms. [*101:*31.3.4.3.3]

13.7.2.18.3.4 Annunciation shall not be required in buildings four or fewer stories in height containing not more than 16 dwelling units and protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 13.3.2.18. [*101:*31.3.4.3.4]

13.7.2.18.3.5 Emergency forces notification shall be accomplished in accordance with 13.7.1.10. [*101:*31.3.4.3.5]

If a fire alarm system is required in an apartment building, then it must provide notification to the fire department using one of the four methods described in 13.7.1.10.2 (i.e., auxiliary fire alarm system, central station fire alarm system, proprietary supervising station fire alarm system, or remote supervising station fire alarm system). This requirement, which first appeared in the 2003 edition of the *Code*, applies to both new and existing apartment buildings.

Note that 13.7.1.10.3 recognizes that some existing fire alarm systems are not readily adaptable to provide automatic fire department notification. In such cases, the AHJ can approve an alternative plan to ensure a prompt fire department response. With the proliferation of personal cellular phones in recent years, the AHJ might consider approving the installation of signs located at the manual fire alarm boxes that read "Local Alarm Only — In Case of Fire, Call 911," or similar wording, in lieu of requiring automatic notification. In all cases, where a supervised automatic sprinkler system is required by the *Code*, a sprinkler waterflow condition must automatically provide alarm notification to the fire department (see 13.3.1.8.2).

13.7.2.18.4 Detection.

13.7.2.18.4.1* In buildings using Option 2 as defined by NFPA *101*, a complete automatic fire detection system in accordance with 9.6.2.9 of NFPA *101* and 13.7.2.18.4.2 shall be required. [*101:*31.3.4.4.1]

A.13.7.2.18.4.1 It is intended that a building compliant with Option 2[, as defined in Chapter 31 of NFPA *101*,] function as described in the paragraph that follows. [*101:*A.31.3.4.4.1]

Occupants within a living unit become aware of a fire emergency, either through personal awareness or through being alerted by the smoke alarm(s) installed within the living unit. Other building occupants are alerted to the fire emergency by the building fire alarm system that is initiated by manual fire alarm boxes adjacent to the exits, heat detection within the living unit where the fire emergency exists, smoke detection in the common areas outside the living unit, or a combination thereof. The installation of system heat detectors versus smoke detectors within the living unit is intended to eliminate nuisance-type alarms and reduce occupant complacency from frequent false alarms. The installation of smoke detection within the living unit should only be contemplated after a careful analysis of the goals and with the approval of the AHJ. [*101:*A.31.3.4.4.1]

13.7.2.18.4.2 Automatic fire detection devices shall be installed as follows:

(1) Smoke detectors shall be installed in all common areas and work spaces outside the living unit, such as exit stairs, egress corridors, lobbies, storage rooms, equipment rooms, and other tenantless spaces in environments that are suitable for proper smoke detector operation.
(2) Heat detectors shall be located within each room of the living unit.

[*101:*31.3.4.4.2]

13.7.2.18.5 Smoke Alarms.

13.7.2.18.5.1* In buildings other than those equipped throughout with an existing, complete automatic smoke detection system, smoke alarms shall be installed in accordance with 13.7.1.8, as modified by 13.7.2.18.5.2, outside every sleeping area in the immediate vicinity of the bedrooms and on all levels of the dwelling unit, including basements. [*101:*31.3.4.5.1]

Δ **A.13.7.2.18.5.1** NFPA *101* provides adequate, balanced fire protection and takes into consideration the passive and active systems required in a given occupancy. The level of protection prescribed by *NFPA 72* which includes smoke alarms in all sleeping rooms, without exception, does not necessarily take into consideration the complete protection package mandated by NFPA *101*. [*101:*A.31.3.4.5.1]

13.7.2.18.5.2 Smoke alarms required by 13.7.2.18.5.1 shall not be required to be provided with a secondary (standby) power source. [*101:*31.3.4.5.2]

13.7.2.18.5.3 In buildings other than those equipped throughout with an existing, complete automatic smoke detection system or a complete, supervised automatic sprinkler system in accordance with 13.3.2.18, smoke alarms shall be installed in every sleeping area in accordance with 13.7.1.8, as modified by 13.7.2.18.5.4. [*101:*31.3.4.5.3]

13.7.2.18.5.4 Smoke alarms required by 13.7.2.18.5.3 shall be permitted to be battery powered. [***101:***31.3.4.5.4]

NFPA *101* provides four options that specify the varying degrees to which an existing apartment building is protected by fire detection or suppression systems. Life safety requirements are predicated on the option with which the existing building complies. The four options prescribed by NFPA *101* are as follows:

Option 1: No automatic sprinkler or fire detection system
Option 2: Complete fire detection system
Option 3: Partial automatic sprinkler system
Option 4: Complete automatic sprinkler system

Existing apartment buildings using Option 2 are protected throughout by a fire detection system (see 13.7.2.18.4.1). The increased travel distance permitted in an Option 2 apartment building (see 31.2.6.1 and 31.2.6.2 of NFPA *101*) is based on early occupant notification of fire. Therefore, the detectors must initiate the alarm system in addition to the initiation provided by manual fire alarm boxes.

Sprinkler systems protect the corridors of existing apartment buildings using Option 3 (see 13.3.2.18.5). The activation of the sprinkler system must initiate the alarm system in addition to the initiation provided by manual fire alarm boxes.

Existing apartment buildings using Option 4 are protected throughout by automatic sprinkler systems (see 13.3.2.18.6). The activation of the sprinkler system must initiate the alarm system in addition to the initiation provided by manual fire alarm boxes.

In existing apartment buildings using Option 2, a total automatic fire detection system is required and must be interconnected with the building fire alarm system in accordance with 13.7.2.18.2.3. This system is required in addition to the smoke alarms required by 13.7.2.18.5. Note that 13.7.2.18.4 does not require the fire detection system to consist solely of smoke detectors but, instead, permits the use of heat or smoke detectors or a combination of the two. Heat detectors are permitted by 13.7.2.18.4 within apartments, because they are used as part of a system that is separate from the smoke alarms addressed in 13.7.2.18.5. The smoke alarms will alert occupants within an apartment of a fire originating within that unit. When an occupant leaves the apartment, the door closes and latches behind the occupant, and the occupant pulls a manual fire alarm box. If the occupant fails to sound the alarm manually and the fire continues to develop in the apartment, the heat detectors will initiate the building fire alarm system prior to the fire becoming a threat to other apartment units. Fire detection systems have proved very effective where used. In addition, because the system is required to be tied into the building fire alarm system, the use of heat detectors instead of system smoke detectors eliminates nuisance alarms that might be caused by cooking or smoking.

The smoke alarm(s) required by 13.7.2.18.5 should be located in the hall area(s) that provides access to rooms used for sleeping. In multilevel apartment units, the smoke alarm covering the upper level should normally be located at the top of the stairs. The smoke alarm(s) should be mounted on the ceiling or on the wall; *NFPA 72* provides detailed smoke alarm placement requirements. Smoke alarms should be remotely located from cooking areas. Where unusual factors such as room configuration, air movement, or stagnant air pockets must be considered, the AHJ and the designer should determine the placement of the smoke alarms.

In existing apartment buildings, sleeping room smoke alarms are required where the building is not protected by a complete smoke detection or automatic sprinkler system. Because this retroactive requirement for smoke alarms in existing apartment building sleeping rooms would likely cause a hardship if they were required to be powered by the building electrical system, 13.7.2.18.5.4 permits the sleeping room smoke alarms to be powered only by replaceable batteries. The smoke alarms outside of the sleeping rooms must be powered as required by *NFPA 72.*

Note that 13.7.1.8.7 requires smoke alarms to be powered as required by *NFPA 72*. *NFPA 72* requires smoke alarms to be powered by the building's electrical system, which is achieved by using directly wired or plug-in-type smoke alarms. Alternatively, smoke alarms are permitted to be powered by a nonrechargeable, nonreplaceable battery capable of operating the device for 10 years under normal conditions, followed by 4 minutes of alarm, followed by 7 days of trouble condition.

It is not the *Code*'s intent to prohibit the interconnection of smoke alarms within individual apartments. Where an apartment unit requires more than one smoke alarm, interconnection will probably be required to meet the performance criterion for audibility detailed in 13.7.1.8.8.

13.7.2.19 New, Small (Not More Than 16 Residents) Residential Board and Care Occupancies.

N **13.7.2.19.1 General.** A fire alarm system shall be provided in accordance with Section 13.7. [***101:***32.2.3.4.1]

N **13.7.2.19.2 Initiation.** Initiation of the required fire alarm system shall be by manual means in accordance with 13.7.1.7.1(1). [***101:***32.2.3.4.2]

13.7.2.19.3 General. A manual fire alarm system shall be provided in accordance with Section 13.7. [***101:***32.2.3.4.1]

13.7.2.19.4 Occupant Notification. Occupant notification shall be provided automatically, without delay, in accordance with 13.7.1.9. [***101:***32.2.3.4.2]

13.7.2.19.5 Smoke Alarms.

13.7.2.19.5.1 Approved smoke alarms shall be provided in accordance with 13.7.1.8. [***101:***32.2.3.4.5.1]

13.7.2.19.5.2 Smoke alarms shall be installed on all levels, including basements but excluding crawl spaces and unfinished attics. [***101:***32.2.3.4.5.2]

13.7.2.19.5.3 Additional smoke alarms shall be installed in all living areas, as defined in 3.3.21.5 of NFPA *101*. [***101:***32.2.3.4.5.3]

13.7.2.19.5.4 Each sleeping room shall be provided with an approved smoke alarm in accordance with 13.7.1.8. [***101:***32.2.3.4.5.4]

In both new and existing small board and care facilities, a means of manually initiating the fire alarm system is required. However, 13.7.2.21.1 contains two options for existing facilities. The use of a system of interconnected multiple-station smoke alarms is permitted by 13.7.2.21.1.1 to meet the fire alarm requirement by providing one manual fire alarm box that is integrated with the smoke alarms on each floor. In addition, 13.7.2.21.1.2 recognizes that, in a small existing building, a sophisticated fire alarm system that employs components listed for use in fire alarm systems might not be necessary. The requirements can be satisfied by the installation of alternative means of notifying the occupants, such as electric bells activated by a clearly identified switch on each floor where approved by the AHJ.

The requirement of 13.7.2.19.5.1 does not mandate a system of smoke detectors in a small facility. If the building is small enough, single-station smoke alarms might meet the criterion of audibility in all sleeping areas. However, if the building is of significant size or consists of multiple levels, interconnected multiple-station smoke alarms will probably be needed. Additional smoke alarms are required in living rooms and day rooms.

Prior to the 2003 edition of the *Code*, several provisions permitted the omission of smoke alarms from small board and care facilities. However, given the wider acceptance of unprotected vertical openings permitted by 32.2.3.1 of NFPA *101*, the smoke alarm exemptions are no longer permitted for new facilities. Several conditions for exempting smoke alarms from existing small board and care facilities, however, are provided. To exempt the requirement for common space smoke alarms, as permitted by 13.7.2.21.4.6 and 13.7.2.21.4.7, the entire building must be protected with an automatic sprinkler system using quick-response or residential sprinklers in accordance with 13.3.2.22.2, and the bedrooms must be provided with smoke alarms. If the existing smoke alarms in the bedrooms are powered solely by batteries, they do not need to be replaced with electrically powered smoke alarms if the AHJ judges that the facility has an adequate testing, maintenance, and battery replacement program.

13.7.2.20 New, Large (More than 16 Residents) Residential Board and Care Occupancies.

13.7.2.20.1 General. A fire alarm system shall be provided in accordance with Section 13.7. [***101:***32.3.3.4.1]

13.7.2.20.2 Initiation. The required fire alarm system shall be initiated by each of the following:

(1) Manual means in accordance with 13.7.1.7
(2) Manual fire alarm box located at a convenient central control point under continuous supervision of responsible employees
(3) Required automatic sprinkler system
(4) Required detection system

[***101:***32.3.3.4.2]

13.7.2.20.3 Annunciator Panel. An annunciator panel, connected to the fire alarm system, shall be provided at a location readily accessible from the primary point of entry for emergency response personnel. [***101:***32.3.3.4.3]

13.7.2.20.4 Occupant Notification. Occupant notification shall be provided automatically, without delay, in accordance with 13.7.1.9. [***101:***32.3.3.4.4]

13.7.2.20.5 High-Rise Buildings. High-rise buildings shall be provided with an approved emergency voice communication/alarm system in accordance with 13.7.2.29.2. [***101:***32.3.3.4.5]

13.7.2.20.6* Emergency Forces Notification. Emergency forces notification shall meet the following requirements:

(1) Emergency forces notification shall be accomplished in accordance with 13.7.1.10.
(2) Smoke detection devices or smoke detection systems shall be permitted to initiate a positive alarm sequence in accordance with 13.7.1.9.4 for not more than 120 seconds.

[***101:***32.3.3.4.6]

A.13.7.2.20.6 Positive alarm sequence applies only to emergency forces notification. Occupant notification is required to occur immediately upon activation of the detection device or system. [***101:***A.32.3.3.4.6]

13.7.2.20.7 Smoke Alarms. Approved smoke alarms shall be installed in accordance with 13.7.1.8 inside every sleeping room, outside every sleeping area in the immediate vicinity of the bedrooms, and on all levels within a resident unit. [***101:***32.3.3.4.7]

13.7.2.20.8 Smoke Detection Systems.

13.7.2.20.8.1 Corridors and spaces open to the corridors, other than those meeting the requirement of 13.7.2.20.8.3, shall be provided with smoke detectors that comply with *NFPA 72* and are arranged to initiate an alarm that is audible in all sleeping areas. [***101:***32.3.3.4.8.1]

13.7.2.20.8.2 Reserved.

13.7.2.20.8.3 Smoke detection systems shall not be required in unenclosed corridors, passageways, balconies, colonnades, or other arrangements with one or more sides along the long dimension fully or extensively open to the exterior at all times. [***101:***32.3.3.4.8.3]

In addition to the normal distribution of manual fire alarm boxes (see 13.7.1.7), 13.7.2.20.2 and 13.7.2.22.2 require certain locations, such as that of the telephone operator, to be equipped with a manual fire alarm box. The intent is that a manual fire alarm box is to be available at the location where a report of an emergency phoned in by residents or staff would be received.

Sleeping room smoke alarms are exempt from activating the building fire alarm system. The detection devices installed in the sleeping rooms are usually single-station or multiple-station smoke alarms and are not part of a required automatic detection system. Therefore, such smoke alarms are intended to notify the occupants of the room of a smoke condition. The provision of 13.7.2.22.2(4) emphasizes this intent. The *Code*, in fact, prohibits sleeping room smoke alarms from activating the fire alarm system, as stated in 13.7.1.8.9, to prevent numerous nuisance alarms, which could pose a particular problem in large board and care facilities. Because the purpose of the sleeping room smoke alarms is to warn the occupants of an individual room, notification of the management and other occupants is the occupants' responsibility. Therefore, manual alarm initiation should be emphasized in the required training for residents. See 20.5.2.2 for resident training requirements.

The location of audible alarm notification devices in residential board and care facilities affects their audibility. In most new construction, corridor walls are of such sound-insulating character that a sounding device would be needed in each room to meet the performance criterion for alarm audibility throughout the building. If sounding devices are installed only in the corridor, they might have to operate at dangerous sound levels to awaken residents in their rooms.

New large board and care facilities must be provided with means to automatically notify the fire department of an alarm condition (see 13.7.1.10) per 13.7.2.20.6. In existing facilities, automatic emergency forces notification is not required by 13.7.2.22.6 unless a new system is installed or the existing system is replaced; at a minimum, however, means must be provided for staff to call the fire department. If a telephone is provided, the telephone must be equipped for direct outside dialing without going through a switchboard; the telephone is not permitted to be a pay phone.

The purpose of placing smoke alarms in each sleeping room, as required by 13.7.2.20.7 and 13.7.2.22.7, is to alert the occupants of a room to the presence of smoke within that room. The alarms are not permitted to be connected to the building fire alarm system, as previously discussed. When an occupant leaves a room, the door automatically closes behind the occupant, and the occupant is expected to pull a manual fire alarm box. If the occupant fails to sound the alarm manually, compensation is provided by corridor smoke detectors or by automatic sprinklers. See 13.7.2.20.8.1, 13.7.2.22.8.1, 13.3.2.21.1, and 13.3.2.22.1.

In existing board and care facilities, 13.7.2.22.7.2 applies only to existing battery-powered alarms — not to newly installed alarms in existing facilities. Battery-powered alarms are permitted only if they already exist and the facility can document that they are properly maintained and tested to ensure their reliability.

The provision of 13.7.2.22.7.3 recognizes that the installation of corridor smoke detection systems, rather than sleeping room smoke alarms, was a *Code* requirement in earlier editions. Note that the installation of a new corridor smoke detection system does not waive the need for single-station smoke alarms in each room. However, if an existing facility already has a corridor smoke detection system, single-station smoke alarms in bedrooms are not required.

New large board and care facilities must be provided with a corridor smoke detection system in accordance with 13.7.2.20.8.1. In existing facilities, 13.7.2.22.8 requires a system of smoke detectors in the corridors and living areas where the facilities are not fully sprinklered. Note that 13.7.2.22.8.2 does not exempt the requirement of 13.7.2.22.7 for the provision of smoke alarms in each sleeping room even when automatic sprinklers are installed. The *Code* is not equating sprinklers with smoke detectors but establishes that a fully sprinklered existing building is an adequate alternative to smoke detection in common spaces. If the facility uses exterior access corridors in the motel style, smoke detection is not required in the exterior corridors in accordance with 13.7.2.20.8.3 and 13.7.2.22.8.3.

N **13.7.2.20.9 Carbon Monoxide Alarms and Carbon Monoxide Detection Systems.**

N **13.7.2.20.9.1** Carbon monoxide alarms or carbon monoxide detectors in accordance with 13.7.1.14 and 13.7.2.20.9 shall be provided in new large board and care facilities where either of the following conditions exists:

(1) Where large board and care facilities have communicating attached garages, unless otherwise exempted by 13.7.2.20.9.3
(2) Where sleeping rooms or sleeping room suites contain fuel-burning appliances or fuel-burning fireplaces

[***101:***32.3.3.4.9.1]

N **13.7.2.20.9.2** Where required by 13.7.20.9.1, carbon monoxide alarms or carbon monoxide detectors shall be installed in the following locations:

(1) Outside each separate sleeping room area in the immediate vicinity of the sleeping rooms
(2) Within sleeping rooms containing fuel-burning appliances or fuel-burning fireplaces
(3) On every occupiable level of a sleeping room and sleeping room suite
(4) Centrally located within occupiable spaces adjacent to a communicating attached garage, unless otherwise exempted by 13.7.2.20.9.3

[***101:***32.3.3.4.9.2]

N **13.7.2.20.9.3** Carbon monoxide alarms and carbon monoxide detectors as specified in 13.7.2.20.9.1(1) shall not be required in the following locations:

(1) In garages
(2) Within facilities with communicating attached garages that are open parking structures as defined by the building code
(3) Within facilities with communicating attached garages that are mechanically ventilated in accordance with the mechanical code

[***101:***32.3.3.4.9.3]

N **13.7.2.20.9.4** Where fuel-burning appliances or fuel-burning fireplaces are installed outside sleeping rooms, carbon monoxide alarms or carbon monoxide detectors shall be installed in the locations specified as follows:

(1) Within rooms containing fuel-burning appliances or fuel-burning fireplaces
(2) Centrally located within occupiable spaces served by the first supply air register from a fuel-burning HVAC system

[***101:***32.3.3.4.9.4]

The requirements of 13.7.2.20.9, which are new to the 2018 edition of the *Code*, mandate the installation of CO detection equipment in new, large residential board and care facilities where there is a potential for accidental CO poisoning from a vehicle in an attached, communicating garage or from fuel-burning appliances, such as a gas-fired or an oil-fired furnace or a fuel-burning fireplace. The reference to 13.7.1.14 in 13.7.2.20.9.1 requires compliance with NFPA 720. NFPA 720, which is modeled after *NFPA 72*, contains the detailed installation requirements for CO alarms, including those for power supply.

Although not mandated in existing board and care facilities, the installation of CO alarms is recommended if there is a potential for CO poisoning. It is important to note that the typical service life of a CO alarm varies from about 5 to 10 years. CO alarms must be replaced by the date indicated on the device to ensure proper operation. See the commentary following 13.7.1.14 for additional details.

13.7.2.21 Existing, Small (Not More Than 16 Residents) Residential Board and Care Occupancies.

See the commentary following 13.7.2.19.5.4.

13.7.2.21.1 Fire Alarm Systems. A manual fire alarm system shall be provided in accordance with Section 13.7, unless the provisions of 13.7.2.21.3.1 or 13.7.2.21.3.2 are met. [***101:***33.2.3.4.1]

13.7.2.21.1.1 A fire alarm system shall not be required where interconnected smoke alarms complying with 13.7.2.21.5, and not less than one manual fire alarm box per floor arranged to continuously sound the smoke detector alarms, are provided. [***101:***33.2.3.4.1.1]

13.7.2.21.1.2 Other manually activated continuously sounding alarms acceptable to the AHJ shall be permitted in lieu of a fire alarm system. [***101:***33.2.3.4.1.2]

N **13.7.2.21.2 Initiation.** Initiation of the required fire alarm system shall be by manual means in accordance with 13.7.1.7.1(1). [***101:***33.2.3.4.2]

13.7.2.21.3 Occupant Notification. Occupant notification shall be in accordance with 13.7.1.9. [***101:***33.2.3.4.4]

13.7.2.21.4* Smoke Alarms.

Δ **A.13.7.2.21.5** Most often, smoke alarms sounding an alarm at 85 dBA or greater, installed outside the bedroom area, will meet the intent of this requirement. Smoke alarms remotely located from the bedroom might not be loud enough to awaken the average person. In such cases, it is recommended that smoke alarms be interconnected so that the activation of any smoke alarm will cause all smoke alarms to activate. [***101:***A.33.2.3.4.3]

NFPA *101* provides adequate, balanced fire protection and takes into consideration the passive and active systems required in a given occupancy. The level of protection prescribed by *NFPA 72* which includes smoke alarms in all sleeping rooms, without exception, does not necessarily take into consideration the complete protection package prescribed by NFPA *101*. [***101:***A.33.2.3.4.3]

13.7.2.21.4.1 Approved smoke alarms shall be provided in accordance with 13.7.1.8, unless otherwise indicated in 13.7.2.21.5.6 and 13.7.2.21.5.7. [***101:***33.2.3.4.4]

13.7.2.21.4.2 Smoke alarms shall be installed on all levels, including basements but excluding crawl spaces and unfinished attics. [***101:***33.2.3.4.3.2]

13.7.2.21.4.3 Additional smoke alarms shall be installed for living rooms, dens, day rooms, and similar spaces. [***101:***33.2.3.4.3.3]

13.7.2.21.4.4 Reserved.

13.7.2.21.4.5 Smoke alarms shall be powered from the building electrical system and, when activated, shall initiate an alarm that is audible in all sleeping areas. [***101:***33.2.3.4.3.5]

13.7.2.21.4.6 Smoke alarms in accordance with 13.7.2.21.5.1 shall not be required where buildings are protected throughout by an approved automatic sprinkler system, in accordance with 13.3.2.22.2, that uses quick-response or residential sprinklers, and are protected with approved smoke alarms installed in each sleeping room, in accordance with 13.7.1.8, that are powered by the building electrical system. [***101:***33.2.3.4.3.6]

13.7.2.21.4.7 Smoke alarms in accordance with 13.7.2.21.5.1 shall not be required where buildings are protected throughout by an approved automatic sprinkler system, in accordance with 13.3.2.22.2, that uses quick-response or residential sprinklers, with existing battery-powered smoke alarms in each sleeping room, and where, in the opinion of the AHJ, the facility has demonstrated that testing, maintenance, and a battery replacement program ensure the reliability of power to the smoke alarms. [***101:***33.2.3.4.3.7]

13.7.2.22 Existing, Large (More Than 16 Residents) Residential Board and Care Occupancies.

See the commentary following 13.7.2.20.8.3.

Δ **13.7.2.22.1 General.** A fire alarm system in accordance with Section 13.7 shall be provided, unless all of the following conditions are met:

(1) The facility has an evacuation capability of prompt or slow.
(2) Each sleeping room has exterior exit access in accordance with 14.10.3.
(3) The building does not exceed three stories in height.

[***101:***33.3.3.4.1]

13.7.2.22.2 Initiation. The required fire alarm system shall be initiated by each of the following means:

(1) Manual means in accordance with 13.7.1.7, unless there are other effective means (such as a complete automatic sprinkler or detection system) for notification of fire as required
(2) Manual fire alarm box located at a convenient central control point under continuous supervision of responsible employees
(3) Automatic sprinkler system, other than that not required by another section of this *Code*
(4) Required detection system, other than sleeping room smoke alarms

[***101:***33.3.3.4.2]

13.7.2.22.3 Reserved.

13.7.2.22.4 Occupant Notification. Occupant notification shall be provided automatically, without delay, by internal audible alarm in accordance with 13.7.1.9. [***101:***33.3.3.4.4]

13.7.2.22.5 Reserved.

13.7.2.22.6 Emergency Forces Notification.

13.7.2.22.6.1* Where the existing fire alarm system does not provide for automatic emergency forces notification in accordance with 13.7.1.10, provisions shall be made for the immediate notification of the public fire department by either telephone or other means, or, where there is no public fire department, notification shall be made to the private fire brigade. [***101:***33.3.3.4.6.1]

A.13.7.2.22.6.1 See A.13.7.2.16.3.6. [***101:***A.33.3.3.4.6.1]

13.7.2.22.6.2 Where a new fire alarm system is installed, or the existing fire alarm system is replaced, emergency forces notification shall be provided in accordance with 13.7.1.10. [***101:***33.3.3.4.6.2]

13.7.2.22.7 Smoke Alarms. Smoke alarms shall be provided in accordance with 13.7.2.22.7.1, 13.7.2.22.7.2, or 13.7.2.22.7.3. [***101:***33.3.3.4.7]

13.7.2.22.7.1 Each sleeping room shall be provided with an approved smoke alarm in accordance with 13.7.1.8 that is powered from the building electrical system. [***101:***33.3.3.4.7.1]

13.7.2.22.7.2 Existing battery-powered smoke alarms, rather than building electrical service–powered smoke alarms, shall be accepted where, in the opinion of the AHJ, the facility has demonstrated that testing, maintenance, and battery replacement programs ensure the reliability of power to the smoke alarms. [***101:***33.3.3.4.7.2]

13.7.2.22.7.3 Sleeping room smoke alarms shall not be required in facilities having an existing corridor smoke detection system that complies with Section 13.7 and is connected to the building fire alarm system. [***101:***33.3.3.4.7.3]

13.7.2.22.8 Smoke Detection Systems.

13.7.2.22.8.1 All living areas, as defined in 3.3.21.5 of NFPA *101*, and all corridors shall be provided with smoke detectors that comply with *NFPA 72* and are arranged to initiate an alarm that is audible in all sleeping areas, as modified by 13.7.2.22.8.2 and 13.7.2.22.8.3. [***101:***33.3.3.4.8.1]

13.7.2.22.8.2 Smoke detection systems shall not be required in living areas of buildings having a prompt or slow evacuation capability protected throughout by an approved automatic sprinkler system installed in accordance with 13.7.2.22.1. [***101:***33.3.3.4.8.2]

13.7.2.22.8.3 Smoke detection systems shall not be required in unenclosed corridors, passageways, balconies, colonnades, or other arrangements with one or more sides along the long dimension fully or extensively open to the exterior at all times. [***101:***33.3.3.4.8.3]

13.7.2.23 New Mercantile Occupancies.

13.7.2.23.1 General. New Class A mercantile occupancies shall be provided with a fire alarm system in accordance with Section 13.7. [***101:***36.3.4.1]

Δ **13.7.2.23.2 Initiation.** Initiation of the required fire alarm system shall be by any one of the following means:

(1) Manual means in accordance with 13.7.1.7.1(1)
(2) Approved automatic fire detection system in accordance with 13.7.1.7.1(2) that provides protection throughout the building, and the provision of 13.7.1.7.6 shall apply.
(3) Approved automatic sprinkler system in accordance with 13.7.1.7.1(3) that provides protection throughout the building, and the provision of 13.7.1.7.6 shall apply.

[***101:***36.3.4.2]

13.7.2.23.3 Notification.

13.7.2.23.3.1 Occupant Notification. During all times that the mercantile occupancy is occupied, the required fire alarm system, once initiated, shall perform one of the following functions:

(1) It shall activate an alarm in accordance with 13.7.1.9 throughout the mercantile occupancy.
(2) Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted.

[***101:***36.3.4.3.1]

13.7.2.23.3.2 Emergency Forces Notification. Emergency forces notification shall be provided and shall include notifying both of the following:

(1) Fire department in accordance with 13.7.1.10
(2) Local emergency organization, if provided

[***101:***36.3.4.3.2]

Neither Class B nor Class C mercantile occupancies are required to have a fire alarm system.

Because all new Class A stores and most existing Class A stores must be sprinklered based on gross floor area (see 13.3.2.23.1 and 13.3.2.24.1), it is logical that the sprinkler system waterflow method described in 13.7.2.23.2(3) and 13.7.2.24.2(3) will be used most commonly to activate the fire alarm system. The requirement for manual fire alarm boxes is waived if the sprinkler waterflow activates the fire alarm system. Eliminating the manual fire alarm boxes and satisfying the initiation requirements by means of waterflow through the sprinkler system may reduce the number of nuisance alarms. However, in accordance with 13.7.1.7.6, at least one manual fire alarm box must be provided at a location acceptable to the AHJ.

If a fire alarm system is required, emergency forces notification must also be provided, as specified by 13.7.2.23.3.2 and 13.7.2.24.3.2. Several different methods of automatically notifying the fire department are permitted by 13.7.1.10.

13.7.2.24 Existing Mercantile Occupancies.

13.7.2.24.1 General. Existing Class A mercantile occupancies shall be provided with a fire alarm system in accordance with Section 13.7. [***101:***37.3.4.1]

Δ **13.7.2.24.2 Initiation.** Initiation of the required fire alarm system shall be by one of the following means:

(1) Manual means in accordance with 13.7.1.7.1(1)
(2) Approved automatic fire detection system in accordance with 13.7.1.7.1(2) that provides protection throughout the building, and the provision of 13.7.1.7.6 shall apply.
(3) Approved automatic sprinkler system in accordance with 13.7.1.7.1(3) that provides protection throughout the building, and the provision of 13.7.1.7.6 shall apply.

[***101:***37.3.4.2]

13.7.2.24.3 Notification.

13.7.2.24.3.1 Occupant Notification. During all times that the mercantile occupancy is occupied, the required fire alarm system, once initiated, shall perform one of the following functions:

(1) It shall activate an alarm in accordance with 13.7.1.9 throughout the mercantile occupancy, and both of the following also shall apply:
   (a) Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted.
   (b) A presignal system in accordance with 13.7.1.9.3 shall be permitted.
(2) Occupant notification shall be made via a voice communication or public address system in accordance with 13.7.1.9.9.2

[***101:***37.3.4.3.1]

13.7.2.24.3.2 Emergency Forces Notification. Emergency forces notification shall be provided and shall include notifying both of the following:

(1) Fire department in accordance with 13.7.1.10
(2) Local emergency organization, if provided

[***101:***37.3.4.3.2]

See the commentary following 13.7.2.23.3.2(2).

13.7.2.25 New Business Occupancies.

Δ **13.7.2.25.1 General.** A fire alarm system in accordance with Section 13.7 shall be provided in all business occupancies where any one of the following conditions exists:

(1) The building is three or more stories in height.
(2) The occupancy is subject to 50 or more occupants above or below the level of exit discharge.
(3) The occupancy is subject to 300 or more total occupants.

[***101:***38.3.4.1]

Δ **13.7.2.25.2 Initiation.** Initiation of the required fire alarm system shall be by any one of the following means:

(1) Manual means in accordance with 13.7.1.7.1(1)
(2) Approved automatic fire detection system in accordance with 13.7.1.7.1(2) that provides protection throughout the building and the provision of 13.7.1.7.6 shall apply.
(3) Approved automatic sprinkler system in accordance with 13.7.1.7.1(3) that provides protection throughout the building and the provision of 13.7.1.7.6 shall apply.

[***101:***38.3.4.2]

13.7.2.25.3 Occupant Notification. During all times that the building is occupied *(see 7.2.1.1.3 of NFPA 101)*, the required fire alarm system, once initiated, shall perform one of the following functions:

(1) It shall activate a general alarm in accordance with 13.7.1.9
(2) A positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted.

[***101:***38.3.4.3]

13.7.2.25.4 Emergency Forces Notification. Emergency forces notification shall be provided and shall include notifying both of the following:

(1) Fire department in accordance with 13.7.1.10
(2) Approved local emergency organization, if provided

[***101:***38.3.4.4]

A fire alarm system is required in a business occupancy under the same conditions as those under which emergency lighting is required (see 38/39.2.9.1 of NFPA *101*). If any one of the three conditions of 13.7.2.25.1 or 13.7.2.26.1 exists, a fire alarm system must be provided.

A required fire alarm system must have initiation means per 13.7.2.25.2 or 13.7.2.26.2, but the requirement for manual fire alarm boxes is waived if the system is initiated by either an automatic fire detection system providing protection throughout the building or an automatic sprinkler system providing protection throughout the building. This waiver does not exempt the fire alarm system but only the manual fire alarm boxes. Note that 13.7.1.7.6 requires at least one manual fire alarm box to be provided at a location acceptable to the AHJ.

When the required fire alarm system is initiated by one of the means specified in 13.7.2.25.2 or 13.7.2.26.2, the system must automatically sound a general alarm throughout the building. In existing business occupancies, if a continuously attended location is provided (as is often the case in high-rise or other large office buildings), the alarm is permitted to sound at that location only, with the appropriate emergency action initiated at that location by use of a voice communication or public address system (see 13.7.1.9.9.2). See 13.7.2.25.3 and 13.7.2.26.3 for details on occupant notification requirements.

Presignal systems are permitted in existing business occupancies only where such systems already exist [see 13.7.2.26.3(1)(b)]; where presignal systems are used, the fire department must be notified automatically, without delay, in case of a delay in notifying, or failure to notify, the building occupants. The superior fail-safe system — positive alarm sequence — is permitted for both new and existing business occupancies. See 13.7.1.9.3, 13.7.1.9.4, and *NFPA 72* for details on presignal and positive alarm sequence systems.

The provision of 13.7.2.25.4 requires automatic emergency forces notification in accordance with 13.7.1.10 for all new business occupancies that are required to be provided with a fire alarm system and for all existing business occupancies when an existing, required fire alarm system is replaced.

N **13.7.2.25.5 Risk Analysis for Mass Notification.**

N **13.7.2.25.5.1** Business occupancies requiring a fire alarm system in accordance with 13.7.2.25.5.1 shall conduct a risk analysis to determine the need for a mass notification system in accordance with 13.7.1.15. [***101:***38.3.4.5.1]

N **13.7.2.25.5.2*** A risk analysis to determine the need for a mass notification system in accordance with Section 13.7.1.15 shall be conducted for buildings containing a classroom where the building is owned, rented, leased, or operated by a college or university. [***101:***38.3.4.5.2]

N **A.13.7.2.25.5.2** It is not the intent of this section to require a new risk analysis where an existing risk analysis addresses the issues or arrangements associated with a new building. [***101:***A.38.3.4.5.2]

Section 13.7.1.15 is new to the 2018 edition of the *Code*. By reference to these new provisions, new business occupancies that include spaces used for college/university classrooms require a risk analysis to be conducted in accordance with Chapter 24 of *NFPA 72* to determine if an MNS is necessary. Paragraph 13.7.2.25.5.1 requires a risk analysis for those business occupancies containing a classroom where the building containing the classroom is owned, rented, leased, or operated by a college or university. This language is intended to apply to classroom buildings on college and university campuses that fall under the business occupancy classification. Those buildings with larger classrooms (50 or more occupants) that are classified as assembly occupancies would need to apply the provisions appropriate to that occupancy. Recent events on college campuses over the past decade have demonstrated a need for better communication of emergencies in college and university settings. Paragraph 13.7.2.25.5.1 clarifies that a new risk analysis is not always required where an existing risk analysis addresses the issues presented when a new building was added. See the commentary associated with 13.7.1.15 for more information.

13.7.2.26 Existing Business Occupancies.

13.7.2.26.1 General. A fire alarm system in accordance with Section 13.7 shall be provided in all existing business occupancies where any one of the following conditions exists:

(1) The building is three or more stories in height.
(2) The occupancy is subject to 100 or more occupants above or below the level of exit discharge.
(3) The occupancy is subject to 1000 or more total occupants.

[***101:***39.3.4.1]

Δ **13.7.2.26.2 Initiation.** Initiation of the required fire alarm system shall be by one of the following means:

(1) Manual means in accordance with 13.7.1.7.1(1)
(2) Approved automatic fire detection system in accordance with 13.7.1.7.1(2) that provides protection throughout the building and the provision of 13.7.1.7.6 shall apply.
(3) Approved automatic sprinkler system in accordance with 13.7.1.7.1(3) that provides protection throughout the building and the provision of 13.7.1.7.6 shall apply.

[***101:***39.3.4.2]

13.7.2.26.3 Occupant Notification. During all times that the building is occupied *(see 7.2.1.1.3 of NFPA 101)*, the required fire alarm system, once initiated, shall perform one of the following functions:

(1) It shall activate a general alarm in accordance with 13.7.1.9, and both of the following also shall apply:
    (a) Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted.
    (b) A presignal system in accordance with 13.7.1.9.3 shall be permitted.
(2) Occupant notification shall be permitted to be made via a voice communication or public address system in accordance with 13.7.1.9.9.2.

[***101:***39.3.4.3]

13.7.2.26.4 Emergency Forces Notification. Emergency forces notification shall be accomplished in accordance with 13.7.1.10 when the existing fire alarm system is replaced. [***101:***39.3.4.4]

13.7.2.27 New and Existing Industrial Occupancies.

13.7.2.27.1 General. A fire alarm system shall be required in accordance with Section 13.7 for new and existing industrial occupancies, unless the total occupant load of the building is under 100 persons and unless, of these, fewer than 25 persons are above or below the level of exit discharge. [***101:***40.3.4.1]

Δ **13.7.2.27.2 Initiation.** Initiation of the required fire alarm system shall be by any of the following means:

(1) Manual means in accordance with 13.7.1.7.1(1)
(2) Approved automatic fire detection system in accordance with 13.7.1.7.1(2) throughout the building, plus a minimum of one manual fire alarm box in accordance with 13.7.1.7.6
(3) Approved, supervised automatic sprinkler system in accordance with 13.7.1.7.1(3) throughout the building, plus a minimum of one manual fire alarm box in accordance with 13.7.1.7.6

[***101:***40.3.4.2]

13.7.2.27.3 Notification.

13.7.2.27.3.1 The required fire alarm system shall meet one of the following criteria:

(1) It shall provide occupant notification in accordance with 13.7.1.9.
(2) It shall sound an audible and visible signal in a constantly attended location for the purposes of initiating emergency action.

[***101:***40.3.4.3.1]

13.7.2.27.3.2 Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted. [***101:***40.3.4.3.2]

13.7.2.27.3.3 Existing presignal systems in accordance with 13.7.1.9.3 shall be permitted. [***101:***40.3.4.3.3]

13.7.2.27.3.4 In high hazard industrial occupancies, as described in 40.1.2.1.3 of NFPA *101*, the required fire alarm system shall automatically initiate an occupant evacuation alarm signal in accordance with 13.7.1.9. [***101:***40.3.4.3.4]

Note that 13.7.2.27 applies to both new and existing industrial occupancies.

The requirements of 13.7.2.27.3.1 and 13.7.2.27.3.4 specify two separate and distinct provisions for audible alarms activated by the fire alarm system required by 13.7.2.27.1. In low and ordinary hazard industrial occupancies, the system is permitted to activate an evacuation alarm or to sound an alarm at a constantly attended location for the purpose of initiating emergency action (see 13.7.2.27.3.1). This provision permits an interface between the alarm system and the plant's emergency organization. The alarm system is permitted to be controlled from a central security console or a similar location. The key feature is that the location from which the alarm sounds must be constantly staffed. This requirement is not intended to mandate the installation of supervisory service, such as that connected to a central station, but the location must be fully attended at all times when the building is occupied.

In high hazard occupancies, the alarm must be arranged to automatically provide evacuation signals (see 13.7.2.27.3.4), because the safety of the occupants of such areas depends on their immediate notification of a fire.

Note that 13.7.2.27.3.3 recognizes existing presignal systems but not new presignal systems. If an automatic form of delay is desired for an existing alarm system that does not already have a presignal feature, or for a new alarm system, the more reliable system feature known as *positive alarm sequence* is permitted by 13.7.2.27.3.2. The positive alarm sequence option might be applied to the high hazard industrial occupancies addressed in 13.7.2.27.3.4 for which an automatic form of occupant notification is needed. Also, positive alarm sequence might be used in industrial occupancies, other than those that are high hazard, where the provisions of 13.7.2.27.3.1(1) are used instead of those of 13.7.2.27.3.1(2).

13.7.2.28 New and Existing Storage Occupancies.

13.7.2.28.1 General. A fire alarm system shall be required in accordance with Section 13.7 for new and existing storage occupancies, except as modified by 13.7.2.28.1.1, 13.7.2.28.1.2, and 13.7.2.28.1.3. [***101:***42.3.4.1]

13.7.2.28.1.1 Storage occupancies limited to low hazard contents shall not be required to have a fire alarm system. [***101:***42.3.4.1.1]

13.7.2.28.1.2 Storage occupancies with ordinary or high hazard contents not exceeding an aggregate floor area of 100,000 ft^2 (9300 m^2) shall not be required to have a fire alarm system. [101:42.3.4.1.2]

13.7.2.28.1.3 Storage occupancies protected throughout by an approved automatic sprinkler system in accordance with Section 13.3 shall not be required to have a fire alarm system. [***101:***42.3.4.1.3]

Δ **13.7.2.28.2 Initiation.** Initiation of the required fire alarm system shall be by any of the following means:

(1) Manual means in accordance with 13.7.1.7.1(1)
(2) Approved automatic fire detection system in accordance with 13.7.1.7.1(2) throughout the building, plus a minimum of one manual fire alarm box in accordance with 13.7.1.7.6
(3) Approved, supervised automatic sprinkler system in accordance with 13.7.1.7.1(3) throughout the building, plus a minimum of one manual fire alarm box in accordance with 13.7.1.7.6

[***101:***42.3.4.2]

13.7.2.28.3 Notification.

13.7.2.28.3.1 The required fire alarm system shall meet one of the following criteria:

(1) It shall provide occupant notification in accordance with 13.7.1.9.
(2) It shall sound an audible and visible signal in a constantly attended location for the purposes of initiating emergency action.

[***101:***42.3.4.3.1]

13.7.2.28.3.2 Positive alarm sequence in accordance with 13.7.1.9.4 shall be permitted. [***101:***42.3.4.3.2]

13.7.2.28.3.3 Existing presignal systems in accordance with 13.7.1.9.3 shall be permitted. [***101:***42.3.4.3.3]

13.7.2.28.3.4 In high hazard storage occupancies, the required fire alarm system shall automatically initiate an occupant evacuation alarm signal in accordance with 13.7.1.9. [***101:***42.3.4.3.4]

Storage placement limits visibility in buildings with large floor areas. As a result, personnel who work in storage areas might be unaware of the occurrence of fire for a long period. If fire spreads, which is highly possible in an unprotected storage building, means of egress could be blocked. An alarm system provides a means of alerting all occupants to the presence of fire and allows for timely egress.

The requirements of 13.7.2.28.3.1 and 13.7.2.28.3.4 specify two separate and distinct provisions for audible alarms activated by the fire alarm system required by 13.7.2.28.1. In low and ordinary hazard storage occupancies (see 13.7.2.28.3.1), the system is permitted to activate an evacuation alarm or sound an alarm in a constantly attended location for the purpose of initiating emergency action. This provision permits an interface between the alarm system and the building's emergency organization. The alarm system is permitted to be controlled from a central security console or a similar location. The key feature is that the location from which the alarm sounds must be constantly staffed. This requirement is not intended to mandate the installation of supervisory service, such as connection to a central station, but the location must be fully attended at all times when the building is occupied.

In high hazard storage occupancies (see 13.7.2.28.3.4), the alarm must be arranged to provide evacuation signals, because the safety of the occupants of such areas depends on their immediate notification of a fire.

13.7.2.29 Special Structures and High-Rise Buildings.

13.7.2.29.1 Detection, Alarm, and Communications Systems. Towers, as defined in 3.3.281 of NFPA *101*, designed for occupancy by not more than three persons shall be exempt from requirements for detection, alarm, and communications systems. [***101:***11.3.3.4]

13.7.2.29.2 New High-Rise Buildings.

13.7.2.29.2.1* A fire alarm system using an approved emergency voice/alarm communication system shall be installed in accordance with Section 13.7 and NFPA *101*. [***101:***11.8.4.1]

A.13.7.2.29.2.1 The need for voice communication can be based on a decision regarding staged or partial evacuation versus total evacuation of all floors. The determination of need is a function of occupancy classification and building height. [***101:***A.11.8.4.1]

13.7.2.29.2.2 Two-way telephone service shall be in accordance with 13.7.2.29.2.2.1 and 13.7.2.29.2.2.2. [***101:***11.8.4.2]

13.7.2.29.2.2.1 Two-way telephone communication service shall be provided for fire department use. This system shall be in accordance with *NFPA 72*. The communications system shall operate between the emergency command center and every elevator car, every elevator lobby, and each floor level of exit stairs. [***101:***11.8.4.2.1]

13.7.2.29.2.2.2* The requirement of 13.7.2.29.2.2.1 shall not apply where the fire department radio system is approved as an equivalent system. [***101:***11.8.4.2.2]

Δ **A.13.7.2.29.2.2.2** Public safety radio enhancement systems provide for greater flexibility and safety for emergency responders during in-building operations. This provision serves to facilitate adoption of *Code* language prescribing design, installation, testing, and maintenance criteria for in-building public safety radio enhancement systems. AHJs are directed to Chapter 24 of *NFPA 72* for details.

13.7.3 Fire Alarm Systems.

13.7.3.1 General.

13.7.3.1.1 Equipment.

13.7.3.1.1.1 Equipment constructed and installed in conformity with this *Code* shall be listed for the purpose for which it is used. [**72:**10.3.1]

Just noting that a piece of equipment is listed is not sufficient. In accordance with the requirements of 13.7.3.1.1.1, equipment must be listed for the purpose for which it is used. The listing of equipment involves evaluation of the equipment to determine its suitability for a specific purpose. The evaluation is usually accomplished through the use of product testing standards developed to demonstrate that specific performance requirements have been met. Many of these performance requirements are based on specific requirements in *NFPA 72* and go far beyond requirements used only to demonstrate electrical safety.

While most equipment would be listed for fire alarm system use, some equipment may possess a different listing. As an example, equipment (such as routers and modems) that might be used with some transmission methods in the signal transmission path between a protected premises and a supervising station might be listed as general communications equipment (see 26.6.3.12 of *NFPA 72*).

Equipment listings generally contain information pertaining to the permitted use, required ambient conditions in the installed location, mounting orientation, voltage tolerances, compatibility, and so on. Equipment must be installed, tested, and maintained in conformance with the listing and the manufacturer's published instructions to meet the requirements of *NFPA 72*. Conformance with the listing and the manufacturer's instructions has been a longstanding requirement, originating in the requirements of *NFPA 70®*, *National Electrical Code®*, and reinforced in 13.7.3.1.1.2.

13.7.3.1.1.2 System components shall be installed, tested, inspected, and maintained in accordance with the manufacturer's published instructions and this *Code*. [**72:**10.3.2]

13.7.3.1.1.3* All devices and appliances that receive their power from the initiating device circuit or signaling line circuit of a control unit shall be listed for use with the control unit. [**72:**10.3.3]

A.13.7.3.1.1.3 This requirement does not apply to notification appliance circuits. [**72:**A.10.3.3]

Detection devices and notification appliances that receive their power directly from either an initiating device circuit (IDC) or a signaling line circuit (SLC) must be listed for that particular control unit. Listing with the specific control unit is not required for devices and appliances installed on notification appliance circuits (NACs).

The most common application where this is a concern is two-wire and addressable (addressable/analog) smoke detectors. A two-wire smoke detector obtains its power from the control unit initiating device circuit. Addressable devices and appliances on signaling line circuits communicate with the control unit using manufacturer-specific protocols. The listing organizations have developed specific requirements for this listing process and should be consulted if necessary to confirm the detector's or appliance's compatibility with a specific control unit.

Δ **13.7.3.1.1.4** All apparatus requiring rewinding or resetting to maintain normal operation shall be restored to normal after each abnormal condition and maintained in normal condition for operation. [**72:**10.3.4]

13.7.3.1.1.5 Equipment shall be designed so that it is capable of performing its intended functions under the following conditions:

(1)* At 85 percent and at 110 percent of the nameplate primary (main) and secondary (standby) input voltage(s)

A.13.7.3.1.1.5(1) The requirement of 13.7.3.1.1.5(1) does not preclude transfer to secondary supply at less than 85 percent of nominal primary voltage, provided the requirements of 10.6.7 of *NFPA 72* are met. [**72:**A.10.3.5(1)]

(2) At ambient temperatures of 0°C (32°F) and 49°C (120°F)
(3) At a relative humidity of 85 percent and an ambient temperature of 30°C (86°F)

[**72:**10.3.5]

Equipment might be listed for use outside these limits, or the space must be conditioned to meet these parameters. If the space must be artificially conditioned, standby power to operate that artificial conditioning should be considered to ensure that the conditioning continues during a power outage for at least as long as the standby power required for the alarm system.

13.7.3.2 Documentation.

13.7.3.2.1 Approval and Acceptance. The AHJ shall be notified prior to installation or alteration of equipment or wiring. [**72:**10.19.2]

13.7.3.2.2 Minimum Required Documentation.

Many AHJs require a permit for the installation or modification of a system prior to that work occurring. A wise practice is to contact the local AHJ to determine if a permit is needed and what the submittal requirements might entail. Additionally, there are many times when more than one AHJ will be interested in the work that will be occurring, and while nongovernmental authorities having jurisdiction might not issue a permit for proposed work, they could be in a position to approve or deny the proposed installation on behalf of the owner or the insurance carrier. Due diligence is always a vital key.

Δ **13.7.3.2.2.1** Where documentation is required by the authority having jurisdiction, the following list shall represent the minimum documentation required for new fire alarm systems, supervising station and shared communication equipment, and emergency communications systems, including new systems and additions or alterations to existing systems:

(1) Written narrative providing intent and system description
(2) Riser diagram
(3) Floor plan layout showing locations of all devices, control equipment, and supervising station and shared communications equipment with each sheet showing the following:
  (a) Point of compass (north arrow)
  (b) A graphic representation of the scale used
  (c) Room use identification
  (d) Building features that will affect the placement of initiating devices and notification appliances
(4) Sequence of operation in either an input/output matrix or narrative form
(5) Equipment technical data sheets
(6) Manufacturers' published instructions, including operation and maintenance instructions
(7) Battery capacity and de-rating calculations (where batteries are provided)
(8) Voltage drop calculations for notification appliance circuits
(9) Mounting height elevation for wall-mounted devices and appliances
(10) Where occupant notification is required, minimum sound pressure levels that must be produced by the audible notification appliances in applicable covered areas
(11) Pathway diagrams between the control unit and the supervising station and shared communications equipment
(12) Completed record of completion in accordance with 13.7.3.2.43.6 and 13.7.3.2.5.2
(13) For software-based systems, a copy of site-specific software, including specific instructions on how to obtain the means of system and software access (password)
(14) Record (as-built) drawings

Some of the documentation required by items (1) through (8) of 13.7.3.2.2.1 will typically need to be provided as part of the permit submittal process for a new system or the alteration of an existing system. Other documentation [items (9) through (12)] will be provided at the system's commission. Still other documentation [items (13) and (14)] will need to be made available as the system is used and maintained during its life.

Many AHJs require a permit for the installation or modification of a system prior to that work occurring. It is always wise to contact the local AHJ to determine if a permit is needed and what the submittal requirements may include. Additionally, more than one AHJ could be regulating the work that will be occurring, and while nongovernmental AHJs might not issue a permit for the proposed work, they could be in a position to approve or deny the proposed installation on behalf of the owner or the insurance carrier.

Due diligence is always vital. Meeting with the AHJ before the system design occurs can often save time and money, especially when it comes to the permit review process.

(15) Records, record retention, and record maintenance in accordance with Section 7.7 of *NFPA 72*
(16) Completed record of inspection and testing in accordance with 13.7.3.2.4.6 and 13.7.3.2.5.2

[**72:**7.2.1]

13.7.3.2.2.2 System design documents shall identify the name and contact information of the system designer. [**72:**7.2.2]

The requirement to identify the system designer on the system design documents encourages the designer to feel a sense of ownership toward the design. This identification, in turn, provides an additional incentive for the designer to meet the requirements of the *Code* and provides the AHJ with the name of the person responsible for the design who can respond to questions or comments.

Δ **13.7.3.2.2.3** All fire alarm drawings shall use symbols described in NFPA 170 or other symbols acceptable to the AHJ. [**72:**7.2.3]

The symbols used on fire alarm drawings should be standardized as described in NFPA 170, *Standard for Fire Safety and Emergency Symbols*, or as permitted by the AHJ. The use of NFPA 170 allows for consistent utilization of fire alarm equipment symbols within jurisdictions and simplifies symbol identification for the alarm industry in the designing of plans for submittal and approval.

13.7.3.2.3 Completion Documentation.

13.7.3.2.3.1 The requirements of 13.7.3.2.3 shall apply only where required by other governing laws, codes, or standards; by other parts of *NFPA 72*; or by project specifications or drawings. [**72:**7.5.1]

13.7.3.2.3.2 Before requesting final approval of the installation, if required by the AHJ, the installing contractor shall furnish a written statement stating that the system has been installed in accordance with approved plans and tested in accordance with the manufacturer's published instructions and the appropriate NFPA requirements. [**72:**7.5.2]

13.7.3.2.3.3 All systems including new systems and additions or alterations to existing systems shall include the following documentation, which shall be delivered to the owner or the owner's representative upon final acceptance of the system:

(1) An owner's manual and manufacturer's published instructions covering all system equipment

In addition to the owner's manual and the manufacturer's published instructions required to be delivered to the owner or the owner's representative by 13.7.3.2.3.3(1), it is advisable to include a copy of the edition of *NFPA 72* that was used to design the system. By having this document on file, the owner will be able to ascertain the inspection, testing, and servicing frequencies and requirements for the system and, for historical purposes, the prescriptive- and performance-based design requirements that were in effect when the system was installed.

(2) Record (as-built) drawings in accordance with 13.7.3.2.3.5
(3) A completed record of completion form in accordance with 13.7.3.2.3.6
(4) For software-based systems, record copy of the site-specific software in accordance with 13.7.3.2.3.7

[**72:**7.5.3]

A record copy of the site-specific software must be delivered to the owner or the owner's representative upon final acceptance of the system. Having a backup copy of the software will help facilitate reconfiguration of the system in situations where a catastrophic failure has occurred due to lightning or other causes. Refer to the definition of the term *site-specific software* in 3.3.269.2 of *NFPA 72*. The site-specific software is the system programming for its specific application and not the executive software or the source code used to develop the site-specific software.

13.7.3.2.3.4 For new emergency communications systems, an owner's manual shall be provided and shall contain the following documentation:

(1) Detailed narrative description of the system inputs, evacuation signaling, ancillary functions, annunciation, intended sequence of operations, expansion capability, application considerations, and limitations
(2) Written sequence of operation for the system including an operational input/output matrix
(3) Operator instructions for basic system operations, including alarm acknowledgment, system reset, interpretation of system output (LEDs, CRT display, and printout), operation of manual evacuation signaling and ancillary function controls, and change of printer paper
(4) Detailed description of routine maintenance and testing as required and recommended and as would be provided under a maintenance contract, including testing and maintenance instructions for each type of device installed, which includes the following:
    (a) Listing of the individual system components that require periodic testing and maintenance
    (b) Step-by-step instructions detailing the requisite testing and maintenance procedures, and the intervals at which those procedures shall be performed, for each type of device installed
    (c) Schedule that correlates the testing and maintenance procedures that are required by this section
(5) Service directory, including a list of names and telephone numbers of those who provide service for the system
(6) Product data sheets for all system equipment (SIG-ECS)

[**72:**7.5.4]

13.7.3.2.3.5 Record Drawings (As-Builts).

Δ **13.7.3.2.3.5.1** Record drawings shall consist of current updated shop drawings reflecting the actual installation of all system equipment, components, and wiring. [**72:**7.5.5.1]

Drawings turned over to the system owner should accurately reflect the installation that has occurred. As-built drawings provide the owner, the owner's representative, or the servicing technician with invaluable assistance when future repairs or changes need to be made. Coupled with the written sequence of operation, the as-built drawings also allow for the orderly and thorough testing of all system components during routine inspection and testing.

13.7.3.2.3.5.2 A sequence of operations in input/output matrix or narrative form shall be provided with the record drawings to reflect actual programming at the time of completion. [**72:**7.5.5.2]

An on-site copy of the sequence of operation enables those who work on or those who provide further designs to the existing system to have a full understanding of how the system is intended to work. As these systems become more complex and have more interactions with other building systems, the information provided in the sequence of operation document is critical.

13.7.3.2.3.5.3 Where necessary, revised calculations in accordance with 7.4.10 of *NFPA 72* shall be provided depicting any changes due to installation conditions. [**72:**7.5.5.3]

Deviations from the approved plans frequently occur during the installation of any system. In addition to the changes being noted of the as-built drawings and documented on the record of completion, changes affecting calculations need to be documented and verified to be correct. Changes can impact standby power and NACs, the loop resistance of a circuit, or the permitted number of devices on an SLC. At times, these changes could result in batteries being incapable of providing the necessary standby power or circuits being overloaded or overextended beyond acceptable limits or the manufacturer's published instructions.

13.7.3.2.3.5.4 Record drawings shall be turned over to the owner with a copy placed inside the documentation cabinet in accordance with Section 7.7 of *NFPA 72*. [**72:**7.5.5.4]

13.7.3.2.3.5.5 Record drawings shall include approval documentation resulting from variances, performance-based designs, risk analyses, and other system evaluations or variations. [**72:**7.5.5.5]

13.7.3.2.3.6 Record of Completion.

13.7.3.2.3.6.1 The record of completion shall be documented in accordance with 13.7.3.2.3.6 using either the record of completion forms, Figure 13.7.3.2.5.2(a) through Figure 13.7.3.2.5.2(f), or an alternative document that contains only the elements of Figure 13.7.3.2.5.2(a) through Figure 13.7.3.2.5.2(f) applicable to the installed system. [**72:**7.5.6.1]

13.7.3.2.3.6.2 The record of completion documentation shall be completed by the installing contractor and submitted to the enforcing authority and the owner at the conclusion of the job. The record of completion documentation shall be permitted to be part of the written statement required in 13.7.3.2.3.2 and part of the documents that support the requirements of 13.7.3.2.3.8. When more than one contractor has been responsible for the installation, each contractor shall complete the portions of the documentation for which that contractor has responsibility. [**72:**7.5.6.2]

13.7.3.2.3.6.3 The preparation of the record of completion documentation shall be the responsibility of the qualified and experienced person in accordance with 10.5.2 of *NFPA 72*. [**72:**7.5.6.3]

The system installer is responsible for the preparation of the record of completion form. It documents the name of the installer and the location of record drawings, owners' manuals, and test reports. The form also provides a confirming record of the acceptance test and gives details of the components and wiring of the system. A record of completion is required for all installed fire alarm and emergency communications systems.

Δ **13.7.3.2.3.6.4** The record of completion documentation shall be updated to reflect all system additions or modifications. [**72:**7.5.6.4]

13.7.3.2.3.6.5 The updated copy of the record of completion documents shall be maintained in a documentation cabinet in accordance with 7.7.2 of *NFPA 72*. [**72:**7.5.6.5]

13.7.3.2.3.6.6 Revisions.

Δ **13.7.3.2.3.6.6.1** All modifications made after the initial installation shall be recorded on a revised version of the original completion documents. [**72:**7.5.6.6.1]

13.7.3.2.3.6.6.2 The revised record of completion document shall include a revision date. [**72:**7.5.6.6.2]

13.7.3.2.3.6.6.3 Where the original or the latest overall system record of completion cannot be obtained, a new system record of completion shall be provided that documents the system configuration as discovered during the current project's scope of work. [**72:**7.5.6.6.3]

Documentation of revisions made to a system after the original installation has been completed is just as important as documentation of the original installation. Every change to the system must be documented so that designers, service personnel, and others will know exactly what is on the system and how the system is to function.

In cases where a record of completion does not exist, it is not required that one be completed retroactively for the entire system when revisions are made to portions of the system. This record of completion is only required to provide pertinent information based upon the revisions to the existing fire alarm system.

13.7.3.2.3.6.7 Electronic Record of Completion.

13.7.3.2.3.6.7.1 Where approved by the AHJ, the record of completion shall be permitted to be filed electronically instead of on paper. [**72:**7.5.6.7.1]

A record of completion that is filed electronically indicates that the individual or entity — the owner, equipment supplier, service company, or installer — has a copy of it in their media records. Refer to 7.7.2.6 of *NFPA 72* regarding storage and access to electronic documentation.

13.7.3.2.3.6.7.2 If filed electronically, the record of completion document shall be accessible with standard software and shall be backed up. [**72:**7.5.6.7.2]

13.7.3.2.3.7 Site-Specific Software.

N **13.7.3.2.3.7.1** For software-based systems, a copy of the site-specific software shall be provided to the system owner or owner's designated representative. [**72:**7.5.7.1]

N **13.7.3.2.3.7.1.1** The site-specific software documentation shall include both the user passcode and either the system programming password or specific instructions on how to obtain the programming password from the system manufacturer. [**72:**7.5.7.1.1]

N **13.7.3.2.3.7.1.2** The passwords provided shall enable currently certified qualified programming personnel to access, edit, modify, and add to the existing system site-specific software. [**72:**7.5.7.1.2]

N **13.7.3.2.3.7.2** A copy of the site-specific software shall be stored on-site in nonvolatile, nonerasable, nonrewritable memory. [**72:**7.5.7.2]

13.7.3.2.3.8 Verification of Compliant Installation.

N **13.7.3.2.3.8.1** Where required by the AHJ, compliance of the completed installation with the requirements of *NFPA 72* shall be certified by a qualified and impartial third-party organization acceptable to the AHJ. [**72:**7.5.8.1]

The AHJ is permitted to mandate that a third-party review and certify an installation for compliance with *NFPA 72*. A third-party is an independent entity that has the experience and knowledge to review and certify an installation for compliance with *NFPA 72*. This requirement applies to all systems and is not the same as the documentation required for central station alarm systems in 13.7.3.4.

13.7.3.2.3.8.2 Verification of compliant installation shall be performed according to testing requirements and procedures specified in 14.4.1 and 14.4.2 of *NFPA 72*. [**72:**7.5.8.2]

13.7.3.2.3.8.3 Verification shall ensure that:

(1) All components and functions are installed and operate per the approved plans and sequence of operation.
(2) All required system documentation is complete and is archived on site.
(3) For new supervising station systems, the verification shall also ascertain proper arrangement, transmission, and receipt of all signals required to be transmitted off-premises and shall meet the requirements of 14.4.1 and 14.4.2 of *NFPA 72*.
(4) For existing supervising station systems that are extended, modified, or reconfigured, the verification shall be required for the new work only, and reacceptance testing in accordance with Chapter 14 of *NFPA 72* shall be acceptable.
(5) Written confirmation has been provided that any required corrective actions have been completed

[**72:**7.5.8.3]

13.7.3.2.3.9 Documentation of central station service shall be in accordance with 26.3.4 of *NFPA 72*. [**72:**7.5.9]

13.7.3.2.3.10 Documentation of remote station service shall be in accordance with 26.5.2 of *NFPA 72*. [**72:**7.5.10]

13.7.3.2.4 Inspection, Testing, and Maintenance Documentation.

13.7.3.2.4.1 Test plan documentation shall be provided in accordance with 14.2.10 of *NFPA 72*. [**72:**7.6.1]

Subsection 14.2.10 of *NFPA 72* requires that a written test plan be created. This is particularly important when the fire alarm system interfaces with other functions, including those functions covered by Chapter 21 of *NFPA 72*. The test plan and the results of the testing that occurs are to be documented and kept with the system records.

It is important to ensure that other systems that interface with fire alarm systems as part of the fire alarm sequence of operation are properly tested as part of an integrated test plan under NFPA 4. It is also important that the interaction of the various systems being tested is properly documented and part of the documentation required in Chapter 7 of *NFPA 72*. This is especially important when system interfaces are complex.

The following is a list of some items that could be included in a test plan:

1. Information regarding the test, such as the intent of the test, established criteria of the design documents, applicable codes, and administrative procedures
2. Documentation that could include the following:
   a. Log books
   b. Daily reports
   c. Issuing nonconformance reports
   d. Clearing nonconformance reports
   e. Final report
   f. Information on what equipment is going to be reviewed and on the visual inspection of items that could include the following:
      i. Fire alarm devices
      ii. Smoke barriers
      iii. Ducts
      iv. Dampers
      v. Fans
      vi. Doors
      vii. Electrical systems
      viii. Interface relays
      ix. Other supervisory devices
3. Information on items, which could include the following, to be tested, how they are going to be tested, and in what mode (normal or abnormal conditions):
   a. Initiation devices
   b. Fans
   c. Duct leakage
   d. Air balancer

Having the interface documentation available for maintenance and future improvements is invaluable. If a building owner is contemplating a fire alarm upgrade and does not have the proper record documentation, finding out what the sequence of operation is for the smoke control system and how it interfaces with the fire alarm system can be difficult. Since the smoke control system relies on input from the fire alarm system, it is important to know how it works. What activates when there is a fire alarm condition? Proper record documentation on system interfaces can answer this type of question.

13.7.3.2.4.2 Acceptance testing documentation shall be provided in accordance with 14.6.1 of *NFPA 72*. [**72:**7.6.2]

13.7.3.2.4.3 Reacceptance test documentation shall be provided in accordance with 14.6.1 of *NFPA 72*. [**72:**7.6.3]

Δ **13.7.3.2.4.4** Periodic inspection and testing documentation shall be provided in accordance with 14.6.2 through 14.6.4 of *NFPA 72*. [**72:**7.6.4]

13.7.3.2.4.5 Impairment documentation shall be provided in accordance with Section 10.20 of *NFPA 72*. [**72:**7.6.5]

Δ **13.7.3.2.4.6 Record of Inspection and Testing.** The record of all inspections, testing, and maintenance as required by 14.6.2.4 of *NFPA 72* shall be documented using either the record of inspection and testing forms, Figure 13.7.3.2.5.2(g) through Figure 13.7.3.2.5.2(l), or an alternative record that includes all the applicable information shown in Figure 13.7.3.2.5.2(g) through Figure 13.7.3.2.5.2(l). [**72:**7.6.6]

13.7.3.2.5 Forms.

13.7.3.2.5.1 General.

13.7.3.2.5.1.1 The requirements of 13.7.3.2.5 shall apply only where required by other governing laws, codes, or standards; by other parts of this *Code*; or by project specifications or drawings. [**72:**7.8.1.1]

13.7.3.2.5.1.2 Where specific forms are required by other governing laws, codes, or standards; by other parts of *NFPA 72*; or by project specifications or drawings, form layouts and content that differ from those in 13.7.3.2.5 shall be permitted provided that the minimum required content is included. [**72:**7.8.1.2]

Δ **13.7.3.2.5.2 Forms for Documentation.** Forms for documentation shall be as follows:

(1) Unless otherwise permitted or required in 13.7.3.2.3.6, 13.7.3.2.4.6, or 13.7.3.2.5.1.2, 13.7.3.2.5.2(a) through Figure 13.7.3.2.5.2(l) shall be used to document the record of completion and record of inspection and testing.
(2) Unless otherwise permitted or required in Figure 13.7.3.2.5.2(g) through Figure 13.7.3.2.5.2(l) shall be used to document the record of inspection and testing.

[**72:**7.8.2]

Forms to satisfy the record keeping requirements of the *Code* have been developed for use. The use of forms other than those found in the *Code* is allowed so long as the required documented information is included in the other form.

13.7.3.3 Manually Actuated Alarm-Initiating Devices.

Many fire alarm systems are not equipped with automatic off-site capability for signal transmission to a supervising station. In those buildings where the fire alarm system is not equipped with automatic off-site signal transmission to a supervising station system, activation of the manual fire alarm box notifies only other occupants in the building of the presence of a fire. The manual fire alarm box does not notify the fire service. For such buildings, explicit instructions to the operator of the manual fire alarm box to also notify the fire department from outside the building are desirable and might be required by the local ordinance or code to be placed at each manual fire alarm box location.

Δ **13.7.3.3.1** Manually actuated alarm-initiating devices for initiating signals other than for fire alarm shall be permitted if the devices are differentiated from manual fire alarm boxes by a color other than red and labeling. [**72:**17.14.1]

The color red is reserved for manual initiating devices that initiate a fire signal. If manual initiating devices are used to initiate some other emergency signal (e.g., toxic release, radiological release, medical emergency, hazardous weather), they must be differentiated from each other and from the fire alarm boxes by both color and labeling. No color code is specified for manual emergency reporting–initiating devices.

13.7.3.3.2 Combination manual fire alarm boxes and guard's signaling stations shall be permitted. [**72:**17.14.2]

If the manual fire alarm box is incorporated into some other non-fire-related assembly (with the single exception of guards' tour supervisory stations), the probability of unwarranted operation is increased. This arrangement leads to false alarms and erodes the occupants' confidence in the system. Also, when manual fire alarms are combined with non-fire-related functions, the probability that a failure in the non-fire-related function will compromise the fire alarm system increases.

13.7.3.3.3 Manually actuated alarm-initiating devices shall be securely mounted. [**72:**17.14.3]

13.7.3.3.4 Manually actuated alarm-initiating devices shall be mounted on a background of contrasting color. [**72:**17.14.4]

13.7.3.3.5 The operable part of a manually actuated alarm-initiating device shall be not less than 42 in. (1.07 m) and not more than 48 in. (1.22 m) from the finished floor. [**72:**17.14.5]

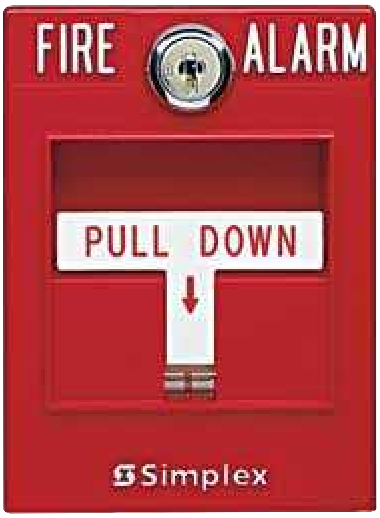
The *Americans with Disabilities Act and Architectural Barriers Act Accessibility Guidelines* specifies a maximum unobstructed "side reach" and unobstructed "forward reach" of 48 in. (1.22 m). Refer to the specific details of the guidelines for what constitutes an obstructed versus unobstructed approach. Information concerning the policies of the Architectural and Transportation Barriers Compliance Board can be found at the website www.access-board.gov. See Exhibit 13.43 for an example of a manual fire alarm box.

13.7.3.3.6 Manually actuated alarm-initiating devices shall be permitted to be single action or double action. [**72:**17.14.6]

13.7.3.3.7* Listed protective covers shall be permitted to be installed over single- or double-action manually actuated alarm-initiating devices. [**72:**17.14.7]

A.13.7.3.3.7 Protective covers, also called pull station protectors can be installed over manually actuated alarm initiating devices to provide mechanical protection, environmental protection, and

Exhibit 13.43



Manual fire alarm box. (Source: SimplexGrinnell, Westminster, MA)

SYSTEM RECORD OF COMPLETION

This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.
Attach additional sheets, data, or calculations as necessary to provide a complete record.

Form Completion Date: __________ Supplemental Pages Attached: __________

1. PROPERTY INFORMATION

Name of property: __________
Address: __________
Description of property: __________
Name of property representative: __________
Address: __________
Phone: __________ Fax: __________ E-mail: __________

2. INSTALLATION, SERVICE, TESTING, AND MONITORING INFORMATION

Installation contractor: __________
Address: __________
Phone: __________ Fax: __________ E-mail: __________
Service organization: __________
Address: __________
Phone: __________ Fax: __________ E-mail: __________
Testing organization: __________
Address: __________
Phone: __________ Fax: __________ E-mail: __________
Effective date for test and inspection contract: __________
Monitoring organization: __________
Address: __________
Phone: __________ Fax: __________ E-mail: __________
Account number: __________ Phone line 1: __________ Phone line 2: __________
Means of transmission: __________
Entity to which alarms are retransmitted: __________ Phone: __________

3. DOCUMENTATION

On-site location of the required record documents and site-specific software: __________

4. DESCRIPTION OF SYSTEM OR SERVICE

This is a: ❏ New system ❏ Modification to existing system Permit number: __________
NFPA 72 edition: __________

4.1 Control Unit

Manufacturer: __________ Model number: __________

4.2 Software and Firmware

Firmware revision number: __________

4.3 Alarm Verification

❏ This system does not incorporate alarm verification.
Number of devices subject to alarm verification: __________ Alarm verification set for __________ seconds

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N ***FIGURE 13.7.3.2.5.2(a)*** *System Record of Completion. [**72:**Figure 7.8.2(a)]*

SYSTEM RECORD OF COMPLETION *(continued)*

5. SYSTEM POWER

5.1 Control Unit

5.1.1 Primary Power

Input voltage of control panel: ______________________ Control panel amps: __________

Overcurrent protection: Type: ______________________ Amps: __________

Branch circuit disconnecting means location: ______________________ Number: __________

5.1.2 Secondary Power

Type of secondary power: ______________________

Location, if remote from the plant: ______________________

Calculated capacity of secondary power to drive the system:

In standby mode (hours): ______________ In alarm mode (minutes): ______________

5.2 Control Unit

❑ This system does not have power extender panels

❑ Power extender panels are listed on supplementary sheet A

6. CIRCUITS AND PATHWAYS

Pathway Type	Dual Media Pathway	Separate Pathway	Class	Survivability Level
Signaling Line				
Device Power				
Initiating Device				
Notification Appliance				
Other (specify):				

7. REMOTE ANNUNCIATORS

Type	Location

8. INITIATING DEVICES

Type	Quantity	Addressable or Conventional	Alarm or Supervisory	Sensing Technology
Manual Pull Stations				
Smoke Detectors				
Duct Smoke Detectors				
Heat Detectors				
Gas Detectors				
Waterflow Switches				
Tamper Switches				

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N *FIGURE 13.7.3.2.5.2(a)* *Continued*

SYSTEM RECORD OF COMPLETION *(continued)*

9. NOTIFICATION APPLIANCES

Type	Quantity	Description
Audible		
Visible		
Combination Audible and Visible		

10. SYSTEM CONTROL FUNCTIONS

Type	Quantity
Hold-Open Door Releasing Devices	
HVAC Shutdown	
Fire/Smoke Dampers	
Door Unlocking	
Elevator Recall	
Elevator Shunt Trip	

11. INTERCONNECTED SYSTEMS

❑ This system does not have interconnected systems.

❑ Interconnected systems are listed on supplementary sheet __________ .

12. CERTIFICATION AND APPROVALS

12.1 System Installation Contractor

This system as specified herein has been installed according to all NFPA standards cited herein.

Signed: ______________________ Printed name: ______________ Date: ____________

Organization: ____________________ Title: ________________ Phone: ____________

12.2 System Operational Test

This system as specified herein has tested according to all NFPA standards cited herein.

Signed: ______________________ Printed name: ______________ Date: ____________

Organization: ____________________ Title: ________________ Phone: ____________

12.3 Acceptance Test

Date and time of acceptance test: ________________________________

Installing contractor representative: ________________________________

Testing contractor representative: ________________________________

Property representative: ________________________________

AHJ representative: ________________________________

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N ***FIGURE 13.7.3.2.5.2(a)*** *Continued*

EMERGENCY COMMUNICATIONS SYSTEMS SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes systems and components specific to emergency communications systems.
This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Form Completion Date: ____________ Number of Supplemental Pages Attached: ________

1. PROPERTY INFORMATION

Name of property: ______________________________

Address: ______________________________

2. DESCRIPTION OF SYSTEM OR SERVICE

❏ Fire alarm with in-building fire emergency voice alarm communication system (EVAC)

❏ Mass notification system

❏ Combination system, with the following components:

❏ Fire alarm ❏ EVACS ❏ MNS ❏ Two-way, in-building, emergency communications system

❏ Other (specify): ______________________________

NFPA 72 edition: ________ Additional description of system(s): ______________________________

____

2.1 In-Building Fire Emergency Voice Alarm Communications System

Manufacturer: ______________________________ Model number: ______________

Number of single voice alarm channels: __________ Number of multiple voice alarm channels: __________

Number of speakers: __________ Number of speaker circuits: __________

Location of amplification and sound processing equipment: ______________________________

____

____

Location of paging microphone stations:

Location 1: ______________________________

Location 2: ______________________________

Location 3: ______________________________

2.2 Mass Notification System

2.2.1 System Type:

❏ In-building MNS–combination

❏ In-building MNS ❏ Wide-area MNS ❏ Distributed recipient MNS

❏ Other (specify): ______________________________

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N ***FIGURE 13.7.3.2.5.2(b)*** *Emergency Communications System Supplementary Record of Completion. [**72:**Figure 7.8.2(b)]*

EMERGENCY COMMUNICATIONS SYSTEMS SUPPLEMENTARY RECORD OF COMPLETION *(continued)*

2. DESCRIPTION OF SYSTEM OR SERVICE *(continued)*

2.2.2 System Features:

❑ Combination fire alarm/MNS ❑ MNS autonomous control unit ❑ Wide-area MNS to regional national alerting interface
❑ Local operating console (LOC) ❑ Distributed-recipient MNS (DRMNS) ❑ Wide-area MNS to DRMNS interface
❑ Wide-area MNS to high power speaker array (HPSA) interface ❑ In-building MNS to wide-area MNS interface
❑ Other (specify): ______________________________

2.2.3 MNS Local Operating Consoles

Location 1: ______________________________

Location 2: ______________________________

Location 3: ______________________________

2.2.4 High Power Speaker Arrays

Number of HPSA speaker initiation zones: ______________________________

Location 1: ______________________________

Location 2: ______________________________

Location 3: ______________________________

2.2.5 Mass Notification Devices

Combination fire alarm/MNS visual devices: ____________ MNS-only visual devices: ____________

Textual signs: ____________ Other (describe): ______________________________

Supervision class: ______________________________

2.2.6 Special Hazard Notification

❑ This system does not have special suppression predischarge notification.

❑ MNS systems DO NOT override notification appliances required to provide special suppression predischarge notification.

3. TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS

3.1 Telephone System

Number of telephone jacks installed: ____________ Number of warden stations installed: ____________

Number of telephone handsets stored on site: ______________________________

Type of telephone system installed: ❑ Electrically powered ❑ Sound powered

3.2 Area of Refuge (Area of Rescue Assistance) Emergency Communications Systems

Number of stations: ________ Location of central control point: ______________________________

Days and hours when central control point is attended: ______________________________

Location of alternate control point: ______________________________

Days and hours when alternate control point is attended: ______________________________

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N ***FIGURE 13.7.3.2.5.2(b)*** *Continued*

EMERGENCY COMMUNICATIONS SYSTEMS
SUPPLEMENTARY RECORD OF COMPLETION ***(continued)***

3. TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS ***(continued)***

3.3 Elevator Emergency Communications Systems

Number of elevators with stations: ___________ Location of central control point: ___________

Days and hours when central control point is attended: ___________

Location of alternate control point: ___________

Days and hours when alternate control point is attended: ___________

3.4 Other Two-Way Communications System

Describe: ___________

4. CONTROL FUNCTIONS

This system activates the following control functions specific to emergency communications systems:

Type	Quantity
Mass Notification Override of Alarm Signaling Systems or Appliances	

See Main System Record of Completion for additional information, certifications, and approvals.

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N ***FIGURE 13.7.3.2.5.2(b)*** *Continued*

POWER SYSTEMS
SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes systems and components specific to power systems that incorporate generators, UPS systems, remote battery systems, or other complex power systems. This form is to be completed by the system installation contractor at the time of system acceptance and approval. It shall be permitted to modify this form as needed to provide a more complete and/or clear record. Insert N/A in all unused lines.

Form Completion Date: ________________ Number of Supplemental Pages Attached: __________

1. PROPERTY INFORMATION

Name of property: ____________________

Address: ____________________

2. SYSTEM POWER

2.1 Control Unit

2.1.1 Primary Power

Input voltage of control panel: ____________ Control panel amps: ____________

Overcurrent protection: Type: ____________ Amps: ____________

Location (of primary supply panelboard): ____________________

Disconnecting means location: ____________________

2.1.2 Engine-Driven Generator

Location of generator: ____________________

Location of fuel storage: ____________ Type of fuel: ____________

2.1.3 Uninterruptible Power System

Equipment powered by UPS system: ____________________

Location of UPS system: ____________________

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): ____________ In alarm mode (minutes): ____________

2.1.4 Batteries

Location: ____________ Type: ________ Nominal voltage: ________ Amp/hour rating: ________

Calculated capacity of batteries to drive the system:

In standby mode (hours): ____________ In alarm mode (minutes): ____________

2.2 In-Building Fire Emergency Voice Alarm Communications System or Mass Notification System

2.2.1 Primary Power

Input voltage of EVACS or MNS panel: ____________ EVACS or MNS panel amps: ____________

Overcurrent protection: Type: ____________ Amps: ____________

Location (of primary supply panelboard): ____________________

Disconnecting means location: ____________________

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N ***FIGURE 13.7.3.2.5.2(c)*** *Power Systems Supplementary Record of Completion. [**72:**Figure 7.8.2(c)]*

POWER SYSTEMS
SUPPLEMENTARY RECORD OF COMPLETION *(continued)*

2. SYSTEM POWER *(continued)*

2.2.2 Engine-Driven Generator

Location of generator: ____________________

Location of fuel storage: ____________________ Type of fuel: ____________________

2.2.3 Uninterruptible Power System

Equipment powered by UPS system: ____________________

Location of UPS system: ____________________

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): ____________________ In alarm mode (minutes): ____________________

2.2.4 Batteries

Location: ______________ Type: ________ Nominal voltage: ________ Amp/hour rating: ________

Calculated capacity of batteries to drive the system:

In standby mode (hours): ____________________ In alarm mode (minutes): ____________________

2.3 Notification Appliance Power Extender Panels

❑ This system does not have power extender panels.

2.3.1 Primary Power

Input voltage of power extender panel(s): ____________ Power extender panel amps: ____________

Overcurrent protection: Type: ____________ Amps: ____________

Location (of primary supply panelboard): ____________________

Disconnecting means location: ____________________

2.3.2 Engine Driven Generator

Location of generator: ____________________

Location of fuel storage: ____________________ Type of fuel: ____________________

2.3.3 Uninterruptible Power System

Equipment powered by UPS system: ____________________

Location of UPS system: ____________________

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): ____________________ In alarm mode (minutes): ____________________

2.3.4 Batteries

Location: ______________ Type: ________ Nominal voltage: ________ Amp/hour rating: ________

Calculated capacity of batteries to drive the system:

In standby mode (hours): ____________________ In alarm mode (minutes): ____________________

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N ***FIGURE 13.7.3.2.5.2(c)*** *Continued*

POWER SYSTEMS
SUPPLEMENTARY RECORD OF COMPLETION *(continued)*

2. SYSTEM POWER *(continued)*

2.4 Supervising Station Transmission Equipment

❏ This system does not use transmission equipment within the building powered by any other source than the alarm system control unit.

2.4.1 Primary Power

Input voltage of shared transmission equipment: ______________________

Shared transmission equipment panel amps: ______________________

Overcurrent protection: Type: ______________ Amps: ______________

Location (of primary supply panelboard): ______________________

Disconnecting means location: ______________________

2.4.2 Engine Driven Generator

Location of generator: ______________________

Location of fuel storage: ______________ Type of fuel: ______________

2.4.3 Uninterruptible Power System

Equipment powered by UPS system: ______________________

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): ______________ In alarm mode (minutes): ______________

2.4.4 Batteries

Location: ______________ Type: ________ Nominal voltage: ________ Amp/hour rating: ________

Calculated capacity of batteries to drive the system:

In standby mode (hours): ______________ In alarm mode (minutes): ______________

See Main System Record of Completion for additional information, certifications, and approvals.

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N ***FIGURE 13.7.3.2.5.2(c)*** *Continued*

NOTIFICATION APPLIANCE POWER PANEL SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes a list of types and locations of notification appliance power extender panels.
This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Form Completion Date: ________________ Number of Supplemental Pages Attached: __________

1. PROPERTY INFORMATION

Name of property: ____

Address: ____

2. NOTIFICATION APPLIANCE POWER EXTENDER PANELS

Make and Model	Location	Area Served	Power Source

See Main System Record of Completion for additional information, certifications, and approvals.

 NFPA 72

N ***FIGURE 13.7.3.2.5.2(d)*** *Notification Appliance Power Panel Supplementary Record of Completion. [**72:**Figure 7.8.2(d)]*

INTERCONNECTED SYSTEMS
SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes a list of types and locations of systems that are interconnected to the main system.
This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Form Completion Date: ________________ Number of Supplemental Pages Attached: __________

1. PROPERTY INFORMATION

Name of property: ______________________________

Address: ______________________________

2. INTERCONNECTED SYSTEMS

Description	Location	Purpose

See Main System Record of Completion for additional information, certifications, and approvals.

 NFPA 72

N **FIGURE 13.7.3.2.5.2(e)** *Interconnected Systems Supplementary Record of Completion. [**72:**Figure 7.8.2(e)]*

DEVIATIONS FROM ADOPTED CODES AND STANDARDS
SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It enables the designer and/or installer to document and justify deviations from accepted codes or standards.
This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Form Completion Date: __________________ Number of Supplemental Pages Attached: ___________

1. PROPERTY INFORMATION

Name of property: ____

Address: ____

2. DEVIATIONS FROM ADOPTED CODES OR STANDARDS

Description	Purpose

See Main System Record of Completion for additional information, certifications, and approvals.

 NFPA 72

N ***FIGURE 13.7.3.2.5.2(f)*** *Deviations from Adopted Codes and Standards Supplementary Record of Completion. [**72:**Figure 7.8.2(f)]*

SYSTEM RECORD OF INSPECTION AND TESTING

This form is to be completed by the system inspection and testing contractor at the time of a system test.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.
Attach additional sheets, data, or calculations as necessary to provide a complete record.

Inspection/Test Start Date/Time: __________________ Inspection/Test Completion Date/Time: __________________

Supplemental Form(s) Attached: ________ (yes/no)

1. PROPERTY INFORMATION

Name of property: ____________________

Address: ____________________

Description of property: ____________________

Name of property representative: ____________________

Address: ____________________

Phone: ______________ Fax: ______________ E-mail: ______________

2. TESTING AND MONITORING INFORMATION

Testing organization: ____________________

Address: ____________________

Phone: ______________ Fax: ______________ E-mail: ______________

Monitoring organization: ____________________

Address: ____________________

Phone: ______________ Fax: ______________ E-mail: ______________

Account number: ______________ Phone line 1: ______________ Phone line 2: ______________

Means of transmission: ____________________

Entity to which alarms are retransmitted: ______________ Phone: ______________

3. DOCUMENTATION

Onsite location of the required record documents and site-specific software: ____________________

4. DESCRIPTION OF SYSTEM OR SERVICE

4.1 Control Unit

Manufacturer: ______________ Model number: ______________

4.2 Software Firmware

Firmware revision number: ____________________

4.3 System Power

4.3.1 Primary (Main) Power

Nominal voltage: ______________ Amps: _______ Location: ______________

Overcurrent protection type: ______________ Amps: _______ Disconnecting means location: ______________

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N ***FIGURE 13.7.3.2.5.2(g)*** *System Record of Inspection and Testing. [**72:**Figure 7.8.2(g)]*

SYSTEM RECORD OF INSPECTION AND TESTING *(continued)*

4. DESCRIPTION OF SYSTEM OR SERVICE *(continued)*

4.3.2 Secondary Power

Type: ______________________ Location: ______________________

Battery type (if applicable): ______________________

Calculated capacity of batteries to drive the system:

In standby mode (hours): ______________________ In alarm mode (minutes): ______________________

5. NOTIFICATIONS MADE PRIOR TO TESTING

Monitoring organization Contact: ______________________ Time: ____________

Building management Contact: ______________________ Time: ____________

Building occupants Contact: ______________________ Time: ____________

Authority having jurisdiction Contact: ______________________ Time: ____________

Other, if required Contact: ______________________ Time: ____________

6. TESTING RESULTS

6.1 Control Unit and Related Equipment

Description	Visual Inspection	Functional Test	Comments
Control unit	❏	❏	
Lamps/LEDs/LCDs	❏	❏	
Fuses	❏	❏	
Trouble signals	❏	❏	
Disconnect switches	❏	❏	
Ground-fault monitoring	❏	❏	
Supervision	❏	❏	
Local annunciator	❏	❏	
Remote annunciators	❏	❏	
Remote power panels	❏	❏	
	❏	❏	

6.2 Secondary Power

Description	Visual Inspection	Functional Test	Comments
Battery condition	❏	❏	
Load voltage	❏	❏	
Discharge test	❏	❏	
Charger test	❏	❏	
Remote panel batteries	❏	❏	

 NFPA 72 (p. 2 of 4)

N ***FIGURE 13.7.3.2.5.2(g)*** *Continued*

SYSTEM RECORD OF INSPECTION AND TESTING *(continued)*

6. TESTING RESULTS *(continued)*

6.3 Alarm and Supervisory Alarm Initiating Device

Attach supplementary device test sheets for all initiating devices.

6.4 Notification Appliances

Attach supplementary appliance test sheets for all notification appliances.

6.5 Interface Equipment

Attach supplementary interface component test sheets for all interface components.

Circuit Interface / Signaling Line Circuit Interface / Fire Alarm Control Interface

6.6 Supervising Station Monitoring

Description	Yes	No	Time	Comments
Alarm signal	❑	❑		
Alarm restoration	❑	❑		
Trouble signal	❑	❑		
Trouble restoration	❑	❑		
Supervisory signal	❑	❑		
Supervisory restoration	❑	❑		

6.7 Public Emergency Alarm Reporting System

Description	Yes	No	Time	Comments
Alarm signal	❑	❑		
Alarm restoration	❑	❑		
Trouble signal	❑	❑		
Trouble restoration	❑	❑		
Supervisory signal	❑	❑		
Supervisory restoration	❑	❑		

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N ***FIGURE 13.7.3.2.5.2(g)*** *Continued*

SYSTEM RECORD OF INSPECTION AND TESTING *(continued)*

7. NOTIFICATIONS THAT TESTING IS COMPLETE

Monitoring organization	Contact: ____________	Time: ________
Building management	Contact: ____________	Time: ________
Building occupants	Contact: ____________	Time: ________
Authority having jurisdiction	Contact: ____________	Time: ________
Other, if required	Contact: ____________	Time: ________

8. SYSTEM RESTORED TO NORMAL OPERATION

Date: ____________ Time: ____________

9. CERTIFICATION

This system as specified herein has been inspected and tested according to NFPA 72, 2013 edition, Chapter 14.

Signed: ____________ Printed name: ____________ Date: ____________

Organization: ____________ Title: ____________ Phone: ____________

Qualifications (refer to 10.5.3): ____________

10. DEFECTS OR MALFUNCTIONS NOT CORRECTED AT CONCLUSION OF SYSTEM INSPECTION, TESTING, OR MAINTENANCE

10.1 Acceptance by Owner or Owner's Representative:

The undersigned accepted the test report for the system as specified herein:

Signed: ____________ Printed name: ____________ Date: ____________

Organization: ____________ Title: ____________ Phone: ____________

 NFPA 72 (p. 4 of 4)

N *FIGURE 13.7.3.2.5.2(g)* *Continued*

NOTIFICATION APPLIANCE
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING

This form is a supplement to the System Record of Inspection and Testing.
It includes a notification appliance test record.
This form is to be completed by the system inspection and testing contractor at the time of the inspection and/or test.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Inspection/Test Start Date/Time: __________________ Inspection/Test Completion Date/Time: __________________

Number of Supplemental Pages Attached: ________

1. PROPERTY INFORMATION

Name of property: ____

Address: ____

2. NOTIFICATION APPLIANCE TEST RESULTS

Appliance Type	Location/Identifier	Test Results

 NFPA 72 (p. 1 of 2)

N *FIGURE 13.7.3.2.5.2(h)* *Notification Appliance Supplementary Record of Inspection and Testing. [72:Figure 7.8.2(h)]*

NOTIFICATION APPLIANCE
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING *(continued)*

2. NOTIFICATION APPLIANCE TEST RESULTS *(continued)*

Appliance Type	Location/Identifier	Test Results

See main System Record of Inspection and Testing for additional information, certifications, and approvals.

 NFPA 72 (p. 2 of 2)

N ***FIGURE 13.7.3.2.5.2(h)*** *Continued*

INITIATING DEVICE
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING

This form is a supplement to the System Record of Inspection and Testing.
It includes an initiating device test record.
This form is to be completed by the system inspection and testing contractor at the time of the inspection and/or test.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Inspection/Test Start Date/Time: ___________________ Inspection/Test Completion Date/Time: __________________

Number of Supplemental Pages Attached: ________

1. PROPERTY INFORMATION

Name of property: ____

Address: ____

2. INITIATING DEVICE TEST RESULTS

Device Type	Address	Location	Test Results

 NFPA 72 (p. 1 of 2)

N ***FIGURE 13.7.3.2.5.2(i)*** *Initiating Device Supplementary Record of Inspection and Testing. [**72:**Figure 7.8.2(i)]*

INITIATING DEVICE
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING *(continued)*

2. INITIATING DEVICE TEST RESULTS *(continued)*

Device Type	Address	Location	Test Results

See main System Record of Inspection and Testing for additional information, certifications, and approvals.

 NFPA 72 (p. 2 of 2)

N *FIGURE 13.7.3.2.5.2(i)* *Continued*

MASS NOTIFICATION SYSTEM
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING

This form is a supplement to the System Record of Inspection and Testing.
It includes a mass notification system test record.
This form is to be completed by the system inspection and testing contractor at the time of the inspection and/or test.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Inspection/Test Start Date/Time: ____________________ Inspection/Test Completion Date/Time: ____________________

Number of Supplemental Pages Attached: ________

1. PROPERTY INFORMATION

Name of property: ______________________________

Address: ______________________________

2. MASS NOTIFICATION SYSTEM

2.1 System Type

❑ In-building MNS—combination

❑ In-building MNS—stand alone ❑ Wide-area MNS ❑ Distributed recipient MNS

❑ Other (specify): ______________________________

2.2 System Features

❑ Combination fire alarm/MNS ❑ MNS ACU only ❑ Wide-area MNS to regional national alerting interface

❑ Local operating console (LOC) ❑ Direct recipient MNS (DRMNS) ❑ Wide-area MNS to DRMNS interface

❑ Wide-area MNS to high-power speaker array (HPSA) interface ❑ In-building MNS to wide-area MNS interface

❑ Other (specify): ______________________________

3. IN-BUILDING MASS NOTIFICATION SYSTEM

3.1 Primary Power

Input voltage of MNS panel: ____________________ MNS panel amps: ____________________

3.2 Engine-Driven Generator ❑ This system does not have a generator.

Location of generator: ______________________________

Location of fuel storage: ____________________ Type of fuel: ____________________

3.3 Uninterruptible Power System ❑ This system does not have a UPS.

Equipment powered by a UPS system: ______________________________

Location of UPS system: ______________________________

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): ____________________ In alarm mode (minutes): ____________________

3.4 Batteries

Location: ____________ Type: ____________ Nominal voltage: ____________ Amp/hour rating: ____________

Calculated capacity of batteries to drive the system:

In standby mode (hours): ____________________ In alarm mode (minutes): ____________________

❑ Batteries are marked with date of manufacture.

 NFPA 72 (p. 1 of 2)

N ***FIGURE 13.7.3.2.5.2(j)*** *Mass Notification System Supplementary Record of Inspection and Testing. [**72:**Figure 7.8.2(j)]*

MASS NOTIFICATION SYSTEM
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING *(continued)*

4. MASS NOTIFICATION EQUIPMENT TEST RESULTS

Description	Visual Inspection	Functional Test	Comments
Functional test			
Reset/power down test			
Fuses			
Primary power supply			
UPS power test			
Trouble signals			
Disconnect switches			
Ground-fault monitoring			
CCU security mechanism			
Prerecorded message content			
Prerecorded message activation			
Software backup performed			
Test backup software			
Fire alarm to MNS interface			
MNS to fire alarm interface			
In-building MNS to wide-area MNS			
MNS to direct recipient MNS			
Sound pressure levels Occupied ❑ Yes ❑ No Ambient dBA:____________ Alarm dBA:____________ (attach supplementary notification appliance form(s) with locations, values, and weather conditions)			
System intelligibility Test method:______ Score:______ CIS value: ____________ (attach supplementary notification appliance form(s) with locations, values, and weather conditions)			
Other (specify):			

See main System Record of Inspection and Testing for additional information, certifications, and approvals.

 NFPA 72 (p. 2 of 2)

N ***FIGURE 13.7.3.2.5.2(j)*** *Continued*

EMERGENCY COMMUNICATIONS SYSTEMS SUPPLEMENTARY RECORD OF INSPECTION AND TESTING

This form is a supplement to the System Record of Inspection and Testing.
It includes systems and components specific to emergency communication systems.
This form is to be completed by the system inspection and testing contractor at the time of the inspection and/or test.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Inspection/Test Start Date/Time: __________________ Inspection/Test Completion Date/Time: _________________

Number of Supplemental Pages Attached: ________

1. PROPERTY INFORMATION

Name of property: ______________________________

Address: ______________________________

2. DESCRIPTION OF SYSTEM OR SERVICE

❑ Fire alarm with in-building fire emergency voice alarm communication system (EVAC)

❑ Mass notification system

❑ Combination system, with the following components:

❑ Fire alarm ❑ EVACS ❑ MNS ❑ Two-way, in-building, emergency communication system

❑ Other (specify): ______________________________

Additional description of system(s): ______________________________

____

2.1 In-Building Fire Emergency Voice Alarm Communication System

Manufacturer: ______________________________ Model number: ________________

Number of single voice alarm channels: ________________ Number of multiple voice alarm channels: ________________

Number of speakers: ________________ Number of speaker circuits: ________________

Location of amplification and sound processing equipment: ______________________________

____

____

Location of paging microphone stations:

Location 1: ______________________________

Location 2: ______________________________

Location 3: ______________________________

2.2 Mass Notification System

2.2.1 System Type:

❑ In-building MNS—combination

❑ In-building MNS ❑ Wide-area MNS ❑ Distributed recipient MNS

❑ Other (specify): ______________________________

 NFPA 72 (p. 1 of 5)

N ***FIGURE 13.7.3.2.5.2(k)*** *Emergency Communications Systems Supplementary Record of Inspection and Testing. [**72:**Figure 7.8.2(k)]*

EMERGENCY COMMUNICATIONS SYSTEMS
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING *(continued)*

2. DESCRIPTION OF SYSTEM OR SERVICE *(continued)*

2.2.2 System Features:

❏ Combination fire alarm/MNS ❏ MNS autonomous control unit ❏ Wide-area MNS to regional national alerting interface

❏ Local operating console (LOC) ❏ Distributed-recipient MNS (DRMNS) ❏ Wide-area MNS to DRMNS interface

❏ Wide-area MNS to high-power speaker array (HPSA) interface ❏ In-building MNS to wide-area MNS interface

❏ Other (specify): ____________________

2.2.3 MNS Local Operating Consoles

Location 1: ____________________

Location 2: ____________________

Location 3: ____________________

2.2.4 High-Power Speaker Arrays

Number of HPSA speaker initiation zones: ____________________

Location 1: ____________________

Location 2: ____________________

Location 3: ____________________

2.2.5 Mass Notification Devices

Combination fire alarm/MNS visual devices: ____________ MNS-only visual devices: ____________

Textual signs: ____________ Other (describe): ____________________

Supervision class: ____________________

2.2.6 Special Hazard Notification

❏ This system does not have special suppression pre-discharge notification

❏ MNS systems DO NOT override notification appliances required to provide special suppression pre-discharge notification

3. TWO-WAY EMERGENCY COMMUNICATION SYSTEMS

3.1 Telephone System

Number of telephone jacks installed: ____________ Number of warden stations installed: ____________

Number of telephone handsets stored on site: ____________________

Type of telephone system installed: ❏ Electrically powered ❏ Sound powered

3.2 Area of Refuge (Area of Rescue Assistance) Emergency Communications Systems

Number of stations: ________ Location of central control point: ____________________

Days and hours when central control point is attended: ____________________

Location of alternate control point: ____________________

Days and hours when alternate control point is attended: ____________________

 NFPA 72 (p. 2 of 5)

N *FIGURE 13.7.3.2.5.2(k)* *Continued*

EMERGENCY COMMUNICATIONS SYSTEMS
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING *(continued)*

3. TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS *(continued)*

3.3 Elevator Emergency Communications Systems

Number of elevators with stations: ____________ Location of central control point: ______________________________

Days and hours when central control point is attended: ______________________________

Location of alternate control point: ______________________________

Days and hours when alternate control point is attended: ______________________________

3.4 Other Two-Way Communication System

Describe: ______________________________

4. TESTING RESULTS

4.1 Control Unit and Related Equipment

Description	Visual Inspection	Functional Test	Comments
Control unit	❑	❑	
Lamps/LEDs/LCDs	❑	❑	
Fuses	❑	❑	
Trouble signals	❑	❑	
Disconnect switches	❑	❑	
Ground fault monitoring	❑	❑	
Supervision	❑	❑	
Local annunciator	❑	❑	
Remote annunciators	❑	❑	
Remote power panels	❑	❑	
Other:	❑	❑	

4.2 Secondary Power

Description	Visual Inspection	Functional Test	Comments
Battery condition	❑	❑	
Load voltage	❑	❑	
Discharge test	❑	❑	
Charger test	❑	❑	
Remote panel batteries	❑	❑	

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N ***FIGURE 13.7.3.2.5.2(k)*** *Continued*

EMERGENCY COMMUNICATIONS SYSTEMS
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING *(continued)*

4. TESTING RESULTS *(continued)*

4.3 Emergency Communications Equipment

Description	Visual Inspection	Functional Test	Comments
Control unit	❑	❑	
Lamps/LEDs/LCDs	❑	❑	
Fuses	❑	❑	
Secondary power supply	❑	❑	
Trouble signals	❑	❑	
Disconnect switches	❑	❑	
Ground fault monitoring	❑	❑	
Panel supervision	❑	❑	
System performance	❑	❑	
System audibility	❑	❑	
System intelligibility	❑	❑	
Other:	❑	❑	

4.4 Mass Notification Equipment

Description	Visual Inspection	Functional Test	Comments
Functional test	❑	❑	
Reset/Power down test	❑	❑	
Fuses	❑	❑	
Primary power supply	❑	❑	
UPS power test	❑	❑	
Trouble signals	❑	❑	
Disconnect switches	❑	❑	
Ground fault monitoring	❑	❑	
CCU security mechanism	❑	❑	
Prerecorded message content	❑	❑	
Prerecorded message activation	❑	❑	
Software backup performed	❑	❑	
Test backup software	❑	❑	
Fire alarm to MNS Interface	❑	❑	
MNS to fire alarm interface	❑	❑	
In-building MNS to wide-area MNS	❑	❑	
MNS to direct recipient MNS	❑	❑	

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N *FIGURE 13.7.3.2.5.2(k)* Continued

EMERGENCY COMMUNICATIONS SYSTEMS
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING *(continued)*

4. TESTING RESULTS *(continued)*

4.4 Mass Notification Equipment *(continued)*

Description	Visual Inspection	Functional Test	Comments
Sound pressure levels (attach report with locations, values, and weather conditions)	❏	❏	
System intelligibility ❏ CSI ❏ STI (attach report with locations, values, and weather conditions)	❏	❏	
Other:	❏	❏	

4.5 Two-Way Communication Equipment

Description	Visual Inspection	Functional Test	Comments
Phone handsets	❏	❏	
Phone jacks	❏	❏	
Off-hook indicator	❏	❏	
Call-in signal	❏	❏	
System performance	❏	❏	
System audibility	❏	❏	
System intelligibility	❏	❏	
Other:	❏	❏	

See main System Record of Inspection and Testing for additional information, certifications, and approvals.

 NFPA 72 (p. 5 of 5)

N ***FIGURE 13.7.3.2.5.2(k)*** *Continued*

INTERFACE COMPONENT
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING

This form is a supplement to the System Record of Inspection and Testing.
It includes an interface component test record for circuit interfaces, signaling line circuit interfaces, and fire alarm control interfaces.
This form is to be completed by the system inspection and testing contractor at the time of the inspection and/or test.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Inspection/Test Start Date/Time: ___________________ Inspection/Test Completion Date/Time: ___________________

Number of Supplemental Pages Attached: ________

1. PROPERTY INFORMATION

Name of property: ____

Address: ____

2. INTERFACE COMPONENT TEST RESULTS

Interface Component Type	Address	Location	Test Results

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N *FIGURE 13.7.3.2.5.2(l) Interface Component Supplementary Record of Inspection and Testing. [72:Figure 7.8.2(l)]*

INTERFACE COMPONENT
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING *(continued)*

2. INTERFACE COMPONENT TEST RESULTS *(continued)*

Interface Component Type	Address	Location	Test Results

See main System Record of Inspection and Testing for additional information, certifications, and approvals.

 NFPA 72 (p. 2 of 2)

N ***FIGURE 13.7.3.2.5.2(l)*** *Continued* to reduce the likelihood of accidental or malicious activation. The protective covers must be listed to ensure that they do not hinder the operation of the pull stations and to ensure that they meet accessibility requirements for activation by persons with physical disabilities. The *Code* explicitly permits installing them over single- or double-action devices. When installed over a double-action device, the assembly effectively becomes a triple-action device. Some units include battery-operated audible warning signals that have been shown to deter malicious activations. To be effective, it is important that the regular staff or occupants be aware of the sound and investigate immediately in order to catch someone who might otherwise activate the device without cause or to ensure that the device is activated if there is a legitimate reason. [**72:**A.17.14.7]

Protective covers are permitted to be installed over manual fire alarm boxes to provide relief from unintentional or malicious alarms. These covers must be listed for such use. Some covers provide a local signal that sounds at the device when the cover is lifted. In locations where an audible signal is incorporated into a cover, users should be aware that the opening of the cover does not initiate a fire alarm signal and that the fire alarm box must still be actuated. See Exhibit 13.40 for an example of a manual fire alarm box protective cover.

13.7.3.3.8 Manual fire alarm boxes shall comply with 13.7.3.3.8.1 through 13.7.3.3.8.6. [**72:**17.14.8]

13.7.3.3.8.1 Manual fire alarm boxes shall be used only for fire alarm initiating purposes. [**72:**17.14.8.1].

If manual fire alarm boxes are used for some other purpose, for the actuation of a special extinguishing system, for example, then someone unfamiliar with the facility could actuate the wrong manual fire alarm box in response to a fire incident. Consequently, manual fire alarm boxes are permitted to be used only for initiation of a fire alarm signal. A manual alarm-initiating device other than a manual fire alarm initiation device must be used for those other purposes. This requirement limits the potential for occupant confusion during a fire.

When manual alarm-initiating devices are installed to initiate some other type of emergency response, such as for toxic release or spill, the manual alarm-initiating device should be obviously different from those used to report a fire to minimize the probability of confusion during an emergency. Refer to Chapter 24 of *NFPA 72* for guidance on manual initiation devices used for MNSs.

13.7.3.3.8.2 Manual fire alarm boxes shall be installed so that they are conspicuous, unobstructed, and accessible. [**72:**17.14.8.2]

The objective is to ensure that, as occupants leave the building, they can easily see manual fire alarm–initiating devices without searching. Each manual fire alarm box must be clearly identifiable from a distance. Decorative items or furnishings that are placed in front of or adjacent to manual fire alarm boxes can hinder a person from locating and operating the manual fire alarm box as that person proceeds to the means of egress. The AHJ determines if the manual fire alarm–initiating devices are sufficiently conspicuous, unobstructed, and accessible.

13.7.3.3.8.3* Unless installed in an environment that precludes the use of red paint or red plastic, manual fire alarm boxes shall be red in color. [**72:**17.14.8.3]

Δ **A.13.7.3.3.8.3** In environments where red paint or red plastic is not suitable, an alternative material, such as stainless steel, could be used as long as the box meets the requirements of 13.7.3.3.8.2. [**72:**A.17.14.8.3].

13.7.3.3.8.4 Manual fire alarm boxes shall be located within 5 ft (1.5 m) of each exit doorway on each floor. [**72:**17.14.8.4]

The purpose of locating the manual fire alarm box within 5 ft (1.5 m) of the exit doorway on each floor is to have the location consistent with the path of travel that occupants will use during an evacuation. As occupants approach the entry door into an exit stairway, a manual fire alarm box (if required) should be in close proximity to that entry door. Normally, the discharge doors of a stairway do not require a manual fire alarm box, because such doors might not be considered an exit entry door; review of the NFPA *101* or the relevant building code is recommended. Doors that serve as entry into an exit passageway or a horizontal exit or doors that provide direct access to the exterior from a grade floor are normally considered exit entry doors and require the manual fire alarm box to be within 5 ft (1.5 m) of the exit doorway, where manual fire alarm boxes are required by codes or ordinances.

13.7.3.3.8.5* Additional manual fire alarm boxes shall be provided so that the travel distance to the nearest manual fire alarm box will not exceed 200 ft (61 m), measured horizontally on the same floor. [**72:**17.14.8.5]

A.13.7.3.3.8.5 It is not the intent of 13.7.3.3.8.5 to require manual fire alarm boxes to be attached to movable partitions or to equipment, nor to require the installation of permanent structures for mounting purposes only. [**72:**A.17.14.8.5]

The criterion described in 13.7.3.3.8.5 is derived from the requirements established in NFPA *101*.

13.7.3.3.8.6 Manual fire alarm boxes shall be mounted on both sides of grouped openings over 40 ft (12.2 m) in width, and within 5 ft (1.5 m) of each side of the grouped opening. [**72:**17.14.8.6]

The objective of 13.7.3.3.8.6 is to provide a manual fire alarm box within easy reach in the normal exit path of the occupants. Where multi-leaf door sets are installed, the actual exitway can become wide enough that departing occupants might not notice the fire alarm box on the far side of a wide set of doors. Also, an occupant might have to cross the doors to activate the manual fire alarm box, which would delay departure. Consequently, when door sets attain 40 ft (12.2 m) in width, fire alarm boxes are required on both sides of the means of egress. The number and the location of the manual fire alarm boxes required for multi-leaf doors must be consistent where there are groups of exit doors.

13.7.3.3.9 When fire alarm systems are not monitored, an approved permanent sign shall be installed adjacent to each manual fire alarm box. The sign shall read as follows:

Local alarm only:

(1) Activate alarm

(2) Exit building

(3) Call fire department

13.7.3.4* Indication of Central Station Service. The prime contractor shall conspicuously indicate that the alarm system providing service at a protected premises complies with all the requirements of this *Code* through the use of a systematic follow-up program under the control of the organization that has listed the prime contractor. [**72:**26.3.4]

A.13.7.3.4 The terms *certificated* and *placarded*, which appeared in previous editions of *NFPA 72*, were considered by some to be too specific to two listing organizations and were replaced with more generic wording. The concept of providing documentation to indicate ongoing compliance of an installed system continues to be reflected by the current language. [**72:**A.26.3.4]

To help ensure the inherent higher level of protection that a central station fire alarm system provides, 13.7.3.4 requires the prime contractor to indicate that the entire fire alarm system meets the requirements of the *Code* through the use of a systematic follow-up program under the control of the organization that has listed the prime contractor.

This requirement does not intend that the organization providing the systematic follow-up service will actually inspect every central station fire alarm system. Nor does it mean that when the organization providing the systematic follow-up service does inspect a central station fire alarm system that such an organization will inspect every aspect of that system. However, by providing a systematic follow-up program under the control of the organization that has listed the prime contractor, the prime contractor makes provision for a potential additional level of oversight.

The requirement in 13.7.3.4 tends to promote and encourage installation, testing, and maintenance procedures that will help ensure the overall quality of the central station alarm system. Further, the conspicuous indication that the installation complies with all the requirements of the *Code* helps promote a much more determined effort to implement the requirements of the *Code* than might otherwise occur.

Listing organizations do not conduct reviews of fire alarm system plans as a part of the listing process. Nor do they conduct acceptance testing or commissioning of systems. These functions are conducted by other entities, such as the local fire authority or an insurance carrier for the protected premises.

The prime contractor must conspicuously post documentation issued by the organization that has listed the prime contractor within a stated distance of the main fire alarm system control unit.

By intent, the *Code* does not provide details of the process by which the listing organization provides follow-up service or issues the required documentation to the listed prime contractor. Rather, the *Code* leaves those details up to the procedures and practices of the listing organization.

13.7.3.4.1 Documentation indicating *Code* compliance of the alarm system shall be issued by the organization that has listed the prime contractor. [**72:**26.3.4.1]

Δ **13.7.3.4.2** The documentation shall include, at a minimum, the following information:

(1) Name of the prime contractor involved with the ongoing *Code* compliance of the central station service
(2)* Full description of the alarm system as installed

A.13.7.3.4.2(2) The record of completion *(see Chapter 10 of NFPA 72)* can be used to fulfill this requirement. [**72:**A.26.3.4.2(2)]

(3) Issue and expiration dates of the documentation
(4) Name, address, and contact information of the organization issuing the document
(5) Identification of the AHJ(s) for the central station service installation

[**72:**26.3.4.2]

13.7.3.4.3 The documentation shall be physically posted within 3 ft (1 m) of the control unit, and copies of the documentation shall be made available to the AHJ(s) upon request. [**72:**26.3.4.3]

13.7.3.4.4 A central repository of issued documentation, accessible to the AHJ, shall be maintained by the organization that has listed the prime contractor. [**72:**26.3.4.4]

13.7.3.4.5* Alarm system service that does not comply with all the requirements of Section 26.3 of *NFPA 72* shall not be designated as central station service. [**72:**26.3.4.5]

A.13.7.3.4.5 It is the prime contractor's responsibility to remove all compliance markings (certification markings or placards) when a service contract goes into effect that conflicts in any way with the requirements of 13.7.3.4. [**72:**A.26.3.4.5]

13.7.3.4.6* For the purpose of Section 26.3 of *NFPA 72*, the subscriber shall notify the prime contractor, in writing, of the identity of the AHJs. [**72:**26.3.4.6]

A.13.7.3.4.6 The prime contractor should be aware of statutes, public agency regulations, or certifications regarding alarm systems that might be binding on the subscriber. The prime contractor should identify for the subscriber which agencies could be an AHJ and, if possible, advise the subscriber of any requirements or approvals being mandated by these agencies. [**72:**A.26.3.4.6]

The subscriber has the responsibility for notifying the prime contractor of those private organizations that are being designated as an AHJ. The subscriber also has the responsibility to notify the prime contractor of changes in the AHJ, such as where there is a change in insurance companies. Although the responsibility is primarily the subscriber's, the prime contractor should also take responsibility for seeking out these private AHJs through the subscriber. The prime contractor is responsible for maintaining current records on the AHJ for each protected premises. [**72:**A.26.3.4.6]

The most prevalent public agency involved as an AHJ with regard to alarm systems is the local fire department or fire prevention bureau. These are normally city or county agencies with statutory authority, and their approval of alarm system installations might be required. At the state level, the fire marshal's office is most likely to serve as the public regulatory agency. [**72:**A.26.3.4.6]

The most prevalent private organizations involved as AHJs are insurance companies. Others include insurance rating bureaus, insurance brokers and agents, and private consultants. It is important to note that these organizations have no statutory authority and become AHJs only when designated by the subscriber. [**72:**A.26.3.4.6]

With both public and private concerns to satisfy, it is not uncommon to find multiple AHJs involved with a particular protected premises. It is necessary to identify all AHJs in order to obtain all the necessary approvals for a central station alarm system installation. [**72:**A.26.3.4.6]

The phrase "in writing" can include any form of correspondence that can be verified upon request, such as a letter, fax, email, or other means of documented transfer of information from one entity to another. [**72:**A.26.3.4.6]

The subscriber and the prime contractor must identify all the AHJs involved at the protected premises. Although this responsibility rests primarily with the subscriber, the subscriber would normally know only the private AHJs. From experience gained by working in a particular jurisdiction, the prime contractor would most often know any additional public AHJs. Thus, a joint effort most effectively resolves this important requirement.

13.7.3.4.7 The AHJ(s) identified in 13.7.3.4.2(5) shall be notified within 30 calendar days of the expiration or cancellation by the organization that has listed the prime contractor. [**72:**26.3.4.7]

13.7.3.4.8 The subscriber shall surrender expired or canceled documentation to the prime contractor within 30 days of the termination date. [**72:**26.3.4.8]

Over the life of a central station system, someone might make a change that results in the expiration or cancellation of contracted service. In turn, that expiration or cancellation would invalidate the designation "central station service." In such a case, the organization that has listed the prime contractor must notify the AHJ, as required in 13.7.3.4.7. Further, the subscriber must return the expired or canceled documentation to the prime contractor within 30 days of the termination date.

The AHJ should rigorously enforce this requirement, which ensures that only those systems meeting and maintaining all the *Code* requirements for central station service have this designation.

13.7.3.5 Automatic Fire Detection and Alarm Service.

13.7.3.5.1 Automatic fire detectors shall be located, maintained, and tested in accordance with *NFPA 72*.

13.7.4 Automatic Fire Detectors.

13.7.4.1 General Requirements.

13.7.4.1.1 The requirements of 13.7.4.1.1 through 13.7.4.1.5 shall apply to all initiating devices. [**72:**17.4.1]

As used in this *Code*, the term *initiating device* covers not only fire detection devices such as manual fire alarm boxes, heat detectors, smoke detectors, and radiant energy–sensing detectors, but also other devices that monitor conditions related to fire safety. These other devices include gas detectors, sprinkler system waterflow switches, pressure switches, valve tamper switches, building temperature monitoring devices, and any signaling switches used to monitor special extinguishing systems or activate suppression systems. The requirements in 13.7.4 apply to all monitoring devices that provide information in the form of binary, digital, or analog data transmitted to a fire alarm control unit (FACU).

13.7.4.1.2 Where subject to mechanical damage, an initiating device shall be protected. A mechanical guard used to protect a smoke, heat, or radiant energy–sensing detector shall be listed for use with the detector. [**72:**17.4.2]

Mechanical guards used to protect smoke detectors, heat detectors, and radiant energy–sensing detectors must be listed for that purpose. Because both smoke detectors and heat detectors rely on the ceiling jet to convey smoke and hot combustion product gases from the fire plume to the detector, any object that impedes that flow retards the detector's response. Similarly, any object that impedes the transmission of radiant energy to radiant energy–sensing detectors would have an adverse effect on the detector's response. The only means to be certain that the mechanical guard is not a material impediment to detector response is to require that a qualified testing laboratory test and list the guard for the specific make and model detector. The listing will indicate the reduction in spacing or sensitivity that will result from use of the guard. See Exhibit 13.44 for an example of a mechanical guard for a smoke detector.

Exhibit 13.44

Protective mechanical guard for a smoke detector.

13.7.4.1.3 Initiating devices shall be supported independently of their attachment to the circuit conductors. [**72:**17.4.3]

The copper used in the wiring conductors is not formulated to serve as a mechanical support. Copper fatigues over time if placed under a mechanical stress, resulting in increasing brittleness and electrical resistance. Ultimately, the fatigued conductor breaks or its resistance becomes too high to allow the circuit to function properly. In either case, the operation of the circuit is impaired, and a loss of life or property conceivably could result because of fire alarm system failure.

Initiating devices must always be mounted as shown in the manufacturer's installation instructions. The requirements for listing include a method for mounting that adequately supports the initiating device so that no undue mechanical stresses are applied to the circuit conductors. If the instructions show the use of an electrical device or outlet box, then installation of the device with a box is a requirement of the listing, and the specific type of box shown must be used. If not shown, the use of an electrical box is determined by field conditions and the requirements of *NFPA 70*.

13.7.4.1.4 Initiating devices shall be installed in a manner that provides accessibility for periodic inspection, testing, and maintenance. [**72:**17.4.4]

It is not permitted to install initiating devices where they cannot be inspected, tested, and maintained during the life of the system. If the initiating devices are inaccessible, the maintenance contractor will not be able to maintain them in accordance with Chapter 14 of *NFPA 72* and the devices cannot be expected to provide reliable service. The term *inaccessible* is not defined in the *Code*; however, Chapter 3 of *NFPA 72* has incorporated three definitions of the term *accessible* from *NFPA 70*. The definitions of *accessible (as applied to equipment)*, *accessible (as applied to wiring methods)*, and *accessible, readily (readily accessible)* provide the criteria to judge the acceptability of equipment, wiring, and device locations. Also see the definition of *accessible spaces (as applied to detection coverage in Chapter 17 [of NFPA 72])* in 3.3.4 of *NFPA 72*.

The intent is not to discourage the use of portable ladders to access detection devices; the use of portable ladders would typically be needed to service detectors on normal height and higher ceilings. Rather, the *Code* is concerned with extreme cases in which unusually tall extension ladders (such as would be required in atriums) would be needed to service the devices. In high ceiling space areas, the only method of readily accessing detectors would be by using proper equipment such as high lifts. If special equipment is necessary to install a detection device, the designer should ensure that the owner understands that this special equipment will be needed for future inspection, testing, and maintenance of that device. The accessibility of a detector or other initiating device will ultimately be reflected in the ability of service personnel to perform the required inspection, testing, and maintenance in accordance with Chapter 14 of *NFPA 72*.

13.7.4.1.5 Initiating devices shall be installed in all areas, compartments, or locations where required by other governing laws, codes, or standards. [**72:**17.4.5]

Paragraph 13.7.4.1.5 provides correlation between this *Code*, *NFPA 72*, and other codes and standards. Initiating devices must be used wherever required by another code or standard. Chapter 17 of *NFPA 72* answers the questions relative to how many devices are required and how they should be installed.

13.7.4.1.6 Duct Detector Installation.

13.7.4.1.6.1 Smoke detectors shall be installed, tested, and maintained in accordance with *NFPA 72*. [**90A:**6.4.4.1]

Δ **13.7.4.1.6.2** In addition to the requirements of 6.4.3 of NFPA 90A where an approved fire alarm system is installed in a building, the smoke detectors required by the provisions of Section 6.4 of NFPA 90A shall be connected to the fire alarm system in accordance with the requirements of *NFPA 72*. [**90A:**6.4.4.2]

13.7.4.1.6.2.1 Smoke detectors used solely for closing dampers or for heating, ventilating, and air-conditioning system shutdown shall not be required to activate the building evacuation alarm. [**90A:**6.4.4.2.1]

Δ **13.7.4.1.6.3** Where smoke detectors required by Section 6.4 of NFPA 90A are installed in a building not equipped with an approved fire alarm system as specified by 13.7.4.1.6.2, the following shall occur:

(1) Smoke detector activation required by Section 6.4 of NFPA 90A shall cause a visual and audible signal in a normally occupied area.
(2) Smoke detector trouble conditions shall be indicated visually or audibly in a normally occupied area and shall be identified as air duct detector trouble.

[**90A:**6.4.4.3]

13.7.4.1.6.4 Smoke detectors powered separately from the fire alarm system for the sole function of stopping fans shall not require standby power. [**90A:**6.4.4.4]

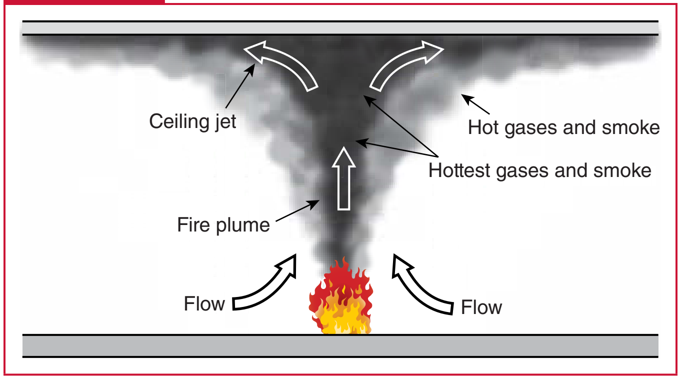
13.7.4.2 Requirements for Smoke and Heat Detectors.

13.7.4.2.1 Recessed Mounting. Unless tested and listed for recessed mounting, detectors shall not be recessed into the mounting surface. [**72:**17.5.1]

Both heat and smoke detectors rely on the flow of the ceiling jet to convey heat and smoke, respectively, to the detectors. Recessing detectors that are not tested and listed for recessed mounting would locate the detector out of the prevailing flow of the ceiling jet and, hence, would have an adverse effect on the detector's ability to perform as intended.

A heat detector must absorb heat from the hot gases of the ceiling jet, as shown in Exhibit 13.45, before it can respond. Approximately 92 percent to 98 percent of the heat that a heat detector receives is carried to the detector in the hot air and combustion product gases of the ceiling jet that are created by

Exhibit 13.45



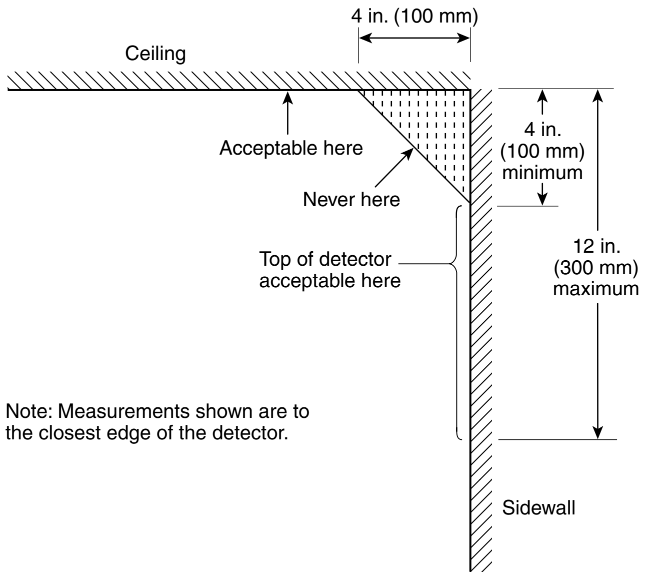
Ceiling jet formed by fire plume.

the fire. This process is called *convection* or *convective heat transfer*. Note that the velocity, temperature, and smoke concentration are not uniform across the thickness of the ceiling jet. At the surface of the ceiling, the ceiling jet moves more slowly due to frictional losses and is slightly cooler due to heat transfer to the ceiling. A heat detector that is recessed is removed from the flow of air; consequently, the quantity of heat it receives per unit of time is reduced. The heat detector's response slows, allowing the fire to grow larger before it is detected. A heat detector also receives a small percentage of radiated heat. If the detector is recessed, less of this radiated heat energy can strike the detector. Consequently, if heat detectors are installed recessed into the ceiling, contrary to the *Code*, the system will likely respond more slowly, if at all, than if the heat detectors are mounted as required by the *Code*.

The effect is the same with smoke detectors. Smoke detectors depend on air movement to convey smoke from the fire to the detector. Usually this air movement is the ceiling jet produced by the fire. Smoke detectors are typically mounted on the ceiling to take advantage of fire plume dynamics and the ceiling jet. However, because of frictional energy loss between the ceiling jet and the ceiling surface, a very thin layer of air immediately beneath the ceiling surface flows more slowly than the layer located a little beneath it. The force that pushes the smoke into the sensing chamber is a function of the ceiling jet velocity. If the velocity at the detector is low, smoke moves into the detector slowly. If a smoke detector is recessed, the more slowly moving air immediately beneath the ceiling surface is the only flow impinging upon the detector. Because a recessed detector is in a no-flow or low-flow location, relative to the ceiling jet, it will be very slow to respond — if it responds at all — compared with the same detector mounted on the ceiling surface.

13.7.4.3 Location.

13.7.4.3.1* Unless otherwise modified by 17.6.3.2.2, 17.6.3.3.2, or 17.6.3.7 of *NFPA 72*, spot-type heat-sensing fire detectors shall be located on the ceiling not less than 4 in. (100 mm) from the sidewall or on the sidewalls between 4 in. and 12 in. (100 mm and 300 mm) from the ceiling. [**72:**17.6.3.1.3.1]



Δ ***FIGURE A.13.7.4.3.1*** *Example of Proper Mounting for Heat Detectors. [**72:** Figure A.17.6.3.1.3.1]*

A.13.7.4.3.1 Figure A.13.7.4.3.1 illustrates the proper mounting placement for detectors. [**72:**A.17.6.3.1.3.1]

Paragraph 13.7.4.3.1 applies only to spot-type heat detectors. A ceiling surface is the upper surface of a space, regardless of height. The ceiling location derives the maximum benefit from the upward flow of the fire plume and the flow of the ceiling jet beneath the ceiling plane. As the ceiling jet approaches the wall, its velocity decreases. Lower ceiling jet velocities result in slower heat transfer to the detector and, therefore, a retarded response. Generally, it is best to keep detectors farther from the wall than the 4 in. (100 mm) minimum distance. In practice, this requirement is also appropriately applied where heat detectors are installed near to downward projecting obstructions such as beams.

The original research data used to support the existence of a "dead air space" where the walls meet the ceiling in a typical room was based on work performed in 1993 [Fire Protection Research Foundation, 1993]. Figure A.13.7.4.3.1 shows this potential dead air space extending 4 in. (100 mm) in from the wall and 4 in. (100 mm) down from the ceiling. More recent work related to smoke detection but not heat detection indicates that this dead air may not exist to the degree originally thought [Fire Protection Research Foundation Report, April 2006]. Since the research has yet to be extended to heat detectors, heat detectors are still excluded from being installed in those areas.

13.7.4.3.2 Unless otherwise modified by 17.6.3.2.2, 17.6.3.3.2, or 17.6.3.7 of *NFPA 72*, line-type heat detectors shall be located on the ceiling or on the sidewalls not more than 20 in. (510 mm) from the ceiling. [**72:**17.6.3.1.3.2]

Line-type heat detectors are generally considered to be equivalent to a row of spot-type detectors for the purposes of spacing and location. However, different manufacturers of line-type detectors have had their products listed with different mounting techniques. The location of line-type detectors must always be in conformance with the manufacturer's installation instructions. Keep in mind that attaching a line-type detector directly to, and in contact with, a structural building component that can absorb heat will retard the response of the detector — the building component will act as a heat sink and retard the increase in detector temperature as a function of time.

13.7.4.3.3* Spot-Type Smoke Detectors.

A.13.7.4.3.3 In high-ceiling areas, such as atriums, where spot-type smoke detectors are not accessible for periodic maintenance and testing, projected beam–type or air sampling–type detectors should be considered where access can be provided. [**72:**A.17.7.3.2]

The importance of accessibility and the maintenance of a smoke detection system cannot be overemphasized. The designer must exercise judgment and discretion to provide a system that can be maintained pursuant to the criteria established in Chapter 14 of *NFPA 72*. Paragraph A.13.7.4.3.3 clarifies 13.7.4.1.4, which requires that all initiating devices, including smoke detectors, be installed in such a manner that they can be effectively maintained.

Atriums and other areas with exceptionally high ceilings (such as auditoriums, gymnasiums, exhibit halls, storage facilities, and some manufacturing facilities) represent difficult situations for the use of spot-type smoke detection. Stratification, maintenance concerns, accessibility for testing, and smoke dissipation may warrant the use of other types of detection. Paragraph A.13.7.4.3.3 advises the designer to consider either air sampling–type or linear projected beam–type photoelectric light obscuration smoke detection as alternatives. However, note that the air-sampling ports of an air sampling–type detector are treated as individual spot-type detectors. Air sampling–type detectors rely on the plume and ceiling jet to carry smoke to the sampling ports. Consequently, where stratification is a concern, this type of detection (air-sampling detectors) might not represent an advantage over traditional spot-type detectors. Furthermore, when stratification is a concern, the beams of projected-beam smoke detection must be carefully located to ensure that the design fire will be detected. Annex B of *NFPA 72* provides additional information on how to predict the elevation of a stratification plane under known conditions.

13.7.4.3.3.1* Spot-type smoke detectors shall be located on the ceiling or, if on a sidewall, between the ceiling and 12 in. (300 mm) down from the ceiling to the top of the detector. [**72:**17.7.3.2.1]

A.13.7.4.3.3.1 Refer to Figure A.13.7.4.3.3.1 for an example of proper mounting for detectors. Sidewall detectors mounted closer to the ceiling will respond faster. [**72:**A.17.7.3.2.1]

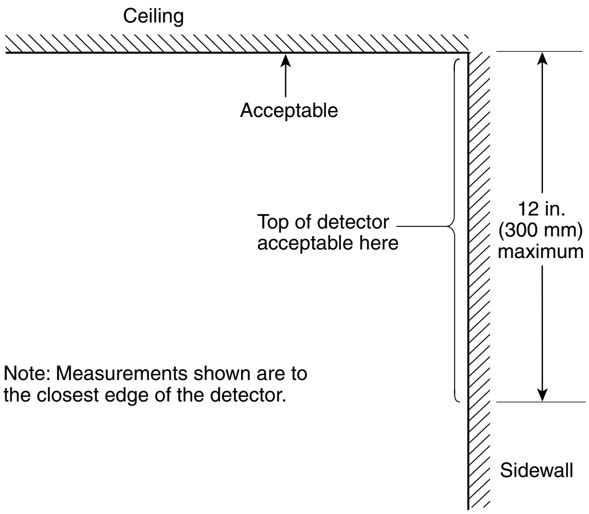


FIGURE A.13.7.4.3.3.1 *Example of Proper Mounting of Smoke Detectors. [**72:** Figure A.17.7.3.2.1]*

Prior to the 2013 edition of *NFPA 72*, ceiling-mounted smoke detectors were not permitted within 4 in. (100 mm) of a sidewall, and sidewall-mounted smoke detectors were not permitted within 4 in. (100 mm) of the ceiling. The concern was that smoke flow would be compromised in a dead-air space in the corner where the ceiling and the wall meet. Computational fluid dynamics simulations have shown smoke flowing into such corners for a range of room geometries and ceiling heights, thereby removing the dead-air space concern. [Note that the 4 in. (100 mm) prohibition still applies to heat detectors. See 13.7.4.3.1.]

The location requirement in 13.7.4.3.3.1 is valid for both a low-energy incipient fire and a high-energy-output fire that is immediately life threatening. Either the normally existing air currents or the fire plume and ceiling jet from the larger fire convey smoke to ceiling-mounted detectors. While the ceiling-wall corner is permitted to be used, it is not the most desirable location. For the detectors to be able to respond, they must be installed in the working air volume of the compartment. A prudent designer should avoid locating detectors in tight corner spaces that may preclude sufficient air flow and circulation of smoke into the detector entry points.

13.7.4.3.3.2* To minimize dust contamination, smoke detectors, where installed under raised floors, shall be mounted only in an orientation for which they have been listed. [**72:**17.7.3.2.2]

A.13.7.4.3.3.2 Figure A.13.7.4.3.3.2 illustrates under-floor mounting installations. [**72:**A.17.7.3.2.2]

The fast-moving air in a data center under-floor space has sufficient energy to suspend dust. As that air enters the detector, it slows down, and the suspended dust settles in the detector. The accumulation of dust within a smoke detector has an effect similar to that of smoke. In an ionization smoke detector, the dust impedes the

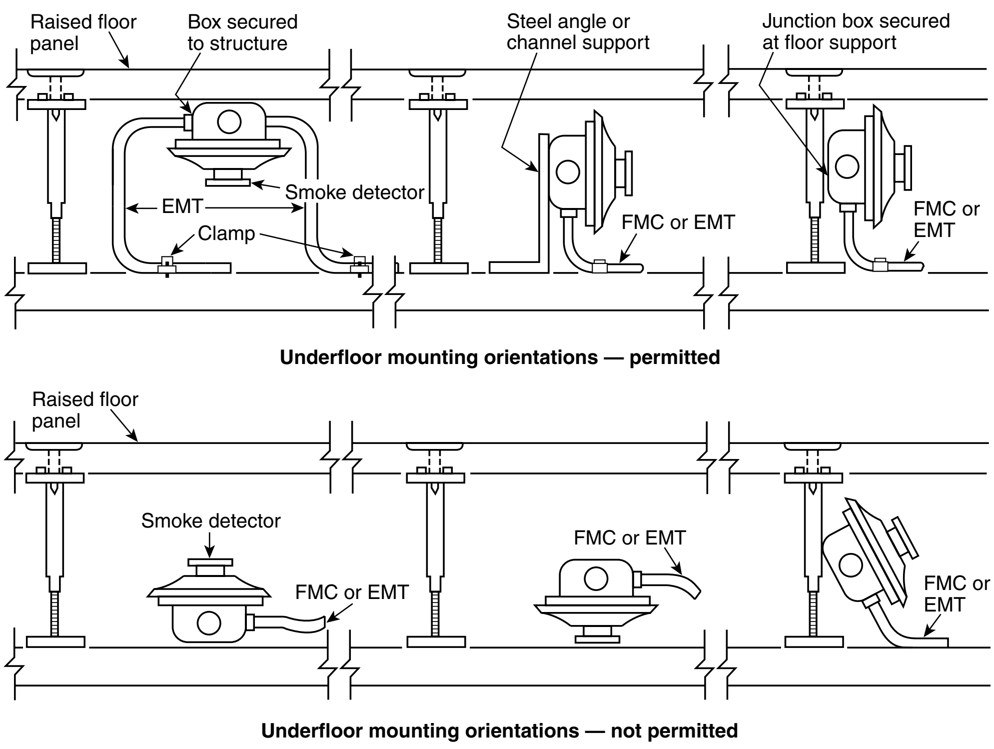


***FIGURE A.13.7.4.3.3.2** Mounting Installations Permitted (**top**) and Not Permitted (**bottom**). [**72:** Figure A.17.7.3.2.2]*

flow of current within the chamber. In a spot-type photoelectric detector, the dust increases the reflectance within the chamber. Thus, dust causes each type of detector to become more sensitive, increasing the likelihood of unwarranted alarms. The permitted orientations shown in Figure A.13.7.4.3.3.2 (top) minimize the probability of dust falling into the detector from the floor and also minimize the effect of air-conveyed dust on the detector.

Other concerns reinforce the benefits of positioning detectors as shown in Figure A.13.7.4.3.3.2 (top). The detector is placed in the upper half of the under-floor volume. Because the purpose of the under-floor space is to allow for the routing of cables between machines, the floor is usually covered with cable. This cable has the same effect on the flow of air in the under-floor volume that joists have on airflow in a room. The cables create turbulence and force the flow to be concentrated in the upper half of the under-floor volume. Placing the detector in the upper half of the under-floor volume improves the system's ability to respond to an early-stage fire.

Another reason for positioning detectors as shown in Figure A.13.7.4.3.2.2 (top) is that detectors mounted in the upper half of the under-floor volume are far less likely to be damaged as new cables are installed or old cables are rerouted through the under-floor space. Where water-cooled computers are in use, the detectors are less likely to become wet if the computer cooling system leaks. Also, when air is not flowing, the detectors will be in the best orientation for detection. Finally, Figure A.13.7.4.3.2.2 (top) shows the detectors in the orientation for which they have been tested and listed.

13.7.4.3.3.3 On smooth ceilings, spacing for spot-type smoke detectors shall be in accordance with 13.7.4.3.3.3.1 through 13.7.4.3.3.3.4. [**72:**17.7.3.2.3]

Δ **13.7.4.3.3.3.1*** In the absence of specific performance-based design criteria, one of the following requirements shall apply:

(1) The distance between smoke detectors shall not exceed a nominal spacing of 30 ft (9.1 m) and there shall be detectors within a distance of one-half the nominal spacing, measured at right angles from all walls or partitions extending upward to within the top 15 percent of the ceiling height.

(2)* All points on the ceiling shall have a detector within a distance equal to or less than 0.7 times the nominal 30 ft (9.1 m) spacing (0.7 *S*).

[**72:**17.7.3.2.3.1]

Δ **A.13.7.4.3.3.3.1** The 30 ft (9.1 m) spacing is a guide for prescriptive designs. The use of such a spacing is based upon customary practice in the fire alarm community. [**72:**A.17.7.3.2.3.1]

Where there are explicit performance objectives for the response of the smoke detection system, the performance-based design methods outlined in Annex B of *NFPA 72* should be used. [**72:**A.17.7.3.2.3.1]

For the purposes of this section, "nominal 30 ft (9.1 m)" should be determined to be 30 ft (9.1 m) ±5 percent [±18 in. (460 mm)]. [**72:**A.17.7.3.2.3.1]

According to the listing investigations performed on smoke detectors, no full-scale fire test establishes a listed spacing for smoke detectors. One reason is because a sufficiently explicit response criterion against which a smoke detector can be measured has not been established. However, experience has shown that installing smoke detectors using a nominal 30 ft (9.1 m) spacing criterion achieves the necessary life safety objectives. Where the owner and other relevant stakeholders have objectives other than life safety or are applying a performance-based design, a different spacing criterion might be appropriate. That criterion could be developed using the performance-based methods outlined in Annex B of *NFPA 72* or other acceptable methods. It is not intended that enforcement authorities measure smoke detector to–smoke detector spacings with critical precision. The nominal plus or minus 5 percent criterion set forth in 13.7.4.3.3.3.1 is intended to provide some latitude in enforcement. The development of a fire and the extension of smoke through a real space are highly variable. A difference in smoke detector spacing of as much as 2 or 3 ft (0.61 to 0.91 m) will have no material effect on the ultimate performance of the system.

Δ **A.13.7.4.3.3.3.1(2)** This is useful in calculating locations in corridors or irregular areas *[see 17.6.3.1.1 of NFPA 72 and Figure A.17.6.3.1.1(h) of NFPA 72]*. For irregularly shaped areas, the spacing between detectors can be greater than the selected spacing, provided the maximum spacing from a detector to the farthest point of a sidewall or corner within its zone of protection is not greater than 0.7 times the selected spacing (0.7*S*). [**72:**A.17.7.3.2.3.1(2)]

13.7.4.3.3.3.2 In all cases, the manufacturer's published instructions shall be followed. [**72:**17.7.3.2.3.2]

When a manufacturer, through its own testing and research program, publishes a specific spacing recommendation that is different from the 30 ft (9.1 m) spacing, that spacing recommendation becomes an enforceable part of this *Code*.

13.7.4.3.3.3.3 Other spacing shall be permitted to be used depending on ceiling height, different conditions, or response requirements. [**72:**17.7.3.2.3.3]

In the prescriptive design environment, a spacing other than 30 ft (9.1 m) can be used, provided that the justification for doing so is based on the fire dynamics, environment, compartment dimensions, and response objectives. The criteria imply, but do not explicitly require, a formal design process such as that required by 17.7.1.3 of *NFPA 72*. The designer should document the basis for selecting a spacing other than 30 ft (9.1 m), and that document should become a permanent part of the project file. Finally, the spacing selected will be subject to review and approval by the relevant AHJ.

13.7.4.3.3.3.4 For the detection of flaming fires, the guidelines in Annex B of *NFPA 72* shall be permitted to be used. [**72:**17.7.3.2.3.4]

Currently, no computational models are designed to develop predictions of smoke flow for nonflaming fires. Where the design objective is the detection of a smoldering fire, the designer should model ambient compartment air currents and the power commitment to them to determine to what extent they will dominate the flow of smoke.

Two analytical methods are provided in Annex B of *NFPA 72*. Because these methods rely on plume and ceiling jet dynamics, their use must be limited to scenarios involving flaming fires that produce a buoyant plume. For smoldering fire scenarios, other methods must be used until open flaming commences, after which the methods of Annex B of *NFPA 72* can be used.

Several available computer models (including FPETool, FastLite, and Hazard 1) predict smoke detector activation to the flaming fire scenario. However, it must be noted that these computer models use a temperature rise model, not optical density or mass density of smoke, to predict the activation of smoke detectors. Their credibility is limited by the validity of the temperature correlation plugged into the model for smoke detector response.

In this regard, the research paper *Fire Detection Modeling, State of the Art*, by Robert P. Schifiliti and William E. Pucci, analyzes the various ways the computer fire models predict smoke detector operation and points out the advantages and disadvantages of each method.

Fire Dynamics Simulator (FDS), a computational fluid dynamics model, has become popular for modeling the flow of smoke and fire plumes in rooms and buildings. However, this computer model is not simple to operate and requires considerable skill to generate reliable simulations. FDS tracks mass, velocity, and temperature. Users of the FDS model must, again, set numerical values for these parameters, which are then used to infer smoke detector activation.

13.7.4.3.3.4* For solid joist and beam construction, spacing for spot-type smoke detectors shall be in accordance with 13.7.4.3.3.4.1 through 13.7.4.3.3.4.5. [**72:**17.7.3.2.4]

A.13.7.4.3.3.4 Detectors are placed at reduced spacings at right angles to joists or beams in an attempt to ensure that detection time is equivalent to that which would be experienced on a flat ceiling. It takes longer for the combustion products (smoke or heat) to travel at right angles to beams or joists because of the phenomenon wherein a plume from a relatively hot fire with significant thermal lift tends to fill the pocket between each beam or joist before moving to the next beam or joist. [**72:**A.17.7.3.2.4]

Though it is true that this phenomenon might not be significant in a small smoldering fire where there is only enough thermal lift to cause stratification at the bottom of the joists, reduced spacing is still recommended to ensure that detection time is equivalent to that which would exist on a flat ceiling, even in the case of a hotter type of fire. [**72:**A.17.7.3.2.4]

13.7.4.3.3.4.1 Solid joists shall be considered equivalent to beams for smoke detector spacing guidelines. [**72:**17.7.3.2.4.1]

When the rules in 13.7.4.3.3.4 for the spacing of spot-type smoke detectors are applied, solid joists and solid beams are treated the same. At the fire sizes normally associated with the response of a smoke detection system, the ceiling jet velocities are relatively low and produce less turbulence at the beam and joist bottoms. Consequently, the effects of beams and joists on the ceiling jet flow are expected to be essentially the same.

13.7.4.3.3.4.2 For level ceilings, the following shall apply:

(1) For ceilings with beam depths of less than 10 percent of the ceiling height (0.1 *H*), smooth ceiling spacing shall be permitted. Spot-type smoke detectors shall be permitted to be located on ceilings or on the bottom of beams.

Because the thickness of the ceiling jet is generally taken to be equal to the upper 10 percent of the floor-to-ceiling height, beams and joists extending down a depth of less than this thickness are not expected to have a significant effect on the response time of the smoke detector, especially in view of the fact that the farthest a detector should be from the fire is 0.7 times the 30 ft (9.1 m) spacing. Consequently, the *Code* permits the designer to use smooth ceiling spacing where the beams and joists extend less than 10 percent of the floor-to-ceiling height down from the ceiling surface, regardless of the beam spacing. Detectors can be located on either the ceiling or the bottom of the beam. Also see 13.7.4.3.3.4.6 where applicable. Refer to Exhibit 13.46.

(2) For ceilings with beam depths equal to or greater than 10 percent of the ceiling height (0.1 *H*), the following shall apply:
   (a) Where beam spacing is equal to or greater than 40 percent of the ceiling height (0.4 *H*), spot-type detectors shall be located on the ceiling in each beam pocket.
   (b) Where beam spacing is less than 40 percent of the ceiling height (0.4 *H*), the following shall be permitted for spot detectors:
      (i) Smooth ceiling spacing in the direction parallel to the beams and at one-half smooth ceiling spacing in the direction perpendicular to the beams
      (ii) Location of detectors either on the ceiling or on the bottom of the beams

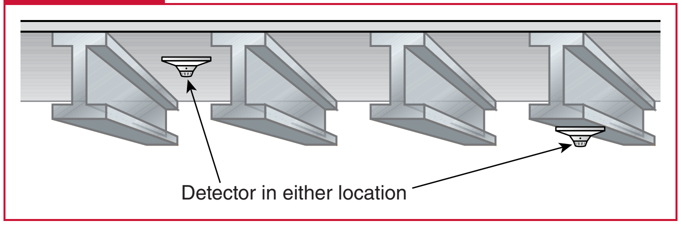
Where the beams extend down from a level ceiling more than 10 percent of the floor-to-ceiling height (0.1 *H*), they are expected to obstruct the ceiling jet flow. The obstruction of the ceiling jet delays the arrival of the smoke at the detector location. Furthermore, the speed with which smoke enters the sensing chamber of the detector is controlled by the speed of the ceiling jet past the detector. When ceiling jet flow is obstructed, it flows more slowly, increasing the smoke entry time once it arrives at the detector location.

Since it is generally accepted that the smoke plume from the fire will diverge at a nominal 22 degrees from the vertical axis, the plume will cover an area on the ceiling equal to 40 percent of the floor-to-ceiling height (0.4 *H*). Where the beam spacing exceeds 40 percent of the floor-to-ceiling height, the entire plume can be surrounded by beams. See Exhibit 13.47. If a smoke detector is not located in the bay created by the beams, the entire bay must fill with smoke before there is fill-and-spill propagation to an adjacent bay where a smoke detector might be located. This phenomenon will result in a delayed response. In the case where the beams are *both* equal to or more than 10 percent of the floor-to-ceiling height in depth *and* spaced equal to or more than 40 percent of the floor-to-ceiling height, a detector must be installed in each beam pocket.

Where the beams are greater than 10 percent of the floor-to-ceiling height and are spaced less than 40 percent of the floor-to-ceiling height, the plume will fill more than one bay, regardless of where the plume is located relative to the beams. The presence of the beams will retard the flow of the ceiling jet in the direction perpendicular to the beams and channel the flow in the direction parallel to the beams. See Exhibit 13.48.

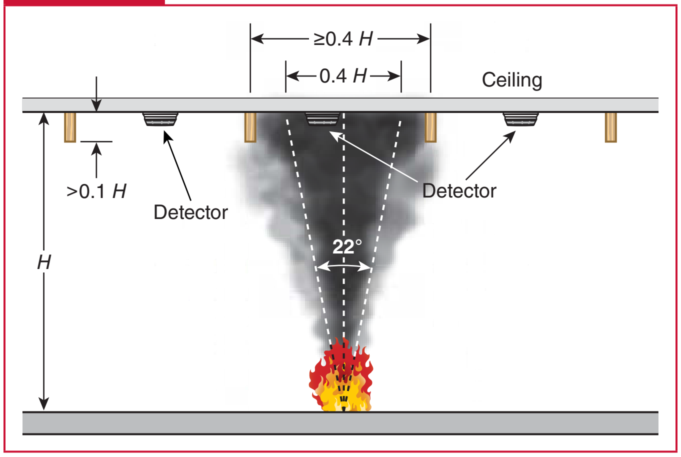
(3)* For beam pockets formed by intersecting beams, including waffle or pan-type ceilings, the following shall apply:
   (a) For beam depths less than 10 percent of the ceiling height (0.1 *H*), spacing shall be in accordance with 13.7.4.3.3.4.2(1).
   (b) For beam depths greater than or equal to 10 percent of the ceiling height (0.1 *H*), spacing shall be in accordance with 13.7.4.3.3.4.2(2)(2).

Exhibit 13.46



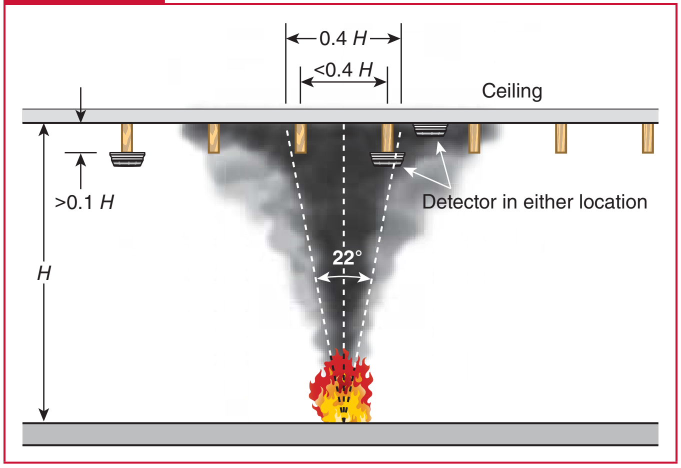
Smoke detector spacing with beams less than 0.1 H.

Exhibit 13.47



Smoke detector spacing with beam depths greater than 0.1 H and spaced more than 0.4 H.

Exhibit 13.48



Smoke detector spacing with beam depths greater than 0.1 H and spaced less than 0.4 H.

A.13.7.4.3.3.4.2(3) The geometry and reservoir effect is a significant factor that contributes to the development of velocity, temperature, and smoke obscuration conditions at smoke detectors located on the ceiling in beam pocket areas or at the bottom of beams as smoke collected in the reservoir volume spills into adjacent pockets. The waffle- or pan-type ceiling created by beams or solid joists, although retarding the initial flow of smoke, results in increased optical density, temperature rise, and gas velocities comparable to unconfined smooth ceilings. [**72:**A.17.7.3.2.4.2(3)]

For waffle- or pan-type ceilings with beams or solid joists, an alternative smoke detector grid arrangement (such as a shifted grid), with detectors located to take advantage of the channeling effect due to the reservoirs created by the beam pockets, will improve detector response and might allow greater spacing. See Figure A.13.7.4.3.3.4.2(3)(a) and Figure A.13.7.4.3.3.4.2(3)(b) for an example of shifted grids. The alternative smoke detector grid arrangement and spacing should be justified by an engineering analysis comparing the alternative smoke detector grid arrangement with the performance of smoke detectors on a level ceiling of equal height using 30 ft (9.1 m) smoke detector spacing. [**72:**A.17.7.3.2.4.2(3)]

Figure A.13.7.4.3.3.4.2(3)(a) illustrates the reservoir and channeling effect that results from the deep beam configuration. The strongest gas flows occur in a direction perpendicular to the beam opposite the fire location. The weaker flow occurs in a directional 45 degrees off the beam grid; however, the reservoir effect accounts for higher concentrations of smoke eventually flowing from the strong area reservoirs into the weak area reservoirs. [**72:**A.17.7.3.2.4.2(3)]

Figure A.13.7.4.3.3.4.2(3)(b) is a generic example illustrating how a smoke detection grid using 30 ft (9.1 m) spacing can be shifted to take advantage of the channeling and reservoir effect to optimize detection response. In the circle, the fire is split into four beam bays that must fill with smoke before appreciable flows occur into the next adjoining eight beam bays. This represents the worst case scenario for smoke to reach the detectors on the circle. The three other fire locations shown require the fire to initially fill only one or two bays before spilling to adjacent bays. [**72:**A.17.7.3.2.4.2(3)]

(4)* For corridors 15 ft (4.6 m) in width or less having ceiling beams or solid joists perpendicular to the corridor length, the following shall apply:
  (a) Smooth ceiling spacing shall be permitted.
  (b) Location of spot-type smoke detectors on ceilings, sidewalls, or the bottom of beams or solid joists

A.13.7.4.3.3.4.2(4) Corridor geometry is a significant factor that contributes to the development of velocity, temperature, and smoke obscuration conditions at smoke detectors located along a corridor. This is based on the fact that the ceiling jet is confined or constrained by the nearby walls without opportunity for entrainment of air. For corridors of approximately 15 ft (4.6 m) in width and for fires of

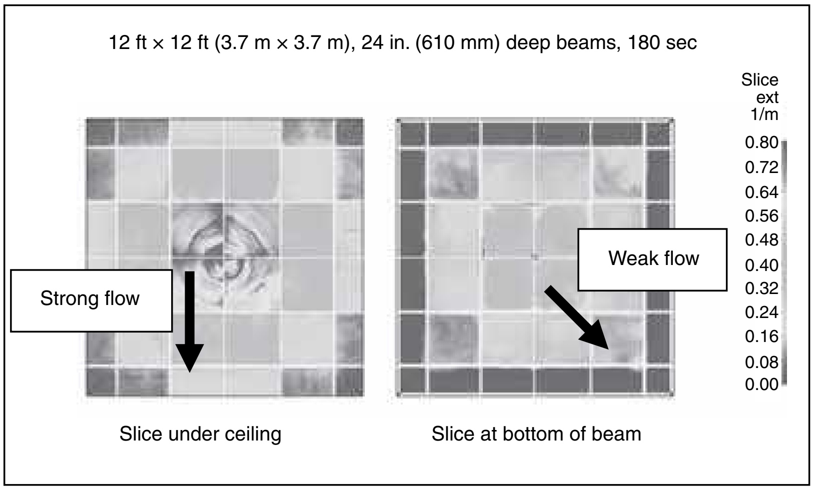


FIGURE A.13.7.4.3.3.4.2(3)(a) *Reservoir and Channeling Effect of Deep Beams. [72: Figure A.17.7.3.2.4.2(3)(a)]*

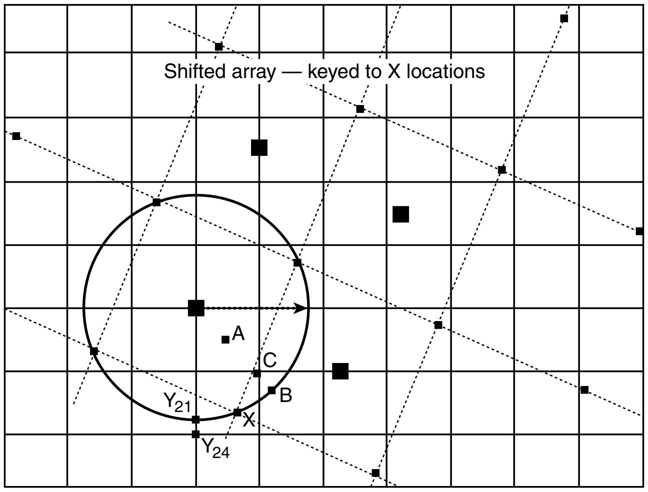


FIGURE A.13.7.4.3.3.4.2(3)(b) Shifted Smoke Detection Grid to Optimize Detection for Deep Beam Effects. [72: Figure A.17.7.3.2.4.2(3)(b)]

approximately 100 kW or greater, modeling has demonstrated that the performance of smoke detectors in corridors with beams has been shown to be comparable to spot smoke detector spacing on an unconfined smooth ceiling surface. [**72:**A.17.7.3.2.4.2(4)]

(5) For rooms of 900 ft² (84 m²) or less, the following shall be permitted:
   (a) Use of smooth ceiling spacing
   (b) Location of spot-type smoke detectors on ceilings or on the bottom of beams

[**72:**17.7.3.2.4.2]

Where smoke detectors are installed in a room of only 900 ft² (84 m²), the small floor constrains the ceiling jet such that even where ceiling beams are present, the fire can be detected sufficiently early to achieve the objective. Where other objectives demand more rapid response, performance-based design methods should be employed.

It is not the intent of 13.7.4.3.3.4.2(5) that the 900 ft² (84 m²) be applied to 5 ft (1.5 m) wide passageways 180 ft (54.9 m) in length, 10 ft (3.1 m) wide corridors 90 ft (27.4 m) in length, or other compartments where the fire hazard and risk are nominally equivalent to the rest of the normally occupied portion of the building. Item (a) requires the use of smooth spacing; see 13.7.4.3.3.3.1.

Δ **13.7.4.3.3.4.3*** For sloping ceilings with beams running parallel up slope, the following shall apply:

(1) Spot-type detector(s) shall be located on the ceiling within beam pocket(s).
(2) The ceiling height shall be taken as the average height over slope.
(3) Spacing shall be measured along a horizontal projection of the ceiling.
(4) Smooth ceiling spacing shall be permitted within beam pocket(s) parallel to the beams.
(5) For beam depths less than or equal to 10 percent of the ceiling height (0.1 *H*), spot-type detectors shall be located with smooth ceiling spacing perpendicular to the beams.
(6) For beam depths greater than 10 percent of the ceiling height (0.1 *H*), the following shall apply for spacing perpendicular to the beams:
   (a) For beam spacing greater than or equal to 40 percent of the ceiling height (0.4 *H*), spot-type detectors shall be located in each beam pocket.
   (b) For beam spacing less than 40 percent of the ceiling height (0.4 *H*), spot-type detectors shall not be required in every beam pocket but shall be spaced not greater than 50 percent of smooth ceiling spacing.

[**72:**17.7.3.2.4.3]

The term *sloping ceiling* is defined in *NFPA 72* as "a ceiling that has a slope of more than 1 in 8." A slope of 1 in 8 corresponds to a rise-over-run ratio of 0.125, or an angle of about 7.2 degrees. Any slope less than or equal to 1 in 8 is deemed to be equivalent to a level ceiling. Beams that are parallel to the slope are perpendicular to the ridge beam of the roof. (Beams that are perpendicular to the slope are parallel to the ridge beam.)

The concept behind these design requirements is analogous to those regarding heat detectors. When a buoyant plume from a flaming fire impinges on a sloped ceiling, it will progress rapidly upward toward the ridge beam. The buoyancy of the ceiling jet gases accelerates the ceiling jet up the slope. This acceleration provides for faster response by detectors that are up-slope from the fire. Computer-based computational fluid dynamics (CFD) modeling demonstrate that the beams are very effective in channeling the smoke in the beam channel up the slope to the peak of the roof. This rapid upward flow reduces the lateral flow parallel to the ridge beam.

A.13.7.4.3.3.4.3 A smoke detector should be placed within each beam channel. Computer modeling has shown that parallel beams (upslope) are very effective at channeling smoke, and smoke spillover is rarely detectable in adjacent parallel pockets. [**72:**A.17.7.3.2.4.3]

Δ **13.7.4.3.3.4.4*** For sloping ceilings with beams running perpendicular across slope, the following shall apply:

(1) Spot-type detector(s) shall be located at the bottom of the beams.
(2) The ceiling height shall be taken as the average height over slope.
(3) Spacing shall be measured along a horizontal projection of the ceiling.
(4) Smooth ceiling spacing shall be permitted within beam pocket(s).
(5) For beam depths less than or equal to 10 percent of the ceiling height (0.1 *H*), spot-type detectors shall be located with smooth ceiling spacing.

(6) For beam depths greater than 10 percent of the ceiling height (0.1 *H*), spot-type detectors shall not be required to be located closer than (0.4 *H*) and shall not exceed 50 percent of smooth ceiling spacing.

[**72:**17.7.3.2.4.4]

Beams that are perpendicular to the slope are parallel to the ridge beam. These beams form dams that prevent the smoke from flowing up the ceiling slope toward the ridge beam. When the smoke encounters a beam running across the slope, the ceiling jet will begin forming a smoke layer. Smoke will flow laterally as the depth of the smoke layer increases. Eventually, the smoke layer will become deep enough to spill over the beam and begin filling the next bay. This process is a much slower propagation than when the beams run up the slope. However, the damming effect of the beams will tend to channel smoke across the roof, parallel to the beams. The spacing adjustments in this section are the result of a detailed analysis of the computer-based CFD modeling research that was conducted to investigate this issue.

A.13.7.4.3.3.4.4 Irregular area spacing guidance for level beam ceilings can be used. Computer modeling has shown that spot-type detectors should be located on the bottom of perpendicular beams. [**72:**A.17.7.3.2.4.4]

Δ **13.7.4.3.3.4.5*** For sloped ceilings with beam pockets formed by intersecting beams, the following shall apply:

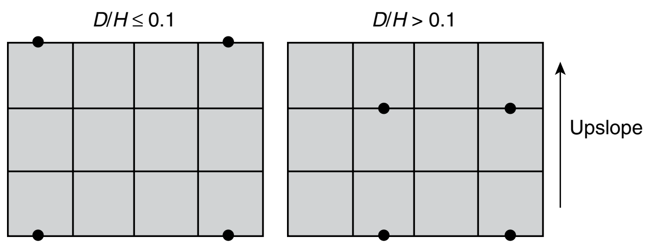
(1) Spot-type detector(s) shall be located at the bottom of the beams.
(2) The ceiling height shall be taken as the average height over slope.
(3) Spacing shall be measured along a horizontal projection of the ceiling.
(4) For beam depths less than or equal to 10 percent of the ceiling height (0.1 *H*), spot-type detectors shall be spaced with not more than three beams between detectors and shall not exceed smooth ceiling spacing.
(5) For beam depths greater than 10 percent of the ceiling height (0.1 *H*), spot-type detectors shall be spaced with not more than two beams between detectors, but shall not be required to be spaced closer than (0.4 *H*), and shall not exceed 50 percent of smooth ceiling spacing.

[**72:**17.7.3.2.4.5]

A.13.7.4.3.3.4.5 Computer modeling has shown that spot-type detectors should be located on the bottom of perpendicular beams and should be aligned with the center of pocket, as shown, in Figure A.13.7.4.3.3.4.5. [**72:**A.17.7.3.2.4.5]

13.7.4.3.3.4.6 For sloped ceilings with solid joists, the detectors shall be located on the bottom of the joist. [**72:**17.7.3.2.4.6]

The relatively small volume of the channel between joists results in smoke filling this volume quickly. Once the channel is filled, the smoke flows across the bottom of the joists. Locating smoke detectors at the bottom of the joist places them where the dominant flow of smoke is expected to occur. Paragraph 13.7.4.3.3.4.1 specifies that solid joists be treated as beams for smoke detector spacing guidelines. However, where the beams are actually joists, that is, greater than 4 in. (100 mm) in depth and on centers 3.0 ft (0.9 m) or less, the detectors must be placed on the bottoms of the joists. Keep in mind that bar joists or open web beams do not affect smoke flow unless the top plate exceeds 4 in. (100 mm) in depth.



Δ ***FIGURE A.13.7.4.3.3.4.5*** *Spot-Type Detector Spacing for Sloping Ceilings with Beam Pockets.* *[72: Figure A.17.7.3.2.4.5]*

13.7.4.3.4 Air Sampling–Type Smoke Detector.

The term *air sampling–type detector*, addressed in 13.7.4.3.4, is defined in 3.3.87.1. These detectors use one or more sampling tubes and draw a sample of air from the hazard area to the detector, where the presence of visible smoke or invisible combustion products is identified. These detectors include a number of cloud chamber–type smoke detectors and several varieties of high sensitivity, photoelectric-type smoke detectors. Air sampling–type smoke detectors consist of a sampling pipe network, an aspirating fan, and a highly sensitive centralized detector.

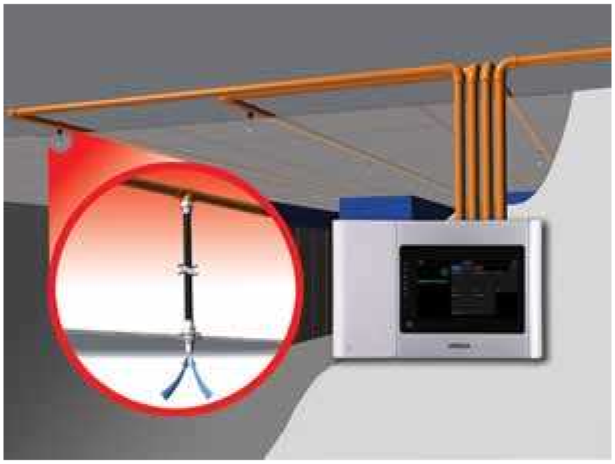
Air sampling–type detectors are used in a variety of applications where the designer is concerned with very early smoke detection and where increased sensitivity is needed to meet the owner's fire protection goals. Because of their sensitivity range flexibility, air-sampling detectors are often used in areas that house valuable equipment as well as conventional settings that do not require high sensitivity. See Exhibit 13.49 through Exhibit 13.52 for examples of air sampling–type smoke detectors.

13.7.4.3.4.1 Each sampling port of an air sampling–type smoke detector shall be treated as a spot-type detector for the purpose of location and spacing. [**72:**17.7.3.6.1]

The International Fire Detection Research Project showed that the sampling port does not produce the effect of drawing the smoke up to the sampling port from lower down in the compartment. Air sampling–type detectors used to protect rooms and other large compartments rely on either ambient air currents or the fire plume and ceiling jet as much as do spot-type smoke detectors.

13.7.4.3.4.2 Maximum air sample transport time from the farthest sampling port to the detector shall not exceed 120 seconds. [**72:**17.7.3.6.2]

Exhibit 13.49



Use of sampling tubes to convey smoke-laden air to the central detection unit of an air-sampling detector. (Courtesy of Xtralis, Inc., Norwell, MA)

The air transport time criterion places an effective limit on the design of the fan and the maximum distance from the detector to the farthest sampling port, as well as the size and layout of the sampling pipes. The manufacturer's listing and instructions provide the details on how the particular product must be used in order to comply with this limitation. Some air sampling–type smoke detectors have a means to detect changes in airflow, which provides some measure of monitoring the integrity of the piping network.

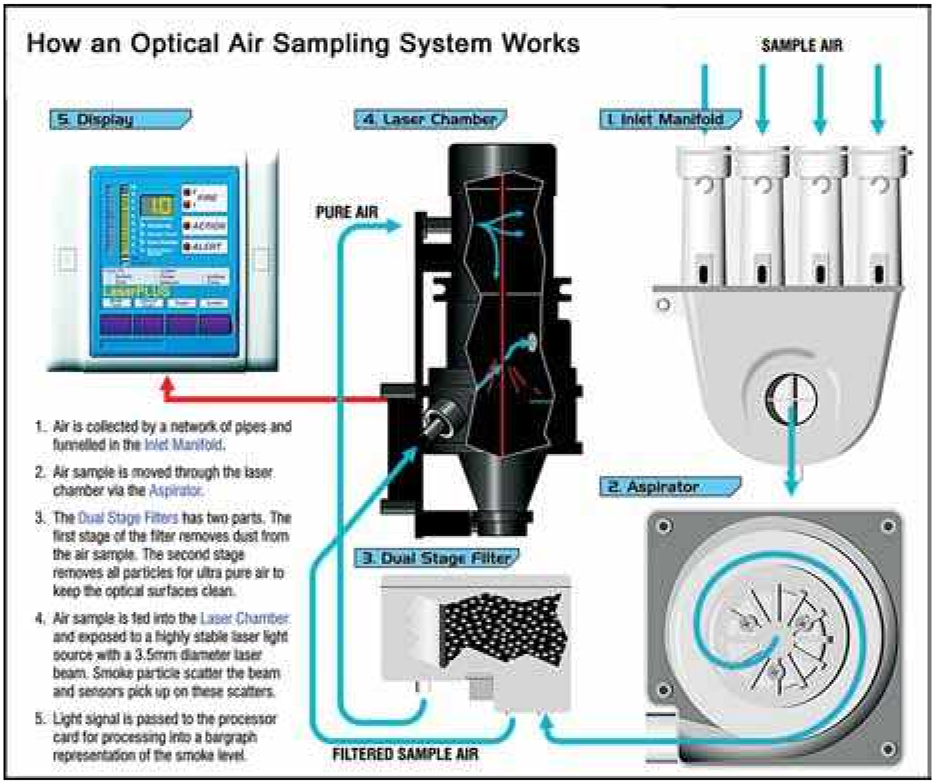
13.7.4.3.4.3* Sampling pipe networks shall be designed on the basis of, and shall be supported by, sound fluid dynamic principles to ensure required performance. [**72:**17.7.3.6.3]

A.13.7.4.3.4.3 A single-pipe network has a shorter transport time than a multiple-pipe network of similar length pipe; however, a multiple-pipe system provides a faster smoke transport time than a single-pipe system of the same total length. As the number of sampling holes in a pipe increases, the smoke transport time increases. Where practicable, pipe run lengths in a multiple-pipe system should be nearly equal, or the system should be otherwise pneumatically balanced. [**72:**A.17.7.3.6.3]

13.7.4.3.4.4 Sampling pipe network design details shall include calculations showing the flow characteristics of the pipe network and each sample port. [**72:**17.7.3.6.4]

The transport time is determined by flow calculations. Flow calculations provide the only way to be certain that sufficient pressure and flow volume are available at all the sampling ports and that the air sampling–type detector will provide detection over the entire area it is to cover.

Exhibit 13.50



How an optical air-sampling system works. (Courtesy of Xtralis, Inc., Norwell, MA)

Exhibit 13.51

Air sampling–type smoke detectors. (Courtesy of Xtralis, Inc., Norwell, MA)

Exhibit 13.52

Air sampling–type smoke detector with cover removed. (Courtesy of Fenwal Protection Systems, Ashland, MA)

13.7.4.3.4.5 Air-sampling detectors shall give a trouble signal if the airflow is outside the manufacturer's specified range. [**72:**17.7.3.6.5]

The detection of a flow rate outside the manufacturer's design range is indicative of a failure of the physical integrity of the sampling pipes. This requirement is analogous to the requirement for monitoring for integrity of the initiating device circuit wiring.

13.7.4.3.4.6* The sampling ports and in-line filter, if used, shall be kept clear in accordance with the manufacturer's published instructions. [**72:**17.7.3.6.6]

A.13.7.4.3.4.6 The air sampling–type detector system should be able to withstand dusty environments by air filtering, electronic discrimination of particle size, or other listed methods or combinations thereof. The detector should be capable of providing optimal time delays of alarm outputs to eliminate nuisance alarms due to transient smoke conditions. The detector should also provide facilities for the connection of monitoring equipment for the recording of background smoke level information necessary in setting alert and alarm levels and delays. [**72:**A.17.7.3.6.6]

Dust from the protected space can cause clogging of the sampling pipes as well as the sampling ports of those makes of detectors that employ a filter at the sampling port. Both clogging and filter loading can lead to reduced sampling flow from the affected portions of the sampling network.

13.7.4.3.4.7 Air-sampling network piping and fittings shall be airtight and permanently fixed. [**72:**17.7.3.6.7]

Although Article 760 of *NFPA 70* has detailed criteria for detection system wiring, no national consensus standards are published for sampling tube installation. Each manufacturer makes its own recommendations that establish the minimum compliance criteria for that product. The integrity of the sampling tube network is just as important to the air sampling–type detector as the integrity of the wiring is to the spot-type smoke detector. The installation methods used for air-sampling tubing should provide equivalent security and mechanical protection.

Δ **13.7.4.3.4.8** Sampling system piping shall be conspicuously identified as "SMOKE DETECTOR SAMPLING TUBE — DO NOT DISTURB," as follows:

(1) At changes in direction or branches of piping
(2) At each side of penetrations of walls, floors, or other barriers
(3) At intervals on piping that provide visibility within the space, but no greater than 20 ft (6.1 m)

[**72:**17.7.3.6.8]

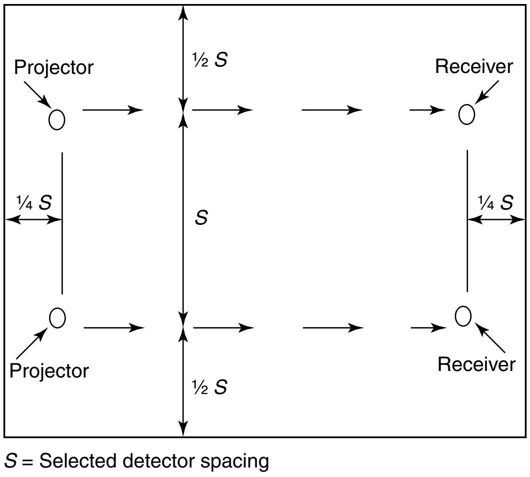
Numerous building systems are often installed in the above-ceiling space. If the sampling piping is damaged by some other trade at a later time, a break in the air-sampling detector piping could result in the detector sampling the above-ceiling air rather than the air beneath the ceiling plane, as intended. This potentiality necessitates that tubing be clearly marked in a manner that will endure for the lifetime of the unit.

13.7.4.3.5* Projected Beam–Type Smoke Detectors.

A.13.7.4.3.5 On smooth ceilings, a spacing of not more than 60 ft (18.3 m) between projected beams and not more than one-half that spacing between a projected beam and a sidewall (wall parallel to the beam travel) should be used as a guide. Other spacing should be determined based on ceiling height, airflow characteristics, and response requirements. [**72:**A.17.7.3.7]

In some cases, the light beam projector is mounted on one end wall, with the light beam receiver mounted on the opposite wall. However, it is also permitted to suspend the projector and receiver from the ceiling at a distance from the end walls not exceeding one-quarter the selected spacing (S). *(See Figure A.13.7.4.3.5.)* [**72:**A.17.7.3.7]

13.7.4.3.5.1 Projected beam–type smoke detectors shall be located in accordance with the manufacturer's published instructions. [**72:**17.7.3.7.1]



Δ ***FIGURE A.13.7.4.3.5*** *Maximum Distance at Which Ceiling-Suspended Light Projector and Receiver Can Be Positioned from End Wall Is One-Quarter Selected Spacing* ***(S)****.* *[**72:**Figure A.17.7.3.7]*

Each make and model of linear projected beam–type smoke detector has specific installation limitations as well as performance capabilities. Most notable of these limitations are the maximum and minimum beam lengths. The designer should make certain that the contemplated installation is consistent with the criteria established in the published installation instructions of the product the designer plans to use. It should be noted that the spacing criteria noted in Figure A.13.7.4.3.5 are general examples and that the actual spacing requirements will be dependent on the technology of the beam detector and the performance standards applied by the listing authority.

13.7.4.3.5.2 The effects of stratification shall be evaluated when locating the detectors. [**72:**17.7.3.7.2]

As with other types of smoke detection, the location selected for detectors must account for the effects of stratification. In high-ceiling areas where stratification is probable and a serious concern, detectors can be positioned at several levels. Alternatively, the methods in Annex B of *NFPA 72* can be used to calculate the plume divergence at the detector mounting height. The plume width at the detector mounting height can then be used as the spacing between adjacent beams in a performance-based design.

13.7.4.3.5.3 The beam length shall not exceed the maximum permitted by the equipment listing. [**72:**17.7.3.7.3]

Linear projected beam–type smoke detectors have limitations on both the minimum and maximum beam length over which they will operate properly. The minimum beam length limitation is established by the lowest smoke concentration that can be detected at that minimum beam length. The maximum beam length is determined by the maximum distance at which the detector can maintain its design stability, even when some normal light obscuration is present. The projected beam–type smoke detector must be able to identify a low concentration of smoke distributed along a substantial portion of the beam and a high concentration of smoke localized in a short segment of the beam. Each manufacturer obtains a listing from a qualified testing laboratory that sets the upper and lower limits on the beam length. Failure to observe these limits could result in an unstable detector or the failure to detect a fire consistent with the performance objectives.

13.7.4.3.5.4 If mirrors are used with projected beams, the mirrors shall be installed in accordance with the manufacturer's published instructions. [**72:**17.7.3.7.4]

Mirrors used with linear projected beam–type smoke detectors must also be listed for use with the detector.

13.7.4.3.5.5 A projected beam–type smoke detector shall be considered equivalent to a row of spot-type smoke detectors for level and sloping ceiling applications. [**72:**17.7.3.7.5]

Given the similarities between the installation and spacing concepts developed for line-type heat detectors and projected beam–type smoke detectors, the logic behind the design requirements remains consistent. When spacing strategies are being developed, a linear projected beam–type detector can be thought of as equivalent to a row of spot-type smoke detectors, much like how a line-type heat detector can be thought of as a row of spot-type heat detectors. The distance between the linear projected beams is analogous to the distance between rows of spot-type smoke detectors.

13.7.4.3.5.6 Projected beam–type detectors and mirrors shall be mounted on stable surfaces to prevent false or erratic operation due to movement. [**72:**17.7.3.7.6]

13.7.4.3.5.7 The beam shall be designed so that small angular movements of the light source or receiver do not prevent operation due to smoke and do not cause nuisance or unintentional alarms. [**72:**17.7.3.7.7]

Contrary to popular belief, buildings move under normal, everyday conditions. Portions of buildings vibrate due to traffic on nearby streets. Buildings sway due to wind or uneven thermal expansion; even the ebb and flow of the tides can cause ocean-front buildings to flex. Modern curtain wall/steel frame buildings are designed to flex. This movement, however, places a demand on fire alarm systems, especially fire alarm systems using projected-beam smoke detection. The detectors must be able to accommodate the natural or designed movement of the building. The manufacturers of projected beam–type detectors provide installation instructions that address the potential for this type of difficulty. Because of the physical instability of mounting surfaces and building movement, some manufacturers do not allow the use of mirrors. Often a limiting factor on beam length is the diameter of the projected beam and the receiver in relation to the expected flexure of the building.

13.7.4.3.5.8* The light path of projected beam–type detectors shall be kept clear of opaque obstacles at all times. [**72:**17.7.3.7.8]

A.13.7.4.3.5.8 Where the light path of a projected beam–type detector is abruptly interrupted or obscured, the unit should not initiate an alarm. It should give a trouble signal after verification of blockage. [**72:**A.17.7.3.7.8]

Projected beam–type detectors use obscuration algorithms in their software that can distinguish the progressive obscuration that occurs during a fire from the step-wise obscuration that usually indicates interference in the path of the beam by an opaque object. However, despite use of the most sophisticated software, Christmas decorations, party balloons, and hanging plants have been known to cause problems. Obstructions that can gradually grow and block a beam detector, such as trees in an atrium, should also be considered a potential problem.

13.7.4.3.6* Protection During Construction.

A.13.7.4.3.6 Construction debris, dust (especially gypsum dust and the fines resulting from the sanding of drywall joint compounds), and aerosols can affect the sensitivity of smoke detectors and, in some instances, cause deleterious effects to the detector, thereby significantly reducing the expected life of the detector. [**72:**A.17.7.1.11]

13.7.4.3.6.1 Where detectors are installed for signal initiation during construction, they shall be cleaned and verified to be operating in accordance with the listed sensitivity, or they shall be replaced prior to the final acceptance test of the system. [**72:**17.7.1.11.1]

Because renovation and construction activities include numerous fire ignition sources, smoke detection is often required in areas under construction. Where the AHJ requires early installation or detection during construction, detectors must be cleaned and measured for their normal operating sensitivity. Those detectors found outside their design sensitivity range must be cleaned and verified to be within their listed sensitivity or replaced.

13.7.4.3.6.2 Where detectors are installed but not operational during construction, they shall be protected from construction debris, dust, dirt, and damage in accordance with the manufacturer's recommendations and verified to be operating in accordance with the listed sensitivity, or they shall be replaced prior to the final acceptance test of the system. [**72:**17.7.1.11.2]

The requirement in 13.7.4.3.6.2 was introduced in the 2012 edition of the *Code* and should be considered as an alternative to the more restrictive provision 13.7.4.3.6.3. If detectors are installed before completion of construction cleanup, they must be protected in accordance with the manufacturer's instructions.

Many smoke detectors are shipped with a thin plastic cover over the sensing portion of the detector. It is widely assumed that these covers are suitable for protecting the detector from construction dust, dirt, and debris. In actuality, most of the covers supplied are merely for shipping and are not intended to be used in lieu of proper protection from construction debris.

Exhibit 13.53

Smoke detector with protective plastic cover. (Courtesy of Hochiki America Corp., Buena Park, CA)

Protective covers cannot be relied on to keep the detector entirely free of contaminants. Therefore, sensitivity measurement and cleaning of the detectors after all construction trades have finished their work will probably still be necessary. If covers are used, the contractor must also have a means of verifying that all of them have been removed when the construction trades have completed their work.

If the AHJ requires the covers to be removed at the end of each day, a good practice is to number the covers to ensure that all have been removed and then to replace them the next morning. Again, if the covers are removed during the construction process, it will be necessary to inspect the detectors closely, clean them when necessary, and test them to ensure that their sensitivity is within the listed and marked sensitivity range. See Exhibit 13.53 for an example of a smoke detector protective cover.

13.7.4.3.6.3 Where detection is not required during construction, detectors shall not be installed until after all other construction trades have completed cleanup. [**72:**17.7.1.11.3]

Many unwanted alarms are caused by smoke detectors installed too early in the construction process. Construction activities produce airborne dust that inevitably finds its way into detectors, contaminating them and making them prone to false alarms. Unless detection is required while the area is under construction, experience has shown that the best practice is to delay installation of smoke detectors until all construction cleanup has been completed.

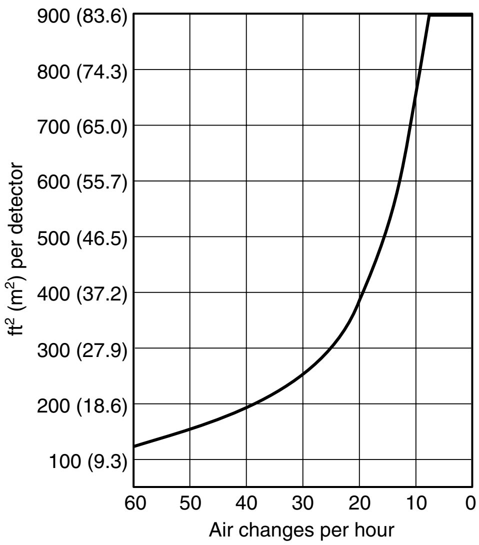
13.7.4.3.7 Ceiling Tiles and Ceiling Assemblies. Where automatic detectors are installed, ceilings necessary for the proper actuation of the fire protection device in accordance with *NFPA 72* shall be maintained.

13.7.4.3.8 High Air Movement Areas.

13.7.4.3.8.1 Location. Smoke detectors shall not be located directly in the airstream of supply registers. [**72:**17.7.6.3.2]

N *TABLE 13.7.4.3.8.2.2 Smoke Detector Spacing Based on Air Movement (Not to Be Used for Under-Floor or Above-Ceiling Spaces)*

Minutes per Air Change	Air Changes per Hour	Spacing per Detector ft²	Spacing per Detector m²
1	60	125	12
2	30	250	23
3	20	375	35
4	15	500	46
5	12	625	58
6	10	750	70
7	8.6	875	81
8	7.5	900	84
9	6.7	900	84
10	6	900	84



N *FIGURE 13.7.4.3.8.2.2 High Air Movement Areas (Not to Be Used for Under-Floor or Above-Ceiling Spaces). [**72:**Figure 17.7.6.3.3.2]*

13.7.4.3.8.2* Spacing.

A.13.7.4.3.8.2 Smoke detector spacing depends on the movement of air within the room. [**72:**A.17.7.6.3.3]

13.7.4.3.8.2.1 Smoke detector spacing shall be reduced where the airflow in a defined space exceeds 8 minutes per air change (total space volume) (equal to 7.5 air changes per hour). [**72:**17.7.6.3.3.1]

Δ **13.7.4.3.8.2.2** Where spacing must be adjusted for airflow, spot-type smoke detector spacing shall be adjusted in accordance with Table 13.7.4.3.8.2.2 or Figure 13.7.4.3.8.2.2 before making any other spacing adjustments required by this *Code*. [**72:**17.7.6.3.3.2]

N **13.7.4.3.8.2.3** Air-sampling or projected beam smoke detectors shall be installed in accordance with the manufacturer's published instructions. [**72:**17.7.6.3.3.3]

N **13.7.4.4 Inspection, Testing, and Maintenance.** The inspection, testing, and maintenance for fire alarm and fire detection systems shall be in accordance with *NFPA 72*.

13.7.4.5 Heat Detectors.

13.7.4.5.1 Fixed-Temperature, Rate-of-Rise, Rate-of-Compensation, Restorable Line, Spot Type (Excluding Pneumatic Tube Type). Heat test shall be performed with a listed and labeled heat source or in accordance with the manufacturer's published inspections. A test method for the installed equipment, shall be used that does not damage the nonrestorable fixed-temperature element of a combination rate-of-rise/fixed-temperature element detector. [**72:** Table 14.4.3.2, 17(d)1]

In previous editions of the *Code*, the heat source was required to be applied for "response within 1 minute." It is assumed that the 1-minute time requirement was introduced as an added level of protection to ensure that the test did not damage the thermal element or the detector housing. The requirement for response within 1 minute was removed from the 2010 edition of *NFPA 72*, because it was found that, in some instances, the 1-minute time frame was being incorrectly interpreted as a sensitivity test of the heat detectors.

There is no standardized, repeatable test method or test apparatus for all brands and all types of heat detectors. Neither the *Code* nor the test standards used by the listing organizations specify a particular response time in the field. The heat source and the test method specified in the manufacturer's published instructions should be used, and caution should be exercised to avoid damaging the detector or its components.

Extreme caution must be used in locations requiring hazardous (classified) electrical equipment (those containing flammable or explosive vapors or dusts) when heat detectors are being tested. In no case should open flames be used to test any type of heat detector. In most cases the use of hot water, a hair dryer, or similar safe means can be used to test a heat detector. For some types of rate-of-rise heat detectors, technicians might be able to actuate the detector by rubbing their hands together and then cupping both hands around the detector. This action is often all it takes to create the rate-of-temperature rise required to actuate the detector.

13.7.4.5.2 Fixed-Temperature, Nonrestorable Line Type. Heat test shall not be performed. Functionality shall be tested mechanically and electrically. Loop resistance shall be measured and recorded. Changes from acceptance test shall be investigated. [**72:** Table 14.4.3.2, 17(d)2]

The test required by 13.7.4.5.2 should be performed by shorting across the conductors at the end of the line to simulate actuation of the circuit or by using some other approved method identified in the manufacturer's published instructions for the device. Heat testing of a nonrestorable heat detector will actuate the detector, resulting in the need for replacement.

13.7.4.5.3 Nonrestorable (General). Heat tests shall not be performed. Functionality shall be tested mechanically and electrically. [**72:** Table 14.4.3.2, 17(d)4]

Testing can be conducted by operating contacts by hand, electrically shorted using a jumper, or other manufacturer-approved method. The purpose of the test is to ensure alarm response. Heat testing of a nonrestorable heat detector will actuate the detector, resulting in the need for replacement.

13.7.4.5.4 Restorable Line Type, Pneumatic Tube Only. Heat tests shall be performed (where test chambers are in circuit), with a listed and labeled heat source or in accordance with the manufacturer's published instructions of the detector or a test with pressure pump shall be conducted. [**72:**Table 14.4.2.2, 17(d)5]

Pneumatic tube–type heat detectors are often found actuating older deluge sprinkler systems or other special fire suppression systems.

13.7.4.6 Smoke Detectors.

Δ **13.7.4.6.1 In Other Than One- and Two-Family Dwellings, System Detectors.** Smoke detectors shall be tested in place to ensure smoke entry into the sensing chamber and an alarm response. Testing with smoke or listed and labeled product, acceptable to the manufacturer or in accordance with their published instructions, shall be permitted as acceptable test methods. Other methods listed in the manufacturer's published instructions that ensure smoke entry from the protected area, through the vents, into the sensing chamber shall be permitted. Any of the following tests shall be performed to ensure that each smoke detector is within its listed and marked sensitivity range:

(1) Calibrated test method
(2) Manufacturer's calibrated sensitivity test instrument
(3) Listed control equipment arranged for the purpose
(4) Smoke detector/control unit arrangement whereby the detector causes a signal at the control unit when its sensitivity is outside its listed sensitivity range
(5) Other calibrated sensitivity test method approved by the AHJ

[**72:**Table 14.4.3.2, 17(h)(1)]

13.7.4.6.2 Projected Beam Type. The detector shall be tested by introducing smoke, other aerosol, or an optical filter into the beam path. [**72:** Table 14.4.3.2, 17(g)6]

• **13.7.4.7*** In other than one- and two-family dwellings, sensitivity of smoke detectors shall be tested in accordance with 13.7.4.7.1 through 13.7.4.6. [**72:**14.4.4.3]

A.13.7.4.7 Detectors that cause unwanted alarms should be tested at their lower listed range (or at 0.5 percent obscuration if unmarked or unknown). Detectors that activate at less than this level should be replaced. [**72:**A.14.4.4.3]

13.7.4.7.1 Sensitivity shall be checked within 1 year after installation. [**72:**14.4.4.3.1]

13.7.4.7.2 Sensitivity shall be checked every alternate year thereafter unless otherwise permitted by compliance with 13.7.4.7.3. [**72:**14.4.4.3.2]

13.7.4.7.3 After the second required calibration test, if sensitivity tests indicate that the device has remained within its listed and marked sensitivity range (or 4 percent obscuration light gray smoke, if not marked), the length of time between calibration tests shall be permitted to be extended to a maximum of 5 years. [**72:**14.4.4.3.3]

After two tests in which sensitivity has remained stable, sensitivity testing may be extended to 5-year intervals in recognition of the apparent stability of the detector and the environment in which it is installed. Extending the sensitivity testing frequency requires maintaining detailed records of unwanted alarms, which may indicate that the detector has drifted outside the acceptable range of sensitivity. Such changes may warrant more frequent testing, cleaning of the detector, or replacement.

Exhibit 13.54 illustrates test equipment that can be used for smoke detector sensitivity testing.

Detectors found to be outside their listed and marked sensitivity range must be recalibrated and then retested or replaced in accordance with 13.7.4.7.4 and 13.7.4.7.5. Removal tools can assist maintenance personnel in removal of smoke detectors. See Exhibit 13.55 for an example of a removal tool.

Detectors manufactured prior to current standards did not require a sensitivity range to be marked on the product. These detectors typically have a sensitivity in the range of 0.5 percent to 4 percent per foot obscuration using light gray smoke. Sensitivities less than 0.5 percent obscuration per foot can lead to unwanted alarms. Sensitivities over 4 percent per foot can result

Exhibit 13.54

Test Equipment. (Left) Smoke Detector Sensitivity Tester (Courtesy of SDi, LLC, Neptune, NJ); (Right) A Calibrated Smoke Detector Sensitivity Test Instrument. (Source: Gemini Scientific, Sunnyvale, CA)

Exhibit 13.55

Removal Tool Used to Remove Detectors on High Ceilings. (Courtesy of SDi, LLC., Neptune, NJ)

in detection delays. The manufacturer of the smoke detector can usually provide a recommended level of sensitivity for unmarked smoke detectors.

13.7.4.7.3.1 If the frequency is extended, records of nuisance alarms and subsequent trends of these alarms shall be maintained. [**72:**4.4.4.3.3.1]

13.7.4.7.3.2 In zones or in areas where nuisance alarms show any increase over the previous year, calibration tests shall be performed. [**72:**14.4.4.3.3.2]

13.7.4.7.4 Unless otherwise permitted by 13.7.4.7.5, smoke detectors found to have a sensitivity outside the listed and marked sensitivity range shall be cleaned and recalibrated or be replaced. [**72:**14.4.4.3.4]

13.7.4.7.5 Smoke detectors listed as field adjustable shall be permitted to either be adjusted within the listed and marked sensitivity range, cleaned, and recalibrated, or be replaced. [**72:**14.4.4.3.5]

13.7.4.7.6 The detector sensitivity shall not be tested or measured using any device that administers an unmeasured concentration of smoke or other aerosol into the detector or smoke alarm. [**72:**14.4.4.3.6]

Available means for sensitivity testing of smoke detectors include the use of manufacturers' calibrated test instruments, control equipment listed for the purpose, a smoke detector/control unit arrangement whereby the detector causes a signal at the control unit when its sensitivity is outside the listed range of sensitivity, or other calibrated sensitivity methods approved by the AHJ.

13.8 Other Fire Protection Systems

Where other fire protection systems are required to be installed by the provisions of this *Code*, or are installed with the approval of the AHJ as an alternative or equivalency, the design and installation of the system shall comply with the appropriate standards listed in Table 13.8. The system shall be tested and maintained in accordance with Section 10.4.

13.9 Non-Listed Fire Protection or Suppression Devices and Equipment

13.9.1 It shall be unlawful to market, sell, advertise, or distribute any device or equipment as suitable for fire protection or fire suppression purposes unless the device or equipment is listed for such purpose by a nationally recognized testing laboratory or as otherwise permitted by 13.9.2.

13.9.2 The requirements of 13.9.1 shall not apply where NFPA standards, other adopted standards, or the adopted code allow the use of non-listed fire protection or suppression equipment.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 3, *Standard for Commissioning of Fire Protection and Life Safety Systems*, 2018 edition.

NFPA 4, *Standard for Integrated Fire Protection and Life Safety System Testing*, 2018 edition.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, 2016 edition.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, 2016 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2016 edition.

Δ **TABLE 13.8** *Other Required Fire Protection Systems*

Type of System	NFPA Standard
Low-, medium-, and high-expansion foam systems	NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
Carbon dioxide systems	NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
Halon 1301 systems	NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
Sprinklers in one- and two-family dwellings and manufactured homes	NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*
Sprinklers in residential occupancies up to and including four stories in height	NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*
Water spray systems	NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
Deluge foam-water sprinkler, foam-water spray systems, and closed-head foam-water sprinkler systems	NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
Dry chemical extinguishing systems	NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
Wet chemical extinguishing systems	NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*
Water mist systems	NFPA 750, *Standard on Water Mist Fire Protection Systems*
Clean agent fire-extinguishing systems	NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*
Aerosol extinguishing systems	NFPA 2010, *Standard for Fixed Aerosol Fire Extinguishing Systems*

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016 edition.
NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2017 edition.
NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2014 edition.
NFPA 70®, *National Electrical Code®*, 2017 edition.
NFPA 72®, *National Fire Alarm and Signaling Code®*, 2016 edition.
NFPA 92, *Standard for Smoke Control Systems*, 2015 edition.
NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2017 edition.
NFPA *101®*, *Life Safety Code®*, 2018 edition.
NFPA 170, *Standard for Fire Safety and Emergency Symbols*, 2018 edition.
NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment*, 2015 edition.
NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting*, 2017 edition.
NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*, 2013 edition.
NFPA 5000®, *Building Construction and Safety Code®*, 2018 edition.
NFPA Fire Protection Handbook®, A. Cote, ed., Section 6.9 and Section 17.5, 20th edition, 2008.
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Workshop on School Safety, Codes and Security: Final Report, NFPA-sponsored workshop at University of Maryland, College Park, MD, December 3-4, 2014.

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ANSI/UL 300, *Standard for Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas*, Underwriters Laboratories Inc., Northbrook, IL, 2005, revised 2014.

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Forney, G. P., R. W. Bukowski, and W. D. Davis, *Field Modeling: Effects of Flat Beamed Ceilings on Detector and Sprinkler Response*, International Fire Detection Research Project Technical Report, Year 1, April 1993.
O'Connor, D. J., et al., *Smoke Detector Performance for Level Ceilings with Deep Beams and Deep Pocket Configurations*, April 2006.

Ford, J., *Automatic Sprinklers: A 10 Year Study: A Detailed History of the Effects of the Automatic Sprinkler Code in Scottsdale, Arizona*, City of Scottsdale/Rural-Metro Fire Department/Home Fire Sprinkler Fire Coalition, 1997.
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Means of Egress

14

Chapter 14 addresses *means of egress,* which is defined in 3.3.182 as "a continuous and unobstructed way of travel from any point in a building or structure to a public way consisting of three separate and distinct parts: (1) the exit access, (2) the exit, and (3) the exit discharge."

The term *exit* is defined by 3.3.105 as that portion of a means of egress that is separated from other building spaces by being enclosed within construction having the minimum degree of fire resistance specified by 14.3.1, with limited openings through the enclosing construction and protection of such openings. The exit might include door assemblies, stairs, ramps, smokeproof enclosures, exit passageways, and outside balconies. In each case, the exit components are required to conform to the *Code* specifications for fire protection, dimensions, and arrangement. In its simplest form, an exit is a doorway or a door opening directly to the exterior at grade. Such doorway or door opening provides the requisite protected way of travel to the exit discharge without the need for fire-rated, separating construction. An exit other than a door opening directly to the outside must provide a protected path of travel.

In the case of a stairway, the exit includes the door assembly into the stairway enclosure, the stair enclosure, the stairs and landings inside the enclosure, and the door assembly from the enclosure to the exterior or interior exit discharge.

The entrance to an exit enclosure is part of the exit and usually consists of a fire protection–rated door assembly that provides a protected entrance into a protected area. A fire door assembly, however, does not always signal an entrance to an exit. A door assembly or fire door assembly between a hotel room and a corridor or a fire door assembly across a corridor or lobby is part of exit access and not part of an exit, unless the corridor or lobby and all other openings into the corridor or lobby are separated and protected as required for an exit in accordance with 14.3.1, as might be accomplished using an exit passageway (see Section 14.7). Such protection is seldom provided for corridors, because, although it might be technically and monetarily feasible at the time the exit passageway is constructed, it would be difficult to maintain over the life of the building, as penetrations for communications cabling and other rehabilitation projects diminish the protection features.

Various building features — where properly arranged, located, or constructed — might constitute an exit. Examples include an exterior exit door assembly, an exit passageway, a horizontal exit, an exit stair, or an exit ramp.

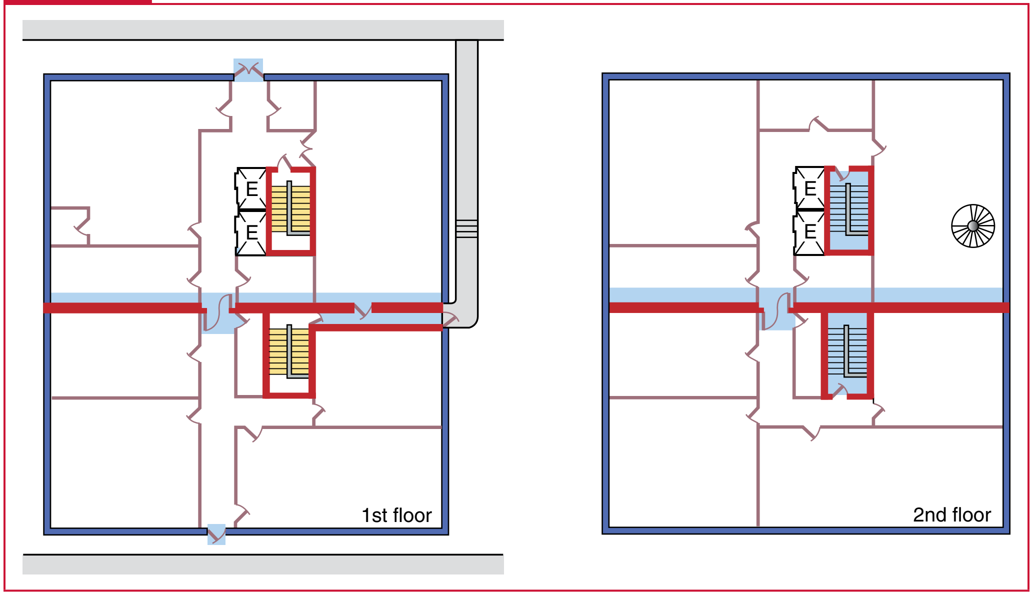
Several types of exits are shown in Exhibit 14.1 as shaded areas. On the second floor, exits include the following:

1. Two exit stairs enclosed by fire resistance–rated barriers, including a fire protection–rated, self-closing door assembly
2. Horizontal exit consisting of a fire resistance–rated barrier, including a pair of fire protection–rated, self-closing cross-corridor door assemblies that completely divide the floor into two fire compartments

On the first floor, exits include the following:

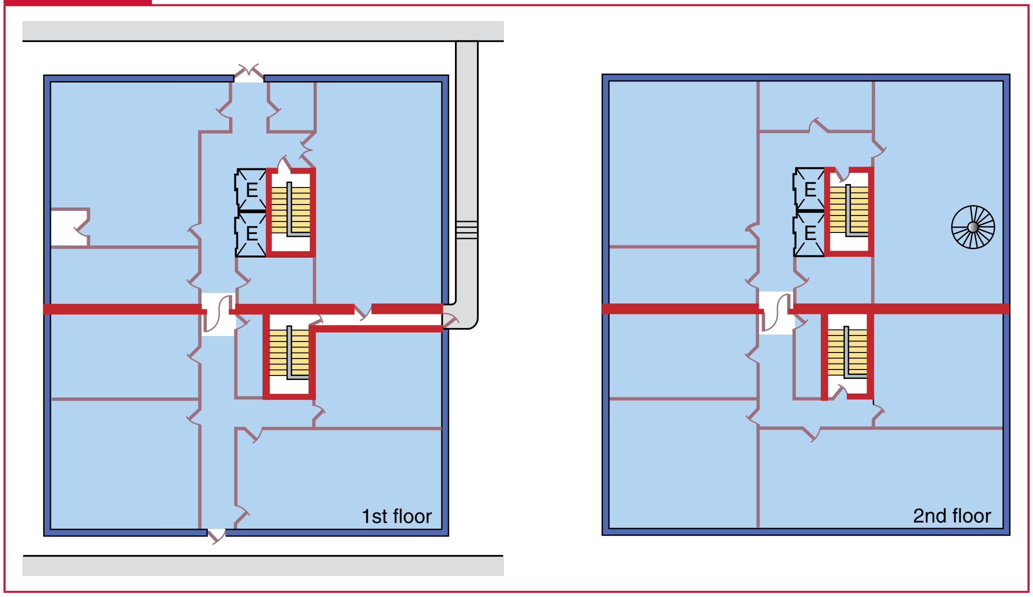
1. Two door assemblies from the corridor directly to the outside at grade level
2. Horizontal exit that is a vertical extension of and, therefore, similar to the horizontal exit located immediately above on the second floor
3. Exit passageway that connects one of the second-floor exit stair enclosures directly with the outside and is separated from the remainder of the first floor by fire resistance–rated barriers, including a fire protection–rated, self-closing door assembly from the room at the upper right corner

Exhibit 14.1



Various forms of exits.

Exhibit 14.2

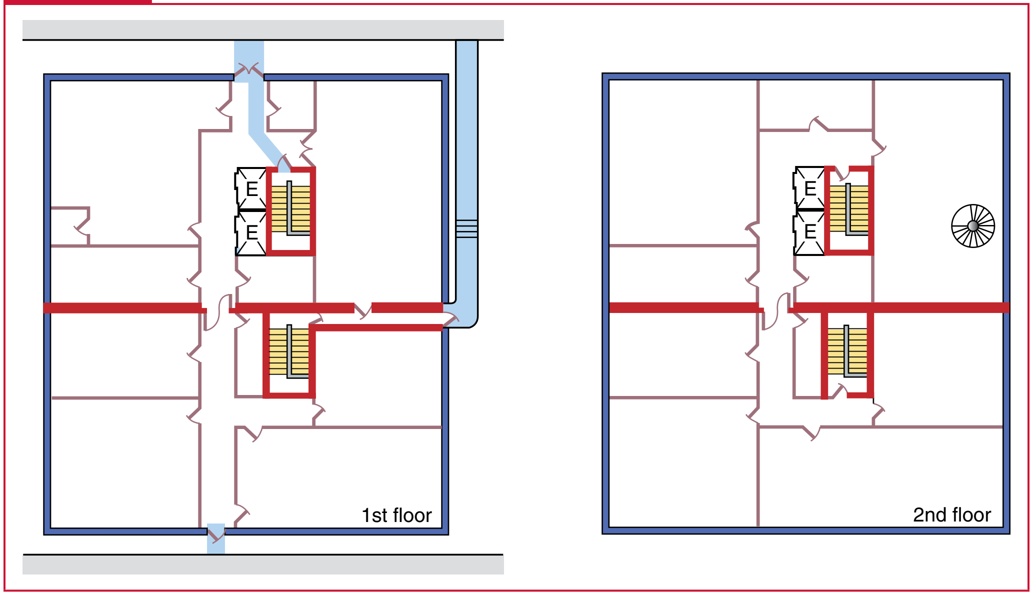


Spaces constituting exit access.

The exit access includes the rooms and building spaces that people occupy and the door assemblies, aisles, corridors, unenclosed stairs, and unenclosed ramps that are traversed to reach an exit. Spaces constituting exit access are shown in Exhibit 14.2 as shaded areas. All spaces occupied and traversed in reaching an exit are considered the exit access portion of the means of egress. The shading shown in Exhibit 14.2 indicates that exit access comprises more floor area than either of the other components of means of egress — the exit and the exit discharge.

The small closet in the room at the upper left corner of the first floor in Exhibit 14.2 is judged to be nonoccupiable and, therefore, is not part of the exit access. Similarly, if an HVAC shaft were running up through the building, it too would be considered nonoccupiable and not part of the exit access.

Exhibit 14.3



Spaces constituting exit discharge.

Note that the two elevators are shaded indicating that they are within the exit access. The elevators are not permitted to serve as components of the means of egress system. The building occupants must be provided with egress components and paths independent of the elevators. Yet, the travel across the elevator floor to the corridor is exit access for the building occupants who find themselves on the elevator at the time the fire emergency is called to their attention.

Because some exits do not discharge directly into a public way, the exit discharge is defined as providing building occupants with a path of travel from the termination of an exit to a public way. This path of travel might be inside the building, as permitted by 14.11.2, or outside. Where an exit opens onto an alley, a court, or a yard, a safe path of travel is required to be provided to a public way or some equivalent safe area. This portion of the means of egress is the exit discharge. (See also 14.11.1.)

Forms of exit discharge are shown in Exhibit 14.3 as shaded areas. Because occupants leave the building at the first floor only, no exit discharge occurs on the second floor. The first-floor exit discharge includes the following:

1. Exterior space beginning at the exit doors from the corridor and continuing to the public way (street)
2. Exterior walkway along the side of the building beginning at the door assembly from the exit passageway and continuing to the public way
3. Interior path of travel from the second-floor exit stair discharging through a portion of the first-floor corridor

A portion of the first floor through which an occupant of the second floor needs to travel is considered exit discharge, because the occupant reaches a required exit on the second floor (i.e., the enclosed exit stair) and then is forced to leave that protected area after traveling through the stair enclosure door opening on the first floor. However, an occupant of the first floor who travels across the same space, the space considered exit discharge for the person whose exit access travel began on the second floor, is considered to be within exit access and still en route to finding an exit, which occurs upon reaching the door opening to the outside. (See also 14.11.2.)

Δ 14.1 Application

Means of egress in new and existing buildings shall comply with this *Code* and NFPA *101*.

Δ 14.2 Exit Access Corridors

Corridors used as exit access and serving an area having an occupant load exceeding 30 shall be separated from other parts of the building by walls having not less than a 1-hour fire resistance rating in accordance with Section 12.7, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to existing buildings, provided that the occupancy classification does not change.

(2) This requirement shall not apply where otherwise provided in Chapters 11 through 43 of NFPA *101*.

[***101:***7.1.3.1]

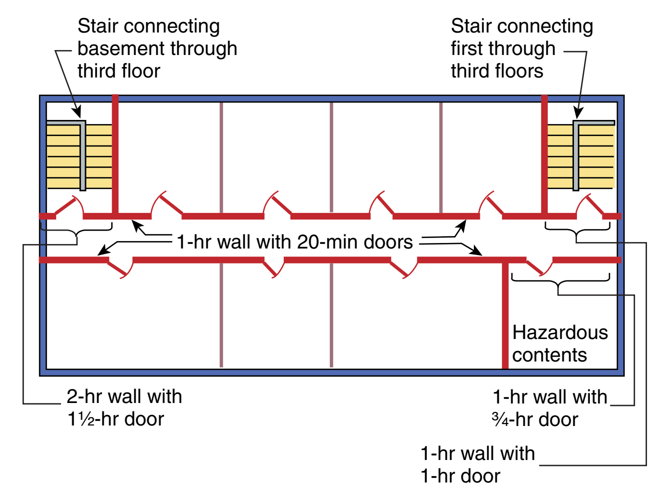
Section 14.2 requires protection via fire-rated corridor walls of exit access corridors serving more than 30 occupants. Note that the requirement for the corridor walls to be fire resistance rated, which is not a requirement for the floor/ceiling or roof/ceiling assemblies forming the top and bottom of the corridor compartment, provides separation only between the corridor and other spaces on the same floor. To provide the 1-hour separation between the corridor and the remainder of the floor, as required by Section 14.2, the fire barriers forming the corridor walls must extend above any ceiling membranes so as to be sealed tightly against the floor or roof above.

Item (1) of Section 14.2 exempts existing corridors from the requirement of Section 14.2, provided that the occupancy classification does not change. Therefore, if the occupancy classification of an existing building does change, the 1-hour corridor wall requirement applies, unless the specific occupancy involved has different requirements. Most of the occupancy chapters of NFPA *101*®, *Life Safety Code*®, establish new exit access corridor wall requirements that supersede the requirements of Section 14.2. Also, some of the occupancy chapters establish corridor wall requirements for existing buildings. Such provisions usually appear in subsection __.3.6 of NFPA *101*. For example, 14.3.6 of NFPA *101* addresses special requirements for corridor walls in new educational occupancies, and 15.3.6 of NFPA *101* addresses special requirements for corridor walls in existing educational occupancies. If no special requirements appear in an occupancy chapter of NFPA *101*, the provisions of Section 14.2 prevail.

Section 14.2 does not require corridors; however, it does require that, where corridors do exist and where they serve an area having an occupant load of more than 30 persons, they must be separated from other (i.e., noncorridor) spaces on that floor by corridor walls. Section 12.7 regulates the construction of the fire barrier forming the corridor walls and the opening protection. Wall segments that serve as both a corridor wall and part of an exit enclosure must meet the more stringent provisions required for the enclosure of exits. Similarly, wall segments that serve as both a corridor wall and enclosure protection of hazardous contents areas must meet the more stringent of the applicable provisions. In some cases, the provisions for corridor walls and those for hazardous area protection require a minimum 1-hour fire resistance rating. Yet, the minimum required fire protection rating of door assemblies in such walls might vary, with a minimum 45-minute rating required for the hazardous area protection and only a 20-minute rating for the corridor wall. Determining which set of requirements is more stringent involves comparing all related requirements, not only the fire resistance rating of the wall.

Exhibit 14.4 is an example of the protection of exit access corridors required by Section 14.2. Note the difference in the required protection for the corridor wall segments serving also as enclosure protection from the hazardous contents area (see Section 8.7 of NFPA *101*) and as part of the enclosure of an exit (see Section 14.3).

Exhibit 14.4



Protection of exit access corridors.

14.3 Exits

Δ **14.3.1** Where this *Code* requires an exit to be separated from other parts of the building, the separating construction shall meet the requirements of Section 8.2 of NFPA *101* and the following:

(1)* The separation shall have a minimum 1-hour fire resistance rating where the exit connects three or fewer stories.

Δ **A.14.3.1(1)** In existing buildings, existing walls in good repair and consisting of lath and plaster, gypsum wallboard, or masonry units can usually provide satisfactory protection for the purposes of this requirement where a 1-hour fire resistance rating is required. Further evaluation might be needed where a 2-hour fire resistance rating is required. Additional guidelines can be found in Annex O of NFPA 914. [***101:***A.7.1.3.2.1(1)]

(2) The separation specified in 14.3.1(1), other than an existing separation, shall be supported by construction having not less than a 1-hour fire resistance rating.

(3)* The separation shall have a minimum 2-hour fire resistance rating where the exit connects four or more stories, unless one of the following conditions exists:

   (a) In existing non-high-rise buildings, existing exit stair enclosures shall have a minimum 1-hour fire resistance rating.

   (b) In existing buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3, existing exit stair enclosures shall have a minimum 1-hour fire resistance rating.

   (c) The minimum 1-hour enclosures in accordance with 28.2.2.1.2, 29.2.2.1.2, 30.2.2.1.2, and 31.2.2.1.2 of NFPA *101* shall be permitted as an alternative to the requirement of 14.3.1(3).

A.14.3.1(3) In existing buildings, existing walls in good repair and consisting of lath and plaster, gypsum wallboard, or masonry units can usually provide satisfactory protection for the purposes of this requirement where a 1-hour fire resistance rating is required. Further evaluation might be needed where a 2-hour fire resistance rating is required. Additional guidelines can be found in Annex O of NFPA 914 and in the *SFPE Handbook of Fire Protection Engineering*. [***101:***A.7.1.3.2.1(3)]

(4) Reserved.

(5) The minimum 2-hour fire resistance–rated separation required by 14.3.1(3) shall be constructed of an assembly of noncombustible or limited-combustible materials and shall be supported by construction having a minimum 2-hour fire resistance rating, unless otherwise permitted by 14.3.1(7).

(6)* Structural elements, or portions thereof, that support exit components and either penetrate into a fire resistance–rated assembly or are installed within a fire resistance–rated wall assembly shall be protected, as a minimum to the fire resistance rating required by 14.3.1(1) or 14.3.1(3).

A.14.3.1(6) It is not the intent to require the structural elements supporting outside stairs, or structural elements that penetrate within exterior walls or any other wall not required to have a fire resistance rating, to be protected by fire resistance–rated construction. [***101:***A.7.1.3.2.1(6)]

(7) Fire-retardant-treated wood enclosed in noncombustible or limited-combustible materials shall be permitted in accordance with NFPA 220.

(8) Openings in the separation shall be protected by fire door assemblies equipped with door closers complying with 14.5.4.

(9)* Openings in exit enclosures shall be limited to door assemblies from normally occupied spaces and corridors and door assemblies for egress from the enclosure, unless one of the following conditions exists:

(a) Vestibules that separate normally unoccupied spaces from an exit enclosure shall be permitted provided the vestibule is separated from adjacent spaces by corridor walls and related opening protectives as required for the occupancy involved but not less than a smoke partition in accordance with Section 8.4 of NFPA *101*.

(b) In buildings of Type I or Type II construction as defined in NFPA 220 (*see 8.2.1.2 of* NFPA *101*), fire protection-rated door assemblies to normally unoccupied building service equipment support areas as addressed in Section 7.13 of NFPA *101* shall be permitted, provided the space is separated from the exit enclosure by fire barriers as required by 14.3.1(3).

(c) Openings in exit passageways in mall buildings as provided in Chapters 36 and 37 of NFPA *101* shall be permitted.

(d) In buildings of Type I or Type II construction, as defined in NFPA 220 (*see 8.2.1.2 of* NFPA *101*), existing fire protection–rated door assemblies to interstitial spaces shall be permitted, provided that such spaces meet all of the following criteria:

i. The space is used solely for distribution of pipes, ducts, and conduits.

ii. The space contains no storage.

iii. The space is separated from the exit enclosure in accordance with Section 12.7.

(e) Existing openings to mechanical equipment spaces protected by approved existing fire protection–rated door assemblies shall be permitted, provided that the following criteria are met:

i. The space is used solely for non-fuel-fired mechanical equipment.

ii. The space contains no storage of combustible materials.

iii. The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3 or the mechanical equipment space is provided with sprinkler protection in accordance with Section 13.3 and provided with complete smoke detection in accordance with Section 13.7.

A.14.3.1(9) Means of egress from the level of exit discharge is permitted to pass through an exit stair enclosure or exit passageway serving other floors. Doors for convenience purposes and unrelated to egress also are permitted to provide access to and from exit stair enclosures and exit passageways, provided that such doors are from corridors or normally occupied spaces. It is also the intent of this provision to prohibit exit enclosure windows, other than approved vision panels in doors, that are not mounted in an exterior wall. [***101:***A.7.1.3.2.1(9)]

(10) Penetrations into, and openings through, an exit enclosure assembly shall be limited to the following:

(a) Door assemblies permitted by 14.3.1(9)

(b)* Electrical conduit serving the exit enclosure

Δ **A.14.3.1(10)(b)** The intent of this provision is to prevent the exit enclosure from being used as a vertical chase for building services. Penetrations for electrical wiring are permitted where the wiring serves equipment permitted by the AHJ to be located within the exit enclosure. [***101:***A.7.1.3.2.1(10)(b)]

(c) Pathways for devices for security and communication systems serving the exit enclosure, where pathways are installed in metal conduit

(d)* Required exit door openings

N **A.14.3.1(10)(d)** This provision will allow security cameras, public address systems, emergency communication systems, telephone repeaters and similar life safety devices in the exit enclosure, and wiring and similar pathways for such devices, to penetrate the fire barrier serving the exit enclosure. It is the intent of this provision to prevent the exit enclosure from being used as a vertical chase for building services. [***101:***A.7.1.3.2.1(10)(d)]

(e) Ductwork and equipment necessary for independent stair pressurization

(f) Water or steam piping necessary for the heating or cooling of the exit enclosure

(g) Sprinkler piping
(h) Standpipes
(i) Existing penetrations
(j) Penetrations for fire alarm circuits, where the circuits are installed in metal conduit

(11) Penetrations or communicating openings shall be prohibited between adjacent exit enclosures.

(12) All penetrations in fire barriers separating the exit from other parts of the building shall be protected in accordance with 12.7.8.

(13) Membrane penetrations shall be permitted on the exit access side of the exit enclosure and shall be protected in accordance with 12.7.5.6.

[***101:***7.1.3.2.1]

Exits must provide protection from fire originating inside or outside the exit. Protection from fire originating within the enclosure is accomplished by prohibiting use of the enclosure for any purpose that could possibly interfere with the exit functioning as a protected path of travel (see 14.3.3) and by limiting the combustibility of interior wall, ceiling, and floor finish materials within exit enclosures (see 7.1.4 of NFPA *101*). Details on interior wall, ceiling, and floor finish are found in Section 12.5 and Chapter 20.

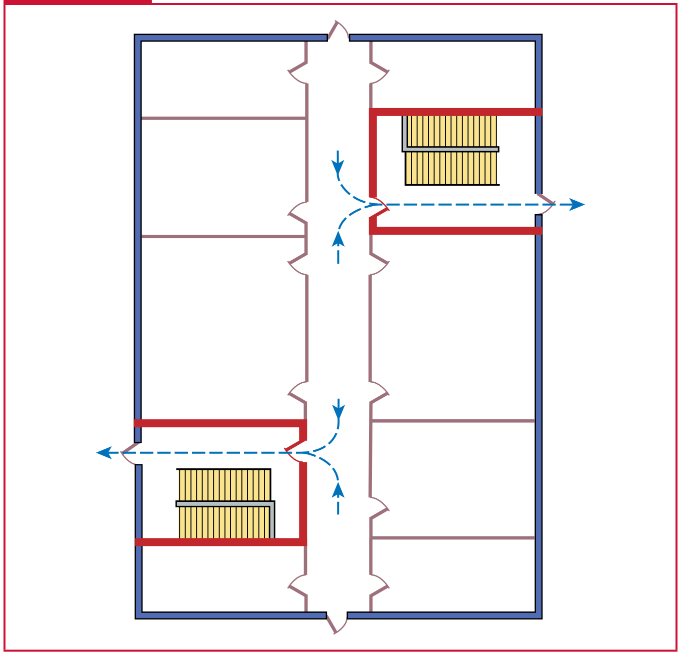
Protection from fire originating outside the exit enclosure is accomplished by providing separating construction having the required specified degree of fire resistance and by careful control of openings into the exit enclosure itself. The only openings permitted in the fire barriers between the exit and the building spaces are those for entering the exit from any normally occupied space or corridor and those for leaving the exit to reach the exit discharge. In other words, only openings provided for an occupant to enter and leave the exit enclosure are permitted.

Exhibit 14.5 depicts an egress arrangement on the ground floor of a building where occupants of that floor can enter the two exit stair enclosures, although such door assemblies are not required, because the door assemblies at the end of the corridor that discharge directly outside provide the required means of egress for the ground floor occupants. Earlier editions of the *Code* limited door assemblies into exit stair enclosures to those necessary for access to the enclosure. Some authorities having jurisdiction (AHJs) interpreted that limitation as prohibiting the convenience door assembly from the ground floor to the exit stair enclosure. The *Code* was revised to delete the concept of necessity for openings and states that openings in exit enclosures are limited to door assemblies from normally occupied spaces and corridors and door assemblies for egress from the enclosure. Thus, the arrangement depicted in Exhibit 14.5, with the convenience door assemblies into the stair enclosures on the ground floor, is permitted.

The required degree of fire resistance–rated separation for the exit enclosure depends on the number of stories or floor levels the exit connects, not the height of the building. It is possible to have stairs in a high-rise building connecting only three or fewer stories. In such a case, the enclosing construction is not required to be more than 1-hour fire resistance rated. See Exhibit 14.6. Where connecting four stories or more, exit stairs must be separated from other spaces within the building by 2-hour fire resistance–rated noncombustible, limited-combustible, or fire retardant–treated wood construction. Where the exit stairs connect three or fewer stories, the separation is permitted to be reduced to a minimum 1-hour rating. In accordance with 14.3.1(3)(a) and 14.3.1(3)(b), existing exit stair enclosures in existing non-high-rise buildings or in existing sprinklered buildings — regardless of height — are permitted a 1-hour fire resistance rating. As indicated by 14.3.1(3)(c), some occupancy chapters of NFPA *101* reduce the 2-hour fire resistance–rated construction requirement to 1 hour — even for new construction — if the building is protected throughout by an approved, supervised automatic sprinkler system. An example applicable to new hotels can be found in 28.2.2.1.2 of NFPA *101*.

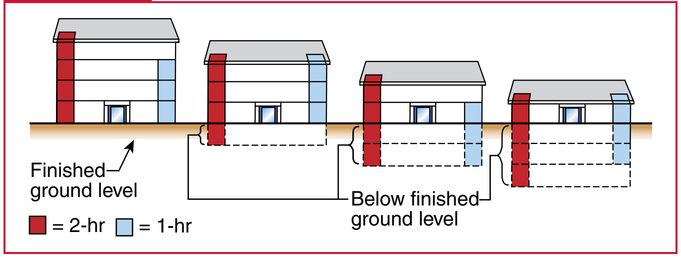
The door assemblies in walls of exit enclosures are to be 1-hour fire protection–rated door assemblies where used

Exhibit 14.5



Convenience door assemblies permitted from ground floor into exit enclosure.

Exhibit 14.6



Required separating construction for exit stairs.

in 1-hour fire resistance–rated enclosures and 1½-hour fire protection–rated door assemblies where used in 2-hour fire resistance–rated enclosures. See Table 12.7.6.2.2. Paragraph 12.7.6.2.3 modifies the provisions of Table 12.7.6.2.2 by permitting existing ¾-hour fire protection–rated door assemblies to continue in use in lieu of the minimum 1-hour fire protection rating required by the table.

The provision of 14.3.1(2) applies a requirement to 1-hour fire resistance–rated exit enclosure barriers similar to the requirement applied to 2-hour barriers by 14.3.1(5) for fire rating the supporting construction. The provisions of 14.3.1(5) and (7) work together to limit the combustibility of the minimum 2-hour fire resistance–rated separating construction required by 14.3.1(3).

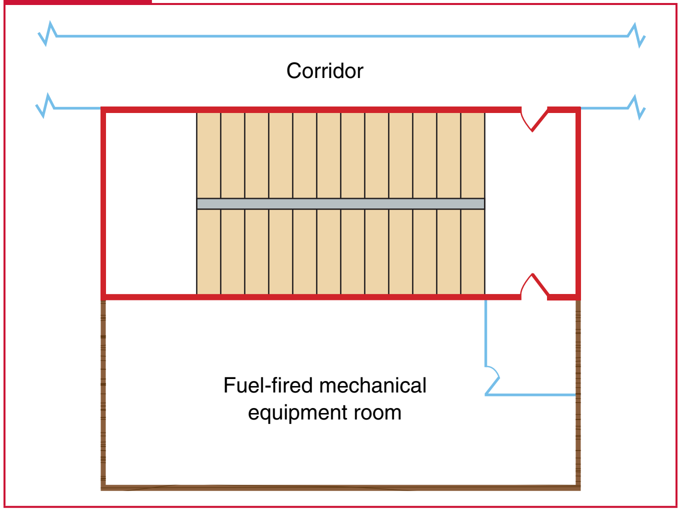
Additionally, such 2-hour separating construction must be supported by construction having a minimum 2-hour fire resistance rating. The effect of this requirement is that, in a building with floor/ceiling assemblies having less than a 2-hour fire resistance rating, the exit stair enclosure fire barrier walls are not permitted to be supported by the building floors. Rather, the exit stair enclosure needs to be a self-supporting shaft system.

The provision of 14.3.1(6) supplements the requirement of 14.3.1(5) to help ensure that structural elements that support exit stair components are protected to the same level as required for the exit enclosure. This provision prevents the early failure of exit enclosures and related egress elements. For example, a hanger rod supporting a stair landing must not be installed within a wall cavity, because the cavity and the outer wall membrane do not provide the required minimum fire resistance rating that the entire wall assembly provides (i.e., the fire resistance rating achieved by the combination of the outer wall membrane, the cavity, and the inner wall membrane). The text of A.14.3.1(6) clarifies that outside walls that are not required to be fire rated to complete the separation of the exit stair from the remainder of the floor are permitted to be penetrated by structural elements, such as the stair landing hanger rod referenced earlier in this paragraph.

The provision of 14.3.1(7) was revised for the 2018 edition of NFPA *101* to recognize that NFPA 220, *Standard on Types of Building Construction*, permits fire-retardant-treated wood (FRTW) for limited applications in all building construction types. It is not the intent for NFPA *101* to overrule the provisions of NFPA 220.

In accordance with 14.3.1(9), the only openings permitted in the exit enclosure are for door assemblies providing access into the enclosure from normally occupied spaces and corridors and for door assemblies providing egress from the enclosure into the exit discharge. These door assemblies are required to be self-closing fire door assemblies, as described in 14.5.4. No opening through the exit enclosure walls — including a door opening — is permitted from storage rooms, closets, boiler rooms, equipment spaces, utility rooms, electrical vaults, or similar spaces that are not normally occupied. Access panels to access building spaces cannot be installed in the walls or ceilings of exit enclosures, regardless of whether the access panels have a fire resistance rating.

Exhibit 14.7



Vestibule separating exit enclosure from normally unoccupied space.

The provision of 14.3.1(9)(a) recognizes the often practiced arrangement whereby a vestibule is created to prevent a normally unoccupied space from opening directly onto an exit enclosure. Exhibit 14.7 depicts a fuel-fired mechanical equipment room that is to be considered as a normally unoccupied space. The vestibule and the associated door that opens directly into the room comply with the corridor wall and door provisions of the applicable occupancy chapter of NFPA *101*. Where an occupancy chapter of NFPA *101* requires no corridor separation, as is the case with existing business occupancies per 39.3.6 of NFPA *101*, the vestibule barriers must be smoke partitions. The corridor is permitted to open directly onto the stair per 14.3.1(9). Similarly, normally occupied spaces are permitted to open directly onto the exit enclosure.

The provision of 14.3.1(9)(b) treats a normally unoccupied building service equipment support area (see Section 7.14 of NFPA *101*) as a normally occupied space but requires that the separation between such space and the exit enclosure be based on the provisions applicable to an exit enclosure that connects four or more stories. In other words, a minimum 2-hour fire resistance–rated separation is required unless one of the exemptions to 14.3.1(3) is met, in which case a minimum 1-hour fire resistance–rated separation is required.

Paragraph 14.3.1(9)(c) permits openings from normally unoccupied spaces within the exit enclosures created by exit passageways in mall structures, as detailed in Chapters 36 and 37 of NFPA *101*. By consulting the provisions of 36.4.4.9.2 and 37.4.4.9.2 of NFPA *101*, one finds that rooms housing building service equipment, service elevators, and janitor closets — spaces not normally occupied — are permitted to open directly onto mall structure exit passageways.

Paragraph 14.3.1(9)(d) recognizes that, in some existing buildings, it is safe to permit unoccupied rooms to open directly onto an exit stair enclosure. For example, in some existing hospitals, a common practice is to have interstitial spaces above the ceiling of each floor for purposes of running pipes, ducts, and conduits. The interstitial spaces appear much like separate floors. For example, in an elevation view of a four-story hospital, it would appear that there are eight stories. Patients would occupy every other floor, and the alternating floors created by the interstitial spaces would house the service pipes, ducts, and conduits. This arrangement is depicted in Exhibit 14.8. Access to the patient floors and to the interstitial space floors would be by means of fire protection–rated door assemblies from the stair enclosure. See 14.3.1(9)(d) for the other criteria necessary to permit the existing situation to be continued in use.

Paragraph 14.3.1(9)(e) has traditionally permitted existing openings, protected by fire protection-rated door assemblies, between an exit enclosure and a mechanical equipment space that has no combustible materials and no fuel-fired equipment, provided the building is protected throughout by automatic sprinklers. For the 2018 edition of NFPA *101*, an option to full-building sprinklering was added. The option recognizes sprinklering of just the mechanical equipment room provided the room has complete smoke detection.

Exit enclosure penetrations generally are prohibited for new construction. Penetrations for ductwork for pressurization of smokeproof enclosures might be permitted (see 7.2.3 of NFPA *101*), but penetration by other ductwork is prohibited. Penetrations are permitted by 14.3.1(10) for the following:

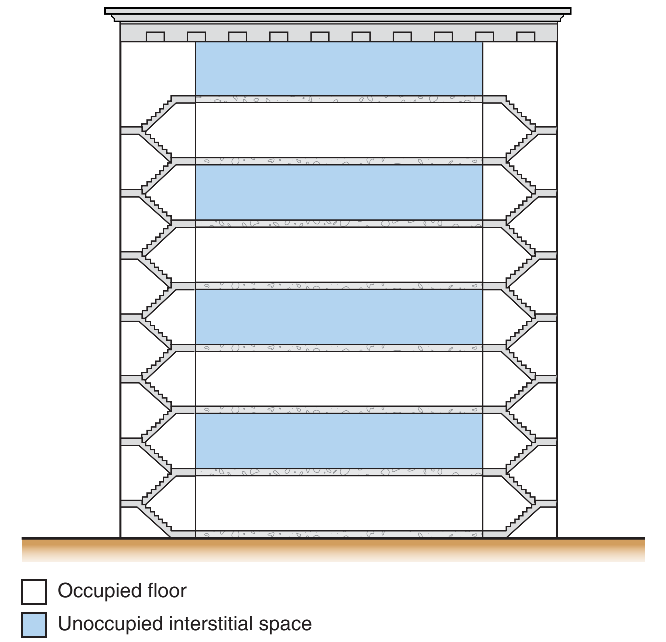
1. Water and steam piping necessary for the heating and cooling of the exit enclosure
2. Electrical conduit serving the exit enclosure
3. Fire alarm system circuit wiring installed in metallic conduit and serving the building
4. Standpipe and sprinkler piping serving the building
5. Security and communication system wiring serving the exit enclosure and installed in metal conduit (new to the 2018 edition of NFPA *101*; see, for example, the stairway video monitoring provisions of 11.8.8 of NFPA *101*)

The NFPA *101* Technical Committee on Means of Egress carefully compiled the list of penetrations permitted by 14.3.1(10) to create a complete list rather than a partial list of examples. Given that fire alarm system circuit wiring installed in metallic conduit is permitted, some designers and contractors have attempted to justify placing control panels within the exit enclosure. It was not the committee's intent to permit fire alarm system controls and associated components, other than circuit wiring in metallic conduit, to be installed within the exit enclosure.

Exhibit 14.9 shows fire protection and alarm system features installed within an exit enclosure. The equipment is connected to equipment outside the enclosure via penetrations of the enclosing fire barriers. Some of the penetrations are specifically permitted by 14.3.1(10), and others might fall into the category of existing penetrations protected in accordance with 12.7.5 as permitted by 14.3.1(10)(h). Other items, such as the fire alarm system cabinets, should not be within the exit enclosure.

The provision of 14.3.1(13) recognizes that the purpose of 14.3.1 is to limit through-penetrations into an exit enclosure but not to prohibit membrane penetrations on the outside of

Exhibit 14.8



Unoccupied interstitial spaces with openings to exit stair enclosure.

Exhibit 14.9

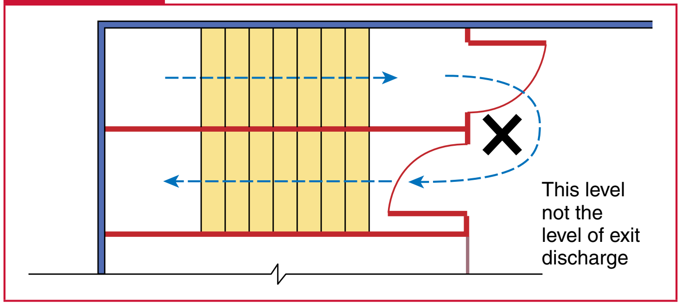
Fire protection and alarm equipment within, and penetrating the barrier walls of, an exit enclosure. (Courtesy of Jake Pauls) the exit enclosure. The new provision allows for membrane penetrations such as those for the installation of fire alarm system manual fire alarm boxes next to the door into the stair enclosure. In prior editions of the *Code,* such membrane penetrations on the outside of the exit enclosure were not addressed, since they were not specifically permitted by 14.3.1(10).

14.3.2 An exit enclosure shall provide a continuous protected path of travel to an exit discharge. [***101:***7.1.3.2.2]

Subsection 14.3.2 emphasizes that exit enclosures and the protection they afford the occupants must be continuous. It is a fundamental premise that, once an occupant has been provided the level of protection afforded by an exit, that level of protection must be maintained to the exit discharge.

Subsection 14.3.2 prohibits an exit stair or exit ramp arrangement that requires a person to leave the exit enclosure, become exposed to conditions on a floor, and then re-enter the exit enclosure to continue moving to the exit discharge. Exhibit 14.10 shows an unacceptable arrangement. The discontinuity of leaving the stair enclosure and then re-entering the stair enclosure to continue moving to the level of exit discharge creates too great a potential for exposing occupants to danger and blocking their egress route.

Exhibit 14.10



Unacceptable arrangement for enclosing a stair serving as a required exit.

14.3.3* An exit enclosure shall not be used for any purpose that has the potential to interfere with its use as an exit and, if so designated, as an area of refuge. *(See also 14.6.3.)* [***101:***7.1.3.2.3]

A.14.3.3 This provision prohibits the use of exit enclosures for storage or for installation of equipment not necessary for safety. Occupancy is prohibited other than for egress, refuge, and access. The intent is that the exit enclosure essentially be "sterile" with respect to fire safety hazards. [***101:***A.7.1.3.2.3]

Subsection 14.3.3 prohibits the use of an exit enclosure for any purpose that could potentially interfere with its use as an exit or as an area of refuge. For example, use of an enclosed exit stair to house vending machines, copying machines, or storage or to run electrical distribution wires and cables to areas of the building is prohibited. Standpipes and emergency lighting that are part of the life safety features are permitted only if their arrangement does not interfere with the passage of people. This limitation covers more than mechanical obstruction of the egress path; it includes any use that could interfere with the use of the exit. See also 14.4.1 and 14.6.3.

Exhibit 14.11 shows rolled carpet on a stair landing within an exit enclosure. The presence of the carpeting violates the requirement of 14.3.3 in two ways:

1. The carpet encroaches on the required egress width.
2. If the combustible carpet were to burn, the resultant heat and smoke would prevent the exit enclosure from serving its intended use.

The prohibitions of 14.3.3 also apply to exit passageways, because they also are exit enclosures.

Exhibit 14.11

Rolled carpet stored in an exit enclosure. (Courtesy of Jake Pauls)

14.4 Means of Egress Reliability

14.4.1* Maintenance. Means of egress shall be continuously maintained free of all obstructions or impediments to full instant use in the case of fire or other emergency. [***101:***7.1.10.1]

A.14.4.1 A proper means of egress allows unobstructed travel at all times. Any type of barrier including, but not limited to, the accumulations of snow and ice in those climates subject to such accumulations is an impediment to free movement in the means of egress. Another example of an obstruction or impediment to full instant use of means of egress is any security device or system that emits any medium that could obscure a means of egress. It is, however, recognized that obstructions occur on a short-duration basis. In these instances, awareness training should be provided to ensure that blockages are kept to a minimum and procedures are established for the control and monitoring of the area affected. [***101:***A.7.1.10.1]

The provision in 14.4.1 emphasizes the importance of keeping the egress system usable at all times. In the case of a

Class A mercantile occupancy, for example, the minimum 60 in. (1525 mm) exit access aisle width required by 36.2.5.6 and 37.2.5.6 of NFPA *101* must not, subsequent to receipt of the store's occupancy permit, be filled with mid-aisle displays that reduce the aisle width. Similarly, in a business occupancy with a new exit stair of the minimum 44 in. (1120 mm) width required by Table 7.2.2.2.1.2(B) of NFPA *101*, the stair width must not be reduced by the introduction of a mechanized chairlift that is installed, for example, to comply with legislation mandating accessibility for persons with mobility impairments. [For additional guidance on the installation of stair descent devices, see A.7.2.12.2.3 of NFPA *101*.] In an apartment building complex, the required width of the outside exit discharge sidewalk that runs along the side of the building must not be reduced by the presence of a trash dumpster on either a temporary or a permanent basis.

An egress path that was *Code* compliant when constructed might have its egress reliability compromised by human action. Exhibit 14.12 shows a stair with flaring tread width near its base. Graspable handrails were installed along the stair flight, but the placement of potted plants prevents the stair user from accessing a handrail while traveling on the lowest three treads.

Exhibit 14.12

Potted plants prevent access to required handrails. (Courtesy of Jake Pauls)

14.4.2 Furnishings and Decorations in Means of Egress.

Paragraphs 14.4.2.1 through 14.4.2.3 provide guidance for the interior decoration and maintenance of buildings that serve, for example, as restaurants and theaters, where mirrored wall surfaces and excessive decoration can camouflage and, in some cases, obstruct exits. For such occupancies, care must be taken to ensure that the required, standard, well-marked exit access that leads to an unobstructed exit is not obscured in the pursuit of period or style authenticity. For example, a restaurant that is heavily decorated with red wall coverings might use green exit signs to help meet the requirements of these paragraphs, despite the fact that Section 14.14 does not specify exit sign color.

14.4.2.1 No furnishings, decorations, or other objects shall obstruct exits or their access thereto, egress therefrom, or visibility thereof. [***101:***7.1.10.2.1]

14.4.2.2 No obstruction by railings, barriers, or gates shall divide the means of egress into sections appurtenant to individual rooms, apartments, or other occupied spaces. Where the AHJ finds the required path of travel to be obstructed by furniture or other movable objects, the authority shall be permitted to require that such objects be secured out of the way or shall be permitted to require that railings or other permanent barriers be installed to protect the path of travel against encroachment. [***101:***7.1.10.2.2]

Paragraph 14.4.2.2 relates to the arrangement of furniture, as well as to the arrangement of railings, gates, or barriers found in lobbies, foyers, waiting spaces, or staging areas of businesses, hospitals, health care clinics, hotels, and apartments. Because these large spaces are often subdivided by furniture (e.g., chairs, tables, and plants) or by railings and gates, furnishings must be prevented from blocking access to exits.

Paragraph 14.4.2.2 recommends fastening furnishings so that they are clear of access to exits or placing railings around furnishings to ensure that they are held within a fixed area and cannot be easily moved or rearranged. The *Code* recognizes the problem created by storage that is placed within the exit access aisles of storage rooms in mercantile occupancies, which is a violation of *Code* requirements. Both Chapters 36 and 37 of NFPA *101* require an unobstructed egress path to be maintained as a specific condition for permitting egress to pass through storerooms.

14.4.2.3 Mirrors shall not be placed on exit door leaves. Mirrors shall not be placed in or adjacent to any exit in such a manner as to confuse the direction of egress. [***101:***7.1.10.2.3]

14.4.2.4 Every door opening and every principal entrance that is required to serve as an exit shall be designed and constructed so that the path of egress travel is obvious and direct. Windows that, because of their physical configuration or design and the materials used in their construction, have the potential to be mistaken for door openings shall be made inaccessible to the occupants by barriers or railings. [***101:***7.2.1.1.2]

The purpose of the barriers or railings required by 14.4.2.4 is to prevent an occupant from walking through a window. Such barriers are not required to comply with the requirements of 7.2.2.4 of NFPA *101* applicable to guards. For example, intermediate rails or balusters spaced to meet the 4 in. (100 mm) diameter sphere requirement of 7.2.2.4.6.3 of NFPA *101* are not needed. A simple barrier rail, without ornamental grille-like fill or closely spaced

Exhibit 14.13

Circular decals that call attention to glass door in corridor egress path.

balusters, will adequately warn occupants to avoid walking into a glass wall or large windowpane.

Exhibit 14.13 shows a clear glass cross-corridor door in a hotel guest floor corridor. The circular decals on the door and glass sidelight call attention to the door positioned across the corridor egress path.

14.4.3 Impediments to Egress. Any device or alarm installed to restrict the improper use of a means of egress, and any device or system installed to monitor or record use of a means of egress, shall be designed and installed so that it cannot, even in case of failure, impede or prevent emergency use of such means of egress unless otherwise provided in 14.5.3 and Chapters 18, 19, 22, and 23 of NFPA *101*. [***101:***7.1.9]

14.5 Door Openings

Doors serve multiple purposes that relate to the comfort and safety of building occupants and provide protection from the following:

1. Weather, drafts, noise, and disturbance from adjoining areas
2. Trespass by unauthorized persons
3. Fire and smoke, with which this *Code* is concerned

14.5.1 Swing and Force to Open.

Δ **14.5.1.1* Swinging-Type Door Assembly Requirement.** Any door assembly in a means of egress shall be of the side-hinged or pivoted-swinging type, and shall be installed to be capable of swinging from any position to the full required width of the opening in which it is installed, unless otherwise specified as follows:

(1) Door assemblies in dwelling units, as provided in Chapter 24 of NFPA *101*, shall be permitted.
(2) Door assemblies in residential board and care occupancies, as provided in Chapters 32 and 33 of NFPA *101*, shall be permitted.
(3) Where permitted in Chapters 11 through 43 of NFPA *101*, horizontal-sliding or vertical-rolling security grilles or door assemblies that are part of the required means of egress shall be permitted, provided that all of the following criteria are met:
   (a) Such grilles or door assemblies shall remain secured in the fully open position during the period of occupancy by the general public.
   (b) On or adjacent to the grille or door opening, there shall be a readily visible, durable sign in letters not less than 1 in. (25 mm) high on a contrasting background that reads as follows: THIS DOOR TO REMAIN OPEN WHEN THE SPACE IS OCCUPIED.
   (c) Door leaves or grilles shall not be brought to the closed position when the space is occupied.
   (d) Door leaves or grilles shall be operable from within the space without the use of any special knowledge or effort.
   (e) Where two or more means of egress are required, not more than half of the means of egress shall be equipped with horizontal-sliding or vertical-rolling grilles or door assemblies.
(4) Horizontal-sliding door assemblies shall be permitted under any of the following conditions:
   (a) Horizontal-sliding door assemblies in detention and correctional occupancies, as provided in Chapters 22 and 23 of NFPA *101*, shall be permitted.
   (b) Special purpose horizontally sliding accordion or folding door assemblies complying with 7.2.1.14 of NFPA *101* shall be permitted.
   (c) Unless prohibited by Chapters 11 through 43 of NFPA *101*, horizontal-sliding door assemblies serving a room or area with an occupant load of fewer than 10 shall be permitted, provided that all of the following criteria are met:
      i. The area served by the door assembly has no high hazard contents.
      ii. The door assembly is readily operable from either side without special knowledge or effort.
      iii. The force required to operate the door assembly in the direction of door leaf travel is not more than 30 lbf (133 N) to set the door leaf in motion and is not more than 15 lbf (67 N) to close the door assembly or open it to the minimum required width.
      iv. The door assembly complies with any required fire protection rating, and, where rated, is self-closing or automatic-closing by means of smoke detection in accordance with 14.5.4 and is installed in accordance with NFPA 80.
      v. Corridor door assemblies required to be self-latching shall have a latch or other mechanism that ensures

that the door leaf will not rebound into a partially open position if forcefully closed.

(d) Where private garages, business areas, industrial areas, and storage areas with an occupant load not exceeding 10 contain only low or ordinary hazard contents, door openings to such areas and private garages shall be permitted to be horizontal-sliding door assemblies.

(5) Where private garages, business areas, industrial areas, and storage areas with an occupant load not exceeding 10 contain only low or ordinary hazard contents, door openings to such areas and private garages shall be permitted to be vertical-rolling door assemblies.
(6) Revolving door assemblies complying with 7.2.1.10 of NFPA *101* shall be permitted.
(7) Existing fusible link–operated horizontal-sliding or vertical-rolling fire door assemblies shall be permitted to be used as provided in Chapters 39, 40, and 42 of NFPA *101*.

[***101:***7.2.1.4.1]

Paragraph 14.5.1.1 requires that door assemblies within the means of egress be of the side-hinged or pivoted-swinging type. A pivoted-swinging door does not have hinges connecting the hinge stile edge of the door to the side of the door frame. Instead, pins inserted into the top and bottom of the door leaf, a short distance from the hinge stile edge, create the pivot point on which the door leaf swings. Side-hinged and pivoted-swinging types of door assemblies are the types most familiar to the general public, and their operation is readily understood.

Furthermore, 14.5.1.1 requires that the door leaf be capable of swinging to the full required width of the opening. The required width is determined by two width considerations. The first consideration involves the width required for egress capacity purposes. The second consideration involves the minimum clear width required, regardless of occupant load served. The required width is the larger of the two widths.

Items (1) and (2) of 14.5.1.1 recognize that some occupancy chapters in NFPA *101* provide exemptions to the requirement that door assemblies be of the side-hinged or pivoted-swinging type. Chapters 24, 32, and 33 of NFPA *101*, which apply to one- and two-family dwellings and residential board and care occupancies, do not require that door leaves be of the swinging type. These exemptions recognize the smaller numbers of persons using door assemblies within dwellings and the familiarity those occupants have with the operation of other door assembly types, such as sliding door assemblies.

Item (3) of 14.5.1.1 permits horizontal-sliding or vertical-rolling security grilles or door assemblies to be used in lieu of side-hinged- or pivoted-swinging-type door assemblies, provided that the exemption is specifically permitted by the applicable occupancy chapter in NFPA *101*. This exemption permits the type of security door assemblies and grilles normally found in mall structures.

Note that there is a difference between 14.5.1.1(3)(a) and 7.2.1.4.1(3)(c). Paragraph 14.5.1.1(3)(a) requires that the door assembly be fully open when the public occupies the space, while 14.5.1.1(3)(c) states that the grille or door leaf cannot be closed when the space is occupied. This allows the common practice of leaving the grille or door leaf partially closed at closing time and at other times when restricting entry to the general public is desired.

As referenced in 14.5.1.1(4)(a), detention and correctional occupancies permit certain sliding door assemblies, because swinging door leaves can become readily accessible weapons for use by residents against staff.

Paragraph 14.5.1.1(4)(b) recognizes the use of a special-purpose horizontally sliding accordion or folding door assembly under detailed conditions. One of the characteristic features of this door assembly is its operability in the direction of door leaf travel when a specified force is applied in the direction of occupant travel. See also 14.5.10.

Paragraph 14.5.1.1(4)(c) was new to the 2009 edition of NFPA *101* and expanded a provision that applied only to horizontal-sliding door assemblies in health care occupancies. The provision recognizes horizontal-sliding door assemblies serving fewer than 10 persons in any occupancy, unless an occupancy chapter specifically prohibits use of the provision. See the detailed criteria in 14.5.1.1(4)(c)i through 14.5.1.1(4)(c)v.

Paragraphs 14.5.1.1(4)(d) and 14.5.1.1(5) recognize that many private garages, small businesses, and industrial and storage buildings typically have only vertical-rolling or horizontal-sliding door assemblies and no side-hinged door assemblies. Provided that the maximum 10-person occupant load is not exceeded and there are no high hazard contents, such door assemblies are permitted to substitute for side-hinged or pivoted-swinging door assemblies.

Paragraph 14.5.1.1(6) cross-references the provisions of 14.5.6, which apply to revolving door assemblies. If 14.5.1.1(6) did not exist, it might be assumed, incorrectly, that revolving door assemblies violate the requirement for door assemblies to be side-hinged or pivoted-swinging.

Paragraph 14.5.1.1(7) recognizes the few occupancies in NFPA *101* that permit existing fusible link–operated sliding door assemblies to be positioned within the exit access of existing business, industrial, and storage occupancies if additional criteria are met. These provisions help to ensure that the door leaf is open when conditions in the door opening's vicinity are tenable for occupant movement and that it is closed once it is no longer safe for persons to seek egress via that exit access path.

A.14.5.1.1 Where doors are subject to two-way traffic, or where their opening can interfere with pedestrian traffic, an appropriately located vision panel can reduce the chance of accidents. [***101:***A.7.2.1.4.1]

Swinging doors in horizontal- or vertical-rolling partitions complying with the following should be permitted in a means of egress where the following criteria are met:

(1) The door or doors comply with 14.5.1.
(2) The partition in which the doors are mounted complies with the applicable fire protection rating and closes upon smoke

detection or power failure at a speed not exceeding 9 in./s (230 mm/s) and not less than 6 in./s (150 mm/s).

(3) The doors mounted in the partition are self-closing or automatic-closing in accordance with 14.5.4.1.

[***101:***A.7.2.1.4.1]

14.5.1.2* Door Leaf Swing Direction. Door leaves required to be of the side-hinged or pivoted-swinging type shall swing in the direction of egress travel under any of the following conditions:

(1) Where serving a room or area with an occupant load of 50 or more, except under any of the following conditions:
  (a) Door leaves in horizontal exits shall not be required to swing in the direction of egress travel where permitted by 7.2.4.3.8.1 or 7.2.4.3.8.2 of NFPA *101*.
  (b) Door leaves in smoke barriers shall not be required to swing in the direction of egress travel in existing health care occupancies, as provided in Chapter 19 of NFPA *101*.

(2) Where the door assembly is used in an exit enclosure, unless the door opening serves an individual living unit that opens directly into an exit enclosure

(3) Where the door opening serves a high hazard contents area

[***101:***7.2.1.4.2]

The provisions regulating the direction of door leaf swing appear in 14.5.1.2 of this *Code* and 7.2.4.3.8(1) of NFPA *101*.

Item (1) of 14.5.1.2 requires all door leaves serving in the means of egress from a room or area with an occupant load of 50 or more persons to swing in the direction of egress travel. For example, if the occupant load of a room with two exit access door assemblies is 80 persons, the door leaves of both door assemblies are required to swing in the direction of egress travel. The 50-person criterion is not related to the number of persons expected to use a given door opening but, rather, to the total occupant load of the room. Therefore, it would be incorrect in the case of this 80-person example to claim that 40 persons will move to each of the two door openings, that the 40-person number is fewer than the 50-person threshold, and that neither door leaf needs to swing in the direction of egress travel. The fact that the total occupant load of the room is more than 50 persons is a sufficient condition to require the exit access door leaves to swing in the direction of egress travel.

Item (2) of 14.5.1.2 requires a door leaf used in an exit enclosure to swing in the direction of egress travel. An example of a door leaf used in an exit enclosure is the door leaf in the opening between an exit access corridor and an enclosed exit stair. The main entrance and exit door leaf from an office building lobby to the outside is not a door leaf used in an exit enclosure, although it is an exit door. Door leaf swing direction for such a door would be regulated by the 50-person criterion of 14.5.1.2(1).

Item (3) of 14.5.1.2 requires a door leaf serving a high hazard contents area to swing in the direction of egress travel. Persons leaving high hazard contents spaces under fire or similar emergency must not be impeded, as would occur if they had to stop and pull a door toward them before egressing the space.

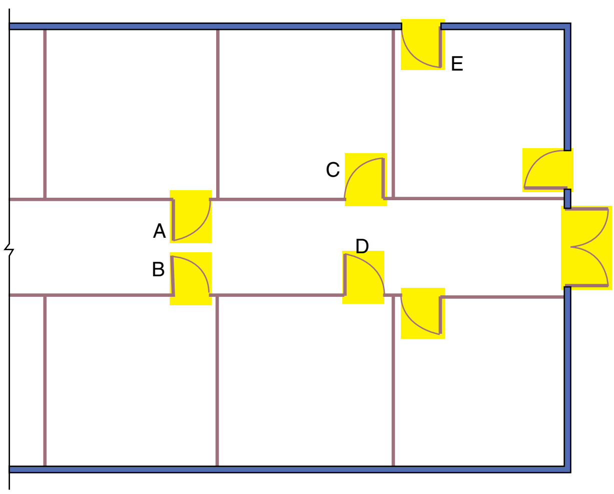
In NFPA *101*, 7.2.4.3.8(1) requires a swinging fire door assembly used in a horizontal exit to swing in the direction of egress travel.

If none of the requirements of 14.5.1.2(1) through (3) or 7.2.4.3.8(1) of NFPA *101* applies, a door leaf is permitted to swing against the direction of egress travel.

Ideally, all door leaves in a means of egress would swing in the direction of egress travel. However, because of operational concerns, there are cases where door leaf swing in the direction of egress travel is not desirable. For example, a classroom door leaf that swings into a corridor serving as an exit access for several classrooms might open against another door leaf or against the flow of people and possibly restrict the width available as corridor exit access. The *Code* recognizes this danger and permits the classroom/corridor door leaf from a room with an occupant load of fewer than 50 persons to swing against the direction of egress travel. This provision limits the number of people using a door opening whose door leaf swings against egress travel to that which is safe. The *Code* also recognizes similar constraints with regard to an exterior exit door assembly; although such a door assembly is considered an exit but not within an exit enclosure, the *Code* does not require that it swing in the direction of egress travel, unless it serves 50 or more occupants.

Exhibit 14.14 illustrates considerations involved in evaluating door leaf swing direction as addressed in 14.5.1.2. Door assembly C is permitted to swing back into the room if the room has an occupant load of fewer than 50 persons and does not have high hazard contents [see 14.5.1.2(1) and (3)]. Door assembly D must swing in the direction of egress travel if the room has an occupant load of 50 or more [see 14.5.1.2(1)]. Door assembly E, although it is an exit door assembly, is not used in an exit enclosure [see 14.5.1.2(2)], so its door leaf is permitted to swing back into the room if the occupant load is fewer than

Exhibit 14.14



Door leaf swing direction considerations.

50 and the room does not have high hazard contents. Door assemblies A and B are related to the encroachment-related provisions of 14.5.1.3. They open into the corridor directly opposite each other. Although this does not violate any *Code* provision, it is preferable that door leaves do not swing in a direction that blocks the use of the corridor when both are open.

Paragraph 14.5.1.2(1)(a) recognizes that the provisions of 7.2.4.3.8.1 of NFPA *101* exempt door leaves in horizontal exits from having to swing in the direction of egress travel in accordance with specific allowances and conditions for existing health care occupancies and existing detention and correctional occupancies. For these occupancies, staff is expected to be able to control occupant movement at horizontal exit door assemblies to prevent a crowd from pushing against a door leaf that is arranged to open only by swinging back toward the occupants. See 7.2.4.3.8.1 of NFPA *101*. Also see 7.2.4.3.8.2 of NFPA *101* for an exemption with applicability to any occupancy that recognizes the impracticality of replacing an existing horizontal exit door leaf with a pair of door leaves where the corridor does not have sufficient width to accommodate the pair.

Paragraph 14.5.1.2(1)(b) exempts smoke barrier door assemblies from having to swing in the direction of egress travel in existing health care occupancies. Such door assemblies usually span the width of a corridor. Because existing health care occupancies are permitted to have corridors as narrow as 48 in. (1220 mm), it might be impractical to install a pair of door leaves swinging in opposite directions. The single door leaf recognized by the exception swings in the correct direction for occupants on one side and swings against the direction of egress travel for occupants on the other side. Because staff directs the egress or relocation movement necessary during an emergency, the direction of door leaf swing problem is alleviated.

The exemption offered by 14.5.1.2(2) addresses the common design in apartment buildings in which door assemblies from the exit enclosure into apartment units normally swing into the apartment units. This design is common in a three-story, single-exit garden apartment. The swing of the door leaf in this arrangement is not a significant concern. The exemption also addresses another situation common to hotels where guest room door assemblies frequently open directly into an exit enclosure created to enclose a formerly open stair. Because it is often necessary to use part of the corridor to create a stair landing for the newly enclosed exit stair, the exemption offers some relief without compromising safety.

Per 14.5.1.2(3), door leaves to high hazard contents areas must swing in the direction of egress travel. A conflict sometimes arises between this requirement and the desire of those responsible for explosion control, who prefer that door leaves to areas subject to explosion be required to swing inward to impede spreading the effects of a blast to adjacent rooms and spaces. In new construction, this conflict can usually be resolved if the high hazard contents area can be located along an outside wall of the main building; the required egress door assemblies then open directly to the outside, which is desirable for life safety. This arrangement is also favorable for explosion relief, because it easily allows the door leaves to swing outward. In existing situations or where the hazardous area must be located internal to a building and away from exterior walls, the conflict is not easily resolved. The AHJ needs to work with the building owner, the insurer, and other involved parties to determine how best to reduce the explosion hazard while adequately providing needed life safety to those who work in the hazardous area. See also Section 7.11 of NFPA *101*.

N **A.14.5.1.2** See 7.4.2.1.2 and 7.4.2.2.2 of NFPA *101* for door swing direction requirements for working space about electrical equipment.

14.5.1.3 Door Leaf Encroachment.

14.5.1.3.1* During its swing, any door leaf in a means of egress shall leave not less than one-half of the required width of an aisle, a corridor, a passageway, or a landing unobstructed, unless both of the following conditions are met:

(1) The door opening provides access to a stair in an existing building.
(2) The door opening meets the requirement of 14.5.1.3.2.

[***101:***7.2.1.4.3.1]

Door leaves capable of swinging a full 180 degrees, so that they rest nearly flat against the wall in which the door opening is installed, have a greater utility than door leaves capable of swinging only 90 degrees. The 180-degree swinging door leaf can be fully opened into a corridor without significant intrusion on corridor width. The 90-degree swinging door leaf, however, might have to open into an unusually wide corridor, be set into an alcove, or otherwise be recessed so as not to exceed the maximum encroachment permitted by 14.5.1.3.1.

Note that 14.5.1.3.1 requires that, during its swing, a door leaf must leave unobstructed at least one-half the required width of a corridor. Note that this requirement is concerned with the required corridor width, which is not necessarily the same as the actual width. For example, in a corridor that is required to be 44 in. (1120 mm) wide but that is voluntarily constructed to be 56 in. (1420 mm) wide, a 34 in. (865 mm) wide door leaf — a door leaf that provides the minimum 32 in. (810 mm) clear width required by 7.2.1.2.3 of NFPA *101* — would swing to encroach on 34 in. (865 mm) of the corridor width. Although this encroachment is more than one-half the *actual* corridor width, it does leave one-half the *required* corridor width [22 in. (560 mm)] unobstructed. Such an arrangement meets the requirement of 14.5.1.3.1.

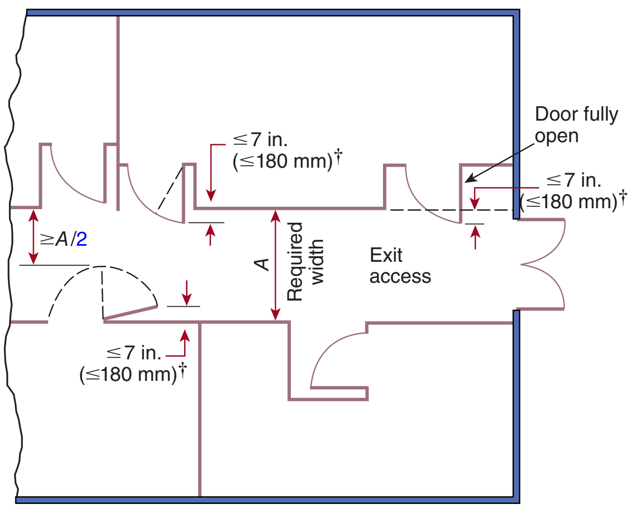
Door leaves that swing within a recessed pocket of the corridor, so as not to protrude into the required corridor width, provide the best arrangement for clear passage through an exit access corridor. Exhibit 14.15 shows a school classroom door swinging into a recessed pocket in the corridor. Door leaves that swing 180 degrees so that they come to rest against a wall and do not extend into more than 7 in. (180 mm) of required corridor width provide an acceptable arrangement. A door leaf that

Exhibit 14.15

Classroom door swinging into recessed pocket in corridor.

swings 90 degrees so that it comes to rest in the path of travel is considered not to encroach excessively on the exit access corridor width if not more than 7 in. (180 mm) of the required width of the corridor remains obstructed. Additionally, any door leaf swinging into the corridor must leave at least one-half the required corridor width unobstructed during its entire swing. See Exhibit 14.16.

Exhibit 14.16



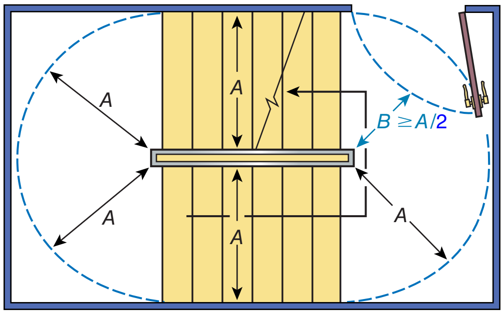
†Unless door leaf is self-closing

Door leaf swing into a corridor.

Door leaves of door assemblies serving as an entrance into an enclosed stair must not unduly block the stair landing or the stairs. Ideally, the door leaf should not reduce the required width either during its swing or while at rest. However, the *Code* does permit encroachment on the stair landing, as shown in Exhibit 14.17. For most stairs, Table 7.2.2.2.1.2(B) of NFPA *101* requires a 44 in. (1120 mm) clear width. In cases such as these, the $B \geq A/2$ rule shown in Exhibit 14.17 requires that the clearance between the leading edge of the opening door leaf and the stair newel post be at least 22 in. (560 mm). However, where the total occupant load of all floors served by the stair is fewer than 50 persons, 7.2.2.2.1.2(A) of NFPA *101* permits a 36 in. (915 mm) wide stair; in this case, the $B \geq A/2$ rule requires that the clearance between the leading edge of the opening door leaf and stair newel post be at least 18 in. (455 mm).

An acceptable arrangement for a door leaf opening onto a stair landing in an existing building is shown in Exhibit 14.18. In lieu of a $B \geq A/2$ rule, existing stairs are not required to maintain a specified clearance between the leading edge of the opening door leaf and the stair newel post.

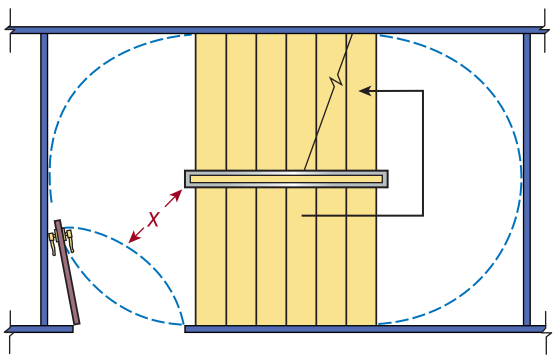
Exhibit 14.17



A — Required width
B — ≥*A*/2

Minimum required unobstructed clearance with door leaf encroaching on landing in new buildings.

Exhibit 14.18



X — No required minimum

Encroachment during door leaf swing not limited in existing buildings.

A.14.5.1.3.1 The requirements of 14.5.1.3 are not intended to apply to the swing of cross-corridor doors, such as smoke barrier doors and horizontal exits. Neither are the requirements intended to apply to doors from rooms that are typically unoccupied such as janitor's closets, electrical closets or telecommunications closets. [***101:***A.7.2.1.4.3.1]

14.5.1.3.2 When fully open, any door leaf in a means of egress shall not project more than 7 in. (180 mm) into the required width of an aisle, a corridor, a passageway, or a landing, unless the door leaf is equipped with an approved self-closing device and is not required by the provisions of 14.5.1.2 to swing in the direction of egress travel. [***101:***7.2.1.4.3.2]

14.5.1.3.3 Surface-mounted latch release hardware on the door leaf shall be exempt from being included in the maximum 7 in. (180 mm) projection requirement of 14.5.1.3.2, provided that both of the following criteria are met:

(1) The hardware is mounted to the side of the door leaf that faces the aisle, corridor, passageway, or landing when the door leaf is in the open position.
(2) The hardware is mounted not less than 34 in. (865 mm), and not more than 48 in. (1220 mm), above the floor.

[***101:***7.2.1.4.3.3]

The provision of 14.5.1.3.3 specifies that latch release hardware that is surface mounted to the side of the door leaf that faces the aisle, corridor, passageway, or landing when the door leaf is in the open position is exempted from inclusion in the maximum 7 in. (180 mm) projection specified in 14.5.1.3.1, provided that such hardware is mounted 34 in. to 48 in. (865 mm to 1220 mm) above the floor. The hardware on the back side of the door leaf is counted in the maximum 7 in. (180 mm) projection, but the hardware on the side of the door leaf that faces the landing is not. The provision is consistent with the door-opening clear width encroachment criteria of 7.2.1.2.1.1(5) of NFPA *101*. This provision helps to alleviate the problem where the AHJ cites the door leaf encroachment as excessive because of the latch release hardware that protrudes into the egress path. Wheelchair users are able to travel past the door without being encumbered, as the hardware must be at least 34 in. (865 mm) off the floor.

14.5.1.4 Screen Door Assemblies and Storm Door Assemblies. Screen door assemblies and storm door assemblies used in a means of egress shall be subject to the requirements for direction of swing that are applicable to other door assemblies used in a means of egress. [***101:***7.2.1.4.4]

14.5.1.5 Door Leaf Operating Forces.

Δ **14.5.1.5.1** The forces required to fully open any door leaf manually in a means of egress shall not exceed 15 lbf (67 N) to release the latch, 30 lbf (133 N) to set the leaf in motion, and 15 lbf (67 N) to open the leaf to the minimum required width, unless otherwise specified as follows:

(1) The opening forces for interior side-hinged or pivoted-swinging door leaves without closers shall not exceed 5 lbf (22 N).
(2) The opening forces for existing door leaves in existing buildings shall not exceed 50 lbf (222 N) applied to the latch stile.
(3) The opening forces for horizontal-sliding door leaves in detention and correctional occupancies shall be as provided in Chapters 22 and 23 of NFPA *101*.
(4) The opening forces for power-operated door leaves shall be as provided in 7.2.1.9 of NFPA *101*.

[***101:***7.2.1.4.5.1]

14.5.1.5.2 The forces specified in 14.5.1.5 shall be applied to the latch stile. [***101:***7.2.1.4.5.2]

The *Code* recognizes that several movements are necessary to move a door leaf from its closed to its fully open position. Paragraph 14.5.1.5.1 identifies each of those movements and limits the force needed to accomplish each. The force required to unlatch the door assembly is limited to 15 lbf (67 N); the force necessary to start the door leaf in motion or to overcome its inertia is limited to not more than 30 lbf (133 N); and the force necessary to move the door leaf to its required open position is limited to not more than 15 lbf (67 N).

Care must be taken to ensure that the 30 lbf (133 N) needed to overcome the inertia of a door leaf in a means of egress is not exceeded for door assemblies opening into pressurized stairs. The pressure necessary to protect the stair often might be such that 30 lbf (133 N) is insufficient to open the door leaf. The use of barometric relief dampers or other pressure-regulating methods might be required. See NFPA 92, *Standard for Smoke Control Systems*.

A person with severe mobility impairment, such as someone who uses a wheelchair, might find it difficult or impossible to exert even the 15 lbf (67 N) specified by 14.5.1.5.1. Specification of a lower operating force for self-closing door assemblies might adversely affect the door assembly closer's ability to perform its intended function of returning an open door leaf to the fully closed and latched position. For interior side-hinged or pivoted-swinging door assemblies without closers, no conflict exists between the needs of a closer and those of a person with physical disabilities. Therefore, 14.5.1.5.1(1) specifies that such door assemblies be operable when not more than 5 lbf (22 N) is applied at the latch stile.

Circumstances such as wet floors, smooth-soled shoes, and light body weight can render many people incapable of exerting 50 lbf (222 N) horizontally. Therefore, the maximum 50 lbf (222 N) operating requirement of earlier editions of the *Code* remains applicable only to existing door assemblies via the provisions of 14.5.1.5.1(2).

Items (3) and (4) of 14.5.1.5.1 address special situations where the operating force requirements of 14.5.1.5 cannot be applied. For horizontal-sliding door assemblies in detention and correctional occupancies, see 22.2.11.1.6 and 23.2.11.1.6 of NFPA *101*. For requirements specific to power-operated door assemblies, see 7.2.1.9 of NFPA *101*.

Paragraph 14.5.1.5.2 clarifies that the forces specified in 14.5.1.5.1 are to be applied to the latch stile.

14.5.2 Locks, Latches, and Alarm Devices.

An increase in thefts, muggings, and similar crimes has led to the practice of providing extra security on door assemblies within the means of egress. Such a practice, particularly where door assemblies to exit stairs and exit discharges are involved, is an open invitation to tragedy in the event of fire or other emergency. The provisions of 14.5.2 are aimed at preventing locked door assemblies in means of egress or any other unnecessary interference with the orderly movement of people through door openings in the event of fire. The *Code* has attempted to accomplish this objective while maintaining features that are essential to security within the building.

The requirement that door assemblies be easily openable from the egress side is consistent with the concept that all components in the means of egress must be under the control of the occupants. This requirement prohibits the use of key locks or hard-to-use devices, such as door handles or latches covered with glass that has to be broken. Where panic hardware or fire exit hardware is used, no device that might interfere with its operation can be used; however, this does not prevent the use of alarm connections that indicate that the door assembly is in use.

Requirements for door assemblies leading to exits also apply to door assemblies that open to roofs where, for example, exit stairs from a high-rise portion of the building discharge to the roof of the low-rise portion of the building and to exit discharge door assemblies leading to the street or other public way.

14.5.2.1 Door leaves shall be arranged to be opened readily from the egress side whenever the building is occupied. [***101:***7.2.1.5.1]

14.5.2.2* The requirement of 14.5.2.1 shall not apply to door leaves of listed fire door assemblies after exposure to elevated temperature in accordance with the listing, based on laboratory fire test procedures. [***101:***7.2.1.5.2]

A.14.5.2.2 Some fire door assemblies are listed for use with fire pins or fusible links that render the door leaf release inoperative upon exposure to elevated temperature during a fire. The door leaf release mechanism is made inoperative where conditions in the vicinity of the door opening become untenable for human occupancy, and such door opening no longer provides a viable egress path. [***101:***A.7.2.1.5.2]

14.5.2.3 Locks, if provided, shall not require the use of a key, a tool, or special knowledge or effort for operation from the egress side. [***101:***7.2.1.5.3]

Paragraph 14.5.2.1 establishes the principle that, when a building is occupied, door assemblies must be able to be opened easily from the side from which egress is to be made.

The provision of 14.5.2.2 is explained in A.14.5.2.2.

Paragraph 14.5.2.3 prohibits the installation of locks that require the use of a key, a tool, or special knowledge or effort to open the door leaf from the egress side. Door assemblies are generally permitted to be locked from the non-egress side, to prevent unauthorized entry into a building. However, door assemblies from an exit stair enclosure to the building floors might have to provide for re-entry as detailed in 14.5.2.8.

See the commentary following 14.5.2.6, which explains the concept whereby a door assembly with a magnetic lock, with building access via a card reader, can be considered a normal door assembly in compliance with 14.5.2.1, 14.5.2.3, and 14.5.2.10 if the door leaf has a latch release, like a lever handle with an integral switch that releases the lock to allow free egress by building occupants.

14.5.2.4 The requirements of 14.5.2.1 and 14.5.2.3 shall not apply where otherwise provided in Chapters 18 through 23 of NFPA *101*. [***101:***7.2.1.5.4]

Paragraph 14.5.2.4 cross-references the provisions applicable to health care occupancies and detention and correctional occupancies where door assemblies locked against egress by building occupants are permitted under specific conditions. For examples, see 18.1.1.1.7, 18.2.2.2.2, 18.2.2.2.4, and 18.2.2.2.5 of NFPA *101* and similar provisions in Chapter 19 of NFPA *101*. Also see 22.2.11.1 and 22.2.11.1.7 through 22.2.11.1.10 of NFPA *101* and similar provisions in Chapter 23 of NFPA *101*.

14.5.2.5 Key-Operated Locks.

Δ **14.5.2.5.1*** Exterior door assemblies shall be permitted to have key-operated locks from the egress side, provided that all of the following criteria are met:

(1) This alternative is permitted in Chapters 11 through 43 of NFPA *101* for the specific occupancy.
(2) A readily visible, durable sign in letters not less than 1 in. (25 mm) high on a contrasting background that reads as follows is located on or adjacent to the door leaf: THIS DOOR TO REMAIN UNLOCKED WHEN THE BUILDING IS OCCUPIED
(3) The locking device is of a type that is readily distinguishable as locked.
(4) A key is immediately available to any occupant inside the building when it is locked.

[***101:***7.2.1.5.5.1]

A.14.5.2.5.1 Where the entrance consists of an exterior vestibule, the locking arrangement should be permitted on the egress side of either the interior or exterior door of the vestibule. [***101:***A.7.2.1.5.5.1]

14.5.2.5.2 The alternative provisions of 14.5.2.5.1 shall be permitted to be revoked by the AHJ for cause. [***101:***7.2.1.5.5.2]

The provisions of 14.5.2.5.1 address key-operated locks that must meet four conditions — one of which is that the appropriate occupancy chapter of NFPA *101* must specifically permit use of the alternative. Compliance with 14.5.2.5.1(3), which requires that the locking device be of a type readily distinguishable as locked, is to be judged by the AHJ. Locks specifically designed to meet this requirement often have an indicating window mechanism that displays the word *open* when the device is in the unlocked position and the word *locked* when the device is in the locked position.

In permitting up to 10 persons in a locked building (i.e., an unoccupied building, as addressed in 7.2.1.1.3 of NFPA *101*), the *Code* does not dismiss such occupants as unimportant. The *Code* recognizes that there are instances in which a building must be occupied by security personnel or by janitorial crews when it is locked. Such persons are generally familiar with the premises, and the *Code* requires that they have keys available for egress when necessary.

The occupancies in the list that follows permit the use of the key-operated lock addressed by 14.5.2.5. Additional restrictions that might be imposed by the applicable occupancy chapter of NFPA *101* are contained in the paragraphs referenced within parentheses in the list. For example, in new assembly occupancies, use of a key-operated lock is restricted to the main exit of a building with an occupant load of not more than 500 persons. In addition, the main exit of the assembly occupancy is required to consist of a single door leaf or single pair of door leaves, and any latch on the door leaf or leaves is required to be released by panic hardware.

The occupancies permitting the use of the key-operated lock addressed in 14.5.2.5 are as follows:

1. Assembly occupancies (12.2.2.2.4 and 13.2.2.2.4 of NFPA *101*)
2. Mercantile occupancies (36.2.2.2.2 and 37.2.2.2.2 of NFPA *101*)
3. Business occupancies (38.2.2.2.3 and 39.2.2.2.3 of NFPA *101*)

Exhibit 14.19 shows the sign for an assembly occupancy required by 14.5.2.5.1(2).

Exhibit 14.19

Sign over door subject to locking in an assembly occupancy.

Δ **14.5.2.6 Door Hardware Release of Electrically Locked Egress Door Assemblies.** Door assemblies in the means of egress shall be permitted to be equipped with approved electrical locking systems released by the operation of door hardware provided that all of the following conditions are met:

(1) The hardware for egress-side occupant release of the electrical lock is affixed to the door leaf.
(2) The hardware has an obvious method of operation that is readily operated in the direction of egress under all lighting conditions.
(3) The hardware is capable of being operated with one hand in the direction of egress.
(4) Operation of the hardware directly interrupts the power supply to the electric lock and unlocks the door assembly in the direction of egress.
(5) Loss of power to the listed releasing hardware automatically electrically unlocks the door assembly in the direction of egress.
(6) Hardware for new installations is listed in accordance with ANSI/UL 294.

[***101:***7.2.1.5.6]

The provisions of 14.5.2.6 address door hardware release of electrically locked egress doors as a normal door assembly and not as a special locking arrangement. Note that the provisions are positioned within 14.5.2, related to traditional locks and latches, and not within 14.5.3, which addresses specialized, nontraditional locking arrangements like delayed-egress electrical locking systems and sensor-release of electrical locking systems.

The door assemblies addressed by 14.5.2.6 typically take the form of a door leaf that is held locked to its frame via an electromagnet. Some AHJs, in enforcing the provisions of earlier editions of the *Code*, often required any door assembly with an electromagnetic lock to comply with one of the sets of provisions of 14.5.3 for special locking arrangements, regardless of how the lock was operated. The text of 14.5.2.6 has the effect of equating the electrically controlled lock to a traditional, mechanically latched or locked door.

The criteria detailed in 14.5.2.6(1) through (6) ensure that the electrically controlled egress door assembly meets the requirements of 14.5.2.1, 14.5.2.3, and 14.5.2.10, as well as additional safeguards imposed, because the lock is electrically controlled. See also the third sentence of A.14.5.2.10.

14.5.2.7 Where permitted in Chapters 11 through 43 of NFPA *101*, key operation shall be permitted, provided that the key cannot be removed when the door leaf is locked from the side from which egress is to be made. [***101:***7.2.1.5.7]

Paragraph 14.5.2.7 permits what is known as *captive key* hardware, which is permitted in lodging or rooming houses via the provisions of 26.2.3.6 of NFPA *101*. The captive key lock has the potential for misuse and must be used carefully. The design of the lock is such that an occupant could unlock the door assembly from the inside, thus freeing the key; move through the door opening, taking the key to the outside; lock the door assembly from the outside; and leave the property — potentially leaving others locked in the building. Thus, this lock is permitted with limited use within the occupancy chapters of NFPA *101*.

Δ **14.5.2.8*** Every door assembly in a stair enclosure serving more than four stories, unless permitted by 14.5.2.8.2, shall meet one of the following conditions:

(1) Re-entry from the stair enclosure to the interior of the building shall be provided.
(2) An automatic release that is actuated with the initiation of the building fire alarm system shall be provided to unlock all stair enclosure door assemblies to allow re-entry.
(3) Selected re-entry shall be provided in accordance with 14.5.2.8.1.

[***101:***7.2.1.5.8]

A.14.5.2.8 It is intended that the re-entry provisions apply only to enclosed exit stairs, not to outside stairs. This arrangement makes it possible to leave the stairway at such floor if the fire renders the lower part of the stair unusable during egress or if the occupants seek refuge on another floor. [***101:***A.7.2.1.5.8]

Every door assembly in a stair enclosure serving more than four stories in a new building or nonsprinklered high-rise existing building [see 14.5.2.8.2(1) and (2)] must be arranged to permit re-entry into the building. However, the *Code* recognizes the need for varying degrees of security and does specify some equivalent alternatives. Stairway door assemblies are permitted to be locked to the stairwell side if arranged to unlock automatically upon initiation of the fire alarm system. Selected re-entry is addressed in the commentary associated with 14.5.2.8.1.

Δ **14.5.2.8.1** Door assemblies on stair enclosures shall be permitted to be equipped with hardware that prevents re-entry into the interior of the building, provided that the following criteria are met:

(1) There shall be not less than two levels where it is possible to leave the stair enclosure to access another exit.
(2) There shall be not more than four stories intervening between stories where it is possible to leave the stair enclosure to access another exit.
(3) Re-entry shall be possible on the top story or next-to-top story served by the stair enclosure, and such story shall allow access to another exit.
(4) Door assemblies allowing re-entry shall be identified as such on the stair side of the door leaf.
(5) Door assemblies not allowing re-entry shall be provided with a sign on the stair side indicating the location of the nearest door opening, in each direction of travel, that allows re-entry or exit.

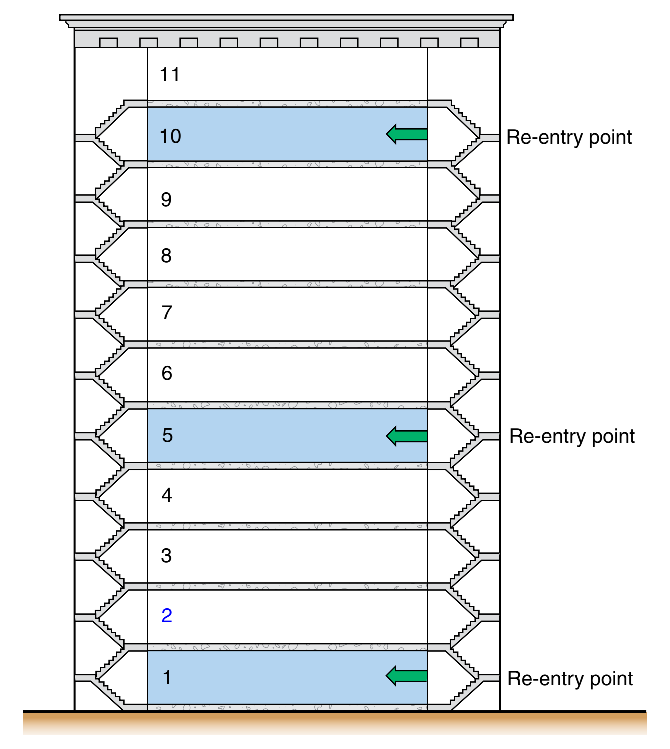
[***101:***7.2.1.5.8.1]

Paragraph 14.5.2.8.1 permits some stair enclosure door assemblies, regardless of occupancy, to be locked to prevent re-entry on selected floors. In such instances, at least two levels with unlocked door assemblies must provide a way out of the stairway, one of which must be the top floor or the next-to-top floor; the other is usually the door assembly at the level of exit discharge. Because the *Code* prohibits more than four floors between floors that provide a way out of the stairway, stair enclosures serving more than six or seven stories must have more than two unlocked re-entry points. This arrangement provides flexibility in buildings that, perhaps for security reasons, need to prevent re-entry on certain floors, while at the same time ensuring that a person can re-enter the building without having to travel up or down too many flights of stairs. See Exhibit 14.20. Any door assembly providing a way out of the stair enclosure must be identified as such on the stairwell side.

Δ **14.5.2.8.2** The requirements of 14.5.2.8, except as provided in 14.5.2.8.3, shall not apply to the following:

(1) Existing installations in buildings that are not high-rise buildings as permitted in Chapters 11 through 43 of NFPA *101*.

Exhibit 14.20



Stairway selected re-entry option.

(2) Existing installations in high-rise buildings as permitted in Chapters 11 through 43 of NFPA *101* where the occupancy is within a building protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3.
(3) Existing approved stairwell re-entry installations as permitted by Chapters 11 through 43 of NFPA *101*.
(4) Stair enclosures serving a building permitted to have a single exit in accordance with Chapters 11 through 43 of NFPA *101*.
(5) Stair enclosures in health care occupancies where otherwise provided in Chapter 18 of NFPA *101*.
(6) Stair enclosures in detention and correctional occupancies where otherwise provided in Chapter 22 of NFPA *101*.

[***101:***7.2.1.5.8.2]

14.5.2.8.3 When the provisions of 14.5.2.8.2 are used, signage on the stair door leaves shall be required as follows;

(1) Door assemblies allowing re-entry shall be identified as such on the stair side of the door leaf.
(2) Door assemblies not allowing re-entry shall be provided with a sign on the stair side indicating the location of the nearest door opening, in each direction of travel, that allows re-entry or exit.

[***101:***7.2.1.5.8.3]

The provisions of 14.5.2.8.2(1) and (2) work together as follows:

1. Existing stair installations in a non-high-rise building are permitted to be exempted by the applicable occupancy chapter of NFPA *101*.

2. Existing stair installations in a high-rise building are permitted to be exempted by the applicable occupancy chapter of NFPA *101* only if the building is fully sprinklered.
3. Where the existing high-rise building is not sprinklered, re-entry in accordance with 14.5.2.8 is required.

Where an existing stairwell re-entry installation does not meet all the criteria of 14.5.2.8, the provision of 14.5.2.8.2(3) establishes that the existing installation can be continued in use if approved. The term *approved* means acceptable to the AHJ, and its definition appears in 3.2.1.

Paragraph 14.5.2.8.2(4) recognizes that re-entry in buildings permitted to have a single exit is not necessary. In most single-exit buildings, the door assemblies from the stairway open directly into the occupant space. Most of the single-exit buildings recognized by the occupancy chapters of NFPA *101* are not more than four stories in height and are exempt from the stairwell re-entry provisions via the base paragraph of 14.5.2.8.

The provisions of 14.5.2.8.2(5) and (6) specify, for correlation with the occupancy chapters of NFPA *101*, that health care occupancies and detention and correctional occupancies are exempt from the stair enclosure re-entry provisions. The exemption is based on the level of protection provided via a defend-in-place approach that minimizes the need for vertical evacuation by stairs or, where such movement is needed, relies heavily on staff with access to keys to direct the evacuation or relocation.

The provisions of 14.5.2.8.3 require signage in each exit stair enclosure serving more than four stories and not providing re-entry in accordance with the criteria of 14.5.2.8(1), (2), or (3). The signage must be installed on the stair side of each door leaf. The provisions of 14.5.2.8.3 are illustrated by the following example: An existing business occupancy building is six stories in height above grade plane. Egress from all floors above floor 1 is provided by two remote exit stair enclosures that are accessed by a corridor on each floor. On floors 2 through 6, all door leaves from the corridor to the exit stair enclosures are locked from the stairwell side to prevent re-entry as permitted by 39.2.2.2.5(1) of NFPA *101* and 14.5.2.8.2(1). On floor 1, the door from the corridor to each stair enclosure is left unlocked to permit re-entry onto the floor. In accordance with 14.5.2.8.3(2), the exit stair enclosure door leaves on floors 2 through 6 must be provided with signage, on the stair side, indicating that re-entry is provided at floor 1.

14.5.2.9 If a stair enclosure allows access to the roof of the building, the door assembly to the roof either shall be kept locked or shall allow re-entry from the roof. [***101:***7.2.1.5.9]

Paragraph 14.5.2.9 was written to prevent building occupants from being trapped on a roof by a locked door assembly that does not permit re-entry into the building. If security concerns, for example, dictate that rooftop door assemblies are to be locked against entry from the outside, then the door assemblies also need to be locked from the inside to prevent unauthorized building occupants from going to the roof and becoming trapped. Note that there is no requirement that stair enclosure door assemblies provide rooftop access. Heroic helicopter rescues from rooftops of burning buildings are Hollywood movie illusions that seldom happen in real life.

14.5.2.10* A latch or other fastening device on a door leaf shall be provided with a releasing device that has an obvious method of operation and that is readily operated under all lighting conditions. [***101:***7.2.1.5.10]

A.14.5.2.10 Examples of devices that might be arranged to release latches include knobs, levers, and bars. This requirement is permitted to be satisfied by the use of conventional types of hardware, whereby the door is released by turning a lever, knob, or handle or by pushing against a bar, but not by unfamiliar methods of operation such as a blow to break glass. It is also within the intent of this requirement that switches integral to traditional doorknobs, lever handles, or bars, and that interrupt the power supply to an electromagnetic lock, be permitted, provided that they are affixed to the door leaf. The operating devices should be capable of being operated with one hand and should not require tight grasping, tight pinching, or twisting of the wrist to operate. [***101:***A.7.2.1.5.10]

Paragraph 14.5.2.10 requires that, where a latch or other similar device is provided, the method of operation of its releasing device must be obvious, even in the dark. The intention of this requirement is that the method of release be one that is familiar to the average person. Generally, a two-step release, such as a knob and an independent slide bolt, is not permitted. In most occupancies, it is important that a single action unlatch the door assembly. See the commentary following 14.5.2.10.7 for an explanation of night latches permitted as a device in addition to the main latch/lock on residential occupancy dwelling unit door assemblies.

See the commentary following 14.5.2.6, which explains the concept whereby a door assembly with an electrically controlled lock can be considered a normal door assembly in compliance with 14.5.2.1, 14.5.2.3, and 14.5.2.10 if the door assembly includes an arrangement where the locked door leaf is provided with a latch release, like a lever handle with an integral switch that releases the lock to allow free egress by building occupants. See 14.5.2.6(1) through (6), which details these criteria.

14.5.2.10.1 The releasing mechanism for any latch shall be located as follows:

(1) Not less than 34 in. (865 mm) above the finished floor for other than existing installations
(2) Not more than 48 in. (1220 mm) above the finished floor

[***101:***7.2.1.5.10.1]

14.5.2.10.2 The releasing mechanism shall open the door leaf with not more than one releasing operation, unless otherwise specified in 14.5.2.10.3 and 14.5.2.10.4 or 14.5.2.10.6. [***101:***7.2.1.5.10.2]

14.5.2.10.3* Egress door assemblies from individual living units and guest rooms of residential occupancies shall be permitted to be provided with devices, including automatic latching devices, that require not more than one additional releasing operation, provided that such device is operable from the inside without the use of a key or tool and is mounted at a height not exceeding 48 in. (1220 mm) above the finished floor. [***101:***7.2.1.5.10.3]

A.14.5.2.10.3 Examples of devices that, when used with a latch, can be arranged to require not more than one additional releasing operation include night latches, dead bolts, and security chains. [***101:***A.7.2.1.5.10.3]

14.5.2.10.4 Existing security devices permitted by 14.5.2.10.3 shall be permitted to have two additional releasing operations. [***101:***7.2.1.5.10.4]

14.5.2.10.5 Existing security devices permitted by 14.5.2.10.3, other than automatic latching devices, shall be located not more than 60 in. (1525 mm) above the finished floor. [***101:***7.2.1.5.10.5]

14.5.2.10.6 Two releasing operations shall be permitted for existing hardware on a door leaf serving an area having an occupant load not exceeding three, provided that releasing does not require simultaneous operations. [***101:***7.2.1.5.10.6]

N **14.5.2.10.7** Where permitted by Chapters 11 through 43 of NFPA *101*, two releasing operations shall be permitted for doors secured against unwanted entry. [***101:***7.2.1.5.10.7]

Paragraph 14.5.2.10.1 specifies that new latch release mechanisms be located at least 34 in. (865 mm) above the floor, and that both new and existing latch release mechanisms be not more than 48 in. (1220 mm) above the floor, so that the latch release is located in a position that is neither too low nor too high to be reached by persons in wheelchairs. The maximum mounting height for the latch release also helps to ensure that children can reach the latch.

Paragraphs 14.5.2.10.3 and 14.5.2.10.4 provide an exemption to the requirement for a single releasing mechanism. The exemption recognizes the use, in residential living units and hotel guest rooms, of one additional device requiring release in new construction and two additional devices requiring release in existing installations. The exemption permits an existing condition to continue where a hotel room door assembly, for example, has hardware arranged such that one operation releases the security chain or bar (i.e., night latch), another operation releases the dead bolt (usually via a thumb turn-type knob), and a third operation releases the door latch (usually by turning the doorknob or operating the door lever). However, in new installations, if a night latch or security device is installed, one operation would release the security device and a second operation, such as turning the doorknob or operating the door lever, would have to release both the dead bolt and normal door latch. Hardware that releases both the dead bolt and the normal door latch by turning the door lever is called a *hotel latch set* and is shown in Exhibit 14.21.

Exhibit 14.21

Hotel latch set.

The *Code* prohibits supplemental automatic latching security devices from being located more than 48 in. (1220 mm) above the floor, even in existing buildings (see 14.5.2.10.3). This prohibition is intended to prevent children and wheelchair users from being trapped in a space when an automatic latching device that is located above a person's reach engages, locking the door assembly. Existing security devices that must be physically engaged are permitted in locations not more than 60 in. (1525 mm) above the floor (see 14.5.2.10.5), based on the assumption that the person engaging such a device is present to disengage it when needed.

Paragraph 14.5.2.10.6 offers a leniency to existing situations where two releasing operations are required to release the door latch. The allowance expands the use of a practice formerly permitted only in residential occupancies but controls such situations by restricting the door to serving an area with an occupant load not exceeding three persons. The provision would permit a night chain to be dropped, followed by the turning of a door knob. It does not permit simultaneous operations such as sliding a bolt and then turning a release lever while holding the bolt in its new position.

The provision of 7.2.1.5.10.7 is new for the 2018 edition of NFPA *101*. It recognizes, for example, the new allowance of 15.2.2.2.4 in NFPA *101* for existing educational occupancy buildings to secure classroom doors against unwanted entry provided that classroom occupants can release the locking mechanism to open the door leaf with not more than two releasing operations. New educational occupancy buildings are permitted by 14.2.2.2.4 in NFPA *101* to lock classroom doors against unwanted entry but must be able to release the lock and open the door leaf with not more than one releasing operation as required by 14.5.2.10.2 of this *Code*.

Δ **14.5.2.11** Where pairs of door leaves are required in a means of egress, one of the following criteria shall be met:

(1) Each leaf of the pair shall be provided with a releasing device that does not depend on the release of one leaf before the other.
(2) Approved automatic flush bolts shall be used and arranged such that both of the following criteria are met:
 (a) The door leaf equipped with the automatic flush bolts shall have no doorknob or surface-mounted hardware on the egress side of the door.
 (b) Unlatching of any leaf shall not require more than one operation.

[***101:***7.2.1.5.11]

The requirement of 14.5.2.11(1) for independent releasing hardware applies only to pairs of door leaves in a common door opening where both door leaves are required for means of egress. If a second leaf is provided for a reason other than required egress, that leaf can have a releasing mechanism that requires the egress leaf to be released first. However, in such a case, the leaf not used for egress must be arranged so it is not mistaken for the egress door leaf.

Paragraph 14.5.2.11(2) permits a pair of door leaves — both a part of the required means of egress — to be placed within a common frame, whereby one leaf has no visible releasing hardware but has approved automatic flush bolts that release that leaf when the other leaf, which has visible hardware, is released. Therefore, the user is directed to the leaf with releasing hardware and disengages the latch on that leaf, and the other leaf automatically unlatches to allow its use if pushed in the direction of door leaf travel.

14.5.2.12* Devices shall not be installed in connection with any door assembly on which panic hardware or fire exit hardware is required where such devices prevent or are intended to prevent the free use of the leaf for purposes of egress, unless otherwise provided in 14.5.3. [***101:***7.2.1.5.12]

A.14.5.2.12 Examples of devices prohibited by this requirement include locks, padlocks, hasps, bars, chains, or combinations thereof. [***101:***A.7.2.1.5.12]

It is not the intent of 14.5.2.12 to require panic hardware or fire exit hardware; that requirement is specified by the various occupancy chapters of NFPA *101*. Rather, 14.5.2.12 requires that, where panic hardware or fire exit hardware is installed, no device or arrangement is to interfere with its intended function. The intended function is the release of the latch when pressure — such as that exerted by persons pushing up against the door leaf — is applied to the bar or pad extending across the majority of the door leaf width [see 14.5.3.4.1(1)].

14.5.3* Special Locking Arrangements.

A.14.5.3 None of the special locking arrangements addressed in 14.5.3 are intended to allow *credentialed egress, request to exit*, or similar provisions, where an occupant cannot leave the building without swiping a card through a reader. Where such an arrangement is desired to keep track of occupants, the swiping of cards needs to be procedural but not necessary for releasing the door lock or latch. Free egress needs to be available at all times. Another option to free egress is the use of a delayed-egress electrically locking system. [***101:***A.7.2.1.6]

The special locking arrangements described in 14.5.3 include delayed-egress electrical locking systems, sensor-release of electrical locking systems, and elevator lobby exit access door assemblies locking. Each of these terms has a specific, but limited, meaning for purposes of applying the *Code*. For example, a building operator installs a magnetic lock on an outside door assembly and provides a card reader outside the building that releases the door assembly lock, so that only authorized persons are allowed entry to the building. Further, a lever handle is mounted on the inside surface of the door leaf and has an integral switch that releases the magnetic lock whenever a building occupant operates the lever. The building operator refers to this system as a sensor-release of electrical locking system, but it is not the sensor-release of electrical locking system addressed in 14.5.3.2, and it is not subject to those requirements. Rather, the door assembly locking system described is an electrically controlled egress door assembly subject to the provisions of 14.5.2.6. Such door assemblies in accordance with 14.5.2.6 comply with 14.5.2.1, 14.5.2.3, and 14.5.2.10 so as not to be considered special locking arrangements. The concept is further explained by the third sentence of A.14.5.2.10.

14.5.3.1 Delayed-Egress Electrical Locking Systems.

Δ **14.5.3.1.1** Approved, delayed-egress electrical locking systems shall be permitted to be installed on door assemblies serving low and ordinary hazard contents in buildings protected throughout by an approved, supervised automatic fire detection system in accordance with Section 13.7 or an approved, supervised automatic sprinkler system in accordance with Section 13.3, and where permitted in Chapters 11 through 43 of NFPA *101*, provided that the following criteria are met:

(1) The delay of the delayed-egress electrical locking system shall deactivate allowing unobstructed egress upon actuation of one of the following:
 (a) Approved, supervised automatic sprinkler system in accordance with Section 13.3
 (b) Not more than one heat detector of an approved, supervised automatic fire detection system in accordance with Section 13.7
 (c) Not more than two smoke detectors of an approved, supervised automatic fire detection system in accordance with Section 13.7
(2) The delay of the delayed-egress electrical locking system shall deactivate allowing unobstructed egress upon loss of power controlling the lock or locking mechanism.
(3)* An irreversible process shall release the electrical lock in the direction of egress within 15 seconds, or 30 seconds where approved by the AHJ, upon application of a force to the release

device required in 14.5.2.10 under all of the following conditions:

(a) The force shall not be required to exceed 15 lbf (67 N).
(b) The force shall not be required to be continuously applied for more than 3 seconds.
(c) The initiation of the release process shall activate an audible signal in the vicinity of the door opening.
(d) Once the electrical lock has been released by the application of force to the releasing device, rearming the delay electronics shall be by manual means only.

A.14.5.3.1.1(3) It is not the intent to require a direct physical or electrical connection between the door release device and the lock. It is the intent to allow door movement initiated by operating the door release device required in 14.5.2.10 as one option to initiate the irreversible process. [***101:***A.7.2.1.6.1.1(3)]

Several factors need to be considered in approving an increase in delay time from 15 seconds to 30 seconds. Some of those factors include occupancy, occupant density, ceiling height, fire hazards present, fire protection features provided, and the location of the delayed-egress locks. An example of a location where the increase on delay time might not be approved is at an exit stair discharge door. [***101:***A.7.2.1.6.1.1(3)]

(4)* A readily visible, durable sign that conforms to the visual characters requirements of ICC/ANSI A117.1 shall be located on the door leaf adjacent to the release device in the direction of egress, and shall read as follows:

(a) PUSH UNTIL ALARM SOUNDS, DOOR CAN BE OPENED IN 15 SECONDS, for doors that swing in the direction of egress travel
(b) PULL UNTIL ALARM SOUNDS, DOOR CAN BE OPENED IN 15 SECONDS, for doors that swing against the direction of egress travel

A.14.5.3.1.1(4) In the event that the AHJ has permitted increased operation time, the sign should reflect the appropriate time. [***101:***A.7.2.1.6.1.1(4)]

(5) The egress side of doors equipped with delayed-egress electrical locking system shall be provided with emergency lighting in accordance with Section 7.9 of NFPA *101*.
(6) Hardware for new installations shall be listed in accordance with ANSI/UL 294, *Standard for Access Control System Units*.

[***101:***7.2.1.6.1.1]

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Delayed-egress locking systems prevent a door leaf from being opened for 15 seconds or 30 seconds under either nonemergency conditions or those encountered very early in a fire or similar emergency. Delayed-egress locking systems are to be used only where specifically permitted by the appropriate occupancy chapter of NFPA *101*. Their use is further limited to buildings protected throughout by either an approved, supervised automatic fire detection system or an approved, supervised automatic sprinkler system.

Item (1) of 14.5.3.1.1 requires that the locking devices unlock upon activation of the corresponding detection or sprinkler system. The required detection system provides early warning; the alternately required sprinkler system provides early control of the fire — with each system performing to the degree necessary to make tolerable the delay experienced in waiting for the door leaf to be unlocked.

Item (2) of 14.5.3.1.1 provides a fail-safe feature where, upon loss of the electrical power that controls the lock, immediate unlocking from the egress side occurs. Note that, where the door leaf is unlocked, it is not required to be unlatched. Building occupants might need to operate the actuating bar or push pad to release the latch before opening the door, and the door might remain locked from the non-egress side. See the sixth paragraph of this commentary.

Item (3) of 14.5.3.1.1 requires that, once the release device is manually activated, the door leaf must unlock within 15 seconds or, with specific permission of the AHJ, within 30 seconds. This action must be irreversible and cannot require the user to maintain pressure on the release device for more than 3 seconds. To provide occupants attempting egress with cues to indicate that the system is functioning, a signal is sounded in the vicinity of the door opening. Additionally, the signage required by 14.5.3.1.1(4) provides useful, reassuring information.

After the door leaf is unlatched and physically opened (i.e., swung on its hinges away from the door frame), it is permitted to be relocked by manual means only. Relocking generally involves returning the door leaf to its closed and latched position and then resetting the system to engage the lock. Relatching is not prohibited, provided that the releasing mechanism (i.e., the push pad or actuating bar), when operated, unlatches the door leaf without any delay.

Note that the unlocking required by 14.5.3.1.1(1), (2), and (3) need not automatically open the door leaf. Rather, the door leaf is permitted to remain latched. The unlocking allows the user to open the door leaf immediately by operating the releasing mechanism on the door leaf. Security is not sacrificed. Of course, any exterior exit door assembly is permitted to be locked against building entry at any time. Also see the third paragraph of this commentary.

The positioning of the provision of 14.5.3.1.1(5) reinforces the emergency lighting requirements of 14.13.1.1(4). It is helpful to the user to see the requirement repeated as part of the provisions for delayed-egress electrical locking systems.

The provision of 14.5.3.1.1(6) is new for the 2018 edition of NFPA *101*. It requires new delayed-egress electrical locking systems hardware to comply with a listing laboratory test standard specifically developed for such hardware, namely, ANSI/UL 294, *Standard for Access Control System Units*.

Exhibit 14.22 shows delayed-egress electrical locking systems hardware and the sign required by 14.5.3.1.1(4).

The occupancies in the list that follows are permitted by NFPA *101* to use delayed-egress electrical locking systems in accordance with 14.5.3.1. Additional restrictions that might be imposed by the occupancy chapter of NFPA *101* are contained in the paragraphs referenced within parentheses in the list. For example, lodging or rooming houses, hotels and dormitories,

Exhibit 14.22

Delayed-egress electrical locking system hardware.

and apartment buildings permit delayed-egress electrical locking systems if all the conditions of 14.5.3.1 are met.

The occupancies permitting delayed-egress electrical locking systems are as follows:

1. Assembly occupancies (12.2.2.2.5 and 13.2.2.2.5 of NFPA *101*)
2. Educational occupancies (14.2.2.2.3.1 and 15.2.2.2.3.1 of NFPA *101*)
3. Day-care occupancies (16.2.2.2.3.1 and 17.2.2.2.3.1 of NFPA *101*)
4. Health care occupancies [18.2.2.2.4(2) and 19.2.2.2.4(2) of NFPA *101*]
5. Ambulatory health care occupancies (20.2.2.2.6 and 21.2.2.2.6 of NFPA *101*)
6. Lodging or rooming houses (26.2.3.5.2 of NFPA *101*)
7. Hotels and dormitories (28.2.2.2.2.2 and 29.2.2.2.2.2 of NFPA *101*)
8. Apartment buildings (30.2.2.2.2.2 and 31.2.2.2.2.2 of NFPA *101*)
9. Residential board and care occupancies [32.2.2.5.5.1, 32.3.2.2.2(4), 33.2.2.5.5.1, and 33.3.2.2.2(4) of NFPA *101*]
10. Mercantile occupancies (36.2.2.2.5 and 37.2.2.2.5 of NFPA *101*)
11. Business occupancies (38.2.2.2.6 and 39.2.2.2.6 of NFPA *101*)
12. Industrial occupancies (40.2.2.2.2 of NFPA *101*)
13. Storage occupancies (42.2.2.2.2 and 42.8.2.2.2.2 of NFPA *101*)

14.5.3.1.2 The provisions of 14.5.3.2 for sensor-release of electrical locking systems shall not apply to door assemblies with delayed-egress electrical locking systems. [***101:***7.2.1.6.1.2]

Paragraph 14.5.3.1.2 serves mainly as a reminder that delayed-egress electrical locking systems and sensor-release of electrical locking systems are two different features that are not to be intermixed. In the case of delayed-egress electrical locking systems, the releasing mechanism is mounted on the door leaf, and the system delays occupants from initially opening the door leaf. Sensor-release of electrical locking systems involve a door assembly that is not provided with an occupant-activated releasing mechanism on the door leaf and, therefore, relies on a motion detector to sense the approaching occupant, with the door leaf unlocking as the occupant reaches the door leaf.

Δ **14.5.3.2 Sensor-Release of Electrical Locking Systems.** Where permitted in Chapters 11 through 43 of NFPA *101*, door assemblies in the means of egress shall be permitted to be equipped with sensor-release electrical locking system hardware provided that all of the following criteria are met:

(1) A sensor shall be provided on the egress side, arranged to electrically unlock the door leaf in the direction of egress upon detection of an approaching occupant.
(2) Door leaves shall automatically electrically unlock in the direction of egress upon loss of power to the sensor or to the part of the locking system that electrically locks the door leaves.
(3) Door locks shall be arranged to electrically unlock in the direction of egress from a manual release device complying with all of the following criteria:
    (a) The manual release device shall be located on the egress side, 40 in. to 48 in. (1015 mm to 1220 mm) vertically above the floor, and within 60 in. (1525 mm) of the secured door openings.
    (b) The requirement of 14.5.3.2(3)(a) to locate the manual release device within 60 in. (1525 mm) of the secured door opening shall not apply to previously approved existing installations.
    (c) The manual release device shall be readily accessible and clearly identified by a sign that reads as follows: PUSH TO EXIT.
    (d) When operated, the manual release device shall result in direct interruption of power to the electrical lock — independent of the locking system electronics — and the lock shall remain unlocked for not less than 30 seconds.
(4) Activation of the building fire-protective signaling system, if provided, shall automatically electrically unlock the door leaves in the direction of egress, and the door leaves shall remain electrically unlocked until the fire-protective signaling system has been manually reset.
(5) The activation of manual fire alarm boxes that activate the building fire-protective signaling system specified in 14.5.3.2(4) shall not be required to unlock the door leaves.
(6) Activation of the building automatic sprinkler or fire detection system, if provided, shall automatically electrically unlock the door leaves in the direction of egress, and the door leaves shall remain electrically unlocked until the fire-protective signaling system has been manually reset.

(7) The egress side of sensor-release electrically locked egress doors, other than existing sensor-release electrically locked egress doors, shall be provided with emergency lighting in accordance with Section 14.13.

(8) Hardware for new installations shall be listed in accordance with ANSI/UL 294.

[***101:***7.2.1.6.2]

The sensor-release of electrical locking systems addressed by 14.5.3.2 are intended to be locked against access from the outside the building and require a magnetic card or similar instrument for authorized entry. However, such door assemblies must be arranged for free egress use whenever the building is occupied. The *Code* addresses these door assemblies under the subject of special locking arrangements because such door assemblies generally do not have the leaf-mounted manual latch/lock release typically installed on egress door assemblies. The absence of the door leaf–mounted manual latch/lock release prevents a person on the outside from inserting a wire hanger or other tool between the gaps at the door leaf edges to reach the release. Use of sensor-release of electrical locking systems requires specific occupancy chapter permission from NFPA *101*.

See the commentary following 14.5.3, which explains the concept whereby a door assembly with a magnetic lock, with building access via a card reader, can be considered a normal door assembly in accordance with 14.5.2.6 if the door leaf has a lever handle with an integral switch that releases the lock to allow free egress by building occupants.

Paragraph 14.5.3.2(1) provides for the door leaf to unlock when a sensor detects an occupant approaching the door opening. This method is the normal primary means of releasing the lock to allow occupants to leave the building. If the sensor and the release system fail, the requirements of 14.5.3.2(3) through (5) provide a backup system consisting of a manual lock release mounted at a usable height in the immediate vicinity of the door opening. The *Code* permits the manual release to be installed as much as 60 in. (1525 mm) from the secured door assembly, recognizing that the glass sidelights featured on many of these door assemblies are an impractical place to install a manual release device.

Additionally, 14.5.3.2(2) requires a fail-safe feature to unlock the door leaf, in the direction of egress travel, immediately upon loss of the electrical power that controls the lock.

Items (1) through (3) of 14.5.3.2 work together to help ensure that the door opening is usable at all times, before and during a fire emergency. Items (4) and (6) of 14.5.3.2 provide added assurance that the door opening is usable under fire emergency conditions. If the building has a fire alarm system, initiation of that system (by devices other than manual fire alarm boxes) must unlock the door leaf. If the building has either a fire detection system or a sprinkler system, activation of such system must unlock the door leaf.

Item (5) of 14.5.3.2 clarifies that, if the building fire alarm system is initiated by a manual fire alarm box (formerly called a pull station), the door assembly is not required to unlock. This provision prevents an occupant who is intent on circumventing the security provided by such a door assembly from pulling the manual fire alarm box lever, which would initiate the alarm system and unlock the door assembly. Such an alarm initiation would readily defeat the purpose of the sensor-release of electrical locking systems provisions, which were developed to address security needs. The life safety features of the provisions of 14.5.3.2 are sufficient so as not to require an alarm initiation via a manual fire alarm box to unlock the door assembly.

The positioning of the provision of 14.5.3.2(7) reinforces the emergency lighting requirements of 14.13.1.1(6). It is helpful to the user to see the requirement repeated as part of the provisions for sensor-release of electrical locking systems.

The provision of 14.5.3.2(8) is new for the 2018 edition of NFPA *101*. It requires new sensor-release of electrical locking system hardware to comply with a listing laboratory test standard specifically developed for such hardware, namely, ANSI/UL 294.

Exhibit 14.23 shows a glass door that spans a hotel guest floor corridor. The door is held locked by an electromagnet and requires either a magnetic card that is inserted and read or a code that is entered into the key pad to unlock the door. The door is not required for egress of the occupants of the guest rooms in that portion of the corridor. Exhibit 14.24 shows the same door from the other side. The door serves as egress for the occupants of the guest rooms in that portion of the corridor. The door is equipped with access-controlled hardware. The motion sensor mounted at the ceiling unlocks the door upon occupant proximity. The "push to exit" button mounted on the wall serves as a backup if the motion sensor fails.

Exhibit 14.23

Non-egress side of sensor-release of electrical locking system door assembly.

Exhibit 14.24

Egress side of sensor-release of electrical locking system door assembly.

Provided that the applicable occupancy chapter of NFPA *101* permits sensor-release of electrical locking systems, and such occupancy chapter does not add an additional requirement limiting their location, the provisions of 14.5.3.2 are meant to permit sensor-release of electrical locking systems to be installed and used anywhere in the egress path; in addition, multiple such devices are permitted along any egress path. Unlike the delayed-egress electrical locking system, there is no waiting period before the door leaf is usable, other than having to push a release button in the fairly uncommon situation in which the electronics controlling the sensor-release of electrical locking systems hardware (such as the motion detector) fail.

Δ **14.5.3.3 Elevator Lobby Exit Access Door Assemblies Locking.** Where permitted in Chapters 11 through 43 of NFPA *101*, door assemblies separating the elevator lobby from the exit access required by 14.9.1.6.1 shall be permitted to be electrically locked, provided that all the following criteria are met:

(1) The electrical locking hardware is listed in accordance with ANSI/UL 294, *Standard for Access Control System Units*.
(2) The building is protected throughout by a fire alarm system in accordance with Section 13.7.
(3) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3.
(4) Waterflow in the sprinkler system required by 14.5.3.3(3) is arranged to initiate the building fire alarm system.
(5) The elevator lobby is protected by an approved, supervised smoke detection system in accordance with Section 13.7.
(6) Detection of smoke by the detection system required by 14.5.3.3(5) is arranged to initiate the building fire alarm system and notify building occupants.
(7) Initiation of the building fire alarm system by other than manual fire alarm boxes unlocks the electrical locks on the elevator lobby door assembly.
(8) Loss of power to the elevator lobby electrical lock system unlocks the electrical locks on the elevator lobby door assemblies.
(9) Once unlocked, the elevator lobby door assemblies remain electrically unlocked until the building fire alarm system has been manually reset.
(10) Where the elevator lobby door assemblies remain mechanically latched after being electrically unlocked, latch-releasing hardware in accordance with 14.5.2.10 is affixed to the door leaves.
(11) A two-way communication system is provided for communication between the elevator lobby and a central control point that is constantly staffed.
(12) The central control point staff required by 14.5.3.3(11) is capable, trained, and authorized to provide emergency assistance.
(13) The provisions of 14.5.3.1 for delayed-egress electrical locking systems are not applied to the elevator lobby door assemblies.
(14)* The provisions of 14.5.3.2 for sensor-release of electrical locking systems are not applied to the elevator lobby door assemblies.

[***101:***7.2.1.6.3]

A.14.5.3.3(14) It is not the intent to prohibit elevator lobby doors from being equipped with card access systems for gaining access, for example, to tenant spaces. It is the sensor-release of electrical locking systems described in 14.5.3.2 that is prohibited from being installed on the same door as the lock addressed by 14.5.3.3. [***101:***A.7.2.1.6.3(14)]

The provisions of 14.5.3.3 provide the technical details supporting the exemption offered by 14.9.1.6.3 to the requirements of 14.9.1.6.1 and 14.9.1.6.2 for unencumbered access to at least one exit from each elevator landing and lobby.

The provisions of 14.5.3.3 for the locking of elevator lobby access door assemblies are permitted to be used only where the applicable occupancy chapter of NFPA *101* specifically permits their use. Many of the occupancy chapters of NFPA *101* were revised concurrently with the development of 14.5.3.3 to permit its use.

Where the provisions of 14.5.3.3 are used, all the criteria detailed in 14.5.3.3(1) through (14) must be met. When the criteria of all 14 items are met, the locked door between the elevator lobby or landing and the exit should present a minimal, but tolerable, obstruction to speedy egress. The criteria blend a host of provisions for fire detection and alarm systems, sprinkler systems, occupant and staff two-way communication systems, and automatic lock release systems.

In earlier editions of the *Code*, 15 numbered criteria had to be met in order to lock elevator lobby exit access door assemblies. For the 2012 edition, the criterion prohibiting the elevator lobby electronic lock system from being supplied with emergency or standby electrical power was deleted. Such prohibition defeated necessary building security and could no longer be justified, provided that all the other criteria were met.

14.5.3.4* Panic Hardware and Fire Exit Hardware.

N **A.14.5.3.4** See 14.9.2.1.2 and 14.9.2.2.2 for door unlatching requirements for working space about electrical equipment. [***101:***A.7.2.1.7]

Δ **14.5.3.4.1** Where a side-hinged or pivoted-swinging door assembly is required to be equipped with panic or fire exit hardware, such hardware shall meet all of the following criteria:

(1) It shall consist of a cross bar or a push pad, with the length of the actuating portion of the cross bar or push pad not less than one-half of the width of the door leaf.
(2) It shall be mounted as follows:
   (a) New installations shall be not less than 34 in. (865 mm), and not more than 48 in. (1220 mm), above the floor.
   (b) Existing installations shall be not less than 30 in. (760 mm), and not more than 48 in. (1220 mm), above the floor.
(3) It shall be constructed so that a horizontal force not to exceed 15 lbf (66 N) actuates the cross bar or push pad and latches.

[***101:***7.2.1.7.1]

Panic hardware and fire exit hardware are required to be instantly and easily released. New panic hardware and fire exit hardware installations are to be located 34 in. to 48 in. (865 mm to 1220 mm) above the floor [for existing installations, 30 in. to 48 in. (760 mm to 1220 mm)]. The actuating member or bar is required to extend at least one-half the width of the door leaf, to create a target width sufficient to ensure that it will be engaged by the bodies of occupants pushing up against the door leaf. Such hardware, where mounted to a door leaf surface, might reduce the usable, clear width of a door opening. Provided that the hardware is installed at least 34 in. (865 mm) above the floor, the provisions of 7.2.1.2.1.1(5) of NFPA *101* permit a 4 in. (100 mm) encroachment on clear width without forcing a reduction in reported clear width. Installed below 34 in. (865 mm), the panic hardware or fire exit hardware might create a reduction in clear width sufficient to obstruct wheelchair passage through the opening associated with a 34 in. (865 mm) width door leaf. Where panic hardware is installed below 34 in. (865 mm), such as at the 30 in. (760 mm) height permitted for existing hardware by 14.5.3.4.1(2)(b), the clear width measurement is reduced by the amount of the panic hardware encroachment.

The maximum force that the panic hardware or fire exit hardware actuating bar or member can require for operation is 15 lbf (66 N). Note that this is the force needed to release the latching device only. The force needed to open the door leaf itself is governed by 14.5.1.5.

14.5.3.4.2* Only approved fire exit hardware shall be used on fire protection–rated door assemblies. New panic hardware and new fire exit hardware shall comply with ANSI/UL 305 and ANSI/BHMA A156.3. [***101:***7.2.1.7.2]

It is not the intent of 14.5.3.4.2 to require the use of panic hardware or fire exit hardware. Only approved hardware is to be used, which means such hardware must be acceptable to the AHJ, which generally relies on laboratory listing of the hardware. Where such hardware is used on a fire-rated door assembly, it must be that special form of panic hardware termed *fire exit hardware*, which ensures that it has been tested for use on fire-rated door assemblies (with the AHJ generally making approval conditional on the device being listed). Additionally, new panic hardware and new fire exit hardware must comply with recognized industry standards.

A.14.5.3.4.2 The presence of fire exit hardware on a door does not imply the door is required to be a fire protection-rated door. [***101:***A.7.2.1.7.2]

14.5.3.4.3 Required panic hardware and fire exit hardware, in other than detention and correctional occupancies as otherwise provided in Chapters 22 and 23 of NFPA *101*, shall not be equipped with any locking device, set screw, or other arrangement that prevents the release of the latch when pressure is applied to the releasing device. [***101:***7.2.1.7.3]

14.5.3.4.5 Devices that hold the latch in the retracted position shall be prohibited on fire exit hardware, unless such devices are listed and approved for such a purpose. [***101:***7.2.1.7.4]

It is the intent of the *Code* to permit the use of the delayed-egress electrical locking systems described by 14.5.3.1.1 where panic hardware is required if the applicable occupancy chapter specifically permits use of delayed-egress electrical locking systems. In those cases, the actuating member or bar, which 14.5.3.4.1(1) requires to extend across at least half the door leaf width, serves as the device that initiates the irreversible process that results in the door leaf unlocking within the 15 seconds or 30 seconds specified.

Panic hardware, which is prohibited from being used on fire-rated door assemblies, often features the ability to "dog" the bar in the down position, so as to hold the door leaf latch in the retracted position. This latch-retracting feature is not available on fire exit hardware, because it would violate the listing of the rated fire door assembly. Rated door assemblies must self-latch upon being brought to the closed position by the required closing device. A latch helps to keep the door leaf closed under the pressures generated by a fire.

14.5.4 Self-Closing Devices.

14.5.4.1* A door leaf normally required to be kept closed shall not be secured in the open position at any time and shall be self-closing or automatic-closing in accordance with 14.5.4.2, unless otherwise permitted by 14.5.4.3. [***101:***7.2.1.8.1]

A.14.5.4.1 Examples of doors designed to normally be kept closed include those to a stair enclosure or horizontal exit. [***101:***A.7.2.1.8.1]

Δ **14.5.4.2** In any building of low or ordinary hazard contents, as defined in 3.3.147.2 and 3.3.147.3, or where approved by the AHJ, door leaves shall be permitted to be automatic-closing, provided that all of the following criteria are met:

(1) Upon release of the hold-open mechanism, the leaf becomes self-closing.
(2) The release device is designed so that the leaf instantly releases manually and, upon release, becomes self-closing, or the leaf can be readily closed.
(3) The automatic releasing mechanism or medium is activated by the operation of approved smoke detectors installed in accordance with the requirements for smoke detectors for door leaf release service in *NFPA 72*.
(4) Upon loss of power to the hold-open device, the hold-open mechanism is released and the door leaf becomes self-closing.
(5) The release by means of smoke detection of one door leaf in a stair enclosure results in closing all door leaves serving that stair.

[***101:***7.2.1.8.2]

14.5.4.3 The elevator car doors and the associated hoistway enclosure doors at the floor level designated for recall in accordance with the requirements of 11.3.1 shall be permitted to remain open during Phase I Emergency Recall Operation. [***101:***7.2.1.8.3]

N **14.5.4.4 Delayed Action Closers.** Doors required to be self-closing and not required to be automatic closing shall be permitted to be equipped with delayed action closers. [***101:***7.2.1.8.4]

Fire door assemblies in a means of egress route should be kept in the closed position, particularly those serving as entrances to a stair enclosure or positioned in a horizontal exit; however, it is in these two locations that door assemblies so often are held open by some type of door-leaf stopping chock to aid in the free flow of normal traffic. This practice establishes conditions conducive to the rapid spread of fire, smoke, and heat to other sections of the building — the very situation that the stringent compartmentation requirements for the exit enclosure intend to prevent.

Exhibit 14.25 shows a door that is required to be self-closing and is equipped with a self-closer where the purpose of the self-closer is defeated by the use of a chair to hold the door in its open position in violation of the requirement of 14.5.4.1.

Recognizing that tampering with the self-closing feature might occur — and in an effort to encourage the use of effective positive measures, rather than ineffective prohibitions that often go ignored — the *Code* presents criteria for holding door leaves in the open position. The *Code* permits door leaves to be held open in buildings that house low or ordinary hazard contents or where the AHJ gives approval.

The provisions of 14.5.4.2 permit door leaves to be held open by an automatic releasing device. The triggering of the automatic release is done through the operation of smoke detectors installed in accordance with the requirements for smoke detectors for door release service as specified in *NFPA 72®, National Fire Alarm and Signaling Code®*. Fusible links are not an acceptable trigger in this system, because untenable smoke conditions could easily render an exit enclosure or adjoining fire compartment unusable long before the temperature in the vicinity of the door opening has risen enough to operate the fusible link.

Additionally, loss of power to the device providing the hold-open feature must cause immediate automatic release. A manual method of release is also required. The manual method might involve tugging on the door leaf to cause its release. Therefore, magnetic devices with significant holding forces that are not easily overcome by a deliberate tug on the door leaf cannot be used. Once the hold-open device is released, the self-closing device installed on the door leaf swings the door leaf to its closed position. On a fire protection–rated door assembly, the required door latch then engages.

Exhibit 14.26 depicts an automatic-closing door in the closed position and shows the door-mounted receptor plate and wall-mounted magnetic hold-open device near floor level. Exhibit 14.27 shows the same door in the open position, with the door receptor plate contacting the wall-mounted magnetic hold-open device.

The door leaves held open in accordance with the provisions of 14.5.4.2 can be arranged to close simultaneously throughout the building or only in the affected zones. Zoning is generally better, because it permits door assemblies in areas unaffected by the emergency to remain open to accommodate normal use. If protecting a room, that room might be considered a zone. If protecting a stair enclosure, the entire stair enclosure is considered a zone, and the signal to close one door leaf in the enclosing walls must close all door leaves in that stair enclosure.

Exhibit 14.25

Self-closing door held open by chair. (Courtesy of Jake Pauls)

Exhibit 14.26

Automatic-closing door in closed position.

Exhibit 14.27

Automatic-closing door in open position.

With the exception of certain hazardous areas where flash fires or explosions could occur, the use of automatic closers in accordance with these provisions is permitted. Use of automatic-closing equipment should be encouraged to prevent door leaves from being secured open by other means. Wedges, for example, need to be removed manually before the self-closer installed on the door leaf can move the door leaf to its closed position.

Paragraph 14.5.4.3 helps to coordinate the door leaf closing requirements of 7.2.1.8 of NFPA *101* with the provisions of 11.3.1 for elevator recall. The fire fighters' emergency operations requirements for elevators, as specified in 11.3.1 and detailed in ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, mandate that an elevator — once recalled — is to remain at the designated recall floor with the elevator shaft and elevator car door leaves held in the open position. The open door leaves allow responding fire service personnel to ensure the elevator has been recalled. Paragraph 14.5.4.3 legitimizes a feature that would otherwise be prohibited by 14.5.4.1.

The provision of 14.5.4.4 is new to the 2018 edition of NFPA *101*. The text recognizes the use of delayed action closers for doors that are required to be self-closing but not required to be automatic closing. Delayed action closers might be effectively used in nursing home cross-corridor door openings in a smoke barrier, to provide additional time for a resident who moves slowly to travel through the door opening. See 7.2.4.3.11 of NFPA *101* for an example of a code requirement that does not offer the option of using self-closing door assemblies (and therefore does not permit the use of delayed action closers) but mandates the use of automatic-closing door assemblies for horizontal exit, cross-corridor locations because cross-corridor door assemblies are so commonly wedged open in violation of requirements.

N **14.5.5* Powered Door Leaf Operation.**

N **A.14.5.5** Special-purpose horizontally sliding accordion or folding door assemblies installed in accordance with 7.2.1.14 of NFPA *101* should not be considered powered doors subject to the provisions of 14.5.5. Powered doors are divided into two categories — power assisted and power operated. Power-assisted doors that conform to ANSI/BHMA A156.19, *Power Assist and Low Energy Power Operated Doors*, use limited power to operate the door. They require fewer safeguards as compared to full power–operated doors. These door operators are for swinging doors only. Power-operated doors that conform to ANSI/BHMA A156.10, *Power Operated Pedestrian Doors*, require more power to operate the door and require additional safeguards to provide protection against personal injury. Power-operated doors can be swinging, sliding, or folding doors. [***101:***A.7.2.1.9]

N **14.5.5.1* General.** Where means of egress door leaves are operated by power upon the approach of a person or are provided with power-assisted manual operation, the design shall be such that, in the event of power failure, the leaves open manually to allow egress travel or close when necessary to safeguard the means of egress. [***101:***7.2.1.9.1]

N **A.14.5.5.1** An example of the type of door addressed by 14.5.5.1 is one actuated by a motion-sensing device upon the approach of a person. [***101:***A.7.2.1.9.1]

N **14.5.5.1.1** New power-operated swinging doors, power-operated sliding doors, and power-operated folding doors shall comply with ANSI/BHMA A156.10, *Power Operated Pedestrian Doors*. [***101:***7.2.1.9.1.1]

N **14.5.5.1.2** New power-assisted swinging doors and low-energy power-operated swinging doors shall comply with ANSI/BHMA

A156.19, *Power Assist and Low Energy Power Operated Doors*. [***101:***7.2.1.9.1.2]

N **14.5.5.1.3** New low-energy power-operated sliding doors and low-energy power-operated folding doors shall comply with ANSI/BHMA A156.38, *Low Energy Power Operated Sliding and Folding Doors*. [***101:***7.2.1.9.1.3]

N **14.5.5.1.4** The forces required to manually open the door leaves specified in 14.5.5.1 shall not exceed those required in 14.5.1.5, except that the force required to set the leaf in motion shall not exceed 50 lbf (222 N). [***101:***7.2.1.9.1.4]

N **14.5.5.1.5** The door assembly shall be designed and installed so that, when a force is applied to the door leaf on the side from which egress is made, it shall be capable of swinging from any position to provide full use of the required width of the opening in which it is installed. *(See 14.5.1.)* [***101:***7.2.1.9.1.5]

N **14.5.5.1.6** A readily visible, durable sign in letters not less than 1 in. (25 mm) high on a contrasting background that reads as follows shall be located on the egress side of each door opening:

IN EMERGENCY, PUSH TO OPEN

[***101:***7.2.1.9.1.6]

N **14.5.5.1.7** Sliding, power-operated door assemblies in an exit access serving an occupant load of fewer than 50 that manually open in the direction of door leaf travel, with forces not exceeding those required in 14.5.1.5, shall not be required to have the swing-out feature required by 14.5.5.1.5. The required sign shall be in letters not less than 1 in. (25 mm) high on a contrasting background and shall read as follows:

IN EMERGENCY, SLIDE TO OPEN

[***101:***7.2.1.9.1.7]

N **14.5.5.1.8*** In the emergency breakout mode, a door leaf located within a two-leaf opening shall be exempt from the minimum 32 in. (810 mm) single-leaf requirement of 7.2.1.2.3.2(1) of NFPA *101*, provided that the clear width of the single leaf is not less than 30 in. (760 mm). [***101:***7.2.1.9.1.8]

N **A.14.5.5.1.8** Although a single power-operated door leaf located within a two-leaf opening might alone not provide more than 30 in. (760 mm) of clear width in the emergency breakout mode, where both leaves are broken out to become side hinged, the required egress width is permitted to be provided by the width of the entire opening. [***101:***A.7.2.1.9.1.8]

N **14.5.5.1.9** For a biparting sliding door assembly in the emergency breakout mode, a door leaf located within a multiple-leaf opening shall be exempt from the minimum 32 in. (810 mm) single-leaf requirement of 7.2.1.2.3.2(1) of NFPA *101* if a clear opening of not less than 32 in. (810 mm) is provided by all leafs broken out. [***101:***7.2.1.9.1.9]

N **14.5.5.1.10** Door assemblies complying with 14.5.10 shall be permitted to be used. [***101:***7.2.1.9.1.10]

N **14.5.5.1.11** The requirements of 14.5.5.1.1 through 14.5.5.1.10 shall not apply in detention and correctional occupancies where otherwise provided in Chapters 22 and 23. [***101:***7.2.1.9.1.11]

N **14.5.5.2 Self-Closing or Self-Latching Door Leaf Operation.** Where door leaves are required to be self-closing or self-latching and are operated by power upon the approach of a person, or are provided with power-assisted manual operation, they shall be permitted in the means of egress where they meet the following criteria:

(1) The door leaves can be opened manually in accordance with 14.5.5.1.1 to allow egress travel in the event of power failure.
(2) New door leaves remain in the closed position, unless actuated or opened manually.
(3) When actuated, new door leaves remain open for not more than 30 seconds.
(4) Door leaves held open for any period of time close — and the power-assist mechanism ceases to function — upon operation of approved smoke detectors installed in such a way as to detect smoke on either side of the door opening in accordance with the provisions of *NFPA 72*.
(5) Door leaves required to be self-latching are either self-latching or become self-latching upon operation of approved smoke detectors per 14.5.5.2(4).
(6) New power-assisted swinging door assemblies comply with BHMA/ANSI A156.19, *Power Assist and Low Energy Power Operated Doors*.

[***101:***7.2.1.9.2]

N 14.5.6 Revolving Door Assemblies.

N **14.5.6.1** Revolving door assemblies, whether used or not used in the means of egress, shall comply with all of the following:

(1) New revolving doors shall comply with ANSI/BHMA A156.27, *Power and Manual Operated Revolving Doors*, and shall be installed in accordance with the manufacturer's installation instructions.
(2) Revolving door wings shall be capable of book-fold or breakout for egress in accordance with BHMA A156.27, unless they are existing revolving doors approved by the authority having jurisdiction.
(3) When revolving door wings are collapsed into the book-fold position, the parallel egress paths formed shall provide an aggregate width of 36 in. (915 mm), unless they are approved existing revolving door assemblies.
(4) Revolving door assemblies shall not be used within 10 ft (3050 mm) of the foot or the top of stairs or escalators.
(5) A dispersal area acceptable to the authority having jurisdiction shall be located between stairs or escalators and the revolving door assembly.
(6) The revolutions per minute (rpm) of door wings shall not exceed the following:
    (a) The values in Table 14.5.6.1 for existing revolving doors.
    (b) The values in BHMA A156.27 for new revolving doors.
(7) Each revolving door assembly shall have a conforming side-hinged swinging door assembly in the same wall as the revolving door within 10 ft (3050 mm) of the revolving door, unless one of the following conditions applies:
    (a) Revolving door assemblies shall be permitted without adjacent swinging door assemblies, as required by 14.5.6.1(6),

TABLE 14.5.6.1 Existing Revolving Door Assembly Maximum Speed

Inside Diameter		Power-Driven Speed Control (rpm)	Manual Speed Control (rpm)
ft/in.	mm		
6 ft 6 in.	1980	11	12
7 ft	2135	10	11
7 ft 6 in.	2285	9	11
8 ft	2440	9	10
8 ft 6 in.	2590	8	9
9 ft	2745	8	9
9 ft 6 in.	2895	7	8
10 ft	3050	7	8

[***101:***Table 7.2.1.10.1]

in street floor elevator lobbies, provided that no stairways or door openings from other parts of the building discharge through the lobby and the lobby has no occupancy other than as a means of travel between the elevators and street.

(b) The requirement of 14.5.6.1(6) shall not apply to existing revolving door assemblies where the number of revolving door assemblies does not exceed the number of swinging door assemblies within 20 ft (6100 mm) of the revolving door assembly.

[***101:***7.2.1.10.1]

N **14.5.6.2** Where permitted in Chapters 11 through 43 of NFPA *101*, revolving door assemblies shall be permitted as a component in a means of egress, provided that all of the following criteria are met:

(1) Revolving door openings shall not be given credit for more than 50 percent of the required egress capacity.
(2) Each revolving door opening shall not be credited with more than a 50-person capacity or, if of not less than a 9 ft (2745 mm) diameter, a revolving door assembly shall be permitted egress capacity based on the clear opening width provided when collapsed into a book-fold position.
(3) Revolving door wings shall be capable of being collapsed into a book-fold position when a force not exceeding 130 lbf (580 N) is applied to the wings within 3 in. (75 mm) of the outer edge.

[***101:***7.2.1.10.2]

N **14.5.6.3** Revolving door assemblies not used as a component of a means of egress shall have a collapsing force not exceeding 180 lbf (800 N) applied at a point 3 in. (75 mm) from the outer edge of the outer wing stile and 40 in. (1015 mm) above the floor. [***101:***7.2.1.10.3]

N **14.5.6.4** The requirement of 14.5.6.3 shall not apply to revolving door assemblies, provided that the collapsing force is reduced to a force not to exceed 130 lbf (580 N) under all of the following conditions:

(1) Power failure, or removal of power to the device holding the wings in position
(2) Actuation of the automatic sprinkler system, where such a system is provided
(3) Actuation of a smoke detection system that is installed to provide coverage in all areas within the building that are within 75 ft (23 m) of the revolving door assemblies
(4) Actuation of a clearly identified manual control switch in an approved location that reduces the holding force to a force not to exceed 130 lbf (580 N)

[***101:***7.2.1.10.4]

N 14.5.7 Turnstiles and Similar Devices.

N **14.5.7.1** Turnstiles or similar devices that restrict travel to one direction or are used to collect fares or admission charges shall not be placed so as to obstruct any required means of egress, unless otherwise specified in 14.5.7.1.1, 14.5.7.1.2 and 14.5.7.1.3. [***101:***7.2.1.11.1]

N **14.5.7.1.1** Approved turnstiles not exceeding 39 in. (990 mm) in height that turn freely in the direction of egress travel shall be permitted where revolving door assemblies are permitted in Chapters 11 through 43 of NFPA *101*. [***101:***7.2.1.11.1.1]

N **14.5.7.1.2** Where turnstiles are approved by the authority having jurisdiction and permitted in Chapters 11 through 43, each turnstile shall be credited for a capacity of 50 persons, provided that such turnstiles meet all of the following criteria:

(1) They freewheel in the egress direction when primary power is lost, and freewheel in the direction of egress travel upon manual release by an employee assigned in the area.
(2) They are not given credit for more than 50 percent of the required egress width.
(3) They are not in excess of 39 in. (990 mm) in height and have a clear width of not less than 16½ in. (420 mm).

[***101:***7.2.1.11.1.2]

N **14.5.7.1.3*** Security access turnstiles that impede travel in the direction of egress utilizing a physical barrier shall be permitted to be considered as a component of the means of egress, where permitted in Chapters 11 through 43 of NFPA *101*, provided that all the following criteria are met:

(1) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 14.8.
(2) Each security access turnstile lane configuration has a minimum clear passage width of 22 in. (560 mm).
(3) Any security access turnstile lane configuration providing a clear passage width of less than 32 in. (810 mm) shall be given an egress capacity of 50 persons.
(4) Any security access turnstile lane configuration providing a clear passage width of 32 in. (810 mm) or more shall be given an egress capacity as calculated in accordance with Section 14.5.6.
(5) Each secured physical barrier shall automatically retract or swing to an unobstructed open position in the direction of egress, under each of the following conditions:
    (a) Upon loss of power to the turnstile or any part of the access control system that secures the physical barrier
    (b) Upon actuation of a readily accessible and clearly identified manual release device that results in direct interruption of power to each secured physical barrier, remains in the

open position for not less than 30 seconds, and is positioned at one of the following locations:
   i. The manual release device is located on the egress side of each security access turnstile lane.
   ii. The manual release device is located at an approved location where it can be actuated by an employee assigned to the area.

(c) Upon actuation of the building fire-protective signaling system, if provided, and for which the following apply:
   i. The physical barrier remains in the open position until the fire-protective signaling system is manually reset.
   ii. The actuation of manual fire alarm boxes that actuate the building fire-protective signaling system is not required to meet the requirements specified in 14.5.7.1.3(5)(c)(i).

(d) Upon actuation of the building automatic sprinkler or fire detection system, and for which the physical barrier remains in the open position until the fire-protective signaling system is manually reset

[***101:***7.2.1.11.1.3]

Security access turnstiles limit entry to those with proper credentials, such as cards placed in proximity to an electronic reader. The security access turnstiles prevent unauthorized entry but are arranged to provide free egress under the conditions specified in 14.5.7.1.3(5).

N **A.14.5.7.1.3** Security access turnstiles are designed to control security access into and out of buildings. Security access turnstiles might utilize physical barriers consisting of arms, wings, gates, or panels. The subject physical barriers come in various heights and function by retracting or opening in the direction of travel. [***101:***A.7.2.1.11.1.3]

N **14.5.7.2** Turnstiles exceeding 39 in. (990 mm) in height shall meet the requirements for revolving door assemblies in 14.5.6 or the requirements of 14.5.7.1.3 for security access turnstiles. [***101:***7.2.1.11.2]

N **14.5.7.3** Turnstiles located in, or furnishing access to, required exits shall provide not less than 16½ in. (420 mm) clear width at and below a height of 39 in. (990 mm) and at least 22 in. (560 mm) clear width at heights above 39 in. (990 mm). [***101:***7.2.1.11.3]

N **14.5.8 Door Openings in Folding Partitions.** Where permanently mounted folding or movable partitions divide a room into smaller spaces, a swinging door leaf or open doorway shall be provided as an exit access from each such space, unless otherwise specified in 14.5.8.1 and 14.5.8.2. [***101:***7.2.1.12]

N **14.5.8.1** A door leaf or opening in the folding partition shall not be required, provided that all of the following criteria are met:

(1) The subdivided space is not used by more than 20 persons at any time.
(2) The use of the space is under adult supervision.
(3) The partitions are arranged so that they do not extend across any aisle or corridor used as an exit access to the required exits from the story.
(4) The partitions conform to the interior finish and other requirements of this *Code*.
(5) The partitions are of an approved type, have a simple method of release, and are capable of being opened quickly and easily by experienced persons in case of emergency.

[***101:***7.2.1.12.1]

N **14.5.8.2** Where a subdivided space is provided with not less than two means of egress, the swinging door leaf in the folding partition specified in 14.5.8 shall not be required, and one such means of egress shall be permitted to be equipped with a horizontal-sliding door assembly complying with 14.5.10. [***101:***7.2.1.12.2]

N **14.5.9 Balanced Door Assemblies.** If panic hardware is installed on balanced door leaves, the panic hardware shall be of the push-pad type, and the pad shall not extend more than approximately one-half the width of the door leaf, measured from the latch stile. *[See 14.5.3.4.1(1).]* [***101:***7.2.1.13]

N **14.5.10 Special-Purpose Horizontally Sliding Accordion or Folding Door Assemblies.** Special-purpose horizontally sliding accordion or folding door assemblies shall be permitted in means of egress, provided that all of the following criteria are met:

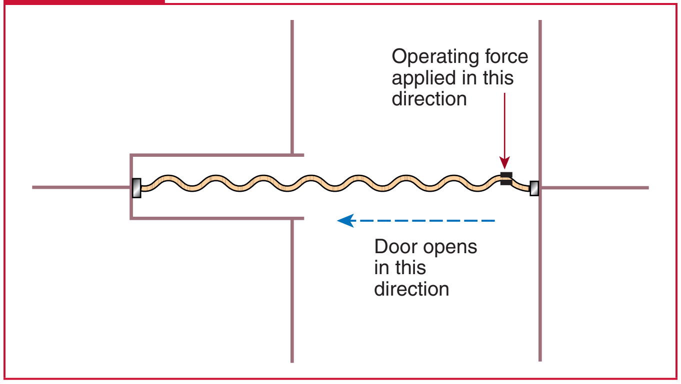
(1) The door leaf is readily operable from either side without special knowledge or effort.
(2) The force that, when applied to the operating device in the direction of egress, is required to operate the door leaf is not more than 15 lbf (67 N).
(3) The force required to operate the door leaf in the direction of travel is not more than 30 lbf (133 N) to set the leaf in motion and is not more than 15 lbf (67 N) to close the leaf or open it to the minimum required width.
(4) The door leaf is operable using a force of not more than 50 lbf (222 N) when a force of 250 lbf (1100 N) is applied perpendicularly to the leaf adjacent to the operating device, unless the door opening is an existing special-purpose horizontally sliding accordion or folding exit access door assembly serving an area with an occupant load of fewer than 50.
(5) The door assembly complies with the fire protection rating, if required, and, where rated, is self-closing or automatic-closing by means of smoke detection in accordance with 14.5.4 and is installed in accordance with NFPA 80.

[***101:***7.2.1.14]

The special type of horizontally sliding door assembly addressed by 14.5.10 — the special-purpose horizontally sliding accordion or folding door assembly — is different from a traditional horizontally sliding door assembly. When force is applied to the door actuator in the direction of egress travel, the door leaf must slide to the side to allow passage. This concept is illustrated in Exhibit 14.28.

It is important that sliding door assemblies, other than those addressed by 14.5.1.1(4)(c), (4)(d), or (5), be evaluated for compliance with all the requirements of 14.5.10. Traditional sliding door assemblies do not comply with these requirements; an example of a type of door assembly that does comply is shown in Exhibit 14.29.

Exhibit 14.28



Horizontally sliding door assembly operation.

Exhibit 14.29

Special-purpose horizontally sliding accordion door assembly addressed by 14.5.10. (Photo courtesy of Won-Door Corp.)

N **14.5.11 Inspection of Door Openings.**

N **14.5.11.1*** Where required by Chapters 11 through 43 of NFPA *101*, the following door assemblies shall be inspected and tested not less than annually in accordance with 14.5.11.2 through 14.5.11.7:

(1) Door leaves equipped with panic hardware or fire exit hardware in accordance with 14.5.3.4
(2) Door assemblies in exit enclosures
(3) Door hardware-release of electrically locked egress door assemblies
(4) Door assemblies with special locking arrangements subject to 14.5.3.3

[***101:***7.2.1.15.1]

N **A.14.5.11.1** Door assemblies within the required means of egress (e.g., door assemblies that discharge from exit enclosures) require a higher level of care and maintenance throughout the life of their installations to ensure they perform as intended by the *Code*. Annual inspection and functional testing of these door assemblies is necessary to verify that they are maintained in proper working condition. Panic hardware and fire exit hardware devices are specifically required to be used in assembly and educational occupancies. However, door leaves that are equipped with panic hardware or fire exit hardware, in areas not specifically required by the *Code* (e.g., stairwell entry doors and double-egress cross-corridor door assemblies not serving an assembly occupancy), should be subject to annual inspection and functional testing to ensure that the operating hardware functions correctly in accordance with 14.5.3.4, since the presence of panic hardware and fire exit hardware implies it is required by the *Code*. [***101:***A.7.2.1.15.1]

Additionally, door assemblies that are door hardware-release of electrically locked egress door assemblies in accordance with 14.5.2.5 and door assemblies that are equipped with special locking arrangements in accordance with 14.5.3.3 are outfitted with electrified hardware and access control devices that are susceptible to wear and abuse. Consequently, these door assemblies need to be inspected and tested on an annual basis, regardless of the occupant load being served. [***101:***A.7.2.1.15.1]

In cases where the authority having jurisdiction determines there is a distinct hazard to building occupant safety, the inspection requirements of 7.2.1.15 should be applied to other exit access, exit, and exit discharge door assemblies. [***101:***A.7.2.1.15.1]

N **14.5.11.2*** The inspection and testing interval for fire-rated and nonrated door assemblies shall be permitted to exceed 12 months under a written performance-based program. [***101:***7.2.1.15.2]

N **A.14.5.11.2** See NFPA 80, Annex J, for information pertaining to performance-based inspection, testing, and maintenance of door assemblies. [***101:***A.7.2.1.15.2]

N **14.5.11.2.1** Goals established under a performance-based program shall provide assurance that the door assembly will perform its intended function. [***101:***7.2.1.15.2.1]

N **14.5.11.2.2** Technical justification for inspection, testing, and maintenance intervals shall be documented. [***101:***7.2.1.15.2.2]

N **14.5.11.2.3** The performance-based option shall include historical data. [***101:***7.2.1.15.2.3]

The introductory requirements of 14.5.11.1 set the inspection and testing interval as once per year. Paragraph 14.5.11.2 provides an exemption so that the inspection interval can exceed 12 months. The text of A.14.5.11.2 advises that helpful information on a written performance-based program can be found in NFPA 80, *Standard for Fire Doors and Other Opening Protectives.* NFPA 80 addresses the performance-based option for extending the inspection and testing interval. The concept of a performance-based inspection and testing frequency program is to establish the type and frequency of inspection needed to demonstrate that the door assemblies are operational. The goal is to balance the inspection frequency with proven reliability of the door assemblies; thus, the performance-based option is required to include historical data acceptable to the AHJ. The goal of a performance-based inspection program is also to adjust test and inspection frequencies commensurate with historical, documented equipment performance and desired reliability. Program attributes that should be considered in the adjustment of test and inspection frequencies include maintenance programs, usage frequencies, history of repairs, building condition, and consequence of failure of the door assemblies.

N **14.5.11.3** A written record of the inspections and testing shall be signed and kept for inspection by the authority having jurisdiction. [***101:***7.2.1.15.3]

The required written record of the inspection and testing must be signed, preferably by the individual who performed the inspection and testing.

N **14.5.11.4** Functional testing of door assemblies shall be performed by individuals who can demonstrate knowledge and understanding of the operating components of the type of door being subjected to testing. [***101:***7.2.1.15.4]

The functional testing of door assemblies is not required to be performed by a licensed or certified individual. Rather, the person performing the functional testing must be able to demonstrate knowledge and understanding of the operating components of the type of door assemblies required to be inspected at the facility.

N **14.5.11.5** Door assemblies shall be visually inspected from both sides of the opening to assess the overall condition of the assembly. [***101:***7.2.1.15.5]

The overall condition of the door assembly can be visually evaluated only if inspected from both sides of the door opening. Some features are evident from only the pull side of the door opening, because the stops in the frame prevent viewing the feature; other features, like the door closer, are evident only from the push side of the door opening.

N **14.5.11.6** As a minimum, the following items shall be verified:

(1) Floor space on both sides of the openings is clear of obstructions, and door leaves open fully and close freely.
(2) Forces required to set door leaves in motion and move to the fully open position do not exceed the requirements in 14.5.1.5.
(3) Latching and locking devices comply with 14.5.2.
(4) Releasing hardware devices are installed in accordance with 14.5.2.10.1.
(5) Door leaves of paired openings are installed in accordance with 14.5.2.11.
(6) Door closers are adjusted properly to control the closing speed of door leaves in accordance with accessibility requirements.
(7) Projection of door leaves into the path of egress does not exceed the encroachment permitted by 14.5.1.3.
(8) Powered door openings operate in accordance with 14.5.5.
(9) Signage required by 14.5.1.1(3), 14.5.2.5, 14.5.3, and 14.5.5 is intact and legible.
(10) Door openings with special locking arrangements function in accordance with 14.5.3.
(11) Security devices that impede egress are not installed on openings, as required by 14.5.2.12.
(12) Where required by 7.2.2.5.5.7 of NFPA *101*, door hardware marking is present and intact.
(13) Emergency lighting on sensor-release of electrical locking systems and doors equipped with delayed-egress electrical locking systems is present in accordance with Section 14.13. [***101:***7.2.1.15.6]

The criteria required to be verified in 14.5.11.6(1) through (13) were developed to evaluate post-installation operating performance where the installation was made to comply with door assembly criteria of 7.2.1 of NFPA *101*. Fire-rated door assemblies must also meet additional criteria as detailed in Section 5.2 of NFPA 80, as required by 12.7.6.3.1.

N **14.5.11.7*** Door openings not in proper operating condition shall be repaired or replaced without delay. [***101:***7.2.1.15.7]

N **A.14.5.11.7** Performing corrective action work on door assemblies frequently requires ordering replacement components that might take time to produce, ship, and install. Consideration of the time it takes to procure and install components should be included in the timeline for restoring the door assemblies to normal working condition. [***101:***A.7.2.1.15.7]

The purpose of the inspection and testing program is to identify problems with door assemblies. Paragraph 14.5.11.7 completes the process by requiring that problems be corrected without delay. The correction of the problem is part of the overall inspection and testing program and needs to be documented in the written record required by 14.5.11.3.

14.6 Enclosure and Protection of Stairs

14.6.1 Enclosures.

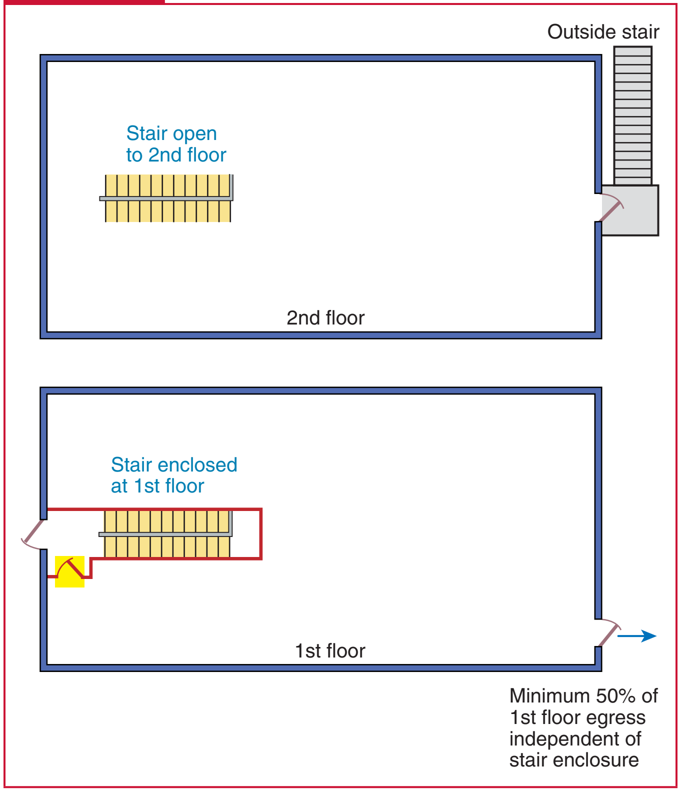
14.6.1.1 All inside stairs serving as an exit or exit component shall be enclosed in accordance with Section 14.3. [***101:***7.2.2.5.1.1]

14.6.1.2 Inside stairs, other than those serving as an exit or exit component, shall be protected in accordance with Section 8.6 of NFPA *101*. [***101:***7.2.2.5.1.2]

14.6.1.3 In existing buildings, where a two-story exit enclosure connects the story of exit discharge with an adjacent story, the exit shall be permitted to be enclosed only on the story of exit discharge, provided that not less than 50 percent of the number and capacity of exits on the story of exit discharge are independent of such enclosures. [***101:***7.2.2.5.1.3]

Paragraphs 14.6.1.1 and 14.6.1.2 emphasize that enclosure protection for stairs depends on whether they serve within an exit or involve a vertical opening between floors. Stairs that are not used as exits but that involve vertical openings are not subject to the requirements of Section 14.3; they must be protected in accordance with Section 8.6 of NFPA *101*. Many interior stairs serve as exits and are vertical openings; they must, therefore, meet the requirements of Section 14.3 for exits as well as those of Section 8.6 of NFPA *101*. Compliance with Section 8.6 of NFPA *101* does not ensure compliance with Section 14.3. Stairs

Exhibit 14.30



Partial enclosure of existing stair.

that are neither within an exit nor part of vertical openings, such as stairs to a platform or stage, or those running between two different floor levels on the same story do not have to comply with either Section 14.3 or Section 8.6 of NFPA *101*.

The provisions of 14.6.1.3 recognize existing two-story stairs that, rather than being fully enclosed by a fire-rated shaft at both the top and bottom, are separated only from the level of exit discharge. Because such stairs are open to another floor, they might compromise the use of the stair enclosure for egress purposes by occupants of the level of exit discharge. The *Code* requires that at least half the egress for the level of exit discharge be independent of the stair enclosure. This requirement limits the effect of occupants who are forced to travel into an enclosure that is smoke-filled due to a fire on another floor that is open to the stair. In Exhibit 14.30, the existing stair connecting the first and second floors, although separated from the first floor, is open to the second floor. This arrangement is permitted because a minimum of 50 percent of the first floor egress can be satisfied independently from use of the stair enclosure via the door assembly that opens directly to the outside at grade level at the right of the exhibit.

14.6.2* Exposures.

A.14.6.2 The purpose of this provision is to protect the exterior wall of a stairway from fires in other portions of the building. If the exterior wall of the stair is flush with the building exterior wall, the fire would need to travel around 180 degrees in order to impact the stair. This has not been a problem in existing buildings, so no protection is required. However, if the angle of exposure is less than 180 degrees, protection of either the stair wall or building wall is required. [***101:***A.7.2.2.5.2]

Figure A.14.6.2(a), Figure A.14.6.2(b), and Figure A.14.6.2(c) illustrate the requirement, assuming nonrated glass on the exterior wall of the stair is used. [***101:***A.7.2.2.5.2]

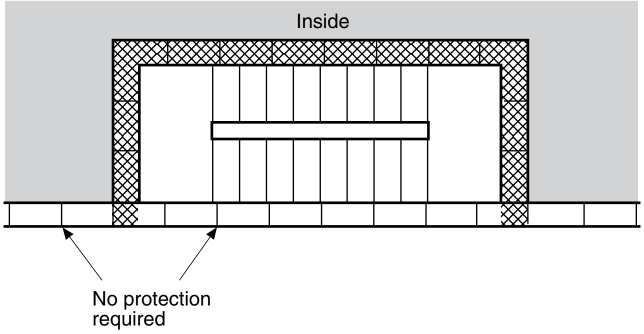


FIGURE A.14.6.2(a) *Stairway with Nonrated Exterior Wall in Same Plane as Building Exterior Wall. [**101:**Figure A.7.2.2.5.2(a)]*

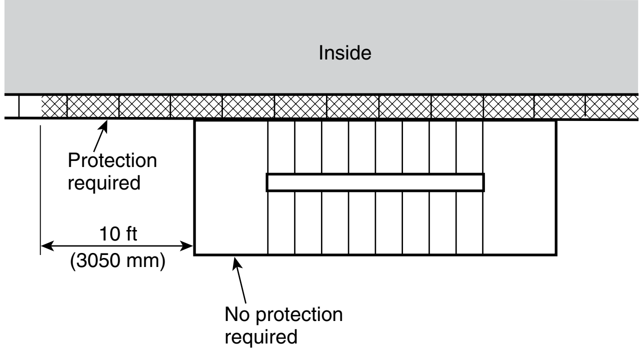


FIGURE A.14.6.2(b) *Stairway with Unprotected Exterior Perimeter Protruding Past Building Exterior Wall. [**101:**Figure A.7.2.2.5.2(b)]*

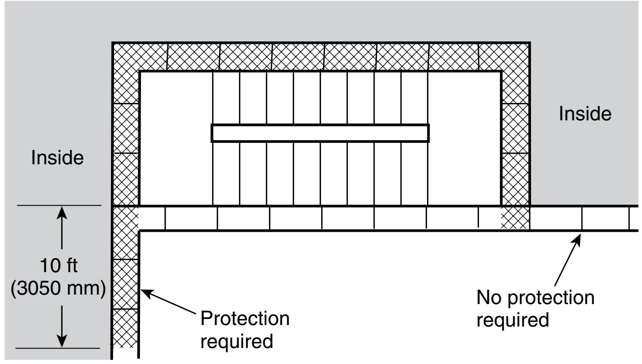


FIGURE A.14.6.2(c) *Stairway with Nonrated Exterior Wall Exposed by Adjacent Exterior Wall of Building. [**101:**Figure A.7.2.2.5.2(c)]*

14.6.2.1 Where nonrated walls or unprotected openings enclose the exterior of a stairway, other than an existing stairway, and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees, the building enclosure walls within 10 ft (3050 mm) horizontally of the nonrated wall or unprotected opening shall be constructed as required for stairway enclosures, including opening protectives. [***101:***7.2.2.5.2.1]

14.6.2.2 Construction shall extend vertically from the finished ground level to a point 10 ft (3050 mm) above the topmost landing of the stairs or to the roofline, whichever is lower. [***101:***7.2.2.5.2.2]

14.6.2.3 The fire resistance rating of the separation extending 10 ft (3050 mm) from the stairs shall not be required to exceed 1 hour where openings have a minimum ¾-hour fire protection rating. [***101:***7.2.2.5.2.3]

14.6.3* Usable Space. Enclosed, usable spaces, within exit enclosures shall be prohibited, including under stairs, unless otherwise permitted by 14.6.3.2. [***101:***7.2.2.5.3]

A.14.6.3 An example of a use with the potential to interfere with egress is storage. [***101:***A.7.2.2.5.3]

14.6.3.1 Open space within the exit enclosure shall not be used for any purpose that has the potential to interfere with egress. [***101:***7.2.2.5.3.1]

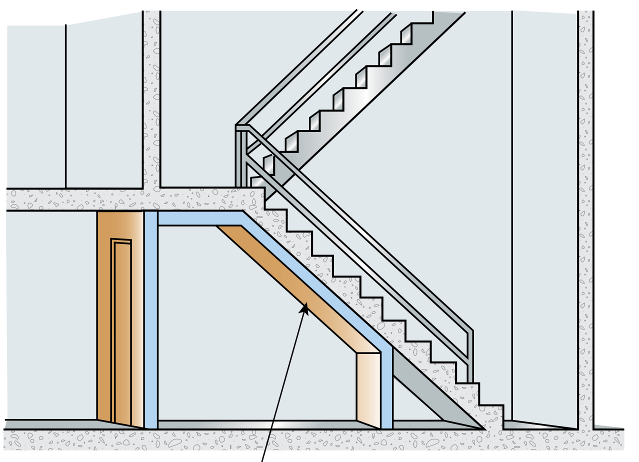
Δ **14.6.3.2** Enclosed, usable space shall be permitted under stairs, provided that both of the following criteria are met:

(1) The space shall be separated from the stair enclosure by the same fire resistance as the exit enclosure.
(2) Entrance to the enclosed, usable space shall not be from within the stair enclosure. *(See also 14.3.3.)*

[***101:***7.2.2.5.3.2]

Paragraphs 14.6.3 and 14.6.3.1 state that, within an exit enclosure, no enclosed, usable space is permitted, nor is any open space permitted to be used for any purpose that could interfere with the use of the exit enclosure. Per 14.6.3.2, an enclosed, usable space under a stair is permitted to be considered outside the exit enclosure, provided that (1) the walls and soffits of the enclosed space meet the same protection requirements as the stair enclosure, thereby separating the space from the exit enclosure; and (2) the door assembly to the space does not open into the exit enclosure. The provision of 14.6.3.2 is depicted in Exhibit 14.31. Note that fire resistance–rated construction isolates the space beneath the last run of stair so that the space is no longer within the exit enclosure. Note also that a door assembly that is outside the exit enclosure is used to enter the space, since a door communicating between the space and the exit enclosure would violate the provisions of 14.3.1(9).

Exhibit 14.31



Enclosed, usable space under flight of stairs.

14.7* Exit Passageways

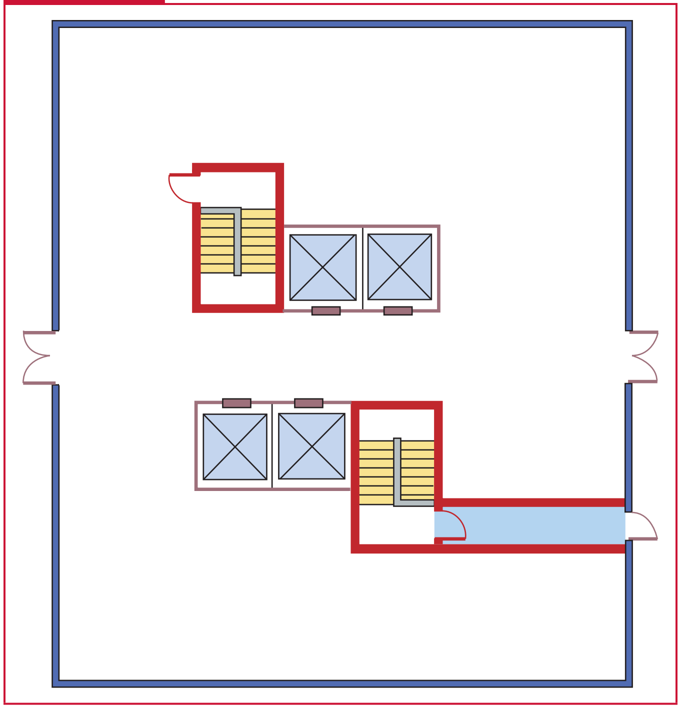
A.14.7 An exit passageway serves as a horizontal means of exit travel that is protected from fire in a manner similar to an enclosed interior exit stair. Where it is desired to offset exit stairs in a multistory building, an exit passageway can be used to preserve the continuity of the protected exit by connecting the bottom of one stair to the top of the stair that continues to the street floor. Probably the most important use of an exit passageway is to satisfy the requirement that at least 50 percent of the exit stairs discharge directly outside from multistory buildings *(see 7.7.2 of* NFPA *101)*. Thus, if it is impractical to locate the stair on an exterior wall, an exit passageway can be connected to the bottom of the stair to convey the occupants safely to an outside exit door. In buildings of extremely large area, such as shopping mall concourse and some factories, the exit passageway can be used to advantage where the travel distance to reach an exit would otherwise be excessive. [***101:***A.7.2.6]

The word *exit*, used in the term *exit passageway*, helps to distinguish between an exit passageway and an ordinary passageway or corridor that serves as exit access. An exit passageway is an exit; it provides a path of travel offering the same level of protection and safety that is required of an enclosed exit stair. An exit passageway is a versatile feature, because it can be used to extend an exit, or, as is done in many cases, it can be used to bring an exit closer to where the occupants are located.

In Exhibit 14.32, an exit passageway is used to continue the exit to the outside from one of the two enclosed interior exit stairs. This arrangement might be used to help comply with the requirements of 14.11.2, which mandate that at least one-half the egress capacity and at least one-half the number of exits must discharge directly to the outside at interior discharge levels.

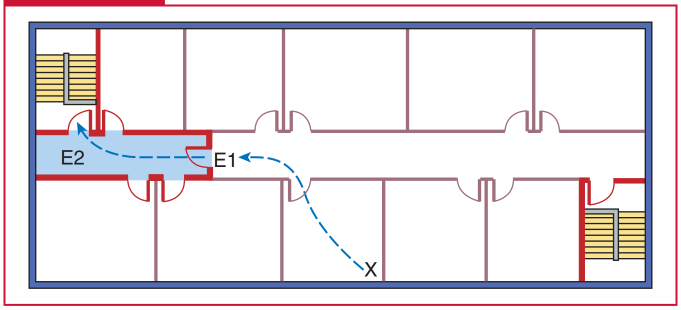
Extending the exit stair's required enclosure to include a portion of the corridor creates an exit passageway that brings the exit closer to the occupants, as is demonstrated in Exhibit 14.33. Travel distance measurement ends at entrance E1 to the exit passageway. The distance from X to E2 exceeds the allowed travel distance. The distance from X to E1 is within the allowed travel

Exhibit 14.32



Exit passageway used to connect exit stair with exterior of building.

Exhibit 14.33

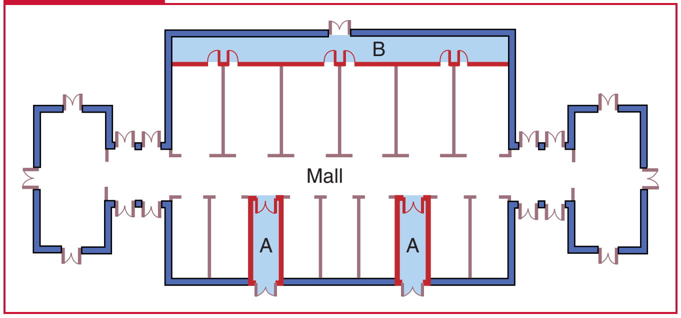


Exit passageway used to keep travel distance from becoming excessive.

distance. Extension of an exit stair's enclosure is often used where travel distance to the exit enclosure would otherwise be in excess of *Code* allowance. Because it is an exit, an exit passageway qualifies as the point at which travel distance measurement ends in accordance with Section 7.6 of NFPA *101*.

In Exhibit 14.34, the two exit passageways marked A bring exits within allowable travel distances for the occupants in a mall structure (similar to the exit passageway illustrated in Exhibit 14.33). The exit passageway marked B allows occupants of multiple stores in the mall structure to enter the exit directly from the rear of each store. This arrangement is often used to limit, for security purposes, the number of door assemblies that open directly to the outside.

Exhibit 14.34



Exit passageways used for multiple purposes in mall structure.

14.7.1* General. Exit passageways used as exit components shall conform to the general requirements of Section 7.1 of NFPA *101* and to the special requirements of Section 14.7. [***101:***7.2.6.1]

A.14.7.1 Examples of building elements that might be arranged as exit passageways include hallways, corridors, passages, tunnels, underfloor passageways, or overhead passageways. [***101:***A.7.2.6.1]

Δ **14.7.2 Enclosure.** An exit passageway shall be separated from other parts of the building as specified in Section 14.3, and the following alternatives shall be permitted:

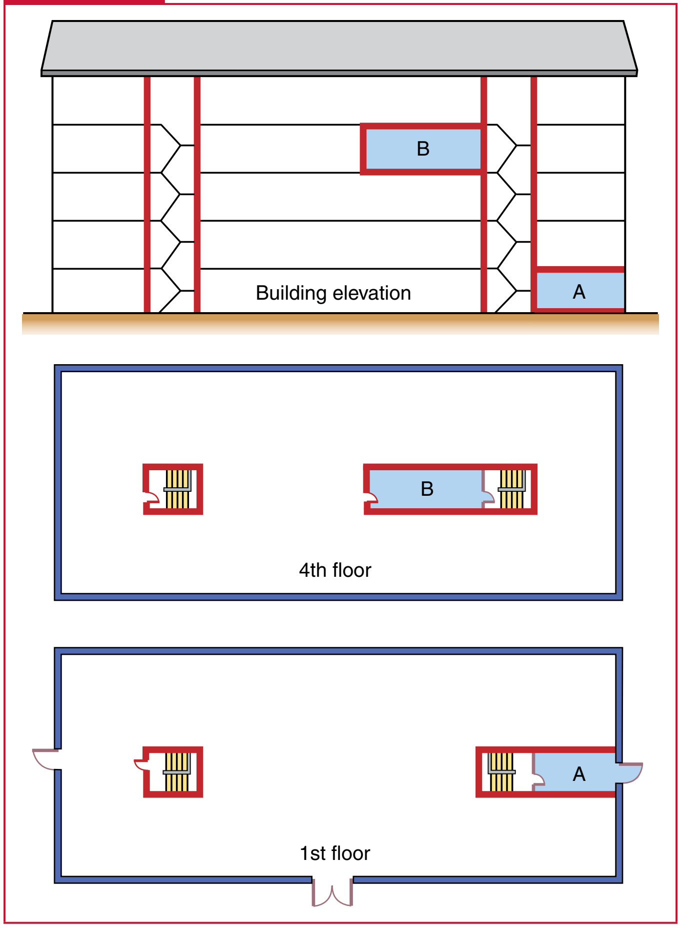
(1) Fire windows in accordance with 12.7.6 shall be permitted to be installed in the separation in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3.
(2) Existing fixed wired glass panels in steel sash shall be permitted to be continued in use in the separation in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3.

[***101:***7.2.6.2]

14.7.3 Stair Discharge. An exit passageway that serves as a discharge from a stair enclosure shall have not less than the same fire resistance rating and opening protective fire protection rating as those required for the stair enclosure. [***101:***7.2.6.3]

Paragraph 14.7.2 requires exit passageways to have walls with the hourly fire resistance ratings and door assemblies with the fire protection ratings required of exit stair enclosures, as detailed in 14.3.1(1) or (2) and 12.7.6.2.2. The requirement also limits door openings into, and penetrations through, the exit enclosure created by the exit passageway, as detailed in 14.3.1(9) and (10). In Exhibit 14.35, new exit passageway A on the first floor — the level of exit discharge — opens at one end to a five-story exit stair enclosure and, at the other end, to a door assembly to the outside. This exit passageway also serves as a horizontal continuation of, and discharge for, the stair enclosure. In serving as a discharge for the exit stair, the exit passageway must provide the same degree of protection required of the stair enclosure. Given that the exit stair must be enclosed by 2-hour fire resistance–rated construction because it is new and serves four or more stories, the exit passageway must also be enclosed

Exhibit 14.35



Exit passageways with fire resistance–rated enclosures and fire protection–rated door assemblies.

by 2-hour fire resistance–rated construction. This protection is addressed in 14.7.3.

In Exhibit 14.35, exit passageway A and the 5-story exit stair enclosure that it serves each have a 2-hour fire resistance rating as discussed in the preceding paragraph. The door shown between the exit stair enclosure and the exit passageway is not required. In other words, the exit passageway is permitted to be open to the exit stair enclosure. If the exit stair enclosure and exit passageway are open to each other, the exit passageway is not permitted to have fire windows as the exit stair enclosure is not permitted to have fire windows [see 14.3.1(9)]. If they are separated from each other as shown in Exhibit 14.35, the exit passageway is permitted to have fire windows in accordance with 14.7.2(1) if the building is sprinklered.

In Exhibit 14.35, exit passageway B, on the fourth floor, is used to provide the safety of an exit to occupants traveling to the exit stair enclosure. This exit passageway might have been built to meet the travel distance limitation. If a fire-rated wall and door assembly separate exit passageway B from the new 2-hour exit stair enclosure, the required rating of exit passageway B is only 1 hour, because the exit passageway serves only the occupants of the fourth floor. A similar 1-hour fire resistance–rated enclosure requirement applies, for example, to an exit passageway serving a single story of a shopping mall structure. Contrast this configuration with exit passageway A on the first floor, which potentially serves occupants of the second through fifth floors and must provide a continuation of the 2-hour separation required of the new stair enclosure.

For the same reasons that the exit stair enclosure cannot have door assemblies opening directly onto it from normally unoccupied spaces, a storage room, for example, is prohibited from opening directly onto exit passageways A and B and the exit stair enclosures. Penetrations through the enclosing walls are limited to those necessary for the functioning of life safety systems, such as lighting powered by electrical cables that enter the exit enclosure via properly sealed conduit penetrations. Ductwork for climate control is prohibited from penetrating enclosing walls. Thus, the exit passageways and the exit stair enclosures must receive their heating and cooling by systems independent of those serving the remainder of the building. Ductwork serving other parts of the floor must be routed around the outside of, not through, the exit passageway enclosures.

14.7.4 Width.

Δ **14.7.4.1** The width of an exit passageway shall be sized to accommodate the aggregate required capacity of all exits that discharge through it, unless one of the following conditions applies:

(1)* Where an exit passageway serves occupants of the level of exit discharge as well as other stories, the capacity shall not be required to be aggregated.

A.14.7.4.1(1) Where an exit passageway serves occupants on the level of exit discharge as well as other floors, it should not be required that the occupant loads be added, thus increasing the width of the exit passageway. The situation is the same as that in which occupants from the level of exit discharge join occupants from upper floors for a few feet of horizontal travel through a stair enclosure. [***101:***A.7.2.6.4.1(1)]

(2) As provided in Chapters 36 and 37 of NFPA *101*, an exit passageway in a mall structure shall be permitted to accommodate occupant loads independently from the mall concourse and the tenant spaces. *(See 36.2.2.7.2 and 37.2.2.7.2 of* NFPA *101.)* [***101:***7.2.6.4.1]

14.7.4.2 In new construction, the minimum width of any exit passageway into which an exit stair discharges, or that serves as a horizontal transfer within an exit stair system, shall meet the following criteria:

(1) The minimum width of the exit passageway shall be not less than two-thirds of the width of the exit stair.
(2) Where stairs are credited with egress capacity in accordance with 14.8.3.2, the exit passageway width shall be sized to accommodate the same capacity as the stair, with such capacity determined by use of the capacity factors in Table 14.8.3.1.

[***101:***7.2.6.4.2]

14.8 Capacity of Means of Egress

14.8.1 Occupant Load.

14.8.1.1 Sufficient Capacity.

Δ **14.8.1.1.1** The total capacity of the means of egress for any story, balcony, tier, or other occupied space shall be sufficient for the occupant load thereof unless one of the following conditions exists:

(1) The authority having jurisdiction shall be permitted to establish the occupant load as the number of persons for which existing means of egress is adequate, provided that measures are established to prevent occupancy by a greater number of persons.
(2) The egress capacity shall have been previously approved as being adequate.

[***101:***7.3.1.1.1]

It is a basic concept of the *Code* that the means of egress system be sized to accommodate all people occupying a building. Sizing is accomplished via a *Code*-specified method of matching the occupant load of a floor with the calculated egress capacity of the egress components serving the floor. The sizing criteria do not ensure that all occupants can leave immediately, but they do provide for sufficient quick movement without unacceptable queuing; that is, occupants might have to wait in line to pass through an exit stair enclosure door assembly to begin moving down the stairs, especially where occupants of upper floors who have already entered the stair enclosure are simultaneously using the stairs for egress travel in the downward direction.

The geometry of a building, its occupancy and related occupant load, and the travel distance to exits dictate, in large measure, the location of exits, the number of exits, and the capacity (i.e., width) of exits and access thereto. As a consequence, the exits themselves influence the plan and layout of the entire means of egress system. The number of people that the means of egress system can accommodate is determined not solely by the capacity of the exits but also by the number of persons each component within the exit access and exit discharge can accommodate. Very wide corridors that lead to very wide exit stair enclosure door assemblies that, in turn, lead to much narrower stairs provide a system comparable to average-width corridors that lead to average-width exit stair enclosure door assemblies that, in turn, lead to average-width stairs. A means of egress system is only as good as its most constricting component.

The number of people or occupant load for which the means of egress system must provide egress capacity is calculated or otherwise determined. The occupant load is to reflect the maximum number of people anticipated to occupy the building rooms or spaces at any given time and under all probable situations. The occupant load must not be based only on normal occupancy.

The provision of 14.8.1.1 was revised for the 2018 edition of NFPA *101* to provide two exemptions to the requirement that the means of egress be sized to handle the occupant load.

1. The provision of 14.8.1.1.1(1) offers relief in the case where the existing egress system is not large enough to accommodate the calculated occupant load; the AHJ establishes and approves a reduced occupant load equal to the number of occupants the current egress system can accommodate; and the building operator establishes and follows procedures that ensure that the number of occupants does not exceed the approved number.
2. The provision of 14.8.1.1.1(2) permits an egress system that was *previously approved* to be continued in use so as not to require that it be increased in size to accommodate the calculated occupant load. The provision recognizes the case where a building is constructed under a building code that permits the use of reduced capacity factors based on the building being sprinklered. The egress width for components providing level travel — like doors — is calculated using 0.15 in./person (3.8 mm/person) and not the 0.2 in./person (5 mm/person) of Table 14.8.3.1; the egress width for stairways is calculated using 0.2 in./person (5 mm/person) and not the 0.3 in./person (7.6 mm/person) of Table 14.8.3.1. Where the doors provide 32 in. (810 mm) of clear width and the associated stair provides 44 in. (1120 mm), the route's egress capacity is calculated to be 220 persons, not the 146 derived from use of Table 14.8.3.1. The egress system was approved at time of construction. The new provision of 14.8.1.1.1(1) permits the previously approved, existing means of egress system to be evaluated using the previously approved method.

14.8.1.1.2 For other than existing means of egress, where more than one means of egress is required, the means of egress shall be of such width and capacity that the loss of any one means of egress leaves available not less than 50 percent of the required capacity. [***101:***7.3.1.1.2]

The provision of 14.8.1.1.2 has the effect of requiring that new egress systems employing two means of egress be balanced in size, so that each egress route accommodates at least half the occupant load of the floor. It also has the effect of requiring that new egress systems employing more than two means of egress be sized so that no one egress route is credited with accommodating more than half the occupant load of the floor. The requirement is aimed at preventing a situation where the loss of any one egress route reduces the remaining egress capacity to less than half that needed to accommodate the occupant load of the floor. Application of the provision of 14.8.1.1.2 is demonstrated in the examples that follow.

Example 1

The occupant load of a floor in a new building is 350 persons. Two means of egress are provided. Egress route 1 is of sufficient width to accommodate 200 persons, and egress route 2 accommodates 150. The two egress routes, together, exactly accommodate the 350-person occupant load of the floor. If a fire or similar emergency were to render egress route 1 unusable, the performance-based criterion of 14.8.1.1.2 would not be met, because less than half the required egress capacity remains usable [i.e., 150 < 350/2]. The designer chooses to resize both egress routes so that each accommodates 175 persons. Following the redesign, the arrangement is again evaluated against the criterion of 14.8.1.1.2. The loss of any one of the two egress routes leaves available not less than 50 percent of the required egress capacity of the floor as required by 14.8.1.1.2.

Example 2

The occupant load of a floor in a new building is 350 persons. Two means of egress are provided. Egress route 1 is of sufficient width to accommodate 200 persons, and egress route 2 accommodates 175 persons. The two egress routes, together, accommodate 375 persons, which is 25 persons more than are required to be accommodated for the 350-person occupant load of the floor. If a fire or similar emergency were to render egress route 1 unusable, the performance-based criterion of 14.8.1.1.2 would be met, as at least half the required egress capacity (i.e., 350/2 = 175) remains usable as required by 14.8.1.1.2.

Example 3

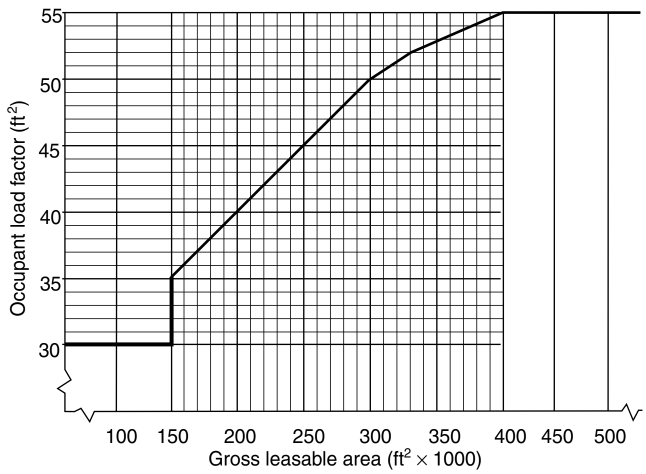
The occupant load of a floor in a new building is 640 persons. Three means of egress are provided in accordance with 14.9.1.2. Egress route 1 is of sufficient width to accommodate 340 persons, and egress route 2 and egress route 3 each accommodate 150 persons. The three egress routes, together, exactly accommodate the 640-person occupant load of the floor. If a fire or similar emergency were to render egress route 1 unusable, the performance-based criterion of 14.8.1.1.2 would not be met, because less than half the required egress capacity remains usable via the combination of egress route 2 and egress route 3 [i.e., 150 + 150 = 300; 300 < 640/2]. The designer chooses to resize all three egress routes so that egress route 1 accommodates 320 persons and egress route 2 and egress route 3 each accommodate 160 persons. Following the redesign, the arrangement is again evaluated against the criterion of 14.8.1.1.2. The loss of egress route 1 leaves available not less than 50 percent of the required egress capacity of the floor as required by 14.8.1.1.2.

Δ **14.8.1.2* Occupant Load Factor.** The occupant load in any building or portion thereof shall be not less than the number of persons determined by dividing the floor area assigned to that use by the occupant load factor for that use as specified in Table 14.8.1.2, Figure 14.8.1.2(a), and Figure 14.8.1.2(b). Where both gross and net area figures are given for the same occupancy, calculations shall be made by applying the gross area figure to the gross area of the portion of the building devoted to the use for which the gross area figure is specified and by applying the net area figure to the net area of the portion of the building devoted to the use for which the net area figure is specified. [***101:***7.3.1.2]

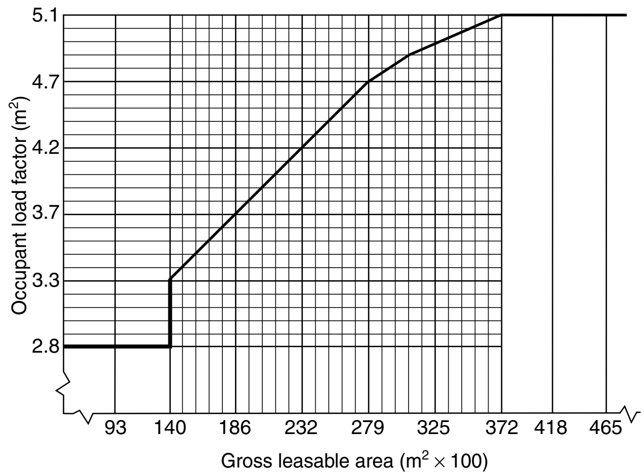
A.14.8.1.2 The normal occupant load is not necessarily a suitable criterion, because the greatest hazard can occur when an unusually large crowd is present, which is a condition often difficult for AHJs to control by regulatory measures. The principle of this *Code* is to provide means of egress for the maximum probable number of occupants, rather than to attempt to limit occupants to a number commensurate with available means of egress. However, limits of occupancy are specified in certain special cases for other reasons. [***101:***A.7.3.1.2]

Suggested occupant load factors for components of large airport terminal buildings are given in Table A.14.8.1.2. However, the AHJ might elect to use different occupant load factors, provided that egress requirements are satisfied. [***101:***A.7.3.1.2]

The figure used in determining the occupancy load for mall shopping centers of varying sizes was arrived at empirically by surveying over 270 mall shopping centers, by studying mercantile occupancy parking requirements, and by observing the number of occupants per vehicle during peak seasons. [***101:***A.7.3.1.2]



Δ ***FIGURE 14.8.1.2(a)*** *Mall Structure Occupant Load Factors (U.S. Customary Units). [**101:**Figure 7.3.1.2(a)]*



Δ ***FIGURE 14.8.1.2(b)*** *Mall Structure Occupant Load Factors (SI Units). [**101:**Figure 7.3.1.2(b)]*

Δ *TABLE 14.8.1.2 Occupant Load Factor*

Use	(ft^2/person)[a]	(m^2/person)[b]
Assembly Use	-	-
Concentrated use, without fixed seating	7 net	0.65 net
Less concentrated use, without fixed seating	15 net	1.4 net
Bench-type seating	1 person/ 18 linear in.	1 person/ 455 linear mm
Fixed seating	Use number of fixed seats	Use number of fixed seats
Waiting spaces	*See 12.1.7.2 and 13.1.7.2 of NFPA 101*	*See 12.1.7.2 and 13.1.7.2 of NFPA 101*
Kitchens	100	9.3
Library stack areas	100	9.3
Library reading rooms	50 net	4.6 net
Swimming pools	50 (water surface)	4.6 (water surface)
Swimming pool decks	30	2.8
Exercise rooms with equipment	50	4.6
Exercise rooms without equipment	15	1.4
Stages	15 net	1.4 net
Lighting and access catwalks, galleries, gridirons	100 net	9.3 net
Casinos and similar gaming areas	11	1
Skating rinks	50	4.6
Business Use (other than below)	100	9.3
Concentrated Business Use[f]	50	4.6
Airport control tower observation levels	40	3.7
Day-Care Use	35 net	3.3 net
Detention and Correctional Use	120	11.1
Educational Use	-	-
Classrooms	20 net	1.9 net
Shops, laboratories, vocational rooms	50 net	4.6 net

Use	(ft^2/person)[a]	(m^2/person)[b]
Health Care Use	-	-
Inpatient treatment departments	240	22.3
Sleeping departments	120	11.1
Ambulatory health care	150	13
Industrial Use	-	-
General and high hazard industrial	100	9.3
Special-purpose industrial	NA	NA
Mercantile Use	-	-
Sales area on street floor[b,c]	30	2.8
Sales area on two or more street floors[c]	40	3.7
Sales area on floor below street floor[c]	30	2.8
Sales area on floors above street floor[c]	60	5.6
Floors or portions of floors used only for offices	See business use.	See business use.
Floors or portions of floors used only for storage, receiving, and shipping, and not open to general public	300	27.9
Mall structures[d]	Per factors applicable to use of space[e]	
Residential Use	-	-
Hotels and dormitories	200	18.6
Apartment buildings	200	18.6
Board and care, large	200	18.6
Storage Use	-	-
In storage occupancies	NA	NA
In mercantile occupancies	300	27.9
In other than storage and mercantile occupancies	500	46.5

NA: Not applicable. The occupant load is the maximum probable number of occupants present at any time.

[a]All factors are expressed in gross area unless marked "net."

[b]For the purpose of determining occupant load in mercantile occupancies where, due to differences in the finished ground level of streets on different sides, two or more floors directly accessible from streets (not including alleys or similar back streets) exist, each such floor is permitted to be considered a street floor. The occupant load factor is one person for each 40 ft^2 (3.7 m^2) of gross floor area of sales space.

[c]For the purpose of determining occupant load in mercantile occupancies with no street floor, as defined in 3.3.234, but with access directly from the street by stairs or escalators, the floor at the point of entrance to the mercantile occupancy is considered the street floor.

[d]For any food court or other assembly use areas located in the mall concourse that are not included as a portion of the gross leasable area of the mall structure, the occupant load is calculated based on the occupant load factor for that use as specified in Table 14.8.1.2. The remaining mall concourse area is not required to be assigned an occupant load.

[e]The portions of the mall concourse that are considered a pedestrian way and not used as gross leasable area are not required to be assessed an occupant load based on Table 14.8.1.2. However, means of egress from a mall pedestrian way are required to be provided for an occupant load determined by dividing the gross leasable area of the mall structure (not including anchor stores) by the appropriate lowest whole number occupant load factor from Figure 14.8.1.2(a) or Figure 14.8.1.2(b).

Each individual tenant space is required to have means of egress to the outside or to the mall concourse based on occupant loads calculated by using the appropriate occupant load factor from Table 14.8.1.2.

Each individual anchor store is required to have means of egress independent of the mall concourse.

[f]See A.14.8.1.2.

[***101:***Table 7.3.1.2]

TABLE A.14.8.1.2 Airport Terminal Occupant Load Factors

Airport Terminal Area	ft² (gross)	m² (gross)
Concourse	100	9.3
Waiting areas	15	1.4
Baggage claim	20	1.9
Baggage handling	300	27.9

[***101:*** Table A.7.3.1.2]

These studies show that, with an increase in shopping center size, there is a decrease in the number of occupants per square foot of gross leasable area. [***101:***A.7.3.1.2]

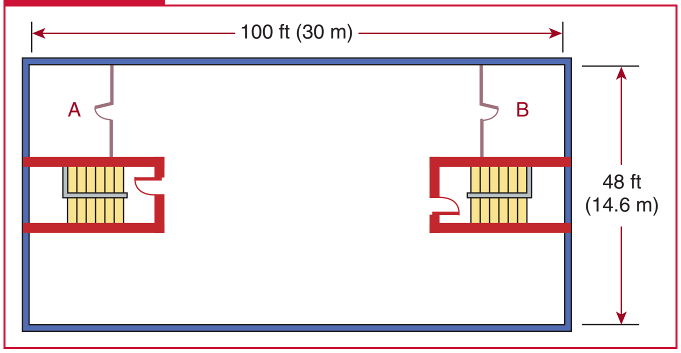
This phenomenon is explained when one considers that, above a certain shopping center gross leasable area [approximately 600,000 ft² (56,000 m²)], there exists a multiplicity of the same types of stores. The purpose of duplicate types of stores is to increase the choices available to a customer for any given type of merchandise. Therefore, when shopping center size increases, the occupant load increases as well, but at a declining rate. In using Table A.14.8.1.2, the occupant load factor is applied only to the gross leasable area that uses the mall concourse as a means of egress. [***101:***A.7.3.1.2]

The value for concentrated business use is intended to address business use spaces with a higher density of occupants than would normally be expected in a general business occupancy. Where furnishings and floor layouts are arranged to maximize the number of occupants in the space, the value for concentrated business use should be applied. Examples of concentrated business use areas are call centers, trading floors, and data processing centers. [***101:***A.7.3.1.2]

Occupant load is determined by the nature of the use of a building or space and the amount of space available for that use. Since different generic uses are characterized by different occupant densities, Table 14.8.1.2 has established occupant load factors for each use. The first column of the table is deliberately headed "use" rather than "occupancy," because the use of an area might differ from its occupancy classification. For example, a meeting room for fewer than 50 people in an office building is not an assembly occupancy; it is part of the larger business occupancy [see 6.1.14.1.3(2)], but its occupant load is based on an assembly use. The same concept applies to a classroom in a university, which, although classified as a business occupancy, has an occupant load based on educational use (for traditional classroom style) or assembly use (for lecture style with theater-type seating).

The occupant load factor, as a density factor, assumes the presence of at least one person for each specified unit of area. Note that some values are for net area, while others are based on gross area. The gross area figure applies to the building as a whole (the area within the confining perimeter walls of the building, including areas that are occupied by shafts and other elements that people do not occupy but excluding vertical openings complying with the communicating space provisions of 8.6.6 of NFPA *101* and the atrium provisions of 8.6.7 of NFPA *101*); the net area figure applies to actual occupied spaces, such as classroom spaces, and does not include the corridors, the area occupied by walls, or other unoccupied areas.

Exhibit 14.36



Floor area for occupant load considerations.

Cases of mixed use might exist where, for example, an assembly use space having an occupant load based on net floor area might be located in a building that is primarily a business occupancy, a classification for which the occupant load is based on gross area. In such instances, the net area calculations should be performed for those specific areas that use occupant load factors based on net area; the remaining floor area can then be used to calculate the occupant load for the uses employing gross floor area. This is illustrated in Exhibit 14.36.

In Exhibit 14.36, the majority of the 4800 ft² (446 m²) gross floor area [i.e., 100 ft × 48 ft (30 m × 14.6 m)] is used for business purposes and is occupied by desks, chairs, file cabinets, office machines, and associated office personnel. Rooms A and B are conference rooms with tables and chairs used on a regular basis, primarily by company personnel from other floors in the building. These rooms can be expected to be occupied simultaneously with the remainder of the floor. Each conference room provides 320 ft² (30 m²) of net usable area. Because neither conference room can accommodate 50 or more persons, an assembly occupancy is not created. Rather, the floor is a business occupancy with some incidental assembly use [again, see 6.1.14.1.3(2)].

Because occupant load is calculated based on use of the space (not occupancy classification), the occupant load of the floor shown in Exhibit 14.36 is calculated using occupant load factors for both an assembly use, which is based on net area, and a business use, which is based on gross area. The occupant load of the assembly use spaces (conference rooms A and B) is calculated first. Using Table 14.8.1.2, a net area factor of 15 ft² (1.4 m²) per person for assembly, "less concentrated use," is chosen. (Note that the concept of "less concentrated use" refers to the possible concentration of occupants where, because of the presence of tables and chairs, there are fewer occupants than would be possible without the tables and chairs, which is an example of "concentrated use.") The two conference rooms must be assumed to have a combined occupant load of at least 43 persons, according to the following calculation:

$$\frac{640 \text{ ft}^2}{15 \text{ ft}^2 \text{ per person}} = 43 \text{ persons}$$

$$\frac{60 \text{ m}^2}{1.4 \text{ m}^2 \text{ per person}} = 43 \text{ persons}$$

Next, the occupant load of the remainder of the floor must be calculated. The use is business, so a gross area factor of 100 ft² (9.3 m²) per person is chosen per Table 14.8.1.2. Because the net area usable as conference rooms has already been assigned an occupant load, that area can be subtracted from the gross floor area, and the remaining business use area is then assigned an occupant load as follows:

$$\left(\begin{array}{c}4800 \text{ ft}^2\\ \text{gross area}\end{array}\right) - \left(\begin{array}{c}640 \text{ ft}^2\\ \text{net assembly}\\ \text{use area}\end{array}\right) = 4160 \text{ ft}^2$$

$$\left(\begin{array}{c}446 \text{ m}^2\\ \text{gross area}\end{array}\right) - \left(\begin{array}{c}60 \text{ m}^2\\ \text{net assembly}\\ \text{use area}\end{array}\right) = 386 \text{ m}^2$$

$$\frac{4160 \text{ ft}^2 \text{ gross business use area}}{100 \text{ ft}^2 \text{ per person}} = 42 \text{ persons}$$

$$\left[\frac{386 \text{ m}^2 \text{ gross business use area}}{9.3 \text{ m}^3 \text{ per person}}\right] = 42 \text{ persons}$$

Adding together the assembly use occupant load (43) and the business use occupant load (42) results in a minimum occupant load of 85 persons for the floor. See the paragraph that follows for an explanation of conditions under which the occupant load might be a number greater than that calculated using the floor area and occupant load factor calculation. In any case, the occupant load is not permitted to be a number smaller than that calculated, even where the building operator plans to limit the number of occupants.

Egress capacity must be provided for at least the occupant load (expressed in number of persons) determined by dividing each area of the space by the appropriate occupant load factor. This calculated occupant load must serve as the minimum starting point for egress sizing, regardless of whether the building operator claims that the occupant load will never reach the occupant load determined by calculation. However, if the building operator plans to have more occupants present than the number determined by calculation using occupant load factors, the means of egress system must be sized to accommodate that larger number of occupants. In return for providing the larger egress system, the building operator is permitted to claim the larger number of persons as the occupant load. This concept is further explained in the commentary following 14.8.1.3.2.

Table 14.8.1.2 provides an occupant load factor for ambulatory health care use. The entry was changed for the 2015 edition of the *Code* from 100 ft² (9.3 m²) to 150 ft² (13.9 m²). The change reflects the technical committee's judgment that ambulatory health care use spaces are not as densely populated as previously assumed. A calculation of occupant load using a factor of 150 ft² (13.9 m²) per person instead of the traditional 100 ft² (9.3 m²) per person results in an occupant load that is two-thirds that specified by previous editions of the *Code* for a given area.

Note that the occupant load for storage use classified as a storage occupancy (e.g., a warehouse) is determined not by calculation but through negotiation between the designer or owner and the AHJ, based on actual use and population (see 42.1.7 of NFPA *101*). Table 14.8.1.2 does not have an occupant load factor for storage use in a storage occupancy. However, Table 14.8.1.2 provides occupant load factors for storage use in occupancies other than a storage occupancy (e.g., a central storage room in a hospital or a stock room in a department store) to allow occupant load to be aggregated via calculations for each use area on a building floor.

14.8.1.3 Occupant Load Increases.

14.8.1.3.1 The occupant load in any building or portion thereof shall be permitted to be increased from the occupant load established for the given use in accordance with 14.8.1.2 where all other requirements of this *Code* are also met, based on such increased occupant load. [***101:***7.3.1.3.1]

14.8.1.3.2 The AHJ shall be permitted to require an approved aisle, seating, or fixed equipment diagram to substantiate any increase in occupant load and shall be permitted to require that such a diagram be posted in an approved location. [***101:***7.3.1.3.2]

The *Code*'s intent for other than assembly occupancies is not to restrict the occupant load of a building based on the floor area of the building. Nor is the *Code* specifying the minimum area needed by each occupant for efficient or sanitary use of the space. An occupant load is established for use in sizing the means of egress system and in determining thresholds at which additional provisions, such as mandatory sprinklers, become applicable. If *Code* provisions can be met for a larger number of persons than the calculation determines, the larger number of occupants is permitted to be present and be considered as the occupant load, provided that the AHJ is satisfied that the egress system (including corridors, aisles, stairs, and other means of egress components) can accommodate the larger occupant load. For assembly occupancies, the increase in occupant load above the calculated number is restricted by 12.1.7 and 13.1.7 of NFPA *101*, based on maximum density criteria. Density is addressed in the last paragraph of this commentary.

As an example of increasing the occupant load above the calculated number, a factory of 20,000 ft² (1860 m²) gross area would be assigned an occupant load of 200 persons if the typical 100 ft² (9.3 m²) per person occupant load factor were used. However, the occupant load would be permitted to be increased (e.g., to 300 persons to accommodate the occupant load of an electronic components manufacturing facility where personnel work side by side on assembly lines) if all *Code* provisions dependent on numbers of persons were met for the increased load.

Assembly occupancies have special but similar provisions for increasing occupant load. Densities greater than one person for each 5 ft² (0.46 m²) are prohibited, because movement speeds are reduced to a crawl where the density exceeds one person for each 3 ft² (0.28 m²) of floor area. This density approaches the jam point at which movement stops.

14.8.1.4 Exits Serving More than One Story. Where an exit serves more than one story, only the occupant load of each story considered individually shall be used in computing the required capacity of the exit at that story, provided that the required egress capacity of the exit is not decreased in the direction of egress travel. [***101:***7.3.1.4]

Paragraph 14.8.1.4 provides that, once a maximum required egress capacity is determined, such required capacity must be maintained — in the direction of egress travel — for the remainder of the egress system.

Required stair width is determined by the required egress capacity of each floor the stair serves, considered independently. It is not necessary to accumulate occupant loads from floor to floor to determine stair width. Each story or floor level is considered separately when calculating the occupant load to be served by the means of egress from that floor. The size or width of the stair need only accommodate the portion of the floor's occupant load assigned to that stair. However, in a multistory building, the floor requiring the greatest egress capacity dictates the minimum stair width from that floor to the level of exit discharge in the direction of egress travel. It is not permissible to reduce such stair width along the remainder of the stair runs encountered in traveling to the level of exit discharge; that is, stairs encountered in the direction of egress travel. Exits serving floors above the floor of greatest egress capacity are permitted to use egress components sized to handle the largest demand created by any floor served by that section of stair run.

Exhibit 14.37 illustrates the intent of 14.8.1.4. It is not necessary to accumulate required egress capacity from floor to floor; no decrease in egress capacity is permitted in the direction of egress travel.

14.8.1.5 Capacity from a Point of Convergence. Where means of egress from a story above and a story below converge at an intermediate story, the capacity of the means of egress from the point of convergence shall be not less than the sum of the required capacity of the two means of egress. [***101:***7.3.1.5]

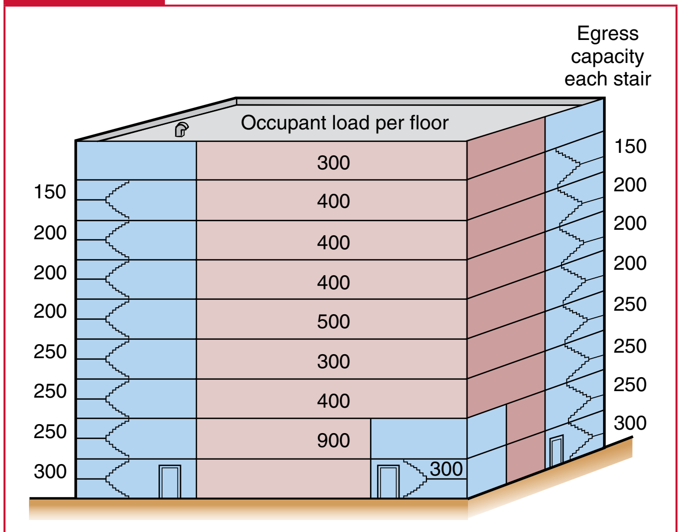
Exhibit 14.38 illustrates the intent of 14.8.1.5. Convergence from floors above and below requires the accumulation of required egress capacity. Paragraph 14.8.1.5 mandates that the *required* capacity, not the actual or provided capacity, must be aggregated at the point of convergence. Note that occupants of the second floor move down the stairs and converge with occupants of the basement, who are traveling up the stairs. From the merge point (i.e., the ground level stair landing) to the public way, the egress path must accommodate the 300-person combined occupant load represented as the sum of those persons moving downward and upward on the stair.

The occupants of the first floor (X) experience level travel through the stair enclosure. They are not considered to have merged from above or below, and egress capacity for the first-floor occupants is not added to that of the second floor and basement.

14.8.1.6 Egress Capacity from Balconies and Mezzanines. Where any required egress capacity from a balcony or mezzanine passes through the room below, that required capacity shall be added to the required egress capacity of the room in which it is located. [***101:***7.3.1.6]

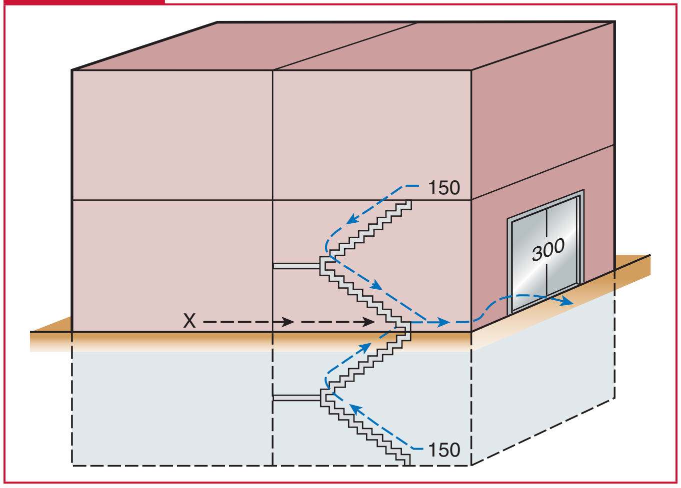
Mezzanines and balconies are considered as part of the room in which they are located. Occupants of mezzanines and balconies experience the effects of a fire in the room to which such spaces are open as readily as do the occupants of those spaces. Thus,

Exhibit 14.37



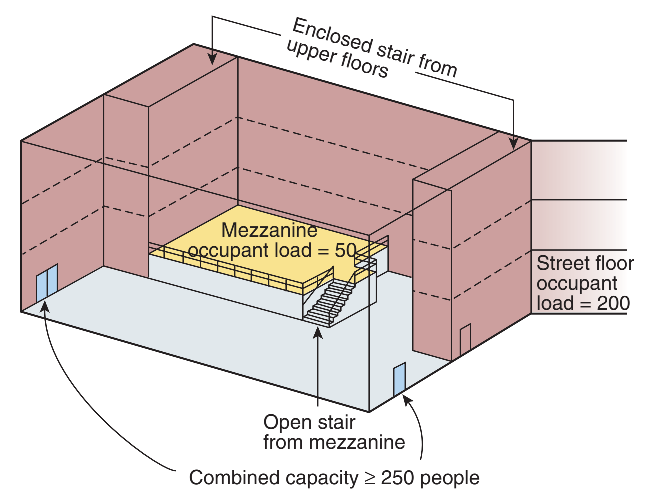
Capacity of exit stairs serving multiple floors.

Exhibit 14.38



Capacity of egress system from point on stairs where occupants from floors above and below converge.

Exhibit 14.39



Required capacity of main floor with mezzanine egress through that floor.

mezzanines and balconies must have their occupant load added to that of the room or space in which they are located if their egress passes through that room or space.

An example is depicted in Exhibit 14.39. There is no direct access to the enclosed exit stair from the mezzanine; therefore, egress from the mezzanine is down the open stair and through the main floor. Thus, the street floor egress capacity must accommodate the occupant load of the street floor and that of the mezzanine. If the main floor has an occupant load of 200 persons and the mezzanine has an occupant load of 50 persons, the egress capacity for the main floor must accommodate at least 250 persons.

14.8.2 Measurement of Means of Egress.

14.8.2.1 The width of means of egress shall be measured in the clear at the narrowest point of the egress component under consideration, unless otherwise provided in 14.8.2.2 or 14.8.2.3. [***101:***7.3.2.1]

14.8.2.2 Projections within the means of egress of not more than 4½ in. (114 mm) on each side shall be permitted at a height of 38 in. (965 mm) and below. In the case of stair and landing handrails forming part of a guard, in accordance with 7.2.2.4.4.3 of NFPA *101*, such projections shall be permitted at a height of 42 in. (1065 mm) and below. [***101:***7.3.2.2]

14.8.2.3 In health care and ambulatory health care occupancies, projections shall be permitted in corridors in accordance with Chapters 18 through 21 of NFPA *101*. [***101:***7.3.2.3]

Paragraph 14.8.2.2 permits maximum 4½ in. (114 mm) projections at each side of an egress component for purposes of determining width for use in egress capacity calculations, provided that such projections occur at a height of not more than 38 in. (965 mm), which is the maximum mounting height for handrails. Note that such encroachments are not limited to items such as handrails that are required by the *Code*. The encroachment might be the result of wainscoting applied to the lower portion of a wall, or it might be caused by the metal stringers to which metal pan stair treads and risers are welded.

A 4½ in. (114 mm) encroachment is permitted by 14.8.2.2 along stairs, corridors, passageways, and other components of the means of egress (other than door openings) for purposes of calculating egress capacity. The egress capacity of door openings is regulated by 7.2.1.2.2.1 of NFPA *101*, which substitutes a maximum 3½ in. (90 mm) projection at each side of the door opening in place of the 4½ in. (114 mm) projection permitted by 14.8.2.2. Figure A.7.2.1.2.2(b) of NFPA *101* depicts the allowable encroachment at each side of a door opening.

Exhibit 14.40 shows handrails along the right wall of the corridor in a medical office building. The handrails are permitted to encroach as much as 4½ in. (114 mm) into the corridor width in accordance with 14.8.2.2. Note that the cross-corridor door leaf (not the door opening) is provided with a handrail that serves as a corridor wall handrail when the door is held in its full open position.

For purposes of determining whether a door opening provides the minimum required width (such as that needed for a person in a wheelchair to pass through a door opening), see 7.2.1.2.1.1, Figure A.7.2.1.2.1(a), and Figure A.7.2.1.2.1(b) of NFPA *101*. Similarly, the minimum 48 in. (1220 mm) clear width

Exhibit 14.40

Permitted handrail encroachment on required corridor width. (Courtesy of Jake Pauls) between handrails, as required by 7.2.12.2.3 of NFPA *101* for stairs serving areas of refuge, does not allow for encroachments, based on the need to provide sufficient clear width to carry a person in a wheelchair on the stair.

Projections at or below 38 in. (965 mm) (i.e., handrail height) and not exceeding 4½ in. (114 mm) do not adversely restrict the effective egress width of stairs or corridors, because the human body is normally widest at shoulder level. Also, the body sway associated with walking, particularly on stairs, is greater at shoulder height than it is at waist height. Other projections, however, might constitute obstructions and cause impediments to the free flow of pedestrian travel. The *Code*, therefore, bases the measurements of widths of means of egress used for egress capacity calculation purposes on the clear, net, usable, unobstructed width. Only those projections specified are permitted to encroach on the required width without having to subtract the encroaching space from the overall width before performing the egress width calculation.

Paragraph 14.8.2.3 serves as a reminder that the provisions of 14.8.2 are modified to permit encroachments in health care and ambulatory health care occupancy corridors where the corridor width is at least 6 ft (1830 mm) — a width greater than the 36 in. (915 mm) minimum established for egress components by 14.8.3.4.1. See, for example, 19.2.3.4(2) of NFPA *101*.

14.8.3 Egress Capacity.

Δ **14.8.3.1** Egress capacity for approved components of means of egress shall be based on the capacity factors shown in Table 14.8.3.1, unless otherwise provided in 14.8.3.2. [***101:***7.3.3.1]

A significant change in egress capacity calculations was introduced in the 1988 edition of NFPA *101*. The unit of exit width formerly used as a measure of egress capacity was replaced by a system of smaller increments of egress width and capacity. The newer method of using smaller increments (approximating a linear formula) provides increased egress capacity.

The differences between the *stairways* and the *level components/ramps* capacity factors specified in Table 14.8.3.1 arise from the following:

Δ ***TABLE 14.8.3.1*** *Capacity Factors*

Area	Stairways (width/person) in.	Stairways (width/person) mm	Level Components and Ramps (width/person) in.	Level Components and Ramps (width/person) mm
Board and care	0.4	10	0.2	5
Health care, sprinklered	0.3	7.6	0.2	5
Health care, nonsprinklered	0.6	15	0.5	13
High hazard contents	0.7	18	0.4	10
All others	0.3	7.6	0.2	5

[***101:***Table 7.3.3.1]

1. Stairs entail a totally different type of movement, by both individuals and crowds, than do level and ramped components.
2. For stairs, there are differences in biomechanics, as well as a difficulty in the ability to see (or otherwise detect) the next stepping surface in order to avoid misstepping and suffering a fall and resulting injury. Exhibit 14.41 shows stair users looking for the next stepping surface.
3. The approximate ratio of 3 to 2, relating the required widths for vertical travel on stairs and level travel on floors, is based on previous ratios and on empirical observations.

The greater range of width requirements for different occupancies reflects the following two factors:

1. The need for a much more rapid egress time in the case of high hazard occupancies
2. The slower movement and greater need for assistance from others during evacuations in nonsprinklered health care and related institutional and semi-institutional occupancies

In summary, given the designer's knowledge of the occupancy, the occupant load of the floor level, and the type of egress component, the required minimum width for each component can be determined by simple multiplication (i.e., multiply the occupant load by the appropriate width-per-person factor found in Table 14.8.3.1 to obtain the minimum width of the component under consideration). If the width of the component under consideration is known, divide that width by the appropriate width-per-person factor to obtain the number of

Exhibit 14.41

Stair users looking for next stepping surface. (Courtesy of Jake Pauls) persons the component can accommodate over the entire evacuation. These calculated minimum widths are then considered along with other *Code* requirements, including minimum widths based on other factors, to design a system in which performance will be closely matched from one part of the system to another.

14.8.3.2* For stairways wider than 44 in. (1120 mm) and subject to the 0.3 in. (7.6 mm) width per person capacity factor, the capacity shall be permitted to be increased using the following equation:

$$C = 146.7 + \left(\frac{Wn - 44}{0.218}\right) \qquad \textbf{[14.8.3.2]}$$

where:

C = capacity, in persons, rounded to the nearest integer

Wn = nominal width of the stair as permitted by 14.8.3.2 (in.) [***101:***7.3.3.2]

Δ **A.14.8.3.2** The effective capacity of stairways has been shown by research to be proportional to the effective width of the stairway, which is the nominal width minus 12 in. (305 mm). This phenomenon, and the supporting research, were described in the chapter, "Movement of People," in the first, second, and third editions of the *SFPE Handbook of Fire Protection Engineering* and was also addressed in Appendix D of the 1985 edition of NFPA *101*, among several other publications. In 1988, this appendix was moved to form Chapter 2 of the 1988 edition of NFPA 101M, *Alternative Approaches to Life Safety*. (This document was later designated as NFPA 101A and this chapter remained in the document through the 1998 edition.) In essence, the effective width phenomenon recognizes that there is an edge or boundary effect at the sides of a circulation path. It has been best examined in relation to stairway width, where the edge effect was estimated to be 6 in. (150 mm) on each side, but a similar phenomenon occurs with other paths, such as corridors and doors, although quantitative estimates of their edge effect are not as well established as they have been for stairways, at least those stairways studied in Canada during the late 1960s through the 1970s in office building evacuation drills and in crowd movement in a variety of buildings with assembly occupancy. [***101:***A.7.3.3.2]

More recent studies have not been performed to determine how the edge effect might be changing (or has changed) with demographic changes to larger, heavier occupants moving more slowly, and thus swaying laterally, to maintain balance when walking. The impact of such demographic changes, which are significant and influential for evacuation flow and speed of movement on stairs, for example, has the effect of increasing the time of evacuation in a way that affects all stair widths, but will be most pronounced for nominal widths less than 56 in. (1422 mm). [***101:***A.7.3.3.2]

Without taking into account occupant demographic changes in the last few decades that affect evacuation performance, especially on stairs, the formula for enhanced capacity of stairways wider than 44 in. (1120 mm) assumes that any portion of the nominal width greater than 44 in. (1120 mm) is as effective proportionally as the effective width of a nominal 44 in. (1120 mm) stair, that is, 32 in. (810 mm). Thus, the denominator (0.218) in the equation is simply the effective width of 32 in. (810 mm) divided by the capacity of 147 persons that is credited, by the 0.3 in. (7.6 mm) capacity factor in Table A.14.8.3.2, to the corresponding nominal width, 44 in. (1120 mm). [***101:***A.7.3.3.2]

The resulting permitted stairway capacities, based on occupant load of single stories (in accordance with 7.3.1.4 of NFPA *101*), for several stairway widths are shown in Table A.14.8.3.2. [***101:***A.7.3.3.2]

TABLE A.14.8.3.2 *Stairway Capacities*

Permitted Capacity (no. of persons)	Nominal Width in.	Nominal Width mm	Clear Width Between Handrails[a] in.	Clear Width Between Handrails[a] mm	Effective Width in.	Effective Width mm
120[b]	36	915	28	710	24	610
147	44	1120	36	915	32	810
202	56	1420	48	1220	44	1120
257	68	1725	60	1525[c]	56	1420

[a]A reasonable handrail incursion of only 4 in. (100 mm), into the nominal width, is assumed on each side of the stair, although 7.3.3.2 of NFPA *101* permits a maximum incursion of 4½ in. (114 mm) on each side.

[b]Other *Code* sections limit the occupant load for such stairs more severely, (e.g., 50 persons in 7.2.2.2.1.2 of NFPA *101*). Such lower limits are partly justified by the relatively small effective width of such stairs, which, if taken into account by Table 7.3.3.1 of NFPA *101*, would result in a correspondingly low effective capacity of only 110 persons (24 divided by 0.218), or a more realistic capacity factor of 0.327, applicable to nominal width.

[c]A clear width of 60 in. (1525 mm) is the maximum permitted by the handrail reachability criteria of 7.2.2.4.1.2 of NFPA *101*. Although some prior editions of the *Code* permitted wider portions of stairs [up to 88 in. (2240 mm), between handrails], such wider portions are less effective for reasonably safe crowd flow and generally should not be used for major crowd movement. To achieve the maximum possible, reasonably safe egress capacity for such stairs, retrofit of an intermediate — not necessarily central — handrail is recommended; for example, with an intermediate handrail located 36 in. (915 mm) from the closest side handrail. In this case, the effective capacity would be 358 persons for the formerly permitted, now retrofitted, stair. This is based on a retrofitted, effective width of about 78 in. (1980 mm) [subtracting 2 in. (51 mm) from each usable side of a handrail and assuming a 2 in. (51 mm) wide, retrofitted intermediate handrail]. [***101:***A.7.3.3.2]

The enhanced capacity provision of 14.8.3.2 permits stairs that are wider than 44 in. (1120 mm) for which the 0.3 in. (7.6 mm) per person capacity factor from the last row (i.e., the entry for "all others") of Table 14.8.3.1 is applied to be credited with more capacity than results from the standard calculation performed by dividing the clear width of the stair by the 0.3 in. (7.6 mm) per person capacity factor. The rationale for the enhanced capacity allowance is detailed in this commentary to A.14.8.3.2.

The equation in 14.8.3.2 is presented only in inch-pound units. Where SI units are used, the equation for calculating capacity, C, is as follows:

$$C = 146.7 + \left[\frac{Wn - 1120}{5.45}\right]$$

where the nominal stair width, Wn, is expressed in mm.

An example of use of the enhanced capacity permitted by 14.8.3.2 follows. A 56 in. (1420 mm) stair has encroachments at handrail height and below that do not exceed the 4½ in. (114 mm) permitted at each side by 14.8.2.2. The stair exceeds the 44 in. (1120 mm) width specified in 14.8.3.2 and is in a business occupancy, so as to be subject to the 0.3 in. (7.6 mm) per person capacity factor from the last row of Table 14.8.3.1. The traditional capacity calculation involves taking the 56 in. (1420 mm) clear width and dividing it by 0.3 in. (7.6 mm) per person, which results in a traditional capacity of 187 persons. The nominal width of the stair, for purposes of performing the enhanced capacity calculation permitted by 14.8.3.2, is the full 56 in. (1420 mm) clear width, and the calculation is performed as follows:

$$\text{Enhanced capacity, } C = 146.7 + \left[\frac{(56\text{ in.} - 44\text{ in.})}{0.218}\right]$$

$$C = 146.7 + \frac{12}{0.218}$$

$$C = 146.7 + 55$$

$$C = 202$$

In SI units:

$$\text{Enhanced capacity, } C = 146.7 + \left[\frac{(1420\text{ mm} - 1120\text{ mm})}{5.45}\right]$$

$$C = 146.7 + \frac{300}{5.45}$$

$$C = 146.7 + 55$$

$$C = 202$$

Note that 7.2.2.4.1.2(2)(b) of NFPA *101* prohibits the enhanced capacity option of 14.8.3.2 from being applied to existing stairs where portions of the stair are more than 30 in. (760 mm) from a handrail even though the provision of 7.2.2.4.1.2(2)(a) of NFPA *101* would otherwise permit 44 in. (1120 mm). In other words, an existing stair is held to the same intermediate handrail criterion as new stairs, as found in 7.2.2.4.1.2(1) of NFPA *101*, if the existing stair is to make use of the increased capacity offered by the equation in 14.8.3.2.

14.8.3.3 The required capacity of a corridor shall be the occupant load that utilizes the corridor for exit access divided by the required number of exits to which the corridor connects, but the corridor capacity shall be not less than the required capacity of the exit to which the corridor leads. [***101:***7.3.3.3]

14.8.3.4 Minimum Width.

Δ **14.8.3.4.1** The width of any means of egress, unless otherwise provided in 14.8.3.4.1.1 through 14.8.3.4.1.3, shall be as follows:

(1) Not less than that required for a given egress component in this chapter or Chapter 7 or Chapters 11 through 43 of NFPA *101*
(2) Not less than 36 in. (915 mm) where another part of this chapter and Chapters 11 through 43 of NFPA *101* do not specify a minimum width.

[***101:***7.3.4.1]

Δ **14.8.3.4.1.1*** The width of exit access serving not more than six people, and having a length not exceeding 50 ft (15 m) shall meet both of the following criteria:

(1) The width shall be not less than 18 in. (455 mm), at and below a height of 38 in. (965 mm), and not less than 28 in. (710 mm) above a height of 38 in. (965 mm).
(2) A width of not less than 36 in. (915 mm) for new exit access, and not less than 28 in. (710 mm) for existing exit access, shall be capable of being provided without moving permanent walls.

[***101:***7.3.4.1.1]

A.14.8.3.4.1.1 The criteria of 14.8.3.4.1.1, as initially written, were intended to provide for minimum widths for small spaces such as individual offices. The intent is that these reductions in required width apply to spaces formed by furniture and movable walls so that accommodations can easily be made for mobility-impaired individuals. One side of a path could be a fixed wall, provided that the other side is movable. This does not exempt the door widths or widths of fixed-wall corridors, regardless of the number of people or length. The allowance for reduction in width has been expanded to include all exit accesses serving not more than six people where the travel length along the reduced-width path does not exceed 50 ft (15 m), regardless of occupancy or use of the space. [***101:***A.7.3.4.1.1]

Figure A.14.8.3.4.1.1(a) and Figure A.14.8.3.4.1.1(b) present selected anthropometric data for adults. The male and female figures depicted in the figures are average, 50th percentile, in size. Some dimensions apply to very large, 97.5 percentile, adults (noted as 97.5 P). [***101:***A.7.3.4.1.1]

14.8.3.4.1.2 In existing buildings, the width of exit access shall be permitted to be not less than 28 in. (710 mm). [***101:***7.3.4.1.2]

Δ **14.8.3.4.1.3** The requirement of 14.8.3.4.1 shall not apply to the following:

(1) Doors as otherwise provided for in 7.2.1.2 of NFPA *101*
(2) Aisles and aisle accessways in assembly occupancies as otherwise provided in Chapters 12 and 13 of NFPA *101*
(3) Industrial equipment access as otherwise provided in 40.2.5.2 of NFPA *101*

[***101:***7.3.4.1.3]

14.8.3.4.2 Where a single exit access leads to an exit, its capacity in terms of width shall be not less than the required capacity of the exit to which it leads. [***101:***7.3.4.2]

14.8.3.4.3 Where more than one exit access leads to an exit, each shall have a width adequate for the number of persons it accommodates. [***101:***7.3.4.3]

14.9 Number of Means of Egress

14.9.1 General.

Δ **14.9.1.1** The number of means of egress from any balcony, mezzanine, story, or portion thereof shall be not less than two, except under one of the following conditions:

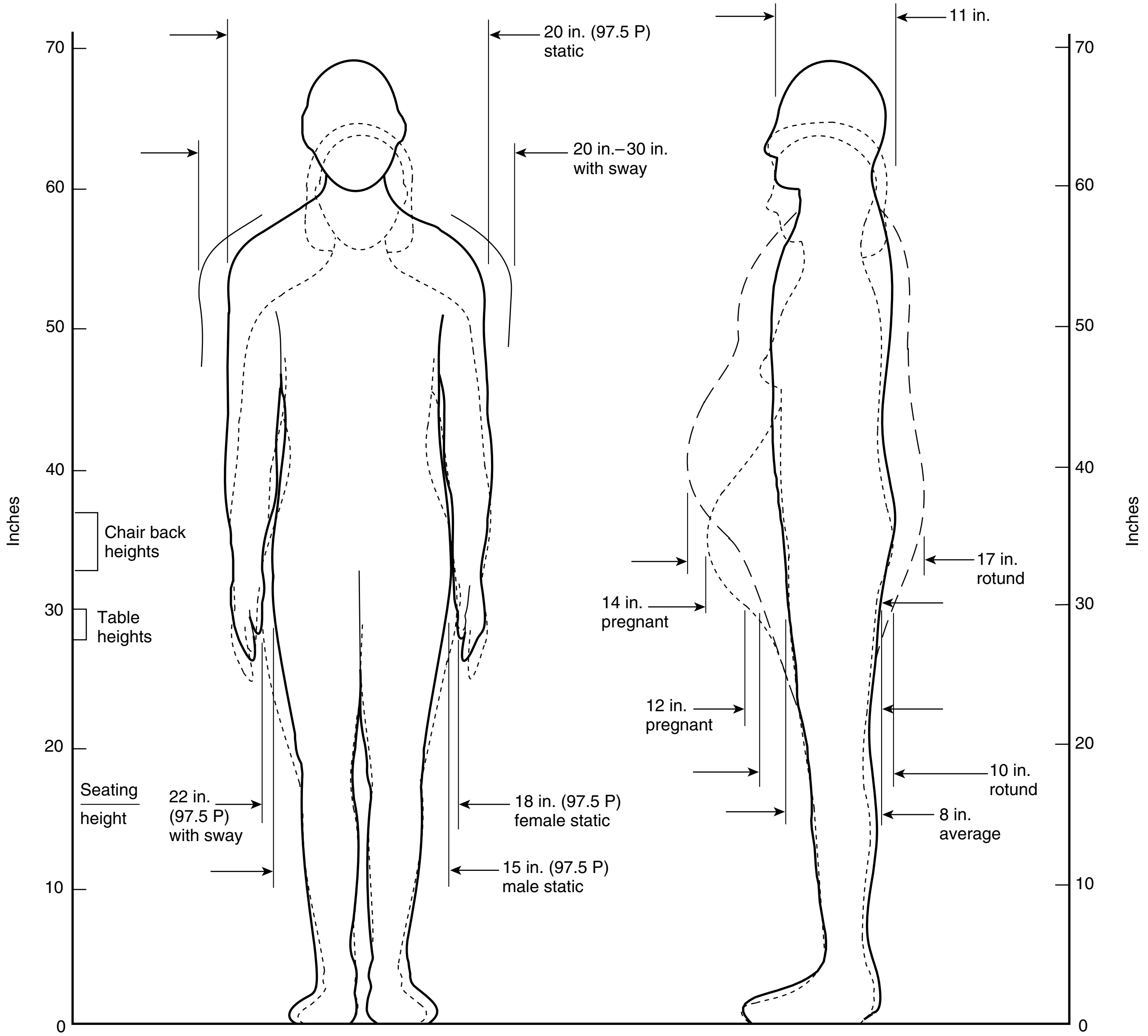


FIGURE A.14.8.3.4.1.1(a) *Anthropometric Data (in in.) for Adults; Males and Females of Average, 50th Percentile, Size; Some Dimensions Apply to Very Large, 97.5 Percentile (97.5 P), Adults. [**101:**Figure A.7.3.4.1.1(a)]*

(1) A single means of egress shall be permitted where permitted in Chapters 11 through 43 of NFPA *101*.

(2) A single means of egress shall be permitted for a mezzanine or balcony where the common path of travel limitations of Chapters 11 through 43 of NFPA *101* are met.

[***101:***7.4.1.1]

Most of the occupancy chapters of NFPA *101* provide redundancy with respect to the number of means of egress by requiring at least two means of egress. Some occupancies identify specific arrangements under which only a single means of egress is required. Where large numbers of occupants are to be present on any floor or portion of a floor in new construction, more than two means of egress must be provided as required by 14.9.1.2.

Mezzanines are required to have the same number of means of egress as any story of the building, unless an occupant can reach either the single exit or a point (at or past the bottom of a single open stair) where access to two exits becomes available within the allowable common path of travel permitted for the applicable occupancy.

Exhibit 14.42 illustrates the mezzanine provisions of 14.9.1.1 and 14.9.1.1(2), which are not intended to override the provisions for openness of mezzanines imposed by 8.6.10.3 of NFPA *101*. In

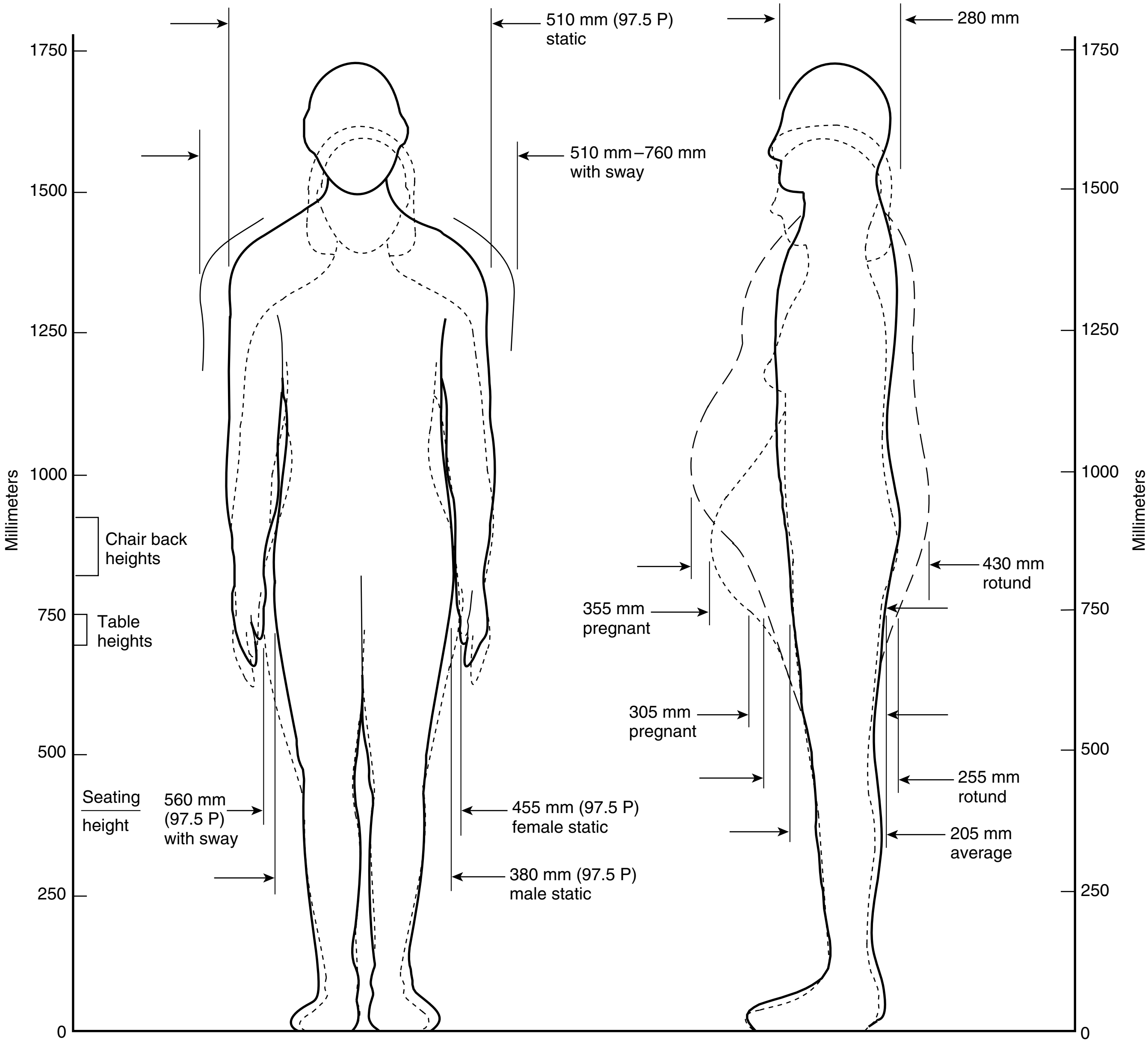
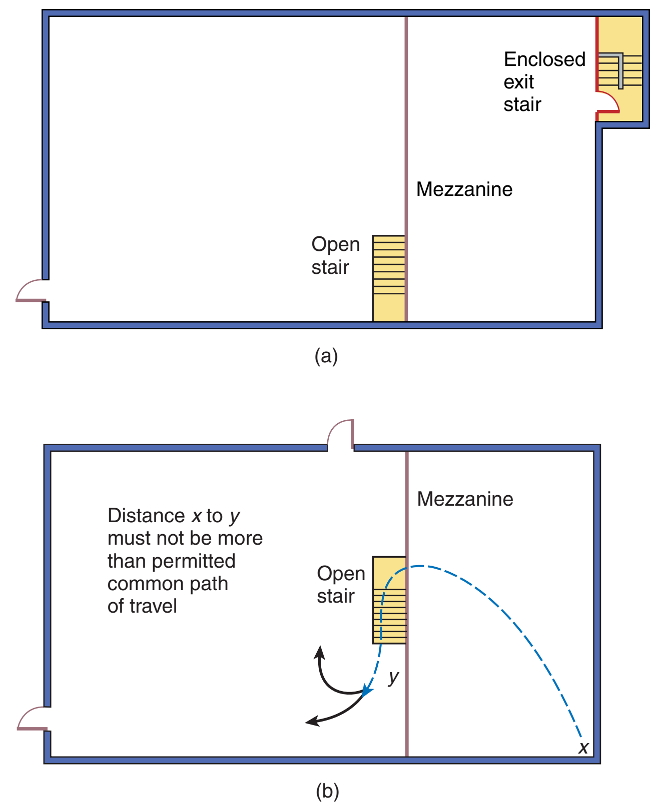


FIGURE A.14.8.3.4.1.1(b) *Anthropometric Data (in mm) for Adults; Males and Females of Average, 50th Percentile, Size; Some Dimensions Apply to Very Large, 97.5 Percentile (97.5 P), Adults. [**101:**Figure A.7.3.4.1.1(b)]*

Exhibit 14.42, part (a) illustrates the requirement for a minimum of two means of egress per 14.9.1.1. One means of egress is an open stair to the floor below, and the other is an enclosed exit stair. Both could be open stairs to the floor below, unless the openness requirements of 8.6.10.3 of NFPA *101* are not met. If the mezzanine were enclosed such that the enclosed area had an occupant load of more than 10 persons, 8.6.10.3 of NFPA *101* would require a second means of egress [similar to the enclosed exit stair in part (a)] that provides direct access from the enclosed area to an exit at the mezzanine level. In part (b) of Exhibit 14.42, a single means of egress is permitted in accordance with 14.9.1.1(2), because the common path of travel is within the limits specified for the occupancy involved and the 10-person enclosed area criterion of 8.6.10.3 of NFPA *101* is not exceeded.

See also Section 14.10 with respect to remoteness of exits and common paths of travel, 7.6.5 of NFPA *101* with respect to measuring travel distance in the plane of the tread nosings on open exit access stairs, and 8.6.10 of NFPA *101* on mezzanines.

Exhibit 14.42



Number of means of egress from mezzanines.

Δ **14.9.1.2** The number of means of egress from any story or portion thereof, other than for existing buildings as permitted in Chapters 11 through 43 of NFPA *101*, shall be as follows:

(1) Occupant load more than 500 but not more than 1000 — not less than 3
(2) Occupant load more than 1000 — not less than 4

[***101:***7.4.1.2]

Chapter 14 requires a minimum number of means of egress, unless otherwise specified by the occupancy chapters of NFPA *101*. Several occupancies establish not only the minimum number of means of egress but also the minimum number of actual exits that must be provided on each floor.

In most occupancies, meeting the requirements for egress capacities and travel distances means the required minimum number of means of egress will automatically be met. However, in occupancies characterized by high occupant loads, such as assembly and mercantile occupancies, compliance with requirements for more than two exits per floor might require specific attention.

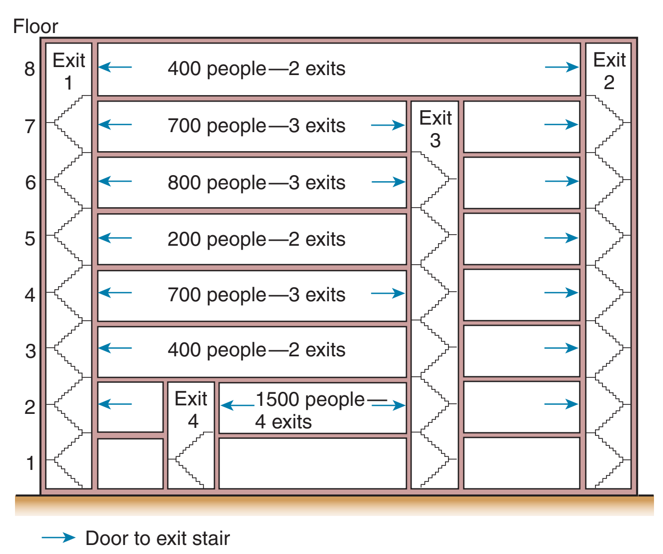
14.9.1.3 Accessible means of egress in accordance with 14.10.4 that do not utilize elevators shall be permitted to serve as any or all of the required minimum number of means of egress. [***101:***7.4.1.3]

Because an accessible means of egress can effectively serve the needs of persons with mobility impairments, the same accessible means of egress should effectively serve the needs of persons without disabilities. Therefore, the *Code* permits accessible means of egress to fulfill any requirements for means of egress. However, this permission does not apply to elevators because of the small number of occupants accommodated during each run of the elevator and concerns that the elevator might be automatically called out of service upon the detection of smoke in the elevator machine room or an elevator lobby or landing on any floor served by the elevator.

14.9.1.4 The occupant load of each story considered individually shall be required to be used in computing the number of means of egress at each story, provided that the required number of means of egress is not decreased in the direction of egress travel. [***101:***7.4.1.4]

Similar to the procedures for determining required egress capacity (see 14.8.1.4), the number of required means of egress is based on a floor-by-floor consideration, rather than the accumulation of the occupant loads of all floors. For example, see Exhibit 14.43, where the fourth floor of the building has an occupant load of 700 persons and would require three means of egress. The third floor of the same building has an occupant load of 400 persons and would require two means of egress; regardless of the fact that the two floors together have an occupant load in excess of 1000 persons, four means of egress are not required. However, the number of means of egress cannot decrease as an occupant proceeds along the egress path. The three exits required from the fourth floor in this example cannot be merged into two exits on the third floor, even though the third floor requires only two

Exhibit 14.43



Minimum number of required means of egress for new construction.

exits. On any floor requiring only two exits, one of the three exits could be left inaccessible (blind) on that floor, as shown at Exit 3 in Exhibit 14.43 on the third and fifth floors. The second floor, with an occupant load of 1500 persons, requires a fourth means of egress.

14.9.1.5 Doors other than the hoistway door; the elevator car door; and doors that are readily openable from the car side without a key, a tool, special knowledge, or special effort, shall be prohibited at the point of access to an elevator car. [***101:***7.4.1.5]

Paragraph 14.9.1.5 prohibits the installation of a door assembly at the entrance to an elevator, unless that door leaf is readily operable by those in the elevator. This prohibition prevents entrapment between the elevator and the door assembly. The primary concern is the potential for an occupant to enter this small space and become trapped during a fire. Exhibit 14.44 shows doors at the entrance to an elevator. Note the door lever on the door leaf at the right side. The door lever provides occupants of the elevator with the required latch release to open the door.

Exhibit 14.44

Permitted doors at entrance to elevator.

14.9.1.6 Elevator Landing and Lobby Exit Access.

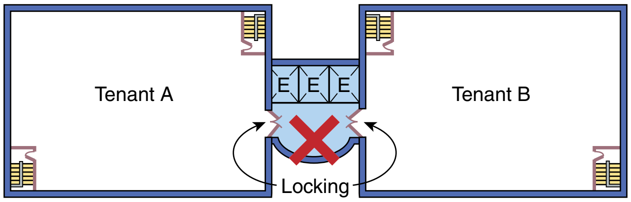
14.9.1.6.1 Each elevator landing and lobby shall have access to at least one exit. [***101:***7.4.1.6.1]

14.9.1.6.2 The elevator landing and lobby exit access required by 14.9.1.6.1 shall not require the use of a key, a tool, special knowledge, or special effort, unless permitted by 14.9.1.6.3. [***101:***7.4.1.6.2]

14.9.1.6.3 Doors separating the elevator lobby from the exit access required by 14.9.1.6.1 shall be permitted to be electronically locked in accordance with 14.5.3.3. [***101:***7.4.1.6.3]

The purpose of 14.9.1.6.1 and 14.9.1.6.2 is to ensure that an occupant who has gained access to an elevator lobby can get out of the lobby without the use of a tool or key. It is not uncommon, especially in office buildings where a tenant occupies an entire floor, for the elevator lobby door assemblies to the tenant space to be locked after normal business hours to prevent entry into the tenant space. This problem is illustrated in Exhibit 14.45. Because the door assemblies between the elevator lobby and the tenant spaces can be locked, access to an exit is not ensured to a person who arrives at the floor via elevator. At least one exit must be accessible from the elevator lobby. The situation can be corrected by repositioning one of the exit stair enclosures depicted at the top of the exhibit so that it is accessed directly from within the elevator lobby.

Exhibit 14.45



Exit access from an elevator lobby.

The provision of 14.9.1.6.3, rather than providing the detailed criteria required of locked elevator lobby exit access door assemblies, references the criteria of 14.5.3.3 as an exemption to the requirements of 14.9.1.6.1 and 14.9.1.6.2. The provisions of 14.5.3.3 for elevator lobby exit access door assemblies locking are correctly positioned within Section 14.5 on door openings and, more important, within 14.5.3, special locking arrangements provisions, because locked elevator lobby exit access doors are a special form of permitted door assembly locking. See the commentary following A.14.5.3.3(14).

14.9.2 Spaces About Electrical Equipment.

14.9.2.1 600 Volts, Nominal, or Less.

14.9.2.1.1 Number of Means of Egress. The minimum number of means of egress for working space about electrical equipment, other than existing electrical equipment, shall be in accordance with *NFPA 70*, Section 110.26(C). [***101:***7.4.2.1.1]

N **14.9.2.1.2 Door Unlatching and Direction of Door Swing.** The method of door unlatching and direction of door swing for working space about electrical equipment, other than existing electrical equipment, shall be in accordance with Section 110.26(C)(3) of *NFPA 70*. [***101:***7.4.2.1.2]

N **14.9.2.2 Over 600 Volts, Nominal.**

N **14.9.2.2.1 Number of Means of Egress.** The minimum number of means of egress for working space about electrical equipment, other than existing electrical equipment, shall be in accordance with *NFPA 70*, Section 110.33(A). [***101:***7.4.2.2.1]

N **14.9.2.2.2 Door Unlatching and Direction of Door Swing.** The method of door unlatching and direction of door swing for working space about electrical equipment, other than existing electrical equipment, shall be in accordance with Section 110.33(A)(3) of *NFPA 70*. [***101:***7.4.2.2.2]

The provisions of 14.9.2 serve as a reminder that *NFPA 70*®, *National Electrical Code*®, has criteria for ingress and egress for working space around electrical equipment that are more specific — and potentially more stringent — than those of this *Code*. Users had complained that, after designing an egress system in accordance with this *Code*, they were cited for not complying with *NFPA 70*. The provisions of 14.9.2 were expanded for the 2018 edition of the *Code* to capture that *NFPA 70* addresses not only the number of means of egress but also the method of door unlatching and direction of door swing for working space about electrical equipment.

14.10 Arrangement of Means of Egress

14.10.1 General.

14.10.1.1 Exits shall be located and exit access shall be arranged so that exits are readily accessible at all times. [***101:***7.5.1.1]

14.10.1.1.1* Where exits are not immediately accessible from an open floor area, continuous passageways, aisles, or corridors leading directly to every exit shall be maintained and shall be arranged to provide access for each occupant to not less than two exits by separate ways of travel, unless otherwise provided in 14.10.1.1.3 and 14.10.1.1.4. [***101:***7.5.1.1.1]

A.14.10.1.1.1 See A.14.10.1.5. [***101:***A.7.5.1.1.1]

14.10.1.1.2 Exit access corridors shall provide access to not less than two approved exits, unless otherwise provided in 14.10.1.1.3 and 14.10.1.1.4. [***101:***7.5.1.1.2]

14.10.1.1.3 The requirements of 14.10.1.1.1 and 14.10.1.1.2 shall not apply where a single exit is permitted in Chapters 11 through 43 of NFPA *101*. [***101:***7.5.1.1.3]

14.10.1.1.4 Where common paths of travel are permitted for an occupancy in Chapters 11 through 43 of NFPA *101*, such common paths of travel shall be permitted but shall not exceed the limit specified. [***101:***7.5.1.1.4]

Paragraphs 14.10.1.1.1 and 14.10.1.1.2 reinforce the desirability of an occupant always having the ability to move in different directions from any location, so as to allow different paths of travel to different exits. However, typical floor layouts and furnishing arrangements often create spaces where travel in a single direction is necessary for a limited distance before it becomes possible to travel in different directions.

Paragraph 14.10.1.1.3 recognizes that a single exit creates a condition under which travel is possible in only one direction. The conditions under which an occupancy chapter permits a single exit usually produce a situation that is as safe as or safer than a building that is provided with two exits but that includes substantial common path of travel before access to both exits is possible.

Paragraph 14.10.1.1.4 recognizes common paths of travel within the limits set by the individual occupancy chapters. For additional information on common paths of travel, see A.14.10.1.5.

14.10.1.2 Corridors shall provide exit access without passing through any intervening rooms other than corridors, lobbies, and other spaces permitted to be open to the corridor, unless otherwise provided in 14.10.1.2.1 and 14.10.1.2.2. [***101:***7.5.1.2]

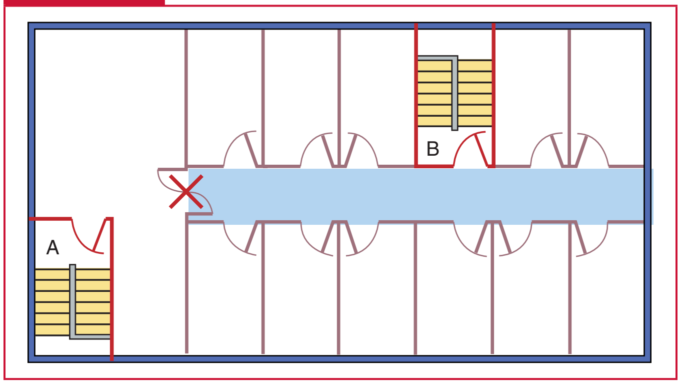
Δ **14.10.1.2.1** Approved existing corridors that require passage through a room to access an exit shall be permitted to continue to be used, provided that all of the following criteria are met:

(1) The path of travel is marked in accordance with Section 14.14.
(2) Doors to such rooms comply with 7.2.1 of NFPA *101*.
(3) Such arrangement is not prohibited by the applicable occupancy chapter in NFPA *101*.

[***101:***7.5.1.2.1]

The exit access arrangement illustrated in Exhibit 14.46 is deficient with respect to the requirement of 14.10.1.2, mandating that corridors provide access to at least two exits without passing through intervening rooms (other than corridors and lobbies). Occupants reaching the corridor have access only to Exit B without leaving the protection afforded by the corridor. Paragraph 14.10.1.2 requires access to both Exit A and Exit B without leaving the corridor and traveling within another use area. One possible solution to this problem would be to extend the corridor walls to the far left of the floor so as to connect directly with exit stair enclosure A.

Exhibit 14.46



Deficient corridor exit access.

Paragraph 14.10.1.2.1 recognizes the continued use of existing corridors that force occupants to travel through a room to access an exit where such existing corridors are approved. Per the definition of 3.2.1, the term *approved* means acceptable to the AHJ, so it is the current AHJ who must approve the existing corridor arrangement in order for it to be continued in use. If the exemption were not permitted, existing arrangements that were in compliance with earlier editions of the *Code* might suddenly be considered noncompliant.

14.10.1.2.2 Corridors that are not required to be fire resistance rated shall be permitted to discharge into open floor plan areas. [***101:***7.5.1.2.2]

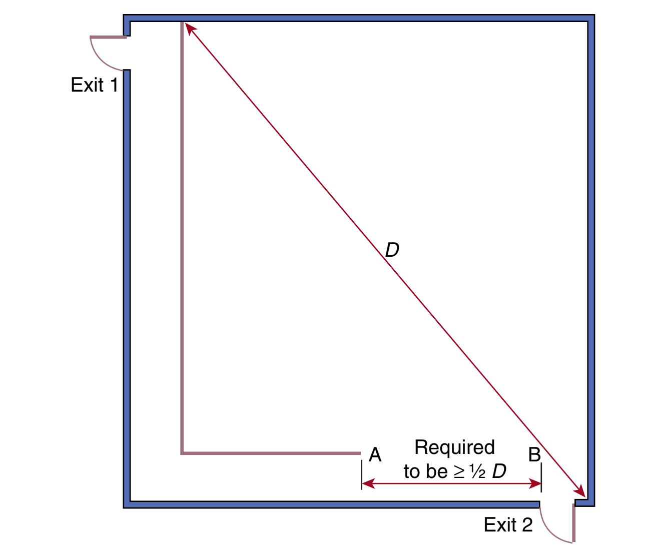
14.10.1.3 Remoteness shall be provided in accordance with 14.10.1.3.1 through 14.10.1.3.7. [***101:***7.5.1.3]

The provisions of 14.10.1.3.1 through 14.10.1.3.7 address the remoteness of exit accesses, the remoteness of exits, and the remoteness of exit discharges.

The concept of remoteness of exit accesses is illustrated in Exhibit 14.47 [which is an adaptation of Figure A.14.10.1.3.2(c)]. For purposes of this illustration, the building is new construction and is not sprinklered, so it is subject to both the qualitative remoteness criterion of 14.10.1.3.1 and the quantitative, one-half diagonal measurement remoteness criterion of 14.10.1.3.2. Exit 1 and Exit 2 — which are about as remotely located from each other as is physically possible — easily comply with the one-half diagonal separation distance criterion of 14.10.1.3.2 for exits. Yet, the L-shaped partition around which occupants must travel to reach Exit 1 has the effect of making the exit accesses less remotely located from each other than the exits, as all occupants are drawn toward Exit 2 before reaching point A, where access to Exit 1 becomes possible. The distance from point A to point B designates the separation distance between exit accesses that the requirements of 14.10.1.3.1 and 14.10.1.3.2 are intended to regulate. Without having to resort to measuring with a scale, it is apparent that the exit accesses do not meet the minimum one-half diagonal (½ *D*) requirement of 14.10.1.3.2. What is not obvious is whether the distance from point A to point B provides sufficient separation between exit accesses to meet the qualitative provision of 14.10.1.3.1, which requires that the exit accesses be remotely located from each other to minimize the possibility that more than one of the exit accesses has the potential to be blocked by any one fire or other emergency condition. Such judgment is left to the AHJ, which might be influenced by the fact that the diagonal measurement criterion of 14.10.1.3.2 was not met. If the building were sprinklered, the provision of 14.10.1.3.3 would be applied in lieu of that of 14.10.1.3.2 to decrease the required separation distance from one-half the diagonal to one-third the diagonal. Although less obvious than before, the remoteness test for the exit accesses would fail, since the distance from point A to point B is less than one-third the diagonal (⅓ *D*).

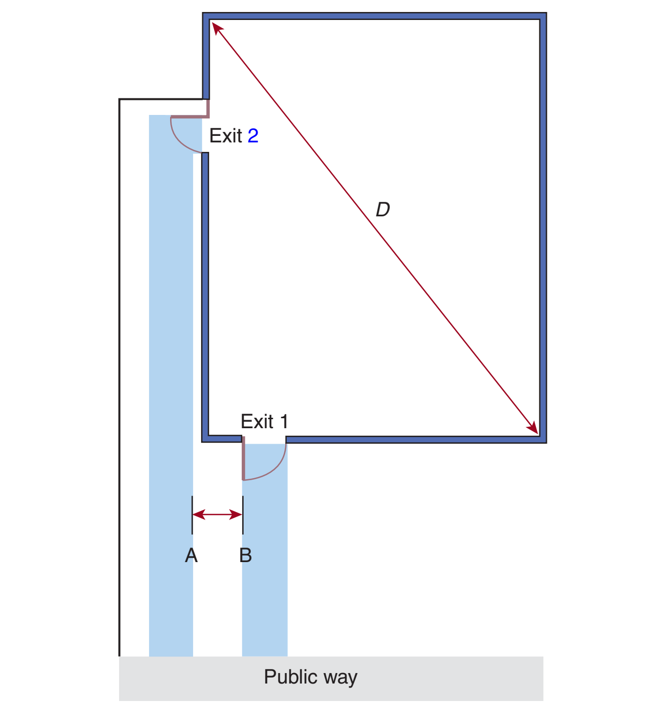
The provisions of 14.10.1.3.1 through 14.10.1.3.3, in addition to regulating the remoteness of exit accesses and the remoteness of exits, require that exit discharges be remotely located from each other. The concept of remoteness of exit discharges is illustrated in Exhibit 14.48. The shaded paths outside the nonsprinklered building are exit discharges. One provides the exit discharge path from Exit 1 to the public way, and the other provides the exit discharge path from Exit 2 to the public way. The proximity of the two exit discharge paths, measured

Exhibit 14.47



Testing the remoteness of exit accesses.

Exhibit 14.48

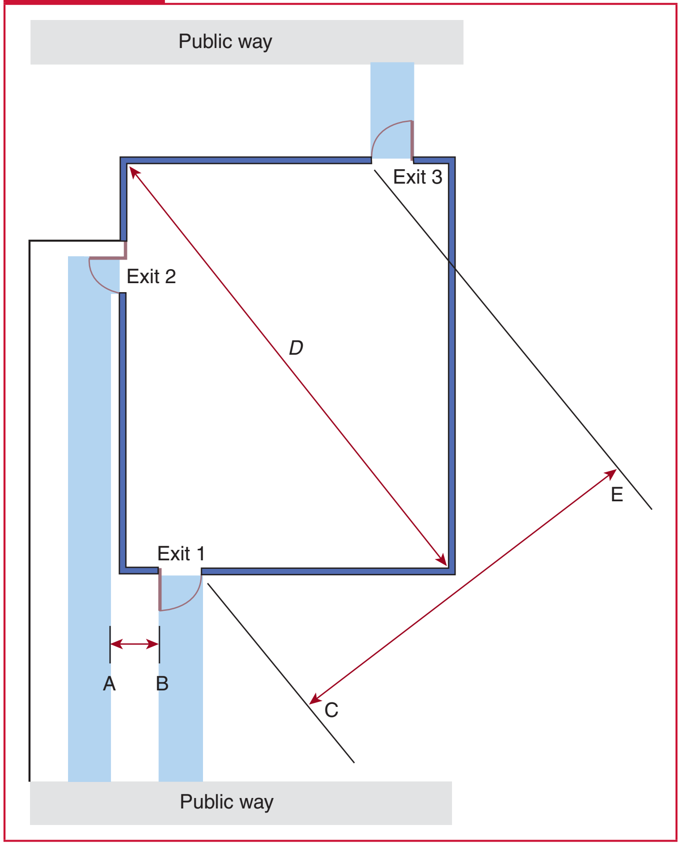


Testing the remoteness of exit discharges.

as the distance between point A and point B, is insufficient to meet the one-half diagonal (½ *D*) requirement of 14.10.1.3.2. Although Exit 1 is sufficiently remote from Exit 2 to comply with 14.10.1.3.2, the exit discharges are not, and the situation must be remedied. One possible solution might be to move Exit 1 to the far right end of the building exterior wall in which it is currently positioned.

Exhibit 14.49 addresses the case of testing the remoteness of exit discharges where three exits are provided. The provision of 14.10.1.3.6 requires that at least two of the required exit discharges be remote from each other. The provision of 14.10.1.3.7 requires that any additional required exit discharges be located so that, if one of the required exit discharges becomes blocked, the others are available. Assume that the single-story, nonsprinklered building depicted has an occupant load of more than 500 persons; it would require three means of egress in accordance with 14.9.1.2. The separation distance between the exit discharges from Exit 1 and Exit 3, measured as the distance from point C to point E, is sufficient to meet the one-half diagonal (½ *D*) requirement of 14.10.1.3.2. Thus, two of the three required exit discharges are remote from each other as required by 14.10.1.3.6. It is left to the AHJ to decide whether the loss of the exit discharge serving Exit 1 leaves the exit discharge serving Exit 2 available as required by 14.10.1.3.7. The *Code* provides no further guidance on what the term *available* means, other than to connote that an exit discharge can be judged as being available without being remote from its nearest neighbor, as defined by the criteria of 14.10.1.3.1, 14.10.1.3.2, or 14.10.1.3.3.

Exhibit 14.49



Testing the remoteness of exit discharges with three exits.

14.10.1.3.1 Where more than one exit, exit access, or exit discharge is required from a building or portion thereof, such exits, exit accesses, or exit discharges shall be remotely located from each other and be arranged to minimize the possibility that more than one has the potential to be blocked by any one fire or other emergency condition. [***101:***7.5.1.3.1]

It is a precept of life safety in buildings, repeated many times in the *Code*, that if multiple exits are required, they need to be not only separate but also remote from one another. Although the objective of this requirement is clear (if one exit is blocked by smoke or fire, the other needs to be maintained available), the term *remote* cannot always be clearly defined.

Where exits are located at each end of a long corridor or at each end or side of a building, they qualify as remotely located exits. However, core-type buildings with elevators, service shafts, and stairs in one central or side core introduce some challenging problems with respect to exit remoteness.

14.10.1.3.2* Where two exits, exit accesses, or exit discharges are required, they shall be located at a distance from one another not less than one-half the length of the maximum overall diagonal dimension of the building or area to be served, measured in a straight line between the nearest edge of the exits, exit accesses, or exit discharges, unless otherwise provided in 14.10.1.3.3 through 14.10.1.3.5. [***101:***7.5.1.3.2]

A.14.10.1.3.2 Figure A.14.10.1.3.2(a) through Figure A.14.10.1.3.2(e) illustrate the method of measurement intended by 14.10.1.3.2. [***101:***A.7.5.1.3.2]

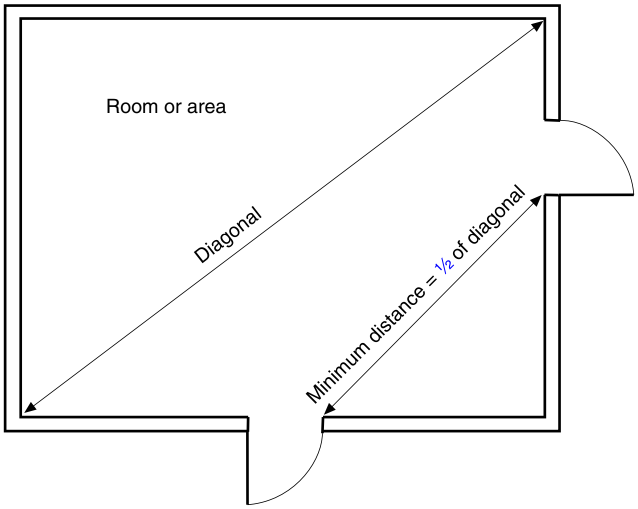


FIGURE A.14.10.1.3.2(a) *Diagonal Rule for Exit Remoteness. [**101:**Figure A.7.5.1.3.2(a)]*

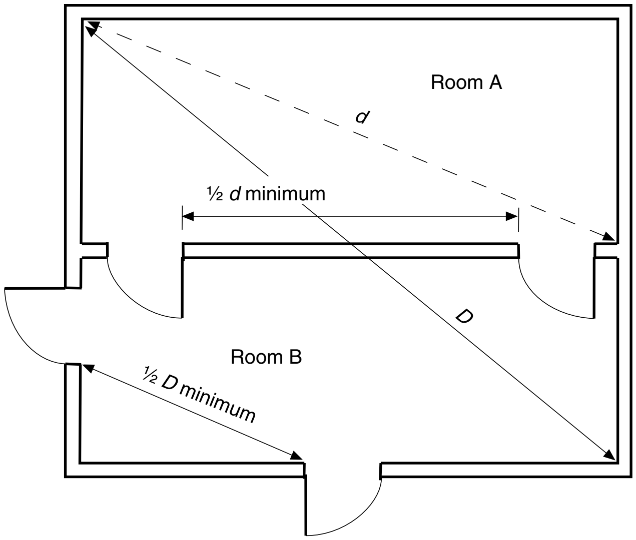


*FIGURE A.14.10.1.3.2(b) Diagonal Rule for Exit and Exit Access Remoteness. [**101:**Figure A.7.5.1.3.2(b)]*

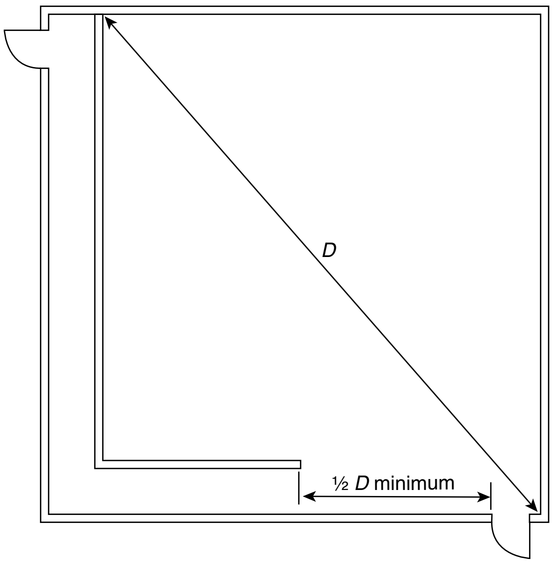


*FIGURE A.14.10.1.3.2(c) Diagonal Rule for Exit and Access Remoteness. [**101:**Figure A.7.5.1.3.2(c)]*

14.10.1.3.3 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3, the minimum separation distance between two exits, exit accesses, or exit discharges, measured in accordance with 14.10.1.3.2, shall be not less than one-third the length of the maximum overall diagonal dimension of the building or area to be served. [***101:***7.5.1.3.3]

14.10.1.3.4* In other than high-rise buildings, where exit enclosures are provided as the required exits specified in 14.10.1.3.2 or

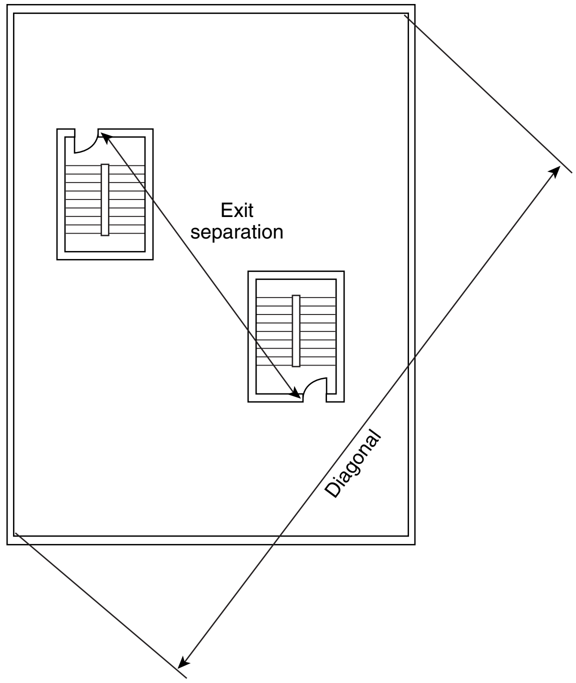


*FIGURE A.14.10.1.3.2(d) Exit Separation and Diagonal Measurement of Area Served. [**101:**Figure A.7.5.1.3.2(d)]*

14.10.1.3.3 and are interconnected by not less than a 1-hour fire resistance–rated corridor, exit separation shall be measured along the shortest line of travel within the corridor [***101:***7.5.1.3.4]

A.14.10.1.3.4 Figure A.14.10.1.3.4 illustrates the method of measuring exit separation distance along the line of travel within a minimum 1-hour fire resistance–rated corridor. [***101:***A.7.5.1.3.4]

14.10.1.3.5 In existing buildings, where more than one exit, exit access, or exit discharge is required, such exits, exit accesses, or exit discharges shall be exempt from the diagonal measurement separation distance criteria of 14.10.1.3.2 and 14.10.1.3.3, provided that such exits, exit accesses, or exit discharges are remotely located in accordance with 14.10.1.3.1. [***101:***7.5.1.3.5]

14.10.1.3.6 In other than existing buildings, where more than two exits, exit accesses, or exit discharges are required, at least two of the required exits, exit accesses, or exit discharges shall be arranged to comply with the minimum separation distance requirement. [***101:***7.5.1.3.6]

14.10.1.3.7 The balance of the exits, exit accesses, or exit discharges specified in 14.10.1.3.6 shall be located so that, if one becomes blocked, the others are available. [***101:***7.5.1.3.7]

Since 1988, NFPA *101* has contained a remoteness formula referred to as the "one-half diagonal rule." This basic rule is stated in 14.10.1.3.2. Figure A.14.10.1.3.2(a) through Figure A.14.10.1.3.2(e) detail the application of the rule. The *Code* uses the one-half diagonal rule to quantify remoteness and to make certain that exit accesses, exits, and exit discharges are

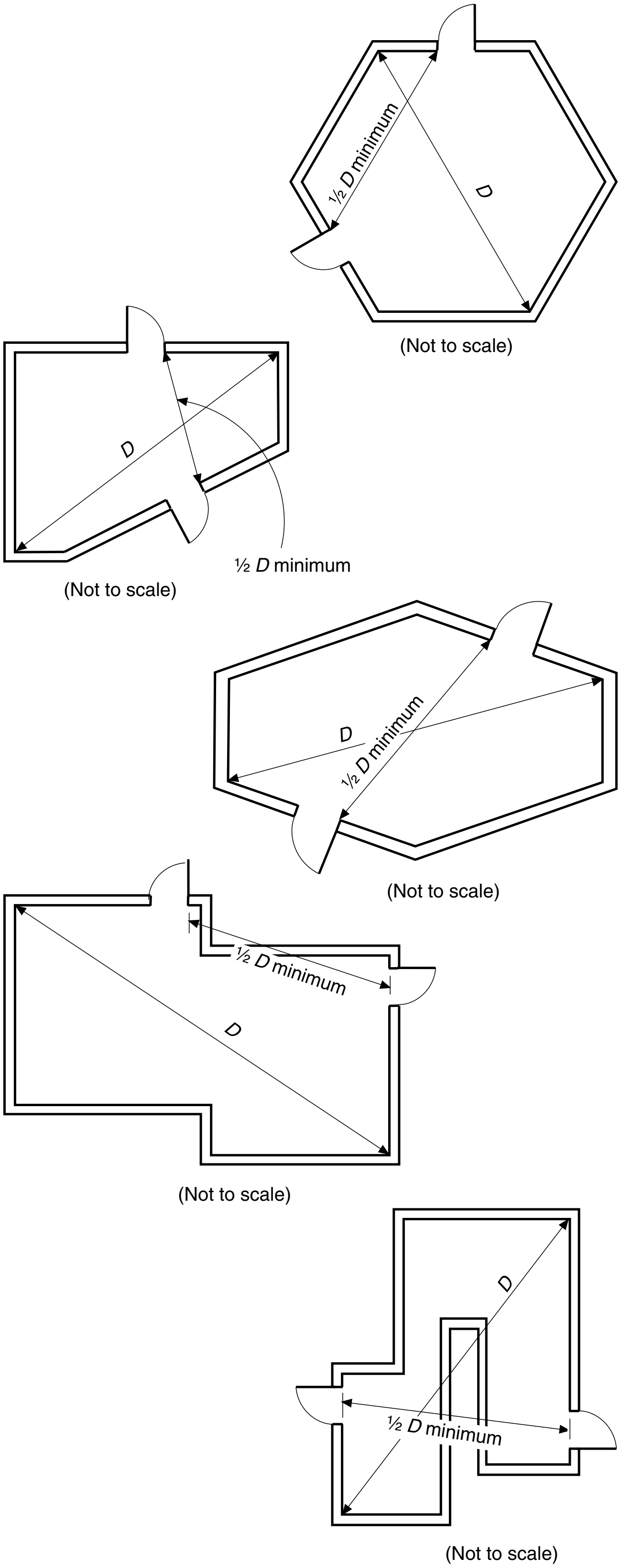


***FIGURE A.14.10.1.3.2(e)** Diagonal Measurement for Unusually Shaped Areas. [**101:**Figure A.7.5.1.3.2(e)]*

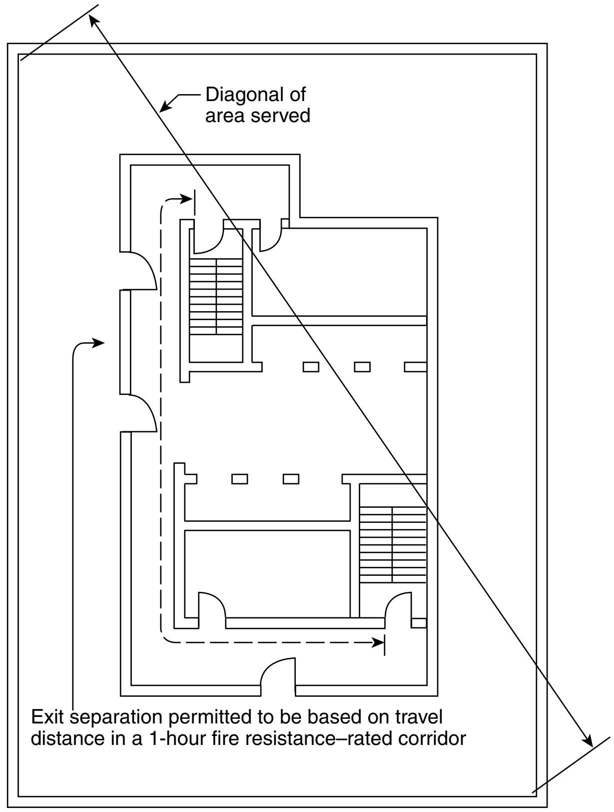


***FIGURE A.14.10.1.3.4** Exit Separation Measured Along Corridor Path. [**101:**A.7.5.1.3.4]*

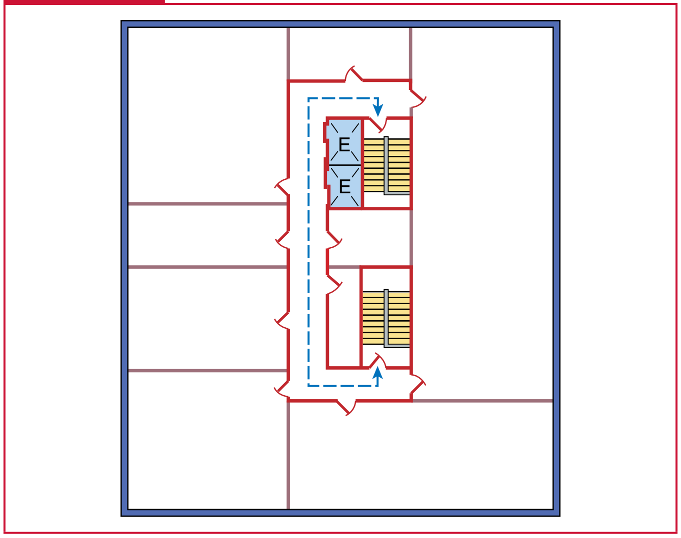
sufficiently remote to ensure, with reasonable certainty, that the same fire will not obstruct multiple egress routes. The exit separation is permitted by 14.10.1.3.3 to be reduced to one-third the maximum overall diagonal measurement in fully sprinklered buildings, because the sprinkler system is expected to control the fire so that the use of multiple egress paths will not be lost.

Although existing buildings are exempted by the provision of 14.10.1.3.5 from the diagonal rule of 14.10.1.3.2 and 14.10.1.3.3, they must meet the remoteness requirement via the performance requirement of 14.10.1.3.1. Therefore, in existing buildings, remoteness is not required to be judged via the diagonal rule; it must be met via the provision of 14.10.1.3.1.

Exhibit 14.50 illustrates the provision of 14.10.1.3.4, which permits — for other than high-rise buildings — the distance between exit enclosures to be measured along a minimum 1-hour fire resistance–rated corridor with appropriate fire protection–rated door assemblies. Although the exit enclosures are physically closer to each other than the dimension measured along the corridor, the exits will behave, under fire conditions, as if they were the corridor length apart.

14.10.1.4 Interlocking or scissor stairs shall comply with 14.10.1.4.1 and 14.10.1.4.2. [***101:***7.5.1.4]

Exhibit 14.50



Exit remoteness measured along 1-hour-rated corridor.

14.10.1.4.1 New interlocking or scissor stairs shall be permitted to be considered only as a single exit. [***101:***7.5.1.4.1]

Δ **14.10.1.4.2*** Existing interlocking or scissor stairs shall be permitted to be considered separate exits, provided that they meet all of the following criteria:

(1) They are enclosed in accordance with Section 14.3.
(2) They are separated from each other by 2-hour fire resistance–rated noncombustible construction.
(3) No protected or unprotected penetrations or communicating openings exist between the stair enclosures.

[***101:***7.5.1.4.2]

A.14.10.1.4.2 It is difficult in actual practice to construct scissor stairs so that products of combustion that have entered one stairway do not penetrate into the other. Their use as separate required exits is discouraged. The term *limited-combustible* is intentionally not included in 14.10.1.4.2. The user's attention is directed to the provisions for noncombustible and limited-combustible in 4.5.9 and 4.5.10, respectively. [***101:***A.7.5.1.4.2]

New scissors stairs are restricted by 14.10.1.4.1 to serving only as a single exit, because it is nearly impossible to ensure that the fire-rated and smoke-resisting separations provided between the two entwined stairs are complete and will stay complete over the life of the building. For example, standpipes are run vertically through the scissor stairs so as to create openings that connect the two stair enclosures.

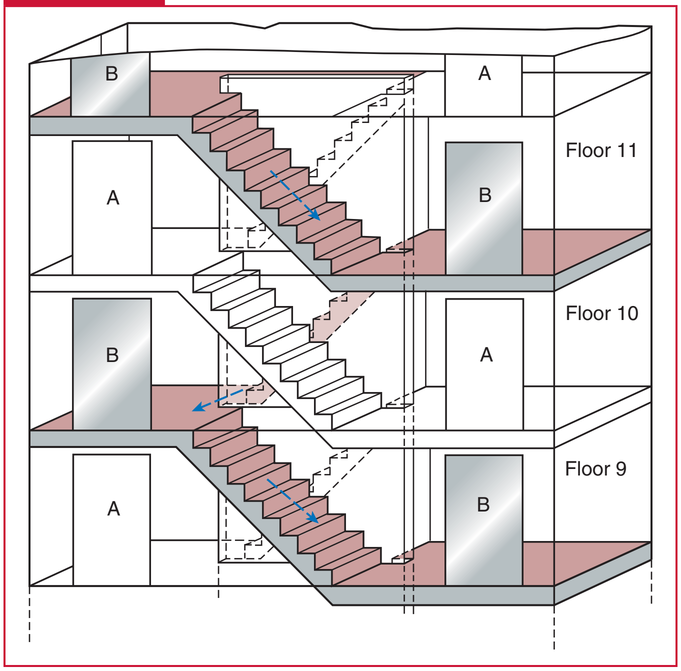
For existing installations, scissors stairs are regulated by 14.10.1.4.2 to ensure that they will perform similarly to two more widely separated exit stairs under fire conditions.

Item (2) of 14.10.1.4.2 requires existing scissors stairs to have noncombustible, 2-hour fire resistance–rated separating construction. Some form of masonry or poured concrete wall, landing, or stair run is normally used to meet the definition of the term *noncombustible (material)* (see 4.5.9). Although scissors stairs can be located with their entrances remotely located from one another and their discharges also remotely placed, the remoteness requirements are applicable to scissors stairs only if they are to be considered as separate exits. Where not sufficiently separated or not remote from each other — or in new construction — scissors stairs cannot be used as separate exits but can be considered as a single exit, with their combined egress width providing increased capacity over that of a single stair. These points are illustrated in Exhibit 14.51 and Exhibit 14.52.

In Exhibit 14.51, the two existing entwined stairways sharing the same enclosing walls are scissors stairs. To be considered separate exits, the existing stairs must be completely separated from each other. In effect, each stair enclosure must consist of a fire resistance–rated tube entwined around the other stair in a form similar to a helix. This arrangement results in space and cost savings by permitting the stairs to share the common enclosing walls that separate them from the remainder of the building. With this arrangement, two independent escape paths are created, similar to those provided by two independent stair enclosures positioned at a distance from one another. The continuity of all walls provides a complete separation at all points. The arrows designate the direction of egress travel in stair B.

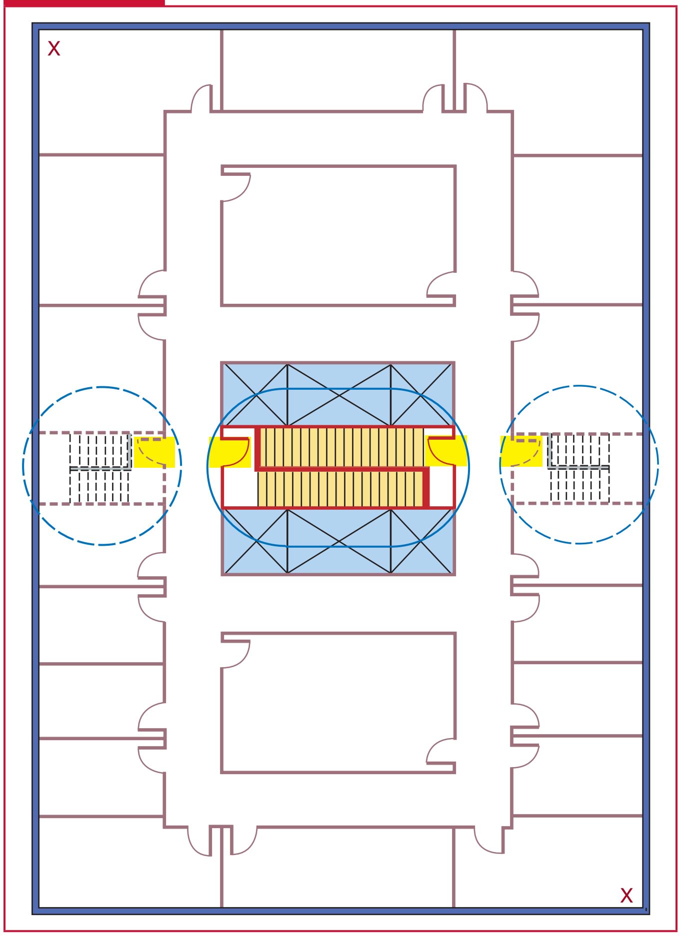
Exhibit 14.52 illustrates some of the advantages of scissors stairs versus conventional exit stairs. The two stairs, positioned at the center of the exhibit and highlighted by placement within the oval, are entwined to create a set of scissors stairs. They provide the same degree of remoteness as the separate and

Exhibit 14.51



Scissors stairs.

Exhibit 14.52



Scissors stairs contrasted with conventional exit stairs.

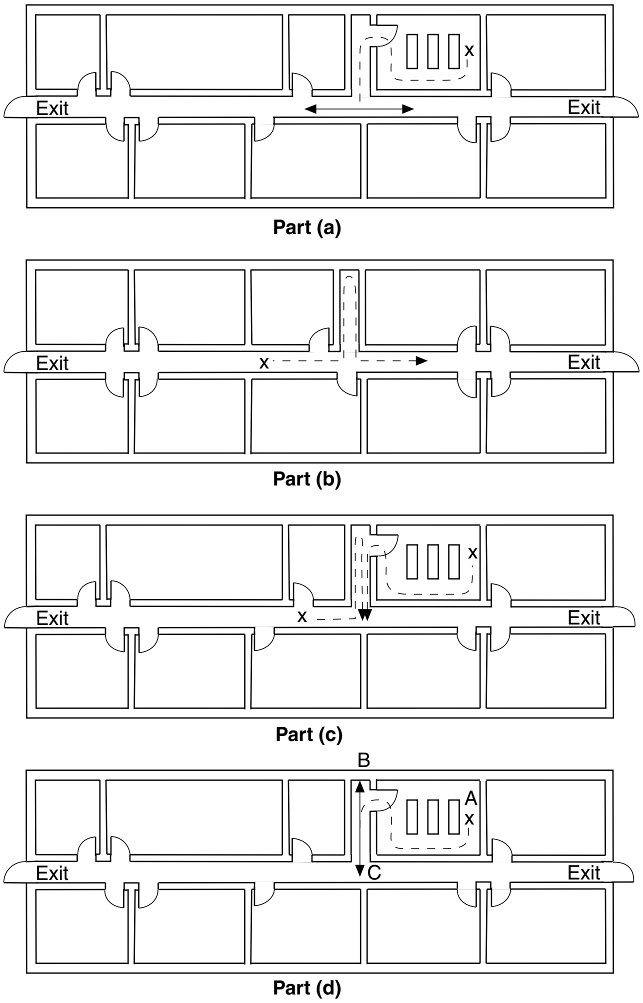


FIGURE A.14.10.1.5 *Common Paths of Travel and Dead-End Corridors. [**101:**Figure A.7.5.1.5]*

independent stairs shown by the dashed lines at the sides of the exhibit and encircled. Travel distance to either the scissors stairs or the independent stairs is equal, even if the independent exit stairs were to be relocated at the opposite corners (X) of the floor.

14.10.1.5* Exit access shall be arranged so that there are no dead ends in corridors, unless permitted by, and limited to the lengths specified in, Chapters 11 through 43 of NFPA *101*. [***101:***7.5.1.5]

A.14.10.1.5 The terms *dead end* and *common path of travel* are commonly used interchangeably. Although the concepts of each are similar in practice, they are two different concepts. [***101:***A.7.5.1.5]

A common path of travel exists where a space is arranged so that occupants within that space are able to travel in only one direction to reach any of the exits or to reach the point at which the occupants have the choice of two paths of travel to remote exits. Part (a) of Figure A.14.10.1.5 is an example of a common path of travel. [***101:***A.7.5.1.5]

While a dead end is similar to a common path of travel, a dead end can exist where there is no path of travel from an occupied space but can also exist where an occupant enters a corridor thinking there is an exit at the end and, finding none, is forced to retrace his or her path to reach a choice of exits. Part (b) of Figure A.14.10.1.5 is an example of such a dead-end arrangement. [***101:***A.7.5.1.5]

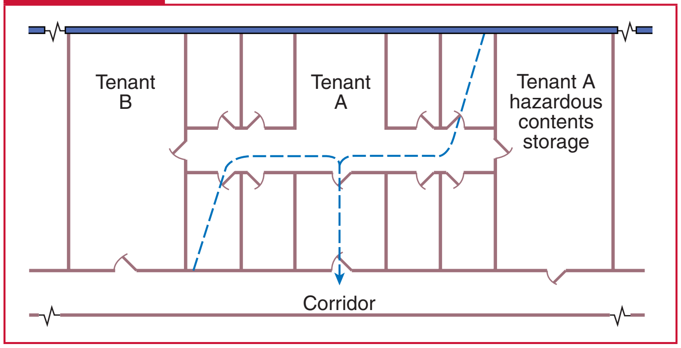
Combining the two concepts, Part (c) of Figure A.14.10.1.5 is an example of a combined dead-end/common path of travel problem. [***101:***A.7.5.1.5]

Common paths of travel and dead-end travel are measured using the same principles used to measure travel distance as described in Section 7.6 of NFPA *101*. Starting in the room shown in Part (d) of Figure A.14.10.1.5, measurement is made from the most remote point in the room, A, along the natural path of travel, and through the doorway along the centerline of the corridor to point C, located at the centerline of the corridor, which then provides the choice of two different paths to remote exits; this is common path of travel. The space between point B and point C is a dead end. *(See 3.3.66 for the definition of common path of travel.)* [***101:***A.7.5.1.5]

14.10.1.6 Exit access from rooms or spaces shall be permitted to be through adjoining or intervening rooms or areas, provided that such rooms or areas are accessory to the area served. Foyers, lobbies, and reception rooms constructed as required for corridors shall not be construed as intervening rooms. Exit access shall be arranged so that it is not necessary to pass through any area identified under Protection from Hazards in Chapters 11 through 43 of NFPA *101*. [***101:***7.5.1.6]

Paragraph 14.10.1.6 permits exit access travel through adjoining spaces if such spaces are accessory to the area served and such travel is not through any area identified under protection from hazards in an occupancy chapter of NFPA *101* (generally subsection __.3.2). Exhibit 14.53 illustrates exit access travel through intervening spaces that are under the control of the tenant and are not hazardous. Even though the hazardous contents storage room is under the control of the occupants of tenant space A, the hazard makes passage through the room unsafe. Passage from tenant space A into tenant space B is not permitted, because there is no assurance that the door assembly into tenant space B will be left unlocked, unblocked, and usable to occupants of tenant space A.

Exhibit 14.53



Exit access through adjoining rooms.

14.10.2 Impediments to Egress. See also 7.1.9 of NFPA *101*, and 14.5.2. [***101:***7.5.2]

14.10.2.1* Access to an exit shall not be through kitchens, storerooms other than as provided in Chapters 36 and 37 of NFPA *101*, restrooms, closets, bedrooms or similar spaces, or other rooms or spaces subject to locking, unless passage through such rooms or spaces is permitted for the occupancy by Chapters 18, 19, 22, or 23 of NFPA *101*. [***101:***7.5.2.1]

A.14.10.2.1 It is not the intent that an area with equipment such as a beverage brewpot, microwave oven, and a toaster be considered a kitchen. [***101:***A.7.5.2.1]

Paragraph 14.10.2.1, in combination with 14.10.1.6, prevents exit access from passing through certain rooms either due to increased relative hazard or potential blockage or locking. The text of A.14.10.2.1 clarifies that the presence of beverage brewpots, microwave ovens, and toasters, commonly found in employee break areas that often are located in spaces not separated from the remainder of an open floor plan, do not cause such spaces to be classified as kitchens through which 14.10.1.6 and 14.10.2.1 restrict exit access.

14.10.2.2* Exit access and exit doors shall be designed and arranged to be clearly recognizable. [***101:***7.5.2.2]

A.14.10.2.2 Doors that lead through wall paneling, and that harmonize in appearance with the rest of the wall to avoid detracting from some desired aesthetic or decorative effect, are not acceptable, because casual occupants might not be aware of such means of egress even though it is visible. [***101:***A.7.5.2.2]

14.10.2.2.1 Hangings or draperies shall not be placed over exit doors or located so that they conceal or obscure any exit, unless otherwise provided in 14.10.2.2.2. [***101:***7.5.2.2.1]

Δ **14.10.2.2.2** Curtains shall be permitted across means of egress openings in tent walls, provided that all of the following criteria are met:

(1) They are distinctly marked in contrast to the tent wall so as to be recognizable as means of egress.
(2) They are installed across an opening that is at least 6 ft (1830 mm) in width.
(3) They are hung from slide rings or equivalent hardware so as to be readily moved to the side to create an unobstructed opening in the tent wall that is of the minimum width required for door openings.

[***101:***7.5.2.2.2]

See the commentary following A.14.4.1 for more information on maintaining means of egress free of obstructions or impediments.

14.10.3 Exterior Ways of Exit Access.

The provisions of 14.10.3 apply to exit access in the typical motel arrangement where exit access from the guest rooms is provided by door openings to an open-air exit access balcony to an open stair. This arrangement is also common in apartment buildings and office buildings in warm climates. An understanding of these provisions is important, because many of the exemptions from the mandatory sprinkler requirements for the various residential occupancies conditionally apply where exterior exit access is provided.

14.10.3.1 Exit access shall be permitted to be by means of any exterior balcony, porch, gallery, or roof that conforms to the requirements of this chapter and Chapter 7 of NFPA *101*. [***101:***7.5.3.1]

14.10.3.2 The long side of the balcony, porch, gallery, or similar space shall be at least 50 percent open and shall be arranged to restrict the accumulation of smoke. [***101:***7.5.3.2]

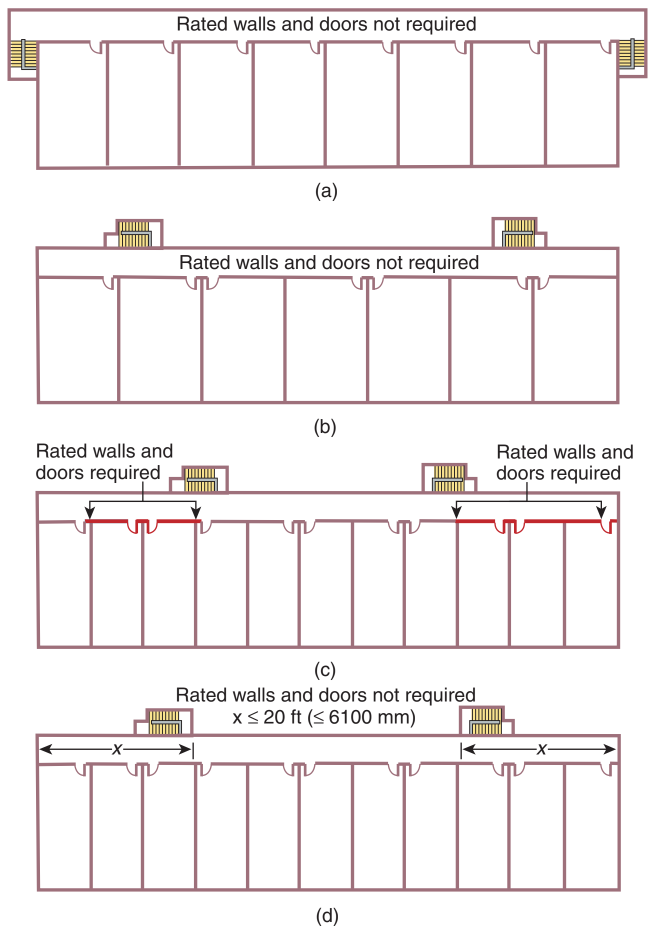
Exterior ways of exit access need significant openings to the exterior so as not to become smoke-logged and unusable. Paragraph 14.10.3.2 establishes that at least 50 percent of the long side of the balcony, porch, gallery, or similar space is required to be open.

14.10.3.3 Exterior exit access balconies shall be separated from the interior of the building by walls and opening protectives as required for corridors, unless the exterior exit access balcony is served by at least two remote stairs that can be accessed without any occupant traveling past an unprotected opening to reach one of the stairs, or unless dead ends on the exterior exit access do not exceed 20 ft (6100 mm). [***101:***7.5.3.3]

Paragraph 14.10.3.3 requires the exterior exit access to be protected by separating construction from the interior of the building via the same rules that are applicable to corridors. However, this requirement does not apply to exit access served by at least two remote stairs, as detailed. Such an arrangement is used more often than the rated construction required by 14.10.3.3. To use this arrangement, access must be possible to both required remote stairs, one of which must be reachable without traveling past an unprotected opening.

Exhibit 14.54 illustrates four arrangements permitted by 14.10.3.3. In part (a) and part (b), it is possible for occupants of all rooms to reach one of the stairs without having to travel past any opening from which fire might issue; thus, fire-rated walls and door assemblies are not required. In part (c), the occupants of rooms at the ends of the building must travel past other rooms to reach a stair; thus, fire resistance–rated walls and fire protection–rated opening protectives, such as windows and door assemblies, are required in the areas indicated.

Exhibit 14.54



Exterior ways of exit access.

In part (d), the alternative of 14.10.3.3, related to limiting the length of the exit access balcony dead end, is used to exempt the fire-rated wall construction and fire-rated opening protectives along the exterior exit access path. Provided that the exit access balcony dead end, denoted by the distance *X*, does not exceed 20 ft (6100 mm), the occupant using the exterior exit access will not be exposed to an excessive number of unprotected openings.

14.10.3.4 Exterior exit access shall be arranged so that there are no dead ends in excess of those permitted for dead-end corridors in Chapters 11 through 43 of NFPA *101*. [***101:***7.5.3.4]

Because 14.10.3.3 permits unrated construction along a maximum 20 ft (6100 mm) dead-end exterior exit access path, it seems logical to recognize longer dead ends, as permitted by some of the occupancy chapters, where the exterior exit access path is protected by rated walls and rated opening protectives.

14.10.4 Accessible Means of Egress.

14.10.4.1* Areas accessible to people with severe mobility impairment, other than in existing buildings, shall have not less than two accessible means of egress, unless otherwise provided in 14.10.4.1.2 through 14.10.4.1.4. [***101:***7.5.4.1]

Δ **A.14.10.4.1** An accessible means of egress should comply with the accessible route requirements of ICC/ANSI A117.1, *Accessible and Usable Buildings and Facilities.* [***101:***A.7.5.4.1]

14.10.4.1.1 Access within the allowable travel distance shall be provided to not less than one accessible area of refuge or one accessible exit providing an accessible route to an exit discharge. [***101:***7.5.4.1.1]

14.10.4.1.2 A single accessible means of egress shall be permitted from buildings or areas of buildings permitted to have a single exit. [***101:***7.5.4.1.2]

14.10.4.1.3 Accessible means of egress shall not be required in health care occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***7.5.4.1.3]

14.10.4.1.4 Exit access travel along the accessible means of egress shall be permitted to be common for the distances permitted as common paths of travel. [***101:***7.5.4.1.4]

Paragraph 14.10.4.1 requires that, in other than existing buildings, accessible means of egress is to be provided for all areas accessible to persons with severe mobility impairment. The term *accessible means of egress* is defined in 3.3.178.1 of NFPA *101* as "a means of egress that provides an accessible route to an area of refuge, a horizontal exit, or a public way." The term *severe mobility impairment* is defined in 3.3.256 of NFPA *101* as "the ability to move to stairs but without the ability to use the stairs."

For a single-story building with typical exit door assemblies to the exterior at finished ground level (grade), the requirement for accessible means of egress is normally met without having to provide any additional features. For a multistory building involving vertical travel to ground, the requirement for accessible means of egress from the upper floors might be met by providing ramps. Because ramp systems use considerable space, the requirement for accessible means of egress from the upper floors will most often be met by providing areas of refuge meeting the requirements of 7.2.12 of NFPA *101*.

Exhibit 14.55 illustrates arrangements providing accessible means of egress. In part (a) and part (b), accessible means of egress are provided via finished ground level door assemblies or ramps from the second story.

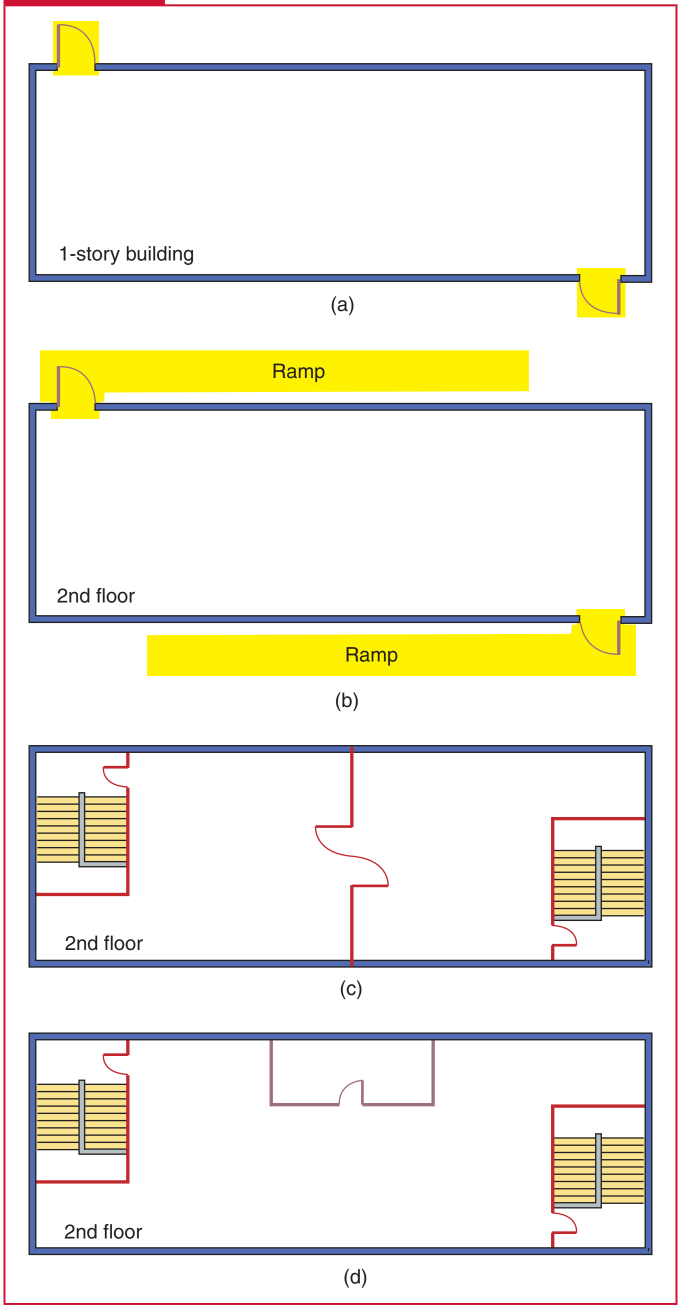
In part (c), areas of refuge with rated barrier and extra-width stairs in accordance with 7.2.12 of NFPA *101* provide accessible means of egress. In part (d), the floor of a fully sprinklered building with a second accessible room on the floor creates an *area of refuge,* as defined in 3.3.23 of NFPA *101,* which provides, via the two stairs and the help of emergency responders, two accessible means of egress paths.

The *Code* does not require areas of refuge; it requires accessible means of egress. The easiest way to meet the requirements for accessible means of egress in multistory buildings is by providing areas of refuge.

Paragraph 14.10.4.1 clarifies that the requirement for accessible means of egress is not retroactively required in existing buildings, unless specifically required by the applicable occupancy chapter.

Paragraph 14.10.4.1.4 does not permit a single accessible means of egress; rather, it permits that, where two accessible means of egress are required, travel is permitted to be along a single accessible path that is not longer than the distance permitted as a common path of travel before travel along two separate accessible paths must become available.

Exhibit 14.55



Accessible means of egress.

14.10.4.2 Where two accessible means of egress are required, the exits serving such means of egress shall be located at a distance from one another not less than one-half the length of the maximum overall diagonal dimension of the building or area to be served. This distance shall be measured in a straight line between the nearest edge of the exit doors or exit access doors, unless otherwise provided in 14.10.4.2.1 through 14.10.4.2.3. [***101:***7.5.4.2]

See A.14.10.1.3.2.

14.10.4.2.1 Where exit enclosures are provided as the required exits specified in 14.10.4.2 and are interconnected by not less than a 1-hour fire resistance–rated corridor, exit separation shall be permitted to be measured along the line of travel within the corridor. [***101:***7.5.4.2.1]

14.10.4.2.2 The requirement of 14.10.4.2 shall not apply to buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***7.5.4.2.2]

14.10.4.2.3 The requirement of 14.10.4.2 shall not apply where the physical arrangement of means of egress prevents the possibility that access to both accessible means of egress will be blocked by any one fire or other emergency condition as approved by the AHJ. [***101:***7.5.4.2.3]

14.10.4.3 Each required accessible means of egress shall be continuous from each accessible occupied area to a public way or area of refuge in accordance with 7.2.12.2.2 of NFPA *101*. [***101:***7.5.4.3]

14.10.4.4 Where an exit stair is used in an accessible means of egress, it shall comply with 7.2.12 of NFPA *101* and either shall incorporate an area of refuge within an enlarged story-level landing or shall be accessed from an area of refuge. [***101:***7.5.4.4]

14.10.4.5 To be considered part of an accessible means of egress, an elevator shall be in accordance with 7.2.12.2.4 of NFPA *101*. [***101:***7.5.4.5]

14.10.4.6 To be considered part of an accessible means of egress, a smoke barrier in accordance with Section 12.9 with not less than a 1-hour fire resistance rating, or a horizontal exit in accordance with 7.2.4 of NFPA *101*, shall discharge to an area of refuge in accordance with 7.2.12 of NFPA *101*. [***101:***7.5.4.6]

14.10.4.7 Accessible stories that are four or more stories above or below a story of exit discharge shall have not less than one elevator complying with 14.10.4.5, except as modified in 14.10.4.8. [***101:***7.5.4.7]

14.10.4.8 Where elevators are required by 14.10.4.7, the smokeproof enclosure required by 7.2.12.2.4 of NFPA *101* shall not be required in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA 13. [***101:***7.5.4.8]

14.10.4.9 An area of refuge used as part of a required accessible means of egress shall be in accordance with 7.2.12 of NFPA *101*. [***101:***7.5.4.9]

Where it might be necessary to carry persons and their wheelchairs on stairs for four or more stories to the ground level, the provision of 14.10.4.7 requires at least one elevator complying with 14.10.4.5, which imposes special elevator features and protection in accordance with 7.2.12.2.4 of NFPA *101*. However, if automatic sprinklers protect the building throughout, the elevator shaft system is exempted by 14.10.4.8 from the smokeproof enclosure requirement of 7.2.12.2.4(3) of NFPA *101*. This is consistent with the premise that sprinklers control fires so as to limit smoke production.

Paragraph 14.10.4.9 completes the package by requiring areas of refuge used as part of accessible means of egress to follow the detailed criteria for areas of refuge presented in 7.2.12 of NFPA *101*.

14.11 Discharge from Exits

14.11.1* Exit Termination. Exits shall terminate directly, at a public way or at an exterior exit discharge, unless otherwise provided in 14.11.1.2 through 14.11.1.4. [***101:***7.7.1]

A.14.11.1 An exit from the upper stories in which the direction of egress travel is generally downward should not be arranged so that it is necessary to change to travel in an upward direction at any point before discharging to the outside. A similar prohibition of reversal of the vertical component of travel should be applied to exits from stories below the floor of exit discharge. However, an exception is permitted in the case of stairs used in connection with overhead or underfloor exit passageways that serve the street floor only. [***101:***A.7.7.1]

It is important that ample roadways be available from buildings in which there are large numbers of occupants so that exits will not be blocked by persons already outside. Two or more avenues of departure should be available for all but very small places. Location of a larger theater — for example, on a narrow dead-end street — might be prohibited by the AHJ under this rule, unless some alternate way of travel to another street is available. [***101:***A.7.7.1]

Exterior walking surfaces within the exit discharge are not required to be paved and often are provided by grass or similar surfaces. Where discharging exits into yards, across lawns, or onto similar surfaces, in addition to providing the required width to allow all occupants safe access to a public way, such access also is required to meet the following:

(1) Provisions of 7.1.7 of NFPA *101* with respect to changes in elevation
(2) Provisions of 7.2.2 of NFPA *101* for stairs, as applicable
(3) Provisions of 7.2.5 of NFPA *101* for ramps, as applicable
(4) Provisions of 7.1.10 of NFPA *101* with respect to maintaining the means of egress free of obstructions that would prevent its use, such as snow and the need for its removal in some climates

[***101:***A.7.7.1]

14.11.1.1 Yards, courts, open spaces, or other portions of the exit discharge shall be of the required width and size to provide all occupants with a safe access to a public way. [***101:***7.7.1.1]

14.11.1.2 The requirement of 14.11.1 shall not apply to interior exit discharge as otherwise provided in 14.11.2. [***101:***7.7.1.2]

14.11.1.3 The requirement of 14.11.1 shall not apply to rooftop exit discharge as otherwise provided in 14.11.6. [***101:***7.7.1.3]

14.11.1.4 Means of egress shall be permitted to terminate in an exterior area of refuge for detention and correctional occupancies as otherwise provided in Chapters 22 and 23 of NFPA *101*. [***101:***7.7.1.4]

The principle addressed in 14.11.1 is that, once a building occupant reaches an exit (the protected portion of the means of egress), the level of protection afforded by that exit cannot be reduced or eliminated. Therefore, except as noted, all exits must be continuous to a public way or other safe place or to an exit discharge that must, in turn, be continuous to the public way.

It is not sufficient to allow the egress system to terminate at the outside of a building, because there might not be enough space to provide safe movement away from the building. Also, the terminus of the egress system cannot be located at the outside in an enclosed court from which travel back through the building might be necessary to get away from the building. In such a case, an exit passageway at least as wide as the exit itself and constructed as specified for exits is required to provide travel from the enclosed court to the safe place.

14.11.2 Exit Discharge Through Interior Building Areas. Exits shall be permitted to discharge through interior building areas, provided that all of the following are met:

(1) Not more than 50 percent of the required number of exit stairs serving normally occupied areas of each floor, and not more

than 50 percent of the exit stair capacity required for normally occupied areas of each floor, shall discharge through areas on any level of discharge, except as otherwise permitted by one of the following:

(a) One hundred percent of the exits shall be permitted to discharge through areas on any level of discharge in detention and correctional occupancies as otherwise provided in Chapters 22 and 23 of NFPA *101*.

(b) In existing buildings, the 50 percent limit on egress capacity shall not apply if the 50 percent limit on the required number of exits is met.

(2) Each level of discharge shall discharge directly outside at the finished ground level or discharge directly outside and provide access to the finished ground level by outside stairs or outside ramps.

(3) The interior exit discharge shall lead to a free and unobstructed way to the exterior of the building, and such way shall be readily apparent or shall be identifiable by exit signage from the point of discharge from the exit.

(4) The interior exit discharge shall be protected by one of the following methods:

(a) The level of discharge shall be protected throughout by an approved automatic sprinkler system in accordance with Section 13.3, or the portion of the level of discharge used for interior exit discharge shall be protected by an approved automatic sprinkler system in accordance with Section 13.3 and shall be separated from the nonsprinklered portion of the floor by fire barriers with a fire resistance rating meeting the requirements for the enclosure of exits. *(See 14.3.1.)*

(b) The interior exit discharge area shall be in a vestibule or foyer that meets all of the following criteria:

i. The depth from the exterior of the building shall be not more than 10 ft (3050 mm), and the length shall be not more than 30 ft (9.1 m).

ii. The foyer shall be separated from the remainder of the level of discharge by fire barriers with a minimum 1-hour fire resistance rating, and existing installations of wired glass in steel frames shall be permitted to be continued in use.

iii. The foyer shall serve only as means of egress and shall include an exit directly to the outside.

(5) The entire area on the level of discharge shall be separated from areas below by construction having a fire resistance rating not less than that required for the exit enclosure, unless otherwise provided in 14.11.2(6).

(6) Levels below the level of discharge in an atrium shall be permitted to be open to the level of discharge where such level of discharge is protected in accordance with 8.6.7 of NFPA *101*.

[***101:***7.7.2]

The provision of 14.11.2(3) was revised for the 2018 edition of NFPA *101* to clarify that the door in the exterior wall through which interior exit discharge flows, so as to become exterior exit discharge, need not be visible from the point where an occupant leaves the enclosed exit stair. Instead, the direction of travel must be apparent or identified by exit signage. Thus, the old myth that occupants must be able to see the door to the outside dies. The provisions of 14.11.2 were revised for the 2012 edition of the *Code* to permit exit discharge through the interior building area of any floor providing discharge from the building, not just the level of exit discharge.

The provisions of 14.11.2 permit a portion of the exit discharge from exit stairs to pass through interior building areas rather than discharge directly to the outside. Compliance with the criteria of 14.11.2 provides users of an exit stair enclosure that discharges through interior building areas with approximately the same level of protection offered to users of exit enclosures that discharge directly to the outside.

Among the questions most often asked regarding the *Code* are those that concern the requirements of 14.11.2(4)(a) related to providing sprinkler protection on the level of discharge (i.e., the story on which the interior exit discharge occurs). The intent of 14.11.2(4)(a) is to require sprinkler protection in the portion of the level of discharge that is used as interior exit discharge and to provide that portion of the level of discharge with fire-rated separation from all other portions of the level of discharge that are not sprinklered. The requirement of 14.11.2(4)(a) can be met by either of the following means:

1. Protecting the entire level of discharge with automatic sprinklers and separating the level of discharge from any floor below by fire-rated construction with the minimum fire rating required for the exit that discharges occupants though the level of discharge [see 14.3.1(1) and (3)]
2. Providing automatic sprinkler protection in only that portion of the level of discharge used for interior exit discharge travel from the exit stair enclosure door opening to the door opening to the outside; separating the sprinklered portion of the level of discharge from the rest of the level of discharge by construction as required for the exit that discharges occupants though the level of discharge [again, see 14.3.1(1) and (3)]; and separating the level of discharge from any floor below by fire-rated construction with the minimum fire rating required for the exit that discharges occupants though the level of discharge

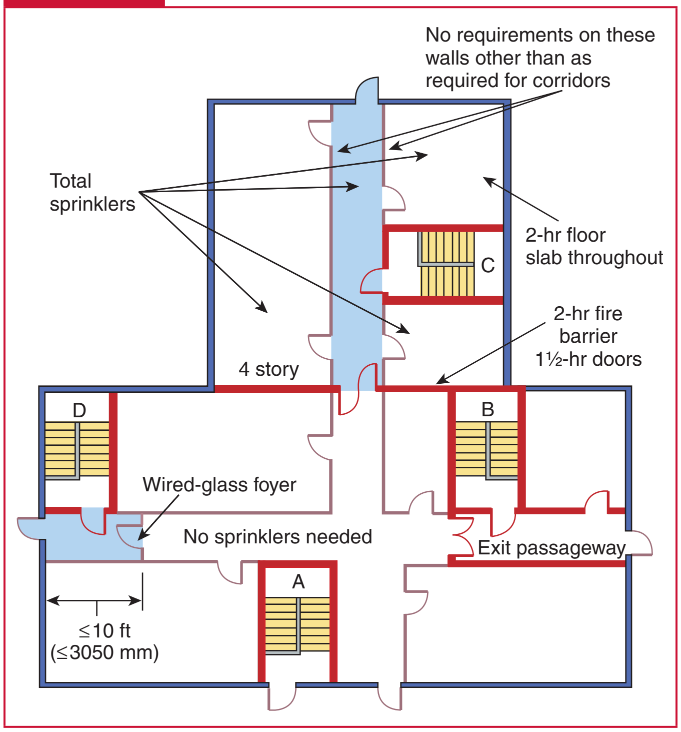
An exemption to the sprinkler requirement of 14.11.2(4)(a) is offered by 14.11.2(4)(b) and involves providing a maximum 10 ft × 30 ft (3050 mm × 9.1 m) wired-glass foyer, which can be used only for egress and, thus, has no occupancy of its own.

Use of the 50 percent rule of 14.11.2 for discharge through the level of discharge is not dependent on occupancy permission; thus, it can be used in all occupancies. However, detention and correctional occupancies (see 22.2.7.3 and 23.2.7.3 and 22.2.7.4 and 23.2.7.4 of NFPA *101*) permit 100 percent of the exits and 100 percent of the egress capacity to discharge through the level of discharge. Hotels and dormitories establish additional requirements limiting the distance occupants are permitted to travel within their interior exit discharge through the level of discharge to the opening to the outside (see 28.2.7.3 and 29.2.7.3 of NFPA *101*).

Exhibit 14.56 illustrates exit discharge arrangements meeting the requirements of 14.11.2. The equally sized stairs provide four required exits from the upper floors. Exit stair A discharges directly outside. Exit stair B is also considered to discharge directly outside, because its attached exit passageway affords protected passage to the door opening to the outside without leaving the protection offered by an exit. The other two exit stairs, C and D, are permitted to discharge across the first floor (the level of discharge), because they do not constitute more than 50 percent of the number of exits from an upper floor or more than 50 percent of the egress capacity of any upper floor. Exit stair C discharges into an area on the discharge level that is sprinklered and separated from the remainder of the floor and the basement, which are not sprinklered. The hourly fire resistance rating of the floor slab and the separating fire barrier are the same as required for the enclosure of exit stair C [e.g., a 2-hour rating if the stair is new and serves four or more stories in accordance with 14.3.1(3)]. Exit stair D discharges into a wired-glass foyer in the nonsprinklered portion of the floor in accordance with 14.11.2(4)(b).

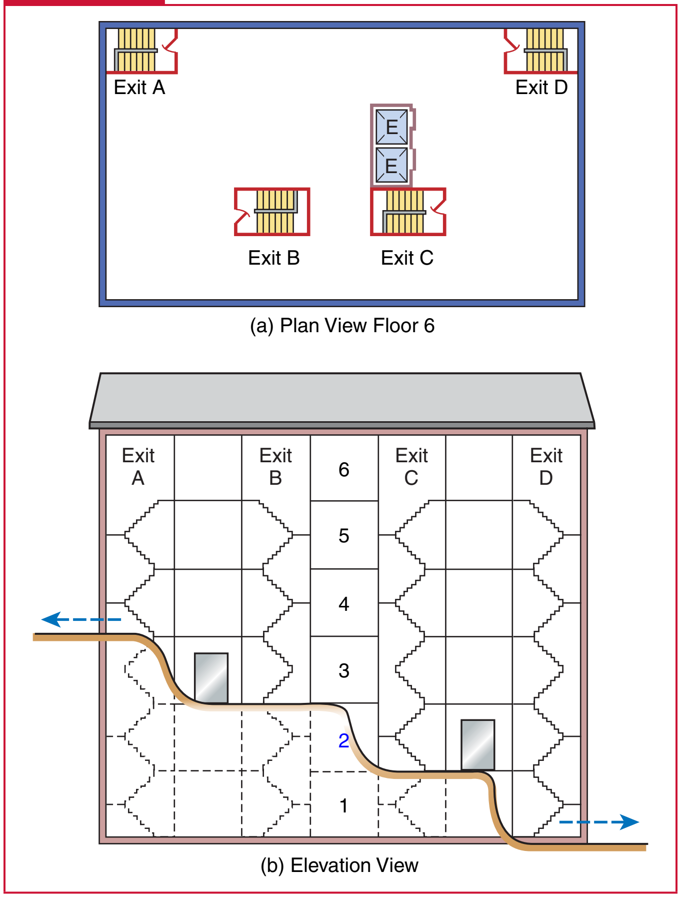
Exhibit 14.57 illustrates interior exit discharge on two floors. Four exits — all by exit stair enclosures — serve all six stories. In part (a), exits A and D are located at exterior building walls, and exits B and C are located away from exterior building walls. In part (b), exits A and D comprise 50 percent of the number of exits, provide 50 percent of the egress capacity for each floor,

Exhibit 14.56



Exit discharge.

Exhibit 14.57



Interior exit discharge on two stories.

and discharge directly to the outside — exit A at story 4 and exit D at story 1. Exits B and C comprise 50 percent of the number of exits, provide 50 percent of the egress capacity for each floor, and discharge to interior areas — exit B onto story 3 and exit C onto story 2. Not more than 50 percent of the exits — both from a number of exits standpoint and from a capacity of exits standpoint — discharge through interior building areas. Such interior exit discharge occurs on two floors, since the *Code* does not restrict interior exit discharge to the level of exit discharge.

14.11.3 Arrangement and Marking of Exit Discharge.

14.11.3.1 Where more than one exit discharge is required, exit discharges shall be arranged to meet the remoteness criteria of 14.10.1.3. [***101:***7.7.3.1]

14.11.3.2 The exit discharge shall be arranged and marked to make clear the direction of egress travel from the exit discharge to a public way. [***101:***7.7.3.2]

14.11.3.3* Stairs and ramps that continue more than one-half story below the level of discharge shall be provided with an approved means to prevent or dissuade occupants from traveling past the level of discharge during emergency building evacuation. [***101:***7.7.3.3]

A.14.11.3.3 Examples include partitions and gates. The design should not obstruct the normal movement of occupants to the exit discharge. Signs, graphics, or pictograms, including tactile types, might be permitted for existing exit enclosures where partitions or gates would obstruct the normal movement of occupants to the exit discharge. [***101:***A.7.7.3.4]

The provision of 14.11.3.1 serves as a reminder that exit discharges, like exits and exit accesses, are required to be remote as addressed in 14.10.1.3.

The provision of 14.11.3.3 was revised for the 2012 edition of the *Code*. Earlier editions required the stair interruption to be provided by partitions, doors, or other effective means. The current language is performance-based and requires an approved means to dissuade occupants from traveling past the level of discharge during building emergency evacuation.

Exhibit 14.58 shows an exit stair landing at the level of discharge to the outside. The gate across the stair to the basement and the large directional exit arrow on the wall are intended to minimize the possibility that occupants traveling on stairs will inadvertently continue their stair descent past the level of exit discharge (LED), stop at the basement level where the stair ends but where there is no discharge, and then have to reverse direction and retrace their steps to the LED. The barrier needed to cue the occupant that the LED has been reached might be a partition with door assembly, a gate, another physical barrier, signage, or a floor marking that effectively interrupts the flow of travel, forcing a person to perform a deliberate act to continue traveling past the LED, but not restricting required egress from floors below the LED. Exhibit 14.59 shows the NO EXIT sign on the side of the gate facing the LED floor landing.

Exhibit 14.58

Interruption of exit stair at LED. (Courtesy of Jake Pauls)

Exhibit 14.59

Sign on gate providing interruption of exit stair. (Courtesy of Jake Pauls)

14.11.4 Components of Exit Discharge. Doors, stairs, ramps, corridors, exit passageways, bridges, balconies, escalators, moving walks, and other components of an exit discharge shall comply with the detailed requirements of this chapter for such components. [***101:***7.7.4]

14.11.5 Signs. See 10.11.3. [***101:***7.7.5]

Δ **14.11.6 Discharge to Roofs.** Where approved by the AHJ, exits shall be permitted to discharge to roofs or other sections of the building or an adjoining building where all of the following criteria are met:

(1) The roof/ceiling assembly construction has a fire resistance rating not less than that required for the exit enclosure.
(2) A continuous and safe means of egress from the roof is available.

[***101:***7.7.6]

An exit discharge to a roof is permitted only where another continuous and safe means of egress from the roof is provided and the roof construction affords protection against fire that is at least equivalent to that of the exit enclosure (e.g., the exit stair) that discharged occupants to the roof. Helicopter rescue from roofs is not dependable enough to be given credit as an exit; many factors in such a rescue are too unpredictable for this method to be a consideration.

Outside stairs leading to the roofs of other sections of the building or onto the roofs of adjoining buildings are acceptable as part of the means of egress, but only with the approval of the AHJ. The conditions and settings of such paths of travel are likely to be so varied that it is virtually impossible to cover them by written provisions. Ideally the AHJ judges each situation individually.

14.12 Illumination of Means of Egress

When fire occurs in a building, the degree of visibility in aisles, corridors, stairs, and exit passageways might mean the difference between orderly evacuation and chaos and, possibly, the difference between life and death.

14.12.1 General.

14.12.1.1* Illumination of means of egress shall be provided in accordance with Section 14.12 for every building and structure where required in Chapters 11 through 43 of NFPA *101*. For the purposes of this requirement, exit access shall include only designated stairs, aisles, corridors, ramps, escalators, and passageways leading to an exit. For the purposes of this requirement, exit discharge shall include only designated stairs, aisles, corridors, ramps, escalators, walkways, and exit passageways leading to a public way. [***101:***7.8.1.1]

A.14.12.1.1 Illumination provided outside the building should be to either a public way or a distance away from the building that is considered safe, whichever is closest to the building being evacuated. [***101:***A.7.8.1.1]

The means of egress (i.e., exit access, exit, and exit discharge) encompasses practically all spaces where persons can be present. The subject addressed by Section 14.12 is illumination of means of egress. It would seem that the title of Section 14.12 indicates that such illumination needs to be provided throughout all portions of the exit access, the exit, and the exit discharge, but this is not so. Illumination is required throughout the exit (e.g., an enclosed exit stair or exit passageway). Yet, 14.12.1.1 clarifies that, for the purposes of applying the requirements of Section 14.12, the portions of the exit access and exit discharge requiring illumination are only the *designated* egress paths, such as aisles, corridors, stairs, and ramps. *Designated* is meant to indicate designation by the AHJ. For example, most AHJs do not designate the space within an individual's work cubicle as a portion of the exit access required to be illuminated, but the aisles serving multiple cubicles are typically designated as requiring illumination.

Illumination of means of egress is not required unless specifically called for in the appropriate occupancy chapter of NFPA *101*. Nearly all occupancy chapters require illumination, but there are a few exemptions. For example, in new assembly occupancies, 12.2.8 of NFPA *101* exempts private-party tents not larger than 1200 ft^2 (112 m^2) from the illumination requirement. Subsection __.2.8 (e.g., 36.2.8 for new mercantile occupancies) of each occupancy chapter of NFPA *101* provides illumination requirements.

14.12.1.2 Illumination of means of egress shall be continuous during the time that the conditions of occupancy require that the means of egress be available for use, unless otherwise provided in 14.12.1.2.2. [***101:***7.8.1.2]

14.12.1.2.1 Artificial lighting shall be employed at such locations and for such periods of time as are necessary to maintain the illumination to the minimum criteria values herein specified. [***101:***7.8.1.2.1]

14.12.1.2.2* Unless prohibited by Chapters 11 through 43 of NFPA *101*, automatic lighting control devices shall be permitted to temporarily turn off the illumination within the means of egress, provided that each lighting control device complies with all of the following:

(1) In new installations, the lighting control device is listed.
(2) The lighting control device is equipped to automatically energize the controlled lights upon loss of normal power and is evaluated for this purpose.
(3) Illumination timers are provided and are set for a minimum 15-minute duration.
(4) The lighting control device is activated by any occupant movement in the area served by the lighting units.
(5) In new installations, the lighting control device is activated by activation of the building fire alarm system, if provided.
(6) The lighting control device does not turn off any lights relied upon for activation of photoluminescent exit signs or path markers.
(7) The lighting control device does not turn off any battery-equipped emergency luminaires, unit equipment, or exit signs.

[***101:***7.8.1.2.2]

A.14.12.1.2.2 Photoluminescent materials and battery-powered luminaires require some period of time to restore themselves to full operational capacity after being de-energized. [***101:***A.7.8.1.2.2]

Photoluminescent products rely on nearby luminaires to maintain their full capacity. When those luminaires are de-energized, the photoluminescent product will gradually deplete its capacity. Listed photoluminescent exit signs and path markers are restored to full rated capacity within one hour and there is no known limit to the number of times they can be discharged and recharged, nor any known degradation of overall capacity or lifetime as a result of discharge/charge cycles. [***101:***A.7.8.1.2.2]

De-energizing the normal (utility) power source will automatically begin the battery discharge cycle of emergency luminaires, unit equipment, and exit signs provided with battery backup. Once drained, these batteries will typically require between 24 to 72 hours, depending on the battery technology and charging circuitry design, to regain full capacity. Frequent discharge/charge cycles can reduce overall battery lifetime and, depending on battery technology, might also prematurely reduce overall battery capacity. [***101:***A.7.8.1.2.2]

14.12.1.2.3* Energy-saving sensors, switches, timers, or controllers shall be approved and shall not compromise the continuity of illumination of the means of egress required by 14.12.1.2. [***101:***7.8.1.2.3]

A.14.12.1.2.3 A consideration for the approval of automatic, motion sensor–type lighting switches, controls, timers, or controllers is whether the equipment is listed as a fail-safe device for use in the means of egress. [***101:***A.7.8.1.2.3]

14.12.1.3 The floors and other walking surfaces within an exit and within the portions of the exit access and exit discharge designated in 14.12.1.1 shall be illuminated as follows:

(1) During conditions of stair use, the minimum illumination for new stairs shall be at least 10 ft-candle (108 lux), measured at the walking surfaces.
(2) The minimum illumination for floors and other walking surfaces, other than new stairs during conditions of stair use, shall be to values of at least 1 ft-candle (10.8 lux), measured at the floor.
(3) In assembly occupancies, the illumination of the walking surfaces of exit access shall be at least 0.2 ft-candle (2.2 lux) during periods of performances or projections involving directed light.
(4)* The minimum illumination requirements shall not apply where operations or processes require low lighting levels.
[***101:***7.8.1.3]

The *Code* requires at least 1 ft-candle (10.8 lux) of illumination at floor level.

Item (1) of 14.12.1.3 requires at least 10 ft-candle (108 lux) for new stairs during conditions of stair use. Note that, during conditions where the stair is not being used but the building is occupied, at least 1 ft-candle (10.8 lux) of illumination must be on the stair walking surfaces in compliance with 14.12.1.3(2). An arrangement that might be used to comply with 14.12.1.3(1) and (2) would include illuminating the stair to a minimum of 1 ft-candle (10.8 lux) during periods that the building is occupied and using motion detectors to sense occupant presence in any portion of the stair enclosure that, upon activation, would increase the illumination level to the minimum 10 ft-candle (108 lux) requirement. Exhibit 14.60 and Exhibit 14.61 show novel lighting techniques — methods that help to ensure that the stair treads are adequately illuminated and tread edges are easily discerned by stair users — for an outdoor stair and an indoor stair, respectively. Exhibit 14.62 shows a stair whose illumination is questionable, especially given that occupants who use the stair in the downward direction are coming from the area near a building window wall with bright outdoor lighting.

When motion pictures, slides, and the like are being shown in theaters, auditoriums, and other assembly occupancies, 14.12.1.3(3) permits the level of illumination to be reduced to 0.2 ft-candle (2.2 lux).

Exhibit 14.60

Exterior stair illumination via lights in stair handrail. (Courtesy of Jake Pauls)

Exhibit 14.61

Interior stair illumination via lights at stair treads. (Courtesy of Jake Pauls)

Exhibit 14.62

Poorly lighted interior stair near brightly lighted window space. (Courtesy of Jake Pauls)

Item (4) of 14.12.1.3 recognizes that some operations (e.g., photographic film manufacturing) require low lighting levels. Special precautions can be taken for occupant life safety so as to not have to require a minimum illumination level.

A.14.12.1.3(4) Some processes, such as manufacturing or handling of photosensitive materials, cannot be performed in areas provided with the minimum specified lighting levels. The use of spaces with lighting levels below 1 ft-candle (10.8 lux) might necessitate additional safety measures, such as written emergency plans, training of new employees in emergency evacuation procedures, and periodic fire drills. [***101:***A.7.8.1.3(5)]

14.12.1.4* Required illumination shall be arranged so that the failure of any single lighting unit does not result in an illumination level of less than 0.2 ft-candle (2.2 lux) in any designated area. [***101:***7.8.1.4]

All lights, circuits, or auxiliary power must be arranged to ensure continuity of egress lighting, although the performance level is permitted to decline from 1 ft-candle to 0.2 ft-candle (10.8 lux to 2.2 lux) if a system element fails. Continuity of egress lighting can be accomplished by means such as use of duplicate light bulbs in fixtures or overlapping light patterns from neighboring fixtures.

A.14.12.1.4 Failure of a lighting unit is deemed to have occurred when the light output drops below 70 percent of its original level. [***101:***A.7.8.1.4]

14.12.1.5 The equipment or units installed to meet the requirements of Section 14.14 also shall be permitted to serve the function of illumination of means of egress, provided that all requirements of Section 14.12 for such illumination are met. [***101:***7.8.1.5]

14.12.2 Sources of Illumination.

14.12.2.1 Illumination of means of egress shall be from a source considered reliable by the AHJ. [***101:***7.8.2.1]

14.12.2.2 Battery-operated electric lights and other types of portable lamps or lanterns shall not be used for primary illumination of means of egress. Battery-operated electric lights shall be permitted to be used as an emergency source to the extent permitted under Section 14.13. [***101:***7.8.2.2]

14.13 Emergency Lighting

14.13.1 General.

Δ **14.13.1.1*** Emergency lighting facilities for means of egress shall be provided in accordance with Section 14.13 for the following:

(1) Buildings or structures where required in Chapters 11 through 43 of NFPA *101*
(2) Underground and limited access structures as addressed in Section 11.7 of NFPA *101*
(3) High-rise buildings as required by NFPA *101*
(4) Doors equipped with delayed-egress locks
(5) Stair shafts and vestibules of smokeproof enclosures, for which the following also apply:
   (a) The stair shaft and vestibule shall be permitted to include a standby generator that is installed for the smokeproof enclosure mechanical ventilation equipment.
   (b) The standby generator shall be permitted to be used for the stair shaft and vestibule emergency lighting power supply.
(6) New sensor-release of electrical locking systems in accordance with 14.5.3.2

[***101:***7.9.1.1]

A.14.13.1.1 Emergency lighting outside the building should provide illumination to either a public way or a distance away from the building that is considered safe, whichever is closest to the building being evacuated. [***101:***A.7.9.1.1]

Emergency lighting is not required unless specifically called for in the appropriate occupancy chapter of NFPA *101* or by a provision of 14.13.1.1.

14.13.1.2 For the purposes of 14.13.1.1, exit access shall include only designated stairs, aisles, corridors, ramps, escalators, and passageways leading to an exit. For the purposes of 14.13.1.1, exit discharge shall include only designated stairs, ramps, aisles, walkways, and escalators leading to a public way. [***101:***7.9.1.2]

The means of egress (i.e., exit access, exit, and exit discharge) encompasses practically all spaces where persons can be present. The subject addressed by Section 14.13 is emergency lighting of means of egress. The title of Section 14.13 seems to indicate that such emergency lighting needs to be provided throughout all portions of the exit access, the exit, and the exit discharge, but this is not so. Emergency lighting is required throughout the exit (e.g., in an enclosed exit stair or exit passageway). Yet, 14.13.1.2 clarifies that, for the purposes of applying the requirements of Section 14.13, the portions of the exit access and exit discharge requiring emergency lighting are only the *designated* egress paths, such as aisles, corridors, stairs, ramps, and passageways. *Designated* is meant to indicate designation by the AHJ. For example, most AHJs do not designate the space within an individual's work cubicle as a portion of the exit access required to be provided with emergency lighting, but the aisles serving multiple cubicles are typically designated as requiring emergency lighting.

14.13.1.3 Where maintenance of illumination depends on changing from one energy source to another, a delay of not more than 10 seconds shall be permitted. [***101:***7.9.1.3]

An on-site generator driven by a prime mover must be automatically started and capable of picking up the emergency lighting load within 10 seconds. If the generator is not able to supply power within this time frame, an auxiliary power source must be provided.

Some turbine-driven emergency generators take longer than 10 seconds to reach operating speed. A backup battery pack, such as an uninterruptible power supply (UPS), capable of delivering emergency power for a few minutes might be used in conjunction with any on-site generator that cannot meet the 10-second requirement. As another alternative, unit lighting packs with their integral batteries might be used to provide emergency lighting immediately upon loss of normal power, with a switchover to other lighting fixtures supplied by power from the generator at a later point in the incident during which normal power was lost.

14.13.2 Periodic Testing of Emergency Lighting Equipment.

14.13.2.1 Required emergency lighting systems shall be tested in accordance with one of the three options offered by 14.13.2.1.1, 14.13.2.1.2, or 14.13.2.1.3. [***101:***7.9.3.1]

Δ **14.13.2.1.1** Testing of required emergency lighting systems shall be permitted to be conducted as follows:

(1) Functional testing shall be conducted monthly with a minimum of 3 weeks and a maximum of 5 weeks between tests, for not less than 30 seconds, except as otherwise permitted by 14.13.2.1.1(2).
(2) The test interval shall be permitted to be extended beyond 30 days with the approval of the AHJ.
(3) Functional testing shall be conducted annually for a minimum of 1½ hours if the emergency lighting system is battery powered.
(4) The emergency lighting equipment shall be fully operational for the duration of the tests required by 14.13.2.1.1(1) and 14.13.2.1.1(3).
(5) Written records of visual inspections and tests shall be kept by the owner for inspection by the AHJ.

[***101:***7.9.3.1.1]

14.13.2.1.2 Testing of required emergency lighting systems shall be permitted to be conducted as follows:

(1) Self-testing/self-diagnostic battery-operated emergency lighting equipment shall be provided.
(2) Not less than once every 30 days, self-testing/self-diagnostic battery-operated emergency lighting equipment shall automatically perform a test with a duration of a minimum of 30 seconds and a diagnostic routine.
(3) Self-testing/self-diagnostic battery-operated emergency lighting equipment shall indicate failures by a status indicator.
(4) A visual inspection shall be performed at intervals not exceeding 30 days.
(5) Functional testing shall be conducted annually for a minimum of 1½ hours.
(6) Self-testing/self-diagnostic battery-operated emergency lighting equipment shall be fully operational for the duration of the 1½ hour test.
(7) Written records of visual inspections and tests shall be kept by the owner for inspection by the AHJ.

[***101:***7.9.3.1.2]

Δ **14.13.2.1.3** Testing of required emergency lighting systems shall be permitted to be conducted as follows:

(1) Computer-based, self-testing/self-diagnostic battery-operated emergency lighting equipment shall be provided.
(2) Not less than once every 30 days, emergency lighting equipment shall automatically perform a test with a duration of a minimum of 30 seconds and a diagnostic routine.
(3) The emergency lighting equipment shall automatically perform annually a test for a minimum of 1½ hours.
(4) The emergency lighting equipment shall be fully operational for the duration of the tests required by 14.13.2.1.3(2) and 14.13.2.1.3(3).
(5) The computer-based system shall be capable of providing a report of the history of tests and failures at all times.

[***101:***7.9.3.1.3]

Periodic testing of emergency lighting equipment is needed to help ensure such equipment will perform as needed upon failure of normal power. The functional test, required to be conducted by 14.13.2.1.1(1), 14.13.2.1.2(2), and 14.13.2.1.3(2), ensures that the bulbs and other equipment work. Additionally, for battery-powered equipment, the 30-second performance criterion for the functional test demonstrates that batteries have more than a residual charge. The 1½-hour performance criterion required yearly for battery-powered equipment ensures sufficient battery life to provide emergency lighting for the 1½ hours required by 14.13.2.1.

The self-testing/self-diagnostic systems permitted by 14.13.2.1.2 and 14.13.2.1.3 use newer technologies and equipment to automate the testing, thereby reducing the manual labor needed to keep the emergency lighting systems in proper operating condition.

Note that 14.13.2.1.1(1) was revised and 14.13.2.1.1(2) was new to the 2009 edition of the *Code*. In prior editions, the functional test, which must be performed manually (as contrasted with the functional testing that is conducted automatically by the self-testing/self-diagnostic systems addressed in 14.13.2.1.2 and 14.13.2.1.3), was required to be conducted at 30-day intervals. Where that requirement was followed exactly, testing performed on January 31 would be performed again the following year on January 25 due to the forward creep caused by 31-day months. The former requirement also offered no leniency for scheduling the testing to avoid weekends when the person responsible for conducting the testing might not normally be present. The current language of 14.13.2.1.1(1) offers flexibility without permitting someone to test, for example, on January 31 and again the next day, February 1, and claim compliance with having tested once in each of those months.

14.14 Marking of Means of Egress

14.14.1 General.

14.14.1.1 Where Required. Means of egress shall be marked in accordance with Section 14.14 where required in Chapters 11 through 43 of NFPA *101*. [***101:***7.10.1.1]

Marking of means of egress is not required unless specifically called for by the applicable occupancy chapter of NFPA *101*. Subsection __.2.10 of each occupancy chapter (e.g., 12.2.10 of NFPA *101* for new assembly occupancies) details where exit signs and directional exit signs are required.

14.14.1.2 Exits.

14.14.1.2.1* Exits, other than main exterior exit doors that obviously and clearly are identifiable as exits, shall be marked by an approved sign that is readily visible from any direction of exit access. [***101:***7.10.1.2.1]

A.14.14.1.2.1 Where a main entrance serves also as an exit, it will usually be sufficiently obvious to occupants so that no exit sign is needed. [***101:***A.7.10.1.2.1]

The character of the occupancy has a practical effect on the need for signs. In any assembly occupancy, hotel, department store, or other building subject to transient occupancy, the need for signs will be greater than in a building subject to permanent or semipermanent occupancy by the same people, such as an apartment house where the residents are presumed to be familiar with exit facilities by reason of regular use thereof. Even in a permanent residence-type building, however, there is need for signs to identify exit facilities such as outside stairs that are not subject to regular use during the normal occupancy of the building. [***101:***A.7.10.1.2.1]

The requirement for the locations of exit signs visible from any direction of exit access is illustrated in Figure A.14.14.1.2.1. [***101:***A.7.10.1.2.1]

14.14.1.2.2* Horizontal components of the egress path within an exit enclosure shall be marked by approved exit or directional exit signs where the continuation of the egress path is not obvious. [***101:***7.10.1.2.2]

Some exit stair enclosures, particularly in high-rise buildings where the upper portion of the tower presents a smaller footprint than the base of the building, include horizontal components (much like exit passageways) at floors where the stair enclosure that serves the next group of floors immediately below shifts horizontally in position. Although exit and directional exit signs are not normally needed within an exit stair enclosure that is stacked vertically without offsets because occupants simply move downward from floor to floor, the presence of the horizontal passageway might confound the egress path. Where the continuation of the egress path is not obvious, 14.14.1.2.2 requires additional exit or directional exit signs.

A.14.14.1.2.2 The direction of travel to the exit discharge within a stair enclosure with horizontal components in excess of the typical landings might need additional signage to be readily visible or obvious. Exit signs should be installed above doors through which the egress path leads. Directional exit signs should be installed where the horizontal egress path changes directions. The stairway marking signs required by 10.12.3, provided within the stair enclosure at each floor landing, indicate the vertical direction to exit discharge. [***101:***A.7.10.1.2.2]

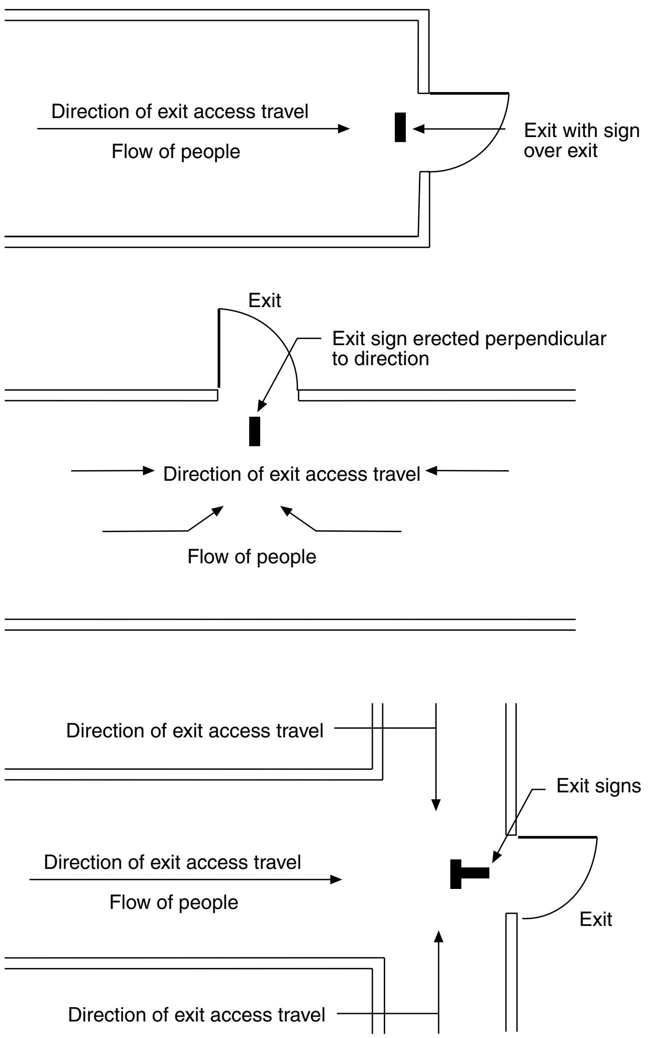


FIGURE A.14.14.1.2.1 *Location of Exit Signs. [**101:**Figure A.7.10.1.2.1]*

14.14.1.3 Exit Stair Door Tactile Signage. Tactile signage shall be provided to meet all of the following criteria, unless otherwise provided in 14.14.1.4:

(1) Tactile signage shall be located at each exit door requiring an exit sign.
(2) Tactile signage shall read as follows: EXIT
(3) Tactile signage shall comply with ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*.

[***101:***7.10.1.3]

14.14.1.4 Existing Exemption. The requirements of 14.14.1.3 shall not apply to existing buildings, provided that the occupancy classification does not change. [***101:***7.10.1.4]

All exit door assemblies required to have an exit sign are also required to have tactile signage, unless the exit door assembly is in an existing building and the occupancy classification does not change. The required tactile signage allows persons with vision impairment to identify the door assembly as an exit. For the same reasons that the requirements of 14.10.4 on accessible means of egress are not required for existing buildings, tactile signage is not required in existing buildings, unless the occupancy classification changes.

The provision of 14.14.1.3(3), requiring that the tactile signage be in accordance with ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*, has the effect of requiring the EXIT element of the sign to be presented both in raised characters and braille. See the last paragraph of the commentary following 10.11.3.1.16.

14.14.1.5 Exit Access.

14.14.1.5.1 Access to exits shall be marked by approved, readily visible signs in all cases where the exit or way to reach the exit is not readily apparent to the occupants. [***101:***7.10.1.5.1]

14.14.1.5.2* New sign placement shall be such that no point in an exit access corridor is in excess of the rated viewing distance or 100 ft (30 m), whichever is less, from the nearest sign. [***101:***7.10.1.5.2]

The placement distance requirement in 14.14.1.5.2 applies only to new exit sign installations in corridors. Internally illuminated signs are required by 14.14.7.1 to be listed in accordance with ANSI/UL 924, *Standard for Emergency Lighting and Power Equipment*. The testing procedures of ANSI/UL 924 determine a distance rating for the listed sign. Externally illuminated signs are not required to be listed and do not have a distance rating associated with them; however, they are subject to the maximum 100 ft (30 m) placement distance requirement.

The requirement by 14.14.1.5.2 to position internally illuminated signs based on their listed distance rating is another step toward promoting performance-based design in lieu of the traditional prescription-based approach [i.e., use of the maximum 100 ft (30 m) distance]. Listed exit signs are required to be marked with a distance rating only if the rating is other than the 100 ft (30 m) default value.

A.14.14.1.5.2 For externally illuminated signs in accordance with 14.14.6 and internally illuminated signs listed without a marked viewing distance, the rated viewing distance should be considered to be 100 ft (30 m). Where placing signs at their rated viewing distance requires them to be placed above the line of sight, consideration should be given to increasing the size of the exit legend to compensate for the additional straight-line distance between the viewer and the sign. [***101:***A.7.10.1.5.2]

14.14.1.6* Floor Proximity Exit Signs. Where floor proximity exit signs are required in Chapters 11 through 43 of NFPA *101*, such signs shall comply with 14.14.3, 14.14.4, 14.14.5, and 14.14.6 for externally illuminated signs and 14.14.7 for internally illuminated signs. Such signs shall be located near the floor level in addition to those signs required for doors or corridors. The bottom of the sign shall be not less than 6 in. (150 mm), but not more than 18 in. (455 mm), above the floor. For exit doors, the sign shall be mounted on the door or adjacent to the door, with the nearest edge of the sign within 4 in. (100 mm) of the door frame. [***101:***7.10.1.6]

A.14.14.1.6 See 14.14.3. [***101:***A.7.10.1.6]

Because locations near the ceiling might be the first to become obstructed by smoke, the provision of 14.14.1.6 makes it possible for the occupancy chapters to specify floor proximity signs to supplement the regular exit signs that are usually placed above the exit door opening or near the ceiling in corridors. Such signs are not intended to replace standard exit signs but are designed as an extra asset to a building occupant seeking egress in a smoke-filled environment. Because the signs are positioned near the floor, they will be among the last signs to become obscured by the descending smoke layer. Exhibit 14.63 shows a floor proximity exit sign at the base of an exit door that is equipped with the traditional exit sign above the door opening.

The provisions of 14.14.1.6 can be used as guidance on the placement and installation of floor proximity signs, even though they might not be required.

The only occupancies currently mandating floor proximity exit signs are assembly occupancies, where they are required in special amusement buildings in accordance with the provisions of 20.1.4.

14.14.1.7* Floor Proximity Egress Path Marking. Where floor proximity egress path marking is required in Chapters 11 through 43 of NFPA *101*, an approved floor proximity egress path marking system that is internally illuminated shall be installed within 18 in.

Exhibit 14.63

Floor proximity EXIT sign. (Courtesy of Jake Pauls)

(455 mm) of the floor. Floor proximity egress path marking systems shall be listed in accordance with ANSI/UL 1994, *Standard for Luminous Egress Path Marking Systems*. The system shall provide a visible delineation of the path of travel along the designated exit access and shall be essentially continuous, except as interrupted by doorways, hallways, corridors, or other such architectural features. The system shall operate continuously or at any time the building fire alarm system is activated. The activation, duration, and continuity of operation of the system shall be in accordance with 7.9.2 of NFPA *101*. The system shall be maintained in accordance with the product manufacturing listing. [***101:***7.10.1.7]

A.14.14.1.7 See 3.3.145.2 of NFPA *101* for the definition of *internally illuminated*. [***101:***A.7.10.1.7]

Paragraph 14.14.1.7 provides a standard for floor proximity egress path marking for mandatory use by the occupancy chapters or for voluntary use by any party. This type of marking has been mandatory on aircraft for several years. It is not mandatory for any occupancy under the *Code*. However, it could be used as part of the directional exit marking required for special amusement buildings by the provisions of 20.1.4. Such systems are required by 14.14.1.7 to be listed (see 3.2.6 for the definition of the term *listed*).

The provisions of 14.14.1.7 require that floor proximity egress path marking systems be internally illuminated. Photoluminescent egress path markers (like photoluminescent exit signs addressed in 14.14.7.2) are internally illuminated. The photoluminescent material stores incident electromagnetic radiation, typically from ambient light sources, and releases it in the form of visible light. The intensity and duration of the ambient light needed for charging the photoluminescent material varies by product and manufacturer. Thus, 14.14.1.7 requires that the system be maintained in accordance with the product manufacturing listing.

14.14.1.8* Visibility. Every sign required in Section 14.14 shall be located and of such size, distinctive color, and design that it is readily visible and shall provide contrast with decorations, interior finish, or other signs. No decorations, furnishings, or equipment that impairs visibility of a sign shall be permitted. No brightly illuminated sign (for other than exit purposes), display, or object in or near the line of vision of the required exit sign that could detract attention from the exit sign shall be permitted. [***101:***7.10.1.8]

In some locations, an otherwise adequate exit sign or directional exit sign might be rendered inconspicuous by a high-intensity illuminated advertising sign in the immediate vicinity. For that reason, such signs are not permitted in the line of vision of any required sign addressed by Section 14.14.

The maximum mounting height for directional exit signs not associated with an egress opening is not specified, and the minimum mounting height for exit signs and directional exit signs is not specified (see 14.14.1.9). Usually they are placed above exit door openings and above head height. There are those who argue, with reason, that smoke builds up more rapidly at higher levels, and signs positioned near the floor would be visible for a much longer time during a fire. However, when several people are moving toward an exit, those in the rear might not be able to see signs located near the floor because of the obstruction created by those ahead of them. Also, in the absence of careful housekeeping, such signs might be damaged or blocked. Thus, 14.14.1.8 treats the subject as a visibility issue and requires that the signs be located to be readily visible and to provide contrast with their surroundings. See also 14.14.1.9 and its related commentary.

A.14.14.1.8 In stores, for example, an otherwise adequate exit sign could be rendered inconspicuous by a high-intensity illuminated advertising sign located in the immediate vicinity. [***101:***A.7.10.1.8]

Red is the traditional color for exit signs and is required by law in many places. However, at an early stage in the development of NFPA *101*, a provision made green the color for exit signs, following the concept of traffic lights in which green indicates safety and red is the signal to stop. During the period when green signs were specified by NFPA *101*, many such signs were installed, but the traditional red signs also remained. In 1949, the Fire Marshals Association of North America voted to request that red be restored as the required exit sign color, because it was found that the provision for green involved difficulties in law enactment that were out of proportion to the importance of safety. Accordingly, the 10th edition of NFPA *101* specified red where not otherwise required by law. The present text avoids any specific requirement for color on the assumption that either red or green will be used in most cases and that there are some situations in which a color other than red or green could actually provide better visibility. [***101:***A.7.10.1.8]

14.14.1.9 Mounting Location. The bottom of new egress markings shall be located at a vertical distance of not more than 6 ft 8 in. (2030 mm) above the top edge of the egress opening intended for designation by that marking. Egress markings shall be located at a horizontal distance of not more than the required width of the egress opening, as measured from the edge of the egress opening intended for designation by that marking to the nearest edge of the marking. [***101:***7.10.1.9]

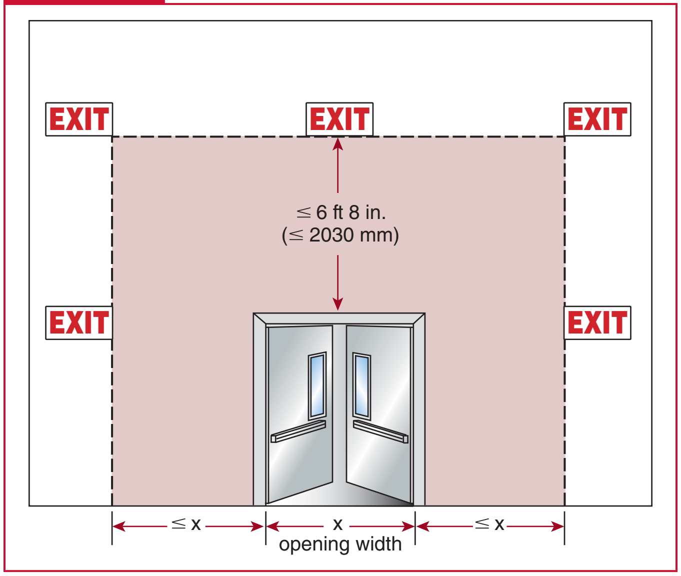
Paragraph 14.14.1.9 addresses the mounting location of exit signs associated with an egress opening such as a door opening, an archway, or a portal. Its provisions are meant to keep the sign from being located too high above the egress opening and too far to the side of the egress opening, at which point the sign would be less effective in designating the opening as the egress route.

Exhibit 14.64 illustrates the maximum distance at which the nearest sign edge is permitted to be positioned above and to the side of the egress opening, which, in this illustration, is a pair of door leaves. Measurement X, shown below the door leaves, is the required width of the egress opening.

14.14.2 Directional Signs.

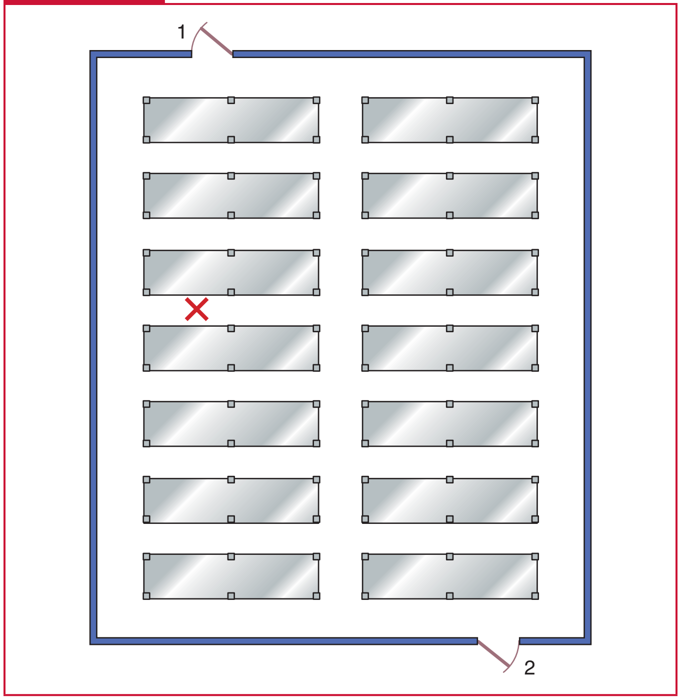
14.14.2.1 A sign complying with 14.14.3 with a directional indicator showing the direction of travel shall be placed in every location

Exhibit 14.64



Maximum permitted distance of sign edge above and to the side of egress opening.

Exhibit 14.65



Warehouse exit sign and directional sign placement to be determined.

where the direction of travel to reach the nearest exit is not apparent. [***101:***7.10.2.1]

The provision of 14.14.2.1 mandates that a directional sign be placed where the direction of travel to reach the nearest exit is not apparent. The directional sign uses an exit sign to which one or two directional indicators are added. For externally illuminated signs, which are not required to be laboratory listed, the detailed criteria for the directional indicator appear in 14.14.6.2. Internally illuminated signs, which are required to be tested and listed in accordance with ANSI/UL 924 have their directional indicators evaluated by the performance criteria of the ANSI/UL 924 test procedure; they are exempt from the specification-based criteria of 14.14.6.2.

The requirement of 14.14.2.1 is somewhat performance based in that it adds another directional exit sign wherever the direction of travel to reach the nearest exit is not apparent. The enforcement of this provision will typically be somewhat subjective, because a judgment call must be made as to whether the direction of travel to reach the nearest exit is apparent. A strict reading and application of the requirement, especially with respect to the word *nearest*, could conceivably lead to the installation of many more signs than are practically needed.

Exhibit 14.65 depicts a warehouse with storage racks and aisles. The racks are of sufficient height and construction to prevent an occupant located within almost any aisle from seeing either of the exit door assemblies from the building. The designer is charged with specifying exit sign and directional sign placement that meets the provisions of Section 14.14. An occupant standing at point X within an aisle has a choice of many possible paths for travel to the two exit door assemblies; there are no dead-end aisles in which to become trapped. The criterion test for exit sign placement is 14.14.2.1, which requires that a directional sign be placed in every location where the direction of travel to reach the "nearest" exit is not apparent. Exit door assembly 1 is the nearest exit, but neither exit door assembly 1 nor exit door assembly 2 can be seen from within the aisle or from within any of the three cross-aisles. A strict interpretation of 14.14.2.1, coupled with the requirement of 14.14.1.2.1 that the exit door assemblies themselves be provided with exit signs, could lead to the installation of 20 signs, as shown in Exhibit 14.66. It could be argued that it is neither unreasonable nor unsafe to reduce the number of signs so as to require the occupant to travel to either of the two nearest cross-aisles in order to see a directional sign that leads to an exit. A check for reasonableness could lead to the placement of eight signs, as shown in Exhibit 14.67.

14.14.2.2 Directional exit signs shall be provided within horizontal components of the egress path within exit enclosures as required by 14.14.1.2.2. [***101:***7.10.2.2]

14.14.3* Sign Legend.

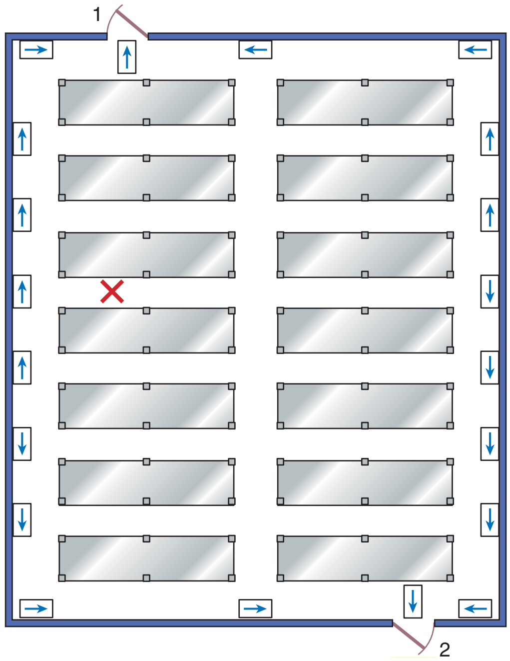
Δ **A.14.14.3** Where graphics are used, the symbols provided in NFPA 170 should be used. Such signs need to provide equal visibility and illumination and are to comply with the other requirements of Section 14.14. [***101:***A.7.10.3]

14.14.3.1 Signs required by 14.14.1 and 14.14.2 shall read as follows in plainly legible letters, or other appropriate wording shall be used:

EXIT

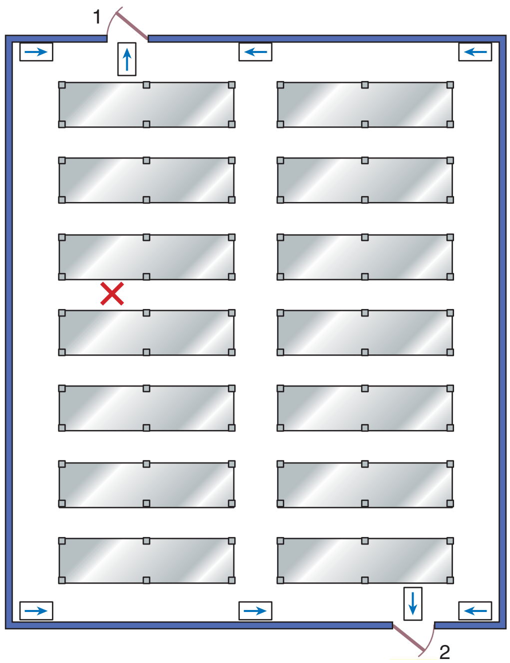
[***101:***7.10.3.1]

Exhibit 14.66



Excessive placement of directional signs.

Exhibit 14.67



Reasonable placement of directional signs.

Δ **14.14.3.2*** Where approved by the AHJ, pictograms in compliance with NFPA 170 shall be permitted. [***101:***7.10.3.2]

A.14.14.3.2 Pictograms are permitted to be used in lieu of, or in addition to, signs with text. [***101:***A.7.10.3.2]

Paragraph 14.14.3.1 permits other wording in lieu of the word EXIT where the alternative wording is appropriate. In countries where Spanish is the predominant language, one might find the word SALIDA. In parts of Canada, where signage appears in both French and English, exit signs have been increased in size to accommodate the words EXIT and SORTIE.

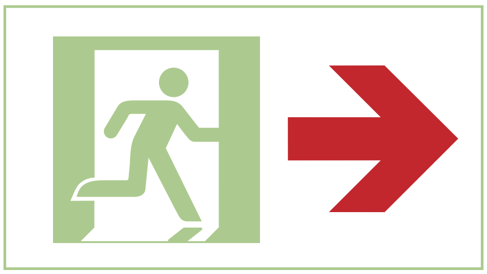
Although 14.14.3.1 refers to wording "in plainly legible letters," it is evident from the language of 14.14.3.2 that graphics, or pictograms, in lieu of words are permitted with the approval of the AHJ in accordance with 14.14.3.2. Graphics have the advantage of being nonspecific to a written language. Paragraph 14.14.3.2 specifies that the pictograms comply with NFPA 170, *Standard for Fire Safety and Emergency Symbols*. NFPA 170 provides a symbol for an emergency exit that should be considered the equivalent of the NFPA *101*'s exit sign. NFPA 170 also provides two symbols that — when used together within the same rectangular field — designate an emergency exit route. This diptych uses the emergency exit symbol and an arrow symbol and should be considered the equivalent of the *Code*'s directional exit sign. See Exhibit 14.68 and Exhibit 14.69. The colors used in the exhibits are consistent with the requirements of NFPA 170.

14.14.4* Power Source. Where emergency lighting facilities are required by the applicable provisions of Chapters 11 through 43 of NFPA *101* for individual occupancies, the signs, other than

Exhibit 14.68

NFPA 170 symbol for emergency exit.

Exhibit 14.69



NFPA 170 symbols for emergency exit route.

approved self-luminous signs and listed photoluminescent signs in accordance with 14.14.7.2, shall be illuminated by the emergency lighting facilities. The level of illumination of the signs shall be in accordance with 14.14.6.3 or 14.14.7 for the required emergency lighting duration as specified in 7.9.2.1 of NFPA *101*. However, the level of illumination shall be permitted to decline to 60 percent at the end of the emergency lighting duration. [***101:***7.10.4]

A.14.14.4 It is not the intent of this paragraph to require emergency lighting but only to have the sign illuminated by emergency lighting if emergency lighting is required and provided. [***101:***A.7.10.4]

It is not the intent to require that the entire stroke width and entire stroke height of all letters comprising the word EXIT be visible per the requirements of 14.14.6.3 under normal or emergency lighting operation, provided that the sign is visible and legible at a 100 ft (30 m) distance under all room illumination conditions. [***101:***A.7.10.4]

The text of A.14.14.4 explains that it is not the intent of 14.14.4 to require an emergency power source for the illumination of exit signs. Rather, it is the intent that the required exit signs be provided with emergency power if the occupancy is required to have emergency lighting. For example, there are business occupancies that are small enough to be exempt from the emergency lighting requirement of 38.2.9.1 and 39.2.9.1 of NFPA *101*. Yet, business occupancies are required to have exit signs in accordance with Section 14.14. Such exit signs are required to be illuminated per 14.14.5.1. In a small business occupancy that is exempt from emergency lighting, if a power failure occurs, the exit signs are permitted to go dark. The business occupancy example can be contrasted with an assembly occupancy. Assembly occupancies are required to have emergency lighting and exit signs. The exit signs must be illuminated in accordance with 14.14.5.1 when the building's normal power is available; the illumination must also be maintained in accordance with 14.14.4 upon failure of the normal power service.

14.14.5 Illumination of Signs.

14.14.5.1* General. Every sign required by 14.14.1.2, 14.14.1.5, or 14.14.8.1, other than where operations or processes require low lighting levels, shall be suitably illuminated by a reliable light source. Externally and internally illuminated signs shall be legible in both the normal and emergency lighting mode. [***101:***7.10.5.1]

A.14.14.5.1 See A.14.12.1.3(4). [***101:***A.7.10.5.1]

Internally illuminated signs are particularly useful in occupancies where reduction of normal illumination is permitted, such as in movie theaters. However, the intent of 14.14.5.1 is to treat externally illuminated and internally illuminated signs equally, with no preference shown to one or the other. Subsequent subsections then treat each type of sign via a specialized package of requirements, such as 14.14.6 for externally illuminated signs and 14.14.7 for internally illuminated signs. This format is provided because externally illuminated signs are not required to be tested and listed by a laboratory. Due to the lack of testing, it is necessary for the *Code* to specify detailed criteria for externally illuminated signs, such as the letter height and stroke width addressed in 14.14.6.1.1 and illumination levels as addressed in 14.14.6.3. Because internally illuminated signs must be laboratory tested and listed, the *Code* can rely on the listing to ensure that necessary criteria are met.

14.14.5.2* Continuous Illumination.

A.14.14.5.2 It is the intent to prohibit a freely accessible light switch to control the illumination of either an internally or externally illuminated exit sign. [***101:***A.7.10.5.2]

14.14.5.2.1 Every sign required to be illuminated by 14.14.6.3, 14.14.7, and 14.14.8.1 shall be continuously illuminated as required under the provisions of Section 14.12, unless otherwise provided in 14.14.5.2.2. [***101:***7.10.5.2.1]

14.14.5.2.2* Illumination for signs shall be permitted to flash on and off upon activation of the fire alarm system. [***101:***7.10.5.2.2]

A.14.14.5.2.2 The flashing repetition rate should be approximately one cycle per second, and the duration of the off-time should not exceed ¼ second per cycle. During on-time, the illumination levels need to be provided in accordance with 14.14.6.3. Flashing signs, when activated with the fire alarm system, might be of assistance. [***101:***A.7.10.5.2.2]

14.14.6 Externally Illuminated Signs.

14.14.6.1* Size of Signs.

A.14.14.6.1 Experience has shown that the word EXIT, or other appropriate wording, is plainly legible at 100 ft (30 m) if the letters are as large as specified in 14.14.6.1. [***101:***A.7.10.6.1]

Δ **14.14.6.1.1** Externally illuminated signs required by 14.14.1 and 14.14.2, other than approved existing signs, unless otherwise provided in 14.14.6.1.2, shall read EXIT or shall use other appropriate wording in plainly legible letters sized as follows:

(1) For new signs, the letters shall be not less than 6 in. (150 mm) high, with the principal strokes of letters not less than ¾ in. (19 mm) wide.
(2) For existing signs, the required wording shall be permitted to be in plainly legible letters not less than 4 in. (100 mm) high.
(3) The word EXIT shall be in letters of a width not less than 2 in. (51 mm), except the letter I, and the minimum spacing between letters shall be not less than ⅜ in. (9.5 mm).
(4) Sign legend elements larger than the minimum established in 14.14.6.1.1(1) through 14.14.6.1.1(3) shall use letter widths, strokes, and spacing in proportion to their height.

[***101:***7.10.6.1.1]

14.14.6.1.2 The requirements of 14.14.6.1.1 shall not apply to marking required by 14.14.1.3 and 14.14.1.7. [***101:***7.10.6.1.2]

Traditionally, the letters in an exit sign have been required to be 6 in. (150 mm) in height, with the principal strokes not less than ¾ in. (19 mm) wide. In an effort to increase visibility, the *Code* requires that the letters, other than capital letter *I*, be at least 2 in. (51 mm) wide and have a minimum spacing between letters of ⅜ in. (9.5 mm). These dimensional criteria have been maintained, but they apply only to externally illuminated signs. Internally illuminated signs are exempt from these criteria, because they must be tested and listed in accordance with ANSI/UL 924. The ANSI/UL 924 test procedures include assessing the readability of a sign's letters.

14.14.6.2* Size and Location of Directional Indicator.

A.14.14.6.2 Figure A.14.14.6.2 shows examples of acceptable locations of directional indicators with regard to left and right orientation. Directional indicators are permitted to be placed under the horizontal stroke of the letter T, provided that spacing of not less than ⅜ in. (9.5 mm) is maintained from the horizontal and vertical strokes of the letter T. [***101:***A.7.10.6.2]

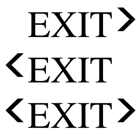


FIGURE A.14.14.6.2 *Directional Indicators. [**101:**Figure A.7.10.6.2]*

Δ **14.14.6.2.1** Directional indicators, unless otherwise provided in 14.14.6.2.2, shall comply with all of the following:

(1) The directional indicator shall be located outside of the EXIT legend, not less than ⅜ in. (9.5 mm) from any letter.
(2) The directional indicator shall be of a chevron type, as shown in Figure 14.14.6.2.1.
(3) The directional indicator shall be identifiable as a directional indicator at a distance of 40 ft (12 m).
(4) A directional indicator larger than the minimum established for compliance with 14.14.6.2.1(3) shall be proportionately increased in height, width, and stroke.
(5) The directional indicator shall be located at the end of the sign for the direction indicated.

[***101:***7.10.6.2.1]

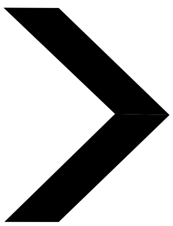


FIGURE 14.14.6.2.1 *Chevron-Type Indicator. [**101:**Figure 7.10.6.2.1]*

14.14.6.2.2 The requirements of 14.14.6.2.1 shall not apply to approved existing signs. [***101:***7.10.6.2.2]

To improve the effectiveness of directional indicators on directional exit signs, the requirements have been changed over the past several editions of the *Code*. The directional indicator cannot be positioned between the letters in the word EXIT. The directional indicator, which formerly was an arrow, must be a chevron, which research has shown is more effective than an arrow. Performance criteria are specified to ensure that the chevron is of adequate size, contrast, and illumination. A specific size is not required, because size depends on factors such as color, contrast, and illumination. However, the directional indicator must be identifiable as a directional indicator at a minimum distance of 40 ft (12 m), which is another performance-based requirement.

14.14.6.3* Level of Illumination. Externally illuminated signs shall be illuminated by not less than 5 ft-candles (54 lux) at the illuminated surface and shall have a contrast ratio of not less than 0.5. [***101:***7.10.6.3]

A.14.14.6.3 Colors providing a good contrast are red or green letters on matte white background. Glossy background and glossy letter colors should be avoided. [***101:***A.7.10.6.3]

The average luminance of the letters and background is measured in footlamberts or candela per square meter. The contrast ratio is computed from these measurements by the following formula:

$$\text{Contrast} = \frac{L_g - L_e}{L_g} \qquad \textbf{[A.14.14.6.3]}$$

Where L_g is the greater luminance and L_e is the lesser luminance, either the variable L_g or L_e is permitted to represent the letters, and the remaining variable will represent the background. The average luminance of the letters and background can be computed by measuring the luminance at the positions indicated in Figure A.14.14.6.3 by numbered spots. [***101:***A.7.10.6.3]

14.14.7 Internally Illuminated Signs.

14.14.7.1 Listing. Internally illuminated signs shall be listed in accordance with ANSI/UL 924, *Standard for Emergency Lighting*

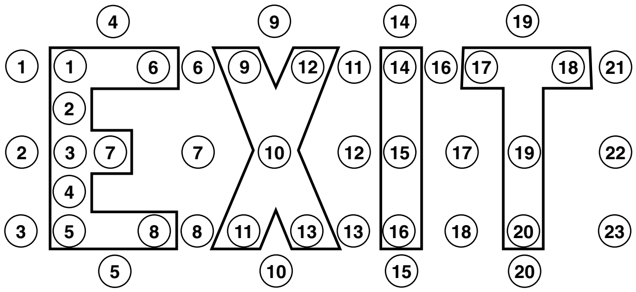


FIGURE A.14.14.6.3 *Measurement of Exit Sign Luminance. [**101:**Figure A.7.10.6.3]* *and Power Equipment*, unless they meet one of the following criteria:

(1) They are approved existing signs.
(2) They are existing signs having the required wording in legible letters not less than 4 in. (100 mm) high.
(3) They are signs that are in accordance with 14.14.1.3 and 14.14.1.6.

[***101:***7.10.7.1]

Internally illuminated signs must be laboratory tested and listed in accordance with ANSI/UL 924. Reliance is placed on the laboratory having conducted a comprehensive examination. By relying on the laboratory listing, the *Code* does not need to address the detailed criteria that it requires of externally illuminated signs, which are not required to be listed.

14.14.7.2* Photoluminescent Signs. The face of a photoluminescent sign shall be continually illuminated while the building is occupied. The illumination levels on the face of the photoluminescent sign shall be in accordance with its listing. The charging illumination shall be a reliable light source as determined by the AHJ. The charging light source shall be of a type specified in the product markings. [***101:***7.10.7.2]

A.14.14.7.2 Photoluminescent signs need a specific minimum level of light on the face of the sign to ensure that the sign is charged for emergency operation and legibility in both the normal and emergency modes. Additionally, the type of light source (for example, incandescent, fluorescent, halogen, metal halide) is important. Each light source produces different types of visible and invisible light (for example, UV) that might affect the ability of some photoluminescent signs to charge and might also affect the amount of light output available during emergency mode. This type of sign would not be suitable where the illumination levels are permitted to decline. The charging light source should not be connected to automatic timers, because the continuous illumination of the sign is needed; otherwise, the sign illumination would not be available, because it would be discharged. [***101:***A.7.10.7.2]

A photoluminescent sign absorbs light from an activation light source in order to emit light (i.e., luminesce). The sign continues to emit light for a time after the activation light source has been removed. The requirements of 14.14.7.2 for photoluminescent signs were new to the 2000 edition of NFPA *101*. Note that these requirements are contained as a subset of the internally illuminated sign requirements of 14.14.7. A photoluminescent sign is an internally illuminated sign. Photoluminescent exit signs are permitted, provided that they are listed in accordance with ANSI/UL 924 and meet the criteria of 14.14.7.2. The criteria of 14.14.7.2 are meant to highlight some of the special considerations needed to use photoluminescent exit signs effectively for life safety.

14.14.8 Special Signs.

14.14.8.1 Sign Illumination.

14.14.8.1.1* Where required by other provisions of this *Code*, special signs shall be illuminated in accordance with 14.14.5, 14.14.6.3, and 14.14.7. [***101:***7.10.8.1.1]

A.14.14.8.1.1 Special signs require sufficient illumination in order for them to be readable at close proximity. They are not expected to be of a size or illumination level necessary to be readable from a distance, as is the case for an exit sign. [***101:***A.7.10.8.1.1]

14.14.8.1.2 Where emergency lighting facilities are required by the applicable provisions of Chapters 11 through 43 of NFPA *101*, the required illumination of special signs shall additionally be provided under emergency lighting conditions. [***101:***7.10.8.1.2]

14.14.8.2 Characters. Special signs, where required by other provisions of this *Code*, shall comply with the visual character requirements of ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*. [***101:***7.10.8.2]

14.14.8.3* No Exit.

A.14.14.8.3 The likelihood of occupants mistaking passageways or stairways that lead to dead-end spaces for exit doors and becoming trapped governs the need for exit signs. Thus, such areas should be marked with a sign that reads as follows:

NO EXIT

Supplementary identification indicating the character of the area, such as TO BASEMENT, STOREROOM, LINEN CLOSET, or the like, is permitted to be provided. [***101:***A.7.10.8.3]

14.14.8.3.1 Any door, passage, or stairway that is neither an exit nor a way of exit access and that is located or arranged so that it is likely to be mistaken for an exit shall be identified by a sign that reads as follows:

NO
EXIT

[***101:***7.10.8.3.1]

14.14.8.3.2 The NO EXIT sign shall have the word NO in letters 2 in. (51 mm) high, with a stroke width of 3⁄8 in. (9.5 mm), and the word EXIT in letters 1 in. (25 mm) high, with the word EXIT below the word NO, unless such sign is an approved existing sign. [***101:***7.10.8.3.2]

14.15 Secondary Means of Escape

14.15.1 Secondary means of escape shall comply with NFPA *101*.

14.15.2 Where approved on secondary means of escape, security bars, grates, grilles, or similar devices shall be equipped with approved release mechanisms that are releasable from the inside without the use of a tool, a key, special knowledge, or force greater than that which it takes for normal operation of the door or window.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 70®, *National Electrical Code*®, 2017 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*®, 2016 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2016 edition.

NFPA 92, *Standard for Smoke Control Systems*, 2015 edition.

NFPA *101*®, *Life Safety Code*®, 2018 edition.

NFPA 170, *Standard for Fire Safety and Emergency Symbols*, 2015 edition.

NFPA 220, *Standard on Types of Building Construction,* 2018 edition.

Underwriters Laboratories, Northbrook, IL.

ANSI/UL 294, *Standard for Access Control System Units*, 1999, revised 2014.

ANSI/UL 924, *Standard for Emergency Lighting and Power Equipment*, 2006, revised 2014.

ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, American Society of Mechanical Engineers, New York, NY, 2013.

ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*, American National Standards Institute, New York, NY, 2009.

Fire Department Service Delivery Concurrency Evaluation

15

A key component of fire safety is the ability of the fire department to match service delivery to demand. Large-scale developments have the potential to overwhelm a fire department's ability to provide service without proper planning in the predevelopment stage. Chapter 15 allows the authority having jurisdiction (AHJ) to address such developmental impacts in a proactive, rather than reactive, manner. It is important to note that Chapter 15 does not specify any service delivery standards; it is only intended to prompt the discussion regarding how services are to be maintained and funded when a jurisdiction is subject to a large development project. It is also intended that this evaluation can be utilized as a tool to communicate to elected officials the potential impact of a large development on a fire department's budget needs before the project is approved.

15.1 Application

15.1.1 The AHJ shall be permitted to require a proposed development in the jurisdiction undergo a fire department service delivery concurrency evaluation.

The AHJ has the discretionary authority to specify whether a proposed development should undergo a fire department service delivery concurrency evaluation.

15.1.1.1 Proposed developments that would increase the fire department's service population by less than 1 percent or increase the fire department's total protected building square footage by less than 1 percent shall not be subject to a fire department service delivery concurrency evaluation.

The 1 percent population increase and 1 percent square footage exemption thresholds are intended to exclude smaller developments that will not have a significant impact on the fire department service level demand.

Both a population threshold and a square footage threshold are specified because population increases are generated by residential development and square footage increases are driven more by commercial development. If a proposed development exceeds either of those two thresholds, it would not be exempt under 15.1.1.1. However, under 15.1.1, the AHJ could still choose to not require a fire department service delivery concurrency evaluation if the AHJ is confident that service levels will not be compromised by the development.

15.2 Level of Service Objectives

15.2.1 The fire department shall provide the developer with the current level of service standards for fire protection, emergency medical, prevention, and other operational services provided by the fire department.

The current level of service can be developed with the assistance of documents such as NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments;* NFPA 1720, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments;* NFPA 1730, *Standard on Organization and Deployment of Fire Prevention Inspection and Code Enforcement, Plan Review, Investigation, and Public Education Operations*; NFPA 450, *Guide for Emergency Medical Services and Systems*; accreditation reports, service level studies, strategic plans, the fire department's budget, and other documents that specify the expected level of performance from fire department services.

15.2.2 The level of service for the proposed development shall not be less than the fire department's current level of service for fire protection, emergency medical, prevention, and other operational services.

It is important to note that fire department levels of service that should be maintained are not just suppression services but also emergency medical services, fire prevention services, and other specialized services provided by the fire department.

15.2.2.1 The AHJ shall be permitted to approve a reduced level of service for the proposed development if a service mitigation plan has been adopted by the jurisdiction.

Revenue used to fund fire department services usually trails the development activity by a couple of years. If the AHJ has approved a service mitigation plan, a reduced level of service could be permitted until revenue from the development supports a restoration to expected service standards.

15.3 Evaluator Qualifications

The fire department service delivery concurrency evaluation shall be prepared by a person with qualifications acceptable to the AHJ.

If the fire department has the available staff with the appropriate expertise, the evaluation could be conducted by the fire department staff. If a third-party consultant is utilized, the consultant needs to demonstrate familiarity with fire department service levels and competence in conducting service level analysis that are acceptable to the AHJ.

15.4 Fire Department Service Delivery Concurrency Evaluation Documentation

15.4.1 The fire department service delivery concurrency evaluation shall include, but not be limited to, the following:

(1) The current level of service for fire protection, emergency medical, and prevention services
(2) The post-development level of service for fire protection, emergency medical, and prevention services
(3) Mitigation recommendations if the level of service in the post-development condition falls below the current level of service

Mitigation recommendations can include, but may not be limited to, additional fire/EMS stations, additional fire/EMS apparatus, personnel staffing, radio communications improvements, and other equipment necessary to maintain service levels.

Ongoing fire prevention services should receive particular attention for mitigation in large-scale development. As an example, if a new covered mall building is proposed in a jurisdiction, not only should inspection and plan review resources for the initial construction be considered for mitigation but also ongoing existing fire occupancy inspections, plans review and new construction services for tenant improvements should be property mitigated for the long-term use of the development.

(4) Short- and long-term funding sources for implementation of the mitigation recommendations

An important part of the service level concurrency evaluation is to identify specific funding sources for each type of mitigation activity that is to occur. Identifying funding sources for each mitigation activity ensures that the developer, AHJ, and the jurisdiction's policy makers are all in agreement as to the source of funding for each mitigation activity. Funding sources may take the form of ad valorem (sales tax) or non-ad valorem property taxes, fees for service, direct funding contributions by the developer, permit fees, impact fees, EMS transport fees or other realistic revenue sources identified by the evaluator.

15.4.2 The fire department service delivery concurrency evaluation shall be provided in a format approved by the AHJ.

The evaluation should be provided in a report format approved by the AHJ that can be presented to and understood by the developer, AHJ, and jurisdiction's policy makers. This may include a presentation to parties that are vested in the outcome of the evaluation.

15.4.3 The fire department service delivery concurrency evaluation shall utilize data sources and standards approved by the AHJ.

NFPA 1710, NFPA 1720, NFPA 1730, NFPA 450, National Fire Incident Reporting System data, accreditation data, a fire department strategic plan, and adopted service levels by the jurisdiction are examples of data sources and standards that could be approved by the AHJ as part of the evaluation.

15.5 Independent Review

The AHJ shall be permitted to require an approved, independent third-party evaluation of the fire department service delivery concurrency evaluation at the expense of the developer.

If a third-party consultant is utilized, the consultant needs to demonstrate familiarity with fire department service levels and competence in conducting service level analysis that are acceptable to the AHJ. The full cost of the evaluation should be funded by the developer.

15.6 Approval

15.6.1 The AHJ shall make the final determination as to whether the level of service objectives have been met for the proposed development and, if applicable, the mitigation strategies are funded and appropriate.

It is intended that the AHJ has final approval of the evaluation report analysis and recommendations. If the AHJ does not concur with the analysis or the recommendations, then the evaluator is responsible for addressing the AHJ's concerns to ensure that the service objectives have been met and the revenue sources are appropriate to fund the mitigation strategies.

15.6.2 If a fire department service delivery concurrency evaluation is required by the AHJ, development shall not proceed until the report has been accepted by the AHJ.

It is the intent of the *Code* that the evaluation study and mitigation strategies are to be integral components of the approval process for the development. Because mitigation strategies may have an impact on both the design and financial feasibility of the development, it is important that acceptance of the evaluation report occur prior to final development approval by the jurisdiction.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 450, *Guide for Emergency Medical Services and Systems*, 2017 edition.

NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, 2016 edition.

NFPA 1720, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments*, 2014 edition.

NFPA 1730, *Standard on Organization and Deployment of Fire Prevention Inspection and Code Enforcement, Plan Review, Investigation, and Public Education Operations*, 2016 edition.

Safeguarding Construction, Alteration, and Demolition Operations

16

There have been fires in buildings since humans first started erecting shelters. Buildings in the course of construction have many additional fire hazards not found in completed structures. Fire protection equipment to restrict the spread of fire and extinguish it promptly is not installed until the last stages of construction, and fires are often difficult for the fire department to access. Opportunities abound for serious fire loss, as is amply evidenced by the case study that appears later in this chapter.

16.1 General Requirements

16.1.1 Structures undergoing construction, alteration, or demolition operations, including those in underground locations, shall comply with NFPA 241 and this chapter.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, is a unique standard in that it is not a "brick and mortar" standard but a standard about the process of putting the brick and mortar in place. The standard ceases to apply when the building is finished, that is, when the certificate of occupancy is issued.

The potential for extensive damage during a fire event is greatest when a building is under construction because it is largely unprotected. A building under construction needs constant supervision and inspection not possible or practical by municipal inspectors. What is fine at 8:00 a.m. may have changed and not be fine by 5:00 p.m. that same day or even by noon. A building under construction is not ready to "protect itself." Code-required passive and active fire-suppression systems such as sprinklers, smoke detection, fire alarms, and fire walls typically are nonexistent until a building is near completion. Regardless of the material used in a building's construction, prolonged exposure to fire without mitigation can lead to structural weakness and potential collapse.

16.1.2 A fire protection plan shall be established where required by the AHJ.

Buildings do not spontaneously combust. There must be an ignition source. Fires that occur during the construction process are most often attributable to human error or lack of understanding and training. Ignition sources include, but are not limited to, temporary heaters, welding, cutting, grinding, soldering, and roofing of various kinds. Such ignition sources are not permanent. They are brought on site and into the building by people. They may be there for only a day or two, but one mistake in the safety procedures for using them can destroy the building and spread fire to other buildings. Such fires are apt to cause losses far beyond the actual physical property destroyed by delaying completion of buildings, with consequent loss of revenue. Important business projects, contingent upon occupancy of a structure at a given date, can be seriously deranged even by a fire causing a relatively small direct loss.

Δ **16.1.3*** In buildings under construction, adequate escape facilities shall be maintained at all times for the use of construction workers. Escape facilities shall consist of doors, walkways, stairs, ramps, fire escapes, ladders, or other approved means or devices arranged in accordance with the general principles of Chapter 14 and NFPA *101* insofar as they can reasonably be applied to buildings under construction. [***101:***4.6.10.3]

A.16.1.3 See also NFPA 241. [***101:***A.4.6.10.2]

Subsection 16.1.3 requires that at least one stairway extend upward as each floor of the building is constructed. During construction, unfinished floor areas are often constructed before permanent access to such areas is available. Such areas are often wide open and accessible only by ladders or other temporary scaffolding. Combustible construction forms and lumber are often present, for example, when concrete is poured. A fire that occurs in such an unfinished floor area can quickly threaten the construction or make escape by ladder or scaffolding impossible due to heat and flames.

Workers need to be provided with two means of escape, with one means located as remotely as possible from the ladders and scaffolding, even if both means involve the use of temporary construction to reach the story below. The remote stairway should never be more than one level below that on which a floor is being installed.

Even in large, single-story construction, a construction worker can easily become lost when walls are erected, cutting off the worker's view of the exterior doors. The placement of temporary directional signs that point to exits throughout the building is important, as well as the rearrangement of such signs as the building interior changes during construction.

16.1.4 Fire department access roads provided in accordance with 18.2.3 shall be provided at the start of a project and shall be maintained throughout construction.

Fire department access roads are required throughout the construction process. The minimum 20 ft (6.1 m) of required clear width must be maintained at all times for access to the building and the building site. Maintenance of fire department access roads should be a key component of the fire protection plan (where required; see 16.1.2) and fire safety program (see 16.3.1).

Large construction sites might require two or more fire department access roads to be provided for access to within 150 ft (46 m) of all exterior first floor walls. (See 7.5.5.7 of NFPA 241.)

16.1.5 Permanent fire department access road markings shall not be required until the building is complete or occupied for use.

Signs marking the fire department access road might be required, in accordance with 18.2.3.5. Permanent signs are not required until after construction is completed. Temporary signs might be required to ensure that fire department access roads are kept clear during construction, alteration, or demolition operations. (Also see 7.5.5.6 of NFPA 241.)

16.2 Processes and Hazards

This section covers specific operations that represent likely ignition sources and lists specific combustible, flammable, or explosive materials that are generated or used in the course of construction. If not handled correctly, these materials can cause a disastrous situation.

16.2.1 Temporary Heating Equipment.

16.2.1.1* Temporary heating equipment shall be listed. [**241:**5.2.1]

A.16.2.1.1 Examples of relevant test standards include, but are not limited to, the following:

(1) UL 647, *Standard for Unvented Kerosene-Fired Room Heaters and Portable Heaters*
(2) ANSI/UL 1278, *Standard for Moveable and Wall- or Ceiling-Hung Electric Room Heaters*

[**241:**A.5.2.1]

16.2.1.2 Temporary heating equipment shall be installed in accordance with its listing, including clearance to combustible material, equipment, or construction. [**241:**5.2.2]

16.2.1.3 Temporary heating equipment shall be installed, used, and maintained in accordance with the manufacturer's instructions, except as otherwise provided in 16.2.1.4. [**241:**5.2.3]

16.2.1.4 Where instructions, as addressed in 16.2.1.3, are not available, temporary heating equipment shall be used in accordance with recognized safe practices. [**241:**5.2.4]

16.2.1.5 Temporary heating equipment shall be situated so that it is secured. [**241:**5.2.5]

Paragraph 16.2.1.5 requires temporary heating devices to be secured to prevent them from being tipped over or accidentally moved. Any associated tanks should also be secured. Heaters that tip over or are easily moved can come into contact with combustible materials or spilled fuel. Special care should be taken with the movement of cylinders and the connection of hoses to heating appliances. (See Chapter 69 for requirements pertaining to liquefied petroleum gas and liquefied natural gas.)

16.2.1.6 Only personnel familiar with the operation of the temporary heating equipment shall be allowed to operate such devices. [**241:**5.2.6]

16.2.1.7* Temporary heating equipment, where utilized, shall be monitored for safe operation and maintained by properly trained personnel. [**241:**5.2.7]

A.16.2.1.7 Misuse of temporary heating devices has resulted in numerous fires and millions of dollars in property loss. Temporary heating equipment, while operating, should be visually inspected every hour to ensure that combustibles have not blown or fallen over near the temporary heating device. During windy periods, it might be necessary to reduce the interval between inspections. Any object near the temporary heating device that is hot to the touch should be moved, or the temporary heating device should be relocated. The visual inspection also should ensure that the appliance is operating properly. Any appliance that is not operating properly should be turned off until repairs have been made. [**241:**A.5.2.7]

Where plastic films are used for temporary enclosures, they must comply with Test Method 2 of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*. Plastic film used for temporary enclosure of buildings should be adequately fastened to ensure that it does not rip off and get blown against a heater or other heat-producing device. Storage of combustible construction materials should be kept a safe distance from any heating appliance.

16.2.1.8 Temporary heating equipment and devices noted to be damaged or considered to be a potential safety hazard shall not be used. [**241:**5.2.8]

16.2.1.9 Temporary heating equipment using exposed radiant heating wires shall not be used. [**241:**5.2.9]

16.2.1.10 Temporary electrical heating equipment shall be equipped with tip-over protection and overheat cutoffs. [**241:**5.2.10]

Δ **16.2.1.11** Chimney or vent connectors, where required from direct-fired heaters, shall be maintained at least 18 in. (460 mm) from combustibles and shall be installed in accordance with NFPA 211. [**241:**5.2.11]

16.2.1.12 Oil-fired heaters shall comply in design and installation features with Section 11.5. [**241:**5.2.12]

Δ **16.2.1.13** Fuel supplies for liquefied petroleum gas-fired heaters shall comply with NFPA 54 and Chapter 69. [**241:**5.2.13]

16.2.1.14* Refueling operations shall be conducted in an approved manner. [**241:**5.2.14]

A.16.2.1.14 This might necessitate the removal of the heater prior to refueling. The appliance also should be allowed to cool prior to refueling. [**241:**A.5.2.14]

16.2.2 Waste Disposal.

16.2.2.1* Accumulations of combustible waste material, dust, and debris shall be removed from the structure and its immediate vicinity at the end of each work shift or more frequently as necessary for safe operations. [**241:**5.4.1]

A.16.2.2.1 Failure to remove scrap and trash accumulations provides fuel for the rapid expansion of a fire that might otherwise be confined to a small area. These accumulations also provide a convenient fuel source for malicious fires. Open-topped dumpsters containing combustible materials should be emptied or moved to at least 35 ft (11 m) from combustible structures at the end of each work shift. [**241:**A.5.4.1]

If a chute is employed for the removal of debris, it should be erected on the outside of the building. The chute must be of noncombustible construction or protected by not less than one temporary automatic sprinkler in accordance with 16.2.2.4.3. (See 5.4.4.3 through 5.4.4.6 of NFPA 241.) The chute should be as straight vertically as practical to avoid the accumulation of combustibles or clogging within the chute.

Chutes often discharge into large dumpsters. Dumpsters are often the targets for carelessly discarded smoking materials or malicious fire setters. Dumpsters should be moved away from the building as soon as they are filled. If they are unable to be secured within a fenced area, they should be moved off site at night, on weekends, and when not in use. Dumpsters should be located at least 35 ft (11 m) from buildings of combustible construction or in accordance with Table 4.2.1 of NFPA 241 to prevent a fire in the dumpster from spreading to the building. See Chapter 19 for additional requirements pertaining to combustible waste and refuse.

16.2.2.2 Rubbish shall not be burned on the premises without first obtaining a permit from the AHJ. *(See Section 10.10.)* [**241:**5.4.2]

Section 10.10 specifies requirements for open burning, which include that the fire be constantly attended by personnel with ready access to fire-extinguishing equipment. Many jurisdictions and environmental protection laws prohibit burning construction materials due to air quality issues and the potential for contaminated water runoff.

16.2.2.3 Materials susceptible to spontaneous ignition, such as oily rags, shall be stored in a listed disposal container. [**241:**5.4.3]

16.2.2.4 Trash chutes, where provided, shall comply with 16.2.2.4.1 through 16.2.2.4.6. [**241:**5.4.4]

16.2.2.4.1* A trash chute safety plan shall be submitted to and approved by the AHJ. [**241:**5.4.4.1]

A.16.2.2.4.1 An approved safety plan should include the following:

(1) A fire watch should be in accordance with Section 5.1 of NFPA 241.
(2) Adequate fire protection should include sprinklers, hose, extinguishers, or barriers as needed for the particular hazard present, including the construction of the chute.
(3) Protection of openings in exterior walls and protection of combustible exterior building surfaces should be adjacent to the chute.
(4) At the end of each work day, provisions should be made to assure that exposure fires are minimized. *(See 16.2.2.1.)*
(5) Trash chutes used in the interior of a building should be of noncombustible construction.
(6) The main artery of the chute should be as straight as practical to avoid accumulations or clogging within the chute.

[**241:**A.5.4.4.1]

16.2.2.4.2 Trash chutes used on the exterior of a building shall be of noncombustible construction, or protected in accordance with 16.2.2.4.3 through 16.2.2.4.6 if of combustible construction. [**241:**5.4.4.2]

16.2.2.4.3* The interior of combustible trash chutes shall be provided with not less than one temporary automatic sprinkler within a recess near the top of the chute. [**241:**5.4.4.3]

Δ **A.16.2.2.4.3** The temporary sprinkler or sprinklers are not required to comply with NFPA 13. Where trash chutes have a length exceeding 36 ft (11 m), intermittent levels of sprinkler protection should be provided at intervals not exceeding 36 ft (11 m). The use of fire retardant coatings can be substituted for sprinkler protection provided that the coating is compatible with the substrate, abrasion resistant, and approved by the AHJ. [**241:**A.5.4.4.3]

16.2.2.4.4 The temporary sprinkler required by 16.2.2.4.3 shall be protected by the recess as well as a listed sprinkler guard. [**241:**5.4.4.4]

16.2.2.4.5 The temporary sprinkler required by 16.2.2.4.3 shall be connected to any available water supply with a listed fire hose, or a flexible, commercial rubber hose, with a diameter of not less than ¾ in. (19 mm) and a listed flexible connector. [**241:**5.4.4.5]

16.2.2.4.6 The temporary sprinkler required by 16.2.2.4.3 shall be protected against freezing where required by the AHJ. [**241:**5.4.4.6]

Trash chutes can create a means for fire to travel from outside the building to the inside and from floor to floor. See the commentary following A.16.2.2.1.

16.2.3 Flammable and Combustible Liquids and Flammable Gases.

16.2.3.1 Storage.

16.2.3.1.1 Storage of flammable and combustible liquids shall be in accordance with Chapter 66, unless otherwise modified by 16.2.3. [**241:**5.5.1.1]

16.2.3.1.2* Storage of Class I and Class II liquids shall not exceed 60 gal (227 L) within 50 ft (15 m) of the structure. [**241:**5.5.1.2]

A.16.2.3.1.2 The reference to "structure" is intended to apply to those structures under construction, alteration, or demolition and not to temporary structures on the construction site. Additionally, existing properly protected storage within 50 ft (15 m) of the structure or inside an existing structure under alteration is not intended to be regulated by this provision. [**241:**A.5.5.1.2]

16.2.3.1.3 Storage areas shall be kept free of weeds, debris, and combustible materials not necessary to the storage. [**241:**5.5.1.3]

Weeds, debris, and other combustible materials are an avenue for fire spread to liquid and gas storage areas. See 10.13.10 for additional requirements regarding exterior vegetation.

16.2.3.1.4 Open flames and smoking shall not be permitted in flammable and combustible liquids storage areas. [**241:**5.5.1.4]

16.2.3.1.5 Such storage areas shall be appropriately posted as "No Smoking" areas. [**241:**5.5.1.5]

Δ **16.2.3.1.6** Storage areas shall be appropriately posted with markings in accordance with NFPA 704. [**241:**5.5.1.6]

16.2.3.2 Handling of Flammable and Combustible Liquids at Point of Final Use.

16.2.3.2.1 Handling of flammable and combustible liquids shall be in accordance with Chapter 66, except as modified by 16.2.3.2.2 through 16.2.3.2.4. [**241:**5.5.2.1]

16.2.3.2.2 Class I and Class II liquids shall be kept in approved safety containers. [**241:**5.5.2.2]

16.2.3.2.3 Means shall be provided to dispose of leakage and spills promptly and safely. [**241:**5.5.2.3]

16.2.3.2.4* Class I liquids shall be dispensed only where there are no open flames or other sources of ignition within the possible path of vapor travel. [**241:**5.5.2.4]

A.16.2.3.2.4 The vapors given off by flammable liquids generally have vapor densities greater than those of air. Therefore, these vapors tend to collect in low spots and travel at floor level. Being invisible, these vapors are difficult to detect without the aid of proper instruments designed specifically for the purpose. [**241:**A.5.5.2.4]

Proper ventilation is, therefore, important in the prevention of accidental ignition of these vapors. Proper ventilation can be accomplished by either natural or mechanical means. [**241:**A.5.5.2.4]

16.2.3.3 Storage and Handling of Combustible and Flammable Gases.

Δ **16.2.3.3.1** Storage and handling of combustible and flammable gases shall be in accordance with NFPA 54 and Chapter 69. [**241:**5.5.3.1]

16.2.3.3.2 Open flames and smoking shall not be permitted in flammable gas storage areas. [**241:**5.5.3.2]

Subsection 10.1.6 and Section 10.10 prescribe additional requirements related to open flames and smoking. The AHJ is authorized to prohibit any such activity wherever it poses a hazard.

16.3 Fire Protection

This section covers items that need to be in the fire protection program and apply throughout the duration of the project.

16.3.1 Fire Safety Program.

16.3.1.1 An overall construction or demolition fire safety program shall be developed.

Δ **16.3.1.2** All of the following items shall be addressed in the fire safety program:

(1) Good housekeeping
(2) On-site security
(3) Fire protection systems
  (a) For construction operations, installation of new fire protection systems as construction progresses
  (b) For demolition operations, preservation of existing fire protection systems during demolition
(4) Organization and training of an on-site fire brigade
(5) Development of a prefire plan with the local fire department
(6) Rapid communication
(7) Consideration of special hazards resulting from previous occupancies
(8) Protection of existing structures and equipment from exposure fires resulting from construction, alteration, and demolition operations

[**241:**7.1]

16.3.2 Owner's Responsibility for Fire Protection.

16.3.2.1* The owner shall designate a person who shall be responsible for the fire prevention program and who shall ensure that it is carried out to completion. [**241:**7.2.1]

A.16.3.2.1 One person should be made responsible for the protection of property from fire. This person should ensure that the proper procedures for controlling fire hazards are established and should have full authority to enforce them. [**241:**A.7.2.1]

The responsible person should be appointed by the owner. Where an entirely new structure is being constructed, the owner should ensure that specifications for new buildings contain a clause stating that the "contractor will take all reasonable precautions against fire in accordance with good fire protection engineering practice." [**241:**A.7.2.1]

The responsibility for loss prevention is the owner's. However, loss prevention recommendations normally are accomplished by the contractor. To ensure that recommendations are carried out promptly, the owner's assistance might be needed. [**241:**A.7.2.1]

Fire prevention education should be a topic at contractor safety meetings ("tailgate talks") at least once a month. Topics that could be discussed include maintaining clear access to fire-fighting equipment, reinforcing cutting and welding procedures, flammable liquids use and storage, use of first aid fire-fighting equipment, roofing operations, and precautions for the use of temporary heating equipment. [**241:**A.7.2.1]

All fires should be investigated by the program manager, and necessary fire prevention improvements that are identified by the investigation should be communicated to all employees as soon as possible. [**241:**A.7.2.1]

16.3.2.1.1 The fire prevention program manager shall have the authority to enforce the provisions of NFPA 241 and other applicable fire protection standards. [**241:**7.2.1.1]

16.3.2.1.2 The fire prevention program manager shall have knowledge of the applicable fire protection standards, available fire protection systems, and fire inspection procedures. [**241:**7.2.1.2]

16.3.2.1.3 Inspection records shall be available for review by the AHJ. [**241:**7.2.1.3]

The AHJ should inform the fire prevention program manager of all inspection records, which must be completed and made available for review. The records should be part of an organized filing system so that they are readily accessible.

16.3.2.2 Where guard service is provided, the fire prevention program manager shall be responsible for the guard service. [**241:**7.2.2]

NFPA 601, *Standard for Security Services in Fire Loss Prevention,* provides guidance for incorporating security services into the fire safety program.

16.3.2.3* Prefire Plans.

A.16.3.2.3 Large-scale construction sites change rapidly as construction progresses. The prefire plan should be flexible to allow for different stages of construction. Critical stages that should be considered include access, installation of water mains and fire hydrants, framing/exterior shell, roofing, covering of interior partitions, installation of fixed fire protection, concrete form work, installation of building systems, and construction safety hazards. [**241:**A.7.2.3]

Since construction projects do change, the local fire department should be encouraged to visit the site on a regular basis. Prefire plan visits should be scheduled by the manager at least semiannually and when there have been major revisions to the fire prevention plan. Since municipal fire departments work rotating shifts, a series of prefire plan visits might be necessary to allow all responding fire fighters an opportunity to visit the site. In rural areas and smaller cities, the local fire department might be a volunteer organization or might have only a small career fire fighter crew on duty during the day. It might be necessary for the manager to schedule the prefire plan visit during the evening hours to meet the needs of the local fire department. [**241:**A.7.2.3]

16.3.2.3.1 Where there is public fire protection or a private fire brigade, the manager shall be responsible for the development of prefire plans in conjunction with the fire agencies. [**241:**7.2.3.1]

16.3.2.3.2 Prefire plans shall be updated as necessary. [**241:**7.2.3.2]

16.3.2.3.3 The prefire plan shall include provisions for on-site visits by the fire agency. [**241:**7.2.3.3]

The fire department should tour the construction site during various stages of the project to become familiar with the layout and fire protection systems. The fire department should be notified of changes that could affect its response, such as changes to the building layout or the installation of new fire protection systems. All shifts should be included in the fire department tours to ensure that emergency responders are familiar with the project in the event of a fire.

16.3.2.4 Program Manager Responsibilities.

16.3.2.4.1 The manager shall be responsible for ensuring that proper training in the use of protection equipment has been provided. [**241:**7.2.4.1]

16.3.2.4.2 The manager shall be responsible for the presence of adequate numbers and types of fire protection devices and appliances and for their proper maintenance. [**241:**7.2.4.2]

16.3.2.4.3 The manager shall be responsible for supervising the permit system for hot work operations. *(See Section 5.1 of NFPA 241.)* [**241:**7.2.4.3]

See Chapter 41 for additional requirements related to welding, cutting, and other hot work operations.

16.3.2.4.4 A weekly self-inspection program shall be implemented, with records maintained and made available. [**241:**7.2.4.4]

16.3.2.4.5* Impairments to the fire protection systems or fire alarm, detection, or communications systems shall be authorized only by the fire prevention program manager. [**241:**7.2.4.5]

A.16.3.2.4.5 See NFPA *101* for impairments to fire protection systems or fire alarm, detection, or communication systems where required by that code. In addition, see *NFPA 72* for impairments resulting to fire alarm equipment and NFPA 25 for impairments resulting to water-based fire protection equipment. [**241:**A.7.2.4.5]

Where a fire protection system must be taken out of service to accommodate a project, only the portion of the system directly affected by the work should be shut down. The portion of the building rendered unprotected should be limited to the smallest area possible. The system should be returned to service at the end of the shift or the day where practical. Where a portion of a building's fire protection system is impaired and the remainder of the building is occupied, a fire watch might be required. See 13.3.3.6 for water-based fire protection system impairments and 13.7.1 for fire alarm system impairments.

16.3.2.4.6 Temporary protective coverings used on fire protection devices during renovations, such as painting, shall be removed promptly when work has been completed in the area. [**241:**7.2.4.6]

A designated person should be assigned to walk the construction site and ensure that no fire protection system component is damaged or otherwise impaired and that protective covers are removed following the completion of construction, alteration, or demolition operations.

16.3.2.5 Site Security.

16.3.2.5.1* Guard service shall be provided where required by the AHJ. [**241:**7.2.5.1]

A.16.3.2.5.1 Due to the growing threat of arson, guard service should be provided on major projects even where not required by the AHJ. The requirements for guard service also should be based on, but should not be limited to, the hazards at the site, the size of the risk, the difficulty of the fire-fighting situation, the exposure risk, and the physical security of the site. [**241:**A.7.2.5.1]

Δ **16.3.2.5.2*** Where guard service is provided, the guard(s) shall be trained in all of the following:

(1) Notification procedures that include calling the fire department and management personnel
(2) Function and operation of fire protection equipment
(3) Familiarization with fire hazards
(4) Use of construction elevators, where provided

[**241:**7.2.5.2]

Δ **A.16.3.2.5.2** It is recommended that areas in buildings should be patrolled at all times when construction, alteration, and demolition operations are not in progress by a competent guard registered on an approved security tour supervision system (watch clock) with stations covering all parts of the building in accordance with NFPA 601. Guard rounds should include all parts of the buildings and outside areas where hazardous equipment or materials are located. Rounds should be conducted every ½ hour for 2 hours after suspension of work for the day and every hour thereafter during the night and nonworking days and should include tours of all accessible work areas. [**241:**A.7.2.5.2]

Guards, where utilized, need to be familiar with and have access to a means to contact the fire department in the event of an emergency. They also need to be familiar with fire protection system locations and operations on site. If any specific fire hazards are present, such as certain construction operations, processes, or materials, guards should be familiar with the associated hazards so they can identify the hazards when notifying the fire department during an emergency.

Guards should have access to and the ability to operate construction elevators for emergency use. Security personnel should be trained in the use of portable fire extinguishers and the operation of any special fire protection features. They also should be provided with keys to permit access to all areas of the building.

16.3.2.5.3 Guards shall be informed of any special status of emergency equipment or hazards. [**241:**7.2.5.3]

16.3.2.5.4* Security fences shall be provided where required by the AHJ. [**241:**7.2.5.4]

A.16.3.2.5.4 The requirements for security fencing should be based on, but should not be limited to, the hazards at the site, the size of the risk, the difficulty of the fire-fighting situation, the exposure risk, and the presence of guard service. [**241:**A.7.2.5.4]

16.3.2.5.5* Entrances (e.g., doors and windows) to the structure under construction, alteration, or demolition shall be secured where required by the AHJ. [**241:**7.2.5.5]

A.16.3.2.5.5 Securing the openings (doors and windows) to the structure, where possible, reduces the chance of entry by unauthorized persons. This, in turn, reduces the chance of arson or accidental fires. It could, in some instances, eliminate the need for guard service or security fencing. It also helps prevent freezing or wind damage to fire protection equipment and prevents combustible material from being blown against heating devices and igniting. [**241:**A.7.2.5.5]

16.3.3* Fire Alarm Reporting.

A.16.3.3 In large projects or tall structures, or both, the use of an audible device for an evacuation signal in case of fire or other emergency is recommended. [**241:**A.7.4]

16.3.3.1 There shall be a readily available public fire alarm box near the premises, telephone service to the responding fire department, or equivalent facilities. [**241:**7.4.1]

16.3.3.2 Instructions shall be issued for the immediate notification of the fire department in the case of a fire. Where telephone service is employed, the local fire department number and site address shall be conspicuously posted near each telephone. [**241:**7.4.2]

Workers might not be permanently assigned to the construction project, and many different workers could be brought in daily. These workers might not know the address of the building or the emergency telephone numbers. A plan should be established to inform all workers of this information no matter when they come on the site or how long they will be there.

16.3.4 Access for Fire Fighting.

16.3.4.1 A suitable location at the site shall be designated as a command post and provided with plans, emergency information, keys, communications, and equipment, as needed. [**241:**7.5.1]

The construction trailer typically houses building plans, telephones, keys, tables and chairs, and other items and could be used as the command post required by 16.3.4.1. If the required items are scattered among numerous trailers, relocating the items to one trailer and designating it as the command post might be beneficial.

16.3.4.2 The person in charge of fire protection shall respond to the location command post whenever fire occurs. [**241:**7.5.2]

16.3.4.3 Where access to or within a structure or an area is unduly difficult because of secured openings or where immediate access is necessary for life-saving or fire-fighting purposes, the AHJ shall be permitted to require a key box to be installed in an accessible location. [**241:**7.5.3]

16.3.4.4 The key box shall be an approved type and shall contain keys to gain access as required by the AHJ. *(See Section 18.2.)* [**241:**7.5.4]

Access boxes are required by 18.2.2.1 to be listed in accordance with ANSI/UL 1037, *Standard for Antitheft Alarms and Devices*.

16.3.4.5 Stairs.

16.3.4.5.1 In all buildings over one story in height, at least one stairway shall be provided that is in usable condition at all times and that meets the requirements of NFPA *101*. [**241:**7.5.6.1]

16.3.4.5.2 This stairway shall be extended upward as each floor is installed in new construction and maintained for each floor still remaining during demolition. [**241:**7.5.6.2]

16.3.4.5.3 The stairway shall be lighted. [**241:**7.5.6.3]

Stairway illumination is important during construction and demolition operations. The power source for the lights should be reliable; it should not be subject to accidental disconnection or failure early in a fire. Stairway illumination should be maintained even when construction workers are not in the building, because fire fighters and security personnel might need to use the stairs to access upper stories during hours when construction is not taking place.

16.3.4.5.4 During construction, the stairway shall be enclosed where the building exterior walls are in place. [**241:**7.5.6.4]

16.3.4.5.5 All exit stairs shall be provided with stair identification signs to include the floor level, stair designation, and exit path direction as required to provide for safe egress. [**241:**7.5.6.5]

See 10.11.3 for detailed requirements regarding stairway identification signs.

16.3.5 Standpipes. In all new buildings in which standpipes are required or where standpipes exist in buildings being altered or demolished, such standpipes shall be maintained in conformity with the progress of building construction in such a manner that they are always ready for use. [**241:**7.6]

An operating standpipe system(s) is required to be extended or removed by floor as construction or demolition takes place. When a new floor is added and the stairs required by 16.3.4.5 are installed, the standpipe system is required to be extended at the same time. Conversely, when demolition is taking place, the standpipe is required to be removed floor by floor as floors are removed.

16.3.6* First-Aid Fire-Fighting Equipment.

A.16.3.6 Portable fire extinguishers, water pails, small hose lines, and 1.5 in. (38 mm) standpipe hose are considered first-aid fire-fighting equipment. To be effective, first-aid fire-fighting equipment should be used in the incipient stage of a fire. [**241:**A.7.7]

16.3.6.1* The suitability, distribution, and maintenance of extinguishers shall be in accordance with Section 13.6. [**241:**7.7.1]

A.16.3.6.1 A suitable number and type of spare fire extinguishers should be provided on site for immediate replacement of discharged fire extinguishers. [**241:**A.7.7.1]

Fire extinguishers should be suitable for the type of equipment and hazard. A single, multipurpose (A:B:C) dry chemical extinguisher that has a normal capacity of 5 lb (2.3 kg) of extinguishing agent and a rating of at least 2-A:10-B:C should be the minimum. However, a risk assessment should be performed to determine whether larger extinguishers or additional extinguishers are needed for specific conditions. Extinguishers should be mounted in conspicuous locations, in the vicinity of heating appliances, and on mobile equipment so that they are immediately available in case of fire. See Section 13.6 and NFPA 10, *Standard for Portable Fire Extinguishers*

16.3.6.2 Wherever a toolhouse, storeroom, or other shanty is located in or adjacent to the building under construction or demolition, or where a room or space within that building is used for storage, a dressing room, or a workshop, at least one approved extinguisher shall be provided and maintained in an accessible location, unless otherwise permitted by 16.3.6.3. [**241:**7.7.2]

16.3.6.3 The requirement of 16.3.6.2 shall be permitted to be waived where the structure does not exceed 150 ft^2 (14 m^2) in floor area or is equipped with automatic sprinklers or other approved protection. [**241:**7.7.3]

16.3.6.4 At least one approved fire extinguisher also shall be provided in plain sight on each floor at each usable stairway as soon as combustible material accumulates. [**241:**7.7.4]

16.3.6.5 Suitable fire extinguishers shall be provided on self-propelled equipment. [**241:**7.7.5]

Case Study

On August 18, 2007, two New York City fire fighters died, and another 115 were injured, in a fire that started on the 17th floor of the Deutsche Bank building, which was in the process of being deconstructed after sustaining heavy damage from the collapse of the World Trade Center towers on September 11, 2001. At the time of the fire, the former 41-story building had been reduced to 26 stories and was undergoing asbestos abatement. The fire was reportedly caused by smoking materials. Fire suppression efforts were hampered by the lack of functioning standpipes, which required fire fighters to stretch hose lines up to the fire floor from the ground. The operation was further complicated by a maze of polyethylene sheets, which had been installed to contain asbestos but which also served to contain smoke and hinder fire suppression. This fire vividly illustrates the need to maintain fire protection systems in accordance with NFPA 241 in buildings during demolition operations. (See Section 16.8 for details on asbestos removal.)

16.3.6.6* Free access to permanent, temporary, or portable first-aid fire equipment shall be maintained at all times. [**241:**7.7.6]

Δ **A.16.3.6.6** Clear and unobstructed access to all first-aid fire-fighting equipment should be maintained. Fire-fighting equipment also should be clearly visible from surrounding areas. If visibility to first-aid fire-fighting equipment is obstructed, signs in accordance with NFPA 170 should be installed to indicate the position of the fire-fighting equipment. [**241:**A.7.7.6]

16.4 Safeguarding Construction and Alteration Operations

16.4.1* Scaffolding, Shoring, and Forms.

A.16.4.1 Steel scaffolding or approved fire-retardant lumber and planking should be used on both the outside and inside of the structure. Construction materials (e.g., forms, shoring, bracing, temporary stairways, platforms, tool boxes, plan boxes, solvents, paints, tarpaulins, and similar items) should be of the noncombustible, fire-retardant, safety solvent, or high flash point type, as the case necessitates. A concerted effort should be made to attain as high a level of noncombustibility of materials as possible. *(See the definition of the term "fire retardant-treated wood" in the building code.)* [**241:**A.8.2]

16.4.1.1 Accumulations of unnecessary combustible forms or form lumber shall be prohibited. [**241:**8.2.1]

16.4.1.2 Combustible forms or form lumber shall be brought into the structure only when needed. [**241:**8.2.2]

16.4.1.3 Combustible forms or form lumber shall be removed from the structure as soon as stripping is complete. [**241:**8.2.3]

16.4.1.4 Those portions of the structure where combustible forms are present shall not be used for the storage of other combustible building materials. [**241:**8.2.4]

16.4.1.5* During forming and stripping operations, portable fire extinguishers or charged hose lines shall be provided to protect the additional combustible loading adequately. [**241:**8.2.5]

A.16.4.1.5 The AHJ should be contacted regarding the adequacy of water supplies for hose lines. [**241:**A.8.2.5]

Based on an evaluation of the potential fire loading, the AHJ should establish the level of fire suppression capability needed. Such capability should include the minimum hose stream flow where hose lines are provided. Consideration should be given to whether form work, shoring, or scaffolding materials are of ordinary wood materials or of steel or fire-retardant–treated wood materials. Fire-retardant–treated wood should comply with NFPA 703, *Standard for Fire-Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials*.

16.4.2 Temporary Separation Walls.

16.4.2.1 Protection shall be provided to separate an occupied portion of the structure from a portion of the structure undergoing alteration, construction, or demolition operations when such operations are considered as having a higher level of hazard than the occupied portion of the building. [**241:**8.6.2.1]

The intent of 16.4.2.1 is to provide a fire barrier between the construction area and the normally occupied portion of the building where the AHJ determines such construction activities pose a hazard to building occupants. The barrier protects against fire spread from the construction area to the occupied portion of the building and also prevents occupants from entering the construction area and consequently subjecting themselves to potential hazards created by construction activities.

16.4.2.2 Walls shall have at least a 1-hour fire resistance rating. [**241:**8.6.2.2]

16.4.2.3 Opening protectives shall have at least a 45-minute fire protection rating. [**241:**8.6.2.3]

Doors leading to construction areas are often made of plywood or other inexpensive materials. Where a fire barrier is required to separate the construction area from the remainder of the building, doors in the barrier must have a 45-minute fire protection rating. A plywood door has no fire protection rating. Rated doors must be labeled, self-closing, and positive-latching. See NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, for further details.

Where a portion of the building is walled off for construction purposes, it is important to ensure that means of egress from occupied portions of the building are not compromised. For example, where access to a required exit stair requires travel through a construction area, alternative egress provisions or other protection measures might be required. See Chapter 43 of NFPA *101*®, *Life Safety Code*®, for further details on building rehabilitation.

16.4.2.4* Nonrated walls and opening protectives shall be permitted when an approved automatic sprinkler system is installed. [**241:**8.6.2.4]

A.16.4.2.4 Construction tarpaulins would not be considered appropriate barriers or opening protectives. [**241:**A.8.6.2.4]

Such barriers must be structural in nature and securely fastened at the top and the bottom to structural components of the building.

16.4.3 Fire Protection During Construction.

16.4.3.1 Water Supply.

16.4.3.1.1* A water supply for fire protection, either temporary or permanent, shall be made available as soon as combustible material accumulates. [**241:**8.7.2.1]

A.16.4.3.1.1 No minimum water supply is specified due to the wide range of construction types, sites, and sizes. However, unless combustibles are essentially nonexistent in the completed structure and occupancy, a minimum of 500 gpm (1893 L/min) should be provided. In most instances, the required supply is greater, and AHJs should be consulted. [**241:**A.8.7.2.1]

See Section 18.3 through 18.5 for additional details on water supply and fire hydrant locations and distribution.

16.4.3.1.2 There shall be no delay in the installation of fire protection equipment. *(See A.16.4.1.5.)* [**241:**8.7.2.2]

Where the installation of the permanent water supply is delayed, the contractor should coordinate with the AHJ to ensure that the temporary fire protection water supply is adequate for the hazards present at the site.

16.4.3.1.3* Where underground water mains and hydrants are to be provided, they shall be installed, completed, and in service prior to commencing construction work on any structure. [**241:**8.7.2.3]

A.16.4.3.1.3 It is not intended to prohibit the construction of noncombustible structure foundation elements, such as foundations and footings, prior to the completion of underground water mains and hydrants. [**241:**A.8.7.2.3]

Planned underground water mains and hydrants serving the building site must be installed and in service prior to the start of the construction of the building. If the water for fire protection is provided by some other means, such as a water truck, such alternative water source must be available prior to the start of construction on the site. The *Code* does not intend to prohibit site work prior to the installation of the fire protection water supply.

16.4.3.2 Sprinkler Protection.

16.4.3.2.1* If automatic sprinkler protection is to be provided, the installation shall be placed in service as soon as practicable. [**241:**8.7.3.1]

A.16.4.3.2.1 With proper scheduling and contracting, it is possible for the sprinkler installation to follow the building construction closely as it progresses. This is frequently done in multiple-story buildings to facilitate protection on the lower floors before the upper floors have been built. [**241:**A.8.7.3.1]

16.4.3.2.2 The details of installation shall be in accordance with NFPA 13. [**241:**8.7.3.2]

16.4.3.2.3 Where sprinklers are required for safety to life, the building shall not be occupied until the sprinkler installation has been entirely completed and tested so that the protection is not susceptible to frequent impairment caused by testing and correction, unless otherwise permitted by 16.4.3.2.4. [**241:**8.7.3.3]

There are times when buildings that are still under construction are given temporary or partial certificates of occupancy for specified areas in which construction has been completed. Where the sprinkler system is required for life safety (i.e., required by this *Code* or NFPA *101*), the entire building sprinkler system should be installed, tested, and accepted prior to issuance of the temporary or partial certificate of occupancy. If the system is not complete prior to occupancy, it will be impaired frequently to complete installation, rendering the building and its occupants unprotected.

16.4.3.2.4 The provision of 16.4.3.2.3 shall not prohibit occupancy of the lower floors of a building, even where the upper floors are in various stages of construction or protection, provided that both of the following conditions are satisfied:

(1) The sprinkler protection of the lower occupied floors has been completed and tested in accordance with 16.4.3.2.3.
(2) The sprinkler protection of the upper floors is supplied by entirely separate systems and separate control valves so that the absence or incompleteness of protection in no way impairs the sprinkler protection of the occupied lower floors.

[**241:**8.7.3.4]

16.4.3.2.5 The operation of sprinkler control valves shall be permitted only by properly authorized personnel and shall be accompanied by the notification of duly designated parties. [**241:**8.7.3.5]

See 13.3.3.4.1.11 and NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, for additional requirements pertaining to automatic sprinkler system impairments.

16.4.3.2.6 Where the sprinkler protection is regularly turned off and on to facilitate connection of newly completed segments, the sprinkler control valves shall be checked at the end of each work shift to ascertain that protection is in service. [**241:**8.7.3.6]

16.4.3.3 Standpipes.

16.4.3.3.1 General.

16.4.3.3.1.1* The pipe size, hose valves, hose, water supply, and other details for new construction shall be in accordance with Section 13.2. [**241:**8.7.4.1.1]

A.16.4.3.3.1.1 Threaded plugs should be inserted in fire department hose connections, and they should be guarded properly against physical damage. [**241:**A.8.7.4.1.1]

16.4.3.3.1.2 On permanent Type II and Type III standpipes, hose and nozzles shall be provided and made ready for use as soon as the water supply is available to the standpipe, unless otherwise permitted by 16.4.3.3.1.3. [**241:**8.7.4.1.2]

16.4.3.3.1.3* In combined systems where occupant hose is not required, temporary hose and nozzles shall be provided during construction. [**241:**8.7.4.1.3]

A.16.4.3.3.1.3 The intent of this provision is to permit the permanent standpipes to be used as temporary standpipes during construction. [**241:**A.8.7.4.1.3]

16.4.3.3.2 Standpipe Installations in Buildings Under Construction. Where required by the AHJ, in buildings under construction, a standpipe system, either temporary or permanent in nature, shall be installed in accordance with 16.4.3.3.2.1 through 16.4.3.3.2.10. [**241:**8.7.4.2]

16.4.3.3.2.1 The standpipes shall be provided with conspicuously marked and readily accessible fire department connections on the outside of the building at the street level and shall have at least one standard hose outlet at each floor. [**241:**8.7.4.2.1]

Standpipe systems must be installed in stairways as required by 16.4.3.3 and marked for easy identification. A fire department connection must be provided, must be conspicuously marked, and must be kept clear of debris and other items in accordance with 13.1.3 and 13.1.4.

16.4.3.3.2.2 The pipe sizes, hose valves, hose, water supply, and other details for new construction shall be in accordance with NFPA 241. [**241:**8.7.4.2.2]

16.4.3.3.2.3 The standpipes shall be securely supported and restrained at each alternate floor. [**241:**8.7.4.2.3]

16.4.3.3.2.4* At least one approved hose valve for attaching fire department hose shall be provided at each intermediate landing or floor level in the exit stairway, as determined by the AHJ. [**241:**8.7.4.2.4]

A.16.4.3.3.2.4 A substantial box, preferably of metal, in which a sufficient amount of hose to reach all parts of the floor, appropriate nozzles, spanner wrenches, and hose straps are kept should be maintained at the highest hose outlet. [**241:**A.8.7.4.2.4]

16.4.3.3.2.5 Valves shall be kept closed at all times and guarded against mechanical injury. [**241:**8.7.4.2.5]

Δ **16.4.3.3.2.6** Hose valves shall have NH standard external threads for the valve size specified in accordance with NFPA 1963 unless modified by 16.4.3.3.2.7. [**241:**8.7.4.2.6]

16.4.3.3.2.7 Where local fire department connections do not conform to NFPA 1963, the AHJ shall designate the connection to be used. [**241:**8.7.4.2.7]

16.4.3.3.2.8* The standpipes shall be extended up with each floor and shall be securely capped at the top. [**241:**8.7.4.2.8]

A.16.4.3.3.2.8 A supply of fire hose and nozzles should be ordered in advance so that it is available as soon as the standpipes are ready. Hose lines should be connected in areas where construction is in progress. [**241:**A.8.7.4.2.8]

16.4.3.3.2.9 Top hose outlets shall be not more than one floor below the highest forms, staging, and similar combustibles at all times. [**241:**8.7.4.2.9]

16.4.3.3.2.10 Temporary standpipes shall remain in service until the permanent standpipe installation is complete. [**241:**8.7.4.2.10]

16.4.4 Alteration of Buildings.

16.4.4.1 Where the building is protected by fire protection systems, such systems shall be maintained operational at all times during alteration.

16.4.4.2 Where alteration requires modification of a portion of the fire protection system, the remainder of the system shall be kept in service and the fire department shall be notified.

16.4.4.3 When it is necessary to shut down the system, the AHJ shall have the authority to require alternate measures of protection until the system is returned to service.

16.4.4.4 The fire department shall be notified when the system is shut down and when the system is returned to service.

See 13.3.3.4.1.5, 13.3.3.4.1.11, 13.3.3.6, and NFPA 25 for additional requirements pertaining to water-based fire protection system impairments. See 13.7.1.5 and *NFPA 72®, National Fire Alarm and Signaling Code*, for fire alarm system impairments.

16.4.4.5 All required exit components shall be maintained in accordance with this *Code* as deemed necessary by the AHJ.

16.4.4.6 Fire-resistive assemblies and construction shall be maintained.

16.5 Fire Safety During Demolition

16.5.1 If a building intended to be demolished contains a sprinkler system, such system shall not be rendered inoperative without approval of the AHJ.

The intent of 16.5.1 is to ensure that the responding fire suppression forces know that the building is no longer protected by an automatic sprinkler system. Emergency responders can then appropriately revise their tactical approach to a fire in the building. The sprinkler system should be maintained in service until the actual demolition begins and should not be shut off days or weeks before the start of the demolition process. If the building is to be demolished in sections and the protection in certain sections can be maintained during the demolition of other sections, such protection should be maintained for as long as possible.

16.5.2 Demolition operations involving the use of cutting and welding shall be done in accordance with Chapter 41.

16.5.3 Combustible waste material shall not be burned at the demolition site unless approved by the AHJ. Combustible materials shall be removed from the site as often as necessary to minimize the hazards therefrom. *(See 16.2.2 and Section 10.10.)*

See Section 10.10 for open burning requirements.

16.5.4 Where in the opinion of the AHJ the demolition site is of a hazardous nature, qualified personnel shall serve as an on-site fire watch.

16.6 Torch-Applied Roofing Systems

16.6.1 Permits. Permits, where required, shall comply with Section 1.12.

Δ **16.6.2** Torch-applied roofing systems shall be installed in accordance with Chapter 9 of NFPA 241.

16.7 Tar Kettles and Rubberized Asphalt Melters

16.7.1 General.

16.7.1.1 The provisions of Section 16.7 shall apply to any type of equipment including, but not limited to, chassis-mounted equipment used for preheating or heating tar, asphalt, rubberized asphalt, pitch, or similar substances for roofs, floors, pipes, or similar objects.

Equipment addressed in Section 16.7 includes tar kettles and rubberized asphalt melters.

16.7.1.2 Permits. Permits, where required, shall comply with Section 1.12.

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Section 1.12 of this *Code* gives the AHJ the authority to issue permits for tar kettles.

N **16.7.2 Tar Kettles.**

N **16.7.2.1** Operating kettles shall not be located inside of or on the roof of any building.

Tar and asphalt kettles must be located outdoors, away from combustibles. Uninsulated fuel containers must be kept at least 10 ft (3 m) from the burner flame and should be secured to prevent them from tipping or falling over. Kettles are not permitted to be operated on the roofs of buildings.

16.7.2.2 Tar Kettle Location. The kettle shall be operated in a controlled area. The area shall be identified by the use of traffic cones, barriers, and other suitable means as approved by the AHJ.

The area in which tar kettles are operating should be protected from entry by unauthorized persons. Protection is best accomplished by fencing. Rope, tape, or other barriers can be used with the approval of the AHJ. In addition, warning signs should be posted if the kettle is in an area that is easily accessible to the public.

16.7.2.3 Kettle Supervision.

16.7.2.3.1 An operating kettle shall be attended by a minimum of one employee who is knowledgeable of the operations and hazards.

16.7.2.3.2 The employee shall be within 25 ft (7.6 m) of the kettle and shall have the kettle within sight.

At least one attendant familiar with the operation of the kettle needs to be within 25 ft (7.6 m) of an operating kettle at all times. It is the attendant's responsibility to ensure that no unauthorized personnel enter the control area, to monitor the kettle, to extinguish fires, and to perform other necessary duties. Although the *Code* does not specify where within the required distance this attendant must be located, the designated individual should be on the ground, rather than on a ladder or a roof, in order to effectively perform the required duties.

16.7.2.4 Fire Extinguishers.

16.7.2.4.1 Two approved 4-A:40-B:C fire extinguishers shall be provided and maintained within 25 ft (7.6 m) of the operating kettle.

Fire extinguishers are to be maintained at the site and are not to be kept on a vehicle that might be away from the site when a fire extinguisher is needed. The AHJ should specify where and how the extinguishers are to be stored, giving consideration to the site and the need to quickly access the extinguishers without having to pass by a burning kettle. If a fire extinguisher is used, it should be recharged or replaced immediately so an extinguisher is available in the event of another fire.

16.7.2.4.2* A minimum of one approved 4-A:40-B:C fire extinguisher shall be provided and maintained on the roof in close proximity to the roofing operations while the roofing material is being applied.

A.16.7.2.4.2 Appropriate means should be provided to prevent portable fire extinguishers from damage and secured from falling when roofing operations are being conducted.

16.7.2.4.3 Fire extinguishers shall be mounted in an accessible and visible or identified location.

16.7.2.5 Exits.

16.7.2.5.1 Roofing kettles shall not block exits, means of egress, gates, roadways, or entrances.

16.7.2.5.2 Kettles shall not be closer than 10 ft (3 m) from exits or means of egress.

16.7.2.6 Fuel System.

16.7.2.6.1 Fuel containers shall be constructed and approved for the use for which they were designed.

16.7.2.6.2 Liquefied petroleum gas (LP-Gas) containers, hose, regulators, and burners shall conform to the requirements in Chapter 69.

16.7.2.6.3 LP-Gas cylinders shall be secured to prevent accidental tipover.

16.7.2.7 Regulators shall be required on any cylinders.

16.7.2.8 Where, in the opinion of the AHJ, physical damage to the container is a danger, protection shall be provided to prevent such physical damage.

If the location of a tar kettle makes it susceptible to being hit by passing traffic, physical barriers acceptable to the AHJ should be provided to protect the fuel container and workers.

16.7.2.9 LP-Gas containers for roofing kettles shall not be used in any building.

16.7.2.10 Maintenance.

16.7.2.10.1 Roofing kettles and all integral working parts shall be in good working condition and shall be maintained free of excessive residue.

16.7.2.10.2 All piping used for pumping heated material to the roof shall be installed in a manner to prevent loss of heated material.

The requirement of 16.7.2.10.2 is intended to ensure that joints between lengths of piping are tight and that the piping is adequately supported so that it is not in danger of breaking or collapsing, particularly in long vertical runs.

16.7.2.10.3 Flexible steel piping shall not be used on the vertical extension of piping systems.

16.7.2.10.4 Flexible steel piping shall be limited to those connections that are immediately adjacent to the pump kettle or discharge outlet.

16.7.2.10.5 No single length of flexible piping shall exceed 6 ft (1.8 m) in length, and all piping shall be able to withstand a pressure of at least four times the working pressure of the pump.

16.7.2.11 Roofing Kettle Doors.

16.7.2.11.1 All roofing kettles shall have doors permanently attached.

16.7.2.11.2 Roofing kettle doors shall be installed in a workmanlike manner and shall be provided with handles that allow them to be opened without the operator having to stand in front of same.

Roofing kettle doors are an integral part of providing for the extinguishing of a kettle fire. These doors should be in good operating condition, be free of residue, and close tightly.

16.7.2.11.3 All kettles shall have an approved, working visible temperature gauge that indicates the temperature of the material being heated.

16.7.2.12 All kettle doors shall be tightly closed and latched when in transit.

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N **16.7.2.13 Construction.**

16.7.2.13.1 The materials and methods of construction of roofing kettles shall be acceptable to the AHJ.

16.7.2.13.2 Minimum Requirements.

16.7.2.13.2.1 Paragraph 16.7.2.13.2 shall apply to all roofing kettles or tar pots in excess of 1 gal (3.8 L) capacity.

16.7.2.13.2.2 No roofing kettle shall have a capacity in excess of 5 barrels (bbl).

16.7.2.13.2.3 Roofing kettles of 2 bbl capacity or less shall be constructed of steel sheet having a thickness of not less than 0.105 in. (No. 12 Manufacturers' Standard Gauge). Kettles of more than 2 bbl capacity shall be constructed of steel sheet having a thickness of not less than 0.135 in. (No. 10 Manufacturers' Standard Gauge). All supports, corners, and the top and bottom of the fire box shall be bound with angle iron or other reinforcements approved by the AHJ. All doors shall be hinged, closely fitted, and adequately latched. Fire boxes shall be of sufficient height from the ground or shall be provided with a system of shields or insulation to prevent heat damage to the street surface.

16.7.2.13.2.4 Lids that can be gravity operated shall be provided on all roofing kettles. The tops and covers of all kettles shall be constructed of steel sheet having a thickness of not less than 0.075 in. (1.90 mm) (No. 14 Manufacturers' Standard Gauge) that is close fitting and attached to the kettle with hinges that allow gravity to close the lid.

16.7.2.13.2.5 The chassis shall be substantially constructed and capable of carrying the load imposed upon it whether it is standing still or being transported.

16.7.2.13.2.6 Fuel containers, burners, and related appurtenances of roofing kettles in which LP-Gas is used for heating shall comply with all the requirements of Chapter 69.

16.7.2.13.2.7 Fuel containers that operate under air pressure shall not exceed 20 gal (76 L) in capacity and shall be subject to the approval of the AHJ.

16.7.2.13.2.8 All fuel containers shall be maintained in accordance with applicable NFPA codes and standards or shall be at least 10 ft (3 m) from the burner flame or at least 2 ft (0.6 m) therefrom when properly insulated from heat or flame.

N **16.7.3 Rubberized Asphalt Melters for Roof Deck Systems.**

Section 16.7.3 is new to the 2018 edition of the *Code*. Section 16.7 was reorganized to include 16.7.1 for general requirements and the past requirements for tar kettles became 16.7.2. The addition of new 16.7.3 is important in distinguishing the differences between safe use of torches or tar kettles and rubberized asphalt melters on roof decks. Both operations need safeguards against the potential for fire, but with different constraints. The reorganized Section 16.7 separates out rubberized asphalt melters for use on roof decks brings with it recognition of fire safety as a part of that process.

Rubberized asphalt melters are defined in 3.3.231 as "Portable equipment used for the heating of rubberized asphalt material that is a mix of asphalt, rubber polymer, and filler material." They operate and perform differently from tar kettles. Importantly, the fuel used to provide indirect heating to the rubberized asphalt melter is diesel. There are temperature controls inherent in melters in part due to the need to maintain the roofing material at 350 to 380 degrees F. Overheating into the temperature range of ordinary combustibles makes the rubberized asphalt product unsuitable for roof deck application. Because of the lower application temperature on noncombustible roof decks the opportunity for fire with this method is greatly decreased when compared to tar kettles and torches.

The new text for rubberized asphalt melters provides important differentiations from the more hazardous operations involving open flames and tar kettles.

N **16.7.3.1 General.**

N **16.7.3.1.1** Fully enclosed chassis-mounted and portable rubberized asphalt melters shall comply with 16.7.3.

N **16.7.3.1.2** Fully enclosed chassis-mounted and portable rubberized asphalt melters for heating a mix of asphalt and inert material for application on roof decks shall use an indirect method of heating that complies with all of the following:

(1) The heating system shall use a fully enclosed oil or air system that transfers heat from a burner to the oil or air around the outside of a material vat which then heats the rubberized material.

(2) The material vat shall not be subject to direct burner or flame impingement.
(3) The temperature rise in the material vat shall be gradual and controlled.

N **16.7.3.2 Permits.**

N **16.7.3.2.1** Permits, where required, shall comply with Section 1.12.

N **16.7.3.2.2** Permits for the operation of a rubberized asphalt melter on a roof deck shall not be deemed a permit for torches or burners. Any use of torches or burners will require a separate permit.

N **16.7.3.3 Rubberized Asphalt Melter Location.** The melter shall be located and operated in a controlled area identified by the use of traffic cones, barriers, and other suitable means as designated by the AHJ.

N **16.7.3.3.1** Melters shall not be located or operated on combustible roof decks.

N **16.7.3.3.2** The design load of the roof deck shall be capable of supporting the weight of the melter when loaded to capacity with rubberized asphalt material. The design load of the roof deck shall be as determined on building drawings or by a design professional acceptable to the AHJ.

N **16.7.3.3.3** Melters shall be chocked in place on the roof deck at locations identified by the design professional and acceptable to the AHJ.

N **16.7.3.3.4** Rubberized asphalt cakes for use in melters shall be located on the roof at a location agreed upon by the design professional and the AHJ.

N **16.7.3.3.5** Rubberized asphalt melters shall not be located inside of any building.

N **16.7.3.4 Exits.**

N **16.7.3.4.1** Melters shall not block exits or a means of egress or escape to an exit.

N **16.7.3.4.2** Melters shall not be closer than 10 ft from exits.

N **16.7.3.5 Fire Extinguishers.**

N **16.7.3.5.1** Two approved 4-A:40-B:C fire extinguishers shall be provided and maintained within 25 ft of the melter.

N **16.7.3.5.2** A minimum of one approved 4-A:40-B:C fire extinguisher shall be provided in close proximity to the roofing material application.

N **16.7.3.5.3** Each worker shall be instructed on the proper use of fire extinguishers and in the event of a fire to turn off all Melter engines and burners and notify the fire department.

N **16.7.3.6 Melter Operation.**

N **16.7.3.6.1** Melters shall be operated according to manufacturer instructions. Melters shall operate using integral control systems that include shut off controls for the diesel fired burner and temperature controls for the oil system and the material vat.

N **16.7.3.6.2** The diesel burner shall fire into an oil or air jacketed tank for uniform transfer.

N **16.7.3.6.3** Melters shall have melter lids permanently attached and closed at all times during operation.

N **16.7.3.7 Melter Supervision.**

N **16.7.3.7.1** An operating melter shall be constantly attended by an employee who is knowledgeable and solely dedicated to the operation of the equipment and associated hazards.

N **16.7.3.7.2** The employee shall be within 25 ft of the melter and shall have the melter within sight.

N **16.7.3.7.3** The employee shall remain in the area of the melter for a minimum of one-hour after the device is shut down.

N **16.7.3.7.4** The roofing contractor shall have the capability to immediately notify the fire department of an emergency on the site.

N **16.7.3.8 Fuel System.**

N **16.7.3.8.1** Fuel containers shall be constructed and approved for the use for which they were designed. Melter fuel tanks shall be attached to the frame of the melter.

N **16.7.3.8.2** Melters shall be diesel fuel or electrically powered.

N **16.7.3.8.3** Portable fuel tanks shall not be utilized to power melters.

N **16.7.3.8.4** Diesel tanks and engines integral to melters shall be maintained in accordance with manufacturer instructions.

N **16.7.3.8.5** Refueling of diesel tanks shall be performed when the melter is off.

N **16.7.3.8.5.1** A refueling and spill prevention plan acceptable to the AHJ shall be utilized.

N **16.7.3.8.5.2** Refueling shall be conducted using approved safety cans.

N **16.7.3.8.5.3** No open flames shall be present within 20 ft of the refueling operation.

N **16.7.3.9 Maintenance.** Melters and all integral working parts shall be in good working condition and shall be maintained free of excessive residue.

N **16.7.3.10 Minimum Requirements.**

N **16.7.3.10.1** Melters shall be operated as a complete unit as designed and built by the manufacturer. Field changes that override controls or safety features shall not be permitted.

N **16.7.3.10.2** Material vats on melters shall have a capacity of 230 gal or less. Material vats shall be a permanent integral part of the melter unit.

N **16.7.3.10.3** The melter chassis shall be substantially constructed and capable of carrying the load imposed upon it whether it is standing still or being transported.

16.8 Asbestos Removal

16.8.1 Notification. The AHJ and the fire department shall be notified 24 hours prior to the commencement and closure of asbestos removal operations.

Due to the blocking of egress, location of containment areas, accumulation of materials, and housekeeping issues, the fire department should be notified when asbestos removal is scheduled to take place. Asbestos removal is also a safety issue both for fire fighters and for anyone in the vicinity when it is airborne with the likelihood of being inhaled.

16.8.2 Permits. Permits, where required, shall comply with Section 1.12.

16.8.3 Signs. Approved signs shall be posted at the entrance, exit and exit access door, decontamination areas, and waste disposal areas for asbestos removal operations.

16.8.3.1 The signs shall state that asbestos is being removed from the area, that asbestos is a suspected carcinogen, and that proper respiratory protection is required.

16.8.3.2 Signs shall have a reflective surface, and lettering shall be a minimum of 2 in. (51 mm) high.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.
NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2017 edition.
NFPA 51B, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 2018 edition.
NFPA 72®, *National Fire Alarm and Signaling Code®*, 2016 edition.
NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2016 edition.
NFPA *101®*, *Life Safety Code®*, 2018 edition.
NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, 2013 edition.
NFPA 601, *Standard for Security Services in Fire Loss Prevention*, 2015 edition.
NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, 2015 edition.
NFPA 703, *Standard for Fire-Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials*, 2018 edition.

ANSI/UL 1037, Standard for Antitheft Alarms and Devices, 1999, Revised 2016, Underwriters Laboratories Inc., Northbrook, IL.

Wildland Urban Interface

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"A person's home is his or her castle." There is a sense of accomplishment, a sense of pride, and truly a sense of ownership, and little can be done to take it away, by law or other means — except by catastrophe. In a discussion about permanent damage to a home caused by nature, typically hurricanes, earthquakes, and tornadoes top the list with the most devastating effects. However, there are many people who would add wildfires to the list of nature's worst.

The evidence suggests otherwise. Yes, the number of wildland fires across North America and the world are on the increase; yes, some are started "naturally," that is, by lightning strikes; and yes, the number of acres of lost property in on the rise, but so-called natural wildfires are minimal and in most cases not the ones that cause the greatest damage. Human-caused fires in the wildland are responsible for at least 80 percent of the fires in the United States in recent years. Fires caused by out-of-control campfires, careless disposal of smoking material, improper prescribed burns, and arson are all preventable human causes of wildfires.

Homeowners can still help themselves to better protect their "castles" and their families to understand how wildland-urban fire disasters occur, how homes can ignite related to ignition zones, the factors that increase ignition potential, and recommendations to mitigate the wildfire potential all contribute to a safe home environment. NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildland Fire*, provides minimum requirements for planning, construction, maintenance, education, and management elements for the protection of life and property in areas where wildland fire poses a potential threat to structures.

Traditional fire responses have not reduced home fire losses in the wildland. Research and observations have challenged the premise of home ignition during wildfires. Applying new knowledge and implementing new approaches can more effectively reduce the loss of structures. Considerable research has been spent on conducting, evaluating, and formulating realistic recommendations and communicating those findings to homeowners.

Wildland fires are a natural disturbance. The following factors should be considered in any discussions that address wildfire control:

1. Wildland fire occurrence is inevitable.
2. Most ecosystems in the United States were developed with and were maintained by fire.
3. Grazing, agriculture, urban development, and the fire exclusion policy, along with elimination of aboriginal burning, has greatly reduced and changed wildland fire occurrence.
4. Ecologically significant wildland fires now largely occur during extreme wildfire conditions.

So, how do we define the problem in order to prevent residential fire disasters? Recent thinking suggests preventing wildland fire disasters largely through control and structure protection. Recent research indicates that home ignition during extreme wildfires is determined primarily by the conditions of the home in relation to its immediate surroundings. An effective home ignition zone plan approach can prevent home destruction during extreme wildfires.

The Firewise Communities Program, an NFPA project cosponsored by the USDA Forest Service, the U.S. Department of the Interior, and the National Association of State Foresters, offers training programs on managing wildland fire risk to the public and to fire protection professionals, both online and through workshops. Visit www.firewise.org for the most current information on managing wildland fire risk. In addition, NFPA offers a professional, two-day, on-site training course on assessing wildland fire hazards to structures. For more information, search for "Assessing Structure Ignition Potential from Wildfire" on NFPA's website, www.nfpa.org.

17.1 General

Δ The planning, construction, maintenance, education, and management elements for the protection of life and property from wildfire shall meet the requirements of this chapter and NFPA 1144.

NFPA 1144 offers fundamental criteria for fire agencies, land use planners, architects, developers, and local governments that formulate areas of property and land use development that might be threatened by wildfire. NFPA 1144 provides a methodology for assessing wildland fire ignition hazards around existing structures, residential developments, and subdivisions as well as for evaluating improved property or planned property improvement that is to be located in a wildland/urban interface area. The standard provides minimum requirements for new construction, grounded on science-based testing research, to reduce the potential of structure ignition from wildland fires.

17.1.1 In cases in which the local jurisdiction declares that an area within the jurisdiction is a wildland urban interface as determined by an assessment tool based upon accepted fire services practices, or where new structures will be located in a wildland/urban interface or intermix area, the AHJ shall perform, or cause to be performed, a wildland fire hazard assessment of each structure ignition zone in the development to determine relative risk, the extent of wildland fire hazard, and applicable mitigation measures.

Individuals conducting structure assessments in accordance with NFPA 1144 are encouraged to meet the qualifications of Wildland/Urban Interface Protection Specialist or Wildland/Urban Interface Coordinator in accordance with the job performance requirements (JPRs) found in NFPA 1051, *Standard for Wildland Firefighting Personnel Professional Qualifications*.

Δ **17.1.2*** The structure assessment shall, at a minimum, include the following:

(1) Identification and documentation of the wildland fire hazards in the ignition zone(s) for each structure within wildland fire hazard areas, according to the elements and conditions in 17.1.4
(2) Determination of mitigation measures for vegetation, other combustibles, and the structure, including the periodic maintenance associated with such measures
(3) Establishment of priorities relative to mitigating the risks from wildland fire
(4) Evaluation of the site for conflagration hazards associated with the property to provide information for fire operations strategies should the site or surrounding properties become involved with fire.

[**1144:**4.1.2]

Assessment of the site, including property and structures, should be reinforced at every opportunity, so fire protection agencies can determine risks and thus allow for the most desirable outcomes.

Δ **A.17.1.2** Figure A.17.1.2 and Table A.17.1.2 are examples of two different approaches to hazard assessment. [**1144:**A.4.1.2]

Figure A.17.1.2 is an example of an assessment guide with assessment information based on observation of the areas around the structure. This form, intended to be given to the resident, can be very useful by indicating the most serious hazards and the mitigation recommendation(s) that can be taken to reduce the ignition hazard. In this example, samples of the kind of information noted in an assessment are given as observations and suggestions for mitigation. [**1144:**A.4.1.2]

This example of an assessment guide is designed to help determine how vulnerable the structure will be during a wildland fire and to convey to the resident those items that should be corrected (mitigated) so that their home will have a better chance to survive a wildland fire. This form is offered as an example of the kind of tool that might be useful during a site visit as a guide for assessing the structure ignition zone. Remember, the following assessment items are for *prevention/mitigation* measures to be done *well in advance* of wildland fire season. [**1144:**A.4.1.2]

Figure A.17.1.2 is a form used to document observations, collect data, provide a hazard assessment, and give mitigation recommendations for the resident. From the mitigation recommendations, a mitigation plan and schedule is developed in accordance with 17.1.10. For more information on the use of this assessment form, refer to the course *Assessing Wildfire Hazards in the Home Ignition Zone*, available from the national Firewise Communities Program (www.firewise.org). [**1144:**A.4.1.2]

Table A.17.1.2 is a modified rating form based on the previous edition of NFPA 1144. Infrastructure elements of water supply, signage, and other fire suppression resources have been deleted, since the presence or absence of such resources does not modify the existing hazards of the structure. The table is presented only as an example of a rating system and should be modified to meet the environmental conditions of the area under consideration. For more information on creating an assessment system, consult *Wildland/Urban Interface Fire Hazards: A New Look at Understanding Assessment Methodologies Pamphlet*, produced by the national Firewise Communities Program (www.firewise.org). [**1144:**A.4.1.2]

A numeric rating form that will yield a hazard rating number can have a variety of uses, for example, determining relative hazards among several properties and mapping overall hazard ratings on a map. However, residents and homeowners often accept the rating number as finite and undertake mitigation measures that will merely reduce the rating rather than actually reduce the ignition potential of the structure. [**1144:**A.4.1.2]

17.1.3 The wildland fire hazard assessment shall be the basis for recommended mitigation measures relative to the vegetation, other combustibles, and structures on the site. [**1144:**4.1.3]

17.1.4* Structure Assessment Elements and Conditions. As a minimum, the structure assessment shall cover elements and conditions indicated in 17.1.5 through 17.1.9. [**1144:**4.2]

A.17.1.4 It is critical to keep in mind that the ignition of the structure might occur from one or more of the following sources:

(1) Big flames (crown fire or intense surface fire). One objective of observation of the conditions and elements and subsequent mitigation recommendations is to keep crown fire and high intensity

STRUCTURE ASSESSMENT GUIDE

Date of assessment: *22 Nov*   Property address: *70 Norris Rd.*

Resident: *John and Jane Doe*   Property owner: *Same*

PRIMARY INFORMATION

Assessment Items	Mitigation Recommendations
1. OVERVIEW OF SURROUNDINGS	
How is the structure positioned in relationship to severe fire behavior? *The house is located near peak of a ridge at local map reference Q-4-12. The setbacks from the lot lines are approximately 15–20 ft. There is a slight sloping of the lot away from the house within 50 ft of the lot line on the north.*	*Since prevailing winds during fire season are most likely from the west-southwest, keep pine needles and leaf litter cleaned up on roadside berm.*
Type of construction: *Wood frame construction with brick façade on the front. Vinyl siding on back and two sides.*	
2. CHIMNEY TO EAVES	
Inspect the roof — noncombustible? shingles missing? shingles flat with no gaps? *Noncombustible roofing in good shape.*	*Inspect roof each spring for damage, especially after a hard winter or wind storm.*
Gutters — present? Noncombustible? *Aluminum gutters at all eaves. No overhanging limbs nearby. Pine needles and leaf litter not likely to collect in deep quantities.*	*Keep gutters free of pine needles and leaves. Check early spring and fall.*
Litter on roof, in gutters, and crevices? *Fairly clean. Not much of a concern. Easy to maintain.*	
3. TOP OF THE EXTERIOR WALL TO FOUNDATION	
Attic, eave, soffit vents, and crawl spaces: *Not much of a concern.*	
Inspect windows and screens — metal screens? Multi-paned windows? Picture windows facing vegetation? *Metal screens on all windows. Some windows on west side are double-paned. Some high vegetation near front windows. Low vegetation in rear.*	*Keep front bushes pruned and watered during fire season. Replace any missing or torn screens immediately, especially the front.*
Walls and attachments — noncombustible? Will they collect litter? *Not much of a concern.*	
Decks — combustible materials? *Wooden deck and privacy fence on south side. No skirting or screening beneath deck. Deck in good condition. Small vegetation around deck but overhanging tree limbs. Some collection of leaves and needles near deck and wooden stairs.*	*Prune trees closest to deck and privacy fence. Remove the pine needles and leaves. Store combustibles elsewhere — perhaps the shed in the backyard — especially during high fire danger periods. Put skirting or 1/4" wire mesh around deck openings.*

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Δ ***FIGURE A.17.1.2*** *Structure Assessment—Guide Example with Notations. [**1144:***Figure A.4.1.2]*

STRUCTURE ASSESSMENT GUIDE *(continued)*

Assessment Items	Mitigation Recommendations
3. TOP OF THE EXTERIOR WALL TO FOUNDATION *(continued)*	
Fences. *Wooden stockade fence joins house on north side. Wooden fencing also on south side. Chain link in rear along lot line. Neighbor's wooden fence is less than 2–3 ft from their wooden fence — will allow leaves and embers to accumulate.*	*Keep wooden fence perimeter clear of dry leaves and other combustible materials like chairs, wood, etc. If the chance presents itself to use noncombustible materials to separate fence from house, you should consider it.*
Flammable material next to or under the structure. *None observed.*	
Combustible materials near or on the structure where walls meet roof or decking surfaces. *Plastic outdoor furniture pads on deck might pose problem from ember shower.*	*Keep combustible chair pads put away except when in use.*
Crawl space, attic vents, soffits. *All appear to be in excellent condition and protected.*	
Nooks and crannies and other small spaces. *All appear to be in excellent condition and protected.*	
4. FOUNDATION TO IMMEDIATE LANDSCAPED AREA	
Landscaped (managed) vegetation — separation distances, maintenance, plant selection? Firewise Landscaping Zones? *Lawn well cared for. Leaf and needle accumulation along east side (rear of property) with small stand of trees. Front and south side have mix of pine and other vegetation.*	*Be sure to keep these areas well tended, pine needles cleared and limbs pruned. Lawn needs to be kept green and mowed. Plants irrigated, pruned and raked — especially during high fire danger periods.*
Propane tanks. *No large ones. Outdoor grill small tank.*	*Make sure this area is kept clear of any combustibles — especially when using the grill.*
Vehicle and RV use and parking, including lawn mowers, etc. *Parking in front. Mower storage in shed which is 40–50 ft from NE corner of house. Plastic children's play house etc. near wooden fence along north side but over 30 ft from house.*	
5. IMMEDIATE LANDSCAPED AREA TO EXTENT OF THE HOME IGNITION ZONE	
Inspect vegetation clearance and crown separation. *Lot is rather small and the neighboring properties' vegetation is more dense than this one. Trees in back should pose little concern as prevailing winds will not communicate fire towards house.*	*Work with neighbors to improve all three lots to reduce the hazards on this corner. The neighbors behind this address and those on either side might benefit from some clearance that might take place but the separation of those properties appears to be sufficient.*

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△ ***FIGURE A.17.1.2*** *Continued*

Δ *TABLE A.17.1.2 Example of Structure Assessment Rating Form*

Rating Values by Areas Assessed	Overview of Surrounding Environment (4.2.1)	From Chimney to Eaves (4.2.2)	From Top of the Exterior Wall to Foundation (4.2.3)	From Foundation to Immediate Landscaped Area (4.2.4)	From Immediate Landscaped Area to Extent of Structure Ignition Zone (4.2.5)
Topographical Features					
(1) Topographical features that adversely affect wildland fire behavior (4.2.1)	0–5				
(2) Areas with history of high fire occurrence (4.3.4)	0–5				
(3) Areas exposed to unusually severe fire weather and strong, dry winds (4.2.1.3)	0–5				
(4) Local weather conditions and prevailing winds (4.2.1.2)	0–5				
(5) Separation of structure on adjacent property that can contribute to fire spread/behavior (4.2.1.3)	0–5			0–5	0–5
Vegetation — Characteristics of predominant vegetation					
(1) Light (e.g., grasses, forbs, sawgrasses, and tundra) NFDRS Fuel Models A, C, L, N, S, and T	5			15	5
(2) Medium (e.g., light brush and small trees) NFDRS Fuel Models D, E, F, H, P, Q, and U	10			20	5
(3) Heavy (e.g., dense brush, timber, and hardwoods) NFDRS Fuel Models B, G, and O	15			25	15
(4) Slash (e.g., timber harvesting residue) NFDRS Fuel Models J, K, and L	15			30	20
Topography (4.2.1.1, 4.2.4, 4.2.5)					
(1) Slope 5–9%				1	1
(2) Slope 10–20%				4	2
(3) Slope 21–30%				7	3
(4) Slope 31–40%				10	6
(5) Slope >41%				15	10
Building Setback, relative to slopes of 30% or more (4.2.1.5, 5.1.3.2)					
(1) 30 ft (9.14 m) to slope	1				
(2) 30 ft (9.14 m) to slope	5				
Roofing Materials and Assembly, nonrated (4.2.2.1, 4.2.2.3)		50*			
Ventilation Soffits, without metal mesh or screening (4.2.3.4)		20			
Gutters, combustible (4.2.2.4, 4.2.2.5)		5			
Building Construction (predominant)† (4.2.4)					
(1) Noncombustible/fire-resistive/ignition-resistant siding and deck			Low		

(continues)

△ *TABLE A.17.1.2 Continued*

Rating Values by Areas Assessed	Overview of Surrounding Environment (4.2.1)	From Chimney to Eaves (4.2.2)	From Top of the Exterior Wall to Foundation (4.2.3)	From Foundation to Immediate Landscaped Area (4.2.4)	From Immediate Landscaped Area to Extent of Structure Ignition Zone (4.2.5)
(2) Noncombustible/fire-resistive/ ignition-resistant siding and combustible deck			Medium		
(3) Combustible siding and deck			High		
Fences and Attachments, combustible (4.2.4.3)				15	
Placement of Gas and Electric Utilities					
(1) One underground, one aboveground	3				
(2) Both aboveground	5				
Fuel Modification within the structure ignition zone (4.2.4, 4.2.5)					
(1) 71–100 ft (21–30 m) of vegetation treatment from the structure(s)					5
(2) 30–70 ft (9–21 m) of vegetation treatment from the structure(s)				7	
(3) <30 ft (9 m) of vegetation treatment from the structure(s)				15	
No Fixed Fire Protection (NFPA 13, 13R, 13D sprinkler system)			5		
TOTALS (if numerical ranking is desired)					
Hazard Rating Scale (Compare with above totals)					
Slight Structure Ignition Hazards from Wildland Fire	0–14	0–14	0–14	0–14	0–14
Moderate Structure Ignition Hazards from Wildland Fire	15–29	15–29	15–29	15–29	15–29
Significant Structure Ignition Hazards from Wildland Fire	30–49	30–49	30–49	30–49	30–49
Severe Structure Ignition Hazards from Wildland Fire	50+	50+	50+	50+	50+

*Nonrated and combustible roof assemblies are predominantly structural exposures and severely increase the ignition hazard from wildland fire.

†The table provides both numerical and value rankings (low, medium, high). The user is urged to assign the value ranking of low, medium, or high based on the other ignition factors prevalent at the assessment site. For example, a deck made of combustible materials might rank low if it is small in size and the rest of the site is in a low fuel loading area that will not promote a large amount of firebrands. That same deck might rate high if it is in an area of high fuel loading that will promote numerous firebrands. Numeric values can be substituted as a local option. [**1144:** Table A.4.1.2]

surface fire at a distance of 100–200 ft (30–60 m) or more from home and other potential hazards (combustibles, buildings, etc.).

(2) Small flames (surface fire). Another objective is to keep small flames at a distance of 30 ft (9 m) or more from home(s) and combustible attachments (decks).

(3) Firebrands (embers). A final and essential objective is to eliminate beds of fine fuel and entry points for firebrands on and near home(s).

[**1144:**A.4.2]

17.1.5 Overview of the Surrounding Environment. The structure assessment shall document the conditions of 17.1.5.1 through 17.1.5.5 in the assessment of the surrounding environment, as they will place the structure in the most risk from ignition by a wildland fire. [**1144:**4.2.1]

17.1.5.1* The structure assessment shall document the location of the structure in relation to predominant topographical features, such as flat open areas, ridges, saddles, steep slopes, natural chimneys like steep narrow draws, or small canyons, that will increase the ignition potential of the structure. [**1144:**4.2.1.1]

A.17.1.5.1 Wildland fire dangers exist in flat land areas, as well as in mountainous terrain. In addition, property line limitations often preclude effective vegetation mitigation, and alternatives for mitigation are needed. [**1144:**A.4.2.1.1]

17.1.5.2* The structure assessment shall document local weather conditions, including wind, relative humidity, temperature, and fine fuel moisture content. [**1144:**4.2.1.2]

A.17.1.5.2 Local weather conditions or prevailing winds play a role in fire behavior (e.g., from which direction a fire is most likely to come, to the intensity and speed of fire travel, depending on the degree of slope), and the direction from which a wildland fire is most likely to approach the structure is an important exposure consideration. Sources of local weather records and fire weather history from the National Weather Service, National Oceanic and Atmospheric Administration (NOAA), local weather bureaus, or wildland fire agencies can be a valuable resource in assessing existing structures or in planning for new construction. [**1144:**A.4.2.1.2]

17.1.5.3* The structure assessment shall document nearby structures using the same criteria as the primary structure. [**1144:**4.2.1.3]

A.17.1.5.3 Adjacent ignitible structures (garages, carports, sheds, gazebos, utility cabinets) can contribute to heat intensity, flame contact, and fire spread from firebrands. [**1144:**A.4.2.1.3]

17.1.5.4* The structure assessment shall document any neighboring properties that could impact the ignition zone of the property being assessed. [**1144:**4.2.1.4]

A.17.1.5.4 Overlapping zones could have a positive result in that the outermost extent of a structure ignition zone might be a neighboring parking lot or already treated vegetation area, such as a fuel modification. On the other hand, the overlap might include other private or public lands, which could make mitigation more difficult because it could involve state or federal agencies or absentee landowners who do little or no vegetation management or hazard mitigation. [**1144:**A.4.2.1.4]

17.1.5.5* The structure assessment shall document the structure's location on the slope relative to the structure's potential exposure to heat from a wildland fire. [**1144:**4.2.1.5]

A.17.1.5.5 Structure location on a slope increases the structure's exposure to heat (e.g., structure setback from the slope is sufficient to reduce its radiant heat exposure). Setback distances of the structure can be measured in accordance with A.5.1.3.2 of NFPA 1144. [**1144:**A.4.2.1.5]

17.1.6 From Chimney to Eaves. The structure assessment shall document the conditions of 17.1.6.1 through 17.1.6.6 to observe construction and vegetation as they place the structure in the most risk from ignition by a wildland fire. [**1144:**4.2.2]

17.1.6.1* The structure assessment shall document the type and construction of roofing materials. [**1144:**4.2.2.1]

A.17.1.6.1 All common coverings (composition shingles, tile, and, in many cases, metal) typically have a fire-resistive roofing classification adequate for interface fire protection if the covering material is tightly assembled to resist firebrand intrusion. [**1144:**A.4.2.2.1]

Untreated wood roofing is easily ignited and a major hazard. The only wood roof coverings that can be considered acceptable are wood shakes or shingles that have been treated at the factory by a pressure-impregnation fire-retardant process, tested for fire resistance, and certified with a fire-resistant roofing classification of Class A, Class B, or Class C. Pressure treated wood roofing looks very similar to the hazardous untreated wood roofing, and currently there is no permanent identification method. If in doubt, assume wood roofing is untreated unless documentation is provided. [**1144:**A.4.2.2.1]

17.1.6.2* The structure assessment shall document the condition of roofing materials and assemblies. [**1144:**4.2.2.2]

A.17.1.6.2 Look for gaps in the roof covering that might allow small wind-blown firebrands to penetrate under the covering and ignite material below. [**1144:**A.4.2.2.2]

Some fire-resistive roof coverings are designed or installed with gaps that allow firebrand intrusion under the covering and have resulted in firebrand intrusion and ignition of the building under the roof covering. The worst example is roof coverings that allow combustible debris to blow under the covering or that allow rodents and birds to bring nesting material in under the roof covering. Clay (Spanish or straight barrel mission) tile roof covering can have this problem unless eave closures or "bird stops" are used to close the convex opening created by the shape of the tile at the eave. Metal tile roofing installed on top of old wood roofing left in place has been a problem. If you can see wood through gaps in metal tile roof covering, firebrands can penetrate and ignite the building. [**1144:**A.4.2.2.2]

17.1.6.3* The structure assessment shall document all skylights in roof assemblies. [**1144:**4.2.2.3]

A.17.1.6.3 Plastic skylights can melt from radiant heat or flaming embers or both. Deformation can result in large openings that can allow the entry of embers and other flaming materials. Skylights constructed of multilayered glazed panels or tempered glass provide increased protection from heat and embers. [**1144:**A.4.2.2.3]

17.1.6.4*

A.17.1.6.4 The roof is the most vulnerable part of the structure and is subject to the collection of combustible vegetative litter (e.g., leaves, pine needles) or other debris and buildup that can be ignited by firebrands. Can litter build up and accumulate on surfaces next to combustible, perpendicular walls? Will combustible decking or roofing provide ember beds next to combustible, perpendicular walls? [**1144:**A.4.2.2.4]

Heat trapping under eaves does not occur until the wall supports flaming combustion as indicated by the portions of the wall that were protected (shaded) and did not char during experiments conducted by the USDA Forest Service Fire Sciences Lab in Missoula, MT. [**1144:**A.4.2.2.4]

17.1.6.5* The structure assessment shall document the construction materials of gutters, downspouts, and connectors. [**1144:**4.2.2.5]

A.17.1.6.5 Gutters and downspouts collect leaves and pine needles. Gutters and eave troughs made from combustible materials (e.g., wood, vinyl) are as vulnerable to firebrand collection as the roof and other parts of the structure. If leaf litter is allowed to gather in gutters, firebrands or embers can ignite the leaf litter, which in turn could ignite combustible eave materials or overhangs. If gutters are attached to combustible fascia boards, the fascia board should be considered as a possible fuel that can be ignited by fine fuels burning in the gutters. [**1144:**A.4.2.2.5]

Gutters that pose a fire threat from an approaching wildland fire are often pulled down by attending fire fighters. For the resident, an alternative might be to remove the gutters along the side(s) of the house most prone to the collection of leaves and needles and install a noncombustible drip line shown in Figure A.17.1.6.5. Removing gutters eliminates the collection of dry leaves and needles along the roof line and fascia board. Also reduced is the possibility of ice damage to the roof in the winter. The use of a gravel bed for drip lines along the leeward side(s) of the house provides reduced ignition potential and reduced wind hazard, since the gravel would be less likely to be blown by high winds on the leeward elevations. The windward sides of the house can be landscaped with mulch (less impact damage in case of wind events) if protected with low volume sprinklers to raise the fine fuel moisture levels in times of high fire danger. [**1144:**A.4.2.2.5]

17.1.6.6* The structure assessment shall document the materials and construction used in eaves of roof overhangs. [**1144:**4.2.2.6]

A.17.1.6.6 Eaves should be boxed to prevent flying embers from entering small spaces. [**1144:**A.4.2.2.6]

17.1.7 From Top of Exterior Wall to Foundation. The structure assessment shall document the conditions of 17.1.7.1 through 17.1.7.6 to observe construction and vegetation as they place the structure in the most risk from ignition by a wildland fire. [**1144:**4.2.3]

FIGURE A.17.1.6.5 *Mitigating Risk of Leaf- and Needle-Filled Gutters. [***1144:*** Figure A.4.2.2.5]*

17.1.7.1* The structure assessment shall document the materials and construction used in exterior walls and exterior siding. [**1144:**4.2.3.1]

A.17.1.7.1 Identify the wall covering or siding (e.g., wood, vinyl, brick, stucco) and determine the possibility of litter buildup and accumulation on surfaces next to walls. Under low radiant heat levels, vinyl siding is damaged and falls off a wall, which can leave openings for firebrands exposing the interior of the home to ignition through eave vents and other possible openings. Vinyl is difficult to ignite by firebrands or radiant heat, but will sustain combustion when directly contacted by flames. [**1144:**A.4.2.3.1]

Hanging ½ in. (12.5 mm) or thicker drywall on the exterior wall studs prior to adding stucco, siding, and so forth can increase the fire rating. [**1144:**A.4.2.3.1]

17.1.7.2 The structure assessment shall document the materials used for gutter downspouts and connectors on exterior walls. [**1144:**4.2.3.2]

17.1.7.3* The structure assessment shall document the materials used in windows and other openings in vertical surfaces. [**1144:**4.2.3.3]

A.17.1.7.3 Windows should be constructed of multi-paned or tempered glass that will resist fracture from intense heat in accordance with 5.7.1 of NFPA 1144, and window screens made from a material that will not allow hot firebrands to enter the home's interior in accordance with 5.7.2 of NFPA 1144. [**1144:**A.4.2.3.3]

17.1.7.4* The structure assessment shall document the location, size, and screening of ventilation openings. [**1144:**4.2.3.4]

A.17.1.7.4 Check attic, crawl space, eave, and soffit vents for appropriate protection (e.g., metal screening, noncombustible skirting) to prevent entry of firebrands. Roof turbine vents should be screened to prevent the entry of firebrands into attic spaces. [**1144:**A.4.2.3.4]

17.1.7.5* The structure assessment shall document all attached accessory structures as part of the primary structure. [**1144:**4.2.3.5]

A.17.1.7.5 Examples of attached structures include decks, lean-to overhangs, patio covers, carports, balconies, fences, and similar structures that could be ignited by convection or firebrands. [**1144:**A.4.2.3.5]

17.1.7.6* The structure assessment shall document areas next to or under a structure where combustible materials that present a source of flame exposure to the structure might collect. [**1144:**4.2.3.6]

A.17.1.7.6 Areas on, next to, or under a structure should be kept free of combustible fuel such as debris, vegetation, wooden furniture, brooms, welcome mats, furniture cushions, gasoline cans, firewood stacks, or piled construction materials. Look for combustible walkways, fencing, or decking attached to the structure, highly combustible fuels adjacent to the structure (e.g., junipers near decks and walkways), combustible materials (e.g., building materials, firewood) stored under decks or adjacent to the structure, animal nests among combustible structural fuels, and landscaping materials (e.g., bark mulch, ground cover plants) near the structure and surrounding plants that might support flaming combustion or that could easily be ignited by firebrands. [**1144:**A.4.2.3.6]

Structures that are attached to the main structure, such as decking, must be kept free of combustible fuels. Exhibit 17.1 shows inspectors looking for potential fuel sources on and around the combustible decking. This should be included in the structure assessment in accordance with 17.1.7.6.

Exhibit 17.1

Inspecting a property for wildfire ignition potential. (Image courtesy of NFPA Firewise® program)

17.1.8* From Foundation to the Immediate Landscaped Area. The structure assessment shall document the conditions of 17.1.8.1 through 17.1.8.5 to observe construction and vegetation, as they place the structure in the most risk from ignition by a wildland fire. [**1144:**4.2.4]

A.17.1.8 The structure ignition zone includes the spatially arranged traditional landscaping zones, but can exceed the extent of the property line. Figure A.17.1.8 illustrates the relationship of the structure and immediate landscaped area to the larger structure ignition zone. Within the immediate landscaped area [from the structure to approximately 30 ft (9 m)], often referred to as the defensible space, special consideration should be given that any combustible materials (e.g., plants, lawn furniture, litter, construction materials) should be removed in the 0 ft to 5 ft (0 m to 1.5 m) zone immediately adjacent to the structure and reduced in the zone from 5 ft to 30 ft (1.5 m to 9 m) to minimize the chance for ignition of the structure. The total structure ignition zone includes any spatially arranged landscaping area and can exceed the extent of the property line. The level of risk of ignition within the total area of the ignition zone depends on the type of construction and is further influenced by slope, soils, and other site-specific conditions. [**1144:**A.4.2.4]

The AHJ should require the development of a landscape plan for the property. Such plans should address four zones around the property as follows:

(1) The most immediate landscaped area is the closest to the house and includes the area encircling the structure for at least 30 ft (9 m) on all sides. The landscaped vegetation within 30 ft (9 m) of structures should be irrigated as needed, cleared of dead vegetation, and/or planted with succulents and other plants (where appropriate) that are low in combustibility potential. Plantings should be limited to carefully spaced, low-growing, low-combustibility species, grasses, and lawns. Shrubs planted next to the structure should be of low combustibility, no more than 18 in. (45 cm) in height, and not planted against the home. The planting bed should be noncombustible (e.g., stone, gravel, bare ground) or irrigated if combustible materials (e.g., bark mulch) are used. All highly combustible plants, such as junipers and ornamental conifers, should be removed or trimmed and maintained to be ignition-resistant. Vegetation deposits (dry leaf and pine litter) that can support surface fire and flames should be removed regularly. Areas of vegetation (natural areas, undeveloped areas, landscaped areas, fields, etc.) that exist near the structure should be evaluated for the possibility of causing ignition of the structure.
(2) Progressing outward from the structure, the types and densities of vegetation should change to reduce the continuity of vegetation fuels. For example, plantings can be done in islands. Trees can be introduced into this zone with careful consideration of their combustibility and continued maintenance to separate crowns and avoid ladder fuels. Tree placement should be planned so that the edge of the canopy of the tree when fully mature is no closer than 10 ft (3 m) to the edge of the structure.
(3) Progressing even farther from the structure, more medium-sized plants and well-spaced trees can be planted in well-spaced groupings to reduce exposure to wildland fire and help maintain privacy. The volume of vegetation (i.e., fuel) should be kept as low as possible or practical.
(4) The most distant area [100 ft to 200 ft (30 m to 60 m)] from the structure determines the extent of the structure ignition zone. Plants in this furthermost area should be carefully pruned and thinned, and highly combustible vegetation removed. Particular attention should be paid to the types and densities of the vegetation in this area. For example, some vegetation and trees generate more firebrands than others and require additional thinning, removal, or replacement.

[**1144:**A.4.2.4]

17.1.8.1* The structure assessment shall document all vegetative fuels and other combustible materials adjacent to and within 30 ft (9 m) of the structure for their potential to contribute to the intensity and spread of wildland fire. [**1144:**4.2.4.1]

A.17.1.8.1 Vegetative fuels include live vegetation, mulch and landscaping materials, slash piles, composting piles, and firewood storage. [**1144:**A.4.2.4.1]

FIGURE A.17.1.8 *The Structure Ignition Zone. [***1144:***Figure A.4.2.4]*

Combustible vegetation close enough to windows to provide intense radiant heat or flame contact should be pruned, moved, or substituted with smaller, lower combustibility plants. Figure A.17.1.8.1(a) illustrates the use of low combustibility plants separated by a gravel area next to the foundation. [**1144:**A.4.2.4.1]

Mulch is an alternative to noncombustible landscaping materials such as gravel and rock. The size and texture of mulching materials affects its ignition and fire spread potential. Larger organic materials are preferable to smaller materials. [**1144:**A.4.2.4.1]

Landscaping with mulch can be acceptable if the mulch is protected with low volume sprinklers to raise the fine fuel moisture levels and offset its combustibility in times of high fire danger. The installation of sprinklers for areas using mulch for landscaping is shown in Figure A.17.1.8.1(b). [**1144:**A.4.2.4.1]

FIGURE A.17.1.8.1(a) *Foundation Planting and Landscaping. [***1144:***Figure A.4.2.4.1(a)]*

FIGURE A.17.1.8.1(b) *Use of Low Volume Sprinklers in Organic Material. [***1144:***Figure A.4.2.4.1(b)]*

Physical Description Similarity Chart of NFDRS and FBO Fuel Models

NFDRS Models Realigned to Fuels Controlling Spread Under Severe Burning Conditions

NFDRS Fuel Models	Fire Behavior Fuel Models													
	1	2	3	4	5	6	7	8	9	10	11	12	13	
A Western Annuals	X													Grass
L Western Perennial	X													Grass
S Tundra	X					3rd			2nd					Grass
C Open Pine with Grass		X							2nd					Grass
T Sagebrush with Grass		X			3rd	2nd								Grass
N Sawgrass			X											Grass
B Mature Brush over 6 ft (1.8 m)				X										Shrub
O High Pocosin				X										Shrub
F Intermediate Brush					2nd	X								Shrub
Q Alaskan Black Spruce						X	2nd							Shrub
D Southern Rough						2nd	X							Shrub
H Short-Needle Closed (Normal Dead)								X						Timber
R Hardwood Litter (Summer)								X						Timber
U Western Long-Needle Pine									X					Timber
P Southern Long-Needle Pine									X					Timber
E Hardwood Litter (Fall)									X					Timber
G Short-Needle Closed (Heavy Dead)										X				Timber
K Light Slash											X			Slash
J Medium Slash												X		Slash
I Heavy Slash													X	Slash
		Grass			Shrub				Timber			Slash		

FIGURE A.17.1.8.1(c) *Sample of a Physical Description Similarity Chart of NFDRS and FBO Fuel Models. [**1144:***Figure A.4.2.4.1(c)]*

Figure A.17.1.8.1(c) describes the physical similarities of the NFDRS fuel models with fire behavior fuel models. See Annex B of NFPA 1144 for fuel model classifications. [**1144:**A.4.2.4.1]

17.1.8.2* The structure assessment shall document the presence and location of all heat and flame sources within 30 ft (9 m) of the primary structure. [**1144:**4.2.4.2]

A.17.1.8.2 Typical heat and flame sources include, but are not limited to, propane heaters, barbecue cookers, and grills. [**1144:**A.4.2.4.2]

17.1.8.3* The structure assessment shall document all projections attached to the primary structure. [**1144:**4.2.4.3]

A.17.1.8.3 Attachments include, but are not limited to, permanent and temporary construction such as decks, fences, awnings, lean-to buildings; and combustible walkways, fencing, or decking attached to the home. [**1144:**A.4.2.4.3]

Figure A.17.1.8.3(a) shows a typical deck where combustible decking materials could result in the gathering of embers next to combustible walls and where the construction and design of decks, balconies, and porches with open spaces underneath could allow leaf and needle debris and embers to collect. [**1144:**A.4.2.4.3]

Figure A.17.1.8.3(b) illustrates one method of separating a combustible fence from the structure by the installation of a transitional section of noncombustible (iron) fencing. Similar use of masonry or stone can provide the same fire-resistant separation. [**1144:**A.4.2.4.3]

17.1.8.4* The structure assessment shall document detached structures within 30 ft (9 m) of the primary structure that might be

*FIGURE A.17.1.8.3(a) Leaf Litter and Needles Collect in Small Spaces. (Courtesy of Firewise Communities Program.) [**1144:**Figure A.4.2.4.3(a)]*

*FIGURE A.17.1.8.3(b) Transition Fence Separates Combustible Fence from Structure. (Courtesy of Firewise Communities Program. Photo by G. Johnston.) [**1144:**Figure A.4.2.4.3(b)]*

ignited by flames, radiant heat, or firebrands from wildland fires. [**1144:**4.2.4.4]

A.17.1.8.4 Examples of such structures include, but are not limited to, hot tubs, utility sheds, outbuildings, detached garages and carports, gazebos, trellises, auxiliary structures, stables, barns and other structures within 30 ft (9 m) of the primary structure, outdoor furniture, and recreational structures (e.g., children's playhouses, swing sets). In some cases, separation distances from lot lines might require the inclusion of neighboring residential structures in the assessment. [**1144:**A.4.2.4.4]

17.1.8.5* The structure assessment shall document vehicle parking areas within 30 ft (9 m) of any surface of the structure. [**1144:**4.2.4.5]

A.17.1.8.5 Parking vehicles on areas of dry grasses and fine fuels could result in ignition by hot exhaust systems or firebrands. Also, a fire that originates from a parked vehicle could present an exposure hazard to the primary structure or nearby vegetation. Any dry vegetation beneath the vehicle could cause ignition of the vehicle, which in turn could cause structure ignition; conversely, the ignition of the structure could cause ignition of the vehicle, which could present additional dangers to responding fire fighters. [**1144:**A.4.2.4.5]

17.1.9 From the Immediate Landscaped Area to the Extent of the Structure Ignition Zone. The structure assessment shall document the conditions of 17.1.9.1 through 17.1.9.8 to observe construction and vegetation, as they place the structure in the most risk from ignition by a wildland fire. [**1144:**4.2.5]

17.1.9.1* The structure assessment shall document vegetation within the area between the outer edge of the immediate landscaped area and the extent of the structure ignition zone as potential fuel that can convey the fire to the structure. [**1144:**4.2.5.1]

A.17.1.9.1 Evaluation of the vegetative fuels should include the following:

(1) Can vegetative fuels lead surface fire and flames to the structure?
(2) Have ladder fuels been eliminated within the structure ignition zone?
(3) Are tree crowns separated enough to prevent big flames from coming within 30 ft (9 m) of the structure?

[**1144:**A.4.2.5.1]

17.1.9.2* The structure assessment shall document the species and location of trees and the separation of tree crowns within the area between the outer edge of the immediate landscaped area and the extent of the structure ignition zone. [**1144:**4.2.5.2]

A.17.1.9.2 The location (placement) of trees and the separation between them is important to prevent ignition of the structure from radiant heat and to reduce the concentration of leaf fall and needle drop near the structure. Adequate separation and control of ignition potential are factors that affect fire intensity and are dependent on the size, density, and species of trees and vegetation. [**1144:**A.4.2.5.2]

Consider using islands of trees that offer separation of trees from the structure and other combustibles. Figure A.17.1.9.2(a) illustrates the use of such planting islands that preserve key trees for aesthetics while providing shade and exposure separation from structures. Figure A.17.1.9.2(b) shows that small planting islands within an expanse of maintained lawn provides both separation and low combustibility protection from ignition close the structure. [**1144:**A.4.2.5.2]

FIGURE A.17.1.9.2(a) Planting Islands Offer Exposure Protection, Preserve Aesthetics. (Courtesy of Firewise Communities Program. Photo by G. Johnston.) [1144:Figure A.4.2.5.2(a)]

FIGURE A.17.1.9.2(b) Small Planting Islands Within an Expanse of Maintained Lawn. (Courtesy of Firewise Communities Program. Photo by D. Frazier.) [1144:Figure A.4.2.5.2(b)]

17.1.9.3* The structure assessment shall document the presence and location of all heat and flame sources within the area between the outer edge of the immediate landscaped area and the extent of the structure ignition zone. [**1144:**4.2.5.3]

A.17.1.9.3 Typical heat and flame sources include, but are not limited to, propane- and charcoal-fired barbecue cookers, heaters, and grills. [**1144:**A.4.2.5.3]

17.1.9.4* The structure assessment shall document detached structures within the area between the outer edge of the immediate landscaped area and the extent of the structure ignition zone that might be ignited by flames, radiant heat, or firebrands from wildland fires. [**1144:**4.2.5.4]

A.17.1.9.4 Examples of such structures include, but are not limited to, hot tubs, utility sheds, outbuildings, detached garages and carports, gazebos, trellises, auxiliary structures, stables, barns and other structures between the immediate landscaped area and the extent of structure ignition zone, outdoor furniture, recreational structures (children's playhouses, swing sets). In some cases, separation distances from lot lines might require the inclusion of neighboring residential structures in the assessment. [**1144:**A.4.2.5.4]

17.1.9.5* The structure assessment shall document vehicle parking areas within the area between the outer edges of the immediate landscaped area and the extent of the structure ignition zone. [**1144:**4.2.5.5]

A.17.1.9.5 See A.17.1.8.5. [**1144:**A.4.2.5.5]

17.1.9.6* The structure assessment shall document all projections attached to the primary structure that extend beyond the immediate landscaped area. [**1144:**4.2.5.6]

A.17.1.9.6 Attachments include, but are not limited to, permanent and temporary construction such as decks, fences, awnings, and lean-to buildings. [**1144:**A.4.2.5.6]

17.1.9.7 The structure assessment shall document all other factors that can affect the risk of ignition or the spread of wildland fire on improved property within the structure ignition zone, including the risk of structure fires spreading to vegetation. [**1144:**4.2.5.7]

17.1.9.8 Any structure that fails to comply with the requirements of Chapter 5 of NFPA 1144 shall be deemed to increase the risk of the spread of wildland fire to improved property and the risk of fires on improved property spreading to wildland fuels. [**1144:**4.2.5.8]

17.1.10 Development of Wildland Fire Hazard Mitigation Plan.

17.1.10.1 From the information gathered in each structure assessment, the AHJ shall require or cause to be developed a wildland fire hazard mitigation plan and schedule to address the wildland fire hazards identified in the specific structure ignition zone assessment. [**1144:**4.3.1]

17.1.10.2 The AHJ shall work with applicable agencies and organizations to resolve any conflicts between recommended wildland fire hazard mitigation measures and mitigation measures or objectives of other hazards. [**1144:**4.3.2]

Δ **17.1.10.3*** This plan shall include, but not be limited to, the following:

(1) Specific mitigation recommendations based on the hazard assessment to reduce the ignition potential around and including the structure
(2) Construction modification or retrofit necessary to reduce the identified hazards as a minimum or to comply with the provisions of Chapter 5 of NFPA 1144

(3) Fuel modification recommendations as specified in Chapter 6 of NFPA 1144
(4) A hazard mitigation implementation and maintenance schedule approved by the AHJ

[**1144:**4.3.3]

Δ **A.17.1.10.3** Access and evacuation concerns along with fire suppression capabilities (such as fire station location, water supply, road widths, and grades) are important to overall fire protection and safety. Likewise, vegetation clearance and maintenance along private roadways, driveways, and water supplies are important elements in fire suppression and emergency evacuation. Since these elements do not relate specifically to reducing the ignition potential of the structure, these are covered in NFPA 1141; NFPA 1142; and 17.3.5.3. [**1144:**A.4.3.3]

17.1.10.4* The history of wildland fire in the area under assessment shall be considered in determining required hazard mitigation plan. [**1144:**4.3.4]

A.17.1.10.4 The frequency of wildland fire occurrence will affect the priorities of the mitigation measures and the periodic maintenance schedule of the property being assessed. [**1144:**A.4.3.4]

17.1.10.5* The AHJ shall approve the mitigating measures relative to access, water supply, and construction based upon the structure assessment established in 17.1.2. [**1144:**4.3.5]

Δ **A.17.1.10.5** NFPA 1141 provides guidance on planning and installing fire protection infrastructure. [**1144:**A.4.3.5]

17.1.10.6 From the information gathered in each structure assessment, the AHJ shall require or cause to be developed a wildland fire hazard severity map of each residential development area addressed. [**1144:**4.3.6]

Δ **17.1.10.7** The map shall include, but not be limited to, the following data elements:

(1) Lot designations
(2) Structure locations on each lot
(3) Locations of wildland fire evacuation centers or safety zones
(4) Hazard severity for each lot
(5) Overlapping ignition zones
(6) Location of fire hydrants, cisterns, or other water sources for fire fighting

[**1144:**4.3.7]

17.1.11 Mitigation Implementation and Enforcement.

17.1.11.1 The AHJ shall require the property owner to develop and comply with the approved wildland fire hazard mitigation plan and schedule according to 17.1.10.1. [**1144:**4.4.1]

17.1.11.2 No permit associated with construction shall be issued if the provisions of this *Code* are not addressed. [**1144:**4.4.2]

17.1.11.3 No permit associated with occupancy shall be issued until the provisions of this *Code* are satisfied. [**1144:**4.4.3]

17.2 Plans

The plans for construction and development within the wildland urban interface shall be submitted to the AHJ for review and approval.

In accordance with Section 17.2, plans must be submitted to the AHJ for review and approval. (See Section 1.14.) The AHJ determines which plans must be submitted for review based on the scope of the project. Plan submittals should meet the following criteria:

1. Plans should be submitted in at least two sets, with one set of plans retained by the AHJ and one set kept on site at all times during which work is in progress.
2. Plans should be drawn to scale indicating the location, nature, and extent of the work proposed.
3. Site plans should include topography, location, width and percent of grade of access roads and driveways, landscaping or vegetation details, locations of existing and proposed structures, building occupancy classifications, proposed or existing aboveground utilities, site water systems or supplies, and types of building construction, including appendages.
4. Details regarding the vicinity within 300 ft (91 m) of property lines, including other structures, access roads, percentage of slope, vegetation, and water systems or water supplies that might be furnished, should be included.
5. Vegetation management plans should be prepared and submitted when a planned development is to be within a wildland/urban interface area. Classification of fuel loading, fuel models, and fire-resistive vegetation is to be included when required by the AHJ.

NFPA 1141, *Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas*, and local building requirements and codes should be incorporated into the plans and the development, design, and location of structures in the wildland interface.

NFPA 1144 offers specific considerations as to what should be included with construction documentation; location with respect to distances from other structures; vegetation and topography; construction design and types of building materials; assembly features limiting embers from settling in areas on or around the structure, including overhangs; and exterior walls, exterior openings, and exterior exposure hazards that could contribute to fire spread and intensity.

Construction design and materials should be ignition resistant and meet fire and mechanical performance–related standard test methods. Flame spread, flame front, weathering, overhangs, exterior use, and exterior openings are various factors that are taken into consideration during testing. Standard tests include ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer at 750°C;* ASTM E84, *Standard Test Method for Surface Burning*

Characteristic of Building Materials; ANSI/UL 723, *Standard for Test for Surface Burning Characteristic of Building Materials;* ASTM D7032, *Standard Specification for Establishing Performance Ratings for Wood-Plastic Composite Deck Boards and Guardrail Systems (Guards or Handrails);* ANSI/UL 790, *Standard for Safety for Tests for Fire Resistance of Roof Covering Materials*; and ASTM E2886, *Test Method for Evaluating the Ability of Exterior Vents to Resist the Entry of Embers and Direct Flame Impingement*, to name only a few.

See Chapter 5 of NFPA 1144 for additional details on plan requirements, building design, location, and construction for wildland areas.

17.3 Wildland Fire–Prone Areas

17.3.1* Safeguards. Safeguards to prevent the occurrence of fires and to provide adequate fire protection and mitigation measures in hazardous fire areas shall be provided and maintained in accordance with Section 17.3.

A.17.3.1 The unrestricted use of grass-, grain-, brush-, or forest-covered lands under the jurisdiction of the AHJ presents a potential hazard to life and property from fire and resulting erosion.

17.3.2* Permits and Approvals. Permits for use of hazardous areas shall not be issued when public safety would be at risk, as determined by the AHJ. *(See Section 1.12 for additional requirements for permits.)*

A.17.3.2 Possible uses include recreation (e.g., camping, hunting, hiking), construction, and seasonal habitation.

17.3.3 Restricted Entry.

To prevent wildland fires, the AHJ might close fire-prone areas to the public when conditions are hazardous. When fire-prone areas are closed, authorized persons — such as residents (full-time and seasonal) and property owners and their guests traveling to or from their properties, public officials, fire service and emergency personnel, and employees of the U.S. government — have right of entry.

17.3.3.1 The AHJ shall determine and publicly announce when hazardous fire areas shall be closed to entry, and when such areas shall again be opened to entry.

17.3.3.2 Unauthorized persons shall not be permitted to enter or remain in closed hazardous fire areas.

17.3.3.3 Signs. Approved signs prohibiting entry by unauthorized persons shall be placed on every closed area and access point.

17.3.4 Use of Flammable Materials and Procedures.

The AHJ can permit or approve the use of flammable materials, explosives, outdoor fires, and open flame devices. Permits or approvals for the use of flammable materials and operations must contain terms and conditions to safeguard the public and property during certain fire danger ratings and during unusual climatic conditions and other weather anomalies. Also see Section 10.10 for additional guidance on the use of open flames, candles, open fires, and incinerators.

17.3.4.1 Smoking. Lighting, igniting, or otherwise setting fire to any smoking material shall be prohibited unless within structures or smoking areas approved by the AHJ. *(See Section 10.9 for additional requirements on smoking.)*

17.3.4.2 Tracer Bullets, Tracer Charges, Rockets, and Model Aircraft.

17.3.4.2.1 Tracer bullets and tracer charges shall not be possessed, fired, or caused to be fired into or across hazardous fire areas.

17.3.4.2.2 Rockets, model planes, gliders, and balloons powered with an engine, propellant, or other feature liable to start or cause fire shall not be fired or projected into or across hazardous fire areas.

17.3.4.3 Explosives and Blasting. Explosives shall not be possessed, kept, stored, sold, offered for sale, given away, used, discharged, transported, or disposed of within hazardous fire areas except as permitted by the AHJ. *(See Chapter 65 for additional guidance.)*

17.3.4.4 Fireworks. Fireworks shall not be used or possessed in hazardous fire areas unless permitted by the AHJ. *(See Chapter 65 for additional guidance.)*

17.3.4.5 Apiaries. Lighted and smoldering material used in connection with smoking bees shall not be allowed in or upon hazardous fire areas except as permitted by the AHJ.

17.3.5 Clearance of Brush and Vegetative Growth.

17.3.5.1 Electrical Transmission Lines.

17.3.5.1.1 Clearance of brush and vegetative growth from electrical transmission and distribution line(s) shall be provided and maintained in accordance with 17.3.5.1.

17.3.5.1.2 A combustible-free space around poles and towers shall consist of a clearing of not less than 10 ft (3.05 m) in each direction from the outer circumference of the pole or tower during such periods of time as designated by the AHJ.

17.3.5.1.3 Trimming Clearance.

17.3.5.1.3.1 At the time of trimming, clearances not less than those established by Table 17.3.5.1.3.1 shall be provided.

17.3.5.1.3.2 The radial clearances in Table 17.3.5.1.3.1 are minimum clearances that shall be established at time of trimming between the vegetation and the energized conductors and associated live parts.

17.3.5.1.4 Clearances not less than those established by Table 17.3.5.1.4 shall be maintained during such periods of time as designated by the AHJ.

TABLE 17.3.5.1.3.1 *Minimum Clearances Between Vegetation and Electrical Lines at Time of Trimming*

	Minimal Radial Clearance from Conductor	
Line Voltage	**ft**	**m**
2400–72,000	4	1.2
72,001–110,000	6	1.8
110,001–300,000	10	3.0
300,001 or more	15	4.6

TABLE 17.3.5.1.4 *Minimum Clearances Between Vegetation and Electrical Lines to Be Maintained*

	Minimum Clearance	
Line Voltage	**in.**	**mm**
750–35,000	6	152
35,001–60,000	12	305
60,001–115,000	19	483
115,001–230,000	30.5	775
230,001–500,000	115	2920

17.3.5.1.4.1 The site-specific clearance achieved, at the time of pruning, shall vary based on species' growth rates, the utility company specific trim cycle, the potential line sway due to wind, line sway due to electrical loading and ambient temperature, and the tree's location in proximity to the high voltage lines.

17.3.5.1.4.2 The AHJ shall establish minimum clearances different than those specified by Table 17.3.5.1.4 when evidence substantiating such other clearances is submitted to the AHJ and approved.

17.3.5.1.5* Electrical Power Line Emergencies. During emergencies, the utility company shall perform the required work to the extent necessary to clear the hazard.

A.17.3.5.1.5 An emergency can include situations such as trees falling into power lines or trees' location in violation of Table 17.3.5.1.3.1.

17.3.5.2 Structures.

17.3.5.2.1 Persons owning, leasing, controlling, operating, or maintaining buildings or structures in, upon, or adjoining hazardous fire areas, and persons owning, leasing, or controlling land adjacent to such buildings or structures, shall maintain an effective defensible space in accordance with 17.3.5.2.1.1 through 17.3.5.2.1.11.5.

Exhibit 17.2 shows a property with defensible space that was saved from fires that pushed through southern New Mexico in March 2002.

Exhibit 17.2

A home that survived the Kokopelli Fire in 2002, Ruidoso, New Mexico. (Image courtesy of NFPA Firewise® program)

17.3.5.2.1.1* Ground fuels, including native vegetation and plants used for landscaping within the defined landscaping zones, shall be treated or removed. [**1144:**6.2.1]

A.17.3.5.2.1.1 Acceptable methods of fuel treatment include, but are not limited to, prescribed burning by qualified personnel, mowing, pruning, removing, substitution, mulching, converting to compost, and grazing. [**1144:**A.6.2.1]

Vegetation. Fire resistance in plants depends on many variables, including location, growing conditions, and maintenance. Plants should be chosen that are suitable for the geographic region and the location in the landscape, and plants with similar needs should be grouped to minimize care. Plant characteristics that reduce maintenance needs include the following:

(1) Drought-resistant
(2) Pest-resistant
(3) Native
(4) Noninvasive
(5) Slow-growing
(6) Wind-resistant
(7) Thriving without supplemental fertilizing
[**1144:**A.6.2.1]

High Combustibility (fire-prone, fire-tolerant) Plants. Some plants burn readily because they are adapted to survive in fire-dependent ecosystems and can contain volatile compounds that support fire. Fire-prone plants have traits (i.e., adaptations) that help them to survive fire, such as thick bark or extensive roots. They often contain resins, oils, or waxes that ignite easily and burn intensely. Fire-prone plants will flame, not smolder, when preheated and ignited with a match. They should be removed from Zone 1 of the landscape, as illustrated in Figure A.17.1.8, Figure A.17.1.9.2(a), and Figure A.17.1.9.2(b). Where it is not practical or desirable to remove a fire-prone plant, surrounding it with open space or fire-resistant plants can reduce the hazard. Typical characteristics of fire-prone plants include the following:

(1) Volatile resins, oils, or waxes, indicated by leaves that are aromatic when crushed
(2) Narrow leaves or needles (often evergreen)
(3) Waxy or fuzzy leaves
(4) Accumulation of fine, twiggy, dry, or dead material on the plant or on the ground under the plant
(5) Loose, papery, or thick bark

[**1144:**A.6.2.1]

Low Combustibility Plants. In place of fire-prone plants, landscapers and homeowners should use low combustibility plants, often referred to as fire-resistant plants. Although all plants will burn at some point, wildland fire researchers have shown that some types of plants, including many native plants, resist burning more than others. Additionally, some ornamental plants, when properly irrigated and maintained, are more resistant to fire than others. Low combustibility plants are typically low fuel volume, non-oily, nonresinous plants that are also drought-resistant, have small thick leathery leaves, and produce very little dead plant material. Typical characteristics of fire-resistant plants include the following:

(1) High moisture content in leaves
(2) Low oil or resin content (not aromatic)
(3) Drought tolerance or drought resistance
(4) Minimal seasonal accumulation of dead vegetation, or accumulation of dead leaves that are somewhat resistant to fire because they hold moisture in the soil (large, flat leaves)
(5) Limited foliage and few dead branches
(6) Open or loose branching habit
(7) Easy maintenance and pruning

[**1144:**A.6.2.1]

17.3.5.2.1.2 Live vegetation within the fuel modification area shall have dead material removed and shall be thinned and pruned in conformance with the wildland fire mitigation plan, as approved by the AHJ. [**1144:**6.2.2]

17.3.5.2.1.3 Dead and downed fuels within 30 ft (9 m) of all buildings shall be removed or treated to maintain the fuel modification area in conformance with the wildland fire mitigation plan, as approved by the AHJ. [**1144:**6.2.3]

17.3.5.2.1.4 Vegetation under trees within the fuel modification area shall be maintained at a height that will preclude ground fire from spreading in the tree crown. [**1144:**6.2.4]

17.3.5.2.1.5* Tree crowns within the structure ignition zone shall be spaced to prevent structure ignition from radiant heat. [**1144:**6.2.5]

A.17.3.5.2.1.5 Studies of structural ignition from radiant heat indicate that ignitions are unlikely to occur from burning vegetation beyond 120 ft (36.6 m) from a structure. Therefore, clearing of vegetation and thinning of trees to a distance of 120 ft (36.6 m) from a dwelling — as in a zoned Firewise landscape — will prevent ignition of a structure from the radiant heat from a flame front in a high-risk ecosystem (Cohen and Butler, 1996). [**1144:**A.6.2.5]

TABLE A.17.3.5.2.1.5 *Recommended Tree Crown Spacing to Prevent Structural Ignition from Wildland Fire Radiant Heat*

Zone	Distance from Structure	Recommended Tree Crown Spacing
1	0–30 ft (0–9 m)	18 ft (5.5 m)
2	30–60 ft (9–18 m)	12 ft (3.7 m)
3	60–100 ft (18–30 m)	6 ft (1.8 m)
4	Beyond 100 ft (30 m)	No restrictions

[**1144:** Table A.6.2.5]

A tree crown spacing of 18 ft (5.5 m) for trees within the Zone 1 defensible space [within 30 ft (9 m) of a structure] will reduce radiant heat to at or below the level where ignition of wood occurs, with closer spacing of trees allowed in the zones further from the structure, as described in Table A.17.3.5.2.1.5. These tree-spacing recommendations apply equally to thinning of mature trees or planting of new trees in high- or extreme-risk areas. Tree spacing is measured between the outer edges of the crowns of mature trees, so new trees must be planted with spacing equivalent to the estimated diameter of the mature crown. [**1144:**A.6.2.5]

Table A.17.3.5.2.1.5 illustrates general clearance distances for tree crowns. However, these distances can be adjusted by the AHJ in consideration of species of trees and understory vegetation, slope of the property, the proximity to other neighboring structures, overlapping ignition zones, and other site-specific factors. [**1144:**A.6.2.5]

17.3.5.2.1.6 The fuel modification plan shall include a maintenance element identifying and defining the responsibility for continued and periodic maintenance. [**1144:**6.2.6]

17.3.5.2.1.7 Chimneys and Flues.

17.3.5.2.1.7.1 Every fireplace and wood stove chimney and flue shall be provided with an approved spark arrester constructed of a minimum 12-gauge welded wire or woven wire mesh, with openings not exceeding ½ in. (12.7 mm). [**1144:**5.8.1]

17.3.5.2.1.7.2 Vegetation shall not be allowed within 10 ft (3 m) of a chimney outlet. [**1144:**5.8.2]

17.3.5.2.1.8* Accessory Structure(s). Accessory structures shall be constructed to meet the requirements of Chapter 5 of NFPA 1144 or shall be separated from the main structure by a minimum of 30 ft (9 m). [**1144:**5.9]

A.17.3.5.2.1.8 Accessory structures include, but are not limited to, outbuildings, patio covers, gazebos, palapas, and similar outdoor structures. [**1144:**A.5.9]

17.3.5.2.1.9 Mobile and Manufactured Homes.

17.3.5.2.1.9.1 Permanently located mobile and manufactured homes with an open space beneath shall have a skirt of noncombustible materials, exterior fire-retardant-treated wood, or other ignition-resistant material. [**1144:**5.10.1]

17.3.5.2.1.9.2 Any enclosed space beneath the mobile or manufactured home shall be vented according to 5.2.2 of NFPA 1144. [**1144:**5.10.2]

17.3.5.2.1.10 Vehicle Parking Areas. Vehicle parking areas within the immediate landscaped zone shall be maintained free of dry grasses and fine fuels that could be ignited by hot exhaust systems or firebrands. [**1144:**5.11]

17.3.5.2.1.11 Exterior Exposure Hazards.

17.3.5.2.1.11.1* Heat and flame sources that are unprotected or unsupervised shall not be permitted within 30 ft (9 m) of the primary structure. [**1144:**5.12.1]

A.17.3.5.2.1.11.1 Unprotected heat and flame sources include, but are not limited to, open burning without spark protection, barbecue pits, clay or stone fireplaces, and fire pits. Supervision of burning includes the presence of a source of water or other extinguishing equipment. [**1144:**A.5.12.1]

17.3.5.2.1.11.2 Incinerators, outdoor fireplaces, permanent barbecues, and grills shall not be built, installed, or maintained in hazardous fire areas without prior approval of the AHJ. [**1144:**5.12.2]

17.3.5.2.1.11.3 Openings in incinerators, outdoor fireplaces, permanent barbecues, and grills shall be provided with an approved spark arrester, screen, or door. [**1144:**5.12.3]

Δ **17.3.5.2.1.11.4** Propane tanks and other combustible liquids storage shall conform to NFPA 58 and the wildland fire hazard mitigation plan required in 17.1.10. [**1144:**5.12.4]

17.3.5.2.1.11.5 Other combustible materials within 30 ft (9 m) of any structure shall be removed or stored in conformance with the wildland fire hazard mitigation plan as approved by the AHJ. [**1144:**5.12.5]

The immediate landscaped area within approximately 30 ft (9 m) of the structure is often referred to as the *defensible space*. Within the defensible space, any combustible materials (e.g., plants, lawn furniture, trash, construction materials) should be removed or reduced to prevent their ignition, which, in turn, could ignite the structure. Reducing ignition hazards around a structure should be a combination of modifying the structure fuel package (the structure and its components) and the vegetative fuel package (the natural vegetation and landscape plantings). Reducing ignition hazards associated with the structure fuel package can be achieved through the use of noncombustible roof coverings, siding, and decking; removal of light combustibles from decks and porches (e.g., lawn furniture cushions, brooms, paper, and cardboard); and separation of combustible fences from direct contact with the structure. Exhibit 17.3 depicts a home constructed of ignition-resistant materials that withstood the effects of a wildland fire.

Exhibit 17.3

Home survival, High Park Fire, Rist Canyon, Colorado, 2012. (Image provided courtesy of Chief Robert Gann, Rist Canyon Volunteer Fire Department)

Vegetative fuel load modifications might include removing highly flammable vegetation and planting vegetation that has a lower ignitability (e.g., those with higher moisture content and/or less resinous oils). Ornamental vegetation and cultivated ground covers, such as maintained green grass, succulents, low-growing annual flowers, and other similar plants, might be permitted within the designated ignition zone as long as they do not provide a continuous means of transmitting fire to any adjacent structures. The first 5 ft to 6 ft (1.5 m to 1.8 m) around the structure's foundation are the most important for vegetation management. Keeping plants and shrubs from contacting the structure or being placed directly under soffits will aid in reducing the structure's ignition potential. When assessing ignition potential, keep in mind that, if a plant or shrub is connected to the structure, it is part of the structure's fuel package.

No plants are fireproof. Any plant can burn under extreme conditions; however, some plants are more difficult to ignite, burn more slowly, and produce less heat with shorter flame lengths. Plants that possess high moisture content, low growing habits, low fuel volume, and desirable chemical content are good choices for high hazard areas, as are plants that grow to a height not greater than 18 in. (45 mm) and are less than ½ in. (13 mm) in diameter. Plants with resinous, oily, or waxy parts should be avoided.

The risk associated with plants in high hazard areas can be reduced by pruning, by removing dead leaves and branches, and by using other appropriate horticultural practices. The area within the structure ignition zone needs to be maintained in a manner that reduces ignition hazards as identified in the hazard assessment process outlined in Section 17.1 and NFPA 1144.

Exhibit 17.4

Structure ignition zone.

For additional information on structure ignition zones, go to www.firewise.org. (See Exhibit 17.4.)

17.3.5.2.2 Where required by the AHJ because of extra hazardous conditions, additional areas shall be maintained to include additional defensible space from buildings or structures, trees adjacent to or overhanging a building shall be maintained free of deadwood, and the roof of a structure shall be free of leaves, needles, or other dead vegetative growth.

Some trees might be permitted within the structure ignition zone, provided that the horizontal distance between crowns of adjacent trees is at least 18 ft (5.5 m) where located within 30 ft (9 m) of the structure. Creating and maintaining planting islands is one way to provide shade and aesthetics while eliminating or reducing crown-to-crown continuity and achieving separation between tree crowns and the structure. Paragraph 17.3.5.2.2 requires that dead limbs on trees and downed fuels beneath trees be removed to maintain the area and prevent a ground fire from spreading into tree crowns. Trees within the ignition zone should be pruned to 6 ft to 10 ft (2 m to 3 m) above the ground surface and within 10 ft (3 m) of a chimney outlet. See Chapters 5 and 6 of NFPA 1144 for more information.

17.3.5.3 Roadways. Areas within 10 ft (3 m) on each side of portions of highways and private streets shall be cleared of combustible vegetation and other combustible growth. Single specimens of trees, shrubbery, or cultivated ground cover such as green grass, ivy, succulents, or similar plants used as ground covers shall be permitted to be exempt provided that they do not form a means of readily transmitting fire.

NFPA 1141 defines *roadway* as "any public or private street, including bridges and rights of way" and describes how roadways should be constructed and maintained. A roadway should be able to accommodate drainage, erosion control, and provisions for utilities. Also defined is the minimum clear width for each lane of travel, curves, parking permitted, intersections with slopes for drainage, and such. Bridges and culverts should be designed to a minimum of 100-year flood elevations and flows. Easements should be incorporated to permit vegetation clearing and also allow for evacuation and access by fire crews to wildland areas. Clearing roadways of combustible vegetation and growth allows access and egress for emergency responders and provides additional time for the use of the roadway for evacuation by removing means of the ready transmission of fire.

See Chapter 18 for minimum requirements for emergency vehicle access, bridges, angles of approach, gates, dead ends, and turning radius. Also see Chapter 5 of NFPA 1141 for additional information on roadways.

17.3.6 Unusual Circumstances. The AHJ shall determine that difficult terrain, danger of erosion, or other unusual circumstances could require additional safeguards.

17.3.7 Fire Roads, Firebreaks, and Emergency Access.

17.3.7.1 The provisions of 17.3.7 and Section 18.2 shall be used to determine the design, clearances, and provisions for emergency access (ingress and egress).

NFPA 1141 offers specific recommendations for means of access whether defined as public or private roadways, ranging from general information to the number of means of access based on the number of households, roadway grades typically not to exceed 8 degrees, dead ends more than 300 ft (91 m) to provide turnarounds not less than 120 ft (366 m) in outside diameter, signage to be addressed in a logical, consistent manner, as well as stipulations for fire lanes and parking lots. For additional guidance, see Chapter 5 of NFPA 1141.

Much of the building access and separation requirements addressed in Chapter 6 of NFPA 1141 are associated to NFPA 13, *Standard for the Installation of Sprinkler Systems*, or NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*.

17.3.7.2 Unauthorized vehicles shall not be driven upon fire roads or firebreaks. Vehicles shall not be parked in a manner that obstructs the entrance to a fire road or firebreak.

17.3.7.3 Radio and television aerials, guy wires, and other obstructions shall not be installed or maintained on fire roads or firebreaks unless the vertical clearance is sufficient to allow the movement of fire and emergency apparatus.

17.3.7.4 Motorcycles, motor scooters, and motor vehicles shall not be operated within hazardous fire areas, except upon clearly established public or private roads.

17.3.8 Tampering with Fire Safety Equipment. See Section 10.7 for requirements on tampering with fire safety equipment.

17.3.9 Maintenance. See 4.5.8 for requirements on maintenance.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.

NFPA 13R, *Standard for Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, 2016 edition.

NFPA 1051, *Standard for Wildland Firefighting Personnel Professional Qualifications,* 2016 edition.

NFPA 1141, *Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas*, 2017 edition.

NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildland Fire*, 2018 edition.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D7032, *Standard Specification for Establishing Performance Ratings for Wood-Plastic Composite Deck Boards and Guardrail Systems (Guards or Handrails),* 2017

ASTM E84, *Standard Test Method for Surface Burning Characteristic of Building Materials;* UL 723, *Standard for Test for Surface Burning Characteristic of Building Materials;* 2015b

ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer at 750°C;* 2016

ASTM E2886, *Test Method for Evaluating the Ability of Exterior Vents to Resist the Entry of Embers and Direct Flame Impingement*, 2014

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 723, *Standard for Test for Surface Burning Characteristic of Building Materials*, 2008, revised 2013.

ANSI/UL 790, *Standard for Safety for Tests for Fire Resistance of Roof Covering Materials*, 2004, revised 2014.

Fire Department Access and Water Supply

18

Chapter 18 includes most site design issues in one location. Fire department access fire lane marking requirements, minimum water supply requirements for manual fire suppression operations, and fire hydrant spacing provisions are all contained within this chapter. Criteria for fire hydrant locations and distribution were contained in Annex E of the 2012 edition of the *Code*; for the 2015 edition, the former Annex E criteria were revised and incorporated into Section 18.5, making the provisions mandatory rather than optional, adoptable requirements.

18.1 General

Fire department access and water supplies shall comply with this chapter.

18.1.1 Application.

18.1.1.1 This chapter shall apply to public and privately owned fire apparatus access roads.

Regardless of who owns a road, if it is utilized as a fire apparatus access road, it must comply with this chapter. There is no exemption for roads owned by a state, county, or municipality.

18.1.1.2 This chapter shall apply to public and privately owned fire hydrant systems.

Regardless of who owns a fire hydrant water system, that system must comply with this chapter. There is no exemption or distinction between private fire service mains, private utilities, and public utility systems.

18.1.2 Permits. Permits, where required, shall comply with Section 1.12.

18.1.3 Plans.

18.1.3.1 Fire Apparatus Access. Plans for fire apparatus access roads shall be submitted to the AHJ for review and approval prior to construction.

For new developments, this review should occur as part of the jurisdiction's site plan review process. If a public or private agency is conducting stand-alone roadway work, the plans for such road work should be submitted to the AHJ as part of the approval process.

18.1.3.2 Fire Hydrant Systems. Plans and specifications for fire hydrant systems shall be submitted to the AHJ for review and approval prior to construction.

For new developments, this review should occur as part of the jurisdiction's site plan review process. If a public or private utility is conducting stand-alone work on the utility system, such as adding new water mains or replacing existing water mains, the design for such work should be submitted to the AHJ as part of the approval process.

18.2 Fire Department Access

18.2.1 Fire department access and fire department access roads shall be provided and maintained in accordance with Section 18.2.

18.2.2* Access to Structures or Areas.

A.18.2.2 Access control devices take many forms such as remote opening devices, card keys, key codes, keys, and so forth.

18.2.2.1 Access Box(es). The AHJ shall have the authority to require an access box(es) to be installed in an accessible location where access to or within a structure or area is difficult because of security. The access box(es) shall be of an approved type listed in accordance with UL 1037.

Access boxes provide an orderly system of gaining access to buildings or areas while maintaining a high level of security. These heavy-duty key repository boxes provide a high-security system that ensures that only the fire department can access the keys or other devices within them. A definition of *access box* is provided in 3.3.2.

Some access box systems have provisions for securing the keys to the key box inside the cabs of fire apparatus. With these systems, the fire company must contact central dispatch to have the key released for use. Central dispatch keeps a log that indicates exactly when and where fire companies are accessing buildings or other secure areas. The dispatch center can also determine when the key has been returned to its secure position

Exhibit 18.1

UL-listed access box. (Courtesy of Knox, Co.)

in the apparatus. This type of system provides a high level of security. If a fire department does not have a good master key control system, the loss of a master key can create potential liability and expense to the department, with the accompanying bad press.

Some fire departments require access boxes to be mounted on a wall at a height of 10 ft to 12 ft (3 m to 3.66 m) to prevent the lock from being vandalized. The fire department can quickly access the box, using a ladder from the apparatus. Exhibit 18.1 illustrates a UL-listed access box in accordance with 18.2.2.1.

Most manufacturers that supply access boxes also provide a variety of other products, such as safety data sheet (SDS) cabinets, which can be used to keep important site information in a secure location for access by the fire department. Padlocks keyed to a master key system are also available. These locks can be used to secure gates and other locations where only the fire department is allowed access.

Factors to consider in determining the keys that should be provided in an access box include the fire department's operational procedures, the presence of fire protection systems, the hazards and hazardous materials present, and the nature of the occupancy and occupants.

18.2.2.2 Access to Gated Subdivisions or Developments. The AHJ shall have the authority to require fire department access be provided to gated subdivisions or developments through the use of an approved device or system.

Access to gated communities or other developments must comply with the same requirements for buildings or areas outlined in 18.2.2.1. Key systems that are compatible with access box master keys are available to facilitate access through electronic gates. Access gates might also use card access readers, siren-operated devices, infrared receivers, or other approved devices rather than keys. Since access codes and card access readers can sometimes change programing or fail without notice to the fire department, the AHJ should consider requiring a primary and a backup method to access electronic gates. For example, a primary access system could be a siren-operated system and a backup system could be a key switch. Exhibit 18.2 shows an example of a gate with an access box attached.

When considering the approval of such systems to access gated subdivisions or developments, the AHJ should consider other jurisdictional needs for access. Law enforcement, public works, garbage disposal, and other services may require access. Therefore, the AHJ should consult with these other entities to make them aware of the restricted access condition and the potential need to develop an access approach that is beyond the fire department and emergency medical services (EMS).

18.2.2.3 Access Maintenance. The owner or occupant of a structure or area, with required fire department access as specified in 18.2.2.1 or 18.2.2.2, shall notify the AHJ when the access is modified in a manner that could prevent fire department access.

Maintaining access devices is often difficult. During inspections and pre-fire planning, all access devices should be checked to ensure that they contain the proper keys and that the access devices function as intended. The on-site maintenance personnel

Exhibit 18.2

Example of gate access and access box.

may be aware of changes to locks or gate access systems that the building owner might have forgotten about or is not familiar with. All building owners with access boxes, gated developments, and area locksmiths should be notified in writing that they should contact the fire department when any front door, gate access programing, or other specified locks are changed. This process should help ensure that appropriate keys and access are available when needed. Jurisdictions should also consider issuing a permit for the initial installation of an access device to ensure it is installed in accordance with the manufacturer's instructions and meets the jurisdiction's specifications. Permitting also assists in creating a database that can be utilized for future maintenance checks by the fire department, and the location of the access box can be added to the dispatch computer-aided design (CAD) system.

18.2.3 Fire Department Access Roads.

18.2.3.1 Required Access.

18.2.3.1.1 Approved fire department access roads shall be provided for every facility, building, or portion of a building hereafter constructed or relocated.

To provide effective manual fire suppression operations, the fire department must be able to gain reasonable access to a building. Paragraph 18.2.3.1.1 addresses this need by requiring fire department access roads to all new facilities and buildings. A fire department access road, such as the one shown in Exhibit 18.3, can be a public or private roadway that meets the requirements of 18.2.3 and is not mandated to be marked as a fire lane unless so required by the AHJ.

Note that 18.2.3.1.1 requires fire department access only for newly constructed or relocated buildings and facilities. The *Code* does not require the modification of previously approved access to existing buildings to meet the current *Code* requirements in 18.2.3.1.1. Maintaining existing access is addressed in 18.2.2.3 and 18.2.4.

Exhibit 18.3

Fire department access road.

Buildings under construction are addressed in 16.1.4, which requires that fire department access roads be provided and maintained during building construction.

18.2.3.1.2 Fire department access roads shall consist of roadways, fire lanes, parking lot lanes, or a combination thereof.

Fire lanes are considered fire apparatus access roads, which are required to be marked in accordance with 18.2.3.6 where required by the AHJ. The term *fire lane* is defined in 3.3.126 as a fire department access road marked with approved signs or other approved notices.

18.2.3.1.3* The provisions of 18.2.3.1 through 18.2.3.2.2.1 shall be permitted to be modified by the AHJ where any of the following conditions exists:

(1) One- and two-family dwellings protected by an approved automatic sprinkler system in accordance with Section 13.1
(2) Existing one- and two-family dwellings
(3) Private garages having an area not exceeding 400 ft^2
(4) Carports having an area not exceeding 400 ft^2
(5) Agricultural buildings having an area not exceeding 400 ft^2
(6) Sheds and other detached buildings having an area not exceeding 400 ft^2

A.18.2.3.1.3 The intent of 18.2.3.1.3 is to not require fire department access roads to detached gazebos and ramadas, independent buildings associated with golf courses, parks, and similar uses such as restrooms or snack shops that are 400 ft^2 (37 m^2) or less in area, and detached equipment or storage buildings for commercial use that are 400 ft^2 (37 m^2) or less in area.

18.2.3.1.4 When fire department access roads cannot be installed due to location on property, topography, waterways, nonnegotiable grades, or other similar conditions, the AHJ shall be authorized to require additional fire protection features.

Site conditions or unique structural designs can result in a fire department access road design that does not meet the specific requirements of this *Code*. An example of such a situation would be a group of zero lot line buildings in a downtown area with no access to the sides or rear of the buildings. Another example would be an environment education building constructed in wetlands that is accessible only via a pedestrian path. Paragraph 18.2.3.1.4 recognizes such situations are sometimes unavoidable from a design standpoint. In these circumstances, the AHJ is authorized to require additional fire protection to offset the increased hazard or the delays created by an access road design that does not comply with 18.2.3. For example, additional fire protection could be in the form of an automatic sprinkler system and standpipe protection where not otherwise required.

18.2.3.2 Access to Building.

18.2.3.2.1 A fire department access road shall extend to within 50 ft (15 m) of at least one exterior door that can be opened from the outside and that provides access to the interior of the building.

Fire department access roads are required to be such that fire apparatus can drive within 50 ft (15 m) of an exterior door that allows access to the interior of the building.

Fire departments typically carry 150 ft or 200 ft (46 m or 61 m), or both, of preconnected hose lines on their apparatus. The access design configuration required in 18.2.3.2 allows fire fighters to quickly extend preconnected hose lines into the building from fire apparatus. If the fire apparatus can access the building within 50 ft (15 m), fire fighters can extend hose lines 100 ft to 150 ft (30 m to 46 m) into the building without undue delay.

Although not a mandatory requirement, in a multiple-tenant building, the exterior door should be placed at a location that allows access to a common hall or common lobby area or, if the building does not have a common interior area, to the largest tenant area. In single-tenant buildings, the exterior door should be placed at a location that allows unobstructed access to the tenant floor area.

Δ **18.2.3.2.1.1** Where a one- or two-family dwelling, or townhouse, is protected with an approved automatic sprinkler system that is installed in accordance with Section 13.3, the distance in 18.2.3.2.1 shall be permitted to be increased to 150 ft (46 m).

This paragraph recognizes that the presence of automatic sprinkler protection in one- and two-family dwellings and townhouses significantly reduces the risk to the occupants and fire fighters along with reducing the consequences of a fire. Due to this significantly reduced risk, the distance to the exterior door can be increased while still maintaining an improved level of building and life safety protection.

18.2.3.2.2 Fire department access roads shall be provided such that any portion of the facility or any portion of an exterior wall of the first story of the building is located not more than 150 ft (46 m) from fire department access roads as measured by an approved route around the exterior of the building or facility.

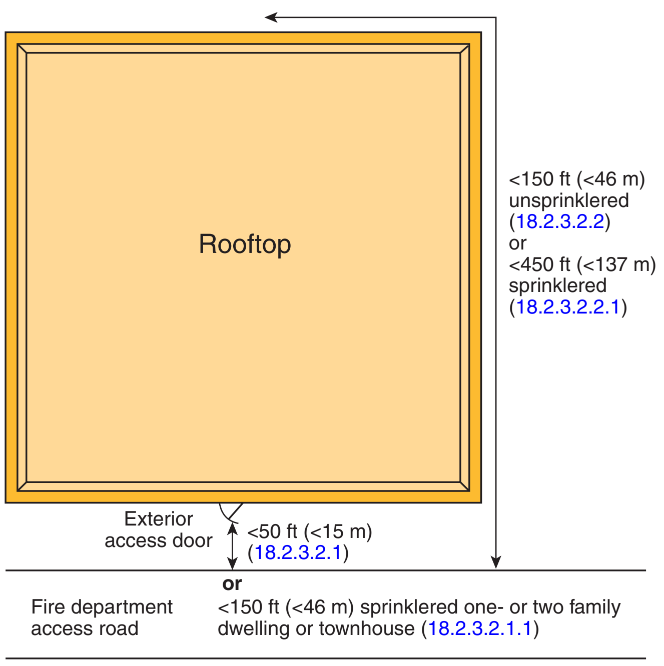
Fire department access is essential to providing effective manual fire suppression operations. Remote sections of the building need to be limited to ensure that hose streams, aerial fire apparatus, and fire fighters can access most portions of the building. Exhibit 18.4 illustrates an acceptable arrangement for compliance with 18.2.3.

18.2.3.2.2.1 When buildings are protected throughout with an approved automatic sprinkler system that is installed in accordance with NFPA 13, NFPA 13D, or NFPA 13R, the distance in 18.2.3.2.2 shall be permitted to be increased to 450 ft (137 m).

Paragraph 18.2.3.2.2.1 recognizes the significant benefits of automatic sprinkler protection in reducing the severity of fire incidents. If there is a fire sprinkler system, the access distance required by 18.2.3.2.2 is permitted to be increased to 450 ft (137 m).

18.2.3.3* Multiple Access Roads. More than one fire department access road shall be provided when it is determined by the AHJ that access by a single road could be impaired by vehicle congestion, condition of terrain, climate conditions, or other factors that could limit access.

Exhibit 18.4



Acceptable fire department access configuration.

N **A.18.2.3.3** Access roads that are below the 100-year base flood elevation and roadways that could be blocked by frequent rail traffic are two conditions that could limit access in an emergency and warrant an additional access roadway. Requiring additional access roads because of possible congestion should be based on a traffic impact analysis of the proposed development. This type of analysis is typically conducted by a transportation or traffic engineer and occurs at the cost of the developer. This *Code* avoids establishing a specific threshold for mandating multiple-access roads; potential congestion conditions are so variable that prescriptive language is not justified. The AHJ has the authority to require a study of the traffic conditions resulting from a development and the subsequent need for additional access via Section 1.15.

The following examples might warrant multiple fire department access roads:

1. Railroad tracks that cross a single fire department access road
2. Potential for mudslides along a single fire department access road
3. Single fire department access road that is below the 100-year flood elevation
4. Commercial or residential projects that generate large traffic counts on fire apparatus access roads

A traffic engineer should review the traffic counts and access design in large-scale development projects to ensure an appropriate access design for emergency vehicles. Even where it might not be feasible to provide multiple fire department access roads for large-scale developments, the traffic engineer can be consulted to provide potential mitigation methods to facilitate improved fire department access. These methods could include items such as mountable curbs, wider travel lanes, traffic signal preemption, or dedicated emergency access lanes.

N **18.2.3.4 Traffic Signal Pre-emption.** Where fire department apparatus are equipped with traffic signal pre-emption devices, newly installed traffic signals shall be equipped with traffic signal pre-emption.

Many fire departments have deployed traffic signal pre-emption systems. These systems reduce the risk of accidents in intersections during emergency responses and improve response times to both emergency and nonemergency incidents. As new traffic signals are installed or existing traffic signal equipment is replaced, it is important that traffic signal pre-emption be provided as part of the new or replacement equipment. AHJs should also be aware of what type of pre-emption technology is being utilized in their jurisdiction and adjacent jurisdictions. Coordination with the jurisdiction's traffic engineers is important to ensure that the AHJ is specifying the appropriate traffic signal equipment compatible with the equipment on fire apparatus.

18.2.3.5 Specifications.

The *Code* provides broad minimum design requirements for fire department access roads. For more specific design information on roadway design, see *A Policy on Geometric Design of Highways and Streets*, published by the American Association of State Highway and Transportation Officials (AASHTO), available for purchase at www.transportation.org, or consult applicable state and local roadway design standards.

18.2.3.5.1 Dimensions.

18.2.3.5.1.1* Fire department access roads shall have an unobstructed width of not less than 20 ft (6.1 m).

The minimum 20 ft (6.1 m) width required by 18.2.3.5.1.1 allows for two-way vehicular traffic and for one fire apparatus vehicle to pass while another is working at a fire hydrant or conducting aerial operations.

N **A.18.2.3.5.1.1** Where parking is permitted along the access road, the unobstructed width is not intended to include the width of the parking.

The AHJ should pay close attention to the parking arrangements in new residential subdivisions and apartment developments. Not all jurisdictions have adequate minimum parking regulations to ensure that a sufficient number of parking spaces are provided on-site for homes and dwelling units at apartments. If adequate parking is not provided for each home or dwelling unit, residents will attempt to park in the fire department access roads. In those circumstances, the 20 ft (6.1 m) minimum width required by 18.2.3.5.1.1 will not be sufficient. Use of the term *unobstructed* in 18.2.3.5.1.1 and emphasized by A.18.2.3.5.1.1 is intended to convey that the minimum 20 ft (6.1 m) width is not to be utilized for parking or any other use. Correction of this type of parking problem after a development has been built will be problematic. Therefore, the AHJ should address this type of issue during the site plan review.

N **18.2.3.5.1.1.1*** Where approved by the AHJ, the width of fire department access roads shall be permitted to be less than the minimum specified in 18.2.3.5.1.1.

N **A.18.2.3.5.1.1.1** One condition to consider in reducing access road width would be intended travel in one direction only.

In considering a reduction in the 20 ft (6.1 m) minimum required under 18.2.3.5.1.1, the AHJ should consider the following:

1. The potential for parking on the fire department access road. The greater the potential for parking to occur on the access roadway, the more difficult it is to justify reducing the width.
2. The length of the access road where the reduced width will be place. If the length of the roadway where the reduced width will be in place is relatively short, the potential for a hazard created by the reduction is also decreased.
3. Whether traffic moves in a single direction or in multiple directions. For one-way access roadways with no parking potential, it may be appropriate to permit roadway width reductions to 14 ft (4.3 m) or even 12 ft (3.7 m).
4. The typical amount of traffic on the roadway. If the roadway is congested during typical use times, it will be more difficult to justify a reduced width.

N **18.2.3.5.1.1.2** The width of fire department access roads shall be increased when the minimum width specified in 18.2.3.5.1.1 is not adequate to accommodate fire apparatus.

A typical example of this situation is an access road where on-street parking will be permitted or is anticipated due to inadequate on-site parking.

18.2.3.5.1.2 Fire department access roads shall have an unobstructed vertical clearance of not less than 13 ft 6 in. (4.1 m).

The minimum 13 ft 6 in. (4.1 m) vertical clearance ensures that fire apparatus can safely pass under power lines, bridges, and other obstructions. *A Policy on Geometric Design of Highways and Streets*, published by AASHTO, recommends a minimum 14 ft (4.3 m) clearance for local and collector roads. A 16 ft (4.9 m) clearance is recommended for rural and urban arterials. The 14 ft or 16 ft (4.3 m or 4.9 ft) recommendations allow for snow accumulation and future changes in roadway depth if additional roadway material is added.

Maintaining the minimum 13 ft 6 in. (4.1 m) clearance is also a consideration where trees are located next to the roadway. Where tree limbs grow to obstruct the 13 ft 6 in. (4.1 m) minimum clearance, the AHJ should require the private property owner or the public right-of-way owner to trim the trees to the appropriate minimum height.

AHJs should also be aware of building design elements that can obstruct the fire department movements. Where porte-cocheres or other overhead structures are utilized to allow vehicles to drive under, the AHJ should consider if the area under the porte-cochere should be considered a fire department access road and thus required to meet the minimum height of 13 ft 6 in. (4.1 m). Consideration should also be given to the need to park EMS vehicles in such locations even if the fire apparatus might not park or drive through the porte-cochere. If a porte-cochere is provided at the building main entrance, it should be designed to the 13 ft 6 in. (4.1 m) minimum.

18.2.3.5.1.2.1 Vertical clearance shall be permitted to be reduced where approved by the AHJ, provided such reduction does not impair access by fire apparatus, and approved signs are installed and maintained indicating the established vertical clearance when approved.

One example of acceptable reduced vertical clearance would be the entrance to a parking garage. Where low clearances are permitted, the *Code* mandates that approved warning signs be provided to notify emergency responders of the restricted access condition.

Δ **18.2.3.5.1.2.2** Vertical clearances shall be increased when vertical clearances are not adequate to accommodate fire apparatus.

An example of the need for an increased vertical clearance might be to accommodate an aircraft rescue fire-fighting (ARFF) vehicle in areas on and adjacent to airports. Many of these vehicles exceed standard apparatus dimensions and require greater vertical clearances.

18.2.3.5.2* Surface. Fire department access roads shall be designed and maintained to support the imposed loads of fire apparatus and shall be provided with an all-weather driving surface.

Fire department access roads need to be able to withstand the live loads of fire apparatus, but they are not required to be constructed of any specific material. The roadway design needs to accommodate water runoff and ice and snow accumulations in locations subject to freezing temperatures.

Special consideration should be given to the design of subsurface structures and their placement relative to the location of the fire department access road. Examples of such subsurface structures include drainage pipes and septic tanks. If improperly designed, these subsurface structures have the potential to collapse under standard fire apparatus loads or the load imposed by an aerial fire apparatus stabilizer. The proposed design should be in accordance with a local, state, or nationally recognized standard for roadway design.

The AHJ might not have sufficient expertise to review the access roadway design to determine if it is appropriately stabilized. Therefore, it is appropriate for the AHJ to request that the access roadway design be completed by a registered design professional and reviewed by individuals with expertise in the area of roadway construction.

N **A.18.2.3.5.2** It is not the intent of 18.2.3.5.2 to restrict the design of fire department access roads to traditional, non-permeable materials such as asphalt or concrete. Permeable materials, pavers, or other designs can be used if approved by the AHJ and meet the loading requirements in all weather conditions. In considering whether to approve non-traditional materials, the AHJ should consider maintenance issues due to weather and traffic.

The designer and AHJ should consider the point loads created by fire department aerial apparatus stabilizers in the design of fire department access roads. NFPA 1901 limits the pressure exerted over the ground contact under the apparatus stabilizer to 75 psi (517 kPa). The 75 psi (517 kPa) design specification, along with a safety margin, should be included in the design of fire department access roads that would be used as a base to operate fire department aerial apparatus.

18.2.3.5.3 Turning Radius.

18.2.3.5.3.1 The turning radius of a fire department access road shall be as approved by the AHJ.

Local authorities should review their current and future apparatus needs and specifications to determine the appropriate design standard for their jurisdictions. In lieu of a specific local design requirement, the dimensions in Exhibit 18.5 should be used as a turning radius guide for most fire apparatus.

Determining turning movements within a development has become much easier in recent years. Software solutions are available that allow the designer to overlay fire apparatus turning movements directly on site plans utilizing the exact specifications of the fire department's apparatus.

18.2.3.5.3.2 Turns in fire department access roads shall maintain the minimum road width.

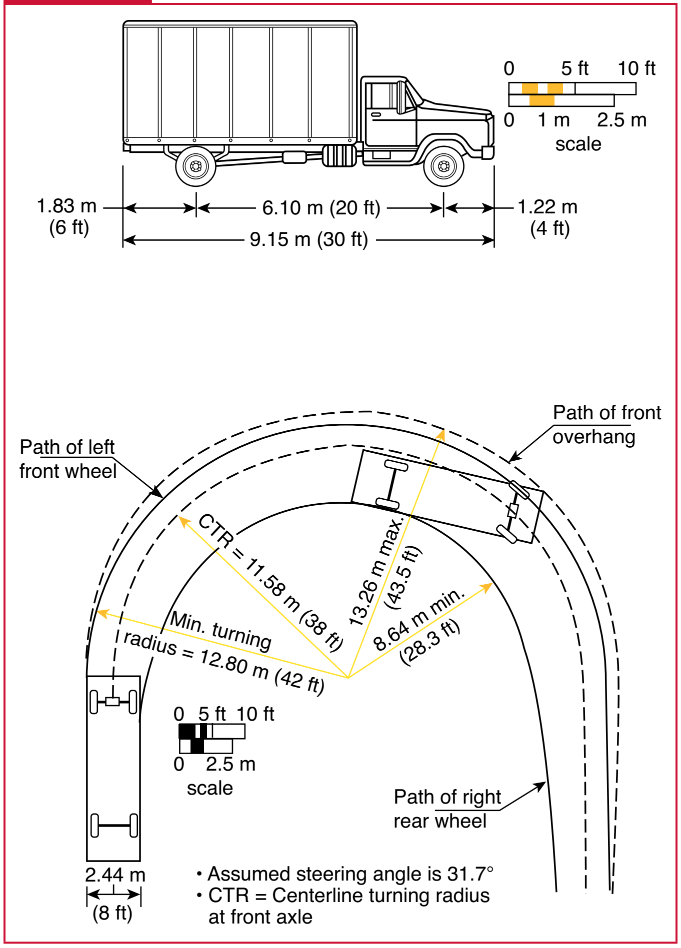
N **18.2.3.5.3.3** Fire department access roads connecting to roadways shall be provided with curb cuts extending at least 2 ft (0.61 m) beyond each edge of the fire department access road.

18.2.3.5.4 Dead Ends. Dead-end fire department access roads in excess of 150 ft (46 m) in length shall be provided with approved provisions for the fire apparatus to turn around.

Where a fire department access road exceeds 150 ft (46 m) in length and is also a dead end, an approved turnaround is required. Appropriate turning radii must be provided for the turnaround, as indicated in 18.2.3.5.3. Acceptable turnarounds can include a U-turn movement, as shown in Exhibit 18.5, or a T-turn or a Y-turn, as shown in Exhibit 18.6.

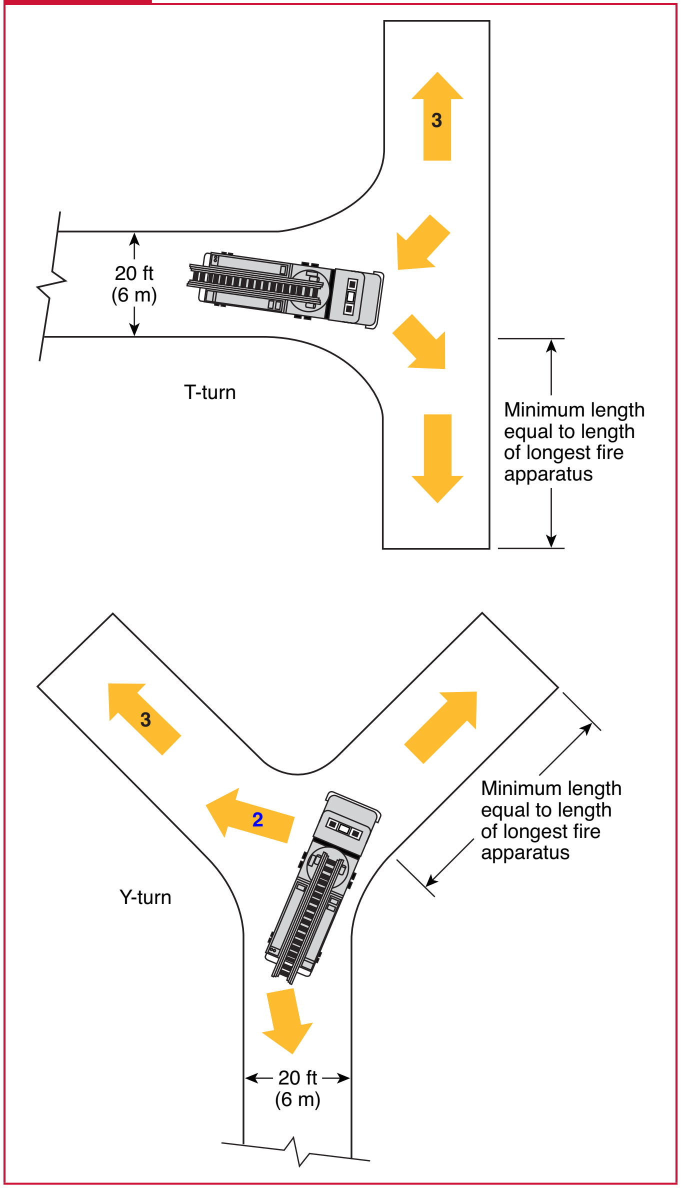
A common question is whether fire department access roads exceeding 150 ft (46 m) in length, but not required to

Exhibit 18.5



Minimum turning path for single unit truck design vehicle. (Source: A Policy on Geometric Design of Highways and Streets, 2011, by the American Association of State Highway and Transportation Officials, Washington, DC; Used by Permission.)

Exhibit 18.6



T-turn and Y-turn turnaround arrangements.

exceed 150 ft (46 m) to meet the building access requirements of 18.2.3.2, are required to be provided with approved turnarounds. The AHJ might determine no turnaround would be required if the dead-end road length were reduced to not greater than 150 ft (46 m). While such reduction of the dead-end road length would eliminate the turnaround requirement, it might be more beneficial to the fire department to provide the longer, nonrequired dead-end road with no turnaround. Such determination should be made by the AHJ on a case-by-case basis.

18.2.3.5.5 Bridges.

18.2.3.5.5.1 When a bridge is required to be used as part of a fire department access road, it shall be constructed and maintained in accordance with nationally recognized standards.

The most widely used nationally recognized standard is *Standard Specifications for Highway Bridges*, published by the American Association of State Highway and Transportation Officials (AASHTO). The AHJ should consult with a registered design profession if there is a question as to the specifications used for the design of a bridge.

18.2.3.5.5.2 The bridge shall be designed for a live load sufficient to carry the imposed loads of fire apparatus.

Bridges must be designed to support the live load of the heaviest piece of fire apparatus likely to be driven on them. All bridges should be designed for an HS-20 highway vehicle load rating in accordance with *Standard Specifications for Highway Bridges*. The AHJ should consult with a registered design professional for assistance if there is there is a question as to the structural design of a bridge.

Exhibit 18.7

Bridge load limit sign.

18.2.3.5.5.3 Vehicle load limits shall be posted at both entrances to bridges where required by the AHJ.

Signage that indicates vehicle load limits should be designed so that it is readily obvious to fire apparatus drivers approaching the bridge. See Exhibit 18.7 for an example of a bridge load limit sign.

18.2.3.5.6 Grade.

The access road gradient should allow fire apparatus use of the fire department access road during all conditions, such as snow, ice, and rain. The grade should not be too steep, which could prevent a speedy response. Fire apparatus designs vary so widely that a specific requirement could be found to be burdensome for some jurisdictions and insufficient for others. Local authorities should review their current and future apparatus needs and specifications to determine a specific design standard in their jurisdiction.

18.2.3.5.6.1 The gradient for a fire department access road shall not exceed the design limitations of the fire apparatus of the fire department and shall be subject to approval by the AHJ.

18.2.3.5.6.2* The angle of approach and departure for any means of fire department access road shall not exceed 1 ft drop in 20 ft (0.3 m drop in 6 m) or the design limitations of the fire apparatus of the fire department, and shall be subject to approval by the AHJ.

A.18.2.3.5.6.2 The design limits of fire department apparatus should take into account mutual aid companies and other response agencies that might respond to emergencies.

The 1 in 20 slope is a reasonable design standard if the AHJ has not adopted specific design limitations based on the needs of the fire department's apparatus.

18.2.3.5.7 Traffic Calming Devices. The design and use of traffic calming devices shall be approved by the AHJ.

The most common type of traffic calming device is the speed bump. Other types of traffic calming devices can include traffic circles, intentional turning movements put into the roadway, rumble strips, and speed humps. Regardless of the type of traffic calming device, the AHJ should review the placement, the size, and other factors of traffic calming devices to ensure response time is not reduced and fire apparatus can navigate the installed devices. The requirement for the AHJ to review and approve traffic calming devices applies to both private and public fire apparatus access roads.

Security devices are often placed to prevent, reduce, or make access more difficult. Security device installation can be a form of traffic calming and should be reviewed to ensure that fire apparatus can maneuver, gain access, and perform fire-fighting operations. (See Exhibit 18.8.)

Exhibit 18.8

Example of a traffic calming security device.

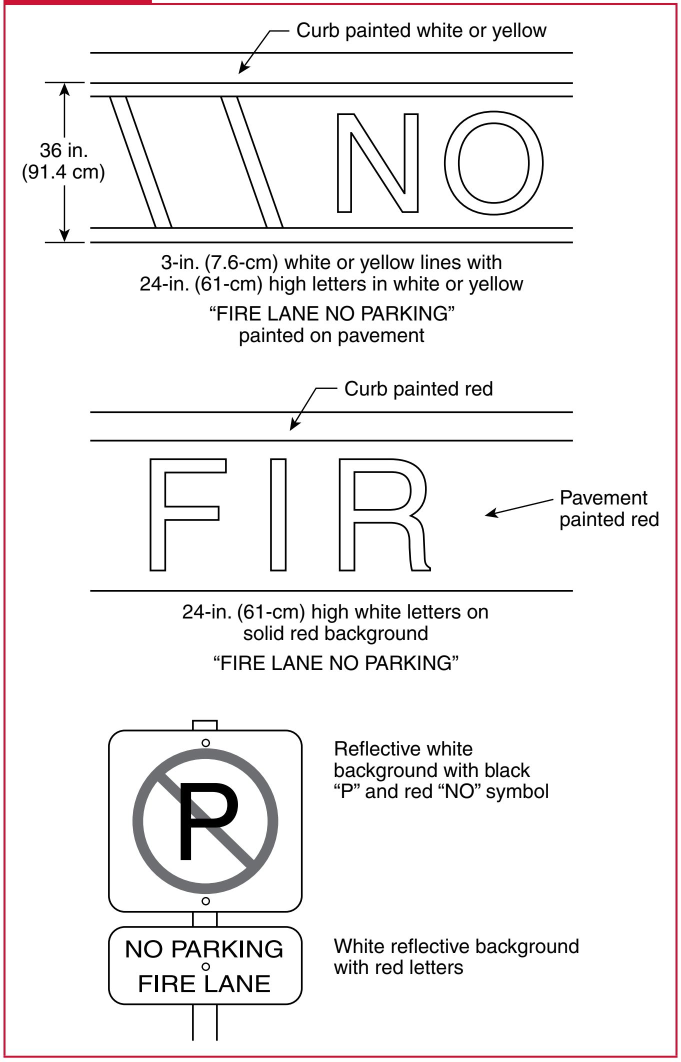
18.2.3.6 Marking of Fire Apparatus Access Road.

18.2.3.6.1 Where required by the AHJ, approved signs, approved roadway surface markings, or other approved notices shall be provided and maintained to identify fire department access roads or to prohibit the obstruction thereof or both.

The *Code* does not require that all fire apparatus roads be marked as fire lanes. Marking is required only where the AHJ determines it is necessary to prohibit obstructions of the fire apparatus access road. In addition to determining if the fire apparatus access road needs to be marked, the AHJ should determine if specific fire protection features require marking to prohibit obstructions of the features. For example, the AHJ might determine that marking is necessary around fire hydrants, fire department connections, and access gates to prevent parking or standing.

The AHJ should ensure that approved markings, signs, and notices are consistent with the requirements of local and state laws. See Exhibit 18.9 for examples of fire department access road markings.

Exhibit 18.9



Examples of fire lane markings.

18.2.3.6.2 A marked fire apparatus access road shall also be known as a fire lane.

The term *fire lane* is sometimes confused with and used interchangeably with the term *fire apparatus access road*. The terms are not the same. A fire apparatus access road can exist without being a fire lane. A fire lane exists only when a fire apparatus access road gets marked in accordance with 18.2.3.6.1 and thus becomes a fire lane. The term *fire lane* is defined in 3.3.126 and further explained in A.3.3.126.

18.2.4* Obstruction and Control of Fire Department Access Road.

A.18.2.4 Fire department access roads should be kept clear of obstructions such as parked vehicles, fences and other barriers, dumpsters, and excess vegetation. However, it should be understood that a severe snowstorm can make these roads temporarily inaccessible. In many parts of the country, the annual snowfall is of such magnitude that alternative arrangements such as temporary roads over the snow accumulation could be necessary.

An AHJ in such an area of the country should pay close attention to the placement of fire hydrants and fire department connections along fire department access roads.

18.2.4.1 General.

18.2.4.1.1 The required width of a fire department access road shall not be obstructed in any manner, including by the parking of vehicles.

18.2.4.1.2 Minimum required widths and clearances established under 18.2.3.5 shall be maintained at all times.

18.2.4.1.3* Facilities and structures shall be maintained in a manner that does not impair or impede accessibility for fire department operations.

A.18.2.4.1.3 These obstructions include those obscuring or interfering with fire department connections to sprinkler systems or standpipe systems or both.

18.2.4.1.4 Entrances to fire department access roads that have been closed with gates and barriers in accordance with 18.2.4.2.1 shall not be obstructed by parked vehicles.

Where necessary, the AHJ should consult 18.2.2 regarding the requirements for access boxes, gated subdivisions, and access maintenance.

18.2.4.2 Closure of Accessways.

18.2.4.2.1 The AHJ shall be authorized to require the installation and maintenance of gates or other approved barricades across roads, trails, or other accessways not including public streets, alleys, or highways.

18.2.4.2.2 Where required, gates and barricades shall be secured in an approved manner.

18.2.4.2.3 Roads, trails, and other accessways that have been closed and obstructed in the manner prescribed by 18.2.4.2.1 shall not be trespassed upon or used unless authorized by the owner and the AHJ.

18.2.4.2.4 Public officers acting within their scope of duty shall be permitted to access restricted property identified in 18.2.4.2.1.

Individuals accessing private property should check with local legal counsel prior to accessing property without permission of the property owner. See 1.7.7 and 1.8.

18.2.4.2.5 Locks, gates, doors, barricades, chains, enclosures, signs, tags, or seals that have been installed by the fire department or by its order or under its control shall not be removed, unlocked, destroyed, tampered with, or otherwise vandalized in any manner.

N **18.2.4.2.6** Gates shall comply with 18.2.4.2.6.1 and 18.2.4.2.6.2.

N **18.2.4.2.6.1** Electric gate operators and systems, where provided, shall be installed, maintained, listed, and labeled in accordance with UL 325, *Door, Drapery, Gate, Louver, and Window Operators and Systems*.

Section 18.2.4.6 is new to the 2018 edition of the *Code*. UL 325, *Door, Drapery, Gate, Louver, and Window Operators and Systems*, covers electric operators for doors, draperies, gates, louvers, windows, exterior awnings, and other opening and closing appliances rated 600 V or less to be employed in ordinary locations in accordance with the locally adopted electrical code. If electric gates are used to control access on fire access roads, gate operators listed to UL 325 have been evaluated to prevent entrapment, and to reliably operate.

The Consumer Product Safety Commission worked with UL to develop tougher safety standards that require automatic gates to have at least two mechanisms to prevent entrapment. These UL 325 provisions are similar to the standards in effect for automatic garage doors. The UL 325 standard, which UL adopted in March 2000, requires an internal sensing device that will reverse the gate if it encounters an obstruction when opening or closing; and a secondary external sensing mechanism, such as an electric eye or an edge sensor that will reverse the gate if an obstruction is detected.

N **18.2.4.2.6.2** Gates intended for automatic operation shall be designed, constructed, installed, and maintained to comply with ASTM F2200, *Standard Specification for Automated Vehicular Gate Construction*.

ASTM F2200, *Standard Specification for Automated Vehicular Gate Construction*, establishes the performance-based and prescriptive-based methods of evaluating various classes of automated gate constructions that are used for vehicular traffic. The gate types addressed in ASTM F2200 include horizontal slide gates, horizontal swing gates, vertical lift gates, vertical pivot gates, and overhead pivot gates.

18.2.4.2.7 When authorized by the AHJ, public officers acting within their scope of duty shall be permitted to obtain access through secured means identified in 18.2.4.2.1.

18.3 Water Supplies

18.3.1* An approved water supply capable of supplying the required fire flow for fire protection shall be provided to all premises upon which facilities, buildings, or portions of buildings are hereafter constructed or moved into the jurisdiction. The approved water supply shall be in accordance with Section 18.4.

A.18.3.1 See Section 18.4 for determining required fire flow.

An approved water supply capable of supplying the needed fire flow must be provided for all new buildings and all buildings moved into the jurisdiction. Section 18.4 specifies the method for determining the required fire flow. The *Code* also provides broad discretion to the AHJ in approving how the water supply can be provided. While fire flow water supply typically is provided via fire hydrants, in rural or suburban locations, the AHJ may approve alternative methods to provide the required fire flow water supply. Such alternative methods could include dry hydrants, drafting locations, ground storage tanks, wells, tanker shuttle operations, longer-than-normal hose lays from remote water supplies, or some combination of these water supply delivery methods. The AHJ has the final authority to determine if the proposed water supply delivery method(s) are appropriate and can be approved.

AWWA M31, *Distribution System Requirements for Fire Protection;* NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting;* and the *NFPA Fire Protection Handbook* provide additional guidance on water distribution system designs for fire protection.

18.3.1.1* Where no adequate or reliable water distribution system exists, approved reservoirs, pressure tanks, elevated tanks, fire department tanker shuttles, or other approved systems capable of providing the required fire flow shall be permitted.

A.18.3.1.1 NFPA 1141 and NFPA 1142 can serve as references for additional water supply and fire flow information.

Paragraph 18.3.1.1 gives the AHJ the authority to approve alternative fire flow water supply sources where no adequate or reliable water distribution system exists. See NFPA 1142 for additional guidance on water supplies for suburban and rural fire fighting.

18.4 Fire Flow Requirements for Buildings

Section 18.4 is performance based, which means it does not specify the type of system to be used to provide the required fire flow. Methods of delivering the required fire flow include, but are not limited to, the methods listed in 18.3.1.1. The AHJ has the final authority to determine if the proposed water supply delivery method(s) are appropriate and can be approved.

18.4.1* Scope.

A.18.4.1 Section 18.4 and the associated tables are only applicable for determining minimum water supplies for manual fire suppression efforts. Water supplies for fire protection systems are not addressed by this section. It is not the intent to add the minimum fire protection water supplies, such as for a fire sprinkler system, to the minimum fire flow for manual fire suppression purposes required by this section.

The explanatory material in A.18.4.1 clarifies that the intent of the *Code* is not to add the fire flow calculated in accordance with Section 18.4 to an automatic sprinkler system demand. For sprinklered buildings, the required water supply is the greater of either the fire flow specified by Section 18.4 or the demand for the automatic sprinkler system. Section 18.4 is used to calculate the required fire flow for manual fire-fighting purposes and does not take into account fire suppression systems or hose stream requirements required by other codes and standards, such as NFPA 13, *Standard for the Installation of Sprinkler Systems*. Water supply requirements for fire protection system designs, such as NFPA 13, are not permitted to take advantage of the reduction in fire flow in 18.4.5.

18.4.1.1* The procedure determining fire flow requirements for buildings hereafter constructed or moved into the jurisdiction shall be in accordance with Section 18.4.

A.18.4.1.1 For the purpose of this section, a building subdivided by fire walls constructed in accordance with the building code is considered to be a separate building.

Fire flow area should be determined based on the area within the surrounding exterior walls and fire separation walls used to create separate buildings as modified by 18.4.4. Areas of the building without surrounding exterior walls should be included in the fire area, if such areas are within the horizontal projection of the roof or the floor above. In most cases, what constitutes a “fire wall” is defined by NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*, and the building code. Typically, fire walls are fire-resistance rated walls with a 2-hour, 3-hour, or 4-hour rating (depending on the hazards the wall is protecting) and are continuous from foundation to or through the roof with structural stability to allow collapse on either side of the wall while maintaining the integrity of the wall. Fire walls are different from fire barrier walls. Fire barrier walls alone would not create sufficient subdivision of the building spaces under a building code or Section 18.4 of this *Code* to be considered separate buildings.

18.4.1.2 Section 18.4 shall not apply to structures other than buildings.

18.4.2 Definitions. See definitions 3.3.14.4, Fire Flow Area, and 3.3.120, Fire Flow.

18.4.3 Modifications.

18.4.3.1 Decreases in Fire Flow Requirements.

The AHJ is permitted to use discretion in reducing the required fire flow in rural areas with isolated buildings where providing the required fire flow would be impractical and the risk can be reasonably managed. It is important to note that reducing the fire flow is at the sole discretion of the AHJ. Before reducing the fire flow, the AHJ should determine if the site conditions warrant a reduction and whether additional protection methods, such as automatic sprinkler protection, limiting the type of building construction, or mandatory setbacks created with easements to prohibit the construction of future exposure hazards, are necessary to justify a reduction while maintaining a reasonable level of property protection and life safety (see 18.4.3.1.1).

18.4.3.1.1* Fire flow requirements shall be permitted to be decreased by the AHJ for isolated buildings or a group of buildings in rural areas or suburban areas where the development of full fire flow requirements is impractical as determined by the AHJ.

A.18.4.3.1.1 The intent of 18.4.3.1.1 is to provide some limited flexibility in those circumstances where there is no water supply available and the fire department’s capabilities to deliver water via a tanker shuttle or drafting operation are also limited. The AHJ should consider establishing additional conditions, such as those contained in 18.4.3.1.2, prior to permitting decreased fire flow capability.

18.4.3.1.2 The AHJ shall be authorized to establish conditions on fire flow reductions approved in accordance with 18.4.3.1.1 including, but not limited to, fire sprinkler protection, type of construction of the building, occupancy, development density, building size, and setbacks.

When establishing conditions to allow for a reduction in the required fire flow, the AHJ should ensure that such conditions are legally attached to the site. Methods to attach those conditions to the site could be via site plan permit approval, building permit approval, or the certificate of occupancy and recorded as part of the public record. It is important to ensure that future owners and tenants are made aware of the conditions that are tied to the property as part of the fire flow reduction.

18.4.3.2 Increases in Fire Flow Requirements. The minimum required fire flow shall be permitted to be increased by the AHJ where conditions indicate an unusual susceptibility to group fires or conflagrations. An upward modification shall not be more than twice that required for the building under consideration.

One condition under which the AHJ might consider increasing the minimum required fire flow is where existing buildings on adjacent sites create significant fire exposures. For example, an existing adjacent building may be of combustible construction, located close to the property line, and constructed with exterior walls not having a fire resistance rating. Those types of existing conditions may not be consistent with the current construction practices mandated in the building code. Therefore, the AHJ might determine that an increase in the required fire flow is necessary to provide for exposure protection fire streams.

18.4.4 Fire Flow Area.

18.4.4.1 General. The fire flow area shall be the total floor area of all floor levels of a building except as modified in 18.4.4.2.

The fire flow area should be determined based on the area within the surrounding exterior walls and fire separation walls used to create *separate* buildings. The type of walls necessary to create separate buildings is typically determined by the applicable building code. Typically, fire walls are fire-resistance rated walls with a 2-hour, 3-hour, or 4-hour rating (depending on the hazards the wall is protecting) and are continuous from foundation to or through the roof with structural stability to allow collapse on either side of the wall while maintaining the integrity of the wall. Fire walls are different from fire barrier walls. Fire barrier walls would not create sufficient subdivision of the building spaces under a building code or Section 18.4 of this *Code* to be considered separate buildings and separate fire flow areas.

Areas of the building without surrounding exterior walls should be included in the fire area, if such areas are within the horizontal projection of the roof or the floor above. The fire area includes the total of all floor areas within the building, except as specified in 18.4.4.2.

18.4.4.2 Type I (443), Type I (332), and Type II (222) Construction. The fire flow area of a building constructed of Type I (443), Type I (332), and Type II (222) construction shall be the area of the three largest successive floors.

Due to their inherent fire resistance, the fire flow areas of buildings of Type I (443), Type I (332), and Type II (222) construction are limited to the three largest successive floors. See NFPA 220, *Standard on Types of Building Construction,* and *NFPA 5000®, Building Construction and Safety Code®*, for more information on building construction types. See A.12.2 and Table A.12.2 for a cross-reference of building construction types used by the various model building codes throughout the United States.

18.4.5 Fire Flow Requirements for Buildings.

18.4.5.1 One- and Two-Family Dwellings Not Exceeding 5000 ft² (464.5 m²).

18.4.5.1.1 The minimum fire flow and flow duration requirements for one- and two-family dwellings having a fire flow area that does not exceed 5000 ft² (464.5 m²) shall be 1000 gpm (3785 L/min) for 1 hour.

For one- and two-family dwellings that do not exceed 5000 ft² (464.5 m²), a standard minimum fire flow of 1000 gpm (378 L/min) is established. Most new homes will not exceed this square footage. Therefore, the 1000 gpm (378 L/min) standardized minimum fire flow avoids forcing the AHJ to calculate separate fire flows demands for each one- or two-family dwelling that is less than 5000 ft² (464.5 m²).

The scope of one- and two-family dwellings is not intended to include townhomes, apartments, or condominiums. Fire flow requirements for those types of dwellings should be calculated under 18.4.5.3.

18.4.5.1.2* A reduction in required fire flow of 75 percent shall be permitted where the one- and two-family dwelling is provided with an approved automatic sprinkler system.

The significant property preservation benefits of automatic sprinkler system protection in one- and two-family dwellings are recognized by permitting a 75 percent reduction in the required fire flow where automatic sprinkler systems are provided. A one- or two-family dwelling that is less than 5000 ft² (464.5 m²) in area and protected by an automatic sprinkler system would have a required fire flow of 250 gpm (946 L/min) with the 75 percent reduction applied under 18.4.5.1.2, rather than the 1000 gpm (3785 L/min) that is required for a nonsprinklered dwelling of the same size. However, 18.4.5.1.5 states that the required fire flow shall not be reduced below 500 gpm (1893 L/min). Therefore, 500 gpm (1893 L/min) would be the minimum required fire flow for a one- and two-family dwelling that is fire sprinkler protected and does not exceed 5000 ft² (464.5 m²).

Δ **A.18.4.5.1.2** Approved automatic sprinkler systems for one- and two-family dwellings include those meeting the requirements of NFPA 13, NFPA 13D, and NFPA 13R.

18.4.5.1.3* Where one- and two-family dwellings are proposed to be constructed in areas where water distribution systems providing fire flow were designed and installed prior to the effective date of this *Code*, the AHJ shall be authorized to accept the previously designed system fire flow where the one- and two-family dwellings are provided with approved automatic sprinkler systems.

The provision of 18.4.5.1.3 recognizes the installation of public water supplies that were approved prior to the adoption of the fire flow provisions of this *Code*. The intent of the *Code* is to not prohibit the construction of new one- and two-family dwellings where such previously approved water supply conditions exist. Because residential sprinkler systems, installed in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, are intended to provide for life safety only and do not necessarily provide complete coverage, building separation distances should be evaluated to reduce the probability of fire spread from one building to another where such diminished water supplies exist. Most building codes also require the rating of exterior walls of one- and two-family dwellings where minimum setbacks are not achieved to the property line or to adjacent buildings.

Δ **A.18.4.5.1.3** Approved automatic sprinkler systems for one- and two-family dwellings include those meeting the requirements of NFPA 13, NFPA 13D, and NFPA 13R.

18.4.5.1.4 A reduction in fire flow shall be permitted for building separation distance in accordance with 18.4.5.1.4 and Table 18.4.5.1.4.

18.4.5.1.4.1 Where multiple buildings are located on a single lot, the building separation distance shall be the distance between the buildings.

***TABLE 18.4.5.1.4** Permitted Fire Flow Reduction for Building Separation*

Separation Distance Between Buildings on a Single Lot		Separation Distance to Lot Line or Easement[a]		Permitted Fire Flow Reduction
ft	M	Ft	M	
>30 and ≤50	>9.1 and ≤15.2	>15 and ≤25	>4.6 and ≤7.6	25%
>50	>15.2	>25	>7.6	40%

[a]See 18.4.5.1.4.3.

18.4.5.1.4.2 Where a building abuts a lot line, the building separation distance shall be the distance between the building and the lot line.

18.4.5.1.4.3 Where a building is contiguous to a public right of way or no-build easement, the separation distance shall be the distance between the building to the opposite side of the right of way or no-build easement.

18.4.5.1.4.4 Where multiple buildings are located on a single lot and abut a lot line, the building separation distance for determining fire flow reduction shall be the smallest of the two distances.

Where one- and two-family dwellings are separated from other buildings by a minimum of 30 ft (9.1 m), exposure fire risk is significantly reduced. Therefore, the 1000 gpm (3785 L/min) fire flow specified by 18.4.5.1.1 is permitted to be reduced by 25 percent, or 250 gpm (946 L/min), in accordance with Table 18.4.5.1.4. A nonsprinklered one- or two-family dwelling, separated from other buildings by at least 30 ft (9.1 m), would have a required fire flow of 750 gpm (2839 L/min). Table 18.4.5.1.4 permits an increased fire flow reduction of 40 percent where the building separation distance exceeds 50 ft (15.2 m). A nonsprinklered one- or two-family dwelling, separated from other buildings by more than 50 ft (15.2 m), would have a required fire flow of 600 gpm (2270 L/min). Equivalent separation distance criteria are provided in Table 18.4.5.1.4 for lot lines and no-build easements. When an AHJ approves a fire flow reduction under the provisions of section 18.4.5.1.4, the AHJ should ensure that a method is utilized to memorialize the conditions of the fire flow reduction so that future owners are legally restricted from new construction that would violate the setback limits of Table 18.4.5.1.4.

18.4.5.1.5* The reductions in 18.4.5.1.2, 18.4.5.1.3, and 18.4.5.1.4 shall not reduce the required fire flow to less than 500 gpm (1900 L/min).

A.18.4.5.1.5 The fire flow reductions specified in 18.4.5.1.2, 18.4.5.1.3, and 18.4.5.1.4 are permitted to be combined. However, where the reductions are combined, the resulting required fire flow is not permitted to be reduced to less than 500 gpm (1900 L/min) for 1 hour.

A minimum fire flow of 500 gpm (1893 L/min) is required for one- and two-family dwellings regardless of the reductions that may be allowed under 18.4.5.1.2, 18.4.5.1.3, and 18.4.5.1.4. If fire flow were permitted to be reduced below 500 gpm (1893 L/min), there is a significant potential to reduce the pressure in a water distribution system below 20 psi (139.9 kPa) residual if a fire hydrant were to be opened. This would have the potential to create contamination of the potable drinking water system. In addition, insurance companies may not recognize fire flows that are provided from fire hydrants that flow less than 500 pm (1893 L/min.)

18.4.5.2 One- and Two-Family Dwellings Exceeding 5000 ft² (464.5 m²).

18.4.5.2.1 Fire flow and flow duration for dwellings having a fire flow area in excess of 5000 ft² (464.5 m²) shall not be less than that specified in Table 18.4.5.2.1.

Where a one- or two-family dwelling exceeds 5000 ft² (464.5 m²), the dwelling's required fire flow needs to be individually calculated under the provisions of Table 18.4.5.2.1 as opposed to utilizing the standard fire flow of 1000 gpm (3785 L/min) under 18.4.5.1.1 for one- and two-family dwellings that are 5000 ft² (464.5 m²) or less.

The fire flow requirements in Table 18.4.5.2.1 are based on buildings without automatic sprinkler system protection. Buildings with sprinkler protection in accordance with NFPA 13, NFPA 13D, or NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies,* as applicable, are permitted a reduction in the fire flow required by Table 18.4.5.2.1. See 18.4.5.2.2, 18.4.5.2.3, 18.4.5.2.4, 18.4.5.3.2, 18.4.5.3.3, 18.4.5.3.4, and 18.4.5.3.5 for the permitted fire flow reductions based on specific conditions or the presence of automatic sprinkler systems.

The building construction types specified by Table 18.4.5.2.1 are defined in NFPA 220 and *NFPA 5000*. See A.12.2 and Table A.12.2 for a cross-reference of building construction types used by the various model building codes throughout the United States.

18.4.5.2.2 Required fire flow shall be reduced by 75 percent and the duration reduced to 1 hour where the one- and two-family dwelling is provided with an approved automatic sprinkler system.

The significant property preservation benefits of automatic sprinkler system protection in one- and two-family dwellings are recognized by permitting a 75 percent reduction in the required fire flow where automatic sprinkler systems are provided.

18.4.5.2.3 A reduction in the required fire flow shall be permitted where a one- and two-family dwelling is separated from all lot lines in accordance with Table 18.4.5.1.4.

The fire flow reduction percentages specified in Table 18.4.5.1.4 also apply to one- and two-family dwellings that exceed 5000 ft² (464.5 m²).

18.4.5.2.4 Required fire flow for one- and two-family dwellings protected by an approved automatic sprinkler system shall not exceed 2000 gpm (7571 L/min) for 1 hour.

The *Code* establishes a maximum cap for required fire flow of 2000 gpm (7571 L/min) where one- and two-family dwellings are protected by an approved automatic sprinkler system. If the dwelling is not provided with an approved automatic sprinkler system, there is no maximum fire flow cap established under the *Code.*

18.4.5.2.5* The reductions in 18.4.5.2.2, and 18.4.5.2.3 shall not reduce the required fire flow to less than 500 gpm (1900 L/min) for 1 hour.

A.18.4.5.2.5 The fire flow reductions specified in 18.4.5.2.2 and 18.4.5.2.3 are permitted to be combined. However, where the reductions are combined, the resulting required fire flow is not permitted to be reduced to less than 500 gpm (1900 L/min) for 1 hour.

Δ ***TABLE 18.4.5.2.1*** *Minimum Required Fire Flow and Flow Duration for Buildings*

Fire Flow Area ft² (× 0.0929 for m²)					Fire Flow gpm† (× 3.785 for L/min)	Flow Duration (hours)
I(443), I(332), II(222)*	**II(111), III(211)***	**IV(2HH), V(111)***	**II(000), III(200)***	**V(000)***		
0–22,700	0–12,700	0–8200	0–5900	0–3600	1500	2
22,701–30,200	12,701–17,000	8201–10,900	5901–7900	3601–4800	1750	
30,201–38,700	17,001–21,800	10,901–12,900	7901–9800	4801–6200	2000	
38,701–48,300	21,801–24,200	12,901–17,400	9801–12,600	6201–7700	2250	
48,301–59,000	24,201–33,200	17,401–21,300	12,601–15,400	7701–9400	2500	
59,001–70,900	33,201–39,700	21,301–25,500	15,401–18,400	9401–11,300	2750	
70,901–83,700	39,701–47,100	25,501–30,100	18,401–21,800	11,301–13,400	3000	3
83,701–97,700	47,101–54,900	30,101–35,200	21,801–25,900	13,401–15,600	3250	
97,701–112,700	54,901–63,400	35,201–40,600	25,901–29,300	15,601–18,000	3500	
112,701–128,700	63,401–72,400	40,601–46,400	29,301–33,500	18,001–20,600	3750	
128,701–145,900	72,401–82,100	46,401–52,500	33,501–37,900	20,601–23,300	4000	4
145,901–164,200	82,101–92,400	52,501–59,100	37,901–42,700	23,301–26,300	4250	
164,201–183,400	92,401–103,100	59,101–66,000	42,701–47,700	26,301–29,300	4500	
183,401–203,700	103,101–114,600	66,001–73,300	47,701–53,000	29,301–32,600	4750	
203,701–225,200	114,601–126,700	73,301–81,100	53,001–58,600	32,601–36,000	5000	
225,201–247,700	126,701–139,400	81,101–89,200	58,601–65,400	36,001–39,600	5250	
247,701–271,200	139,401–152,600	89,201–97,700	65,401–70,600	39,601–43,400	5500	
271,201–295,900	152,601–166,500	97,701–106,500	70,601–77,000	43,401–47,400	5750	
Greater than 295,900	Greater than 166,500	106,501–115,800	77,001–83,700	47,401–51,500	6000	
		115,801–125,500	83,701–90,600	51,501–55,700	6250	
		125,501–135,500	90,601–97,900	55,701–60,200	6500	
		135,501–145,800	97,901–106,800	60,201–64,800	6750	
		145,801–156,700	106,801–113,200	64,801–69,600	7000	
		156,701–167,900	113,201–121,300	69,601–74,600	7250	
		167,901–179,400	121,301–129,600	74,601–79,800	7500	
		179,401–191,400	129,601–138,300	79,801–85,100	7750	
		Greater than 191,400	Greater than 138,300	Greater than 85,100	8000	

*Types of construction are based on NFPA 220.

†Measured at 20 psi (139.9 kPa).

A minimum fire flow of 500 gpm (1893 L/min) is required for one- and two-family dwellings regardless of the reductions that may be allowed under 18.4.5.2.2, and 18.4.5.2.3. If fire flow were permitted to be reduced below 500 gpm (1893 L/min), there is a significant potential to reduce the pressure in a water distribution system below 20 psi (139.9 kPa) residual if a fire hydrant were to be opened. This would have the potential to create contamination of the potable drinking water system. In addition, insurance companies may not recognize fire flows that are provided from fire hydrants that flow less than 500 gpm (1893 L/min).

18.4.5.3 Buildings Other Than One- and Two-Family Dwellings.

18.4.5.3.1 The minimum fire flow and flow duration for buildings other than one- and two-family dwellings shall be as specified in Table 18.4.5.2.1.

18.4.5.3.2 Required fire flow shall be reduced by 75 percent when the building is protected throughout by an approved automatic sprinkler system. The resulting fire flow shall not be less than 1000 gpm (3785 L/min).

Recognizing the significant benefits of automatic sprinkler system protection in extinguishing or controlling fires, the *Code* provides for a 75 percent reduction in required fire flow for sprinklered buildings. However, a minimum fire flow of not less than 1000 gpm (3785 L/min) must be provided unless the conditions of 18.4.5.3.3, which specifies the use of quick response sprinklers, are met. The example that follows illustrates the reduction in fire flow for a sprinklered building.

Example

Determine the required fire flow for a building of Type II (000) construction with a fire flow area of 26,000 ft^2 (2415 m^2) that is sprinklered with standard response sprinklers in accordance with NFPA 13.

Solution:

From Table 18.4.5.2.1, the minimum required fire flow for a building of the specified area and construction type is 3500 gpm (13,250 L/min) for not less than 3 hours. Because the building is sprinklered in accordance with NFPA 13, a 75 percent reduction is permitted by 18.4.5.3.2, as follows:

$$\frac{3500 \text{ gpm}}{(13{,}250 \text{ L/min})} \times 75 \text{ percent} = \frac{2625 \text{ gpm}}{(9937 \text{ L/min})} \left(\begin{array}{c}\text{fire flow}\\ \text{credit}\end{array}\right)$$

$$\frac{3500 \text{ gpm}}{(13{,}250 \text{ L/min})} - \frac{2625 \text{ gpm}}{(9937 \text{ L/min})} \left(\begin{array}{c}\text{fire flow}\\ \text{credit}\end{array}\right) = \frac{875 \text{ gpm}}{(3312 \text{ L/min})}$$

The calculated fire flow of 875 gpm (3312 L/min) is less than 1000 gpm (3785 L/min), the minimum permitted by 18.4.5.3.2. In this case, a minimum of 1000 gpm (3875 L/min) must be provided for a duration of not less than 2 hours. The 2-hour maximum duration for sprinklered buildings is specified by 18.4.5.3.4. Note that, if the building is provided with quick response sprinklers throughout, the minimum fire flow is permitted to be reduced to not less than 600 gpm (2270 L/min) in accordance with 18.4.5.3.3.

In most circumstances, the minimum fire flow required by Section 18.4 will be greater than the automatic sprinkler system demand. However, in a small number of circumstances, the fire flow required by Section 18.4 might be less than the demand required by NFPA 13 for the automatic sprinkler system. In those cases, the minimum water supply required by NFPA 13 must be provided. However, as stated in 18.4.5.4, it is not the intent to require the minimum fire flow required by this *Code* to be added to the water supply required by an automatic sprinkler system.

18.4.5.3.3 Required fire flow shall be reduced by 75 percent when the building is protected throughout by an approved automatic sprinkler system, which utilizes quick response sprinklers throughout. The resulting fire flow shall not be less than 600 gpm (2270 L/min).

18.4.5.3.4* Required fire flow for buildings protected by an approved automatic sprinkler system shall not exceed 2000 gpm (7571 L/min) for 2 hours.

Δ **A.18.4.5.3.4** The provision of 18.4.5.3.4 is intended to limit the required fire flow duration to not more than 2 hours where the building is sprinklered. The 2000 gpm (7571 L/min) limit is based on a 75% reduction of 8000 gpm (30,283 L/min), which is the maximum fire flow required by Table 18.4.5.2.1. The required 2-hour duration is consistent with the maximum hose stream duration requirements of NFPA 13.

18.4.5.3.5 Required fire flow for open parking structures that are not protected throughout by an approved automatic sprinkler system shall be reduced by 75 percent where all of the following conditions are met:

(1) The structure complies with the building code.
(2) The structure is of Type I or Type II construction.
(3) The structure is provided with a Class I standpipe system in accordance with NFPA 14. Class I standpipe systems of the manual dry type shall be permitted.
(4) The resulting fire flow is not less than 1000 gpm (3785 L/min).

The provisions of 18.4.5.3.5 recognize that the risk of significant fire spread in a fire fully involving an open, noncombustible parking structure is minimal, even where not protected by automatic sprinklers. The term *open parking structure* is defined in 3.3.192.26.3 as a parking structure that meets the requirements of Section 5.5 of NFPA 88A, *Standard for Parking Structures*. Section 5.5 of NFPA 88A specifies the exterior wall opening requirements for open parking structures as follows:

> **5.5 Opening Requirements for Open Parking Structures.**
>
> **5.5.1** Each parking level shall have wall openings open to the atmosphere, for an area of not less than 0.4 m^2 for each linear meter (1.4 ft^2 for each linear foot) of its exterior perimeter.
>
> **5.5.2** Such openings shall be distributed over 40 percent of the building perimeter or uniformly over two opposing sides.
>
> **5.5.3** Interior wall lines and column lines shall be at least 20 percent open, with openings distributed to provide ventilation.

18.4.5.4* Required Fire Flow and Automatic Sprinkler System Demand. For a building with an approved fire sprinkler system, the fire flow demand and the fire sprinkler system demand shall not be required to be added together. The water supply shall be capable of delivering the larger of the individual demands.

A.18.4.5.4 The fire sprinkler system demand is generally significantly less than the demands in Table 18.4.5.2.1, even after hose stream demands are applied. The sprinkler system demand can be a part of the overall flow available to a building site. There is no need to add these flow demands together, which would penalize the building owner that has decided to put fire sprinkler systems in place.

18.5 Fire Hydrants

18.5.1 Fire Hydrant Locations and Distribution. Fire hydrants shall be provided in accordance with Section 18.5 for all new buildings, or buildings relocated into the jurisdiction unless otherwise permitted by 18.5.1.1 or 18.5.1.2.

18.5.1.1 Fire hydrants shall not be required where the water distribution system is not capable of providing a fire flow of greater than 500 gpm (1893 L/min) at a residual pressure of 20 psi (139.9 kPa).

Where a water main system is incapable of supplying a theoretical flow of at least 500 gpm (1893 L/min) at a residual pressure of 20 psi (139.9 kPa), there is a risk of fire apparatus drawing a vacuum on the system, potentially resulting in damage to the underground piping and to the fire apparatus pump. Such a condition also has the potential of contaminating the public water supply.

18.5.1.2* Fire hydrants shall not be required where modification or extension of the water distribution system is deemed to be impractical by the AHJ.

A.18.5.1.2 The conditions where a local jurisdiction might determine that a modification or extension of the water distribution system is deemed to be impractical are varied and should be evaluated on a case-by-case basis. Conditions that should be considered in determining if an extension is impractical should include, but not be limited to, the following:

(1) Distance required to extend the water distribution system
(2) Capability of the existing water distribution system to meet the fire flow demand
(3) Density and occupancy of the proposed development
(4) Potential additional future development in the area of the extension
(5) Other codes and standards, which might warrant extension of the water distribution system
(6) Future anticipated improvements to the water distribution system
(7) Buildings within a previously approved development

If the AHJ determines that the current conditions to modify or extend the water distribution system might be impractical, the AHJ should consider requiring a developer to provide escrow funds that will facilitate the system modification or extension when it does become practical to provide the fire hydrants. In lieu of providing funding by the developer up front, AHJ should consider having the developer execute legal agreements to ensure that the fire hydrants and water are provided, at the developer's/owner's cost, when certain conditions are satisfied making the modification or extension of the water distribution system practical at a future date.

18.5.1.3 The provisions of 18.5.1.1 and 18.5.1.2 shall not eliminate the fire flow requirements of Section 18.4.

The developer is required to provide the needed fire flow under Section 18.4 even if it is impractical to extend or modify the water distribution system to provide fire hydrants. The AHJ maintains the authority to approve the methods that the developer is proposing in lieu of providing the required fire flow via fire hydrants. See Section 18.3.

18.5.1.4* The distances specified in Section 18.5 shall be measured along fire department access roads in accordance with 18.2.3.

A.18.5.1.4 Fire department access roads are intended to include public streets provided they meet the requirements of 18.2.3.

18.5.1.5 Where fire department access roads are provided with median dividers incapable of being crossed by fire apparatus, or where fire department access roads have traffic counts of more than 30,000 vehicles per day, hydrants shall be placed on both sides of the fire department access road on an alternating basis, and the distances specified by Section 18.5 shall be measured independently of the hydrants on the opposite side of the fire department access road.

18.5.1.6 Fire hydrants shall be located not more than 12 ft (3.7 m) from the fire department access road.

Fire hydrants that are set back too far from the fire department access road are difficult to access because hose must be manually dragged from the fire apparatus to the fire hydrant. In addition, fire hydrants that are set back far from the fire department access road can be difficult to locate.

18.5.2 Detached One- and Two-Family Dwellings. Fire hydrants shall be provided for detached one- and two-family dwellings in accordance with both of the following:

(1) The maximum distance to a fire hydrant from the closest point on the building shall not exceed 600 ft (183 m).
(2) The maximum distance between fire hydrants shall not exceed 800 ft (244 m).

Fire hydrants serving one- and two-family dwellings must be arranged so that the distance between each building and the nearest hydrant does not exceed 600 ft (183 m). Additional hydrants might be required to limit the distance between hydrants to not more than 800 ft (244 m) along the fire department access road as stated in 18.5.1.4. Only those hydrants within 1000 ft (305 m) of a building are permitted to be given credit for supplying the building's required fire flow in accordance with 18.5.4.2. This criterion combined with the 600 ft (183 m) maximum building distance criterion might result in hydrants spaced less than 800 ft (244 m) apart.

The distance should be measured as the fire apparatus would lay hose out down the fire department access road to the subject building. The distance should not be measured across adjacent lots, through fences, gates or other obstructions that would prevent the normal movement of a fire apparatus performing a hose lay to a fire hydrant.

18.5.3 Buildings Other than Detached One- and Two-Family Dwellings. Fire hydrants shall be provided for buildings other than detached one- and two-family dwellings in accordance with both of the following:

(1) The maximum distance to a fire hydrant from the closest point on the building shall not exceed 400 ft (122 m).
(2) The maximum distance between fire hydrants shall not exceed 500 ft (152 m).

Fire hydrants serving buildings other than one- and two-family dwellings must be arranged so that the distance between each building and the nearest hydrant does not exceed 400 ft (122 m). Additional hydrants might be required to limit the distance between hydrants to not more than 500 ft (152 m) along the fire department access road as stated in 18.5.1.4. Only those hydrants within 1000 ft (305 m) of a building are permitted to be given credit for supplying the building's required fire flow in accordance with 18.5.4.2. This criterion combined with the 400 ft (122 m) maximum building distance criterion might result in hydrants spaced less than 500 ft (152 m) apart.

The distance should be measured as the fire apparatus would lay hose out down the fire department access road to the subject building. The distance should not be measured across adjacent lots, through fences, gates, or other obstructions that would prevent the normal movement of a fire apparatus performing a hose lay to a fire hydrant.

18.5.4 Minimum Number of Fire Hydrants for Fire Flow.

18.5.4.1 The minimum number of fire hydrants needed to deliver the required fire flow for new buildings in accordance with Section 18.4 shall be determined in accordance with Section 18.5.4.

In some cases, the fire flow required under Section 18.4 and 18.5.4 may result in additional hydrants or closer spaced hydrants than required by the spacing criteria of 18.5.2 or 18.5.3. In other cases, the spacing criteria of 18.5.2 or 18.5.3 may require additional hydrants than is necessary to provide the minimum required fire flow under Section 18.4 and 18.5.4. The minimum number of hydrants required for the fire flow contained in Section 18.4 and 18.5.4 and minimum spacing for fire hydrants under 18.5.2 and 18.5.3 both need to be complied with separately.

18.5.4.2 The aggregate fire flow capacity of all fire hydrants within 1000 ft (305 m) of the building, measured in accordance with 18.5.1.4 and 18.5.1.5, shall be not less than the required fire flow determined in accordance with Section 18.4.

The distance should be measured as the fire apparatus would lay hose out down the fire department access road to the subject building. The distance should not be measured across adjacent lots, through fences, gates, or other obstructions that would prevent the normal movement of a fire apparatus performing a hose lay to a fire hydrant.

Δ **18.5.4.3*** The maximum fire flow capacity for which a fire hydrant shall be credited shall be as specified by Table 18.5.4.3. Capacities exceeding the values specified in Table 18.5.4.3 shall be permitted when local fire department operations have the ability to accommodate such values as determined by the fire department.

TABLE 18.5.4.3 *Maximum Fire Hydrant Fire Flow Capacity*

Distance to Building[a]		Maximum Capacity[b]	
(ft)	(m)	(gpm)	(L/min)
≤250	≤76	1500	5678
>250 and ≤500	>76 and ≤152	1000	3785
>500 and ≤1000	>152 and ≤305	750	2839

[a]Measured in accordance with 18.5.1.4 and 18.5.1.5.
[b]Minimum 20 psi (139.9 kPa) residual pressure.

A.18.5.4.3 It is not the intent of Table 18.5.4.3 to limit the actual fire flow capacity of a fire hydrant, only the fire flow capacity for which a fire hydrant is credited based on its distance from the building.

See the commentary for 18.5.4.1.

18.5.4.4 Fire hydrants required by 18.5.2 and 18.5.3 shall be included in the minimum number of fire hydrants for fire flow required by 18.5.4.

The provisions of 18.5.4 ensure a sufficient number of fire hydrants are available within reasonable proximity to the building in question to deliver the building's required fire flow in accordance with Section 18.4. For example, a building might have a required fire flow of 4000 gpm (15,142 L/min) based on its size and type of construction in accordance with Table 18.4.5.2.1. The water distribution system in the vicinity of the building might be fully capable of delivering a theoretical fire flow of at least 4000 gpm (15,142 L/min) at 20 psi (139.9 kPa); however, if only one fire hydrant is located near the building, it likely will not be possible for one fire department pumper to extract 4000 gpm (15,142 L/min) from the water distribution system due to the physical constraints of the hydrant outlets and pump capacity — typical fire department pumpers are rated between 750 gpm (2840 L/min) to 1500 gpm (5680 L/min). The following example illustrates the application of 18.5.4.

Example

Determine the number of required fire hydrants for a proposed new manufacturing building with a fire area of 50,000 ft^2 (4645 m^2) and a construction classification of Type II (000) (noncombustible and unprotected). The building will be protected throughout by an approved automatic sprinkler system with standard response sprinklers.

Solution:

A flow test is conducted on the water distribution system serving the site using the guidance contained in NFPA 291, *Recommended Practice for Fire Flow Testing and Marking of Hydrants*; the test results indicate the theoretical available fire flow is 3500 gpm (13,200 L/min) at a residual pressure of 20 psi (139.9 kPa).

Using Table 18.4.5.2.1, the designer determines the building's required fire flow is 4750 gpm (18,000 L/min). However, because the building will be protected by an automatic sprinkler system with standard response sprinklers, a 75 percent reduction is permitted in accordance with 18.4.5.3.2. The adjusted required fire flow is calculated as follows:

4750 gpm − [0.75 (4750 gpm)] = 1187.5 gpm, which is rounded to approximately 1200 gpm

18,000 L/min − [0.75 (18,000 L/min)] = 4500 L/min

The water distribution system is capable of delivering the required fire flow (RFF) based on the available fire flow (AFF):

AFF: 3500 gpm (13,200 L/min) ≥ RFF: 1200 gpm (4500 L/min)

To minimize cost, the designer chooses to locate one fire hydrant on the existing public water mains at a distance of 350 ft (107 m) from the building, which meets the maximum 400 ft (122 m) distance criterion of 18.5.3(1), rather than extend a private fire service main onto the building's property. Using Table 18.5.4.3, it is determined that a hydrant located 400 ft (122 m) from the building can be credited with not more than 1000 gpm (3785 L/min). Because this is less than the required fire flow of 1200 gpm (4500 L/min), one additional hydrant is required within 1000 ft (305 m) of the building, or the designer could choose to extend a private fire service main onto the property and locate a hydrant at a distance of not more than 250 ft (76 m) from the building. In accordance with Table 18.5.4.3, such a hydrant would be permitted to be credited with up to 1500 gpm (5678 L/min), which exceeds the required fire flow of 1200 gpm (4500 L/min). If the designer chooses to add a second hydrant on the public main, they should be spaced so the distance between them does not exceed 500 ft (152 m) in accordance with 18.5.3.

The AHJ should require an additional flow test following the installation of the new hydrant or hydrants to verify that they are capable of delivering the required fire flow.

18.5.5 Testing and Maintenance.

Δ **18.5.5.1** Private water supply systems shall be tested and maintained in accordance with NFPA 25.

18.5.5.2 Public water supply systems providing fire flow shall be tested and maintained in accordance with ANSI/AWWA G200, *Standard for Distribution Systems Operation and Management*.

18.5.6 Accessibility. Fire hydrants and connections to other approved water supplies shall be accessible to the fire department.

Fire hydrants and connections to approved water supplies must be installed and maintained in a manner that allows the fire department to access the water supply point without being delayed by fences, landscaping, signs, utility poles, utility boxes, or other obstructions.

18.5.7 Clear Space Around Hydrants.

18.5.7.1 A 36 in. (914 mm) clear space shall be maintained around the circumference of fire hydrants except as otherwise required or approved.

Fire hydrants are subject to a number of types of obstructions that can impede the ability of the fire department to access and utilize a fire hydrant. A typical location for a fire hydrant is in a landscape island in a parking lot. This type of placement has the potential to create obstructions due to parking and landscaping conflicts. If parking is provided next to the landscape island, the parking needs to be placed at least 36 in. (914 mm) away from the fire hydrant. In addition, no landscaping should be provided within 36 in. (914 mm) of the fire hydrant. In addition to landscaping and parking, fences, signs, utility poles, and other similar types of obstructions should not be allowed in the 36 in. (914 mm) clear space surrounding the fire hydrant.

The provision of 18.5.7.1 should be used in conjunction with 18.5.7.2 and 18.5.6. Fire hydrant placement should comply with all three of those requirements to ensure that the fire hydrant is visible, accessible, and usable by the fire department. Exhibit 18.10 shows a fire hydrant that does not maintain a 36 in. clearance around the entire circumference of the hydrant.

18.5.7.2 A clear space of not less than 60 in. (1524 mm) shall be provided in front of each hydrant connection having a diameter greater than 2½ in. (64 mm).

This paragraph is intended to ensure that fire department pumper apparatus have the ability to park adjacent to a fire hydrant and have adequate room to connect a large-diameter hose from the hydrant's steamer outlet to the pump inlet. Parked vehicles and

Exhibit 18.10

Fire hydrant without proper clearance maintained.

other obstructions within 60 in. (1524 mm) of the front of the hydrant pose an undue hindrance to fire suppression operations.

The provisions of 18.5.7.2 should be used in conjunction with 18.5.7.1 and 18.5.6. For example, 18.5.7.2 requires a 60 in. (1524 mm) clearance in front of the fire hydrant steamer port. This does not mean that a landscaping hedge row can be placed at 65 in. in front of the steamer port. The placement of this type of obstruction would violate 18.5.6.

18.5.8 Protection. Where required by the AHJ, fire hydrants subject to vehicular damage shall be protected unless located within a public right of way.

Protection of fire hydrants with bollards or curbs are a couple of methods to assist in preventing vehicular damage. If bollards are utilized, they should be placed in locations that do not obstruct access or use of the fire hydrant. These methods are more effective in the low-speed environments of parking lots.

18.5.9 Hydrants Out of Service. Where water supplies or fire hydrants are out of service for maintenance or repairs, a visible indicator acceptable to the AHJ shall be used to indicate that the hydrant is out of service.

Where fire hydrants or other water supplies are found to be out of service, it is important that the fire hydrant or water supply is immediately marked with an indicator so responding fire department units will quickly observe the out-of-service condition prior to attempting to utilize the fire hydrant or water supply. One of the easiest methods to mark a fire hydrant as being out of service is with an out-of-service plastic ring inserted between the hydrant steamer cap and the threads. See NFPA 291. Exhibit 18.11 shows a fire hydrant with an 'out of service ring' indicating that the hydrant is out of service and not available for use.

18.5.10 Marking of Hydrants.

18.5.10.1 Fire hydrants shall be marked with an approved reflector affixed to the roadway surface where required by the AHJ.

If fire hydrants are difficult to locate due to topography, landscaping, or other visual obstructions, the AHJ has the authority to require that the hydrant location be identified with a marker affixed to the roadway surface. Typically, this is a blue reflector placed in the center of the travel lane closest to the fire hydrant.

18.5.10.2 Fire hydrants shall be marked with an approved flag or other device affixed to or proximate to the fire hydrant where required by the AHJ.

In areas where significant snowfall is common or if a fire hydrant is placed at a much lower elevation than the fire department access roadway, the use of an elevated flag or other device attached to the fire hydrant can be required by the AHJ to improve the ability of the fire department to local the fire hydrant.

18.5.10.3* Where required by the AHJ, fire hydrants shall be color coded or otherwise marked with an approved system indicating the available flow capacity.

Exhibit 18.11

Fire hydrant with out of service indicator.

Δ **A.18.5.10.3** Color coding or stenciling a fire hydrant with the actual flow capacity are two methods to accomplish the capacity marking of fire hydrants when it is required by the AHJ. NFPA 291, Recommended Practice for Fire Flow Testing and Marking of Hydrants, specifies the following approach to hydrant marking for flow indication:

Classification of Hydrants. Hydrants should be classified in accordance with their rated capacities [at 20 psi (1.4 bar) residual pressure or other designated value] as follows:

(1) Class AA — Rated capacity of 1500 gpm (5680 L/min) or greater
(2) Class A — Rated capacity of 1000–1499 gpm (3785–5675 L/min
(3) Class B — Rated capacity of 500–999 gpm (1900–3780 L/min)
(4) Class C — Rated capacity of less than 500 gpm (1900 L/min)

The tops and nozzle caps should be painted with the following capacity-indicating color scheme:

(1) Class AA — Light blue
(2) Class A — Green
(3) Class B — Orange
(4) Class C — Red paint

The capacity colors should be of a reflective-type paint.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2016 edition.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes,* 2016 edition.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies,* 2016 edition.

NFPA 88A, *Standard for Parking Structures*, 2015 edition.

NFPA 220, *Standard on Types of Building Construction,* 2018 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*, 2018 edition.

NFPA 291, *Recommended Practice for Fire Flow Testing and Marking of Hydrants*, 2016 edition.

NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting,* 2017 edition.

NFPA 5000®, Building Construction and Safety Code®, 2018 edition.

NFPA Fire Protection Handbook®, A. Cote, ed., 20th edition, 2008.

American Association of State Highway and Transportation Officials (AASHTO), 444 North Capitol Street, NW, Suite 249, Washington, DC 20001.

A Policy on Geometric Design of Highways and Streets, 6th edition, 2011.

Standard Specifications for Highway Bridges, 17th edition, 2002.

ASTM F2200, *Standard Specification for Automated Vehicular Gate Construction,* ASTM International, West Conshohocken, PA, 2014.

AWWA M31, *Distribution System Requirements for Fire Protection*, American Water Works Association, Denver, CO, 2008.

UL 325, *Door, Drapery, Gate, Louver, and Window Operators and Systems*, Underwriters Laboratories Inc., Northbrook, IL, 2013.

19 Combustible Waste and Refuse

Chapter 19 addresses combustible waste and refuse and includes sections on rubbish containers, dumpsters, and commercial rubbish-handling operations.

19.1 General

19.1.1 Permits. Permits, where required, shall comply with Section 1.12.

19.1.2 Persons owning or having control of any property shall not allow any combustible waste material to accumulate in any area or in any manner that creates a fire hazard to life or property.

The problem of accumulating combustible waste has increased with the advent of recycling efforts. Many building owners supply small personal recycling containers at each worker's desk (see Exhibit 19.1) and larger storage containers, or bins, to collect the recyclable material from the individual containers (see Exhibit 19.2). The bins are then emptied at a larger collection point. The collection and storage of recycling material has resulted in delayed removal of many types of combustible waste from a building or property. Recognition of this situation is important. The attempt to control the location and amount of recyclable material in buildings, as well as the ignition sources in the vicinity of its storage, especially in work areas such as desks, is critical. Proper storage prevents the spread of fire from or to these areas.

Exhibit 19.1

Typical personal recycling container.

Exhibit 19.2

Storage bin for recyclables.

19.1.3 Combustible waste or refuse shall be properly stored or disposed of to prevent unsafe conditions.

19.1.4 Fire extinguishing capabilities approved by the AHJ including, but not limited to, fire extinguishers, water supply and hose, and earth-moving equipment shall be provided at waste disposal sites.

Waste disposal sites should be equipped with the means to extinguish or control the spread of fire in the disposal area until the arrival of the fire department. The fire department should evaluate the fire potential and work with the property owner to ensure adequate water supplies for fire department use in case of fire. Ensuring adequate water supplies might require extending water mains with additional hydrants or, if the site is remote from a municipal water system, the provision of on-site water storage.

19.1.5 Burning debris shall not be dumped at a waste disposal site except at a remote location on the site where fire extinguishment can be accomplished before compacting, covering, or other disposal activity is carried out. *(See Section 10.10 for additional guidance.)*

Burning or smoldering debris should be dumped at a specific site used exclusively for hot debris. The debris should be monitored, wet down if necessary, and, when cold, placed with normal waste.

19.1.6 Electrical Wiring.

Δ **19.1.6.1** Electrical wiring and equipment in any combustible fiber storage room or building shall be installed in accordance with the requirements of Section 11.1 and NFPA 70 for Class III hazardous locations.

19.1.6.2 The AHJ shall be responsible for designating the areas that require hazardous location electrical classifications and shall classify the areas in accordance with the classification system set forth in NFPA 70.

19.1.7 No Smoking.

See Section 10.9 for additional restrictions on smoking.

19.1.7.1 No smoking or open flame shall be permitted in any area where combustible fibers are handled or stored or within 50 ft (15 m) of any uncovered pile of such fibers.

19.1.7.2 "No Smoking" signs shall be posted.

19.1.8 Vehicles or Conveyances Used to Transport Combustible Waste or Refuse.

19.1.8.1 Vehicles or conveyances used to transport combustible waste or refuse over public thoroughfares shall have all cargo space covered and maintained tight enough to ensure against ignition from external fire sources and the scattering of burning and combustible debris that can come in contact with ignition sources.

19.1.8.2 Transporting burning waste or refuse shall be prohibited.

Δ **19.1.8.3** Trucks or automobiles, other than mechanical handling equipment and approved industrial trucks as listed in NFPA 505 shall not enter any fiber storage room or building but shall be permitted to be used at loading platforms.

19.2 Combustible Waste and Refuse

19.2.1 Rubbish Containers.

19.2.1.1 General. Rubbish containers kept outside of rooms or vaults shall not exceed 40.5 ft³ (1.15 m³) capacity.

Exhibit 19.3

Large rubbish container in a protected room.

The capacity of a container that holds 40.5 ft³ (1.15 m³) converts to 303 gal (1150 L). These larger rubbish containers need to be placed in properly protected rooms. See NFPA *101*®, *Life Safety Code*®, for additional requirements on hazardous area protection. See Exhibit 19.3 for an example of a large rubbish container that is located in a protected room.

19.2.1.1.1 Containers exceeding a capacity of 5⅓ ft³ [40 gal (0.15 m³)] shall be provided with lids.

Containers of 40 gal (0.15 m³) capacity are used as receptacles into which employees can empty smaller containers during normal working hours. They are usually found at strategically located sites that are easily accessible throughout the occupancy. Such containers are also used in many occupancies as collection points for occupants or residents to discard trash. They are typically located in common areas accessible to all occupants. See Exhibit 19.2 for an example of a 40 gal (0.15 m³) container.

19.2.1.1.2 Such containers and lids as described in 19.2.1.1.1 shall be constructed of noncombustible materials or nonmetallic materials complying with 19.2.1.2.

19.2.1.2 Nonmetallic Containers.

19.2.1.2.1* Nonmetallic rubbish containers exceeding a capacity of 5⅓ ft³ [40 gal (0.15 m³)] shall be manufactured of materials having a peak rate of heat release not exceeding 300 kW/m² at a flux of 50 kW/m² when tested in the horizontal orientation, at a thickness as used in the container but not less than of 0.25 in. (6 mm), in accordance with ASTM E1354, *Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*.

A.19.2.1.2.1 Nonmetallic or plastic rubbish containers should be limited in their combustibility and should be tested for heat release with the cone calorimeter, to the recognized standard of ASTM E1354 referred to as the cone or oxygen consumption calorimeter. The cone calorimeter test standard does not indicate the exact conditions (heat flux and orientation) needed for testing. This test is intended to give detailed information as to how the fire performance of materials perform under actual fire conditions. The value of 300 kW/m^2 for peak rate of heat release of the rubbish container material corresponds to the value that Douglas fir wood emits under the same conditions. Rubbish containers are often manufactured of polyethylene [effective heat of combustion ca. 19,000 Btu/lb (45 MJ/kg)], which releases much more heat in a fire than the typical contents of the container, much of which is paper (effective heat of combustion ca. 6400 Btu/lb (15 MJ/kg]). For comparison purposes, Table A.19.2.1.2.1 shows peak heat release rates of a series of materials (34 plastics and Douglas fir wood) at an incident heat flux of 40 kW/m^2, in the horizontal orientation and at a thickness of 0.25 in. (6 mm) [Hirschler 1992]. For further comparison, a fire test conducted with a small ignition source on a 22.4 lb polyethylene rubbish container resulted in the release of 1.34 MW within 13.35 minutes of ignition (before it had to be manually extinguished) and caused flashover in the test room. The maximum a container can release is 300 kW/m^2 or maximum heat release rate. Douglas fir has a constant of 300 kW/m^2 where polyethylene has a peak heat release rate of 1268 kW/m^2. Nonmetallic containers such as polyethylene can represent more fuel than their contents (high density polyethylene 19,994 Btu/lb versus newsprint at 8000). A detailed review of listings or approvals is advised prior to acceptance.

TABLE A.19.2.1.2.1 *Peak Rate of Heat Release of Materials in the Cone Calorimeter at an Incident Heat Flux of 40 kW/m^2, in the Horizontal Orientation, at a Thickness of 6 mm*

	Material Description	Abbreviation	Peak Rate of Heat Release (kW/m^2)
1	Polytetrafluorethylene	PTFE	14
2	Poly(vinyl chloride) flexible 1	PVC Plenum 1	43
3	Poly(vinyl chloride) flexible 2	PVC Plenum 2	64
4	Poly(vinyl chloride) flexible 3	PVC Plenum 3	87
5	Polycarbonate 1	PolyCarb 1	429
6	Poly(vinyl chloride) flexible 4	PVC Plenum 4	77
7	Chlorinated PVC	CPVC	84
8	Poly(vinyl chloride) rigid computer housing	PVC computer	175
9	Poly(vinyl chloride) flexible wire FR	PVC flex FR	92
10	Poly(vinyl chloride) rigid low smoke	PVC low smoke	111
11	Cross linked polyethylene FR	XLPE FR	192
12	Poly(vinyl chloride) flexible wire semi FR	PVC Flex semi FR	142
13	Poly(vinyl chloride) rigid window	PVC window	183
14	Poly(vinyl chloride) flexible wire non FR	PVC Flex non FR	167
15	Poly(methyl methacrylate) FR Blend	PMMA FR	176
16	Polycarbonate 2	Polycarb 2	420
17	Polyphenylene Oxide FR Blend 1	PPO/PS 1	276
18	Polyphenylene Oxide FR Blend 2	PPO/PS 2	265
19	Acrylonitrile butadiene styrene FR 1	ABS FR 1	291
20	Acrylonitrile butadiene styrene FR 2	ABS FR 2	402
21	Poly(vinyl chloride) flexible bath curtain	PVC Flex Poor	237
22	Douglas fir	D Fir	221
23	Polystyrene FR	PS FR	334
24	Polyacetal	P Acetal	360
25	Polyurethane Flexible Foam non FR	PU	710
26	Poly(methyl methacrylate)	PMMA	665
27	Polyurethane Thermoplastic	TPU	221
28	Nylon	Nylon	1313
29	Acrylonitrile butadiene styrene	ABS	944
30	Polystyrene	PS	1101
31	Styrene acrylonitrile EPDM blend	EPDM SAN	956
32	Poly(butylene terephthalate)	PBT	1314
33	Poly(ethylene terephthalate)	PET	534
34	Polyethylene	PE	1408
35	Polypropylene	PP	1509

Source: Hirschler 1992. "Heat release from plastic materials", M.M. Hirschler, Chapter 12 a, in "Heat Release in Fire," Elsevier, London, UK, Eds. V. Babrauskas and S.J. Grayson, 1992. pp. 375–422.

19.2.1.2.2 Such containers shall be permanently labeled indicating capacity and peak rate of heat release.

19.2.1.3 Removal. Combustible rubbish stored in containers outside of noncombustible vaults or rooms shall be removed from buildings at least once each working day.

19.2.1.4 Rubbish Within Dumpsters. Dumpsters and combustible waste containers with an individual capacity of 1.5 yd^3 [40.5 ft^3 (1.15 m^3)] or more shall not be stored in buildings or placed within 10 ft (3050 mm) of combustible walls, openings, or combustible roof eave lines unless otherwise permitted by 19.2.1.4.1 or 19.2.1.4.2.

19.2.1.4.1 The requirement of 19.2.1.4 shall not apply to building areas protected by an approved automatic sprinkler system and enclosed by fire barriers having a fire resistance rating not less than of 1 hour.

19.2.1.4.2 The requirement of 19.2.1.4 shall not apply to structures meeting all of the following requirements:

(1) Structures shall be Type I or Type II construction.
(2) Structures shall be located not less than 10 ft (3050 mm) from other structures.
(3) Structures shall be used only for storage of dumpsters and combustible waste containers.

Many dumpster fires have extended into adjacent buildings because the dumpster was located too close to the adjacent building. See Exhibit 19.4, which depicts a dumpster located directly against the building's exterior wall. A fire in such a dumpster can quickly spread to the building's combustible walls.

Dumpsters should be placed a minimum of 10 ft (3 m) from combustible walls, openings, combustible roof eaves, or any other area that might pose a fire risk. The 10 ft (3 m) distance is measured perpendicularly from the farmost projection. Permanent barriers should be installed to ensure that dumpsters are not inadvertently placed within 10 ft (3 m) of the hazard area.

Exhibit 19.4

Dumpster against building exterior. (Thinkstock)

19.2.1.5 Commercial Rubbish-Handling Operations. Occupancies exclusively performing commercial rubbish handling or recycling shall maintain rubbish or product to be processed or recycled in one of the following ways:

(1) In approved vaults
(2) In covered metal or metal-lined receptacles or bins
(3) Completely baled and stacked in an orderly manner in an approved location

19.2.1.6 Approved metal receptacles with self-closing covers shall be provided for the storage or disposal of oil-soaked waste or cloths.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA *101*®, *Life Safety Code*®, 2018 edition.

20

Occupancy Fire Safety

Chapter 20 extracts occupancy-based requirements from NFPA *101*®, *Life Safety Code*®. Each occupancy section contains requirements for interior finish, operating features (such as inspections, furnishings, and decorations), drills, emergency plans, smoking, heating equipment, and other provisions specific to the occupancy. The format of Chapter 20 is as follows:

20.1 Assembly Occupancies

The requirements for assembly occupancies are based on protecting concentrations of occupants in a building or area. The occupant load factors for assembly uses (see Table 14.8.1.2) accurately reflect the large numbers of occupants in a given area that are characteristic of such use. Large numbers of occupants present unique challenges, such as arranging and designing the egress facilities to move the occupants efficiently and quickly. In addition, there are issues that must be balanced, such as sloping the floor to achieve line of sight for audience spectators (e.g., during theater performances, sporting events, or concerts) without creating stepped aisles that are too steep to use effectively.

Assembly occupancies include, but are not limited to, buildings or portions of buildings used for gatherings of 50 or more people for such purposes as deliberation, worship, entertainment, eating, drinking, amusement, or awaiting transportation. Assembly occupancies also include special amusement buildings (such as a fun house attraction at an amusement park or a multilevel play structure in a fast-food restaurant), regardless of occupant load (see item 2 of 6.1.2.1 and 20.1.4).

For other than special amusement buildings, the criteria for assembly occupancy classification include the 50-person threshold addressed in the preceding paragraph and consideration of the activities in which those persons are involved. The activities that lead to the classification of an occupancy as an assembly occupancy include those detailed in item 1 of 6.1.2.1 — deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses. For example, working at a desk in a large open plan office area is not an assembly use, so the presence of 50 or more persons in the office space constitutes a business occupancy, not an assembly occupancy. Examples of assembly occupancies can be found in A.6.1.2.1, if they have an occupant load of at least 50 persons.

Passenger stations and terminals of air, surface, underground, and marine public transportation facilities are also considered assembly occupancies. If the jurisdiction enforcing the *Code* has adopted NFPA 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems*, requirements for transit stations might fall under NFPA 130 rather than this *Code*. See NFPA 130 for additional details.

Assembly occupancies with an occupant load of fewer than 50 persons (except for special amusement buildings) are considered incidental to the predominant occupancy in which they are located. For example, a conference room with an occupant load of fewer than 50 persons (see 14.8.1.2) that is located in an office area is considered part of the overall business occupancy. A freestanding diner with an occupant load of fewer than 50 persons is normally assigned a mercantile occupancy classification. Regardless of occupancy classification, the occupant load for areas of assembly use needs to be calculated based on the use of the space, not the occupancy classification, using the occupant load factors of Table 14.8.1.2 for assembly uses.

20.1.1 Application. New and existing assembly occupancies shall comply with Section 20.1 and NFPA *101*.

20.1.1.1 Permits. Permits, where required, shall comply with Section 1.12.

20.1.1.2 Indoor children's playground structures shall also comply with Section 10.19.

20.1.2 Flame-Retardant Requirements.

Δ **20.1.2.1** Combustible scenery of cloth, film, vegetation (dry), and similar materials shall comply with one of the following:

(1) They shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701.
(2) They shall exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289 using the 20 kW ignition source.

[***101:***12.4.6.11.1; ***101:***13.4.6.11.1]

Δ **20.1.2.2** Foamed plastics *(see definition of cellular or foamed plastic in 3.3.41 of* NFPA *101)* shall be permitted to be used if they exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289 using the 20 kW ignition source or by specific approval of the AHJ. [***101:***12.4.6.11.2; ***101:***13.4.6.11.2]

20.1.2.3 Scenery and stage properties not separated from the audience by proscenium opening protection shall be of noncombustible materials, limited-combustible materials, or fire-retardant-treated wood. [***101:***13.4.6.11.3]

Δ **20.1.2.4** In theaters, motion picture theaters, and television stage settings, with or without horizontal projections, and in simulated caves and caverns of foamed plastic, any single fuel package shall have a heat release rate not to exceed 100 kW where tested in accordance with one of the following:

(1) ANSI/UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
(2) NFPA 289 using the 20 kW ignition source

[***101:***12.4.6.11.4; ***101:***13.4.6.11.4]

20.1.3 Interior Finish.

20.1.3.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***12.3.3.1]

20.1.3.2 Corridors, Lobbies, and Enclosed Stairways. New and existing interior wall and ceiling finish materials complying with Section 12.5 shall be Class A or Class B in all corridors and lobbies and shall be Class A in enclosed stairways. [***101:***12.3.3.2; ***101:***13.3.3.2]

20.1.3.3 Assembly Areas. New and existing interior wall and ceiling finish materials complying with Section 12.5 shall be Class A or Class B in general assembly areas having occupant loads of more than 300 and shall be Class A, Class B, or Class C in assembly areas having occupant loads of 300 or fewer. [***101:***12.3.3.3; ***101:***13.3.3.3]

20.1.3.4 Screens. New and existing screens on which pictures are projected shall comply with requirements of Class A or Class B interior finish in accordance with Section 12.5. [***101:***12.3.3.4; ***101:***13.3.3.4]

Evaluation of existing interior finish is sometimes difficult. Where flame spread characteristics cannot be readily determined, the questionable material should be removed or treated with approved flame retardants. Where treatment cannot reduce flame spread to the required limits, automatic sprinklers might be provided to help compensate for the deficiency.

20.1.3.5 Interior Floor Finish.

20.1.3.5.1 New interior floor finish shall comply with Section 12.5. [***101:***12.3.3.5.1]

20.1.3.5.2 New interior floor finish in exit enclosures and exit access corridors and in spaces not separated from them by walls complying with 12.3.6 of NFPA *101* shall be not less than Class II. [***101:***12.3.3.5.2]

20.1.3.5.3 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***12.3.3.5.3]

20.1.3.5.4 Existing Interior Floor Finish. (Reserved) [***101:***13.3.3.5]

20.1.4* Special Amusement Buildings.

A.20.1.4 Where a special amusement building is installed inside another building, such as within an exhibit hall, the special amusement building requirements apply only to the special amusement building. For example, the smoke detectors required by 20.1.4.4 are not required to be connected to the building's system. Where installed in an exhibit hall, such smoke detectors are also required to comply with the provisions applicable to an exhibit. [***101:***A.12.4.8; ***101:***A.13.4.8]

20.1.4.1* General. Special amusement buildings, regardless of occupant load, shall meet the requirements for assembly occupancies in addition to the requirements of 20.1.4, unless the special amusement building is a multilevel play structure that is not more than 10 ft (3050 mm) in height and has aggregate horizontal projections not exceeding 160 ft^2 (15 m^2). [***101:***12.4.8.1; ***101:***13.4.8.1]

A.20.1.4.1 The aggregate horizontal projections of a multilevel play structure are indicative of the number of children who might be within the structure and at risk from a fire or similar emergency. The word "aggregate" is used in recognition of the fact that the platforms and tubes that make up the multilevel play structure run above each other at various levels. In calculating the area of the projections, it is important to account for all areas that might be expected to be occupied within, on top of, or beneath the components of the structure when the structure is used for its intended function. [***101:***A.12.4.8.1; ***101:***A.13.4.8.1]

20.1.4.2* Automatic Sprinklers. Every special amusement building, other than buildings or structures not exceeding 10 ft (3050 mm) in height and not exceeding 160 ft^2 (15 m^2) in aggregate horizontal projection, shall be protected throughout by an approved, supervised automatic sprinkler system installed and maintained in accordance with Section 13.3. [***101:***12.4.8.2; ***101:***13.4.8.2]

A.20.1.4.2 See A.20.1.4.1. [***101:***A.12.4.8.2; ***101:***A.13.4.8.2]

20.1.4.3 Temporary Water Supply. Where the special amusement building required to be sprinklered by 20.1.4.2 is movable or portable, the sprinkler water supply shall be permitted to be provided by an approved temporary means. [***101:***12.4.8.3; ***101:***13.4.8.3]

20.1.4.4 Smoke Detection. Where the nature of the special amusement building is such that it operates in reduced lighting levels, the building shall be protected throughout by an approved automatic smoke detection system in accordance with Section 13.7. [***101:***12.4.8.4; ***101:***13.4.8.4]

20.1.4.5 Alarm Initiation. Actuation of any smoke detection system device shall sound an alarm at a constantly attended location on the premises. [***101:***12.4.8.5, ***101:***13.4.8.5]

Δ **20.1.4.6 Illumination.** Actuation of the automatic sprinkler system, or any other suppression system, or actuation of a smoke detection system having an approved verification or cross-zoning operation capability shall provide for the following:

(1) Increase in illumination in the means of egress to that required by Section 14.12
(2) Termination of any conflicting or confusing sounds and visuals

[***101:***12.4.8.6; ***101:***13.4.8.6]

20.1.4.7 Exit Marking.

20.1.4.7.1 Exit marking shall be in accordance with Section 14.14. [***101:***12.4.8.7.1; ***101:***13.4.8.7.1]

20.1.4.7.2 Floor proximity exit signs shall be provided in accordance with 14.14.1.6. [***101:***12.4.8.7.2; ***101:***13.4.8.7.2]

20.1.4.7.3* In special amusement buildings where mazes, mirrors, or other designs are used to confound the egress path, approved directional exit marking that becomes apparent in an emergency shall be provided. [***101:***12.4.8.7.3; ***101:***13.4.8.7.3]

A.20.1.4.7.3 Consideration should be given to the provision of directional exit marking on or adjacent to the floor. [***101:***A.12.4.8.7.3; ***101:***A.13.4.8.7.3]

20.1.4.8 Interior Finish. Interior wall and ceiling finish materials complying with Section 12.5 shall be Class A throughout. [***101:***12.4.8.8; ***101:***13.4.8.8]

Any special amusement building is considered an assembly occupancy, even if the occupant load is not 50 or more persons. However, special amusement buildings do not include theaters, movie houses, and other similar types of assembly occupancies. An example of a special amusement building that typically has an occupant load of not more than 49 persons is a children's play structure, complete with chutes, slides, and ladders, installed as an attraction at a fast-food restaurant.

Paragraph 20.1.4.6 addresses the importance of the exits and means of egress being well lighted upon the activation of a smoke detection or fire suppression system. It is also important that any conflicting or confusing sounds or visuals be stopped and that, where a person's relative position to an exit is changed, additional exit signs be provided.

In special amusement buildings, the provision of directions to an exit is particularly important. Floor proximity exit signs, as required by 20.1.4.7.2, should provide patrons an additional tool to assist them in finding their way out under emergency conditions. Exhibit 20.1 shows a floor proximity exit sign as well as exit signs mounted above the door opening height in a large special amusement attraction in a Florida amusement park.

20.1.5 Operating Features.

20.1.5.1 Means of Egress Inspection.

20.1.5.1.1 The building owner or agent shall inspect the means of egress to ensure it is maintained free of obstructions, and correct

Exhibit 20.1

Floor proximity exit sign in special amusement building.

any deficiencies found, prior to each opening of the building to the public. [***101:***12.7.1.1; ***101:***13.7.1.1]

20.1.5.1.2 The building owner or agent shall prepare and maintain records of the date and time of each inspection on approved forms, listing any deficiencies found and actions taken to correct them. [***101:***12.7.1.2; ***101:***13.7.1.2]

20.1.5.1.3 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15 of NFPA *101*. [***101:***12.7.1.3]

The means of egress features for assembly occupancies cannot be ensured to be effective unless maintained. The requirement for inspection and correction of the deficiencies found helps to keep the means of egress features usable. The required record keeping serves as an enforcement tool for the authority having jurisdiction (AHJ) to help ensure that such inspection is conducted as specified.

20.1.5.2 Special Provisions for Food Service Operations.

20.1.5.2.1 All devices in connection with the preparation of food shall be installed and operated to avoid hazard to the safety of occupants. [***101:***12.7.2.1; ***101:***13.7.2.1]

20.1.5.2.2 All devices in connection with the preparation of food shall be of an approved type and shall be installed in an approved manner. [***101:***12.7.2.2; ***101:***13.7.2.2]

20.1.5.2.3 Food preparation facilities shall be protected in accordance with Chapter 50 (NFPA 96) and shall not be required to have openings protected between food preparation areas and dining areas. [***101:***12.7.2.3; ***101:***13.7.2.3]

Δ **20.1.5.2.4** Portable cooking equipment that is not flue-connected shall be permitted only as follows:

(1) Equipment fueled by small heat sources that can be readily extinguished by water, such as candles or alcohol-burning equipment, including solid alcohol, shall be permitted to be used, provided that precautions satisfactory to the AHJ are taken to prevent ignition of any combustible materials.
(2) Candles shall be permitted to be used on tables used for food service where securely supported on substantial noncombustible bases located to avoid danger of ignition of combustible materials and only where approved by the AHJ.
(3) Candle flames shall be protected.
(4) "Flaming sword" or other equipment involving open flames and flamed dishes, such as cherries jubilee or crêpes suzette, shall be permitted to be used, provided that precautions subject to the approval of the AHJ are taken.
(5) Listed and approved LP-Gas commercial food service appliances shall be permitted to be used where in accordance with Chapter 69.

[***101:***12.7.2.4; ***101:***13.7.2.4]

An approved type of device, as required by 20.1.5.2.2, is one that, with regard to potential fire hazards, is acceptable to the AHJ. An "approved manner" of installation means installation acceptable to the AHJ. See definition of *approved* in 3.2.1.

The *Code* depends on the automatic extinguishing system mandated by Chapter 50 to control any fire on the cooking surfaces; thus, 20.1.5.2.3 does not require enclosure by rated construction.

The list of tragic fires in assembly occupancies caused by "friendly" fires (e.g., alcohol or solid alcohol fires in restaurants, flames used for dramatic effects in theaters) is well documented. The requirements of 20.1.5.2.4 and 20.1.5.3 attempt to prevent fires by strictly controlling the use of open flame devices.

20.1.5.2.4.1 Permits. Permits, where required, shall comply with Section 1.12.

Δ **20.1.5.3 Open Flame Devices and Pyrotechnics.** No open flame devices or pyrotechnic devices shall be used in any assembly occupancy, unless otherwise permitted by one of the following:

(1) Pyrotechnic special effect devices shall be permitted to be used on stages before proximate audiences for ceremonial or religious purposes, as part of a demonstration in exhibits, or as part of a performance, provided that both of the following criteria are met:
    (a) Precautions satisfactory to the AHJ are taken to prevent ignition of any combustible material.
    (b) Use of the pyrotechnic device complies with Section 65.3.
(2) Flame effects before an audience shall be permitted in accordance with Section 65.4.
(3) Open flame devices shall be permitted to be used in the following situations, provided that precautions satisfactory to the AHJ are taken to prevent ignition of any combustible material or injury to occupants:
    (a)* For ceremonial or religious purposes
    (b) On stages and platforms where part of a performance
    (c) Where candles on tables are securely supported on substantial noncombustible bases and candle flame is protected
(4) The requirement of 20.1.5.3 shall not apply to heat-producing equipment complying with 11.2.2.
(5) The requirement of 20.1.5.3 shall not apply to food service operations in accordance with 20.1.5.2.
(6) Gas lights shall be permitted to be used, provided that precautions are taken, subject to the approval of the AHJ, to prevent ignition of any combustible materials.

[***101:***12.7.3; ***101:***13.7.3]

A.20.1.5.3(3)(a) Securely supported altar candles in churches that are well separated from any combustible material are permitted. On the other hand, lighted candles carried by children wearing cotton robes present a hazard too great to be permitted. There are many other situations of intermediate hazard where the AHJ will have to exercise judgment. [***101:***A.12.7.3(3)(a); ***101:***A.13.7.3(3)(a)]

20.1.5.3.1 Permits. Permits, where required, shall comply with Section 1.12.

20.1.5.4 Furnishings, Decorations, and Scenery.

20.1.5.4.1* Fabrics and films used for decorative purposes, all draperies and curtains, and similar furnishings shall be in accordance with the provisions of 12.6.2. [***101:***12.7.4.1; ***101:***13.7.4.1]

A.20.1.5.4.1 Fabric applied over unused seating sections should meet the requirements of 20.1.5.4. [***101:***A.12.7.4.1; ***101:***A.13.7.4.1]

20.1.5.4.2 The AHJ shall impose controls on the quantity and arrangement of combustible contents in assembly occupancies to provide an adequate level of safety to life from fire. [***101:***12.7.4.2; ***101:***13.7.4.2]

Δ **20.1.5.4.3*** Exposed foamed plastic materials and unprotected materials containing foamed plastic used for decorative purposes or stage scenery shall have a heat release rate not exceeding 100 kW where tested in accordance with one of the following:

(1) UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
(2) NFPA 289 using the 20 kW ignition source

[***101:***12.7.4.3; ***101:***13.7.4.3]

A.20.1.5.4.3 The phrase "unprotected materials containing foamed plastic" is meant to include foamed plastic items covered by "thermally thin" combustible fabrics or paint. *(See A.12.5.4.4.)* [***101:***A.12.7.4.3; ***101:***A.13.7.4.3]

20.1.5.4.4 The requirement of 20.1.5.4.3 shall not apply to individual foamed plastic items and items containing foamed plastic where the foamed plastic does not exceed 1 lb (0.45 kg) in weight. [***101:***12.7.4.4; ***101:***13.7.4.4]

20.1.5.5 Special Provisions for Exposition Facilities.

20.1.5.5.1 Permits. Permits, where required, shall comply with Section 1.12.

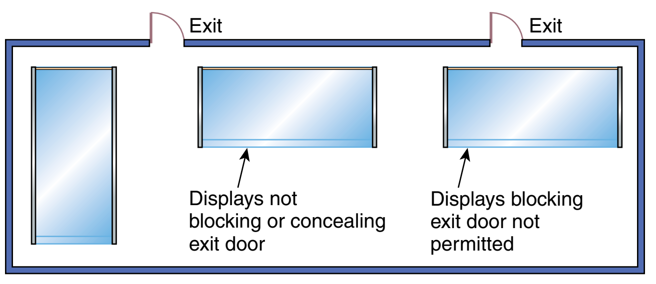
20.1.5.5.2 General. No display or exhibit shall be installed or operated to interfere in any way with access to any required exit or with the visibility of any required exit or required exit sign; nor shall any display block access to fire-fighting equipment. [***101:***12.7.5.1; ***101:***13.7.5.1]

20.1.5.5.3 Materials Not on Display. A storage room having an enclosure consisting of a smoke barrier having a minimum 1-hour fire resistance rating and protected by an automatic extinguishing system shall be provided for combustible materials not on display, including combustible packing crates used to ship exhibitors' supplies and products. [***101:***12.7.5.2; ***101:***13.7.5.2]

Exposition facilities have potential problems that differ from those of theaters, restaurants, or other assembly occupancies. They are generally large, multi-use facilities with high ceilings appropriate to their size. Combustible materials are frequently displayed, and the containers in which the exhibits are shipped contribute to the fuel load. Due to the size of exhibition halls, most are required by 12.1.6 and 13.1.6 of NFPA *101* and by 13.3.2.7, and 13.3.2.8 of this *Code* to be protected by automatic sprinklers.

The AHJ at the local level often works with organizations that exhibit on a national basis and that are unaware of local fire safety regulations. The intent is that this *Code* provide the more consistent and universal treatment needed in these occupancies and, at the same time, encourage more uniform enforcement practices.

Exhibit 20.2



Arrangement of displays in an exhibition hall.

Prior to the inclusion of 20.1.5.5, the trade show and exposition hall regulations used by many jurisdictions were similar; however, no nationally recognized model code could be referenced. This lack of a model code presented a hardship, as well as confusion between the local AHJ and persons responsible for the various functions of the trade show or exposition.

To meet the intent of 20.1.5.5.2, it is advisable to have prepared plans or diagrams to show the arrangement of displays or exhibits, including any that are to be suspended from the ceiling or housed within an overhead structure. Displays or exhibits must not interfere with access to any required exit, and they must not conceal exit signs. This point is illustrated in Exhibit 20.2. A display should not block access to fire-fighting equipment or interfere with the normal operation of automatic extinguishing equipment or devices for smoke evacuation.

Aisles serving rows of booths are exit accesses; therefore, booths and other temporary construction should be of minimal combustible construction or should be protected to avoid undue hazard of fire that might endanger occupants before they can reach available exits.

Displays or exhibits of combustible material must be limited in quantity to reduce the fuel load to an acceptable level. In accordance with 20.1.5.5.3, excess combustible display material and all other combustible materials that are not in use must be kept in a separate storage room until needed. A separation with a fire resistance rating of 1 hour is required between such a storage room and all other parts of the building, and the room must be protected by an automatic sprinkler system.

20.1.5.5.4 Exhibits.

20.1.5.5.4.1 Exhibits shall comply with 20.1.5.5.4.2 through 20.1.5.5.4.11. [***101:***12.7.5.3.1; ***101:***13.7.5.3.1]

20.1.5.5.4.2 The travel distance within the exhibit booth or exhibit enclosure to an exit access aisle shall not exceed 50 ft (15 m). [***101:***12.7.5.3.2; ***101:***13.7.5.3.2]

20.1.5.5.4.3 The upper deck of multilevel exhibits exceeding 300 ft^2 (28 m^2) shall have not less than two remote means of egress. [***101:***12.7.5.3.3; ***101:***13.7.5.3.3]

Δ **20.1.5.5.4.4** Exhibit booth construction materials shall be limited to the following:

(1) Noncombustible or limited-combustible materials
(2) Wood exceeding ¼ in. (6.3 mm) nominal thickness
(3) Wood that is pressure-treated, fire-retardant wood meeting the requirements of NFPA 703
(4) Flame-retardant materials complying with one of the following:
  (a) They shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701.
  (b) They shall exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289 using the 20 kW ignition source.
(5) Textile wall coverings, such as carpeting and similar products used as wall or ceiling finishes, complying with the provisions of 10.2.2 and 10.2.4 of NFPA *101*
(6) Plastics limited to those that comply with Sections 12.3.3 and 10.2 of NFPA *101*
(7) Foamed plastics and materials containing foamed plastics having a heat release rate for any single fuel package that does not exceed 100 kW where tested in accordance with one of the following:
  (a) UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
  (b) NFPA 289 using the 20 kW ignition source
(8) Cardboard, honeycombed paper, and other combustible materials having a heat release rate for any single fuel package that does not exceed 150 kW where tested in accordance with one of the following:
  (a) UL 1975
  (b) NFPA 289, using the 20 kW ignition source

[***101:***12.7.5.3.4; ***101:***13.7.5.3.4]

20.1.5.5.4.5 Curtains, drapes, and decorations shall comply with 12.6.2. [***101:***12.7.5.3.5; ***101:***13.7.5.3.5]

20.1.5.5.4.6 Acoustical and decorative material including, but not limited to, cotton, hay, paper, straw, moss, split bamboo, and wood chips shall be flame-retardant treated to the satisfaction of the AHJ. [***101:***12.7.5.3.6; ***101:***13.7.5.3.6]

20.1.5.5.4.6.1 Materials that cannot be treated for flame retardancy shall not be used. [***101:***12.7.5.3.6.1; ***101:***13.7.5.3.6.1]

Δ **20.1.5.5.4.6.2** Foamed plastics, and materials containing foamed plastics and used as decorative objects such as, but not limited to, mannequins, murals, and signs, shall have a heat release rate for any single fuel package that does not exceed 150 kW where tested in accordance with one of the following:

(1) UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
(2) NFPA 289 using the 20 kW ignition source

[***101:***12.7.5.3.6.2; ***101:***13.7.5.3.6.2]

20.1.5.5.4.6.3 Where the aggregate area of acoustical and decorative materials is less than 10 percent of the individual floor or wall area, such materials shall be permitted to be used subject to the approval of the AHJ. [***101:***12.7.5.3.6.3; ***101:***13.7.5.3.6.3]

Δ **20.1.5.5.4.7** The following shall be protected by automatic extinguishing systems:

(1) Single-level exhibit booths exceeding 300 ft^2 (28 m^2) and covered with a ceiling
(2) Each level of multilevel exhibit booths, including the uppermost level where the uppermost level is covered with a ceiling

[***101:***12.7.5.3.7; ***101:***13.7.5.3.7]

Δ **20.1.5.5.4.7.1** The requirements of 20.1.5.5.4.7 shall not apply where otherwise permitted by the following:

(1) Ceilings that are constructed of open grate design or listed dropout ceilings in accordance with NFPA 13 shall not be considered ceilings within the context of 20.1.5.5.4.7.
(2) Vehicles, boats, and similar exhibited products having over 100 ft^2 (9.3 m^2) of roofed area shall be provided with smoke detectors acceptable to the AHJ.
(3)* The requirement of 20.1.5.5.4.7(2) shall not apply where fire protection of multilevel exhibit booths is consistent with the criteria developed through a life safety evaluation of the exhibition hall in accordance with 12.4.1 or 13.4.1 of NFPA *101*, subject to approval of the AHJ.

[***101:***12.7.5.3.7.1; ***101:***13.7.5.3.7.1]

A.20.1.5.5.4.7.1(3) See A.10.14.3.1. [***101:***A.12.7.5.3.7.1(3); ***101:***A.13.7.5.3.7.1(3)]

20.1.5.5.4.7.2 A single exhibit or group of exhibits with ceilings that do not require sprinklers shall be separated by a distance of not less than 10 ft (3050 mm) where the aggregate ceiling exceeds 300 ft^2 (28 m^2). [***101:***12.7.5.3.7.2; ***101:***13.7.5.3.7.2]

20.1.5.5.4.7.3 The water supply and piping for the sprinkler system shall be permitted to be of an approved temporary means that is provided by a domestic water supply, a standpipe system, or a sprinkler system. [***101:***12.7.5.3.7.3; ***101:***13.7.5.3.7.3]

The requirement of 20.1.5.5.4.2 applies to a standard exhibit booth arrangement, whether it is constructed of pipe supports and cloth or paper drapes or is a large exhibit enclosure designed and built from other materials, which could include small booths, open displays, large board displays, or other arrangements. This requirement also includes exhibit enclosures created by the arrangement of products such as machinery or vehicles. The intent is that travel distance is not to be more than 50 ft (15 m) for occupants who are inside the enclosure, whether they are employees or patrons. Note that this travel distance is not to an exit, but only to an aisle.

The requirement of 20.1.5.5.4.3 ensures that larger exhibits with a second level will provide at least two means of egress to prevent occupants from being entrapped on the upper level.

Paragraph 20.1.5.5.4.4 is intended to provide direction to manufacturers of exhibit booths as well as decorators, exhibitors, and AHJs. This paragraph focuses on the construction components of the ceilings, walls, and floors of an exhibit booth or display area in addition to the finish treatment. The intent is to regulate the materials used for large signs and display boards; small signs might be considered interior finish materials per the criteria of 12.5.6.3. Paragraph 20.1.5.5.4.4 does not apply to the goods or products that are being displayed.

Plastics are limited to Class A and Class B for wall and ceiling finishes. The intent of 20.1.5.5.4.4(7) is to prohibit the use of foamed plastics because of their inherent burning characteristics, unless they have been tested for heat release rate in accordance with UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, or NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, and meet the maximum 100 kW threshold. Foamed plastics are used in sign construction and display boards, and, in some cases, the entire booth is constructed of foamed plastics.

Large booths and multistory booths pose special life safety problems in exhibit halls. A fire in such booths could grow to proportions large enough to have a significant negative impact on the performance of the building's sprinkler system. The intent of 20.1.5.5.4.7 is to provide sprinkler protection in these booths by means of a temporary tap into the existing sprinkler system. Sprinklers should provide the protection necessary to extinguish a fire in its incipient stage, thus reducing the life hazard to occupants.

Item (1) of 20.1.5.5.4.7.1 is not really an exemption to 20.1.5.5.4.7, because the exemption of sprinklers below drop-out ceilings is already permitted by the reference document, NFPA 13, *Standard for the Installation of Sprinkler Systems*. The exemption was added to emphasize that the intent is not to prohibit this provision of the sprinkler installation standard from being applied.

Item (2) of 20.1.5.5.4.7.1 exempts large vehicles (e.g., boats, mobile homes, and recreational vehicles) from the sprinkler requirement but requires a smoke detector if the vehicle is larger than 100 ft^2 (9.3 m^2) to provide early warning in the immediate area to allow for orderly evacuation. This provision most probably could be met by single-station, battery-operated smoke alarms.

Item (3) of 20.1.5.5.4.7.1 permits exposition hall operators to work with the AHJ to devise alternative methods of compliance via the life safety evaluation of 12/13.4.1 of NFPA *101*.

20.1.5.5.4.8 Open flame devices within exhibit booths shall comply with 20.1.5.3. [***101:***12.7.5.3.8; ***101:***13.7.5.3.8]

Δ **20.1.5.5.4.9** Cooking and food-warming devices in exhibit booths shall comply with 20.1.5.2 and all of the following:

(1) Gas-fired devices shall comply with the following:
  (a) Natural gas-fired devices shall comply with Section 11.4.
  (b) The requirement of 20.1.5.5.4.9(1)(a) shall not apply to compressed natural gas where permitted by the AHJ.
  (c) The use of LP-Gas cylinders shall be prohibited.
  (d) Nonrefillable LP-Gas cylinders shall be approved for use where permitted by the AHJ.
(2) The devices shall be isolated from the public by not less than 48 in. (1220 mm) or by a barrier between the devices and the public.
(3) Multi-well cooking equipment using combustible oils or solids shall comply with Chapter 50.
(4) Single-well cooking equipment using combustible oils or solids shall meet all of the following criteria:
  (a) The equipment shall have lids available for immediate use.
  (b) The equipment shall be limited to 2 ft^2 (0.2 m^2) of cooking surface.
  (c) The equipment shall be placed on noncombustible surface materials.
  (d) The equipment shall be separated from each other by a horizontal distance of not less than 24 in. (610 mm).
  (e) The requirement of 20.1.5.5.4.9(4)(d) shall not apply to multiple single-well cooking equipment where the aggregate cooking surface area does not exceed 2 ft^2 (0.2 m^2).
  (f) The equipment shall be kept at a horizontal distance of not less than 24 in. (610 mm) from any combustible material.
(5) A portable fire extinguisher in accordance with Section 13.6 shall be provided within the booth for each device, or an approved automatic extinguishing system shall be provided.

[***101:***12.7.5.3.9; ***101:***13.7.5.3.9]

20.1.5.5.4.10 Combustible materials within exhibit booths shall be limited to a one-day supply. Storage of combustible materials behind the booth shall be prohibited. *(See 20.1.5.4.2 and 20.1.5.5.3.)* [***101:***12.7.5.3.10; ***101:***13.7.5.3.10]

20.1.5.5.4.11 Plans for the exposition, in an acceptable form, shall be submitted to the AHJ for approval prior to setting up any exhibit. [***101:***12.7.5.3.11; ***101:***13.7.5.3.11]

20.1.5.5.4.11.1 The plan shall show all details of the proposed exposition. [***101:***12.7.5.3.11.1; ***101:***13.7.5.3.11.1]

20.1.5.5.4.11.2 No exposition shall occupy any exposition facility without approved plans. [***101:***12.7.5.3.11.2; ***101:***13.7.5.3.11.2]

Open flame devices, as noted in 20.1.5.5.4.8, need to comply with the provisions of 20.1.5.3. Any use of open flames requires the approval of the AHJ.

The provisions of 20.1.5.5.4.9 recognize the inherent dangers in cooking and food-warming devices that are used in an exhibit hall subject to large, transient crowds.

Item (2) of 20.1.5.5.4.9 requires separation distance or a barrier between the public and the device. The purpose is to guard against the dangers of accidental spills of hot greases or foods and to minimize the potential for ignition of combustibles, especially clothing worn by patrons.

Item (3) of 20.1.5.5.4.9 requires that multi-vat, or multi-well, cooking equipment comply with Chapter 50.

The intent of requiring the lid in 20.1.5.5.4.9(4)(a) is to provide the operator with a ready method of smothering the fire.

The requirement in 20.1.5.5.4.9(4)(c) is important, because the bottom surface of many devices could be subject to heating to temperatures that could ignite combustible surfaces.

The minimum separation distance in 20.1.5.5.4.9(4)(d) is necessary to minimize the danger of a fire in one device extending into another device; the same principle applies to 20.1.5.5.4.9(4)(f), except that the exposure of concern is to combustible decorations or other products, as opposed to another cooking device.

Item (5) of 20.1.5.5.4.9 requires a portable extinguisher for each cooking device. The intent is to provide an extinguisher near each cooking device so the operator is able to access the extinguisher readily if a lid does not extinguish the fire or cannot be applied. The intent is not to permit all extinguishers to be located in one place. The reference to Section 13.6 leads the user to NFPA 10, *Standard for Portable Fire Extinguishers*, which provides the necessary information with regard to the appropriate type and size of extinguisher.

Paragraph 20.1.5.5.4.10 limits the amount of literature, brochures, boxes, giveaways, and other products that are kept in the exhibit booth. The number of items necessary to constitute a one-day supply obviously varies. However, the AHJ should be able to make a judgment after reviewing the activity anticipated by the exhibitor. Additional supplies and combustible crates (such as those used for shipping) should be kept in a separate storage area having a fire resistance rating of 1 hour and protected by an automatic sprinkler system, as required by 20.1.5.5.3.

The intent of 20.1.5.5.4.11 is to provide the AHJ with a set of plans that shows aisle widths, travel distances, exits, booth locations, display area configurations, types of displays (e.g., cooking, machinery, drapery, arts and crafts), location of fire protection equipment (extinguishers, manual fire alarm boxes, hose cabinets), and lobby and registration area usage. This list is not complete, but it provides some guidance in determining the contents of the plan that should be submitted. The plan should be drawn to scale, but the scale used is not usually critical, provided that it is indicated on the plan.

20.1.5.5.4.12 Vehicles. Vehicles on display within an exposition facility shall comply with 20.1.5.5.4.12.1 through 20.1.5.5.4.12.5. [***101:***12.7.5.4; ***101:***13.7.5.4]

20.1.5.5.4.12.1 All fuel tank openings shall be locked and sealed in an approved manner to prevent the escape of vapors; fuel tanks shall not contain in excess of one-half their capacity or contain in excess of 10 gal (38 L) of fuel, whichever is less. [***101:***12.7.5.4.1; ***101:***13.7.5.4.1]

20.1.5.5.4.12.2 At least one battery cable shall be removed from the batteries used to start the vehicle engine, and the disconnected battery cable shall then be taped. [***101:***12.7.5.4.2; ***101:***13.7.5.4.2]

20.1.5.5.4.12.3 Batteries used to power auxiliary equipment shall be permitted to be kept in service. [***101:***12.7.5.4.3; ***101:***13.7.5.4.3]

20.1.5.5.4.12.4 Fueling or defueling of vehicles shall be prohibited. [***101:***12.7.5.4.4; ***101:***13.7.5.4.4]

20.1.5.5.4.12.5 Vehicles shall not be moved during exhibit hours. [***101:***12.7.5.4.5; ***101:***13.7.5.4.5]

Paragraph 20.1.5.5.4.12 on vehicles is intended to minimize the danger from both fuel and ignition sources. In accordance with 20.1.5.5.4.12.1, it is important that fuel tank openings be locked to prevent tampering with and accessibility to fuel. It is also important that the tank openings be taped to prevent the escape of flammable vapors. When these *Code* requirements were written, the issue of the quantity of fuel permitted in a tank was studied. Some jurisdictions preferred empty tanks to eliminate fuel, while others preferred full tanks to prevent vapors. It was determined that most exhibitors were unaware of the local regulation until they arrived at the exhibit hall. After learning the specific rule (empty or full), exhibitors proceeded to make their adjustment in the adjacent parking area or some other unsuitable area. It is also difficult for the AHJ to determine whether a tank is absolutely full or empty. Fueling and defueling by exhibitors outside the hall presented a greater danger than the level of fuel in the tanks, given that the tanks are locked and sealed, and ignition sources are eliminated from the vehicle. However, to avoid excessive quantities of fuel in the exhibition hall, the *Code* does limit the quantity of fuel in tanks.

In accordance with 20.1.5.5.4.12.2, it is important that at least one of the battery cables be removed from each battery. Many vehicles have more than one battery. The intent is to eliminate the possibility of a spark from the battery that might ignite fuel or surrounding combustibles. Battery cable connectors should be thoroughly taped after they have been removed.

The provision of 20.1.5.5.4.12.3 permits batteries that cannot be used to start the vehicle to remain in service. These batteries present no more of an ignition hazard than does providing house electrical power to the item on display.

Vehicle movement is addressed in 20.1.5.5.4.12.5. The movement of vehicles inside the exhibit hall potentially compromises the means of egress by blocking the exit access; vehicles should, therefore, be positioned before the hall is opened to the public. The effects of carbon monoxide (CO) inside an exhibit hall that is occupied is also a concern.

20.1.5.5.4.13 Prohibited Materials.

Δ **20.1.5.5.4.13.1** The following items shall be prohibited within exhibit halls:

(1) Compressed flammable gases
(2) Flammable or combustible liquids
(3) Hazardous chemicals or materials
(4) Class II or greater lasers, blasting agents, and explosives

[***101:***12.7.5.5.1; ***101:***13.7.5.5.1]

20.1.5.5.4.13.2 The AHJ shall be permitted to allow the limited use of any items specified in 20.1.5.5.4.13.1 under special circumstances. [***101:***12.7.5.5.2; ***101:***13.7.5.5.2]

Compressed gas containers, as addressed by 20.1.5.5.4.13.1, are subject to fire damage that could cause an explosion or create a serious threat to life safety. Flammable and combustible liquids compromise life safety by their inherent capability to contribute to rapid fire spread. Hazardous materials present a variety of hazards to life safety, from their flammability to their toxicity. Class II or greater lasers can cause tissue damage to humans, and blasting agents and explosives can cause a large loss of life or injury if handled improperly.

Exhibitors who wish to display explosives, pesticides, or a type of compressed gas container, among other items, can effectively do so without bringing the actual product into the hall by using empty containers instead.

Paragraph 20.1.5.5.4.13.2 gives the AHJ the discretion to permit small amounts of otherwise prohibited materials under special circumstances. For example, an exhibit or trade show for collectors of small arms ammunition or a highly supervised and closed (to the public) vocational trade show using such materials is permitted where special controls and professional supervision are provided.

20.1.5.6 Crowd Managers.

Δ **20.1.5.6.1** Assembly occupancies shall be provided with a minimum of one trained crowd manager or crowd manager supervisor. Where the occupant load exceeds 250, additional trained crowd managers or crowd manager supervisors shall be provided at a ratio of 1 crowd manager or crowd manager supervisor for every 250 occupants, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to assembly occupancies used exclusively for religious worship with an occupant load not exceeding 500.
(2) The ratio of trained crowd managers to occupants shall be permitted to be reduced where, in the opinion of the AHJ, the existence of an approved, supervised automatic sprinkler system and the nature of the event warrant.

[***101:***12.7.6.1; ***101:***13.7.6.1]

20.1.5.6.2* The crowd manager and crowd manager supervisor shall receive approved training in crowd management techniques. [***101:***12.7.6.2; ***101:***13.7.6.2]

Since the 2006 edition of the *Code*, a minimum of one crowd manager has been required for each assembly occupancy, regardless of occupant load. Where the occupant load exceeds 250, additional crowd managers are required at the specified ratio. In editions prior to 2006, a crowd manager was required only if the occupant load exceeded 1000. The change was made in reaction to The Station nightclub fire of 2003 in West Warwick, Rhode Island, in which 100 occupants perished.

The procedures for providing trained crowd managers must be part of the written emergency action plan as required by 20.1.5.6.3. The delineation of duties and responsibilities of crowd managers, as listed in 20.1.5.6.4, will lead to standardization in the training the crowd managers receive and consistency in the services they provide in the various assembly venues in which they work. The provisions of 20.1.5.6.5 charge the crowd manager supervisors with understanding the workings of the specific venue. The crowd manager supervisors are expected to provide the venue-specific training that elevates a generalist crowd manager to a specialist crowd manager for a particular venue.

Crowd management meshes the design features of a facility, the established operating features of the facility, and an understanding of the occupants' expected natural behavior in the facility for a specific type of event. Chapter 56 of the *SFPE Handbook of Fire Protection Engineering*, "Egress Concepts and Design Approaches," cites numerous technical references that provide additional detail on crowd management concepts. Included is "The Causes and Prevention of Crowd Disasters," by John J. Fruin, a leading expert on pedestrian movement and crowd safety. Fruin differentiates crowd control from crowd management by defining crowd management as "the systematic planning for, and supervision of, the orderly movement and assembly of people. Crowd control is the restriction or limitation of group behavior. Crowd management involves the assessment of the people handling capabilities of a space prior to use. It includes evaluation of projected levels of occupancy, adequacy of means of ingress and egress, processing procedures such as ticket collection, and expected types of activities and group behavior."

The options for training programs for crowd managers increased greatly beginning in 2010 with the introduction of a readily available and affordable web-based program from the International Association of Venue Managers (IAVM), formerly the International Association of Assembly Managers, which can be accessed at http://www.iaamtraining.com/tcm.html. The web-based program provides 6 hours of training that can be completed in multiple sessions. The enrollee is awarded a certificate upon successful completion of a comprehensive examination. The recipient of the certificate then needs to complete, on-site, venue-specific training and receives a certificate from the venue before being officially designated as a trained crowd manager. An individual can complete multiple venue-specific training programs so as to qualify to serve as a trained crowd manager at the multiple venues.

The IAVM also conducts live training and hosts the annual GuestX Guest Experience & Crowd Management Conference (visit www.iavm.org for more information). Additional crowd manager certification programs are available online. The determination of acceptability of such programs must be made by the AHJ.

A.20.1.5.6.2 Crowd managers and crowd manager supervisors need to clearly understand the required duties and responsibilities specific to the venue's emergency plan. The crowd management training program should include a clear appreciation of crowd dynamics factors including space, energy, time, and information, as well as specific crowd management techniques, such as metering. Training should involve specific actions necessary during normal and emergency operations, and include an assessment of people handling capabilities of a space prior to its use, the identification of hazards, an evaluation of projected levels of occupancy, the adequacy of means of ingress and egress and identification of ingress and egress barriers, the processing procedures such as ticket collection, and the expected types of human behavior. Training should also involve the different types of emergency evacuations and, where required by the emergency plan, relocation and shelter-in-place operations, and the challenges associated with each. [***101:***A.12.7.6.2; ***101:***A.13.7.6.2]

20.1.5.6.3 Duties and responsibilities for the crowd manager and crowd manager supervisor shall be documented within a written emergency plan as required by 12.7.13 of NFPA 101. [***101:***12.7.6.3; ***101:***13.7.6.3]

20.1.5.6.4* The training for the duties and responsibilities of crowd managers shall include the following:

(1) Understanding crowd manager roles and responsibilities
(2) Understanding safety and security hazards that can endanger public assembly
(3) Understanding crowd management techniques
(4) Introduction to fire safety and fire safety equipment
(5) Understanding methods of evacuation and movement
(6) Understanding procedures for reporting emergencies
(7) Understanding crowd management emergency response procedures
(8) Understanding the paths of travel and exits, facility evacuation and emergency response procedures and, where provided, facility shelter-in-place procedures
(9) Familiarization with the venue and guest services training
(10) Other specific event-warranted training

[***101:***12.7.6.4; ***101:***13.7.6.4]

A.20.1.5.6.4 In large facilities, crowd managers typically have a specific area of responsibility. In such facilities, the requirements of 20.1.5.6.4 might apply only to the crowd managers' area of responsibility. [***101:***A.12.7.6.4; ***101:***A.13.7.6.4]

20.1.5.6.5 The training for the duties and responsibilities of crowd manager supervisors shall include the following:

(1) The duties described in 20.1.5.6.4
(2) Understanding crowd manager supervisor roles and responsibilities
(3) Understanding of incident management procedures
(4) Understanding the facility evacuation plan
(5) Understanding the facility command structure

[***101:***12.7.6.5; ***101:***13.7.6.5]

20.1.5.7* Fire Detail. Fire details, if deemed necessary in any assembly occupancy, shall be determined by the AHJ.

A.20.1.5.7 Because of the variety of types of places of assembly covered in this *Code*, no general requirement for patrols or fire watchers has been included. The NFPA 102 Committee fully recognizes the importance of this feature of fire protection, however, and believes that a system of well-trained patrols or fire watchers should be maintained in every place of assembly where fire hazards might develop. Such locations would include, among others, the spaces underneath grandstands and the areas inside and outside tents and air-supported structures. The fire watchers serve to detect incipient fires and to prevent an accumulation of materials that will carry fire. The number of such watchers required will, of course, vary for the different types of assembly occupancies, depending upon the combustibility of the construction and the number of persons accommodated. Provided with an adequate supply of portable fire extinguishing equipment located at readily accessible points, such a fire watch or detail should be able to prevent small fires from reaching serious proportions.

20.1.5.8* Drills.

A.20.1.5.8 It is important that an adequate number of competent attendants are on duty at all times when the assembly occupancy is occupied. [***101:***A.12.7.7; ***101:***A.13.7.7]

20.1.5.8.1 The employees or attendants of assembly occupancies shall be trained and drilled in the duties they are to perform in case of fire, panic, or other emergency to effect orderly exiting. [***101:***12.7.7.1; ***101:***13.7.7.1]

20.1.5.8.2 Employees or attendants of assembly occupancies shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment where provided. [***101:***12.7.7.2; ***101:***13.7.7.2]

Δ **20.1.5.8.3*** In the following assembly occupancies, an audible announcement shall be made, or a projected image shall be shown, prior to the start of each program that notifies occupants of the location of the exits to be used in case of a fire or other emergency:

(1) Theaters
(2) Motion picture theaters
(3) Auditoriums
(4) Other similar assembly occupancies with occupant loads exceeding 300 where there are noncontinuous programs

[***101:***12.7.7.3; ***101:***13.7.7.3]

A.20.1.5.8.3 It is not the intent of this provision to require an announcement in bowling alleys, cocktail lounges, restaurants, or places of worship. [***101:***A.12.7.7.3; ***101:***A.13.7.7.3]

20.1.5.8.4 The requirement of 20.1.5.8.3 shall not apply to assembly occupancies in schools where used for nonpublic events. [***101:***12.7.7.4; ***101:***13.7.7.4]

The provisions of 20.1.5.8.2 do not require fire extinguishers for life safety in an assembly occupancy. They do specify, however, that, if fire extinguishers are provided, the staff must be trained in their use to prevent a false sense of security and possible injury. The AHJ determines the extent of this training, whether instruction only or instruction and hands-on use.

The relatively simple requirement of 20.1.5.8.3 for notifying occupants of the location of exits can make a significant difference during an emergency. Note that the requirement does not apply to assembly occupancies where the flow of people is constantly changing, such as in a restaurant. Movie theaters commonly meet the provisions of 20.1.5.8.3 through means of sound and screen projection that are presented prior to the main feature, during the same period that notifications of restroom, trash container, and snack bar locations are made and previews are shown. The same complete message is thereby delivered to each audience without the need for human intervention.

20.1.5.9 Smoking.

20.1.5.9.1 Smoking in assembly occupancies shall be regulated by the AHJ. [***101:***12.7.8.1; ***101:***13.7.8.1]

20.1.5.9.2 In rooms or areas where smoking is prohibited, plainly visible signs shall be posted that read as follows:

NO SMOKING

[***101:***12.7.8.2; ***101:***13.7.8.2]

Δ **20.1.5.9.3** No person shall smoke in prohibited areas that are so posted, unless permitted by the AHJ under both of the following conditions:

(1) Smoking shall be permitted on a stage only where it is a necessary and rehearsed part of a performance.
(2) Smoking shall be permitted only where the smoker is a regular performing member of the cast.

[***101:***12.7.8.3; ***101:***13.7.8.3]

20.1.5.9.4 Where smoking is permitted, suitable ashtrays or receptacles shall be provided in convenient locations. [***101:***12.7.8.4; ***101:***13.7.8.4]

20.1.5.10 Seating.

20.1.5.10.1 Secured Seating.

20.1.5.10.1.1 Seats in assembly occupancies accommodating more than 200 persons shall be securely fastened to the floor, except where fastened together in groups of not less than three and as permitted by 20.1.5.10.1.2 and 20.1.5.10.2. [***101:***12.7.9.1.1; ***101:***13.7.9.1.1]

20.1.5.10.1.2 Balcony and box seating areas that are separated from other areas by rails, guards, partial-height walls, or other physical barriers and have a maximum of 14 seats shall be exempt from the requirement of 20.1.5.10.1.1. [***101:***12.7.9.1.2; ***101:***13.7.9.1.2]

20.1.5.10.2 Unsecured Seating.

20.1.5.10.2.1 Seats not secured to the floor shall be permitted in restaurants, night clubs, and other occupancies where fastening seats to the floor might be impracticable. [***101:***12.7.9.2.1; ***101:***13.7.9.2.1]

20.1.5.10.2.2 Unsecured seats shall be permitted, provided that, in the area used for seating, excluding such areas as dance floors and stages, there is not more than one seat for each 15 ft^2 (1.4 m^2) of net floor area, and adequate aisles to reach exits are maintained at all times. [***101:***12.7.9.2.2; ***101:***13.7.9.2.2]

20.1.5.10.2.3 Seating diagrams shall be submitted for approval by the AHJ to permit an increase in occupant load per 14.8.1.3. [***101:***12.7.9.2.3; ***101:***13.7.9.2.3]

The function of 20.1.5.10.1 is to prevent the movement of seats so that aisles, rows, and access to the exits do not become blocked in an assembly occupancy during the jostling that occurs when people flee from a fire.

The provision of 20.1.5.10.1.1 for fastening seats together in groups was revised for the 2009 edition of the *Code*. In prior editions, the seats were required to be fastened together in groups of not fewer than three and not more than seven. The maximum number of seats in a group was deleted, as it served no practical purpose.

The provision of 20.1.5.10.1.2 was revised for the 2012 edition of the *Code*. It replaces a requirement for all seats in balconies and galleries to be securely fastened to the floor. Its wording results in the 200-seat criterion of 20.1.5.10.1.1 becoming the threshold for balcony and gallery seat fastening. Then, private boxlike seating areas are exempted from the requirement for fastening seats to the floor if the box is separated from other boxes and the area has not more than 14 seats.

Paragraph 20.1.5.10.2.3 requires that seating diagrams be provided to the AHJ to support a request for an increase in occupant load above that calculated using the occupant load factors of Table 14.8.1.2 characteristic of the uses of the space. Such increase in occupant load must not exceed the limits imposed by 12.1.7 and 13.1.7 of NFPA *101*.

Δ **20.1.5.10.3 Festival Seating.** Festival seating, as defined in 3.3.114, shall be prohibited within a building, unless otherwise permitted by one of the following:

(1) Festival seating shall be permitted in assembly occupancies having occupant loads of 250 or less.
(2) Festival seating shall be permitted in assembly occupancies where occupant loads exceed 250, provided that an approved life safety evaluation has been performed. *(See 10.15.3.)*

[***101:***12.2.5.4.1; ***101:***13.2.5.4.1]

20.1.5.10.4 Occupant Load Posting.

20.1.5.10.4.1 Every room constituting an assembly occupancy and not having fixed seats shall have the occupant load of the room posted in a conspicuous place near the main exit from the room. [***101:***12.7.9.3.1; ***101:***13.7.9.3.1]

20.1.5.10.4.2 Approved signs shall be maintained in a legible manner by the owner or authorized agent. [***101:***12.7.9.3.2; ***101:***13.7.9.3.2]

20.1.5.10.4.3 Signs shall be durable and shall indicate the number of occupants permitted for each room use. [***101:***12.7.9.3.3; ***101:***13.7.9.3.3]

The provisions of 20.1.5.10.4 for occupant load posting are unique to assembly occupancies. All occupancies use occupant load for capacity calculations to ensure that the means of egress system is adequately sized. Assembly occupancies use occupant load for the additional purpose of posting the occupant load as a tool to help avoid overcrowding.

Exhibit 20.3 shows an occupant load posting in an airline membership club at an airport. The maximum occupant load of

Exhibit 20.3

Occupant load posting indicative of one consistent use of a space.

Exhibit 20.4

Dual occupant load postings indicative of two common uses of a space.

825 persons is indicative of the club's singular use as a seating area with many chairs and some tables. Exhibit 20.4 shows two occupant load postings for a ballroom in a hotel. The maximum occupant load of 182 persons is for use of the room with tables and chairs; the maximum occupant load of 391 persons is for use of the room with chairs only.

Δ **20.1.5.11 Clothing.** Clothing and personal effects shall not be stored in corridors, and spaces not separated from corridors, unless otherwise permitted by one of the following:

(1) In new assembly occupancies, this requirement shall not apply to corridors, and spaces not separated from corridors, that are protected by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***12.7.12(1)]

(2) In existing assembly occupancies, this requirement shall not apply to corridors, and spaces not separated from corridors, that are protected by an approved automatic sprinkler system in accordance with Section 13.3. [***101:***13.7.12(1)]

(3) This requirement shall not apply to corridors, and spaces not separated from corridors, that are protected by a smoke detection system in accordance with Section 13.3. [***101:***12.7.12(2); ***101:***13.7.12(2)]

(4) This requirement shall not apply to storage in metal lockers, provided that the required egress width is maintained.

[***101:***12.7.12(3); ***101:***13.7.12(3)]

Clothing hung on hooks along corridor walls or on racks in lobbies greatly increases the combustible load and will generally allow flames to spread quickly. Each of the exemptions (control of fire by sprinklers, early warning of incipient-stage fire via smoke detection, or isolation of fuel packages by locating the clothing in metal lockers) helps to mitigate the chance that a clothing fire would render the exit access unusable. The wording of 20.1.5.11 clarifies that the provision applies to clothing in spaces not separated from the corridor as well as in the corridor.

20.1.5.12 Projection Rooms.

20.1.5.12.1 Film or video projectors or spotlights utilizing light sources that produce particulate matter or toxic gases, or light sources that produce hazardous radiation, without protective shielding shall be located within a projection room complying with 12.3.2.1.2 of NFPA *101*. [***101:***12.4.7.3; ***101:***13.4.7.3]

Δ **20.1.5.12.2** Every projection room shall be of permanent construction consistent with the building construction type in which the projection room is located and shall comply with the following:

(1) Openings shall not be required to be protected.

(2) The room shall have a floor area of not less than 80 ft^2 (7.4 m^2) for a single machine and not less than 40 ft^2 (3.7 m^2) for each additional machine.

(3) Each motion picture projector, floodlight, spotlight, or similar piece of equipment shall have a clear working space of not less than 30 in. (760 mm) on each side and at its rear, but only one such space shall be required between adjacent projectors.

[***101:***12.4.7.4; ***101:***13.4.7.4]

The requirements for projection booths were developed jointly with those of NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*, and the motion picture industry when cellulose nitrate film was still being used. Although only safety film is now used (except at film festivals or revivals) in those facilities still utilizing film projectors (many have gone all digital) and the risk level has been reduced, the primary function of the requirements of 20.1.5.12.1 is to enclose the projection booth, eliminating it as an exposure threat to the theater audience.

The intent of 20.1.5.12.1 is to protect the audience from the dangers associated with light sources, such as electric arc or xenon. Where incandescent light is used, projection booths are not required in assembly occupancies. Note that the booth is required based on the light source, not on the use of film.

The provisions of 20.1.5.12.2 apply only to projection booths for the use of cellulose acetate or other safety film. Although openings in the booth do not need to be protected, they must be provided with glass or other approved material that will completely close the opening and prevent gas, dust, or radiation from contaminating the audience seating area.

Newer projection equipment has a console that draws air in at the floor and up through the projection machine, thus eliminating the need to provide ducts near the floor.

N **20.1.5.13 Integrated Fire Protection Systems.** Integrated fire protection systems shall be tested in accordance with 13.1.3. [***101:***12.7.14; ***101:***13.7.14]

The provision of 20.1.5.13 is new to the 2018 edition of the *Code*. Where fire protection and life safety systems are needed to function together to provide the intended level of protection, they must meet the testing requirements of 13.1.3, which in turn references NFPA 4, *Standard for Integrated Fire Protection and Life Safety System Testing*. The integrated systems test addressed by NFPA 4 verifies and documents the operation and function of all interconnected fire protection and life safety systems, including performance in accordance with applicable codes and standards, sequence of operation, performance in accordance with manufacturers' published instructions, and accuracy of record documents. See the commentary following A.13.1.3 for additional information on integrated fire protection and life safety system testing.

20.2 Educational Occupancies

Section 20.2 provides the life safety features necessary to protect students in an educational setting such as a school. This section applies to educational settings for students in kindergarten through the twelfth grade; it does not apply to college classrooms. The range of student characteristics and self-preservation abilities found in the educational occupancies regulated by Section 20.2 requires that students' fire safety needs be treated differently from those of adults occupying a college classroom.

The protection measures used for educational occupancies recognize the structured environment found in a school. For example, class times, time between classes, and activities during class time are rigidly structured. These factors make it possible to train students to respond to a fire by conducting emergency egress and relocation drills.

Schools also have one of the more assertive schedules for conducting emergency egress drills (see 20.2.4.2). The drills not only provide a structured fire escape plan, they also help to instill fire-safe behavior for long-term use.

20.2.1 Application. New and existing educational occupancies shall comply with Section 20.2 and NFPA *101*.

Educational occupancies include those buildings, or portions of buildings, used for educating six or more students for 4 or more hours per day or more than 12 hours per week, but only through the twelfth grade.

The provisions of 14.1.1.4 and 15.1.1.4 of NFPA *101* recognize that colleges, universities, and similar educational facilities that do not meet the definition of an educational occupancy do not pose the same life safety concerns as elementary and high schools. Because of the maturity of their occupants, college buildings more closely resemble business occupancies.

Paragraphs 14.1.1.4 and 15.1.1.4 of NFPA *101* also identify how to classify an occupancy for other educational uses that do not meet the definition of an educational occupancy. Note that the provisions of 14.1.1.4(1) through (5) and 15.1.1.4(1) through (5) of NFPA *101* apply only where the educational use does not meet the definition of an educational occupancy. For example, 14.1.1.4(3) and 15.1.1.4(3) of NFPA *101* specify that a classroom with an occupant load of 50 or more persons be classified as an assembly occupancy only if such classroom is not an educational occupancy. A classroom occupied by 60 eighth-grade students for more than 12 hours per week is an educational occupancy and not an assembly occupancy, because it meets the definition of an educational occupancy. A classroom occupied by 60 college students is an assembly occupancy in accordance with 14.1.1.4(3) and 15.1.1.4(3) of NFPA *101*, because the definition of an educational occupancy applies through only the twelfth grade. A classroom occupied by 49 college students is a business occupancy in accordance with 14.1.1.4(2) and 15.1.1.4(2) of NFPA *101*, because the definition of an educational occupancy applies through only the twelfth grade.

20.2.2 Flexible Plan and Open Plan Buildings.

20.2.2.1 Flexible plan and open plan buildings shall comply with the requirements of 20.2.2 as modified by 20.2.2.2 through 20.2.2.5. [***101:***14.4.3.1; ***101:***15.4.3.1]

20.2.2.2 Each room occupied by more than 300 persons shall have two or more means of egress entering into separate atmospheres. [***101:***14.4.3.2; ***101:***15.4.3.2]

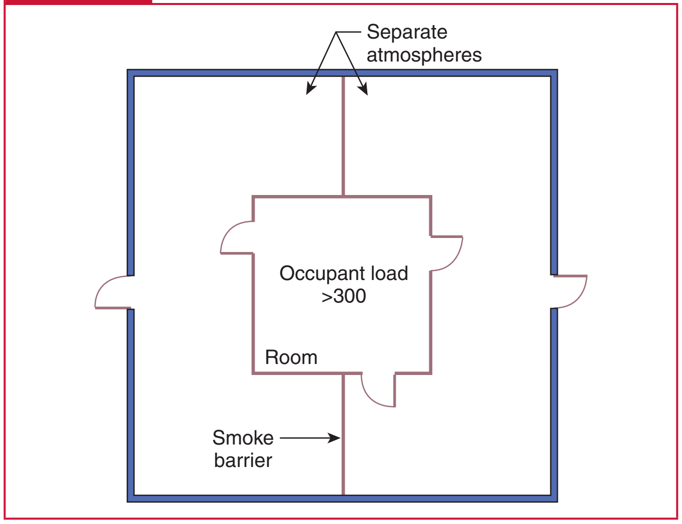
20.2.2.3 Where three or more means of egress are required, the number of means of egress permitted to enter into the same atmosphere shall not exceed two. [***101:***14.4.3.3; ***101:***15.4.3.3]

20.2.2.4 Flexible plan buildings shall be permitted to have walls and partitions rearranged periodically only if revised plans or diagrams have been approved by the AHJ. [***101:***14.4.3.4]

20.2.2.5 Flexible plan buildings shall be evaluated while all folding walls are extended and in use as well as when they are in the retracted position. [***101:***14.4.3.5; ***101:***15.4.3.5]

Flexible plan and open plan buildings are addressed in 20.2.2. Rooms occupied by more than 300 persons require special treatment in flexible plan and open plan schools. To ensure the safety of this large number of persons occupying one room, means of egress must be arranged so that each of the egress paths traverses atmospheres that are separate from each other. If more than two separate means of egress paths are required, not more than two are permitted to pass through the same atmosphere. See the definition of the term *separate atmosphere* in 3.3.27.2 of NFPA *101*. Using this arrangement should prevent a single fire from contaminating or blocking all egress routes in an open plan or flexible plan building.

Exhibit 20.5



Room in open plan building requiring two or more means of egress into separate atmospheres.

Exhibit 20.5 illustrates a room in an open plan building that requires two or more means of egress into separate atmospheres.

In accordance with 20.2.2.4, approval of revised plans or diagrams is necessary to avoid the possibility of circuitous egress paths or other arrangements that do not comply with the intent of the *Code*. Also, flexible plan buildings are required to meet the provisions for corridor protection, as well as those for the subdivision of building spaces, using smoke barriers.

20.2.3 Interior Finish.

20.2.3.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***14.3.3.1; ***101:***15.3.3.1]

20.2.3.2 Interior Wall and Ceiling Finish. New and existing interior wall and ceiling finish materials complying with Section 12.5 shall be permitted as follows:

(1) Exits — Class A [***101:***14.3.3.2(1); ***101:***15.3.3.2(1)]
(2) In new educational occupancies other than exits — Class A or Class B [***101:***14.3.3.2(2)]
(3) In existing educational occupancies, corridors and lobbies — Class A or Class B [***101:***15.3.3.2(2)]
(4) Low-height partitions not exceeding 60 in. (1525 mm) and used in locations other than exits — Class A, Class B, or Class C [***101:***14.3.3.2(3); ***101:***15.3.3.2(3)]

20.2.3.3 Interior Floor Finish.

20.2.3.3.1 New interior floor finish shall comply with Section 12.5. [***101:***14.3.3.3.1]

20.2.3.3.2 New interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 14.3.6 of NFPA *101* shall be not less than Class II. [***101:***14.3.3.3.2]

20.2.3.3.3 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***14.3.3.3.3]

20.2.3.3.4 Existing Interior Floor Finish. (Reserved) [***101:***15.3.3.3]

20.2.4 Operating Features.

20.2.4.1 Emergency Action Plan. Emergency action plans shall be provided in accordance with Section 10.8. [***101:***14.7.1; ***101:***15.7.1]

20.2.4.2 Emergency Egress Drills.

20.2.4.2.1* Emergency egress drills shall be conducted in accordance with Section 10.5 and the applicable provisions of 20.2.4.2.3 as otherwise provided in 20.2.4.2.2. [***101:***14.7.2.1; ***101:***15.7.2.1]

A.20.2.4.2.1 The requirements are, of necessity, general in scope, as it is recognized that they apply to all types of educational occupancies as well as conditions of occupancies, such as truant schools; schools for the mentally handicapped, vision impaired, hearing impaired, and speech impaired; and public schools. It is fully recognized that no one code can meet all the conditions of the various buildings involved, and it will be necessary for site administrators to issue supplements to these requirements, but all supplements should be consistent with these requirements. [***101:***A.14.7.2.1; ***101:***A.15.7.2.1]

20.2.4.2.2 Approved training programs designed for education and training and for the practice of emergency egress to familiarize occupants with the drill procedure, and to establish conduct of the emergency egress as a matter of routine, shall be permitted to receive credit on a one-for-one basis for not more than four of the emergency egress drills required by 20.2.4.2.3, provided that a minimum of four emergency egress drills are completed prior to the conduct of the first such training and practice program. [***101:***14.7.2.2; ***101:***15.7.2.2]

Δ **20.2.4.2.3** Emergency egress drills shall be conducted as follows:

(1) Not less than one emergency egress drill shall be conducted every month the facility is in session, unless both of the following criteria are met:
  (a) In climates where the weather is severe, the monthly emergency egress drills shall be permitted to be deferred.
  (b) The required number of emergency egress drills shall be conducted, and not less than four shall be conducted before the drills are deferred.
(2) All occupants of the building shall participate in the drill.
(3) One additional emergency egress drill, other than for educational occupancies that are open on a year-round basis, shall be required within the first 30 days of operation.

[***101:***14.7.2.3; ***101:***15.7.2.3]

20.2.4.2.4 All emergency drill alarms shall be sounded on the fire alarm system. [***101:***14.7.2.4; ***101:***15.7.2.4]

Emergency egress drills for educational occupancies, particularly those at the grade school level, are essential to ensure an orderly response during a fire. Unfortunately, the predictability of such drills often leads to their ineffectiveness. When an alarm bell sounds and a fire department monitor appears in a corridor, some teachers ignore the bell, assuming that it is a false alarm. If the bell sounds and a fire department monitor is not seen, teachers opt to either evacuate or remain in the building. This decision is made in the hallway. While the bell continues to ring, the students remain in their classrooms. Therefore, when a bell sounds, the primary emphasis should be placed on evacuation, regardless of who is or is not present in the hallways and regardless of whether fire equipment is parked in front of the school. Essentially, the fire department and the school should vary the timing and arrangement of the drills but not the required response, which is orderly evacuation. See also Section 10.5.

The provisions of 20.2.4.2.2 permit emergency egress training programs to substitute for as many as four of the required monthly emergency egress drills. The mixture of training programs and emergency egress drills might elicit student egress behavior that is superior to that instilled by drills alone. However, at least four egress drills need to be conducted prior to the first training program to ensure that the students have walked the egress route and demonstrated other behavior addressed by the emergency plan. The concept behind the requirement that emergency drills be conducted at the start of the school year is that training without the hands-on instruction accomplished by drilling does not guarantee that students will be familiar with the egress routes and able to interact with others during an emergency evacuation or relocation.

20.2.4.3 Inspection.

20.2.4.3.1* It shall be the duty of principals, teachers, or staff to inspect all exit facilities daily to ensure that all stairways, doors, and other exits are in proper condition. [***101:***14.7.3.1; ***101:***15.7.3.1]

A.20.2.4.3.1 Particular attention should be given to keeping all doors unlocked; keeping doors that serve to protect the safety of paths of egress closed and under no conditions blocked open, such as doors on stairway enclosures; keeping outside stairs and fire escape stairs free from all obstructions and clear of snow and ice; and allowing no accumulation of snow or ice or materials of any kind outside exit doors that might prevent the opening of the door or interfere with rapid escape from the building. [***101:***A.14.7.3.1; ***101:***A.15.7.3.1]

Any condition likely to interfere with safe egress should be corrected immediately, if possible, or otherwise should be reported at once to the appropriate authorities. [***101:***A.14.7.3.1; ***101:***A.15.7.3.1]

20.2.4.3.2 Open plan buildings shall require extra surveillance to ensure that exit paths are maintained clear of obstruction and are obvious. [***101:***14.7.3.2; ***101:***15.7.3.2]

20.2.4.3.3 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15 of NFPA *101*. [***101:***14.7.3.3; ***101:***15.7.3.3]

Compliance with the requirement of 20.2.4.3.1 for daily inspection of the egress system has benefits that far outweigh the time and resources required to conduct such inspections. The provision permits staff other than principals and teachers to make such inspections. The inspection function is often better performed by maintenance personnel who have responsibility for and intimate working knowledge of the many building features and systems.

The provision of 20.2.4.3.3 requires the inspection of door openings in accordance with 7.2.1.15 of NFPA *101*, the criteria of which are formatted to apply only where specifically required by another portion of the *Code*. The inspection requirements apply only to specific doors. This application threshold was chosen to help ensure that the egress doors used under emergency egress or relocation are inspected and tested. Door leaves that are infrequently used, such as those into exit stair enclosures in high-rise buildings, might be misaligned within their frames so as to be difficult to open within the operating forces requirements of 14.5.1.5. The door inspection and testing criteria of 14.5.11 are intended to help identify problems with door openings and ensure that such problems are remedied.

20.2.4.4 Furnishings and Decorations.

20.2.4.4.1 Draperies, curtains, and other similar furnishings and decorations in educational occupancies shall be in accordance with the provisions of 12.6.2. [***101:***14.7.4.1; ***101:***15.7.4.1]

Δ **20.2.4.4.2** Clothing and personal effects shall not be stored in corridors, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to corridors protected by an automatic sprinkler system in accordance with Section 13.3.
(2) This requirement shall not apply to corridor areas protected by a smoke detection system in accordance with 13.7.1.4.
(3) This requirement shall not apply to storage in metal lockers, provided that the required egress width is maintained.

[***101:***14.7.4.2; ***101:***15.7.4.2]

Clothing hung on hooks along corridor walls or on racks in school lobbies greatly increases the combustible load and will generally allow flames to spread quickly. Because Section 20.2 regulates the interior wall finish for corridors and lobbies, surfaces covered by combustible clothing that would allow flame to spread more quickly than is permitted by wall surfaces should not be created. The three provisions of 20.2.4.4.2 (control of fire by sprinklers, early warning of incipient-stage fire via smoke detection, or isolation of fuel packages by locating the clothing in metal lockers) help to mitigate the potential for a clothing fire to render the exit access unusable. Exhibit 20.6 shows metal lockers in a corridor.

20.2.4.4.3 Artwork and teaching materials shall be permitted to be attached directly to the walls in accordance with the following:

(1) In new educational occupancies, the artwork and teaching materials shall not exceed 20 percent of the wall area in a building that is not protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***14.7.4.3(1)]

Exhibit 20.6

Metal lockers in corridor.

Exhibit 20.7

Sprinklered building classroom with artwork and teaching materials attached to walls.

(2) In existing educational occupancies, the artwork and teaching materials shall not exceed 20 percent of the wall area in a building that is not protected throughout by an approved automatic sprinkler system in accordance with Section 13.3. [***101:***15.7.4.3(1)]

(3) In new educational occupancies, the artwork and teaching materials shall not exceed 50 percent of the wall area in a building that is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***14.7.4.3(2)]

(4) In existing educational occupancies, the artwork and teaching materials shall not exceed 50 percent of the wall area in a building that is protected throughout by an approved automatic sprinkler system in accordance with Section 13.3. [***101:***15.7.4.3(2)]

It is advantageous not only to limit the quantity of artwork displayed but also to avoid placing such materials near a room's exit access doors. Because the combustibility of the artwork cannot be effectively controlled, the quantity, in terms of the percentage of wall area covered, is regulated to avoid creating a continuous combustible surface that will spread flame across the room. If the building is protected throughout by automatic sprinklers, the percentage of wall area permitted to be covered with artwork and teaching materials is increased to 50 percent. Exhibit 20.7 shows artwork and teaching materials affixed to walls in a classroom in a sprinklered school building.

NFPA technical staff often hear the criticism that the *Code* is overly restrictive and hampers day-to-day function by limiting the percentage of wall area that can be covered by artwork and teaching materials in educational occupancies. The commenters fail to realize that the wall artwork provision is a relaxation of earlier *Code* provisions, not a more stringent requirement. Prior to the recognition of artwork and teaching materials on up to 20 percent of wall area, such materials were treated like any other interior wall finish material. AHJs routinely prohibited all wall artwork unless there was proof the material met the requisite Class A, B, C interior finish classification requirements based on testing — something that paper and fiberboard cannot meet. The 20 percent criterion was established in accordance with the technical committee's judgment as to a quantity of material that would not spread flame continuously. The 50 percent allowance for sprinklered areas is a further relaxation that the technical committee offered when educators said the 20 percent limit did not meet their educational needs.

20.2.4.5 Unvented Fuel-Fired Heating Equipment. Unvented fuel-fired heating equipment, other than gas space heaters in compliance with NFPA 54 /ANSI Z223.1, *National Fuel Gas Code*, shall be prohibited. [***101:***14.5.2.2; ***101:***15.5.2.2]

It is not in the interest of reasonable life safety to permit unvented fuel-fired equipment in a school building occupied by children; the typical use of such equipment might jeopardize the life safety of the students. Improper venting and potential misuse by students might result in injury to students, especially younger children. Paragraph 20.2.4.5 recognizes a special form of gas space heater that — although not vented in the conventional way — can be used safely.

N **20.2.4.6 Integrated Fire Protection Systems.** In new educational occupancies, integrated fire protection systems shall be tested in accordance with 13.1.3. [***101:***14.7.6]

Subsection 13.1.3 is new for the 2018 edition of the *Code*. By reference to this new subsection, new educational occupancies will require that, where two or more fire protection or life safety systems are integrated, the integrated system be tested to verify the proper operation and function of the system in accordance with NFPA 4. See the commentary associated with 13.1.3 for more information.

20.3 Day-Care Occupancies

Section 20.3 addresses not only traditional child day care but also the growing field of adult day care. In both cases, Section 20.3 recognizes that many of the individuals who occupy these facilities are not totally capable of self-preservation. Very young children will require a certain amount of assistance from the day-care staff to help with relocation or evacuation. Likewise, some adults in adult day care will also require staff assistance during a fire emergency. For those reasons, Section 20.3 of this *Code* and Chapters 16 and 17 of NFPA *101* mandate select features that anticipate that these occupants will respond more slowly to a fire than is average. The requirements address a range of protection features, including the physical location of the day-care facility as it relates to the building construction type and the presence of automatic sprinklers (see Table 16.1.6.1 and Table 17.1.6.1 of NFPA *101*).

20.3.1 Application. New and existing day-care occupancies shall comply with Section 20.3 and NFPA *101*.

20.3.1.1 In new day-care occupancies, where a facility houses more than one age group or self-preservation capability, the strictest requirements applicable to any group present shall apply throughout the day-care occupancy or building, as appropriate to a given area, unless the area housing such a group is maintained as a separate fire area. [***101:***16.1.1.6]

20.3.1.2 In existing day-care occupancies, where a facility houses clients of more than one self-preservation capability, the strictest requirements applicable to any group present shall apply throughout the day-care occupancy or building, as appropriate to a given area, unless the area housing such a group is maintained as a separate fire area. [***101:***17.1.1.6]

Δ **20.3.1.3*** Rooms or spaces used for temporary child care, during short-term activities of the child's relative or guardian within the same building, shall not be required to meet the provisions of this chapter. [***101:***16.1.1.7; ***101:***17.1.1.7]

N **A.20.3.1.3** The definition of day-care occupancy is intended to exclude day-care uses that are part of some other occupancy. In such cases, the requirements of the predominant occupancy apply. Examples of excluded facilities include the following:

(1) Rooms located within places of worship used as nurseries or for supervision of children or religious education while services are being held in the building.
(2) Rooms used for temporary child care during short-term recreational activities of the child's relative or guardian, such as within a health club or park district.
(3) Rooms used for temporary child care during short-term activities such as court hearings, medical appointments, libraries, or other similar circumstances.

[***101:***A.16.1.1.7; ***101:***A.17.1.1.7]

Paragraph 20.3.1.3 addresses day care provided within a place of worship while religious services are being held. The parents of the clients of the day-care center would be among those attending a worship service; they and others assembled for the worship service would be expected to assist the day-care staff with any necessary evacuation. The requirements of Section 20.3, therefore, do not apply under such circumstances. On the other hand, if day-care operations are conducted in the same building while religious services are not being conducted — such as during the work week — the day-care provisions of Section 20.3 would apply.

The provisions of 20.3.1.1 and 20.3.1.2 tailor the protection package to the client group with the greatest needs. This concept is similar to that applied by 6.1.14.3 to a multiple occupancy protected as a mixed occupancy. Paragraph 6.1.14.3.2 requires that the most stringent *Code* provisions applicable to any of the occupancies present must be applied throughout the facility, unless separate safeguards are approved.

For example, 16.1.6.2 of NFPA *101* requires smoke partitions in new day-care centers if clients are 30 months old or younger. If any client in a facility is 30 months old or younger, the floors of the building occupied by that client must be provided with smoke partitions. A portion of the facility separated from that occupied by a client who is 30 months old or younger is not required to have smoke partitions. A separated fire area is usually constructed with walls that have a fire resistance rating of 2 hours, as required by Table 6.1.14.4.1(a) or Table 6.1.14.4.1(b), or 1 hour where sprinklers are provided.

Paragraph 20.3.1.3 has been updated for the 2018 edition of the *Code* to expand current *Code* provisions allowing some short-term incidental day-care use, beyond just those child care services at places of worship, to not be classified as a day-care occupancy and thereby not required to apply the provisions of Chapter 16 and Chapter 17 of NFPA *101*. The parents of the clients of the day-care services would be among those attending the activity; they and others at the facility would be expected to assist the day-care staff with any necessary evacuation. The requirements of Chapters 16 and 17 of NFPA *101*, therefore, do not apply under such circumstances. On the other hand, if standalone day-care operations are conducted in the same building while the short-term activities are not being conducted — such as during the work week — the day-care provisions of Chapters 16 and 17 would apply. New A.20.3.1.3 assists in providing examples of those day-care uses that would not be considered a day-care occupancy but rather would fall under the requirements of the predominant occupancy of the building. Some of the areas intended to utilize the provisions of 20.3.1.3 include, but are not limited to, rooms in places of worship that provide care or supervision during religious services, rooms used as temporary care within a health club or recreation club and while parents are located in the same facility, and rooms used for temporary child care during events such as court hearings, medical appointments, library activities, or other similar circumstances.

20.3.1.4 General. Occupancies that include preschools, kindergartens, and other schools whose purpose is primarily educational for children 24 months of age or older, even though the children who attend such schools are of preschool age, shall comply with the provisions of Chapter 14 or Chapter 15 of NFPA *101*, as applicable. [***101:***16.1.2.1;***101:***17.1.2.1]

20.3.1.5 Adult Day-Care Occupancies.

20.3.1.5.1 Adult day-care occupancies shall include any building or portion thereof used for less than 24 hours per day to house more than three adults requiring care, maintenance, and supervision by other than their relative(s). [***101:***16.1.2.2.1; ***101:***17.1.2.2.1]

20.3.1.5.2 Clients in adult day-care occupancies shall be ambulatory or semiambulatory and shall not be bedridden. [***101:***16.1.2.2.2; ***101:***17.1.2.2.2]

20.3.1.5.3 Clients in adult day-care occupancies shall not exhibit behavior that is harmful to themselves or to others. [***101:***16.1.2.2.3; ***101:***17.1.2.2.3]

The specific reference to an adult day-care occupancy in 20.3.1.5 acknowledges that more and more senior citizens are being cared for in day-care centers similar to child day-care centers. The definition of an adult day-care occupancy includes the characteristics of clients who might be cared for in this type of occupancy. Essentially, the capabilities of adult day-care clients clarify that these occupancies are not nursing homes or old-age homes but occupancies used by adults who are capable of self-preservation but who are in need of limited attendance, supervision, or observation.

Earlier editions of the *Code* included several cues for identifying adults who meet the criteria of adult day-care clients as described in the preceding paragraph. However, to avoid the implication that medical training is necessary for assessing such adults, these cues were removed from the *Code*. It might be appropriate, however, to use some of the following guidelines from previous editions to determine the acceptability of a client for adult day care:

1. The client does not require medical injections from staff but might require the administration of oral medication by staff when and as prescribed by a licensed medical examiner.
2. The client might require limited supervision, attendance, or observation.
3. The client exhibits acceptable behavior (not harmful to self or others).

20.3.2 General Requirements.

20.3.2.1 Unvented fuel-fired heating equipment, other than gas space heaters in compliance with NFPA 54/ANSI Z223.1, *National Fuel Gas Code*, shall be prohibited. [***101:***16.5.2.2; ***101:***17.5.2.2]

The interest of reasonable life safety is not served by permitting the use of unvented fuel-fired equipment in buildings occupied by day-care center clients. Thus, 20.3.2.1 prohibits such equipment, with the exception of a special form of gas space heater that can be used safely.

20.3.2.2* Door Latches. Every door latch to closets, storage areas, kitchens, and other similar spaces or areas shall be such that clients can open the door from inside the space or area. [***101:***16.2.2.2.4; ***101:***17.2.2.2.4]

A.20.3.2.2 The purpose of this requirement is to prevent arrangements whereby a client can be trapped in a space or area. It is intended that this provision be broadly interpreted by the AHJ to include equipment such as refrigerators and freezers. [***101:***A.16.2.2.2.4; ***101:***A.17.2.2.2.4]

20.3.2.3 Bathroom Doors. Every bathroom door lock shall be designed to allow opening of the locked door from the outside by an opening device that shall be readily accessible to the staff. [***101:***16.2.2.2.5; ***101:***17.2.2.2.5]

20.3.2.4 Flexible Plan and Open Plan Buildings.

20.3.2.4.1 In new day-care occupancies, flexible plan and open plan buildings shall comply with the requirements of 20.3.2.4 as modified by 20.3.2.4.3 through 20.3.2.4.6. [***101:***16.4.3.1]

20.3.2.4.2 In existing day-care occupancies, flexible plan and open plan buildings shall comply with the requirements of 20.3.2.4 as modified by 20.3.2.4.3 and 20.3.2.4.4. [***101:***17.4.3.1]

20.3.2.4.3 Flexible plan buildings shall be permitted to have walls and partitions rearranged periodically only if revised plans or diagrams have been approved by the AHJ. [***101:***16.4.3.2; ***101:***17.4.3.2]

20.3.2.4.4 Flexible plan buildings shall be evaluated while all folding walls are extended and in use as well as when they are in the retracted position. [***101:***16.4.3.3; ***101:***17.4.3.3]

20.3.2.4.5 Each room occupied by more than 300 persons shall have two or more means of egress entering into separate atmospheres. [***101:***16.4.3.4]

20.3.2.4.6 Where three or more means of egress are required from a single room, the number of means of egress permitted to enter into a common atmosphere shall not exceed two. [***101:***16.4.3.5]

20.3.3 Interior Finish.

20.3.3.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***16.3.3.1; ***101:***17.3.3.1]

20.3.3.2 New Interior Wall and Ceiling Finish. New interior wall and ceiling finish materials complying with Section 12.5 shall be Class A in stairways, corridors, and lobbies; in all other occupied areas, new interior wall and ceiling finish shall be Class A or Class B. [***101:***16.3.3.2]

20.3.3.3 Existing Interior Wall and Ceiling Finish. Existing interior wall and ceiling finish materials complying with Section 12.5 shall be Class A or Class B throughout. [***101:***17.3.3.2]

20.3.3.4 Interior Floor Finish.

20.3.3.4.1 New interior floor finish shall comply with Section 12.5. [***101:***16.3.3.3.1]

20.3.3.4.2 New interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 14.3.6 of NFPA *101* shall be not less than Class II. [***101:***16.3.3.3.2]

20.3.3.4.3 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***16.3.3.3.3]

20.3.3.4.4 Existing Interior Floor Finish. (Reserved) [***101:***17.3.3.3]

20.3.4 Day-Care Homes.

20.3.4.1 Classification.

20.3.4.1.1 In new day-care homes, the requirements of 20.3.4 shall apply to day-care homes in which more than 3, but not more than 12, clients receive care, maintenance, and supervision by other than their relative(s) or legal guardian(s) for less than 24 hours per day, generally within a dwelling unit. *(See also 16.6.1.4 of NFPA 101.)* [***101:***16.6.1.1.2]

20.3.4.1.2* In existing day-care homes, the requirements of Section 17.6 of NFPA *101* shall apply to existing day-care homes in which more than 3, but not more than 12, clients receive care, maintenance, and supervision by other than their relative(s) or legal guardian(s) for less than 24 hours per day, generally within a dwelling unit. An existing day-care home shall be permitted the option of meeting the requirements of Section 16.6 of NFPA *101* in lieu of Section 17.6 of NFPA *101*. Any existing day-care home that meets the requirements of Chapter 16 of NFPA *101* shall be judged as meeting the requirements of this chapter. *(See also 17.6.1.4 of NFPA 101.)* [***101:***17.6.1.1.2]

Δ **A.20.3.4.1.2** Day-care homes do not provide for the full-time maintenance of a client. Day-care occupancies that provide a primary place of residence are addressed in other occupancy chapters. *(See Chapters 24 through 33 of NFPA 101.)* [***101:***A.17.6.1.1.2]

20.3.4.1.3 In new day-care homes, where a facility houses more than one age group or one self-preservation capability, the strictest requirements applicable to any group present shall apply throughout the day-care home or building, as appropriate to a given area, unless the area housing such a group is maintained as a separate fire area. [***101:***16.6.1.1.3]

20.3.4.1.4 In existing day-care homes, where a facility houses clients of more than one self-preservation capability, the strictest requirements applicable to any group present shall apply throughout the day-care home or building, as appropriate to a given area, unless the area housing such a group is maintained as a separate fire area. [***101:***17.6.1.1.3]

20.3.4.1.5 Facilities that supervise clients on a temporary basis with a parent or guardian in close proximity shall not be required to meet the provisions of 20.3.4. [***101:***16.6.1.1.4; ***101:***17.6.1.1.4]

20.3.4.1.6 Places of religious worship shall not be required to meet the provisions of 20.3.4 where operating a day-care home while services are being held in the building. [***101:***16.6.1.1.5; ***101:***17.6.1.1.5]

20.3.4.2 Operating Features.

20.3.4.2.1* Emergency Action Plans. Emergency action plans shall be provided in accordance with Section 10.8. [***101:***16.7.1; ***101:***17.7.1]

Δ **A.20.3.4.2.1** The requirements are, of necessity, general in scope, because it is recognized that they apply to all types of day-care occupancies as well as conditions of occupancies, such as truant day-care occupancies; occupancies for the mentally handicapped, vision impaired, hearing impaired, and speech impaired; adult day-care; care of infants; and day-care occupancies. It is fully recognized that no one code can meet all the conditions of the various buildings involved, and it will be necessary for site administrators, through the written fire emergency response plan, to issue supplements to these requirements; however, all supplements should be consistent with these requirements. Additionally, it is recommended that fire safety be a part of the educational programs of the occupancy for clients. [***101:***A.16.7.1; ***101:***A.17.7.1]

Fire emergency response plans need to be written and made available to all employees, including temporary or substitute staff, so that all employees know what is expected of them during a fire emergency. The elements needed in the written plan should be identified in coordination with the AHJ. [***101:***A.16.7.1; ***101:***A.17.7.1]

The facility fire emergency response plan might be a module of a facility disaster plan that covers other emergencies. [***101:***A.16.7.1; ***101:***A.17.7.1]

The proper safeguarding of clients during a fire emergency requires prompt and effective response by the facility employees in accordance with the fire emergency response plan. Duties covered under the plan should be assigned by position rather than by employee name. Such assignment ensures that, in the absence of an employee, the duties of the position will be performed by a substitute or temporary employee assigned to the position. Temporary or substitute employees should be instructed in advance regarding their duties under the plan for the position to which they are assigned. [***101:***A.16.7.1; ***101:***A.17.7.1]

Written fire emergency response plans should include, but should not be limited to, information for employees regarding methods and devices available for alerting occupants of a fire emergency. Employees should know how the fire department is to be alerted. Even where automatic systems are expected to alert the fire department, the written plan should provide for backup alerting procedures by staff. Other responses of employees to a fire emergency should include the following:

(1) Removal of clients in immediate danger to areas of safety, as set forth in the plan
(2) Methods of using building features to confine the fire and its by-products to the room or area of origin
(3) Control of actions and behaviors of clients during removal or evacuation activities and at predetermined safe assembly areas

[***101:***A.16.7.1; ***101:***A.17.7.1]

The written plan should state clearly the facility policy regarding the actions staff are to take or not take to extinguish a fire. It should also incorporate the emergency egress and relocation drill procedures set forth in 20.3.4.2.2. [***101:***A.16.7.1; ***101:***A.17.7.1]

For additional guidance on emergency action plans, see *NFPA 1600*. This standard establishes a common set of criteria for disaster management, emergency management, and business continuity programs. [***101:***A.16.7.1; ***101:***A.17.7.1]

20.3.4.2.2 Emergency Egress and Relocation Drills.

20.3.4.2.2.1* Emergency egress and relocation drills shall be conducted in accordance with Section 10.5 and the applicable provisions of 20.3.4.2.2.2. [***101:***16.7.2.1; ***101:***17.7.2.1]

A.20.3.4.2.2.1 The requirements are, of necessity, general in scope, because it is recognized that they apply to all types of day-care occupancies as well as conditions of occupancies, such as truant day-care occupancies; day-care occupancies for the mentally handicapped, vision impaired, hearing impaired, and speech impaired. It is fully recognized that no one code can meet all the conditions of the various buildings involved, and it will be necessary for site administrators to issue supplements to these requirements, but all supplements should be consistent with these requirements. [***101:***A.16.7.2.1; ***101:***A.17.7.2.1]

Δ **20.3.4.2.2.2** Emergency egress and relocation drills shall be conducted as follows:

(1) Not less than one emergency egress and relocation drill shall be conducted every month the facility is in session, unless both of the following criteria are met:
   (a) In climates where the weather is severe, the monthly emergency egress and relocation drills shall be permitted to be deferred.
   (b) The required number of emergency egress and relocation drills shall be conducted, and not less than four shall be conducted before the drills are deferred.
(2) The monthly frequency specified by 20.3.4.2.2.2(1) shall be permitted to be bimonthly in adult day-care centers.
(3) All occupants of the building shall participate in the drill.
(4) One additional emergency egress and relocation drill, other than for day-care occupancies that are open on a year-round basis, shall be required within the first 30 days of operation.

[***101:***16.7.2.2; ***101:***17.7.2.2]

Emergency egress drills for day-care occupancies are essential to ensure an orderly response of staff and clients during a fire. The day-care facility should vary the timing and arrangement of the drills but not the required response, which is orderly evacuation. See also Section 10.5.

Item (2) of 20.3.4.2.2.2 is new to the 2018 edition of the *Code* and permits the monthly drills as required by 20.3.4.2.2.2(1) to be bimonthly (every other month) in adult day-care centers. It can be seen as excessive to require the same frequency of drills for adult facilities as those facilities caring for small children. Adults don't need to be drilled this much nor does adult day-care staff need to be drilled as frequently. A monthly frequency can be overly burdensome on adult day-care operators without a perceived benefit or increase in the level of safety.

20.3.4.2.3 Inspections.

20.3.4.2.3.1 Fire prevention inspections shall be conducted monthly by a trained senior member of the staff, after which a copy of the latest inspection report shall be posted in a conspicuous place in the day-care facility. [***101:***16.7.3.1; ***101:***17.7.3.1]

20.3.4.2.3.2* It shall be the duty of site administrators and staff members to inspect all exit facilities daily to ensure that all stairways, doors, and other exits are in proper condition. [***101:***16.7.3.2; ***101:***17.7.3.2]

A.20.3.4.2.3.2 Particular attention should be given to keeping all doors unlocked; keeping doors that serve to protect the safety of paths of egress closed and under no conditions blocked open, such as doors on stairway enclosures; keeping outside stairs and fire escape stairs free from all obstructions and clear of snow and ice; and allowing no accumulation of snow or ice or materials of any kind outside exit doors that might prevent the opening of the door or interfere with rapid escape from the building. [***101:***A.16.7.3.2; ***101:***A.17.7.3.2]

20.3.4.2.3.3 Open plan buildings shall require extra surveillance to ensure that exit paths are maintained clear of obstruction and are obvious. [***101:***16.7.3.3; ***101:***17.7.3.3]

20.3.4.2.3.4 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15 of NFPA *101*. [***101:***16.7.3.4; ***101:***17.7.3.4]

Compliance with the requirement of 20.3.4.2.3.2 for daily inspection of the egress system has benefits that far outweigh the time and resources required to conduct such inspections. Staff members are permitted to conduct such inspections because they are typically well acquainted with the building features and operations of the facility.

The door inspection requirements of 20.3.4.2.3.4 apply to specific doors as detailed in 7.2.1.15 of NFPA *101*. Door leaves that get used frequently are more apt to experience wear that adversely affects operability and leads to failure. Door leaves that are infrequently used might be misaligned within their frames so as to be difficult to open within the operating forces requirements of 14.5.1.5. The door inspection and testing criteria of 7.2.1.15 of NFPA *101* are intended to help identify problems with door openings and ensure that such problems are remedied.

20.3.4.2.3.5 Furnishings and Decorations.

20.3.4.2.3.5.1 Draperies, curtains, and other similar furnishings and decorations in day-care occupancies, other than in day-care homes, shall be in accordance with the provisions of 12.6.2. [***101:***16.7.4.1; ***101:***17.7.4.1]

Δ **20.3.4.2.3.5.2** Clothing and personal effects shall not be stored in corridors, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to corridors protected by an automatic sprinkler system in accordance with Section 13.3.
(2) This requirement shall not apply to corridor areas protected by a smoke detection system in accordance with Section 13.7.
(3) This requirement shall not apply to storage in metal lockers, provided that the required egress width is maintained.

[***101:***16.7.4.2; ***101:***17.7.4.2]

See the commentary following 20.2.4.4.2.

20.3.4.2.3.5.3 Artwork and teaching materials shall be permitted to be attached directly to the walls in accordance with the following:

(1) In new day-care homes, the artwork and teaching materials shall not exceed 20 percent of the wall area in a building that is not protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***16.7.4.3(1)]
(2) In existing day-care homes, the artwork and teaching materials shall not exceed 20 percent of the wall area in a building that is not protected throughout by an approved automatic sprinkler system in accordance with Section 13.3. [***101:***17.7.4.3(1)]
(3) In new day-care homes, the artwork and teaching materials shall not exceed 50 percent of the wall area in a building that is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3. [***101:***16.7.4.3(2)]
(4) In existing day-care homes, the artwork and teaching materials shall not exceed 50 percent of the wall area in a building that is protected throughout by an approved automatic sprinkler system in accordance with Section 13.3. [***101:***17.7.4.3(2)]

It is advantageous not only to limit the quantity of artwork displayed but also to avoid placing such materials near a room's exit access doors. Because the combustibility of the artwork cannot be effectively controlled, the quantity, in terms of the percentage of wall area covered, is regulated to avoid creating a continuous combustible surface that will spread flame across the room. If the building is protected throughout by automatic sprinklers, the percentage of wall area permitted to be covered with artwork and teaching materials is increased to 50 percent. See also the commentary following 20.2.4.4.3.

20.3.4.2.3.5.4 The provision of 12.6.3 for cigarette ignition resistance of newly introduced upholstered furniture and mattresses shall not apply to day-care homes. [***101:***16.7.4.4; ***101:***17.7.4.4]

20.3.4.2.3.6* Day-Care Staff. Adequate adult staff shall be on duty and alert at all times where clients are present. [***101:***16.7.5; ***101:***17.7.5]

A.20.3.4.2.3.6 It is the intent that the requirement for adequate adult staff to be awake at all times when clients are present be applied to family day-care and group day-care homes that are operated at night, as well as day-care occupancies. [***101:***A.16.7.5; ***101:***A.17.7.5]

N **20.3.4.2.3.7 Integrated Fire Protection Systems.** In new day care occupancies, integrated fire protection systems shall be tested in accordance with 13.1.3. [***101:***16.7.6]

20.4 Health Care Occupancies

Life safety in health care occupancies is so encompassing that it includes nearly the entire gamut of systems, options, and features addressed in the core chapters of NFPA *101*. Unlike most other buildings and use groups addressed by the *Code*, the least desirable emergency action in a health care occupancy is the wholesale relocation or evacuation of patients. For that reason, a defend-in-place strategy is used, whereby patients are relocated to unaffected smoke compartments in the event of a fire.

The defend-in-place strategy is implemented using a total concept approach. As detailed in 18.1.1.3 and 19.1.1.3 of NFPA *101*, the total concept approach provides an assortment of features that are deemed necessary to avoid the movement of patients to the outside during a fire. Of course, those patients who might be perilously close to the effects of the fire are given a range of protection features, such as being moved to an adjacent smoke compartment on the same floor. Exhibit 20.8 shows cross-corridor smoke barrier doors that, when closed, complete the continuity of the smoke barrier, separating one smoke compartment from the adjacent smoke compartment.

Requirements for allowable building construction types, sprinklers, alarm and detection systems, and staff training work in harmony to help ensure that patients can be safely and adequately protected, regardless of where a fire starts.

Staff action is an integral part of the life safety features required in a health care facility. The proper response from staff in terms of availability, actions, and management of a fire can readily influence the outcome of a fire. Health care facility staff members are charged with the responsibility of preserving the safety of their charges, whether that involves informing patients who are not in jeopardy from the fire or helping to relocate those who are.

Staff training, coupled with the traditional built-in systems and features (e.g., construction; compartmentation; interior finish; alarm, detection, and sprinkler systems; and control of contents and furnishings), provides one of the safest environments for one of the most vulnerable population groups addressed by the *Code*.

The health care occupancy environment continues to change as new technology is implemented, especially in

Exhibit 20.8

Cross-corridor smoke barrier doors, which are part of the defend-in-place protection strategy.

hospitals where patient information privacy requirements have made computer screens, mounted on corridor walls and visible to passersby, obsolete. Computers on wheels accompany staff on most interactions with patients. The computers on wheels, when not in use, present challenges to maintaining the corridor clear width required by 18.2.3 and 19.2.3 of NFPA *101*. Exhibit 20.9 shows the ubiquitous computer on wheels.

Health concerns have led to a ban on smoking in health care occupancy buildings and in proximate outdoor areas. Fires caused by smoldering cigarettes trapped in dirty linen were common in years past. Similar incidents are rare today. Exhibit 20.10 shows an outdoor sign, at the main entrance of a hospital, reminding visitors of the smoking ban.

Exhibit 20.9

Computer on wheels.

Exhibit 20.10

Outdoor sign at main entrance of a hospital declaring area to be smoke free.

20.4.1 Application. New and existing health care occupancies shall comply with Section 20.4, NFPA *101*, and NFPA 99.

Health care occupancies are those facilities used on an inpatient basis for the medical care or treatment of four or more persons suffering from physical or mental illness, disease, or infirmity and for the care of infants, convalescents, or infirm aged persons. The health care occupancies addressed in Section 20.4 include the following:

1. Hospitals
2. Nursing homes
3. Limited care facilities

Hospitals, nursing homes, and limited care facilities provide sleeping facilities for occupants incapable of self-preservation due to age, physical or mental disabilities, or security measures not under their control.

Ambulatory health care facilities differ from health care occupancies in that they provide health care services on an outpatient basis; they are addressed separately in Section 20.6.

20.4.2* Operating Features.

A.20.4.2 Health care occupants have, in large part, varied degrees of physical disability, and their removal to the outside, or even their disturbance caused by moving, is inexpedient or impractical in many cases, except as a last resort. Similarly, recognizing that there might be an operating necessity for the restraint of the mentally ill, often by use of barred windows and locked doors, fire exit drills are usually extremely disturbing, detrimental, and frequently impracticable. [***101:***A.18.7; ***101:***A.19.7]

In most cases, fire exit drills, as ordinarily practiced in other occupancies, cannot be conducted in health care occupancies. Fundamentally, superior construction, early discovery and extinguishment of incipient fires, and prompt notification need to be relied on to reduce the occasion for evacuation of buildings of this class to a minimum. [***101:***A.18.7; ***101:***A.19.7]

20.4.2.1 Evacuation and Relocation Plan and Fire Drills.

20.4.2.1.1 The administration of every health care occupancy shall have, in effect and available to all supervisory personnel, written copies of a plan for the protection of all persons in the event of fire, for their evacuation to areas of refuge, and for their evacuation from the building when necessary. [***101:***18.7.1.1; ***101:***19.7.1.1]

20.4.2.1.2 All employees shall be periodically instructed and kept informed with respect to their duties under the plan required by 20.4.2.1.1. [***101:***18.7.1.2; ***101:***19.7.1.2]

20.4.2.1.3 A copy of the plan required by 20.4.2.1.1 shall be readily available at all times in the telephone operator's location or at the security center. [***101:***18.7.1.3; ***101:***19.7.1.3]

20.4.2.1.4 The provisions of Section 10.5 and 20.4.2.1.2 through 20.4.2.2.3 shall apply.

20.4.2.1.5* Fire drills in health care occupancies shall include the transmission of a fire alarm signal and simulation of emergency fire conditions. [***101:***18.7.1.4; ***101:***19.7.1.4]

A.20.4.2.1.5 Many health care occupancies conduct fire drills without disturbing patients by choosing the location of the simulated emergency in advance and by closing the doors to patients' rooms or wards in the vicinity prior to initiation of the drill. The purpose of a fire drill is to test and evaluate the efficiency, knowledge, and response of institutional personnel in implementing the facility fire emergency action plan. Its purpose is not to disturb or excite patients. Fire drills should be scheduled on a random basis to ensure that personnel in health care facilities are drilled not less than once in each 3-month period. [***101:***A.18.7.1.4; ***101:***A.19.7.1.4]

Drills should consider the ability to move patients to an adjacent smoke compartment. Relocation can be practiced using simulated patients or empty wheelchairs. [***101:***A.18.7.1.4; ***101:***A.19.7.1.4]

20.4.2.1.6 Infirm or bedridden patients shall not be required to be moved during drills to safe areas or to the exterior of the building. [***101:***18.7.1.5; ***101:***19.7.1.5]

20.4.2.1.7 Drills shall be conducted quarterly on each shift to familiarize facility personnel (nurses, interns, maintenance engineers, and administrative staff) with the signals and emergency action required under varied conditions. [***101:***18.7.1.6; ***101:***19.7.1.6]

20.4.2.1.8 When drills are conducted between 9:00 p.m. (2100 hours) and 6:00 a.m. (0600 hours), a coded announcement shall be permitted to be used instead of audible alarms. [***101:***18.7.1.7; ***101:***19.7.1.7]

20.4.2.1.9 Employees of health care occupancies shall be instructed in life safety procedures and devices. [***101:***18.7.1.8; ***101:***19.7.1.8]

The life safety provisions applicable to health care occupancies involve more than fixed building features and systems. Life safety in this defend-in-place occupancy relies heavily on staff readiness and action. The evacuation and relocation plan and fire drill provisions of 20.4.2.1 provide the foundation for carrying out the needed staff duties, as detailed in 20.4.2.2.

The former requirement for patient beds to be on wheels or casters was deleted from NFPA *101* in 1991. Ordinary practice in health care occupancies is to move patients through the hospital on narrow beds, on gurneys, on carts, or in wheelchairs. The furniture in patient rooms — chairs, nightstands, food trays/tables, and medical equipment — must be moved out of the way to allow patient beds to be turned and moved out of the room. Moving patients in this way requires extra staff time that is usually unavailable during a fire. Emphasis should be placed on the quick movement of patients who are in the room of fire origin, as well as others who are directly exposed to the fire. Patient movement in fire emergencies is often achieved by dragging occupants on bedding, as opposed to moving beds.

20.4.2.2 Procedure in Case of Fire.

20.4.2.2.1* Protection of Patients.

A.20.4.2.2.1 Each facility has specific characteristics that vary sufficiently from other facilities to prevent the specification of a universal emergency procedure. The recommendations that follow, however, contain many of the elements that should be considered and adapted, as appropriate, to the individual facility. [***101:***A.18.7.2.1; ***101:***A.19.7.2.1]

Upon discovery of fire, personnel should immediately take the following action:

(1) If any person is involved in the fire, the discoverer should go to the aid of that person, calling aloud an established code phrase, which provides for both the immediate aid of any endangered person and the transmission of an alarm.
(2) Any person in the area, upon hearing the code called aloud, should activate the building fire alarm using the nearest manual fire alarm box.
(3) If a person is not involved in the fire, the discoverer should activate the building fire alarm using the nearest manual fire alarm box.
(4) Personnel, upon hearing the alarm signal, should immediately execute their duties as outlined in the facility fire safety plan.
(5) The telephone operator should determine the location of the fire as indicated by the audible signal.
(6) In a building equipped with an uncoded alarm system, a person on the floor of fire origin should be responsible for promptly notifying the facility telephone operator of the fire location.
(7) If the telephone operator receives a telephone alarm reporting a fire from a floor, the operator should regard that alarm in the same fashion as an alarm received over the fire alarm system and should immediately notify the fire department and alert all facility personnel of the place of fire and its origin.
(8) If the building fire alarm system is out of order, any person discovering a fire should immediately notify the telephone operator by telephone, and the operator should then transmit this information to the fire department and alert the building occupants.

[***101:***A.18.7.2.1; ***101:***A.19.7.2.1]

20.4.2.2.1.1 For health care occupancies, the proper protection of patients shall require the prompt and effective response of health care personnel. [***101:***18.7.2.1.1; ***101:***19.7.2.1.1]

Δ **20.4.2.2.1.2** The basic response required of staff shall include the following:

(1) Removal of all occupants directly involved with the fire emergency
(2) Transmission of an appropriate fire alarm signal to warn other building occupants and summon staff
(3) Confinement of the effects of the fire by closing doors to isolate the fire area
(4) Relocation of patients as detailed in the health care occupancy's fire safety plan

[***101:***18.7.2.1.2; ***101:***19.7.2.1.2]

20.4.2.2.2 Fire Safety Plan. A written health care occupancy fire safety plan shall provide for all of the following:

(1) Use of alarms
(2) Transmission of alarms to fire department
(3) Emergency phone call to fire department
(4) Response to alarms

(5) Isolation of fire
(6) Evacuation of immediate area
(7) Evacuation of smoke compartment
(8) Preparation of floors and building for evacuation
(9) Extinguishment of fire
(10) Location and operation of doors disguised with murals as permitted by 18.2.2.2.7 and 19.2.2.2.7 of NFPA *101*.

[***101:***18.7.2.2; ***101:***19.7.2.2]

20.4.2.2.3 Staff Response.

20.4.2.2.3.1 All health care occupancy personnel shall be instructed in the use of and response to fire alarms. [***101:***18.7.2.3.1; ***101:***9.7.2.3.1]

Δ **20.4.2.2.3.2** All health care occupancy personnel shall be instructed in the use of the code phrase to ensure transmission of an alarm under the following conditions:

(1) When the individual who discovers a fire must immediately go to the aid of an endangered person
(2) During a malfunction of the building fire alarm system

[***101:***18.7.2.3.2; ***101:***19.7.2.3.2]

20.4.2.2.3.3 Personnel hearing the code announced shall first activate the building fire alarm using the nearest manual fire alarm box and then shall execute immediately their duties as outlined in the fire safety plan. [***101:***18.7.2.3.3; ***101:***19.7.2.3.3]

In addition to the requirements of 20.4.2.2, evacuation plans should stress that the doors of as many patient rooms as possible be closed to block smoke spreading from a fire and, if possible, to confine the fire in a room. This single action taken by the staff (i.e., manually closing the doors) achieves the level of safety to life mandated by the *Code* in Section 20.4 and Chapters 18 and 19 of NFPA *101*.

In many fatal fires in health care facilities, staff either did not close doors or someone reopened them; the fire spread was sizable, and the loss of life was high. Emphasis must be placed on training staff to sound an alarm, to rescue patients (as needed), and then to close all doors. The closing of doors historically has had the most significant effect on limiting the spread of fire and smoke.

20.4.2.3 Maintenance of Means of Egress.

20.4.2.3.1 Proper maintenance shall be provided to ensure the dependability of the method of evacuation selected. [***101:***18.7.3.1; ***101:***19.7.3.1]

20.4.2.3.2 Health care occupancies that find it necessary to lock means of egress doors shall, at all times, maintain an adequate staff qualified to release locks and direct occupants from the immediate danger area to a place of safety in case of fire or other emergency. [***101:***18.7.3.2; ***101:***19.7.3.2]

20.4.2.3.3* Where required by the AHJ, a floor plan shall be provided to indicate the location of all required means of egress corridors in smoke compartments having spaces not separated from the corridor by partitions. [***101:***18.7.3.3; ***101:***19.7.3.3]

A.20.4.2.3.3 The purpose of this requirement is to provide a means for building designers, occupants, and operators to clearly designate approved egress corridors that can be identified even though physical or other obvious barriers might not be present to indicate their location. Floor plans used to satisfy this requirement might incorporate more than one function and more than one smoke compartment of the building, provided egress corridors are clearly identified where no fixed barriers are present. Such plans should be accessible to the AHJ but should not be required to be posted. [***101:***A.18.7.3.3; ***101:***A.19.7.3.3]

Δ **20.4.2.4* Smoking.** Smoking regulations shall be adopted and shall include not less than the following provisions:

(1) Smoking shall be prohibited in any room, ward, or individual enclosed space where flammable liquids, combustible gases, or oxygen is used or stored and in any other hazardous location, and such areas shall be posted with signs that read NO SMOKING or shall be posted with the international symbol for no smoking.
(2) In health care occupancies where smoking is prohibited and signs are prominently placed at all major entrances, secondary signs with language that prohibits smoking shall not be required.
(3) Smoking by patients classified as not responsible shall be prohibited.
(4) The requirement of 20.4.2.4(3) shall not apply where the patient is under direct supervision.
(5) Ashtrays of noncombustible material and safe design shall be provided in all areas where smoking is permitted.
(6) Metal containers with self-closing cover devices into which ashtrays can be emptied shall be readily available to all areas where smoking is permitted.

[***101:***18.7.4; ***101:***19.7.4]

A.20.4.2.4 The most rigid discipline with regard to prohibition of smoking might not be nearly as effective in reducing incipient fires from surreptitious smoking as the open recognition of smoking, with provision of suitable facilities for smoking. Proper education and training of the staff and attendants in the ordinary fire hazards and their abatement is unquestionably essential. The problem is a broad one, varying with different types and arrangements of buildings; the effectiveness of rules of procedure, which need to be flexible, depends in large part on the management. [***101:***A.18.7.4; ***101:***A.19.7.4]

The provision of 20.4.2.4(1), related to areas where smoking is prohibited, includes the words "or individual enclosed space." The words help to clarify that smoking is to be regulated on a space-by-space basis. For example, smoking is required to be prohibited from a room where flammable liquids are stored, but is not required to be prohibited from the other rooms within the same smoke compartment where those rooms do not meet the criteria of 20.4.2.4(1) for the prohibition of smoking. The issue is almost moot in that smoking is prohibited widely in and near health care occupancy buildings.

See Section 10.9 for additional information on smoking prohibitions.

20.4.2.5 Furnishings, Mattresses, and Decorations.

20.4.2.5.1* Draperies, curtains, and other loosely hanging fabrics and films serving as furnishings or decorations in health care occupancies shall be in accordance with the provisions of 12.6.2 *(see 18.3.5.10 or 19.3.5.10 of* NFPA *101)*, and the following also shall apply:

(1) Such curtains shall include cubicle curtains.
(2) Such curtains shall not include curtains at showers and baths.
(3) Such draperies and curtains shall not include draperies and curtains at windows in patient sleeping rooms in sprinklered smoke compartments.
(4) Such draperies and curtains shall not include draperies and curtains in other rooms or areas where the draperies and curtains comply with all of the following:
  (a) Individual drapery or curtain panel area does not exceed 48 ft^2 (4.5 m^2).
  (b) Total area of drapery and curtain panels per room or area does not exceed 20 percent of the aggregate area of the wall on which they are located.
  (c) Smoke compartment in which draperies or curtains are located is sprinklered in accordance with 13.3.2.12.

[***101:***19.7.5.1]

A.20.4.2.5.1 In addition to the provisions of 12.6.2, which deal with ignition resistance, additional requirements with respect to the location of cubicle curtains relative to sprinkler placement are included in NFPA 13. [***101:***A.18.7.5.1; ***101:***A.19.7.5.1]

20.4.2.5.2 Newly introduced upholstered furniture within health care occupancies shall comply with one of the following provisions, unless otherwise provided in 20.4.2.5.3:

(1) The furniture shall meet the criteria specified in 12.6.3.1 and 12.6.3.2.1.
(2) The furniture shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA 13.

[***101:***18.7.5.2; ***101:***19.7.5.2]

20.4.2.5.3 The requirements of 20.4.2.5.2, 12.6.3.1, and 12.6.3.2.1 shall not apply to upholstered furniture belonging to the patient in sleeping rooms of existing nursing homes where the following criteria are met:

(1) A smoke detector shall be installed where the patient sleeping room is not protected by automatic sprinklers.
(2) Battery-powered single-station smoke detectors shall be permitted.

[***101:***19.7.5.3]

20.4.2.5.4 Newly introduced mattresses within health care occupancies shall comply with one of the following provisions, unless otherwise provided in 20.4.2.5.5:

(1) The mattresses shall meet the criteria specified in 12.6.3.2 and 12.6.3.2.2.
(2) The mattresses shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA 13.

[***101:***18.7.5.4; ***101:***19.7.5.4]

20.4.2.5.5 The requirements of 12.6.3.2, 12.6.3.2.2, and 20.4.2.5.4 shall not apply to mattresses belonging to the patient in sleeping rooms of existing nursing homes where the following criteria are met:

(1) A smoke detector shall be installed where the patient sleeping room is not protected by automatic sprinklers.
(2) Battery-powered single-station smoke detectors shall be permitted.

[***101:***19.7.5.5]

Δ **20.4.2.5.6** Combustible decorations shall be prohibited in any health care occupancy, unless one of the following criteria is met:

(1) They are flame-retardant or are treated with approved fire-retardant coating that is listed and labeled for application to the material to which it is applied.
(2)* The decorations meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701.

A.20.4.2.5.6(2) The user should verify that the products meet the referenced test methods of NFPA 701, and not the small-scale test procedure that was previously eliminated from NFPA 701. [***101:***A.18.7.5.6(2); ***101:***A.19.7.5.6(2)]

(3) The decorations exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289 using the 20 kW ignition source.
(4)* The decorations, such as photographs, paintings, and other art, are attached directly to the walls, ceiling, and non-fire-rated doors in accordance with the following:
  (a) Decorations on non-fire-rated doors do not interfere with the operation or any required latching of the door and do not exceed the area limitations of 20.4.2.5.6(b), (c), or (d).
  (b) Decorations do not exceed 20 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is not protected throughout by an approved automatic sprinkler system in accordance with Section 13.3.
  (c) Decorations do not exceed 30 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is protected throughout by an approved supervised automatic sprinkler system in accordance with Section 13.3.
  (d) Decorations do not exceed 50 percent of the wall, ceiling, and door areas inside patient sleeping rooms having a capacity not exceeding four persons, in a smoke compartment that is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 13.3.

A.20.4.2.5.6(4) The percentage of decorations should be measured against the area of any wall or ceiling, not the aggregate total of walls, ceilings, and doors. The door is considered part of the wall. The decorations must be located such that they do not interfere with the operation of any door, sprinkler, smoke detector, or any other life safety equipment. Other art might include hanging objects or three-dimensional items. [***101:***A.18.7.5.6(4); ***101:***A.19.7.5.6(4)]

(5) In existing health care occupancies, they are decorations, such as photographs or paintings, in such limited quantities that a hazard of fire development or spread is not present.

[***101:***18.7.5.6; ***101:***19.7.5.6]

The provision of 20.4.2.5.1(4) offers some leniency from the fabric testing requirement for small drapery or curtain panels.

Cigarette ignition–resistance testing and rate of heat release testing are required by 20.4.2.5.2 and 20.4.2.5.4 for newly introduced upholstered furniture and newly introduced mattresses in health care occupancies, unless the building is fully sprinklered. However, these requirements would seldom apply in new health care occupancies, because 13.3.2.11.1 requires new health care occupancies to be sprinklered. Unlike new health care occupancies, which are required to be sprinklered, many existing facilities are not sprinklered. Yet government regulations require that patients be permitted to take their own furniture with them to a nursing home, and such movement of existing furniture into the facility mandates the requirement that applies to newly introduced upholstered furniture and newly introduced mattresses. Paragraphs 20.4.2.5.3 and 20.4.2.5.5 offer nonsprinklered existing health care facilities another option — providing smoke detection within the patient room. If early warning is provided to staff, then an incipient-stage fire might be extinguished manually almost as quickly as would occur automatically in a room that is sprinklered.

The provisions of 20.4.2.5.6 permit furnishings that help to make the health care occupancy setting more homelike, especially for nursing home residents. Exhibit 20.11 shows limited decorations on the door to a nursing home resident's room. Note the furniture and furnishings that the resident has interspersed among the institutional-like furniture provided by the facility.

Exhibit 20.11

Limited decorations on nursing home resident's room door.

Δ **20.4.2.5.7** Soiled linen or trash collection receptacles shall not exceed 32 gal (121 L) in capacity and shall meet the following requirements:

(1) The average density of container capacity in a room or space shall not exceed 0.5 gal/ft^2 (20.4 L/m^2).
(2) Mobile soiled linen or trash collection receptacles with capacities greater than 32 gal (121 L) shall be located in a room protected as a hazardous area when not attended.
(3) Container size and density shall not be limited in hazardous areas.

[***101:***18.7.5.7.1; ***101:***19.7.5.7.1]

Δ **20.4.2.5.8*** Containers used solely for recycling clean waste or for patient records awaiting destruction shall be permitted to be excluded from the limitations of 20.4.2.5.7 where all the following conditions are met:

(1) Each container is limited to a capacity of 96 gal (363 L) except as permitted by 20.4.2.5.8(2) or (3).
(2)* Containers with capacities greater than 96 gal (363 L) shall be located in a room protected as a hazardous area when not attended.
(3) Container size shall not be limited in hazardous areas.
(4) Containers for combustibles shall be labeled and listed as meeting the requirements of FM Approval 6921, *Approval Standard for Containers for Combustible Waste*; however, such testing, listing, and labeling shall not be limited to FM Approvals.

[***101:***18.7.5.7.2; ***101:***19.7.5.7.2]

A.20.4.2.5.8 It is the intent that this provision allows recycling for bottles, cans, paper and similar clean items to use larger containers or have several adjacent containers and not be restricted to hazardous areas. Containers for medical records waiting shredding are often larger than 32 gallons. These containers are not to be included in the calculations and limitations of 20.4.2.5.7. There is no limit on the number of these containers as the FM Standard assures that the fire will not spread out of the container.

A.20.4.2.5.8(2) See 20.4.2.5.7(3).

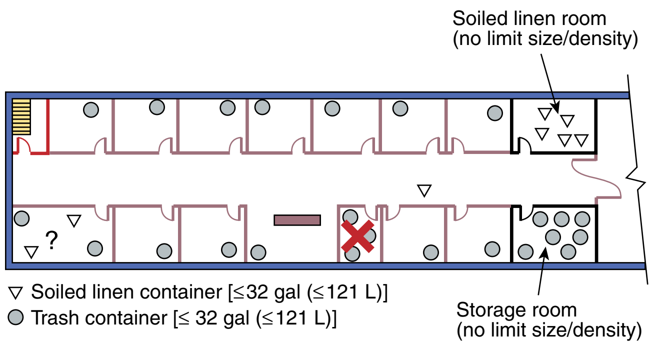
Paragraph 20.4.2.5.7 establishes maximum trash container sizes and placement densities permitted within a room. For the 2018 edition of the *Code*, the criterion that a capacity of 32 gal (121 L) not be exceeded within any 64 ft^2 (6 m^2) area, was deleted. The effect is, for example, that two 32 gal (121 L) containers can be placed side-by-side in a 128 ft^2 (12 m^2) area. Containers larger than those specified or grouped containers exceeding the density per room criterion present a hazard greater than that associated with the normal furnishing of an ambulatory health care center room.

Large, mobile soiled linen or trash receptacles can be moved along the corridor as collections occur but must be attended by staff. If housekeeping staff, for example, must leave the area, the container must be stored in a room designed and maintained as a hazardous area in accordance with 18/19.3.2.1 of NFPA *101*. Exhibit 20.12 shows an aggregation of wheeled trash bins in a

Exhibit 20.12

Wheeled trash bins in room protected as hazardous area.

Exhibit 20.13



Allowable soiled linen or trash collection receptacles.

room protected as a hazardous area. Receptacles positioned at nurses' stations are not to be considered as being attended. Exhibit 20.13 illustrates the requirements of 20.4.2.5.7.

The provisions of 20.4.2.5.8 recognize the need for secure disposal of clean waste, such as paper, that might include patient information. Such waste is typically aggregated in containers larger than the 32 gal (121 L) limitation imposed by 20.4.2.5.7, since it might not be feasible to have such materials removed and shredded as frequently as would be necessitated if smaller containers were used. The maximum 96 gal (363 L) container presents little fire challenge, because the container has been tested for fire performance. The larger clean waste containers typically are outfitted with a tight-fitting lid and narrow slot in order to pass the required fire testing. Exhibit 20.14 illustrates a maximum 96 gal (363 L) container meeting the criteria of 20.4.2.5.8.

Exhibit 20.14

Clean trash or recycling container meeting the requirements of 20.4.2.5.8.

20.4.2.5.9 The provisions of 19.2.1.1 through 19.2.1.2 applicable to soiled linen and trash receptacles shall not apply.

Δ **20.4.2.6 Portable Space-Heating Devices.** Portable space-heating devices shall be prohibited in all health care occupancies, unless both of the following criteria are met:

(1) Such devices are permitted to be used only in nonsleeping staff and employee areas.
(2) The heating elements of such devices do not exceed 212°F (100°C).

[***101:***18.7.8; ***101:***19.7.8]

Δ **20.4.2.7 Integrated Fire Protection Systems.** Integrated fire protection systems shall be tested in accordance with 13.1.3. [***101:***18.7.10, 19.7.10]

The provisions of 20.4.2.7 are new to the 2018 edition of the *Code*. For new health care occupancies, integrated fire protection systems must be tested in accordance with 20.4.2.7. The concept is one in which, if two or more fire protection or life safety systems are integrated, the integrated system must be tested to verify the proper operation and function of such system in accordance with NFPA 4. Users should note that for existing health care occupancies, the requirement for compliance with NFPA 4 in accordance with Section 13.1.3 applies only to integrated systems in high-rise buildings, as stated in NFPA *101* Section 19.7.10, which is not reflected by the language of 20.4.2.7.

20.4.3 Interior Finish.

20.4.3.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***18.3.3.1; ***101:***19.3.3.1]

20.4.3.2 New Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 12.5 shall be permitted throughout if Class A, except as indicated in 20.4.3.2.1 or 20.4.3.2.2. [***101:***18.3.3.2]

20.4.3.2.1 New walls and ceilings shall be permitted to have Class A or Class B interior finish in individual rooms having a capacity not exceeding four persons. [***101:***18.3.3.2.1]

20.4.3.2.2 New corridor wall finish not exceeding 48 in. (1220 mm) in height that is restricted to the lower half of the wall shall be permitted to be Class A or Class B. [***101:***18.3.3.2.2]

20.4.3.2.3 Existing Interior Wall and Ceiling Finish. Existing interior wall and ceiling finish materials complying with Section 12.5 shall be permitted to be Class A or Class B. [***101:***19.3.3.2]

20.4.3.3 Interior Floor Finish.

20.4.3.3.1 New interior floor finish shall comply with Section 12.5. [***101:***18.3.3.3.1]

20.4.3.3.2 New interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 18.3.6 of NFPA *101* shall be Class I or Class II. [***101:***18.3.3.3.2]

20.4.3.3.3 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***18.3.3.3.3]

New interior finishes on walls and ceilings are limited to Class A materials, with the exception of small rooms (see 20.4.3.2.1) and the lower portion of corridor walls (see 20.4.3.2.2). However, if the new interior wall and ceiling finish material is installed in a sprinklered smoke compartment (all new health care occupancies are required to be sprinklered by 13.3.2.11.1), the Class A requirement can be relaxed to Class B per the provisions of 12.5.9.1. Existing interior finish materials are permitted to be Class A or Class B without requiring sprinkler protection.

Paragraph 20.4.3.2.1 permits Class B interior wall and ceiling finish materials in rooms with a capacity of four or fewer persons, but, again, the presence of automatic sprinklers would relax this requirement to permit Class C materials. Paragraph 20.4.3.2.2 permits wall finish in corridors to be of Class B materials where located 48 in. (1220 mm) or less above the floor, but, once again, the presence of automatic sprinklers would relax this requirement to permit Class C materials. This provision recognizes fire research from "Flame Spread in Corridors: Effects of Location and Area of Wall Finish" in *Fire Journal* that has shown the finish on the lower half of the wall to be far less significant in its influence on early fire growth than the finish on the upper half. In the case of textile materials on walls or ceilings, 12.5.5.4 would take precedence and require automatic sprinkler protection in conjunction with Class A materials, or such wall and ceiling materials must be proved safe by specialized fire testing.

Existing interior finishes on walls and ceilings are limited solely on the basis of flame spread. Paragraph 12.5.4.3.1 exempts existing interior finishes from the limitations based on smoke development.

Paragraph 12.5.7.1 provides for the application of approved fire-retardant coatings to existing interior finish materials for the purpose of reducing the flame spread characteristics to an acceptable level. Similarly, 12.5.7.2 permits the surfaces of walls, partitions, columns, and ceilings to be finished with factory-applied fire-retardant-coated products. The commentary following 12.5.7.3 offers additional guidance.

It has been shown that floor coverings will not spread a fire until the fire approaches flashover (see A.12.5.8.3 and associated commentary). Automatic sprinklers will activate well in advance of any significant involvement of a floor covering. Paragraph 20.4.3.2 has the effect of regulating new interior floor finish in exit enclosures and exit access corridors only in nonsprinklered areas, since 12.5.9.2 permits the Class II criterion to be reduced to no rating where sprinkler protection is provided. Existing floor finish materials are permitted to continue to be used.

20.4.3.4 Interior Finish (Nonsprinklered Smoke Compartment Rehabilitation).

20.4.3.4.1 General. Interior finish within the modification area shall be in accordance with Section 12.5. [***101:***18.4.4.6.1]

20.4.3.4.2 Interior Wall and Ceiling Finish. Newly installed interior wall and ceiling finish materials complying with Section 12.5 shall be permitted throughout nonsprinklered smoke compartments if the materials are Class A, except as otherwise permitted in 20.4.3.4.2.1 or 20.4.3.4.2.2. [***101:***18.4.4.6.2]

20.4.3.4.2.1 Walls and ceilings shall be permitted to have Class A or Class B interior finish in individual rooms having a capacity not exceeding four persons. [***101:***18.4.4.6.2.1]

20.4.3.4.2.2 Corridor wall finish not exceeding 48 in. (1220 mm) in height and restricted to the lower half of the wall shall be permitted to be Class A or Class B. [***101:***18.4.4.6.2.2]

20.4.3.5 Interior Floor Finish.

20.4.3.5.1 Newly installed interior floor finish shall comply with Section 12.5. [***101:***18.4.4.6.3.1]

20.4.3.5.2 The requirements for newly installed interior floor finish in exit enclosures and corridors not separated from them by walls complying with 19.3.5.7 of NFPA *101* shall be as follows:

(1) Unrestricted in smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7 of NFPA *101*

(2) Not less than Class I in smoke compartments not protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7 of NFPA *101*

[***101:***18.4.4.6.3.2]

20.4.3.5.3 Existing Interior Floor Finish. No restrictions shall apply to existing interior floor finish. [***101:***19.3.3.3]

20.5 Residential Board and Care Occupancies

The primary characteristics that differentiate residential board and care occupancies from other residential occupancies is the assumed ability (or lack thereof) of occupants to evacuate the building in the event of a fire or similar emergency and the availability or level of personal care services. The term *personal care*, as defined in 3.3.209, includes assistance with many of the activities of daily living. Personal care services might include assisting residents with bathing and dressing and helping residents with bill payment and similar household maintenance–related tasks. Personal care does not include nursing home–type care; nor does it include medical care.

Prior to the 2003 edition of the *Code*, application of the requirements for both new and existing residential board and care facilities required the determination of the occupants' evacuation capability — that is, the occupants' ability to move, as a group, to a point of safety in the event of a fire. Evacuation capability was broken down into three subclasses — prompt, slow, and impractical. Ongoing evaluation by the AHJ was required to ensure that the facility was not being used outside the limitations of its design (e.g., a facility designed and constructed using the provisions for slow evacuation capability but actually having an impractical evacuation capability). When tasked with the development of provisions for residential board and care facilities to be included in *NFPA 5000®*, *Building Construction and Safety Code®*, the NFPA Technical Committee on Board and Care Facilities recognized that, because a facility's population is expected to change over time, a facility's evacuation capability will likely change over time as well. It was not, then, practical to simply insert the requirements from this *Code* into *NFPA 5000*. As such, the committee modified the requirements for new board and care facilities so as not to depend on the evacuation capability of the occupants of the facility.

For consistency with *NFPA 5000*, the committee also revised the provisions of Chapter 32 of NFPA *101*, which address new facilities, so they no longer depend on the determination of evacuation capability. Chapter 33 of NFPA *101*, which addresses existing facilities, retains the evacuation capability provisions so as to not unnecessarily place existing facilities out of compliance. Since new board and care facilities might have occupants who do not have the ability to evacuate without assistance, they must be designed and constructed to facilitate the defend-in-place occupant protection strategy, much like health care occupancies. To utilize the defend-in-place strategy, the building must be able to withstand the effects of fire for the time necessary to either evacuate the occupants or relocate them to a safe location within the building.

Section 20.5 classifies residential board and care occupancies based on the number of residents. For that purpose, Section 20.5 is subdivided to address requirements for small (16 or fewer residents) and large (more than 16 residents) facilities. As the number of residents put at risk by fire increases, the requirements become more strict.

Of the determinations that must be made to classify a residential board and care occupancy (i.e., availability of personal care, number of residents, and, in the case of existing facilities, evacuation capability), the most difficult is evacuation capability. Evacuation capability is established on the basis of the occupants' (i.e., residents and staff working together) ability to move to a safe location, such as an enclosed exit stair or a point outside the structure. The term *evacuation capability* is defined in 3.3.81 of NFPA *101*; guidance on classifying evacuation capability is provided in A.3.3.81 of NFPA *101*.

Where an existing facility does not comply with the requirements for new facilities in Chapter 32 of NFPA *101*, Chapter 33 of NFPA *101* requires facility management to furnish the AHJ with an evacuation capability determination conducted using a procedure acceptable to the AHJ. If such documentation is not furnished, the evacuation capability is considered, by default, as impractical.

As in the case of other occupancy chapters that address occupants with limited self-preservation capability, Section 20.5 relies on staff intervention and staff support to assist the residents during fire and similar emergencies. It is the responsibility of the staff to understand and implement the emergency plan for the facility. The plan must include a method for familiarizing residents with the procedures to be followed during a fire. Exhibit 20.15 depicts a typical residential board and care occupancy.

Exhibit 20.15

Typical residential board and care occupancy.

20.5.1 Application. New and existing residential board and care occupancies shall comply with Section 20.5 and NFPA *101*.

20.5.2 Operating Features.

20.5.2.1 Emergency Action Plan.

20.5.2.1.1 The administration of every residential board and care facility shall have, in effect and available to all supervisory personnel, written copies of a plan for protecting all persons in the event of fire, for keeping persons in place, for evacuating persons to areas of refuge, and for evacuating persons from the building when necessary. [***101:***32.7.1.1; ***101:***33.7.1.1]

20.5.2.1.2 The emergency action plan shall include special staff response, including the fire protection procedures needed to ensure the safety of any resident, and shall be amended or revised whenever any resident with unusual needs is admitted to the home. [***101:***32.7.1.2; ***101:***33.7.1.2]

20.5.2.1.3 All employees shall be periodically instructed and kept informed with respect to their duties and responsibilities under the plan, and such instruction shall be reviewed by the staff not less than every 2 months. [***101:***32.7.1.3; ***101:***33.7.1.3]

20.5.2.2 Resident Training.

20.5.2.2.1 All residents participating in the emergency action plan shall be trained in the proper actions to be taken in the event of fire. [***101:***32.7.2.1; ***101:***33.7.2.1]

20.5.2.2.2 The training required by 20.5.2.2.1 shall include actions to be taken if the primary escape route is blocked. [***101:***32.7.2.2; ***101:***33.7.2.2]

20.5.2.2.3 If a resident is given rehabilitation or habilitation training, training in fire prevention and the actions to be taken in the event of a fire shall be a part of the training program. [***101:***32.7.2.3; ***101:***33.7.2.3]

20.5.2.2.4 Residents shall be trained to assist each other in case of fire to the extent that their physical and mental abilities permit them to do so without additional personal risk. [***101:***32.7.2.4; ***101:***33.7.2.4]

20.5.2.3 Emergency Egress and Relocation Drills. Emergency egress and relocation drills shall be conducted in accordance with 20.5.2.3.1 through 20.5.2.3.6. [***101:***32.7.3; ***101:***33.7.3]

20.5.2.3.1 Emergency egress and relocation drills shall be conducted not less than six times per year on a bimonthly basis, with not less than two drills conducted during the night when residents are sleeping, as modified by 20.5.2.3.5 and 20.5.2.3.6. [***101:***32.7.3.1; ***101:***33.7.3.1]

20.5.2.3.2 The emergency drills shall be permitted to be announced to the residents in advance. [***101:***32.7.3.2; ***101:***33.7.3.2]

20.5.2.3.3 The drills shall involve the actual evacuation of all residents to an assembly point, as specified in the emergency action plan, and shall provide residents with experience in egressing through all exits and means of escape required by this *Code*. [***101:***32.7.3.3; ***101:***33.7.3.3]

20.5.2.3.4 Exits and means of escape not used in any drill shall not be credited in meeting the requirements of this *Code* for board and care facilities. [***101:***32.7.3.4; ***101:***33.7.3.4]

20.5.2.3.5 Actual exiting from windows shall not be required to comply with 20.5.2.3; opening the window and signaling for help shall be an acceptable alternative. [***101:***32.7.3.5; ***101:***33.7.3.5]

20.5.2.3.6 Residents who cannot meaningfully assist in their own evacuation or who have special health problems shall not be required to actively participate in the drill. Subsection 20.4.2 shall apply in such instances. [***101:***32.7.3.6; ***101:***33.7.3.6]

20.5.2.4 Smoking.

20.5.2.4.1* Smoking regulations shall be adopted by the administration of board and care occupancies. [***101:***32.7.4.1; ***101:***33.7.4.1]

A.20.5.2.4.1 Smoking regulations should include the following:

(1) Smoking should be prohibited in any room, compartment, or area where flammable or combustible liquids, combustible gases, or oxygen is used or stored and in any other hazardous location, and the following also should apply:
    (a) Such areas should be posted with signs that read NO SMOKING or the international symbol for no smoking.
    (b) In residential board and care facilities where smoking is totally prohibited and signs so indicating are placed at all major entrances, secondary signs with language that prohibits smoking are not required.
(2) Smoking by residents classified as not responsible with regard to their ability to safely use and dispose of smoking materials should be prohibited.
(3) Where a resident, as specified in A.20.5.2.4.1(2), is under direct supervision by staff or by a person approved by the administration, smoking might be permitted.
(4) Smoking materials should not be provided to residents or maintained by residents without the approval of the administration.
(5) Areas where smoking is permitted should be clearly identified.
(6) Ashtrays of noncombustible material and safe design should be provided and required to be used in all areas where smoking is permitted.
(7) Self-closing cover devices into which ashtrays can be emptied should be made available to all areas where smoking is permitted and should be required to be used.

[***101:***A.32.7.4.1; ***101:***A.33.7.4.1]

20.5.2.4.2 Where smoking is permitted, noncombustible safety-type ashtrays or receptacles shall be provided in convenient locations. [***101:***32.7.4.2; ***101:***33.7.4.2]

20.5.2.5* Furnishings, Bedding, and Decorations.

A.20.5.2.5 The requirements applicable to draperies/curtains, upholstered furniture, and mattresses apply only to new draperies/curtains, new upholstered furniture, and new mattresses. The word *new* means unused, normally via procurement from the marketplace, either by purchase or donation, of items not previously used.

Many board and care facilities allow residents to bring into the board and care home upholstered furniture items from the resident's previous residence. Such an item is not new and, thus, is not regulated. On the other hand, some of the larger board and care homes purchase contract furniture, as is done in hotels. Such new, unused furniture, whether purchased or received as a donation, is regulated by the requirements of 20.5.2.5.2. By federal law, mattresses manufactured and sold within the United States must pass testing per 16 CFR 1632 (FF4-72), *Standard for the Flammability of Mattresses and Mattress Pads*. [***101:***A.32.7.5; ***101:***A.33.7.5]

20.5.2.5.1 New draperies, curtains, and other similar loosely hanging furnishings and decorations in board and care facilities shall comply with 20.5.2.5.1.1 and 20.5.2.5.1.2. [***101:***32.7.5.1; ***101:***33.7.5.1]

20.5.2.5.1.1 New draperies, curtains, and other similar loosely hanging furnishings and decorations in board and care facilities shall be in accordance with the provisions of 12.6.2, unless otherwise permitted by 20.5.2.5.1.2. [***101:***32.7.5.1.1; ***101:***33.7.5.1.1]

20.5.2.5.1.2 In other than common areas, new draperies, curtains, and other similar loosely hanging furnishings and decorations shall not be required to comply with 20.5.2.5.1.1 where the building is protected throughout by an approved automatic sprinkler system installed in accordance with 13.3.2.21.2 for new small facilities, 13.3.2.21.1 for new large facilities, 13.3.2.22.2 for existing small facilities, or 13.3.2.22.1 for existing large facilities. [***101:***32.7.5.1.2; ***101:***33.7.5.1.2]

20.5.2.5.2* New upholstered furniture within board and care facilities shall comply with 20.5.2.5.2.1 or 20.5.2.5.2.2. [***101:***32.7.5.2; ***101:***33.7.5.2]

A.20.5.2.5.2 New upholstered furniture within board and care homes should be tested for rates of heat release in accordance with 12.6.3.2.1. [***101:***A.32.7.5.2; ***101:***A.33.7.5.2]

20.5.2.5.2.1 New upholstered furniture shall be tested in accordance with the provisions of 12.6.3.1(1) and 12.6.3.2.1. [***101:***32.7.5.2.1; ***101:***33.7.5.2.1]

20.5.2.5.2.2 Upholstered furniture belonging to residents in sleeping rooms shall not be required to be tested, provided that a smoke alarm is installed in such rooms; battery-powered single-station smoke alarms shall be permitted in such rooms. [***101:***32.7.5.2.2; ***101:***33.7.5.2.2]

20.5.2.5.2.3* Newly introduced mattresses within board and care facilities shall comply with 20.5.2.5.2.3.1 or 20.5.2.5.2.3.2. [***101:***32.7.5.3; ***101:***33.7.5.3]

A.20.5.2.5.2.3 New mattresses within board and care homes should be tested for rates of heat release in accordance with 12.6.3.2.2. [***101:***A.32.7.5.3; ***101:***A.33.7.5.3]

20.5.2.5.2.3.1 Newly introduced mattresses shall be tested in accordance with the provisions of 12.6.3.2 and 12.6.3.2.2. [***101:***32.7.5.3.1; ***101:***33.7.5.3.1]

20.5.2.5.2.3.2 Mattresses belonging to residents in sleeping rooms shall not be required to be tested, provided that a smoke alarm is installed in such rooms; battery-powered single-station smoke alarms shall be permitted in such rooms. [***101:***32.7.5.3.2; ***101:***33.7.5.3.2]

The provisions of 20.5.2.5 extend the level of life safety provided to a residential board and care facility by further attempting to prevent room flashover. However, rather than impose these requirements retroactively on existing facilities, they apply to newly introduced draperies, curtains, upholstered furniture, and mattresses. The text of A.20.5.2.5 sufficiently details the meaning of the term *new* in this context.

Draperies must be flame resistant in accordance with 12.6.1, unless they are located in other than common areas (e.g., sleeping rooms) of sprinklered facilities (see 20.5.2.5.1.2). Newly introduced upholstered furniture and mattresses must be resistant to cigarette ignition in accordance with 12.6.3. Newly introduced upholstered furniture and mattresses must have limited rates of heat release in accordance with 12.6.2, unless the building is sprinklered. See the commentary on Section 12.6 for additional details on testing requirements for draperies, curtains, upholstered furniture, and mattresses.

20.5.2.5.3 No stove or combustion heater shall be located to block escape in case of fire caused by the malfunction of the stove or heater. [***101:***32.2.5.2.2; ***101:***33.2.5.2.2]

20.5.2.5.4 Unvented fuel-fired heaters shall not be used in any residential board and care facility. [***101:***32.2.5.2.3; ***101:***33.2.5.2.3]

The provision of 20.5.2.5.3 does not require a kitchen containing a stove to be completely separated by smoke partitions, only that the stove be located so that a malfunction does not result in a blockage of the means of escape. If, in the opinion of the AHJ, the location of the stove would cause the means of escape to be blocked in the event of a malfunction, protection of the area as a hazardous area in accordance with NFPA *101* might be appropriate.

The use of typical kerosene portable heaters, as well as other fuel-fired, unvented heaters, is prohibited by 20.5.2.5.4.

20.5.3 Interior Finish.

20.5.3.1 Small Facilities.

20.5.3.1.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***32.2.3.3.1; ***101:***33.2.3.3.1]

20.5.3.1.2 New Interior Wall and Ceiling Finish. New interior wall and ceiling finish materials complying with Section 12.5 shall be Class A, Class B, or Class C. [***101:***32.2.3.3.2]

20.5.3.1.3 Existing Interior Wall and Ceiling Finish. Existing interior wall and ceiling finish materials complying with Section 12.5 shall be as follows:

(1) Class A or Class B in facilities other than those having prompt evacuation capability
(2) Class A, Class B, or Class C in facilities having prompt evacuation capability

[***101:***33.2.3.3.2]

20.5.3.1.4 Interior Floor Finish.

20.5.3.1.4.1 New interior floor finish shall comply with Section 12.5. [***101:***32.2.3.3.3.1]

20.5.3.1.4.2 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***32.2.3.3.3.2]

20.5.3.1.4.3 Existing Interior Floor Finish. (Reserved) [***101:***33.2.3.3.3]

20.5.3.2 Large Facilities.

20.5.3.2.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***32.3.3.3.1; ***101:***33.3.3.3.1]

20.5.3.2.2 New Interior Wall and Ceiling Finish. New interior wall and ceiling finish materials complying with Section 12.5 shall be in accordance with the following:

(1) Exit enclosures — Class A
(2) Lobbies and corridors — Class B
(3) Rooms and enclosed spaces — Class B

[***101:***32.3.3.3.2]

20.5.3.2.3 Existing Interior Wall and Ceiling Finish. Existing interior wall and ceiling finish materials complying with Section 12.5 shall be Class A or Class B. [***101:***33.3.3.3.2]

20.5.3.2.4 Interior Floor Finish.

20.5.3.2.4.1 New interior floor finish shall comply with Section 12.5. [***101:***32.3.3.3.3.1]

20.5.3.2.4.2 New interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 32.3.3.6 of NFPA *101* shall be not less than Class II. [***101:***32.3.3.3.3.2]

20.5.3.2.4.3 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***32.3.3.3.3.3]

20.5.3.2.4.4 Existing Interior Floor Finish. Existing interior floor finish, other than approved existing floor coverings, shall be Class I or Class II in corridors or exits. [***101:***33.3.3.3.3]

20.5.3.3 Apartment Buildings Housing Board and Care Occupancies.

20.5.3.3.1 New Interior Finish.

20.5.3.3.1.1 The requirements of 20.9.3 shall apply only to the parts of means of egress serving the apartment(s) used as a residential board and care occupancy, as modified by 20.5.3.3.1.2. [***101:***32.4.3.1.1]

20.5.3.3.1.2 If a new board and care occupancy is created in an existing apartment building, the requirements of 31.3.3 of NFPA *101* shall apply to the parts of the means of egress serving the apartment(s) used as a residential board and care occupancy. [***101:***32.4.3.1.2]

20.5.3.3.2 Existing Interior Finish. The requirements of 20.9.3 shall apply only to the parts of means of egress serving the apartment(s) used as a residential board and care occupancy. [***101:***33.4.3.1]

20.6 Ambulatory Health Care Centers

Section 20.6 addresses the needs of occupants of facilities that provide medical treatment on an outpatient basis. The patient treatment is not merely a routine medical visit, such as to a doctor's office, but rather a treatment that renders the patient incapable of self-preservation, a treatment that requires anesthesia that renders the patient incapable of self-preservation, or a treatment for patients who, due to the nature of their injury or illness, are incapable of self-preservation when they arrive at the ambulatory health care facility. Although these descriptions might seem to resemble a situation typically associated with a hospital, the major difference is that an ambulatory health care facility does not provide care for any individual for 24 hours or more. Rather, a patient receives treatment and then leaves the facility. Patients suffering complications that would prevent them from leaving the ambulatory health care facility would typically be transported and admitted to a hospital that provides care on a 24-hour basis. Patients requiring rehabilitation following a procedure or treatment would be admitted to a 24-hour rehabilitation facility.

There is also an important distinction concerning the number of occupants required to constitute classification as an ambulatory health care occupancy — that number being four or more (see the definition of the term *ambulatory health care occupancy* in 3.3.192.1). The Centers for Medicare and Medicaid Services (CMS) play an important role in the government financing of health care services in the United States. CMS applies a stricter definition of an ambulatory health care occupancy than NFPA by requiring surgical centers and some other outpatient services facilities for one or more patients to be classified as an ambulatory health care occupancy. NFPA's four-person criterion applies to all forms of ambulatory health care occupancies.

The provisions of Section 20.6 for ambulatory health care occupancies were drawn from those applicable to hospitals and those applicable to business occupancies. If an outpatient medical facility does not meet the definition of the term *ambulatory health care occupancy*, it generally needs to be classified as, and comply with the requirements for, a business occupancy.

Commentary Table 20.1 differentiates among health care, ambulatory health care, and business occupancies on the basis of the patient load and care provided. Incapability of self-preservation might be the result of the use of general anesthesia, a treatment such as dialysis, or an injury or illness that brings the patient to the ambulatory health care facility for treatment. Based on the information in Commentary Table 20.1, if a dentist administers general anesthesia to not more than three patients simultaneously, the dentist's office would be classified as a business occupancy. If the dentist expands the simultaneous administration of general anesthesia to a fourth patient, the more stringent requirements for ambulatory health care occupancies would apply.

COMMENTARY TABLE 20.1 *Occupancy Classification Comparison*

Factor	Section 20.4 and Chapters 18 and 19 of NFPA 101 Health Care Occupancies	Section 20.6 and Chapters 20 and 21 of NFPA 101 Ambulatory Health Care Occupancies	Section 20.13 and Chapters 38 and 39 of NFPA 101 Business Occupancies
Number of patients rendered incapable of self-preservation	4 or more*,†	4 or more*,†	3 or fewer
Care provided on a 24-hour basis?	Yes	No	No

*Incapability of self-preservation might exist prior to admission and be unrelated to the treatment provided.

†Incapability of self-preservation might not exist prior to admission but be related to the treatment provided.

20.6.1 Application. New and existing ambulatory health care centers shall comply with Section 20.6 and NFPA *101*.

Ambulatory health care facilities exhibit some of the occupancy characteristics of business occupancies and some of the characteristics of health care occupancies. Section 20.6 prescribes a level of life safety from fire that is greater than that typically specified for business occupancies but less than that typically found in hospitals, nursing homes, and limited care facilities.

20.6.2* Operating Features.

A.20.6.2 Ambulatory health care occupants have, in large part, varied degrees of physical disability, and their removal to the outside, or even their disturbance caused by moving, is inexpedient or impractical in many cases, except as a last resort. Similarly, recognizing that there might be an operating necessity for the restraint of the mentally ill, often by use of barred windows and locked doors, fire exit drills are usually extremely disturbing, detrimental, and frequently impracticable. [***101:***A.20.7; ***101:***A.21.7]

In most cases, fire exit drills, as ordinarily practiced in other occupancies, cannot be conducted in ambulatory health care occupancies. Fundamentally, superior construction, early discovery and extinguishment of incipient fires, and prompt notification need to be relied on to reduce the occasion for evacuation of buildings of this class to a minimum. [***101:***A.20.7; ***101:***A.21.7]

20.6.2.1 Evacuation and Relocation Plan and Fire Drills.

20.6.2.1.1 The administration of every ambulatory health care facility shall have, in effect and available to all supervisory personnel, written copies of a plan for the protection of all persons in the event of fire, for their evacuation to areas of refuge, and for their evacuation from the building when necessary. [***101:***20.7.1.1; ***101:***21.7.1.2]

20.6.2.1.2 All employees shall be periodically instructed and kept informed with respect to their duties under the plan required by 20.6.2.1.1. [***101:***20.7.1.2; ***101:***21.7.1.2]

20.6.2.1.3 A copy of the plan required by 20.6.2.1.1 shall be readily available at all times when the facility is open. [***101:***20.7.1.3; ***101:***21.7.1.3]

20.6.2.1.4 The provisions of Section 10.6 and 20.6.2.1.5 through 20.6.2.2.3 shall apply.

20.6.2.1.5* Fire drills in ambulatory health care facilities shall include the simulation of emergency fire conditions. [***101:***20.7.1.4; ***101:***21.7.1.4]

A.20.6.2.1.5 Many ambulatory health care occupancies conduct fire drills without disturbing patients by choosing the location of the simulated emergency in advance and by closing the doors in the vicinity prior to the initiation of the drill. The purpose of a fire drill is to test and evaluate the efficiency, knowledge, and response of personnel in implementing the facility fire emergency plan. Its purpose is not to disturb or excite patients. Fire drills should be scheduled on a random basis to ensure that personnel in ambulatory health care facilities are drilled not less than once in each 3-month period. [***101:***A.20.7.1.4; ***101:***A.21.7.1.4]

Drills should consider the ability to move patients to an adjacent smoke compartment. Relocation can be practiced using simulated patients or empty wheelchairs. [***101:***A.20.7.1.4; ***101:***A.21.7.1.4]

20.6.2.1.6 Patients shall not be required to be moved during drills to safe areas or to the exterior of the building. [***101:***20.7.1.5; ***101:***21.7.1.5]

20.6.2.1.7 Drills shall be conducted quarterly on each shift to familiarize facility personnel (including but not limited to nurses, interns, maintenance engineers, and administrative staff) with the emergency action required under varied conditions. [***101:***20.7.1.6; ***101:***21.7.1.6]

20.6.2.1.8 Employees of ambulatory health care facilities shall be instructed in life safety procedures and devices. [***101:***20.7.1.7; ***101:***21.7.1.7]

20.6.2.2 Procedure in Case of Fire.

20.6.2.2.1* Protection of Patients.

A.20.6.2.2.1 Each facility has specific characteristics that vary sufficiently from other facilities to prevent the specification of a universal emergency procedure. The recommendations that follow, however, contain many of the elements that should be considered and adapted, as appropriate, to the individual facility. [***101:***A.20.7.2.1; ***101:***A.21.7.2.1]

Upon discovery of fire, personnel should immediately take the following action:

(1) If any person is involved in the fire, the discoverer should go to the aid of that person, calling aloud an established code phrase, which provides for both the immediate aid of any endangered person and the transmission of an alarm.
(2) Any person in the area, upon hearing the code called aloud, should activate the building fire alarm using the nearest manual fire alarm box.
(3) If a person is not involved in the fire, the discoverer should activate the building fire alarm using the nearest manual fire alarm box.
(4) Personnel, upon hearing the alarm signal, should immediately execute their duties as outlined in the facility fire safety plan.
(5) The telephone operator should determine the location of the fire as indicated by the audible signal.
(6) In a building equipped with an uncoded alarm system, a person on the floor of fire origin should be responsible for promptly notifying the facility telephone operator of the fire location.
(7) If the telephone operator receives a telephone alarm reporting a fire from a floor, the operator should regard that alarm in the same fashion as an alarm received over the fire alarm system and should immediately notify the fire department and alert all facility personnel of the place of fire and its origin.
(8) If the building fire alarm system is out of order, any person discovering a fire should immediately notify the telephone operator by telephone, and the operator should then transmit this information to the fire department and alert the building occupants.

[***101:***A.20.7.2.1; ***101:***A.21.7.2.1]

20.6.2.2.1.1 For ambulatory health care facilities, the proper protection of patients shall require the prompt and effective response of ambulatory health care personnel. [***101:***20.7.2.1.1; ***101:***21.7.2.1.1]

Δ **20.6.2.2.1.2** The basic response required of staff shall include the following:

(1) Removal of all occupants directly involved with the fire emergency
(2) Transmission of an appropriate fire alarm signal to warn other building occupants and summon staff
(3) Confinement of the effects of the fire by closing doors to isolate the fire area
(4) Relocation of patients as detailed in the facility's fire safety plan

[***101:***20.7.2.1.2; ***101:***21.7.2.1.2]

Δ **20.6.2.2.2 Fire Safety Plan.** A written fire safety plan shall provide for all of the following:

(1) Use of alarms
(2) Transmission of alarms to fire department
(3) Response to alarms
(4) Isolation of fire
(5) Evacuation of immediate area
(6) Evacuation of smoke compartment
(7) Preparation of floors and building for evacuation
(8) Extinguishment of fire

[***101:***20.7.2.2; ***101:***21.7.2.2]

The AHJ should require a fire safety plan to be put in place to ensure that the staff of the ambulatory health care occupancy has been trained on their duties. This plan should include occasional review by all staff members.

20.6.2.2.3 Staff Response.

20.6.2.2.3.1 All personnel shall be instructed in the use of and response to fire alarms. [***101:***20.7.2.3.1; ***101:***21.7.2.3.1]

20.6.2.2.3.2 All personnel shall be instructed in the use of the code phrase to ensure transmission of an alarm under either of the following conditions:

(1) When the individual who discovers a fire must immediately go to the aid of an endangered person
(2) During a malfunction of the building fire alarm system

[***101:***20.7.2.3.2; ***101:***21.7.2.3.2]

20.6.2.2.3.3 Personnel hearing the code announced shall first activate the building fire alarm using the nearest fire alarm box and then shall execute immediately their duties as outlined in the fire safety plan. [***101:***20.7.2.3.3; ***101:***21.7.2.3.3]

20.6.2.3 Maintenance of Exits.

20.6.2.3.1 Proper maintenance shall be provided to ensure the dependability of the method of evacuation selected. [***101:***20.7.3.1; ***101:***21.7.3.1]

20.6.2.3.2 Ambulatory health care occupancies that find it necessary to lock exits shall, at all times, maintain an adequate staff qualified to release locks and direct occupants from the immediate danger area to a place of safety in case of fire or other emergency. [***101:***20.7.3.2; ***101:***21.7.3.2]

Δ **20.6.2.4* Smoking.** Smoking regulations shall be adopted and shall include not less than the following provisions:

(1) Smoking shall be prohibited in any room, ward, or compartment where flammable liquids, combustible gases, or oxygen is used or stored and in any other hazardous location, and such areas shall be posted with signs that read NO SMOKING or shall be posted with the international symbol for no smoking.
(2) In ambulatory health care facilities where smoking is prohibited and signs are placed at all major entrances, secondary signs with language that prohibits smoking shall not be required.
(3) Smoking by patients classified as not responsible shall be prohibited.
(4) The requirement of 20.6.2.4(3) shall not apply where the patient is under direct supervision.
(5) Ashtrays of noncombustible material and safe design shall be provided in all areas where smoking is permitted.
(6) Metal containers with self-closing cover devices into which ashtrays can be emptied shall be readily available to all areas where smoking is permitted.

[***101:***20.7.4; ***101:***21.7.4]

A.20.6.2.4 The most rigid discipline with regard to prohibition of smoking might not be nearly as effective in reducing incipient fires from surreptitious smoking as the open recognition of smoking, with provision of suitable facilities for smoking. Proper education and training of the staff and attendants in the ordinary fire hazards and their abatement is unquestionably essential. The problem is a broad one, varying with different types and arrangements of buildings; the effectiveness of rules of procedure, which need to be flexible, depends in large part on the management. [***101:***A.20.7.4; ***101:***A.21.7.4]

20.6.2.5 Furnishings, Mattresses, and Decorations.

Δ **20.6.2.5.1*** Draperies, curtains, and other loosely hanging fabrics and films serving as furnishings or decorations in ambulatory health care occupancies shall be in accordance with the provisions of 12.6.2, and the following also shall apply:

(1) Such curtains shall include cubicle curtains.
(2) Such curtains shall not include curtains at showers.
[***101:***20.7.5.1; ***101:***21.7.5.1]

A.20.6.2.5.1 In addition to the provisions of 12.6.2, which deal with ignition resistance, additional requirements with respect to the location of cubicle curtains relative to sprinkler placement are included in NFPA 13. [***101:***A.20.7.5.1; ***101:***A.21.7.5.1]

Δ **20.6.2.5.2** Newly introduced upholstered furniture shall comply with 12.6.3.1 and one of the following provisions:

(1) The furniture shall meet the criteria specified in 12.6.3.2.1.
(2) The furniture shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA 13.
[***101:***20.7.5.2; ***101:***21.7.5.2]

Δ **20.6.2.5.3** Newly introduced mattresses shall comply with 12.6.3.2 and one of the following provisions:

(1) The mattresses shall meet the criteria specified in 12.6.3.2.2.
(2) The mattresses shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA 13.
[***101:***20.7.5.3; ***101:***21.7.5.3]

Δ **20.6.2.5.4** Combustible decorations shall be prohibited, unless one of the following criteria is met:

(1) They are flame-retardant.
(2) The decorations meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701.
(3) The decorations exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289 using the 20 kW ignition source.
(4)* The decorations, such as photographs, paintings, and other art, are attached directly to the walls, ceiling, and non-fire-rated doors in accordance with the following:
   (a) Decorations on non-fire-rated doors do not interfere with the operation or any required latching of the door and do not exceed the area limitations of 20.6.2.5.4(4)(b) or (c).
   (b) Decorations do not exceed 20 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is not protected throughout by an approved automatic sprinkler system in accordance with Section 13.3.
   (c) Decorations do not exceed 30 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is protected throughout by an approved supervised automatic sprinkler system in accordance with Section 13.3.

[***101:***20.7.5.4; ***101:***21.7.5.4]

A.20.6.2.5.4(4) The percentage of decorations should be measured against the area of any wall or ceiling, not the aggregate total of walls, ceilings, and doors. The door is considered part of the wall. The decorations must be located such that they do not interfere with the operation of any door, sprinkler, smoke detector, or any other life safety equipment. Other art might include hanging objects or three-dimensional items. [***101:***A.20.7.5.4(4); ***101:***A.21.7.5.4(4)]

20.6.2.5.5 Soiled Linen and Trash Receptacles.

Δ **20.6.2.5.5.1** Soiled linen or trash collection receptacles shall not exceed 32 gal (121 L) in capacity, and all of the following also shall apply:

(1) The average density of container capacity in a room or space shall not exceed 0.5 gal/ft^2 (20.4 L/m^2).
(2) Mobile soiled linen or trash collection receptacles with capacities greater than 32 gal (121 L) shall be located in a room protected as a hazardous area when not attended.
(3) Container size and density shall not be limited in hazardous areas.
[***101:***20.7.5.5.1; ***101:***21.7.5.5.1]

20.6.2.5.5.2* Containers used solely for recycling clean waste or for patient records awaiting destruction shall be permitted to be excluded from the requirements of 20.6.2.5.5.1 where all the following conditions are met:

(1) Each container shall be limited to a maximum capacity of 96 gal (363 L), except as permitted by 20.6.2.5.5.2(2) or (3).
(2) Containers with capacities greater than 96 gal (363 L) shall be located in a room protected as a hazardous area when not attended.
(3) Container size shall not be limited in hazardous areas.
(4) Containers for combustibles shall be labeled and listed as meeting the requirements of FM Approval 6921, *Approval Standard for Containers for Combustible Waste*; however, such testing, listing, and labeling shall not be limited to FM Approvals.
[***101:***20.7.5.5.2; ***101:***21.7.5.5.2]

A.20.6.2.5.5.2 It is the intent that this provision permits recycling of bottles, cans, paper and similar clean items that do not contain grease, oil, flammable liquids, or significant plastic materials using larger containers or several adjacent containers and not require locating such containers in a room protected as a hazardous area.

Containers for medical records awaiting shredding are often larger than 32 gal (121 L). These containers are not to be included in the calculations and limitations of 20.6.2.5.5.1. There is no limit on the number of these containers, as FM Approval Standard 6921, *Containers for Combustible Waste*, ensures that the fire will not spread outside of the container. FM approval standards are written for use with FM Approvals. The tests can be conducted by any approved laboratory. The portions of the standard referring to FM Approvals are not included in this reference. [***101:***A.20.7.5.5.2; ***101:***A.21.7.5.5.2]

20.6.2.5.5.3 The provisions of 19.2.1.1 through 19.2.1.2 applicable to soiled linen and trash receptacles shall not apply.

Cigarette ignition–resistance testing for newly introduced upholstered furniture and mattresses is required for ambulatory health care occupancies. Further, rate of heat release testing, as detailed in 12.6.3.1 and 12.6.3.2, is required by 20.6.2.5.2 and 20.6.2.5.3 for newly introduced upholstered furniture and newly introduced mattresses in ambulatory health care occupancies, unless the building is sprinklered throughout.

Paragraph 20.6.2.5.5.1 establishes maximum trash container sizes and placement densities permitted within a room. For the 2018 edition of the *Code*, the criterion that a capacity of 32 gal (121 L) not be exceeded within any 64 ft^2 (6 m^2) area was deleted. The effect is, for example, that two 32 gal (121 L) containers can be placed side-by-side in a 128 ft^2 (12 m^2) area. Containers larger than those specified or grouped containers exceeding the density per room criterion present a hazard greater than that associated with the normal furnishing of an ambulatory health care center room.

Large, mobile soiled linen or trash receptacles can be moved along the corridor as collections occur but must be attended by staff. If housekeeping staff, for example, must leave the area, the container must be stored in a room designed and maintained as a hazardous area in accordance with 20/21.3.2 of NFPA *101*. Exhibit 20.13 illustrates the requirements of 20.6.2.5.5.

The provisions of 20.6.2.5.5.2 recognize the need for secure disposal of clean waste, such as paper, that might include patient information. Such waste is typically aggregated in containers larger than the 32 gal (121 L) limitation imposed by 20.6.2.5.5.1, since it might not be feasible to have such materials removed and shredded as frequently as would be necessitated if smaller containers were used. The maximum 96 gal (363 L) container presents little fire challenge, because the container has been tested for fire performance. The larger, clean waste containers typically are outfitted with a tight-fitting lid and narrow slot in order to pass the required fire testing. Exhibit 20.14 illustrates a maximum 96 gal (363 L) container meeting the criteria of 20.6.2.5.5.2.

Δ **20.6.2.6 Portable Space-Heating Devices.** Portable space-heating devices shall be prohibited in all ambulatory health care occupancies, unless both of the following criteria are met:

(1) Such devices are used only in nonsleeping staff and employee areas.
(2) The heating elements of such devices do not exceed 212°F (100°C).

[***101:***20.7.8; ***101:***21.7.8]

N **20.6.2.7 Integrated Fire Protection Systems.** Integrated fire protection systems shall be tested in accordance with 13.1.3. [***101:***20.7.10, ***101:***21.7.10]

The provisions of 20.6.2.7 are new to the 2018 edition of the *Code*. For new ambulatory health care occupancies, integrated fire protection systems must be tested in accordance with 13.1.3. The concept is one in which if two or more fire protection or life safety systems are integrated, the integrated system must be tested to verify the proper operation and function of such system in accordance with NFPA 4. For existing ambulatory health care occupancies, the requirement for compliance with NFPA 4 applies only to integrated systems in high-rise buildings.

20.6.3 Interior Finish.

Δ **20.6.3.1 General.** Interior finish shall be in accordance with Section 12.5. [***101:***20.3.3.1; ***101:***21.3.3.1]

20.6.3.2 Interior Wall and Ceiling Finish.

Δ **20.6.3.2.1** Interior wall and ceiling finish material complying with Section 12.5 shall be Class A or Class B in exits and in exit access corridors. [***101:***20.3.3.2.1; ***101:***21.3.3.2.1]

20.6.3.2.2 Interior wall and ceiling finishes shall be Class A, Class B, or Class C in areas other than those specified in 20.6.3.2.1. [***101:***20.3.3.2.2; ***101:***21.3.3.2.2]

20.6.3.3 New Interior Floor Finish.

20.6.3.3.1 New interior floor finish shall comply with Section 12.5. [***101:***20.3.3.3.1]

20.6.3.3.2 New interior floor finish in exit enclosures shall be Class I or Class II. [***101:***20.3.3.3.2]

20.6.3.3.3 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***20.3.3.3.3]

The provision of 20.6.3.3.2, applicable to new floor finish materials, requires that the interior floor finish be Class I or Class II only in exit enclosures, such as enclosed exit stairs. The intent is that the interior floor finish materials used in exits are to resist the spread of fire if exposed to the radiant energy from a fully developed room fire by means of an open door. It should be noted that the reference to 12.5.9.1 and 12.5.9.2 in 20.6.3.3.3 should be to 12.5.8.1 and 12.5.8.2 of this *Code*. The provision of 12.5.9.2 permits a reduction of one class of interior floor finish (i.e., from Class I to Class II or from Class II to no classification required) in sprinklered buildings.

In all cases, regardless of sprinkler protection, new carpet and carpet-like floor finishes must comply with ASTM D2859, *Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials*, as referenced in 12.5.8.1. New floor finish materials, other than carpet, must resist a minimum critical radiant flux of 0.1 W/cm^2 per 12.5.8.2 per the testing requirements described in 12.5.8.3.

20.6.3.4 Existing Interior Floor Finish. (Reserved) [***101:*** 21.3.3.3]

20.7 Detention and Correctional Occupancies

Detention and correctional occupancies apply the total concept approach to life safety — complete with a defend-in-place strategy — much as is done for health care occupancies. Unlike people in health care occupancies, whose incapability of self-preservation is due to medical conditions, those in detention and correctional occupancies are incapable of self-preservation because of security restrictions. Security restrictions prevent, to a large extent, free and customary movement and access to other areas of a building. In general, many of the normal features needed in a detention facility are nearly the exact opposite of what the *Code* attempts to provide for other occupancies. The use of locked doors, often with key-operated locks (see 22/23.2.11.1.2 and 22/23.2.11.1.3 of NFPA *101*); egress components for which use is restricted or traffic flow is constricted, such as a sally port (see 22.2.5.4 and 23.2.5.4 of NFPA *101*); and discharge of exits onto other than public ways (see 22.2.7.1 and 23.2.7.1 of NFPA *101*) are features not usually permitted in other occupancies.

Chapters 22 and 23 of NFPA *101* impose limitations on the degree of locking that can be used. These limits form a classification scheme based on the appropriate use condition. In general, the amount of restriction (e.g., Use Condition I is free egress and Use Condition V is contained; see 22.1.2.1 and 23.1.2.1 of NFPA *101*) in the detention and correctional facility dictates the use of acceptable locking methods and means of egress features not permitted in other occupancies. As in a health care facility, those unique features necessary to protect the occupants in place include construction, compartmentation, alarm and detection, and staff facilitation to help lead or direct occupants to safe areas within the premises of the detention facility campus.

Subsection 20.7.2 provides routine operating requirements, such as 24-hour staffing; means for resident notification of staff in an emergency; preparation and maintenance of evacuation plans; staff training in the use of portable fire extinguishers; storage of combustible personal property; presence of heat-producing appliances; control of flammability of draperies, curtains, mattresses, and upholstered furniture; and visual and tactile identification of keys necessary for unlocking doors within the means of egress. Because locking doors — which is necessary for the intended function of the facility — is contrary to the basic *Code* tenet that the means of egress system is under the control of building occupants, the presence of properly trained staff is paramount to providing a level of life safety equivalent to that provided in other occupancies. Subsection 20.7.2 requires the necessary staffing and training that — where combined with the requirements of NFPA *101* — achieve the necessary level of life safety. Exhibit 20.16 shows the front entrance of Lubbock County Detention Center, Lubbock, Texas.

20.7.1 Application. New and existing detention and correctional occupancies shall comply with Section 20.7 and NFPA *101*.

Exhibit 20.16

Detention facility front entrance.

20.7.2 Operating Features.

20.7.2.1 Attendants, Evacuation Plan, Fire Drills.

20.7.2.1.1 Detention and correctional facilities, or those portions of facilities having such occupancy, shall be provided with 24-hour staffing, and the following requirements also shall apply:

(1) Staff shall be within three floors or a 300 ft (91 m) horizontal distance of the access door of each resident housing area.
(2) For Use Condition III, Use Condition IV, and Use Condition V, the arrangement shall be such that the staff involved starts the release of locks necessary for emergency evacuation or rescue and initiates other necessary emergency actions within 2 minutes of alarm.
(3) The following shall apply to areas in which all locks are unlocked remotely in compliance with 22.2.11.8 or 23.2.11.8 of NFPA *101*.
    (a) Staff shall not be required to be within three floors or 300 ft (91 m) of the access door.
    (b) The 10-lock, manual key exemption of 22.2.11.8.2 or 23.2.11.8.2 of NFPA *101* shall not be permitted to be used in conjunction with the alternative requirement of 20.7.2.1.1(3)(a).

[***101:***22.7.1.1; ***101:***23.7.1.1]

Paragraph 20.7.2.1.1 requires 24-hour staffing, which is typically accomplished from control rooms where the staff has visibility of large spaces or multiple areas, including those on more than one level. Such control rooms are often walled-in glass or other glazing material. Exhibit 20.17 shows a glass-enclosed control room.

20.7.2.1.2* Provisions shall be made so that residents in Use Condition III, Use Condition IV, and Use Condition V shall be able to notify staff of an emergency. [***101:***22.7.1.2; ***101:***23.7.1.2]

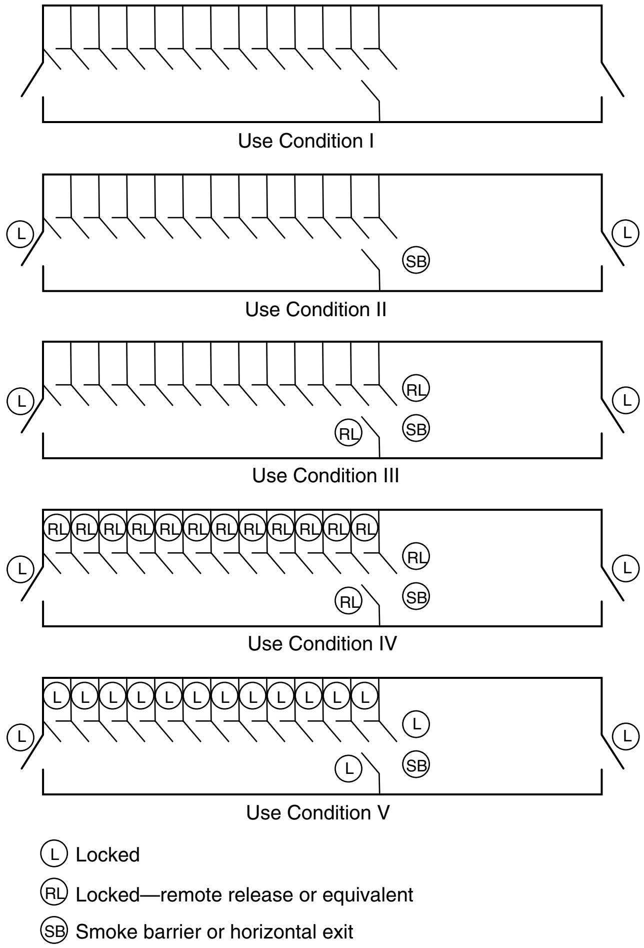
A.20.7.2.1.2 This requirement is permitted to be met by electronic or oral monitoring systems, visual monitoring, call signals, or other means. [***101:***A.22.7.1.2; ***101:***A.23.7.1.2]

20.7.2.1.3* The administration of every detention or correctional facility shall have, in effect and available to all supervisory personnel, written copies of a plan for the protection of all persons

Exhibit 20.17

Glass-enclosed control rooms.

Exhibit 20.18



Detention and correctional use conditions.

in the event of fire, for their evacuation to areas of refuge, and for evacuation from the building when necessary. [***101:***22.7.1.3; ***101:***23.7.1.3]

A.20.7.2.1.3 Periodic, coordinated training should be conducted and should involve detention and correctional facility personnel and personnel of the fire department legally committed to serving the facility. [***101:***A.22.7.1.3; ***101:***A.23.7.1.3]

Paragraph 20.7.2.1.2 requires that residents in Use Condition III, Use Condition IV, and Use Condition V facilities be able to notify staff of an emergency. Use Condition IV and Use Condition V facilities rely on staff action to release locks to allow residents to leave their rooms; Use Condition III, Use Condition IV, and Use Condition V facilities rely on staff action to release locks to allow residents to move to an adjacent smoke compartment. The staff needs to be made aware of fire conditions early in a fire. Thus, in case residents discover a fire before automatic detection devices are initiated, they need a means of notifying staff. Exhibit 20.18 illustrates the five use conditions.

A properly designed and well-tested fire emergency plan, as required by 20.7.2.1.3, is important in detention and correctional occupancies where residents depend heavily on staff performance for safety under fire conditions.

20.7.2.1.3.1 All employees shall be instructed and drilled with respect to their duties under the plan. [***101:***22.7.1.3.1; ***101:***23.7.1.3.1]

20.7.2.1.3.2 The plan shall be coordinated with, and reviewed by, the fire department legally committed to serve the facility. [***101:***22.7.1.3.2; ***101:***23.7.1.3.2]

20.7.2.1.4 Employees of detention and correctional occupancies shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment. [***101:***22.7.1.4; ***101:***23.7.1.4]

20.7.2.1.4.1 The training specified in 20.7.2.1.4 shall be provided to new staff promptly upon commencement of duty. [***101:***22.7.1.4.1; ***101:***23.7.1.4.1]

20.7.2.1.4.2 Refresher training shall be provided to existing staff at not less than annual intervals. [***101:***22.7.1.4.2; ***101:***23.7.1.4.2]

20.7.2.2* Combustible Personal Property. Books, clothing, and other combustible personal property allowed in sleeping rooms shall be stored in closable metal lockers or an approved fire-resistant container. [***101:***22.7.2; ***101:***23.7.2]

A.20.7.2.2 Personal property provides combustible contents for fire development. Therefore, adequate controls are needed to limit the quantity and combustibility of the fuels available to burn to reduce the probability of room flashover. The provisions of 20.7.2.4 will not, by themselves, prevent room flashover if personal property controls are not provided. [***101:***A.22.7.2; ***101:***A.23.7.2]

20.7.2.3 Heat-Producing Appliances. The number of heat-producing appliances, such as toasters and hot plates, and the overall use of electrical power within a sleeping room shall be controlled by facility administration. [***101:***22.7.3; ***101:***23.7.3]

20.7.2.4* Furnishings, Bedding, and Decorations.

A.20.7.2.4 The type, quantity, and arrangement of furniture and other combustibles are important factors in determining how fast the fire will develop. Furnishings, including upholstered items and wood items, such as wardrobes, desks, and bookshelves, might provide sufficient fuel to result in room flashover, which is the full fire involvement of all combustibles within a room once sufficient heat has been built up within the room. [***101:***A.22.7.4; ***101:***A.23.7.4]

20.7.2.4.1 Draperies and curtains, including privacy curtains, in detention and correctional occupancies shall be in accordance with the provisions of 12.6.2. [***101:***22.7.4.1; ***101:***23.7.4.1]

20.7.2.4.2 Newly introduced upholstered furniture within detention and correctional occupancies shall be tested in accordance with the provisions in 12.6.3.1(2) and 12.6.3.2.1. [***101:***23.7.4.2]

20.7.2.4.3* Newly introduced mattresses within detention and correctional occupancies shall be tested in accordance with the provisions in 12.6.3.2 and 12.6.3.2.2. [***101:***23.7.4.3]

A.20.7.2.4.3 Mattresses used in detention and correctional facilities should be evaluated with regard to the fire hazards of the environment. The potential for vandalism and excessive wear and tear also should be taken into account when evaluating the fire performance of the mattress. ASTM F1870, *Standard Guide for Selection of Fire Test Methods for the Assessment of Upholstered Furnishings in Detention and Correctional Facilities* provides guidance for this purpose. [***101:***A.23.7.4.3]

20.7.2.4.4 Combustible decorations shall be prohibited in any detention or correctional occupancy unless they are flame-retardant and approved. [***101:***22.7.4.4; ***101:***23.7.4.4]

20.7.2.4.5 Wastebaskets and other waste containers shall be of noncombustible or other approved materials. Waste containers with a capacity exceeding 20 gal (76 L) shall be provided with a noncombustible lid or lid of other approved material. [***101:***22.7.4.5; ***101:***23.7.4.5]

The provisions of 20.7.2.4 make use of the menu of provisions in Section 12.6 that apply to furnishings and contents, particularly those that address upholstered furniture and mattresses. Nevertheless, the control of combustible personal property is needed to limit fire development in sprinklered facilities and prevent the occurrence of room flashover in nonsprinklered facilities. Paragraph 20.7.2.2 provides staff with the authority to regulate the quantities of personal property in sleeping rooms.

The provisions of 20.7.2.4.1 through 20.7.2.4.5 are the most rigorous regulations of contents and furnishings provided by this *Code*. It is appropriate that these provisions be applied to detention and correctional occupancies in consideration of the protect-in-place strategy required of these occupancies by the *Code* and the reluctance of staff to unlock doors to allow residents to move to the outside.

Draperies and curtains must be flame resistant in accordance with 12.6.1, which requires flame propagation performance criteria in accordance with NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.

Paragraphs 20.7.2.4.2 and 20.7.2.4.3 require newly introduced upholstered furniture and mattresses to be resistant to cigarette ignition, regardless of whether the facility is sprinklered. Paragraphs 20.7.2.4.2 and 20.7.2.4.3 also have the effect of limiting the rate of heat release for newly introduced upholstered furniture and mattresses in existing, nonsprinklered detention and correctional facilities.

20.7.2.5 Keys. All keys necessary for unlocking doors installed in a means of egress shall be individually identified by both touch and sight. [***101:***22.7.5; ***101:***23.7.5]

20.7.2.6 Portable Space-Heating Devices. Portable space-heating devices shall be prohibited in all detention and correctional occupancies. [***101:***22.7.6; ***101:***23.7.6]

20.7.2.7 Door Inspection. Doors and door hardware in means of egress shall be inspected annually by an appropriately trained person. The inspection shall be documented. [***101:***22.7.7; ***101:***23.7.7]

The provision of 20.7.2.7 recognizes that detention and correctional occupancies make extensive use of doors — especially locked doors — for security reasons and that such doors need inspection. The regular inspection of doors and door hardware in these occupancies is particularly important.

N **20.7.2.8 Integrated Fire Protection Systems.** Integrated fire protection systems shall be tested in accordance with 13.1.3. [***101:***22.7.8; ***101:***23.7.7]

The provisions of 20.7.2.8 are new to the 2018 edition of the *Code*. Where fire protection and life safety systems are needed to function together to provide the intended level of protection, they must meet the testing requirements of 13.1.3, which in turn references NFPA 4. The integrated systems test addressed by NFPA 4 verifies and documents the operation and function of all interconnected fire protection and life safety systems, including performance in accordance with applicable codes and standards, sequence of operation, performance in accordance with manufacturers' published instructions, and accuracy of record documents. See the commentary following A.13.1.3 for additional information on integrated fire protection and life safety system testing.

20.7.3 Interior Finish.

20.7.3.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***22.3.3.1; ***101:***23.3.3.1]

20.7.3.2 New Interior Wall and Ceiling Finish. New interior wall and ceiling finish materials complying with Section 12.5 shall be Class A or Class B in corridors, in exits, and in any space not separated from corridors and exits by partitions capable of retarding the passage of smoke; and Class A, Class B, or Class C in all other areas. The provisions of 12.5.9.1 shall not apply to new detention and correctional occupancies. [***101:***22.3.3.2]

20.7.3.3 Existing Interior Wall and Ceiling Finish. Existing interior wall and ceiling finish materials complying with Section 12.5 shall be Class A or Class B in corridors, in exits, and in any space not separated from corridors and exits by partitions capable of retarding the passage of smoke; and Class A, Class B, or Class C in all other areas. [***101:***23.3.3.2]

20.7.3.4 New Interior Floor Finish.

20.7.3.4.1 New interior floor finish shall comply with Section 12.5. [***101:***22.3.3.3.1]

20.7.3.4.2 Interior floor finish in exit enclosures and exit access corridors shall be not less than Class II. The provisions of 12.5.9.2 shall not apply to new detention and correctional occupancies. [***101:***22.3.3.3.2]

20.7.3.4.3 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***22.3.3.3.3]

Compliance with the interior wall and ceiling finish provisions within resident rooms is typically easily accomplished given the construction materials and finishes used for security reasons. Painted masonry often meets the requirements for Class A interior wall and ceiling finish. *Code*-compliant interior wall and ceiling finish in resident rooms might be compromised by combustible decorations applied to the walls and ceiling, and that issue is addressed by 20.7.2.4.4. Exhibit 20.19 shows a resident room after construction and before resident occupancy. The interior wall and ceiling finishes appear not to pose a flame spread problem.

Exhibit 20.19

Resident room with interior wall and ceiling finishes that do not pose a fire spread problem.

Paragraph 20.7.3.3 imposes stricter interior wall and ceiling finish requirements in exits, corridors, and spaces not separated from the corridor than it does in other use areas. To apply the less stringent requirements within the use areas, the required separation need be only a partition capable of retarding the passage of smoke. The partition must be of substantial construction but is not required to have a fire resistance rating.

Paragraph 20.7.3.5.2 recognizes existing interior floor finish materials that have been tested in accordance with the test procedures specified in 12.5.4.3 for wall and ceiling finish materials (i.e., ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*) as an exemption to the requirement of 12.5.8 that testing of floor finish materials be performed per NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, or ASTM E648, *Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*. ASTM E84 and ANSI/UL 723 contain the flame spread and smoke development measurement method currently used to evaluate interior wall and ceiling finish materials in accordance with the requirements of Section 12.5. Prior to the 1981 edition of the *Code*, floor finish was tested in accordance with ASTM E84. Paragraph 20.7.3.5.2 permits material that was tested and approved by this method to remain in use.

20.7.3.5 Existing Interior Floor Finish.

20.7.3.5.1 Existing interior floor finish complying with Section 12.5 shall be Class I or Class II in corridors and exits. [***101:***23.3.3.3.1]

20.7.3.5.2 Existing floor finish material of Class A or Class B in nonsprinklered smoke compartments and Class A, Class B, or Class C in sprinklered smoke compartments shall be permitted to be continued to be used, provided that it has been evaluated based on tests performed in accordance with 12.5.4. [***101:***23.3.3.3.2]

20.7.3.6 Interior Finish (Nonsprinklered Existing Building Renovations).

20.7.3.6.1 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 12.5 shall be Class A in corridors, in exits, and in any space not separated from corridors and exits by partitions capable of retarding the passage of smoke; and Class A, Class B, or Class C in all other areas. [***101:***22.4.4.8.1]

20.7.3.6.2 Interior Floor Finish.

20.7.3.6.2.1 Interior floor finish shall comply with Section 12.5. [***101:***22.4.4.8.2.1]

20.7.3.6.2.2 New interior floor finish in exit enclosures and exit access corridors shall be not less than Class I. [***101:***22.4.4.8.2.2]

20.7.3.6.2.3 Interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***22.4.4.8.2.3]

20.8 Hotels and Dormitories

Section 20.8 addresses residential occupancies that are primarily transient in nature. Hotel and motel accommodations that are mainly used for stays of relatively short duration fit into this category. Dormitory occupancies, although typically used for up to nine months of near-continuous occupancy in the case of a college or university dormitory, are also regulated by this section.

The hotel and dormitory classification is one of five residential occupancy types addressed by the *Code*. Other residential occupancies include one- and two-family dwellings (Section 20.11 and Chapter 24 of NFPA *101*); lodging or rooming houses (Section 20.10 and Chapter 26 of NFPA *101*); apartment buildings (Section 20.9 and Chapters 30 and 31 of NFPA *101*); and residential board and care occupancies (Section 20.5 and Chapters 32 and 33 of NFPA *101*).

The common principle of life safety that is applied to all residential occupancies addressed by Chapters 24 through 33 of NFPA *101* is highlighted by 6.1.8.1, which states that residential occupancies are those occupancies in which sleeping accommodations are provided for purposes other than health care or detention and correction. The presence of sleeping occupants is central to the provisions of Chapters 24 through 33 of NFPA *101*, because occupants who are asleep will be unaware of a developing fire and, when awakened to be alerted to the emergency, might be somewhat confused. The definition of the term *residential occupancy* in 6.1.8.1 also differentiates between sleeping occupants in residential occupancies and those in health care or detention and correctional occupancies, which are also characterized by the occupants' incapability of self-preservation. The provisions of Chapters 24 through 33 of NFPA *101* are also based on the presence of hazards (such as cooking and heating equipment) in residential occupancies and the degree to which occupants are familiar with their living space. Occupants might have little or no familiarity with the building, as in the case of the transient residents of hotels, or they might have the total familiarity that is common to residents of single-family dwellings.

Unfamiliar surroundings and the possibility of being asleep when a fire occurs are factors that jeopardize the safety of hotel guests in particular. Hotels pose an additional problem, because typical hotel building configurations often require escaping guests to traverse an interior corridor, which subsequently might expose them to the heat and smoke of corridor and room fires. In recognition of these potential hazards, the *Code* requires most new hotels and dormitories to be protected throughout by approved, supervised automatic sprinkler systems.

In recent years, hotels and motels have experienced a steady reduction in the number of fires, civilian casualties, and civilian injuries. Part of the explanation for these reductions is the increasing percentage of hotels that are provided with smoke detection and automatic sprinkler systems. From 2009 to 2013, hotels and motels averaged 3520 structure fires per year, as reported to fire departments across the United States. These fires resulted in a yearly average of 9 civilian deaths and 120 civilian injuries. These numbers are approximately equivalent to, or slightly down from, the previous 4-year averages for which statistics were available (2007 to 2013) of 3600 structure fires, 11 civilian deaths, and 139 civilian injuries per year.

Exhibit 20.20

The former MGM Grand Hotel and Casino, site of the November 1980 fire in which 85 occupants perished.

Exhibit 20.20 depicts Bally's Resort and Casino, formerly the MGM Grand Hotel and Casino in Las Vegas, Nevada, as it appears today. On the morning of November 21, 1980, a fire at the MGM Grand resulted in the deaths of 85 occupants. Because of this fire, and several others in the 1980s, nearly all new hotels and many existing hotels are protected with automatic sprinkler systems.

20.8.1 Application. New and existing hotels and dormitories shall comply with Section 20.8 and NFPA *101*.

Section 20.8 applies to various operations that do not specifically use the term *hotel* but are considered such by definition. The terms *dormitory* and *hotel* are defined in 3.3.192.9 and 3.3.192.14, respectively. In some cases, Section 20.8 applies even if the identification of the occupancy suggests the application of a different section. For example, a rooming house that accommodates more than 16 people is classified as a hotel.

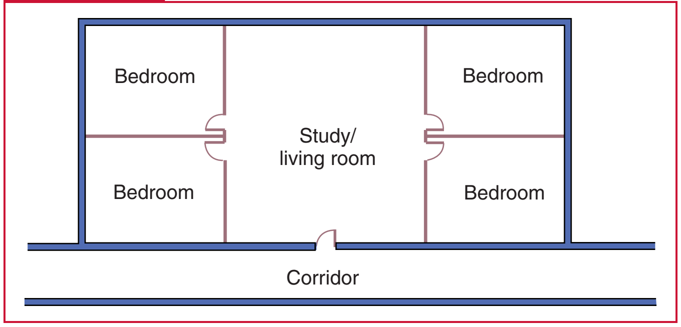
Conversely, some operations that one might expect to be covered by Chapters 28 and 29 of NFPA *101* are not. For example, 28.1.1.4 and 29.1.1.4 of NFPA *101* recognize that the common dormitory design in which a group of bedrooms opens into a study or living room duplicates a typical apartment design in which several bedrooms open into a living room or kitchen. Because the design and the risk of fire are similar, the *Code* treats this arrangement as an apartment building, despite the lack of individual kitchens. Exhibit 20.21 illustrates the arrangement of a dormitory suite that would be treated as an apartment.

20.8.2 Operating Features.

20.8.2.1 Hotel Emergency Organization.

20.8.2.1.1* Employees of hotels shall be instructed and drilled in the duties they are to perform in the event of fire, panic, or other emergency. [***101:***28.7.1.1; ***101:***29.7.1.1]

Exhibit 20.21



Dormitory suite apartment.

A.20.8.2.1.1 Employers are obligated to determine the degree to which employees are to participate in emergency activities. Regulations of the U.S. Department of Labor (OSHA) govern these activities and provide options for employers, from total evacuation to aggressive structural fire fighting by employee brigades. *(For additional information, see 29 CFR 1910, E and L, "OSHA Regulations for Emergency Procedures and Fire Brigades.")* [***101:***A.28.7.1.1; ***101:***A.29.7.1.1]

The AHJ should put a plan in place to ensure that the staff of the hotel or dormitory occupancy has been trained in their duties. Staff training for those supervising students in dormitories should be conducted annually at the beginning of each school year, and refresher training should be provided in the second semester.

20.8.2.1.2* Drills of the emergency organization shall be held at quarterly intervals and shall cover such points as the operation and maintenance of the available first aid fire appliances, the testing of devices to alert guests, and a study of instructions for emergency duties. [***101:***28.7.1.2; ***101:***29.7.1.2]

A.20.8.2.1.2 Emergencies should be assumed to have arisen at various locations in the occupancy in order to train employees in logical procedures. [***101:***A.28.7.1.2; ***101:***A.29.7.1.2]

One of the leading problems within college dormitories is tampering with smoke alarms and using portable fire extinguishers for non–fire suppression activities. The local AHJ needs to have a plan in place to verify that the devices are in working order. It is also vitally important to teach students the reasons for not tampering with fire safety equipment and the ramifications that tampering can have if an emergency should occur. A sound philosophy is one that includes prevention (teaching students how to avoid the occurrence of fire); detection (early detection and sounding the alarm); and suppression (preferably through the activation of the building's automatic fire sprinkler system).

Δ **20.8.2.2 Emergency Duties.** Upon discovery of a fire, employees shall carry out all of the following duties:

(1) Activation of the facility fire protection signaling system, if provided
(2) Notification of the public fire department
(3) Other action as previously instructed

[***101:***28.7.2; ***101:***29.7.2]

20.8.2.3 Drills in Dormitories. Emergency egress and relocation drills in accordance with Section 10.5 shall be held with sufficient frequency to familiarize occupants with all types of hazards and to establish conduct of the drill as a matter of routine. Drills shall be conducted during peak occupancy periods and shall include suitable procedures to ensure that all persons subject to the drill participate. [***101:***28.7.3; ***101:***29.7.3]

The requirements for fire drills in hotels and dormitories differ. In hotels, employees must be trained in and practice the duties they are expected to perform in the event of a fire. The *Code* specifically does not require hotel guests to take part in fire drills so as to not contribute to complacency with regard to fire alarms. In dormitories, the provisions of 20.8.2.3 require all occupants to participate in drills, because occupants of dormitories tend to be less transient than those of hotels. Dormitory occupants typically live in the building for several weeks or months at a time (or longer), making them semipermanent residents. As such, they require a high degree of familiarization with the actions they should take in the event of a fire or similar emergency.

20.8.2.4 Emergency Instructions for Residents or Guests.

20.8.2.4.1* A floor diagram reflecting the actual floor arrangement, exit locations, and room identification shall be posted in a location and manner acceptable to the AHJ on, or immediately adjacent to, every guest room door in hotels and in every resident room in dormitories. [***101:***28.7.4.1; ***101:***29.7.4.1]

A.20.8.2.4.1 Floor diagrams should reflect the actual floor arrangement and should be oriented with the actual direction to the exits. [***101:***A.28.7.4.1; ***101:***A.29.7.4.1]

The manner in which the information specified in 20.8.2.4.1 is to be posted and the nature of its contents are at the discretion of the AHJ and depend on the building, its layout, and the protection provided.

20.8.2.4.2* Fire safety information shall be provided to allow guests to make the decision to evacuate to the outside, to evacuate to an area of refuge, to remain in place, or to employ any combination of the three options. [***101:***28.7.4.2; ***101:***29.7.4.2]

A.20.8.2.4.2 Factors for developing the fire safety information include such items as construction type, suppression systems, alarm and detection systems, building layout, and building HVAC systems. [***101:***A.28.7.4.2; ***101:***A.29.7.4.2]

20.8.2.4.3 Emergency Action Plans. Emergency action plans in accordance with Section 10.8 shall be provided. [***101:***28.7.5]

20.8.2.5 Contents and Furnishings.

Δ **20.8.2.5.1** New draperies, curtains, and other similar loosely hanging furnishings and decorations shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701. [***101:***28.7.6.1; ***101:***29.7.6.1]

20.8.2.5.2 Upholstered Furniture and Mattresses.

20.8.2.5.2.1 Newly introduced upholstered furniture shall meet the criteria specified in 12.6.3.1 and 12.6.3.2.2. [***101:***28.7.6.2.1; ***101:***29.7.6.2.1]

20.8.2.5.2.2 Newly introduced mattresses shall meet the criteria specified in 12.6.3.2 and 12.6.3.2.2. [***101:***28.7.6.2.2]

20.8.2.5.3 Furnishings or decorations of an explosive or highly flammable character shall not be used. [***101:***28.7.6.3; ***101:***29.7.6.3]

20.8.2.5.4 Fire-retardant coatings shall be maintained to retain the effectiveness of the treatment under service conditions encountered in actual use. [***101:***28.7.6.4; ***101:***29.7.6.4]

20.8.2.6 Fuel-Fired Heaters. Unvented fuel-fired heaters, other than gas space heaters in compliance with NFPA 54 shall not be used. [***101:***28.5.2.2; ***101:***29.5.2.2]

Unvented fuel-fired heaters can produce dangerous levels of CO. The danger from CO cannot be stressed enough. Depending on the concentrations of CO within a space, a person can quickly be disabled and suffer fatal injuries.

N **20.8.2.7 Integrated Fire Protection Systems.** In new hotels and dormitories, integrated fire protection systems shall be tested in accordance with 13.1.3. [***101:***28.7.8]

The provision of 20.8.2.7 is new to the 2018 edition of the *Code*. Where fire protection and life safety systems are needed to function together to provide the intended level of protection, they must meet the testing requirements of 13.1.3, which in turn references NFPA 4. The integrated systems test addressed by NFPA 4 verifies and documents the operation and function of all interconnected fire protection and life safety systems, including performance in accordance with applicable codes and standards, sequence of operation, performance in accordance with manufacturers' published instructions, and accuracy of record documents. See the commentary following A.13.1.3 for additional information on integrated fire protection and life safety system testing.

20.8.3 Interior Finish.

20.8.3.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***28.3.3.1; ***101:***29.3.3.1]

20.8.3.2 New Interior Wall and Ceiling Finish. New interior wall and ceiling finish materials complying with Section 12.5 shall be permitted as follows:

(1) Exit enclosures — Class A
(2) Lobbies and corridors — Class A or Class B
(3) Other spaces — Class A, Class B, or Class C
[***101:***28.3.3.2]

20.8.3.3 Existing Interior Wall and Ceiling Finish. Existing interior wall and ceiling finish materials complying with Section 12.5 shall be permitted as follows:

(1) Exit enclosures — Class A or Class B
(2) Lobbies and corridors — Class A or Class B
(3) Other spaces — Class A, Class B, or Class C
[***101:***29.3.3.2]

20.8.3.4 New Interior Floor Finish.

20.8.3.4.1 New interior floor finish shall comply with Section 12.5. [***101:***28.3.3.3.1]

20.8.3.4.2 New interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 28.3.6.1 of NFPA *101* shall be not less than Class II. [***101:***28.3.3.3.2]

20.8.3.4.3 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***28.3.3.3.3]

20.8.3.5 Interior Floor Finish (Existing Nonsprinklered Buildings). In nonsprinklered buildings, newly installed interior floor finish in exits and exit access corridors shall be not less than Class II in accordance with 12.5.9. [***101:***29.3.3.3]

20.9 Apartment Buildings

The apartment building classification is one of five residential occupancy types addressed by NFPA *101*. Other residential occupancies include one- and two-family dwellings, lodging or rooming houses, hotels and dormitories, and residential board and care occupancies.

The common principle of life safety that is applied to all residential occupancies addressed by Chapters 24 through 33 of NFPA *101* is highlighted by 6.1.8.1, which states that residential occupancies are those occupancies in which sleeping accommodations are provided for purposes other than health care or detention and correction. The presence of sleeping occupants is central to the provisions of Chapters 24 through 33 of NFPA *101*, because occupants who are asleep will be unaware of a developing fire and, when awakened to be alerted to the emergency, might be somewhat confused. The definition of the term *residential occupancy* in 6.1.8.1 also differentiates between sleeping occupants in residential occupancies and those in health care or detention and correctional occupancies, which are also characterized by the occupants' incapability of self-preservation. The provisions of Chapters 24 through 33 of NFPA *101* are also based on the presence of hazards (such as cooking and heating equipment) in residential occupancies and the degree to which occupants are familiar with their living space. Occupants might have little or no familiarity, as in the case of the transient residents of hotels, or they might have the total familiarity that is common to residents of single-family dwellings.

Apartment buildings pose a problem from a life safety perspective, because the typical building configuration often requires an escaping resident to traverse an interior corridor, which subsequently might expose the resident to the heat and smoke of a corridor or dwelling unit fire. In recognition of these potential hazards, the *Code* requires most new apartment buildings to be protected throughout by an approved, supervised automatic sprinkler system.

From 2011 to 2015, apartment buildings accounted for an average of 95,900 structure fires per year, as reported to U.S. fire departments (up from 93,700 for the previous 5-year period of 2008 to 2012). This number represents approximately 26 percent of the 367,500 total home fires per year on average for the period (down from 30 percent for the period 2008 to 2012). Apartment building fires resulted in an average of 385 civilian deaths per year (15 percent of all home fire deaths), which is about consistent with the period 2008 to 2012, and 3840 civilian injuries per year (31 percent of all home fire injuries), which is about consistent with the period 2008 to 2012.

The causes of apartment building fires differ significantly from those of one- and two-family dwelling fires in building equipment areas. Data from 2010 through 2014 indicate heating and electrical equipment accounted for 31 percent of the fires in one- and two-family dwellings, while accounting for only 10 percent of the fires in apartment buildings. This difference is most likely due to the centralized arrangement of the heating and electrical systems typical of most apartment buildings. Equipment fires are usually the result of poor maintenance or human error. Heating and electrical systems tend to be more closely regulated, maintained, and supervised in apartment buildings, which results in a reduced chance of equipment malfunction.

The number of fires caused by occupants (e.g., those due to cooking and smoking) is high in both categories of home structures.

These data demonstrate the importance of applying the *Code* to apartment buildings to help ensure fire safety, but they also demonstrate the continuing need for public education regarding the causes and prevention of home fires.

20.9.1 Application. New and existing apartment buildings shall comply with Section 20.9 and NFPA *101*.

Due to the disproportionate percentage of deaths associated with residential occupancies, this *Code* and NFPA *101* mandate sprinkler protection in new apartment buildings with no exceptions. For existing apartment buildings, NFPA *101* provides four alternative protection packages referred to as options.

The options specify the varying degrees to which an apartment building is protected by fire detection or fire suppression systems as follows:

1. Option 1 — no suppression or detection systems
2. Option 2 — total automatic fire detection and notification (although 31.3.4.5.1 of NFPA *101* requires single-station smoke alarms within each apartment unit, such smoke alarms are not part of a system and are not located in all areas of the building; therefore, their presence does not signify an Option 2 apartment building)
3. Option 3 — partial sprinkler protection (mainly corridor sprinklers — see 31.3.5.9 of NFPA *101*)
4. Option 4 — protection throughout by means of an automatic sprinkler system (see 31.3.5.10 of NFPA *101*)

In recognition of the life safety benefits associated with a properly installed and maintained sprinkler system, an Option 4 apartment building is exempted from selected NFPA *101* provisions required of Option 1 through Option 3 apartment buildings. The benefits of such exemptions include the following:

1. Increased travel distance allowances
2. Reduction in required corridor fire resistance ratings
3. Less restrictive interior finish requirements
4. Exemption from the smoke compartmentation requirement

The protection requirements of NFPA *101* for new apartment buildings are equivalent to Option 4.

Commentary Table 20.2 summarizes the different protection packages required, depending on whether an existing apartment building is provided with the protection features required for Option 1, Option 2, Option 3, or Option 4.

This comprehensive approach is an attempt to codify system design. Although a total system would consist of many alternatives, the systems detailed in Options 1 through 4 are more limited, because only four options are available. However, the user can identify the most appropriate option, based on the existing building's size, height, and arrangement. The options provide an opportunity to coordinate the safety approach that best fits a building, rather than adapting a building to a single codified set of criteria.

20.9.2 Operating Features.

20.9.2.1 Emergency Instructions for Residents of Apartment Buildings. Emergency instructions shall be provided annually to each dwelling unit to indicate the location of alarms, egress paths, and actions to be taken, both in response to a fire in the dwelling unit and in response to the sounding of the alarm system. [***101:***30.7.1; ***101:***31.7.1]

The manner in which the information required by 20.9.2.1 is provided to the residents and the nature of its contents are at the discretion of the AHJ and depend on the building, its layout, and the protection provided. For example, the instructions could be provided to residents when they sign their lease and move into their apartment and every year thereafter when the lease is renewed. The building's management should review the instructions periodically so they can be updated with any needed revisions resulting from changes to the building's configuration or protection systems.

20.9.2.2 Fuel-Fired Heaters. Unvented fuel-fired heaters, other than gas space heaters in compliance with NFPA 54, shall not be used. [***101:***30.5.2.2; ***101:***31.5.2.2]

Unvented fuel-fired heaters can produce dangerous levels of CO. The danger from CO cannot be stressed enough. Depending on the concentrations of CO within a space, a person can quickly become disabled and suffer fatal injuries.

N **20.9.2.3 Inspection of Door Openings.** Door openings shall be inspected in accordance with 7.2.1.15 of NFPA *101*. [***101:***30.7.3; ***101:***31.7.3]

The provision of 20.9.2.3 requires the annual inspection of certain means of egress door openings in accordance with 7.2.1.15 of NFPA *101* to ensure they operate correctly in the event of an

COMMENTARY TABLE 20.2 *Alternative Requirements for Existing Apartment Buildings According to Protection Provided*

Feature	*No Suppression or Detection System Option 1*	*Complete Automatic Fire Detection Option 2*	*Automatic Sprinkler Protection in Selected Areas Option 3*	*Automatic Sprinkler Protection Throughout per NFPA 13 (with exceptions) Option 4*
Exit Access				
Travel distance from apartment door to exit	100 ft (30 m)	150 ft (45 m)	150 ft (45 m)	200 ft (61 m)
Travel distance within apartment	75 ft (23 m)	125 ft (38 m)	75 ft (23 m)	125 ft (38 m)
Smoke barrier required *(See 31.3.7 of NFPA 101.)*	R	R	R	NR
Maximum single path corridor distance	35 ft (10.7 m)	35 ft (10.7 m)	35 ft (10.7 m)	35 ft (10.7 m)
Maximum dead end	50 ft (15 m)	50 ft (15 m)	50 ft (15 m)	50 ft (15 m)
Corridor fire resistance				
Walls	½ hr	½ hr	½ hr	½ hr
Doors (fire protection rating)	20 min. or 1¾ in. (44 mm) thick	20 min. or 1¾ in. (44 mm) thick	Smoke resisting	Smoke resisting
Interior Finish				
Lobbies and corridors	A or B	A or B	A or B	A, B, or C
Other spaces	A, B, or C	A, B, or C	A, B, or C	A, B, or C
Floors in corridors	I or II	I or II	NR	NR
Exits				
Wall fire resistance				
1–3 stories*	1 hr	1 hr	1 hr	1 hr
>3 stories*	2 hr	2 hr	2 hr	1 hr
Smokeproof enclosures				
Not high-rise	NR	NR	NR	NR
High-rise	R	R	R	NR
Door fire resistance				
1–3 stories*	1 hr	1 hr	1 hr	1 hr
>3 stories*	1½ hr	1½ hr	1½ hr	1 hr
Interior finish				
Walls and ceilings	A or B	A or B	A or B	A, B, or C
Floors	I or II	I or II	I or II	NR
Within Living Unit (Apartment)				
Escape windows, per Section 24.2 of NFPA 101 (See 31.2.1 of NFPA 101.)	R	R	R	NR
Alarm System				
>3 stories or >11 units*	Manual initiation	Manual and auto initiation	Manual and auto initiation	Manual and auto initiation
>2 stories or >50 units*	Annunciator panel	Annunciator panel	Annunciator panel	Annunciator panel

R: Required *(see Code for details and exemptions)*. NR: No requirements.

*Number of stories in height.

emergency. Doors subject to the required annual inspection include doors equipped with panic hardware or fire exit hardware, doors serving exit enclosures, electrically controlled egress doors, and door assemblies with special locking arrangements in accordance with 14.5.3. The annual inspection must be documented to permit verification of compliance by the AHJ.

N **20.9.2.4 Integrated Fire Protection Systems.** In new high-rise apartment buildings, integrated fire protection systems shall be tested in accordance with 13.1.3. [***101:***30.7.4]

20.9.3 Interior Finish.

20.9.3.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***30.3.3.1; ***101:***31.3.3.1]

20.9.3.2 New Interior Wall and Ceiling Finish. New interior wall and ceiling finish materials complying with Section 12.5 shall be permitted as follows:

(1) Exit enclosures — Class A
(2) Lobbies and corridors — Class A or Class B
(3) Other spaces — Class A, Class B, or Class C
[***101:***30.3.3.2]

20.9.3.3 Existing Interior Wall and Ceiling Finish. Existing interior wall and ceiling finish materials complying with Section 12.5 shall be permitted as follows:

(1) Exit enclosures — Class A or Class B
(2) Lobbies and corridors — Class A or Class B
(3) Other spaces — Class A, Class B, or Class C
[***101:***31.3.3.2]

20.9.3.4 New Interior Floor Finish.

20.9.3.4.1 New interior floor finish shall comply with Section 12.5. [***101:***30.3.3.3.1]

20.9.3.4.2 New interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 30.3.6 of NFPA *101* shall be not less than Class II. [***101:***30.3.3.3.2]

20.9.3.4.3 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***30.3.3.3.3]

20.9.3.5 Existing Interior Floor Finish. In buildings utilizing Option 1 or Option 2, as defined in 31.1.1.1 of NFPA *101*, newly installed interior floor finish in exits and exit access corridors shall be not less than Class II in accordance with 12.5.9. [***101:***31.3.3.3]

20.9.4 Contents and Furnishings.

20.9.4.1 Contents and furnishings shall not be required to comply with Section 12.6. [***101:***30.7.2.1; ***101:***31.7.2.1]

20.9.4.2 Furnishings or decorations of an explosive or highly flammable character shall not be used outside of dwelling units. [***101:***30.7.2.2; ***101:***31.7.2.2]

20.9.4.3 Fire-retardant coatings shall be maintained to retain the effectiveness of the treatment under service conditions encountered in actual use. [***101:***30.7.2.3; ***101:***31.7.2.3]

20.10 Lodging or Rooming Houses

Section 20.10 addresses the requirements for both new and existing lodging or rooming houses. These facilities provide sleeping accommodations for 16 or fewer occupants on a transient basis. While some users of the *Code* might confuse lodging or rooming facilities with a hotel occupancy — or a board and care facility — the primary differences among the occupancies center on the total number of occupants served and the nature of any personal care that is provided. While some of these facilities might provide what appear to be longer-term, daily living accommodations, other facilities, such as a bed-and-breakfast facility, might provide accommodations on a short-term basis. If a bed-and-breakfast facility serves more than 16 occupants, it would be appropriate to use Section 20.8 for hotels and dormitories to evaluate the requisite life safety features.

Commentary Table 20.3 is a guide to the appropriate occupancy chapter for multi-tenant residential occupancies.

20.10.1 Application. New and existing lodging or rooming houses shall comply with Section 20.10 and NFPA *101*.

COMMENTARY TABLE 20.3 *Comparative Factors for Classification of Residential Occupancies*

Factor	*Section 20.10 and Chapter 26 of NFPA 101 Lodging or Rooming Houses*	*Section 20.8 and Chapters 28 and 29 of NFPA 101 Hotels and Dormitories*	*Section 20.9 and Chapters 30 and 31 of NFPA 101 Apartment Buildings*	*Section 20.5 and Chapters 32 and 33 of NFPA 101 Residential Board and Care*
Occupants of a transient nature?	Yes	Yes	No	No
Number of occupants in facility?	16 or fewer	More than 16	As few as 3; application based on presence of 3 or more independent dwelling units	4 or more
Personal care services provided?	No	No	No	Yes

20.10.2 Fuel-Fired Heaters. Unvented fuel-fired heaters, other than gas space heaters in compliance with NFPA 54, shall not be used. [***101:***26.5.2.2]

Unvented fuel-fired heaters can produce dangerous CO levels. The danger from CO cannot be stressed enough. Depending on the concentrations of CO within a space, a person can quickly become disabled and suffer fatal injuries.

20.10.3 Interior Finish.

20.10.3.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***26.3.3.1]

20.10.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 12.5 shall be Class A, Class B, or Class C. [***101:***26.3.3.2]

20.10.3.3 Interior Floor Finish.

20.10.3.3.1 Newly installed interior floor finish shall comply with Section 12.5. [***101:***26.3.3.3.1]

20.10.3.3.2 Newly installed interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***26.3.3.3.2]

20.10.4 Contents and furnishings shall not be required to comply with Section 12.6. [***101:***26.7.1.1]

20.10.4.1 Furnishings or decorations of an explosive or highly flammable character shall not be used. [***101:***26.7.1.2]

20.10.4.2 Fire-retardant coatings shall be maintained to retain the effectiveness of the treatment under service conditions encountered in actual use. [***101:***26.7.1.3]

20.11 One- and Two-Family Dwellings and Manufactured Housing

Although most people feel safest in their homes, fire deaths in the home account for some 80 percent of all fatalities attributable to fire in the United States. Section 20.11 and Chapter 24 of NFPA *101* highlight a number of factors that significantly mitigate the fire problem. A key and unique component that is addressed in Chapter 24 of NFPA *101* and that is selectively applied to the other residential chapters is means of escape (see Section 24.2 of NFPA *101*). The concept of means of escape focuses on providing a second way out of an occupied room or space within a living unit, regardless of whether it is a single-family home or a dwelling unit within an apartment building. Means of escape features do not need to meet the high standards and criteria that apply to the means of egress. In short, means of escape is an important yet broadly applied concept that is intended to reduce the chance of occupants becoming trapped in a room or space if the primary egress route is unavailable.

Recognizing that the greatest number of fire fatalities occur in what has historically been the least regulated occupancy, the *Code* has required, since the 2006 edition, all new one- and two-family dwellings to be protected by automatic sprinkler systems. Residential sprinkler systems have a phenomenal record of success in preventing fire deaths and injuries. Although residential sprinkler systems are designed exclusively to protect life and not necessarily property, many homes and personal possessions have, in fact, been saved from the devastating effects of fire thanks to their installation.

20.11.1 Application. New and existing one- and two-family dwellings shall comply with Section 20.11 and NFPA *101*.

Considerable debate has centered on the term *family*. The intent of 24.1.1.2 of NFPA *101* is not to define the term; however, A.24.1.1.2 of NFPA *101* provides assistance in determining where the term is inappropriate and another chapter of the *Code* should be used. If more than three outsiders are accommodated in rented rooms within a dwelling unit, the occupancy should be classified as a lodging or rooming house and should meet the requirements of Section 20.10 and Chapter 26 of NFPA *101*. The reasoning behind this classification guideline is that outsiders do not tend to keep each other as informed as family members do with regard to conditions within the building. In addition, when occupying their rooms, they keep their room doors closed more often than do family members. The lack of communication and reduced openness and awareness justify the additional alarm system, vertical opening, and corridor wall and door requirements that apply to lodging or rooming houses.

20.11.2 Fuel-Fired Heaters. Unvented fuel-fired heaters shall not be used, unless they are listed and approved. [***101:***24.5.1.2]

Unvented fuel-fired heaters can produce dangerous CO levels. The danger from CO cannot be stressed enough. Depending on the concentrations of CO within a space, a person can quickly become disabled and suffer fatal injuries.

20.11.3 Interior Finish.

20.11.3.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***24.3.3.1]

20.11.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 12.5 shall be Class A, Class B, or Class C. [***101:***24.3.3.2]

20.11.3.3 Interior Floor Finish. (Reserved) [***101:***24.3.3.3]

20.11.4 Fire Protection of Floors. In new construction, floor assemblies shall be provided with a continuous membrane of gypsum wallboard having a nominal thickness of not less than ½ in. (13 mm), or equivalent, to protect the floor framing members from a fire exposure from below.

20.11.4.1 Protection in accordance with 20.11.4 shall not be required where the building is protected by an approved automatic sprinkler system installed in accordance with 13.3.1.2.

20.11.4.2 Protection in accordance with 20.11.4 shall not be required for floor assemblies located directly over a crawl space not intended for storage or fuel-fired equipment.

20.11.4.3 Portions of floor assemblies shall be permitted to be unprotected where the aggregate area of the unprotected portions does not exceed 80 ft^2 (7.4 m^2) per story and where fire blocking is installed along the perimeter of the unprotected portion to separate the unprotected portion from the remainder of the floor assembly.

20.11.4.4* Protection in accordance with 20.11.4 shall not be required in floor assemblies using wood joists with nominal dimensions not less than 2 in. (51 mm) in thickness by 10 in. (254 mm) in width, or other approved floor assemblies providing equivalent performance.

A.20.11.4.4 Materials such as wood I-Joist, wood or steel trusses, or cold formed steel would not typically be considered equivalent.

20.11.4.5 Protection in accordance with 20.11.4 shall not be required in floor assemblies using wood joist structural composite lumber that are compliant with ASTM D5456 and that have dimensions not less than 1½ in. (38 mm) in thickness by 9¼ in. (235 mm) in width.

20.11.4.6 Penetrations by mechanical, plumbing, fire protection, and electrical systems through the membrane protection required by 20.11.4 shall not be required to be protected.

The intent of the requirements of 20.11.4 is to provide for a minimal degree of structural fire resistance for floors in new nonsprinklered one- and two-family dwellings to permit for fire department search and rescue operations. It is not uncommon for the room of fire origin to be fully involved by the time the fire department arrives on the scene; in many cases, the fire has extended beyond the room of origin. With no sprinkler system to keep the fire in check, the fire intensity can significantly affect the structural stability of floor construction and increase the risk to search and rescue crews.

While it is noted that the *Code* requires all new one- and two-family dwellings to be protected by automatic sprinkler systems (see 13.3.2.20.1), it is recognized that not all jurisdictions will include such requirement in their *Code* adoptions. For this reason, the *Code* includes the requirements of 20.11.4 for new, nonsprinklered one- and two-family dwellings.

Δ **20.11.5 Manufactured Housing.** New manufactured housing shall comply with Section 20.11 and NFPA 501.

NFPA 501, *Standard on Manufactured Housing*, covers all the equipment and installations used in the design, construction, transportation, fire safety, plumbing, heat-producing, and electrical systems of manufactured homes that are designed to be used as dwelling units.

20.12 Mercantile Occupancies

Mercantile occupancies include stores, markets, and other rooms, buildings, or structures used for the display and sale of merchandise. This occupancy classification includes, but is not limited to, the following:

1. Supermarkets
2. Convenience stores
3. Department stores
4. Hardware stores
5. Video sales/rental stores
6. Pharmacies
7. Rental equipment centers
8. Automobile sales showrooms
9. Flea markets and craft centers
10. Building materials/supplies centers
11. Shopping centers/malls
12. Office supply stores
13. Computer and electronics stores
14. Sporting goods stores
15. Warehouse club stores

Minor merchandising operations in buildings that house other predominant occupancies, such as a newsstand in an office building, are typically classified as incidental uses and must, therefore, meet the *Code* requirements of the predominant occupancy (see 6.1.14.1.3).

The life safety provisions for mercantile occupancies are based on their characteristic of displaying merchandise for sales purposes, which introduces significant quantities of fuel in sales areas occupied by persons who are mostly unfamiliar with the building. Mercantile occupancies are also characterized by the use of layouts of merchandise displays and store fixtures that can confuse the egress path. Fires in department stores, mall buildings, and similar mercantile occupancies that once resulted in occupant fatalities have been practically unheard of in the United States over the past two decades. Although some serious fires have occurred in such properties, the established *Code* provisions have served the life safety needs of the occupants very well.

As marketing techniques change to meet consumer demands — beginning in the 1960s, when the first covered shopping malls were built — store design and layout also change. Consumers are offered choices that include everything from one-stop shopping to unique specialty stores. As the big-box store concept became popular in the early 1980s, the general public found itself shopping in warehouse-type surroundings. The *Code* provisions that apply to mercantile occupancies have recognized these challenges to providing adequate life safety via a combination of flexible general requirements and specialized provisions, such as those contained in 36.4.4 and 37.4.4 of NFPA *101* for mall buildings and 36.4.5 and 37.4.5 of NFPA *101* for bulk merchandising retail buildings.

The features of a mercantile occupancy that determine the needed protection include the items for sale, the location of the areas occupied by the public with respect to the level of exit discharge, and the size (i.e., gross area) of the facility. Guidance on establishing the appropriate subclassification for mercantile occupancies is provided by 36.1.2.2 and 37.1.2.2 of NFPA *101*.

Establishing and controlling the widths of aisles that lead to exits is an important consideration. For example, 36.2.5.5 and 37.2.5.5 of NFPA *101* establish minimum widths, which are based on the clear width, to prevent boxed or loose merchandise from obstructing the egress path. In certain larger stores, minimum 60 in. (1525 mm) aisles might be the norm to accommodate shopping carts as well as large numbers of occupants. Automatic sprinkler protection and a manual fire alarm system complement the major features of the protection package for the larger Class A stores.

The requirements for bulk merchandising retail buildings found in 36.4.5 and 37.4.5 of NFPA *101* establish criteria that meet the special needs of such stores. The typical bulk merchandising retail store includes display and storage racks that are often more than 20 ft (6100 mm) high. Display merchandise is typically maintained at the lower levels, while the excess inventory of merchandise is stored on the upper tiers of the rack systems. In such cases, the range of materials in the occupancies is extensive and can include building materials, paint, electrical equipment, and indoor/outdoor power equipment and appliances. In some cases, the store inventory might consist of foodstuffs as well as household goods. Due to the crossover nature of such occupancies — which are part warehouse and part retail store — 36/37.4.5.2 and 36/37.4.5.3 of NFPA *101* establish requirements for providing the egress measures needed for an occupancy with a large occupant load and the fire protection measures needed for a warehouse.

20.12.1 Application. New and existing mercantile occupancies shall comply with Section 20.12 and NFPA *101*.

20.12.2 Operating Features.

20.12.2.1 Emergency Plans. Emergency action plans complying with Section 10.8 shall be provided in high-rise buildings. [***101:***36.7.1; ***101:***37.7.1]

The AHJ should require that a plan be put in place to ensure that the staff of the mercantile occupancy has been trained in their duties as specified by the emergency plan.

20.12.2.2 Drills. In every Class A or Class B mercantile occupancy, employees shall be periodically trained in accordance with Section 10.5. [***101:***36.7.2; ***101:***37.7.2]

20.12.2.3 Extinguisher Training. Employees of mercantile occupancies shall be periodically instructed in the use of portable fire extinguishers. [***101:***36.7.3; ***101:***37.7.3]

The AHJ determines the extent of the extinguisher training required by 20.12.2.3 (e.g., instruction only or instruction and hands-on use).

20.12.2.4 Food Service Operations. Food service operations shall comply with Chapter 50. [***101:***36.7.4; ***101:***37.7.4]

N **20.12.2.5 Inspection of Door Openings.** Door openings shall be inspected in accordance with 7.2.1.15 of NFPA *101*. [***101:***36.7.7; ***101:***37.7.7]

N **20.12.2.6 Integrated Fire Protection Systems.** In new apartment buildings, integrated fire protection systems shall be tested in accordance with 13.1.3. [***101:***36.7.8; ***101:***37.7.8]

20.12.3 Interior Finish.

20.12.3.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***36.3.3.1; ***101:***37.3.3.1]

20.12.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 12.5 shall be Class A, Class B, or Class C. [***101:***36.3.3.2; ***101:***37.3.3.2]

20.12.3.3 Interior Floor Finish.

20.12.3.3.1 New interior floor finish shall comply with Section 12.5. [***101:***36.3.3.3.1]

20.12.3.3.2 New interior floor finish in exit enclosures shall be Class I or Class II. [***101:***36.3.3.3.2]

20.12.3.3.3 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***36.3.3.3.3]

20.12.3.3.4 Existing Interior Floor Finish. (Reserved) [***101:***37.3.3.3]

20.13 Business Occupancies

Business occupancies, such as the one shown in Exhibit 20.22, are typically occupied by persons who are awake and ready to begin emergency egress or relocation, with little or no staff assistance, as soon as they become aware of a fire. Exhibit 20.22 depicts a typical business occupancy building.

Historical evidence validates that the package of life safety features imposed on business occupancies by the *Code* does not need to be extensive. Nonetheless, several notable multiple-death fires have occurred in business occupancies in the United States in recent years. (For the purposes of fire data analysis, the term *multiple-death* means three or more fatalities.)

On October 17, 2003, a fire broke out on the twelfth floor of the 37-story, nonsprinklered Cook County Administration Building in Chicago, Illinois. Six occupants perished after becoming trapped in an exit stair. On February 9, 2000, a fire took place in a 3-story (with a basement), partially sprinklered building in Newton, Massachusetts, and resulted in five deaths. The fire, of

Exhibit 20.22

Typical business occupancy building.

undetermined cause, started in a second-floor nonsprinklered office. Smoke spread quickly throughout the building, making escape impossible for those victims who perished. Another fire resulting in five deaths took place in an Atlanta, Georgia, high-rise office building in 1989. One of the fire victims was intimate with the fire source in an electrical vault; the other four victims were occupying their areas on the same floor when the fire began. This was the first office building fire in 17 years to result in more than three fatalities.

The life safety features in Section 20.13 and Chapters 38 and 39 of NFPA *101* center on arrangement of the means of egress as well as alarm and occupant notification provisions. The travel distance and common path of travel allowances are generous. Fire resistance–rated corridor walls or other mitigating features, such as sprinkler protection, are required in an effort to keep the means of egress system usable.

20.13.1 Application. New and existing business occupancies shall comply with Section 20.13 and NFPA *101*.

20.13.2 Operating Features.

20.13.2.1 Emergency Plans. Emergency action plans complying with Section 10.8 shall be provided in high-rise buildings. [***101:***38.7.1; ***101:***39.7.1]

Emergency action plans must be provided for both new and existing high-rise business occupancies per 20.13.2.1. This requirement, along with the companion requirements of Section 10.8 and the associated Annex A material, were developed and revised, respectively, in response to recommendations by the NFPA High Rise Building Safety Advisory Committee, which was appointed following the collapse of the World Trade Center towers on September 11, 2001. See Section 10.8 and its associated commentary for details on the contents of the required emergency action plan.

20.13.2.2 Drills. In all business occupancy buildings occupied by more than 500 persons, or by more than 100 persons above or below the street level, employees and supervisory personnel shall be periodically instructed in accordance with Section 10.5 and shall hold drills periodically where practicable. [***101:***38.7.2; ***101:***39.7.2]

The AHJ should ensure that business occupancies conduct evacuation drills in accordance with 20.13.2.2. The term *periodically* is not defined, but, at a minimum, there should be one full drill per year and quarterly instruction provided to both new and existing staff.

20.13.2.3 Extinguisher Training. Designated employees of business occupancies shall be periodically instructed in the use of portable fire extinguishers. [***101:***38.7.3; ***101:***39.7.3]

The AHJ determines the extent of the portable fire extinguisher training required by 20.13.2.3 (e.g., instruction only, or instruction and hands-on use).

20.13.2.4 Food Service Operations. Food service operations shall comply with Chapter 50. [***101:***38.7.4; ***101:***39.7.4]

N **20.13.2.5 Inspection of Door Openings.** Door openings shall be inspected in accordance with 7.2.1.15 of NFPA *101*. [***101:***38.7.7; ***101:***39.7.7]

Added in the 2015 edition of the *Code*, 20.13.2.5 mandates the annual inspection of egress doors equipped with panic hardware or fire exit hardware, doors in exit enclosures, electrically controlled egress doors, and doors with special locking arrangements, via the reference to 7.2.1.15 of NFPA *101*, which is also included in this *Code* as Section 14.5.11 The intent is to ensure that such doors, which might not be used routinely, operate properly in an emergency. See 7.2.1.15 of NFPA *101* or 14.5.11 of this *Code* and its associated commentary for additional details on the required inspection.

20.13.3 Interior Finish.

20.13.3.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***38.3.3.1; ***101:***39.3.3.1]

20.13.3.2 Interior Wall and Ceiling Finish.

20.13.3.2.1 Interior wall and ceiling finish material complying with Section 12.5 shall be Class A or Class B in exits and in exit access corridors. [***101:***38.3.3.2.1; ***101:***39.3.3.2.1]

20.13.3.2.2 Interior wall and ceiling finishes shall be Class A, Class B, or Class C in areas other than those specified in 20.13.3.2.1. [***101:***38.3.3.2.2; ***101:***39.3.3.2.2]

20.13.3.3 Interior Floor Finish.

20.13.3.3.1 New interior floor finish shall comply with Section 12.5. [***101:***38.3.3.3.1]

20.13.3.3.2 New interior floor finish in exit enclosures shall be Class I or Class II. [***101:***38.3.3.3.2]

20.13.3.3.3 New interior floor finish shall comply with 12.5.9.1 or 12.5.9.2, as applicable. [***101:***38.3.3.3.3]

20.13.3.3.4 Existing Interior Floor Finish. (Reserved) [***101:***39.3.3.3]

20.14 Industrial Occupancies

The industrial occupancy classification is broad in its scope and application. For examples of industrial occupancies, see A.6.1.12.1.

The range of facilities that are classified as industrial occupancies is diverse. Industrial occupancies comprise a wide variety of building configurations, uses, and equipment types. Some industrial occupancies might be considered innocuous with respect to the threat of fire hazard, such as a factory that manufactures concrete blocks. An industrial occupancy subject to the threat of serious fire hazard might be a petroleum processing and refining plant, where the threat of explosion is always present. The subclassification system used in 40.1.2.1 of NFPA *101* is intended to assist the user in establishing the level of hazard to the occupants of an industrial occupancy.

One of the major features to be considered in the design of an industrial occupancy's life safety system is the use of automatic sprinkler protection. Originally developed for industrial property protection, automatic sprinkler systems have also been largely responsible for an excellent life safety record in industrial occupancies — limiting the size of a fire by means of sprinklers provides sufficient time for the safe evacuation of occupants. This record has been recognized by the fire protection community, as evidenced by the widespread use of automatic sprinkler systems in buildings with significant hazards to life. The contribution of the automatic sprinkler to safety to life can be fully appreciated only when the wide range of fire risks associated with the many processes used in an industrial facility are recognized.

Employees and other occupants of industrial buildings are generally ambulatory and capable of quick response to fires. They are also able to exit rapidly once properly alerted. To capitalize on this employee capability, many industrial facilities include life safety measures in their emergency preplanning. A well-conceived plan provides a valuable tool in preventing loss of life. Provisions that should be part of the emergency pre-plan include the following:

1. Measures for alerting employees
2. Identification and posting of exit access routes
3. Establishment of group assembly areas for occupants once they have evacuated the building
4. Procedures for determining that all employees have safely evacuated

Responsibilities are usually established and assigned in the pre-plan to ensure that the tasks necessary to facilitate safe evacuation of the building are performed. The pre-plan should routinely be evaluated through simulated fire exercises and drills. Only through the execution of such drills can flaws in the pre-plan be recognized and modified.

Although the life safety record in industrial occupancies has been good, the trend toward constructing large industrial plants that house hazardous operations might prove problematic. The introduction of combustible materials, such as extensive quantities of plastics, has increased the need for additional measures to help protect workers from fire. Compared with the industrial buildings of the early twentieth century, the modern industrial complex has placed a larger number of employees in a more complex and increasingly hazardous environment. This trend has increased the need for facility managers to concentrate on life safety principles, not only during the design stage but also during day-to-day plant operations.

As part of their employee training programs, most industrial firms include education in the use of first aid fire-fighting equipment, such as in-plant standpipes, hose, and portable fire extinguishers. Although first aid fire-fighting measures are primarily a property protection measure, they also provide a significant life safety benefit when utilized correctly by trained individuals. Industrial training of this type, where fully utilized, has resulted in a major reduction in loss of property and life.

20.14.1 Application. New and existing industrial occupancies shall comply with Section 20.14 and NFPA *101*.

20.14.2 Permits. Permits, where required, shall comply with Section 1.12.

N **20.14.3 Operating Features.**

N **20.14.3.1 Inspection of Door Openings.** Door openings shall be inspected in accordance with 7.2.1.15 of NFPA *101*.[***101:***40.7.3]

Paragraph 20.14.3.1 mandates the annual inspection of egress doors equipped with panic hardware or fire exit hardware, doors in exit enclosures, electrically controlled egress doors, and doors with special locking arrangements, via the reference to 7.2.1.15, also included in this *Code* as 14.5.11. The intent is to ensure that such doors, which might not be used routinely, operate properly in an emergency. See 7.2.1.15 of NFPA *101* or 14.5.11 of this *Code* and its associated commentary for additional details on the required inspection.

N **20.14.3.2 Integrated Fire Protection Systems.** Integrated fire protection systems shall be tested in accordance with 13.1.3. [***101:***40.7.4]

Subsection 13.1.3 is new to the 2018 edition of the *Code*. By reference to this new subsection, all industrial occupancies will require that, where two or more fire protection or life safety systems are integrated, the integrated system be tested to verify the proper operation and function of the system in accordance with NFPA 4. See the commentary associated with 13.1.3 for more information.

20.14.4 Interior Finish.

20.14.4.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***40.3.3.1]

20.14.4.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 12.5 shall be Class A, Class B, or Class C in operating areas and shall be as required by 7.1.4 of NFPA *101* in exit enclosures. [***101:***40.3.3.2]

20.14.4.3 Interior Floor Finish.

20.14.4.3.1 Interior floor finish in exit enclosures and in exit access corridors shall be Class I or Class II in accordance with 12.5.9.4. [***101:***40.3.3.3.1]

20.14.4.3.2 Interior floor finish in areas other than those specified in 20.14.4.3.1 shall not be required to comply with 12.5.9. [***101:***40.3.3.3.2]

20.15 Storage Occupancies

Storage occupancies include all buildings or structures used primarily for the storage or sheltering of goods, merchandise, products, or vehicles. For examples of storage occupancies, see A.6.1.13.1.

Section 20.15 and Chapter 42 of NFPA *101* cover a range of facilities used for storage of a wide variety of commodities. While the same life safety philosophy that prevails in the other occupancy chapters applies to storage occupancies, the protection scheme is less complicated, given the relatively small number of people who characteristically occupy a storage occupancy. Although some warehouse facilities are substantially larger than buildings housing other occupancies, few people typically occupy them.

Once the basic characteristics of a given storage occupancy are determined, the general protection measures of Sections 42.2 and 42.3 of NFPA *101* can be applied. In addition to these measures, the supplementary provisions that are specific to a particular type of storage occupancy can be applied. These provisions include those for aircraft storage hangars (Section 21.1), grain and other bulk storage elevators (20.15.5), and parking structures (Chapter 29).

20.15.1 Application. New and existing storage occupancies shall comply with NFPA *101*, Chapter 34, appropriate codes or standards referenced in Chapter 2, and Section 20.15.

20.15.2 Permits. Permits, where required, shall comply with Section 1.12.

N **20.15.3 Operating Features.**

N **20.15.3.1 Inspection of Door Openings.** Door openings shall be inspected in accordance with 7.2.1.15 of NFPA *101*. [***101:***42.9.3]

Paragraph 20.15.3.1 mandates the annual inspection of egress doors equipped with panic hardware or fire exit hardware, doors in exit enclosures, electrically controlled egress doors, and doors with special locking arrangements, via the reference to 7.2.1.15, and also included in this *Code* as 14.5.11. The intent is to ensure that such doors, which might not be used routinely, operate properly in an emergency. See 7.2.1.15 of NFPA *101* or 14.5.11 of this *Code* and its associated commentary for additional details on the required inspection.

N **20.15.3.2 Integrated Fire Protection Systems.** Integrated fire protection systems shall be tested in accordance with 13.1.3. [***101:***42.9.4]

Subsection 13.1.3 is new to the 2018 edition of the *Code*. By reference to this new subsection, storage occupancies require that, where two or more fire protection or life safety systems are integrated, the integrated system be tested to verify the proper operation and function of the system in accordance with NFPA 4. See the commentary associated with 13.1.3 for more information.

20.15.4 Interior Finish.

20.15.4.1 General. Interior finish shall be in accordance with Section 12.5. [***101:***42.3.3.1]

20.15.4.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials shall be Class A, Class B, or Class C in accordance with 12.5 in storage areas and shall be as required by 7.1.4 of NFPA *101* in exit enclosures. [***101:***42.3.3.2]

20.15.4.3 Interior Floor Finish.

20.15.4.3.1 Interior floor finish in exit enclosures and in exit access corridors shall be Class I or Class II. [***101:***42.3.3.3.1]

20.15.4.3.2 Interior floor finish in areas other than those specified in 20.15.4.3.1 shall not be required to comply with 12.5.9. [***101:***42.3.3.3.2]

Δ **20.15.5 Bulk Storage Elevators.** Bulk storage elevators shall comply with 20.15.5 and NFPA 61.

Δ **20.15.5.1* Application.** The requirements of 20.15.5 shall apply to all of the following:

(1) All facilities that receive, handle, process, dry, blend, use, mill, package, store, or ship dry agricultural bulk materials, their by-products, or dusts that include grains, oilseeds, agricultural seeds, legumes, sugar, flour, spices, feeds, dry dairy/food powders, and other related materials
(2) All facilities designed for manufacturing and handling starch, including drying, grinding, conveying, processing, packaging, and storing dry or modified starch, and dry products and dusts generated from these processes
(3) Those seed preparation and meal-handling systems of oilseed processing plants not covered by NFPA 36

[**61:**1.3.1]

A.20.15.5.1 Examples of facilities covered by NFPA 61 include, but are not limited to, bakeries, grain elevators, feed mills, flour mills, milling, corn milling (dry and wet), rice milling, dry milk products, mix plants, soybean and other oilseed preparation operations, cereal processing, snack food processing, tortilla plants, chocolate processing, pet food processing, cake mix processing, sugar refining and processing, and seed plants. [**61:**A.1.3.1]

20.15.5.2 Subsection 20.15.5 shall not apply to oilseed extraction processes that are covered by NFPA 36. [**61:**1.3.2]

20.15.5.3 Applicability.

20.15.5.3.1 Unless otherwise noted, the provisions of 20.15.5 on bulk storage elevators shall not be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of this *Code*, except in those cases where it is determined by the AHJ that the existing situation involves a distinct hazard to life or adjacent property.

20.15.5.3.2 The requirements of Chapter 11 of NFPA 61 shall apply to all facilities.

20.15.6 Record Storage.

Δ **20.15.6.1** Records protection equipment, facilities, and records-handling techniques that provide protection from the hazards of fire shall comply with 20.15.6 and NFPA 232.

NFPA 232, *Standard for the Protection of Records*, provides requirements for records protection equipment and facilities and records-handling techniques that provide protection from the hazards of fire. NFPA 232 does not consider forcible entry. NFPA 232 covers the following four categories of records storage environments and corresponding levels of risk tolerance:

1. Records vaults — provide the highest level of protection
2. File rooms — provide an intermediate level of protection for active and semiactive records
3. Archival storage — provides a high level of protection for permanently valuable records
4. Records centers — provide an intermediate level of protection for temporary records

NFPA 232 does not cover the storage and handling of useful records. For the storage and handling of cellulose nitrate motion picture film records, see 20.15.7.

20.15.6.2* Because of the volume of records, 20.15.6.1 shall not cover large archives or records storage buildings.

Δ **A.20.15.6.2** See NFPA 232 where large archives or records storage buildings are involved.

20.15.7 Cellulose Nitrate Motion Picture Film Storage.

Δ **20.15.7.1 Application.** The storage and handling of cellulose nitrate film records shall comply with 20.15.7 and NFPA 40.

20.15.7.2 Permits. Permits, where required, shall comply with Section 1.12.

NFPA 40 applies to all facilities that are involved with the storage and handling of cellulose nitrate–based film. NFPA 40 does not apply to the storage and handling of film having a base other than cellulose nitrate. NFPA 40 includes general provisions regarding the storage and handling of cellulose nitrate film and special provisions for such occupancies as motion picture projection booths, nitrate film vaults, and laboratories handling nitrate film. These special provisions apply in addition to any and all applicable general provisions.

20.15.8 High-Piled Storage.

20.15.8.1 Application. Buildings containing high-piled storage shall comply with Chapter 13, Chapter 34, and 20.15.8.

20.15.8.2 Permits. Permits, where required, shall comply with Section 1.12.

20.15.8.3 Fire Department Hose Connections.

20.15.8.3.1 When any portion of the high-piled combustible storage area is greater than 200 ft (61 m) from a fire department access door, Class I standpipe outlets connected to a system sized to deliver 250 gpm (946.4 L/min) at the most hydraulically remote outlet shall be provided in accordance with 20.15.8.3.

20.15.8.3.2 The outlet shall be permitted to be supplied from the sprinkler system and shall be hydraulically calculated.

20.15.8.3.3 Standpipe outlets shall be provided at each of the following locations:

(1) In each exit passageway at the entrance from the storage areas into the passageway
(2) At each intermediate landing between floor levels in every required exit stairway serving the storage area
(3) At exterior entrances into the storage

20.16 Special Structures and High-Rise Buildings

The facilities to which Section 20.16 provisions might be applied range from a refinery petroleum-cracking plant to an air traffic control tower. While the life safety and functional use considerations of such properties might, at times, seem to conflict, this section and Chapter 11 of NFPA *101* provide the necessary guidance to make them safe as well as functional.

Examples of usual occupancies housed in unusual surroundings or special structures include a large convention center located on a pier where the facility is surrounded by water on three sides, or a storage facility located completely below grade level. Exhibit 20.23 depicts an air traffic control tower, which is an example of a usual occupancy in an unusual structure.

Exhibit 20.23

Air traffic control tower at Denver International Airport. (Courtesy of Denver International Airport)

The AHJ should ensure that any engineered solutions to the special structure's inherent egress deficiencies provide an overall level of life safety equivalent to that specified by the requirements of the NFPA *101* occupancy chapter that applies to the structure's use. In some cases, a structure might be so unusual that the only practical option is a complete performance-based design in accordance with Chapter 5.

Section 20.16 of this *Code* and Chapter 11 of NFPA *101* also regulate water-surrounded structures, vehicles and vessels, and limited-access (referred to as *windowless* prior to the 2003 edition of NFPA *101*) and underground structures. These provisions apply regardless of the occupancy classification. For example, a permanently moored ship that is used as a hotel with restaurants and other entertainment facilities must comply with Section 20.1 of this *Code* and Chapter 12 or Chapter 13 of NFPA *101*, for assembly occupancies, and Section 20.8 of this *Code* and Chapter 28 or Chapter 29 of NFPA *101*, for hotels and dormitories, as appropriate, by virtue of the language in 11.6.2 of NFPA *101*. The Queen Mary, which has been permanently moored in Long Beach, California, since 1967, is an example of such an occupancy. See Exhibit 20.24.

Section 11.8 of NFPA *101* presents a series of unique provisions applicable to high-rise buildings. Sections 11.9 through 11.11 of NFPA *101* provide a series of requirements applicable to membrane structures and tents. See Chapter 25 for additional guidance on this subject.

Exhibit 20.24

The Queen Mary in Long Beach, CA. (Courtesy of the Queen Mary, Long Beach, CA)

20.16.1 Application.

20.16.1.1 New and existing special structures and high-rise buildings shall comply with NFPA *101*.

20.16.1.2 Motion picture and television production studio soundstages and approved production facilities shall comply with Chapter 32.

20.17 Historic Buildings and Cultural Resources

Historic buildings pose unique fire and life safety problems. Historic structures are irreplaceable artifacts of history and culture with immeasurable, intangible value. Special consideration is necessary to design fire and life safety into such structures without sacrificing historic integrity. The AHJ must have latitude in applying the *Code* to historic structures, because strict compliance, in most cases, cannot be achieved without considerable expense and usually provides little or no gain in safety.

The provisions of NFPA 909, *Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship*, and NFPA 914, *Code for Fire Protection of Historic Structures*, as referenced in Section 20.17, offer alternative approaches to providing for fire protection in historic buildings and cultural resource properties. A fundamental tenet of these codes involves bringing together all interested stakeholders at the start of a project, rather than at the project's conclusion, to ensure that the necessary level of fire and life safety is provided without destroying the building's historic fabric or cultural significance. Strict application of *Code* requirements without due consideration of their impact on a building's historic or cultural significance can be nearly as destructive as a fire.

Δ **20.17.1** Historic buildings shall comply with this *Code* or with the provisions of NFPA 914.

Subsection 20.17.1 applies to buildings that are designated as historic buildings by a local, regional, or national jurisdiction. Conditions created by deviating from full *Code* compliance should not constitute a serious life safety hazard.

NFPA 914 describes fire safety requirements for the protection of historic structures and for those who operate, use, or visit them. It covers ongoing operations, renovation, and restoration and acknowledges the need to preserve historic character. NFPA 914 addresses those construction, protection, operational, and occupancy features that are necessary to minimize danger to life, structures, and contents from the effects of fire, including smoke, heat, and fumes. NFPA 914 identifies the minimum fire safety criteria to allow prompt escape of the building occupants to a safe area and to minimize the impact of fire and fire protection on the structure, contents, or features associated with the historic character. For library and museum collections, see 20.17.2.

Δ **20.17.2** Buildings that store or display cultural resources, including museum or library collections, or spaces within other buildings used for such culturally significant purposes, shall comply with this *Code* or with the provisions of NFPA 909.

NFPA 909 describes principles and practices of fire safety for cultural resource properties (museums, libraries, and places of worship) and for those who operate, use, or visit them.

NFPA 909 covers ongoing operations and rehabilitation and acknowledges the need to preserve culturally significant and character-defining building features and sensitive, often irreplaceable, collections and to provide continuity of operations. NFPA 909 prescribes minimum requirements for the protection of cultural resource properties and their contents from fire through a comprehensive fire protection program.

20.17.3 The provisions of this *Code* relating to the construction, repair, alteration, enlargement, restoration, and moving of buildings or structures shall not be mandatory for the following:

(1) Existing buildings or structures identified and classified by the state or local government authority as historic buildings where such buildings comply with NFPA 914

(2)* Buildings or spaces within buildings that store or display cultural resources and comply with the provisions of NFPA 909

Δ **A.20.17.3(2)** See also NFPA 914.

References Cited in Commentary

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NFPA 4, *Standard for Integrated Fire Protection and Life Safety System Testing*, 2018 edition.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2018 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2016 edition.

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film,* 2016 edition.

NFPA *101®*, *Life Safety Code®*, 2018 edition.

NFPA 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems,* 2017 edition.

NFPA 232, *Standard for the Protection of Records,* 2017 edition.

NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, 2015 edition.

NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages,* 2013 edition.

NFPA 501, *Standard on Manufactured Housing,* 2017 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films,* 2015 edition.

NFPA 909, *Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship,* 2017 edition.

NFPA 914, *Code for Fire Protection of Historic Structures,* 2015 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2018 edition.

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ASTM D2859, *Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials*, 2015.

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Airports and Heliports

21

Chapter 21 addresses airport and heliport hangars and terminals. Aircraft refueling is covered in Section 42.10.

Δ 21.1 Hangars

The construction and protection of aircraft hangars from fire shall comply with this section; NFPA 409, NFPA 410, and Sections 40.6 and 42.6 of NFPA *101*.

NFPA 409, *Standard on Aircraft Hangars*, defines the term *aircraft hangar* as a "building or other structure inside any part of which aircraft are housed." NFPA 409 contains the minimum requirements for the proper construction of aircraft hangars and for their protection from fire.

NFPA 410, *Standard on Aircraft Maintenance*, covers the minimum requirements for fire safety to be followed during aircraft maintenance and does not include the health and safety requirements for personnel involved in aircraft maintenance. The operations include maintenance of electrical systems; maintenance of oxygen systems; fuel tank repair, cleaning, painting, and paint removal; welding operations in hangars; interior cleaning; and refurbishing operations. NFPA 410 also covers requirements for fire protection of aircraft ramp areas.

NFPA *101*®, *Life Safety Code*®, also deals with aircraft hangars: Section 40.6 covers aircraft servicing hangars, and Section 42.6 covers aircraft storage hangars.

21.1.1 Permits. Permits, where required, shall comply with Section 1.12.

21.1.2 Fire Department Access. Fire department access roads shall be provided and maintained in accordance with Section 18.2 for all aircraft hangars.

21.1.3 Smoking.

21.1.3.1 Smoking shall be prohibited in aircraft hangars.

21.1.3.2 Smoking shall be in accordance with Section 10.9.

21.1.4* Means of Egress Provisions for Aircraft Servicing Hangars.

Δ **A.21.1.4** For further information on aircraft hangars, see NFPA 409. [***101:***A.40.6]

21.1.4.1 The requirements of Sections 40.1 through 40.5 of NFPA *101* shall be met, except as modified by 21.1.4.2 through 21.1.4.4. [***101:***40.6.1]

21.1.4.2 The requirements for exits from aircraft servicing areas shall comply with 21.1.4.2.1 through 21.1.4.2.4. [***101:***40.6.2]

NFPA 409 defines an *aircraft storage and servicing area* as "that part of a hangar normally used for the storage and servicing of one or more aircraft, not including any adjacent or contiguous areas or structures, such as shops, storage areas, and offices."

21.1.4.2.1 There shall be not less than two means of egress from each aircraft servicing area. [***101:***40.6.2.1]

21.1.4.2.2 Exits from aircraft servicing areas shall be provided at intervals not exceeding 150 ft (46 m) on all exterior walls. [***101:***40.6.2.2]

21.1.4.2.3 Where horizontal exits are provided, doors shall be provided in the horizontal exit fire barrier at intervals not exceeding 100 ft (30 m). [***101:***40.6.2.3]

21.1.4.2.4 Where dwarf, or "smash," doors are provided in doors that accommodate aircraft, such doors shall be permitted for compliance with 21.1.4.2.1 through 21.1.4.2.3. [***101:***40.6.2.4]

21.1.4.3 Means of egress from mezzanine floors in aircraft servicing areas shall be arranged so that the travel distance to the nearest exit from any point on the mezzanine does not exceed 75 ft (23 m), and such means of egress shall lead directly to a properly enclosed stair discharging directly to the exterior, to a suitable cutoff area, or to outside stairs. [***101:***40.6.3]

21.1.4.4 Dead ends shall not exceed 50 ft (15 m) for other than high hazard contents areas and shall not be permitted for high hazard contents areas. [***101:***40.6.4]

21.1.5* Means of Egress Provisions for Aircraft Storage Hangars.

Δ **A.21.1.5** For further information on aircraft hangars, see NFPA 409. [***101:***A.42.6]

21.1.5.1 The requirements of Sections 42.1 through 42.5 of NFPA *101* shall be met, except as modified by 21.1.5.1.1 through 21.1.5.1.3. [***101:***42.6.1]

21.1.5.1.1 There shall be not less than two means of egress from each aircraft storage area. [***101:***42.6.1.1]

21.1.5.1.2 Exits from aircraft storage areas shall be provided at intervals not exceeding 150 ft (46 m) on all exterior walls. [***101:***42.6.1.2]

21.1.5.1.3 Where horizontal exits are provided, doors shall be provided in the horizontal exit fire barrier at intervals not exceeding 100 ft (30 m). [***101:***42.6.1.3]

21.1.5.1.4 Where dwarf, or "smash," doors are provided in doors that accommodate aircraft, such doors shall be permitted for compliance with 21.1.5.1.1, 21.1.5.1.2, and 21.1.5.1.3. [***101:***42.6.1.4]

21.1.5.2 Means of egress from mezzanine floors in aircraft storage areas shall be arranged so that the travel distance to the nearest exit from any point on the mezzanine does not exceed 75 ft (23 m), and such means of egress shall lead directly to a properly enclosed stair discharging directly to the exterior, to a suitable cutoff area, or to outside stairs. [***101:***42.6.2]

21.1.5.3 Dead ends shall not exceed 50 ft (15 m) for other than high hazard contents areas and shall not be permitted for high hazard contents areas. [***101:***42.6.3]

For provisions that apply to aircraft servicing hangars, see Section 40.6 of NFPA *101*.

Section 21.1.5 specifies two alternative methods of providing egress from aircraft storage hangars. Where egress is possible through the outside wall, a distance of 150 ft (46 m) between exit doors is adequate. In larger hangars, the storage bay might have offices and other rooms located along one or more sides, with the walls constructed of fire resistance–rated assemblies. In those cases where the wall has a fire resistance rating so as to qualify as a horizontal exit, exit door spacing of up to 100 ft (30 m) is specified. If the wall is nonrated, access to the outside is required. During inclement weather, when large hangar doors typically are closed, a common design method is to provide small access doors for personnel in the larger aircraft hangar door. The small doors can be considered normal means of egress from an aircraft hangar. If possible, the door should swing in the direction of egress; however, this might not be possible due to the design of the aircraft hangar door. A typical aircraft storage hangar is depicted in Exhibit 21.1.

Exhibit 21.1

Typical aircraft storage hangar.

21.2 Terminals

Δ **21.2.1 Application.** Airport terminal buildings shall comply with the requirements of Section 21.2 and NFPA 415.

The term *airport terminal building* is defined in 3.3.29.1 as "a structure used primarily for air passenger enplaning or deplaning, including ticket sales, flight information, baggage handling, and other necessary functions in connection with air transport operations. This term includes any extensions and satellite buildings used for passenger handling or aircraft flight service functions. Aircraft loading walkways and 'mobile lounges' are excluded." NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways*, specifies the minimum fire protection requirements for the construction and protection of airport terminal buildings. In addition, the minimum requirements for the design, construction, and fire protection of aircraft loading walkways between the terminal building and aircraft are covered.

The term *terminal* is sometimes applied to airport facilities other than those serving passengers, such as cargo and freight facilities and fuel-handling facilities, which are covered by NFPA 30, *Flammable and Combustible Liquids Code*, and not by this chapter. See Chapters 20, 42, 60, and 66 for additional guidance.

Airport control towers are not considered part of the terminal building. See Section 20.16, which references NFPA *101* for requirements for these special structures.

The minimum requirements for the design and maintenance of the drainage system of an aircraft fueling ramp are specified to control the flow of fuel that can be spilled on a ramp and to minimize the resulting possible danger. Ramp drainage systems are intended to limit the fire and exposure hazard from fuel spillage. The requirements control the spread of a fuel spill to limit exposure to buildings, aircraft loading walkways, concourses, or elevated structures in order to prevent the fuel's liquid or vapors from reaching a source of ignition or accumulating within structures and thus limiting the spread of the fuel spill over the ramp surface. They also prevent the transmission of vapors by the drainage system from exposing aircraft or other equipment parked or operating on the ramp. NFPA 415 also specifies the minimum criteria for fire protection of aircraft loading walkways that can serve as an egress route from an aircraft in the event of a flammable liquid spill fire on the airport ramp that could expose the walkway and the aircraft.

21.2.2 General.

21.2.2.1 Permits. Permits, where required, shall comply with Section 1.12.

21.2.2.2 Fire Department Access. Fire department access roads for all airport terminal buildings shall be provided and maintained in accordance with Section 18.2.

21.2.3 Smoking.

21.2.3.1 Smoking shall be prohibited in fuel ramp areas and loading walkways.

21.2.3.2 Smoking shall be in accordance with Section 10.9.

21.2.4 General.

Δ **21.2.4.1** Airport terminal buildings shall be of Type I, Type II, or Type IV construction, as defined in NFPA 220.

See Section 12.2 and its associated commentary for descriptions of construction types as defined in NFPA 220, *Standard on Types of Building Construction*.

21.2.4.2* Interior finish materials shall be limited to Class A or Class B regardless of the occupant load. [**415:**4.1.2]

Δ **A.21.2.4.2** Furniture, floor and wall coverings, and other furnishings in airport terminal occupancies, including passenger holding lounges, waiting areas, restaurant dining rooms, bars, and retail stores, should not be made of materials that have high combustibility, smoke-development characteristics, or both, for example, some plastic foams, latex-rubber foam, some plastics, and some synthetic fibers. Such materials have a tendency to release combustible gases at relatively low temperatures, making them easily ignitible. When burning, these materials also release high amounts of heat energy at rapid rates, thereby contributing greatly to fire propagation. [**415:**A.4.1.2]

Interior finish Class A and Class B are described in NFPA *101*. [**415:**A.4.1.2]

See Section 12.5 for additional guidance on interior finish classifications.

Δ **21.2.4.3** Aircraft fueling facilities and ramps shall be designed in accordance with NFPA 407, and Chapter 5 of NFPA 415. [**415:**4.1.3]

Δ **21.2.4.4** Belowgrade areas and blind spaces in airport terminal buildings shall be protected against flammable fuel and vapor penetration or shall be mechanically ventilated to provide at least four complete air changes per hour. The mechanical ventilation system shall be installed in accordance with NFPA 91. [**415:**4.1.4]

Where operationally feasible, openings to areas of terminals that are belowgrade should not be located on the ramp side of the building, in order to minimize the probability of flammable fuel or vapors entering such areas.

21.2.4.5 Glazing Material–Covered Openings Facing the Ramp.

21.2.4.5.1 Openings covered with glazing material that have the lowest part of the glazing material not less than 7 ft (2.1 m) above each finished floor level shall not be required to comply with 21.2.4.5.3. [**415:**4.1.5.1]

21.2.4.5.2 Openings covered with glazing material listed for use in a fire barrier and installed in accordance with the listing shall not be required to comply with 21.2.4.5.3. [**415:**4.1.5.2]

21.2.4.5.3 Where potential fuel spill points are located less than 100 ft (30.5 m) horizontally from glazing material–covered openings in airport terminal building walls facing the airport ramp, they shall be provided with an automatically activated water spray system in accordance with 21.2.4.5.3.1 or an automatically activated, listed fire shutter system in accordance with 21.2.4.5.3.2. *(See Annex C of NFPA 415.)* [**415:**4.1.5.3]

Δ **21.2.4.5.3.1** Where an automatically activated water spray system(s) is provided, it shall be installed in accordance with NFPA 15. [**415:**4.1.5.3.1]

21.2.4.5.3.1.1 The system shall be designed to provide a density of at least 0.25 gpm/ft^2 [10.2 (L/min)/m^2] over the exterior surface area of the glazing material. [**415:**4.1.5.3.1.1]

21.2.4.5.3.1.2 Where multiple water spray systems are used, the water supply shall be capable of supplying all systems that could be expected to operate as a result of one fire incident. [**415:**4.1.5.3.1.2]

When the flow rate for the water supply is being determined, all heads must be included in the demand calculation. One method for performing this calculation is addressed in NFPA 13, *Standard for the Installation of Sprinkler Systems*, where the flow is calculated by multiplying the K-factor of the head by the square root of the pressure. In these calculations, the friction loss for the pipe, fittings, and elevation must be considered in the evaluation.

21.2.4.5.3.1.3 The detection system design analysis for the water spray system shall include consideration of false alarms and detector response time. [**415:**4.1.5.3.1.3]

21.2.4.5.3.2 Where an automatically activated, listed fire shutter is provided, it shall be installed in accordance with its listing. [**415:**4.1.5.3.2]

21.2.5 Heating, Ventilating, and Air Conditioning.

21.2.5.1 Heating, ventilating, and air-conditioning systems shall be installed in accordance with Section 11.2 and Section 11.5, as applicable.

21.2.5.2* Air supply intake and exhaust openings for air-conditioning or ventilating equipment serving the terminal building, if located on the ramp side, shall be not less than 10 ft (3 m) above the grade level of the ramp and shall be at least 50 ft (15 m) from any point of flammable vapor release. [**415:**4.2.2]

A.21.2.5.2 Examples of points of flammable vapor release are fuel tank vent openings and fuel hydrant pits. Air supply intake and exhaust openings for air-conditioning or ventilating equipment serving the terminal building should not be located on the ramp side of an airport terminal building. Fixed air-conditioning and ventilating equipment serving only aircraft should be in a room that has no openings communicating with the remainder of the terminal building. [**415:**A.4.2.2]

21.2.5.3* Openings to rooms that contain coal-, gas-, or oil-fired equipment or any other open-flame device and that face the ramp side of the terminal shall be above ramp grade and 50 ft (15 m) from any point of flammable vapor release. [**415:**4.2.3]

A.21.2.5.3 Rooms that contain coal-, gas-, or oil-fired equipment or any other open-flame device should not have openings on the ramp side of the building. Combustion and ventilation air should be supplied from the street side or the roof of the building or through a gravity louver from a nonhazardous area in the building. [**415:**A.4.2.3]

21.2.5.4 Stacks or chimneys from a boiler, heater, or incinerator shall terminate at least 20 ft (6.1 m) above ramp grade and above the roof of the building. Stacks or chimneys from boilers or heaters that use solid fuel or from any incinerator shall be fitted with double screening to control fly ash and sparks. Such stacks or chimneys shall be located so the outlet is at least 100 ft (30.5 m) horizontally from any aircraft position or point of flammable vapor release. [**415:**4.2.4]

Δ **21.2.5.5** Incinerators shall conform to the requirements of Chapter 4 of NFPA 82. [**415:**4.2.5]

21.2.5.6 Exhaust hood ventilation systems for restaurant and flight kitchens shall conform to the applicable portions of Chapter 50. [**415:**4.2.6]

See Chapter 50 and its associated commentary for additional guidance on the protection of commercial cooking operations.

21.2.6 Exits.

Δ **21.2.6.1** Airport terminal building means of egress shall conform to the requirements of NFPA *101*. [**415:**4.3.1]

21.2.6.2* In addition to the exit signage requirements specified in NFPA *101*, doors serving as exits that discharge onto an airport ramp and are provided solely for the purpose of meeting emergency egress requirements from public areas shall be placarded "Emergency Exit Only" in letters at least 2 in. (50 mm) high. [**415:**4.3.2]

A.21.2.6.2 The hazards to persons from jet intakes and blast, noise, propellers, and so forth, on the ramp should be taken into consideration in locating emergency exit points leading to ramps from the airport terminal building. A means of notification of unauthorized usage (such as an alarm system) of these emergency exits may be desirable. [**415:**A.4.3.2]

21.2.7* Fire Protection — Sprinkler Systems.

A.21.2.7 The assembly portion of the terminal building can include areas such as the concourse waiting areas, baggage claim areas, and restaurants. The assembly portion should exclude kitchens, toilets, small office areas, and other areas not normally accessible to the public. [**415:**A.4.5.1]

21.2.7.1 An airport terminal building with more than 12,000 ft² (1115 m²) total floor area for the assembly portion of the occupancy shall be provided with an automatic sprinkler system installed in accordance with Section 13.3. [**415:**4.5.1.1]

21.2.7.2 Terminal buildings with less than 12,000 ft² (1115 m²) total floor area for the assembly portion of the occupancy shall not be required to be provided with an automatic sprinkler system. [**415:**4.5.1.2]

21.2.7.3 Passenger-handling areas shall be classified as Ordinary Hazard Group 1 Occupancy, as defined in NFPA 13, for the purpose of sprinkler system design. [**415:**4.5.1.3]

21.2.7.4 Baggage, package, and mail-handling areas shall be classified as Ordinary Hazard Group 2 Occupancy, as defined in NFPA 13, for the purpose of sprinkler system design. [**415:**4.5.1.4]

21.2.7.5* Other areas of the airport terminal building shall be classified in accordance with Chapter 5 of NFPA 13, based on the occupancy of the area. [**415:**4.5.1.5]

A.21.2.7.5 The exposure to the airport terminal building from the airport ramp is significant. The number of building sprinklers operating from the exposure fire could be greater than the number of building sprinklers operating from an internal ignition source. [**415:**A.4.5.1.5]

Δ **21.2.7.6 Covered Plane-Loading Positions.** Airport terminal buildings having canopy areas or roofed-over recesses at aircraft loading positions that, in effect, place the aircraft totally or substantially under such canopies or roofs shall have the canopies or roofs protected by automatic sprinkler systems in accordance with NFPA 409. [**415:**4.5.1.6]

21.2.8 Fire Alarm and Communications Systems. A fire alarm and communications system shall be installed as required by 13.7.2.1. [**415:**4.5.2]

21.2.8.1 Means to alert the public fire department or the airport fire station shall be available through manual fire alarm pull stations. Manual fire alarm services shall be installed in accordance with *NFPA 72*. [**415:**4.5.2.1]

21.2.8.2* Annunciation for all building fire alarm signals shall be provided near the front entrance of the building. [**415:**4.5.2.2]

A.21.2.8.2 If the public fire department is responding to the "street" side of the airport terminal building, timely access to the normal alarm receiving point might be limited by emergency conditions or distance. Planned radio communication with a constantly attended alarm-receiving point can assist in a more efficient response by the public fire department. The remote annunciator on the street side of the terminal building can provide building condition information not otherwise available. [**415:**A.4.5.2.2]

21.2.8.3 If the public fire department has two-way voice communication with a constantly attended location, 21.2.8.2 shall not apply. [**415:**4.5.2.3]

21.2.9 Fire Hydrants. Fire hydrants shall be provided on both the ramp and the street sides of airport terminal buildings. Such hydrants shall be located so that no portion of the terminal building is more than 500 ft (152.4 m) from a hydrant. [**415:**4.5.3]

When the location of hydrants is being determined, the direction of approach for fire apparatus should be considered. Hydrants should be accessible to the fire department as it approaches the terminal. Consideration should also be given to traffic flow in front of the terminal, so that hose lines from the hydrant to the normal position where a pumper sets up or to a sprinkler or standpipe connection do not restrict traffic movement to the point that response by other apparatus is hampered. See Chapter 18 for additional fire flow and fire hydrant requirements.

21.2.10 Standpipe and Hose Systems. Standpipe and hose systems shall be provided for all airport terminal buildings in excess of two stories [35 ft (10.7 m)] in height or 100 ft (30.5 m) in shortest horizontal dimension. Standpipe and hose systems shall be installed in accordance with Section 13.2. [**415:**4.5.4]

21.2.10.1 Class I standpipe systems shall be provided in buildings protected throughout by an approved automatic sprinkler system. Each 2½ in. (63.5 mm) hose connection shall be equipped with a 2½ in. × 1½ in. (63.5 mm × 38 mm) reducer and cap. [**415:**4.5.4.1]

21.2.10.2 Class III standpipe systems shall be provided in nonsprinklered buildings. Paragraphs 5.3.3.1 and 5.3.3.2 of NFPA 14 for Class III systems shall be applicable to this requirement. [**415:**4.5.4.2]

21.2.11 Portable Fire Extinguishers. Portable fire extinguishers shall be provided throughout the airport terminal building in accordance with Section 13.6. [**415:**4.5.6]

21.3 Rooftop Heliport Construction and Protection

Δ **21.3.1 Application.** Rooftop heliport construction and protection shall comply with Section 21.3 and NFPA 418.

NFPA 418, *Standard for Heliports*, specifies the minimum requirements for fire protection for heliports and rooftop hangars and establishes minimum fire safety requirements for operation at heliports for the protection of persons, aircraft, and other property. NFPA 418 does not apply to ground-level helicopter hangars, temporary landing sites, and emergency evacuation facilities.

To identify specifically where the requirements for a rooftop heliport are to be applied, NFPA 418 includes two definitions that are relevant. The term *heliport* is defined as "an identifiable area located on land, on water, or on a structure that also includes any existing building or facilities thereon, used or intended to be used for the landing and takeoff of helicopters." (The term *heliport* applies to all sites used or intended to be used for the landing and takeoff of helicopters.) The term *rooftop landing pad* is defined as "the entire load-bearing surface intended for the touchdown and liftoff (TLOF) of helicopters." The requirements for helicopter landing sites are not intended to apply to entire roof areas or the building's structure beyond the landing area.

Note that NFPA 418 is not intended to apply to military aircraft with onboard armaments.

21.3.1.1 Section 21.3 shall not apply to ground level helicopter hangars. All hangars not covered by this section shall comply with NFPA 409.

21.3.1.2 Temporary landing sites and emergency evacuation facilities shall not be required to comply with Section 21.3.

21.3.2 General.

21.3.2.1 Permits. Permits, where required, shall comply with Section 1.12.

21.3.2.2 Fire Department Access. Fire department access roads for all buildings with a rooftop heliport shall be provided and maintained in accordance with Section 18.2.

21.3.2.3 Smoking.

21.3.2.3.1 Smoking shall be prohibited at rooftop heliports.

21.3.2.3.2 Smoking shall be in accordance with Section 10.9.

21.3.3 General Requirements — Land-Based Facilities.

21.3.3.1* Plans.

A.21.3.3.1 FAA AC 150/5390-2C, *Heliport Design Advisory Circular*, contains design and construction information on heliports. This advisory circular provides for adequate clearance between operating aircraft and buildings or structures located at the heliport. The FAA advisory circular should be consulted to ensure that adequate safe practice and facilities are maintained. [**418:**A.4.2]

21.3.3.1.1 The design drawings for the construction and protection of the heliport shall be approved by the AHJ. [**418:**4.2.1]

21.3.3.1.2 The design of the heliport, including all the aeronautical components, shall be in accordance with FAA AC 150/5390-2C, *Heliport Design Advisory Circular*. [**418:**4.2.2]

21.3.3.1.3 The final approach and takeoff (FATO) area, the approach/departure path, and the touchdown and liftoff (TLOF) area shall be designated on the design drawings. [**418:**4.2.3]

21.3.3.2 Tank and Equipment Locations.

21.3.3.2.1 Storage, handling, and use of flammable and combustible liquids shall be in accordance with Chapter 66. [**418:**4.3.1]

Δ **21.3.3.2.2** Oxygen and other medical gases shall be stored and used in accordance with NFPA 99. [**418:**4.3.2]

21.3.3.2.3 Aboveground flammable liquid storage tanks, compressed gas storage tanks, fuel storage tanks, and liquefied gas storage tanks shall be laterally located at least 50 ft (15.2 m) from the edge of the final approach and takeoff (FATO) area as defined in FAA AC 150/5390-2C, *Heliport Design Advisory Circular*. [**418:**4.3.3]

21.3.3.3 Fire-Fighting Access.

21.3.3.3.1 The heliport shall have at least two access points for fire-fighting/rescue personnel. The access points shall be located at least 90 degrees from each other as measured from the center of the landing pad (TLOF). [**418:**4.4.1]

21.3.3.3.2 Fences shall not prevent access by fire-fighting/rescue personnel. [**418:**4.4.2]

21.3.3.4 Fuel Spill Control. The landing pad shall be designed so that fuel spills are directed away from access/egress points and passenger holding areas. [**418:**4.5]

See the commentary following 21.3.4.2.

21.3.3.5 No Smoking.

For additional guidance on smoking restrictions, see Section 10.9.

21.3.3.5.1 No smoking shall be permitted within 50 ft (15.2 m) of the landing pad edge. [**418:**4.6.1]

21.3.3.5.2 NO SMOKING signs shall be erected at access/egress points to the heliport. [**418:**4.6.2]

21.3.3.6 Fueling System. Fueling systems shall be designed in accordance with Section 42.10. [**418:**4.7]

21.3.3.6.1 Fueling equipment shall not hinder or obstruct access to exits or fire-fighting equipment. [**418:**4.7.1]

21.3.3.6.2 Fueling equipment shall be located a minimum of 25 ft (7.6 m) from hangars and fixed fire protection equipment. [**418:**4.7.2]

21.3.3.6.3 Fuel servicing equipment shall be designed to not penetrate the FATO and safety area obstruction clearance requirements in FAA AC 150/5390-2C, *Heliport Design Advisory Circular*. [**418:**4.7.3]

21.3.3.7* Means of Egress. At least two means of egress that lead to a public way shall be provided from the landing pad. [**418:**4.8]

A.21.3.3.7 The two means of egress can also be used for access to the landing pad for fire-fighting and/or rescue operations. Where doors accessing the interior of the building are locked, an approved means should be provided for entry of emergency responders. [**418:**A.4.8]

21.3.3.7.1* The egress points shall be located at least 90 degrees from each other as measured from the center of the landing pad (TLOF). [**418:**4.8.1]

A.21.3.3.7.1 Figure A.21.3.3.7.1(a) and Figure A.21.3.3.7.1(b) are examples of acceptable configurations of egress points on landing pads. The geometry of the landing pad in Figure A.21.3.3.7.1(b) is such that it has no sides and does not comply with 21.3.3.7.3; however, it does comply with the 90-degree rule in 21.3.3.7.1. Figure A.21.3.3.7.1(c) is an example of an unacceptable configuration, due to both egress points being on the same side of the landing pad. [**418:**A.4.8.1]

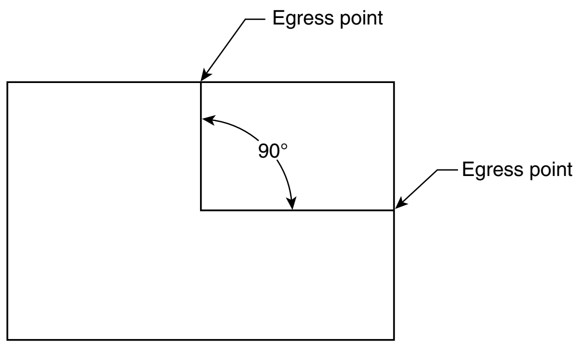


*FIGURE A.21.3.3.7.1(a) Example of an Acceptable Configuration of Egress Points on a Landing Pad. [**418:**Figure A.4.8.1(a)]*

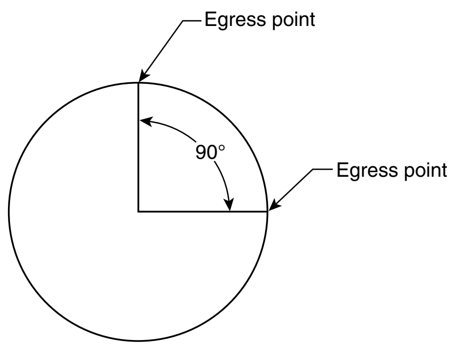


*FIGURE A.21.3.3.7.1(b) Example of an Acceptable Configuration of Egress Points on a Landing Pad with No Sides. [**418:**Figure A.4.8.1(b)]*

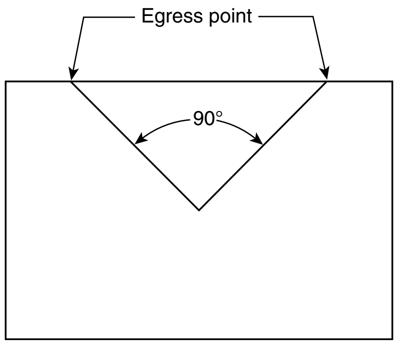


*FIGURE A.21.3.3.7.1(c) Example of an Unacceptable Configuration of Egress Points on a Landing Pad. [**418:**Figure A.4.8.1(c)]*

21.3.3.7.2 The egress points shall be located remotely from each other, not less than 30 ft (9.1 m) apart. [**418:**4.8.2]

21.3.3.7.3 No two egress points shall be located on the same side of the landing pad. [**418:**4.8.3]

21.3.4 Rooftop Landing Facilities.

21.3.4.1* Structural Support. Main structural support members that could be exposed to a fuel spill shall be made fire resistant using listed materials and methods to provide a fire-resistance rating of not less than 2 hours. [**418:**5.2]

A.21.3.4.1 Where the landing pad is nonporous, fuel-tight, and provided with a proper drainage system, and where fuel cannot flow to support members, the main structural support members would not need to be fire rated. [**418:**A.5.2]

21.3.4.2 Landing Pad Pitch. The rooftop landing pad shall be pitched to provide drainage at a slope of 0.5 percent to 2 percent. [**418:**5.3]

To reduce fuel leak–related hazards, 21.3.4.2 requires that the pitch of the landing area be directed away from locations where people might be waiting or where the fuel could enter a building.

The requirement for handling fuel drainage, including water-oil separators, is addressed by federal and state regulations. This commentary also applies to 21.3.3.4.

21.3.4.2.1 The pitch of the pad shall be designed to protect, at a minimum, the primary egress path, passenger holding area, rooftop hangar, and fire protection activation systems. [**418:**5.3.1]

21.3.4.2.2 Drainage flow shall not penetrate alternate egress points, stairways, ramps, hatches, and other openings not designed for drainage. [**418:**5.3.2]

21.3.4.2.3 The pitch of the pad shall not be required where the pad consists of a passive fire protection grid surface designed and listed for fuel catchment and containment. [**418:**5.3.3]

21.3.4.3 Landing Pad Construction Materials.

21.3.4.3.1 The rooftop landing pad surface shall be constructed of approved noncombustible, nonporous materials. [**418:**5.4.1]

21.3.4.3.2 The contiguous building roof covering within 50 ft (15.2 m) of the landing pad edge shall have a Class A fire resistance rating for exterior fire exposure, and shall be tested according to FM 4470, *Approval for Class 1 Roof Covers;* ANSI/UL 790, *Standard Test Methods for Fire Tests of Roof Covering;* or ASTM E108, *Standard Test Methods for Fire Tests of Roof Coverings*. [**418:**5.4.2]

21.3.4.4* Means of Egress. Two means of egress from the rooftop landing pad to the building's egress system shall be provided. [**418:**5.5]

A.21.3.4.4 Design of the means of egress from a rooftop landing pad might involve a compromise among several different code requirements. Rooftop landing pads bring with them an inherent risk. The means of egress must be provided for safety to human life. Strict compliance with a code's requirement for rated stairways off the landing pad is not the intent of this standard. The intent of this standard is to provide a minimum safeguard to provide a reasonable degree of safety to all persons on the roof. The building's egress system is dictated by the adopted building code. Once those persons enter the building's egress system, they are away from the FATO area. [**418:**A.5.5]

The purpose of 21.3.4.4 requiring landing pads to have two remotely located means of egress from the pad edge is to allow passengers and crew to exit the pad area quickly in an emergency and to allow emergency personnel to reach the area from more than one direction. For example, see Exhibit 21.2, which shows a landing pad on a hospital roof with one means of egress leading directly to the hospital building and another means to the roof area.

21.3.4.4.1* The egress points shall be located at least 90 degrees from each other as measured from the center of the landing pad (TLOF). [**418:**5.5.1]

A.21.3.4.4.1 See Figure A.21.3.3.7.1(a) through Figure A.21.3.3.7.1(c) for examples of acceptable configurations of egress points on landing pads. The geometry of the landing pad in Figure A.21.3.3.7.1(b) is such that it has no sides and cannot comply with 21.3.4.4.3; however, it does comply with the 90-degree rule in 21.3.4.4.1. Figure A.21.3.3.7.1(c) is not an acceptable configuration due to both egress points being on the same side of the landing pad. [**418:**A.5.5.1]

Exhibit 21.2

Landing pad on a hospital roof. (Dave Greenberg/Dreamstime.com)

21.3.4.4.2 The egress points shall be remotely located from each other, not less than 30 ft (9.1 m) apart. [**418:**5.5.2]

21.3.4.4.3 No two egress points shall be located on the same side of the rooftop landing pad. [**418:**5.5.3]

21.3.4.4.4* Means of egress from the landing pad shall not obstruct flight operations. [**418:**5.5.4]

A.21.3.4.4.4 When considering the means of egress from the landing pad and for the rooftop, obstructions to the FATO need to be avoided since they can create unsafe flight conditions that have been shown to cause aircraft accidents. Exterior, open stairways leading to the building's egress system should not encroach into the FATO. [**418:**A.5.5.4]

21.3.4.5 Fire-Fighting Access. (Reserved)

21.3.4.6 Fire Protection.

N **21.3.4.6.1 General.** A foam fire-extinguishing system with either a fixed discharge outlet(s) in accordance with 21.3.4.6.2.1 or a hose line(s) in accordance with 21.3.4.6.3.1 shall be designed and installed to protect the rooftop landing pad, unless otherwise permitted by the following:

(1) A foam fire-extinguishing system shall not be required for heliports located on open parking structures or buildings that are not normally occupied.
(2) For H-1 heliports, two portable foam extinguishers, each having a rating of 20-A:160-B, shall be permitted to be used to satisfy the requirement of 21.3.4.6.

[**418:**5.7.1]

21.3.4.6.1.1 Where trained personnel are not available, fixed fire protection outlet(s) shall be provided. [**418:**5.7.1.1]

21.3.4.6.1.2* The foam discharge rate for the fire-extinguishing system shall be 0.10 gpm/ft^2 (4.1 L/min·m^2) for aqueous film forming foam (AFFF). [**418:**5.7.1.2]

A.21.3.4.6.1.2 Currently, the qualified products listed for MIL-F-24385 do not contain any fluoroprotein or protein foam products. [**418:**A.5.7.1.2]

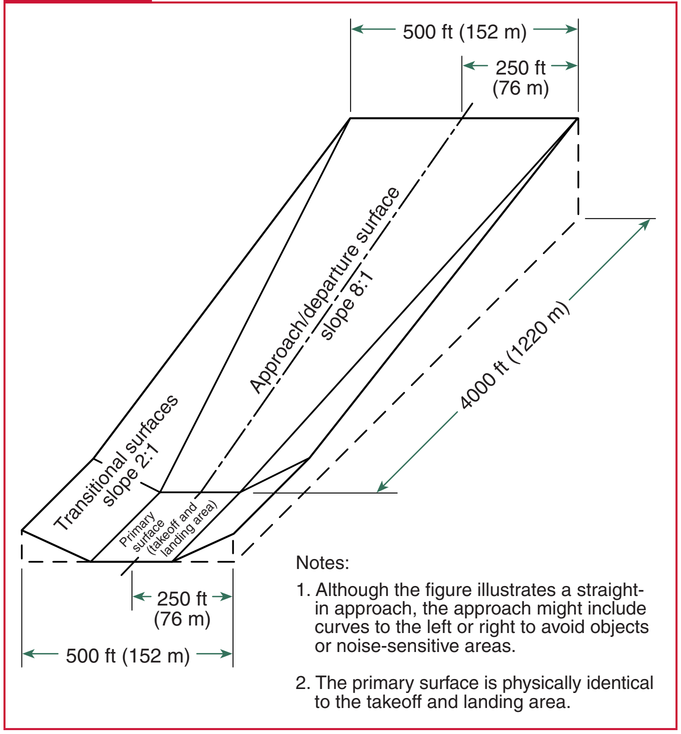
N **21.3.4.6.1.3** Where freezing is possible, freeze protection shall be provided. [**418:**5.7.1.3]

N **21.3.4.6.1.4** The foam components shall be installed in an area of the heliport and shall not penetrate the approach takeoff surface, transitional surfaces, and safety area as defined in FAA AC 150/5390-2C, *Heliport Design Advisory Circular*. [**418:**5.7.1.4]

Paragraph 21.3.4.6.1.4 is important because foam equipment and piping must be kept clear of the primary surface and must remain outside the approach/departure surface and the transitional surface. Penetration into these imaginary surfaces increases the risk that an aircraft could impact the fire protection system, causing it to be inoperative when it is needed.

The contents of FAA A/C 150/5390-2B, *Heliport Design Advisory Circular*, are too extensive to repeat here. They address the normal design of the heliport approach and departure surfaces and the required clearances to the designated landing area. The clearance has three components: the primary surface, the approach/departure surface, and the transitional surface. These three surfaces, illustrated in Exhibit 21.3, are defined as follows:

Exhibit 21.3



Heliport imaginary surfaces.

1. Primary surface. An area of a size and shape that coincides with the designated takeoff and landing area of a heliport. This surface is a horizontal plane with an elevation equivalent to the established heliport elevation.
2. Approach/departure surface. An imaginary surface that begins at the end of the heliport primary surface. It has the same width as the primary surface and extends outward and upward horizontally to a distance of 4000 ft (1220 m), where its width is 500 ft (152 m). The slope of the approach/departure surface is 8 to 1 for civil heliports.
3. Transitional surface. An imaginary surface that extends outward and upward from the lateral boundaries of the heliport primary surface and from the approach surface at a slope of 2 to 1 for a distance of 250 ft (76 m), measured horizontally from the centerline of the primary and approach surfaces.

21.3.4.6.2 Fixed Foam Fire-Extinguishing Systems.

N **21.3.4.6.2.1** Fixed foam fire-extinguishing systems shall be designed and installed in accordance with NFPA 11, NFPA 16, or an equivalent standard, as appropriate, except as modified by Chapter 5 of NFPA 418. [**418:**5.7.2.1]

21.3.4.6.2.2* The area of application of foam discharge for fixed discharge outlet systems shall be the entire rooftop landing pad. [**418:**5.7.2.2]

A.21.3.4.6.2.2 Consideration should be given to the environmental conditions of the rooftop landing pad in the design of the system, including wind, exhaust fans, and other factors that affect the distribution of the foam on the rooftop landing pad. [**418:**A.5.7.2.2]

21.3.4.6.2.3 The duration of foam discharge for the fixed discharge outlet system shall be 10 minutes. [**418:**5.7.2.3]

N **21.3.4.6.2.4** A fixed nozzle discharge outlet system shall be one of the following: fixed stationary nozzles around the perimeter, two or more oscillating monitors/nozzles, or in-deck nozzles within the perimeter of the deck. [**418:** 5.7.2.4]

N **21.3.4.6.2.5** Where fixed foam systems utilizing fixed deck nozzles or oscillating foam turrets, or both, are installed, system components shall be listed or approved. [**418:**5.7.2.5]

N **21.3.4.6.2.6 Activation of Systems.**

N **21.3.4.6.2.6.1*** The fixed discharge outlet system shall be activated manually. [**418:**5.7.2.6.1]

N **A.21.3.4.6.2.6.1** Training on the operation of the fire protection system should be in accordance with Annex B of NFPA 418. [**418:**A.5.7.2.6.1]

N **21.3.4.6.2.6.2*** Manual actuation stations shall be located at each egress point from the rooftop landing pad and at an approved location inside the building from which the rooftop landing pad can be viewed. [**418:**5.7.2.6.2]

N **A.21.3.4.6.2.6.2** It is acceptable for the rooftop landing pad to be viewed using video or other acceptable means. [**418:**A.5.7.2.6.2]

N **21.3.4.6.2.6.3** Manual foam activation stations shall be clearly labeled or identified as to the purpose and hazard protected. [**418:**5.7.2.6.3]

N **21.3.4.6.2.7** Where buildings are provided with a fire alarm system, the activation of the foam system shall be monitored by the building fire alarm system in accordance with *NFPA 72*. [**418:**5.7.2.6.4]

N **21.3.4.6.2.8** An approved manual control for foam system shutdown shall be accessible at all times, including the time of fire and system operation. [**418:**5.7.2.6.5]

21.3.4.6.3 Manual Fire-Fighting Equipment.

21.3.4.6.3.1* The area of application of foam discharge for hose line systems shall be the practical critical fire area for the category of the helicopter landing facility in accordance with Table 21.3.4.6.3.1. [**418:**5.7.3.1]

TABLE 21.3.4.6.3.1 *Practical Critical Fire Areas for Hose Line Systems Only*

Heliport Category	Helicopter Overall Length*	Practical Critical Fire Area ft²	m²
H-1	Less than 50 ft (15.2 m)	375	34.8
H-2	50 ft (15.2 m) up to but not including 80 ft (24.4 m)	840	78.0
H-3	80 ft (24.4 m) up to but not including 120 ft (36.6 m)	1440	133.8

*Helicopter length, including the tail boom and the rotors.
[**418:** Table 5.7.3.1]

The minimum required foam discharge rate, as specified in 21.3.4.6.1.2, is based on the rate developed by the NFPA Technical Committee on Aircraft Rescue and Fire Fighting, which determined the amount of foam required to control aviation fuel fires. See Annex C of NFPA 418 for information on establishing extinguishing agent quantities and discharge rates for helicopters.

A.21.3.4.6.3.1 The area of application and the duration where using a hose line system is reduced because foam is applied efficiently and directly on the fire by trained personnel. [**418:**A.5.7.3.1]

The concept of *critical fire area* referenced in 21.3.4.6.4.3.1 was initially developed for fixed-wing aircraft. Critical fire area is the area equal to the length of the fuselage multiplied by the width of the wing. The formula was used to determine the amount of foam needed for application in the event of a crash. In a study of 106 fixed-wing aircraft fires, the quantities of agents used were less than those recommended by the theoretical critical fire area calculations in 99 of 106 fires. As a result, a practical critical area (PCA) of fixed-wing aircraft was determined to be approximately two-thirds of the theoretical area.

21.3.4.6.3.2 The duration of foam discharge for the hose line systems shall be 2 minutes. [**418:**5.7.3.2]

N **21.3.4.6.4** Standpipes and hose stations, if used, shall be installed in accordance with Section 13.4. [**418:**5.7.4]

21.3.4.6.5 Water Supply.

N **21.3.4.6.5.1** The water supply for the foam system shall be from a source approved by the AHJ. [**418:**5.7.5.1]

21.3.4.6.5.2 Fire pumps, if used, shall be installed in accordance with Section 13.4. [**418:**5.7.5.2]

N **21.3.4.6.6 Foam Concentrate Supply.**

N **21.3.4.6.6.1** The supply of foam concentrate shall be sufficient to supply the largest system. [**418:**5.7.6.1]

Δ **21.3.4.6.7** The foam concentrate for the fixed system or manual fire-fighting equipment shall be listed in accordance with UL 162, *Standard for Foam Equipment and Liquid Concentrates*, and shall be on the qualified products list for MIL-F-24385, or equivalent. [**418:**5.7.6.2]

21.3.4.6.8 Fire Alarm. A means of communication shall be provided from the roof area to notify the fire department of emergencies. [**418:**5.7.7.1]

21.3.4.6.8.1 Where buildings are provided with a fire alarm system, a manual pull station shall be provided for each designated means of egress from the roof. *(See 21.3.4.4.)* [**418:**5.7.7.2]

N **21.3.4.6.9 Acceptance Testing.**

N **21.3.4.6.9.1 Fixed Foam Fire-Extinguishing Systems.** The fixed foam discharge outlet system shall be tested with foam to determine the coverage of the rooftop landing pad. [**418:**5.7.8.1]

N **21.3.4.6.9.1.1** The system shall cover 95 percent of the rooftop landing pad during the test. [**418:**5.7.8.1.1]

N **21.3.4.6.9.1.2** The access points for firefighting and for egress shall be covered. [**418:**5.7.8.1.2]

N **21.3.4.6.9.2 Manual Fire-Fighting Equipment.** The hose handlines shall be flow tested to demonstrate that the design objectives are met. [**418:**5.7.8.2]

N **21.3.4.6.10 Inspection, Testing, and Maintenance.**

N **21.3.4.6.10.1** Fire protection systems installed in accordance with NFPA 14 or NFPA 16 shall be inspected, tested, and maintained in accordance with NFPA 25. [**418:**5.7.9.1]

N **21.3.4.6.10.2** Foam systems installed in accordance with NFPA 11 shall be maintained in accordance with NFPA 11. [**418:**5.7.9.2]

21.3.5 Portable Fire Extinguishers.

21.3.5.1 Minimum Requirement. At least one portable fire extinguisher as specified in Table 21.3.5.1 shall be provided for each takeoff and landing area, parking area, and fuel storage area. [**418:**9.2]

TABLE 21.3.5.1 *Minimum Ratings of Portable Fire Extinguishers for Heliport Categories*

Heliport Category	Helicopter Overall Length*	Minimum Rating
H-1	Less than 50 ft (15.2 m)	4-A:80-B
H-2	50 ft (15.2 m) up to but not including 80 ft (24.4 m)	10-A:120-B
H-3	80 ft (24.4 m) up to but not including 120 ft (36.6 m)	30-A:240-B

*Helicopter length, including the tail boom and the rotors.
[**418:** Table 9.2]

21.3.5.2 Extinguishers Subject to Damage, Theft, or Tampering. Where the portable extinguisher cannot be maintained and safeguarded against damage, theft, or tampering, the portable fire extinguisher shall be omitted with the approval of the AHJ. [**418:**9.3]

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2016 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2018 edition.

NFPA *101*®, *Life Safety Code*®, 2018 edition.

NFPA 220, *Standard on Types of Building Construction,* 2018 edition.

NFPA 409, *Standard on Aircraft Hangars,* 2016 edition.

NFPA 410, *Standard on Aircraft Maintenance,* 2015 edition.

NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways,* 2016 edition.

NFPA 418, *Standard for Heliports,* 2016 edition.

FAA A/C 150/5390-2B, *Heliport Design Advisory Circular,* U.S. Government Publishing Office, Washington, DC 20402, April 24, 2012.

22 Automobile Wrecking Yards

Chapter 22 covers automobile wrecking yards, which pose a wide variety of hazards, including hot work and the handling and storage of fuels and fluids, tires, plastics, combustibles, and hazardous materials. Automobile wrecking yards also pose general housekeeping issues. The nature of operations conducted at automobile wrecking yards presents many possibilities for fire hazards and hazardous materials incidents.

22.1 General

Automobile wrecking yards shall be in accordance with this chapter.

22.2 Permits

Permits, where required, shall comply with Section 1.12.

In addition to a permit to operate an automobile wrecking yard, Section 1.12 might require other permits. Other permits could cover, for example, storage of flammable and combustible liquids, hot work operations, burning, and storage of hazardous materials. See Section 1.12 for additional information on required permits.

22.3 Fire Department Access Roads

Fire department access roads shall be in accordance with Section 18.2.

22.4 Welding and Cutting

Welding and cutting operations shall be in accordance with Chapter 41.

22.5 Housekeeping

The yard shall be kept free of vegetation, debris, and any other material that is not necessary to the proper operation of the facility.

Housekeeping is a typical problem at automobile wrecking yards. All materials not necessary for the operation of the facility should be removed as soon as practicable to reduce unnecessary accumulations of combustible materials. Additionally, weeds and other vegetation should be kept clear to prevent a fire from spreading out of the automobile wrecking yard or to another adjacent area or into the facility. See 10.13.10 for additional guidance on managing combustible vegetation.

22.6 Fire Extinguishers

Fire extinguishers shall be placed and sized in accordance with Section 13.6.

22.7 Tire Storage

The storage of tires shall be in accordance with Chapters 33 and 34.

22.8 Burning Operations

Burning operations shall be in accordance with Section 10.10.

22.9 Motor Vehicle Fluids and Hazardous Materials

22.9.1 General. The storage, use, and handling of motor vehicle fluids and hazardous materials shall be in accordance with Chapters 60 and 66.

22.9.2 Motor Vehicle Fluids.

22.9.2.1 Motor vehicle fluids shall be drained from salvage vehicles when such fluids are leaking.

Leaking fluids from vehicles pose fire, health, and environmental concerns. When a vehicle is found to be leaking fluids, 22.9.2.1 requires that the fluids be drained completely from the vehicle. Paragraph 22.9.1 requires the storage of such fluids to comply with Chapters 60 and 66. A good practice is to drain all fluids from the vehicles upon entry to the yard, thus eliminating the potential for leaks due to handling or deterioration of vehicle components.

22.9.2.2 Storage and handling of motor vehicle fluids shall be done in an approved manner.

22.9.2.3 Flammable and combustible liquids shall be stored and handled in accordance with Chapter 66.

22.9.3 Mitigation for Vehicle Fluid Leaks.

22.9.3.1 Supplies or equipment capable of mitigating leaks from fuel tanks, crankcases, brake systems, and transmissions shall be kept available on site.

Vehicle fluid leaks are common at automobile wrecking yards. Appropriate means must be provided on site for immediate containment and cleanup of such leaks.

22.9.3.2 Single-use plugging, diking, and absorbent materials shall be disposed of as hazardous waste and removed from the site in a manner approved by federal, state, and local requirements.

Materials used to control and contain vehicle fluid leaks should be disposed of after use in an appropriate manner and in compliance with applicable environmental regulations.

22.9.4 Air Bag Systems. Removed air bag systems shall be handled and stored in accordance with Chapter 60.

Air bag systems contain sodium azide (NaN_3), which reacts with potassium nitrate (KNO_3) to produce nitrogen gas to inflate the air bags. Sodium azide is not only highly explosive but also extremely toxic. Care should be taken when working with, removing, or handling air bags, including attention to the bumper area and side area where activation can occur. Vehicle manufacturers should be contacted for information on the best way to handle air bag systems.

22.9.5 Lead-Acid Batteries.

Much like draining motor vehicle fluids, a best practice might be to remove all batteries from vehicles upon their arrival at the automobile wrecking yard. This practice prevents damage to batteries during operations and eliminates the need to mitigate battery acid leaks as well as possible electrical faults, which could start fires.

22.9.5.1 Lead-acid batteries shall be removed from salvage vehicles when such batteries are leaking.

22.9.5.2 Lead-acid batteries that have been removed from vehicles shall be stored in an approved manner.

23 Cleanrooms

Cleanrooms in semiconductor fabrication facilities and other comparable fabrication facilities are addressed by Chapter 23. Also see Chapter 60 for additional requirements for hazardous materials used in the fabrication of semiconductors or semiconductor research and development.

Δ 23.1 General

All semiconductor facilities containing a cleanroom or a clean zone, or both, shall comply with this chapter and NFPA 318.

The loss potential in a semiconductor manufacturing plant can be enormous. Typical plants cost more than $100 million to construct and $1 billion to equip. Add to this figure the value of completed and in-process semiconductor wafers, which are very susceptible to damage from fire and smoke, and the cost of the potential disruption of production schedules, product distribution, and business, and the loss could be staggering.

NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities*, applies to semiconductor fabrication facilities and comparable research and development areas in which hazardous chemicals are used, stored, and handled and that contain a *cleanroom,* a *clean zone,* or both (see 3.3.48 and 3.3.49). The purpose of NFPA 318 is to provide reasonable safeguards for the protection of facilities containing cleanrooms from fire and related hazards. Those safeguards are intended to provide protection against injury, loss of life, and property damage.

Semiconductor fabrication facilities are defined in NFPA 318 as "buildings or portions thereof used for the fabrication of semiconductors and related research containing quantities of hazardous materials exceeding the maximum allowable quantities of Level 5 contents permitted in a control area."

NFPA 318 covers the following topics:

1. Chapter 4 addresses building construction and related services.
2. Chapter 5 addresses hazardous materials.
3. Chapter 6 addresses liquid chemical storage and handling.
4. Chapter 7 addresses gas storage and handling.
5. Chapter 8 addresses production and support equipment.
6. Chapter 9 addresses exhaust systems.
7. Chapter 10 addresses waste treatment.
8. Chapter 11 addresses fire protection.
9. Chapter 12 addresses general safety precautions.

23.2 Applicability

Unless otherwise noted in NFPA 318, the provisions of NFPA 318 shall not be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of this *Code*, except in those cases where it is determined by the AHJ that the existing situation involves a distinct hazard to life or adjacent property.

23.3 Permits

Permits, where required, shall comply with Section 1.12.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities*, 2018 edition.

Drycleaning

24

24.1 General

Δ **24.1.1** Drycleaning plants shall comply with this chapter and NFPA 32.

NFPA 32, *Standard for Drycleaning Facilities*, prescribes safeguards intended to prevent fires and explosions involving drycleaning processes and to minimize the personal injury and property damage consequences of such incidents. NFPA 32 does not include requirements for disposal of any hazardous chemicals or materials.

The term *drycleaning* is defined in NFPA 32 as "the process of removing dirt, grease, paints, and other stains from such items as apparel, textiles, fabrics, and rugs by the use of nonaqueous liquids." Methods of drycleaning include the following:

1. Immersion and agitation with solvent in closed machines
2. Spotting with cleaning solvents
3. Dual-phase processing

NFPA 32 addresses five types of drycleaning plants or systems, as follows:

1. Type I. Systems employing Class I [flash point below 73°F (22.8°C)] solvents, which are prohibited by this *Code*, in accordance with 4.2.1 of NFPA 32 [e.g., 50°F (10°C) flash point naphtha]
2. Type II. Systems employing Class II solvents and complying with the requirements of Chapters 4, 5, 6, and 7 of NFPA 32 (e.g., Stoddard solvent)
3. Type IIIA. Systems employing Class IIIA solvents and complying with the requirements of Chapters 4, 5, 6, and 8 of NFPA 32 [e.g., 140°F (60°C) flash point solvent]
4. Type IIIB. Systems employing Class IIIB liquids and complying with the requirements of Chapters 4, 5, 6, and 8 of NFPA 32 (e.g., specially compounded oils)
5. Type IV. Systems employing Class IV (nonflammable) solvents and complying with the requirements of Chapters 4, 5, 6, and 9 of NFPA 32 (e.g., perchloroethylene, also known as "perc")

NFPA 32 recognizes the use of nonflammable liquefied gases, such as liquefied carbon dioxide, for drycleaning. Such use must comply with the requirements for Type IV plants, with additional requirements for the unique hazards of this solvent.

24.1.2 Drycleaning plants or systems using solvents that have a flash point below 100°F (37.8°C) shall be prohibited.

24.2 Permits

Permits, where required, shall comply with Section 1.12.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 32, *Standard for Drycleaning Facilities*, 2016 edition.

Grandstands and Bleachers, Folding and Telescopic Seating, Tents, and Membrane Structures

25

Chapter 25 addresses the construction, location, protection, and maintenance of grandstands and bleachers, folding and telescopic seating, tents, and membrane structures. Exhibit 25.1 depicts the terminal building at Denver International Airport, which is an example of a membrane structure.

25.1 General

Δ **25.1.1** The construction, location, protection, and maintenance of grandstands and bleachers, folding and telescopic seating, tents, and membrane structures shall meet the requirements of this chapter. Seating facilities located in the open air or within enclosed or semi-enclosed structures, such as tents, membrane structures, and stadium complexes, shall comply with this chapter, NFPA *101*, and NFPA 102.

25.1.2 Permits. Permits, where required, shall comply with Section 1.12.

25.1.3 Means of Egress.

25.1.3.1 Means of egress shall comply with the requirements of Chapter 14.

25.1.3.2 No guy wire or guy rope shall cross any means of egress at a height of less than 7 ft (2.1 m).

The 7 ft (2.1 m) height for guy wires required by 25.1.3.2 prevents people from walking or running into the guy wire. Tent stakes also present a tripping hazard. Stakes located near a means of egress or walkway must be protected and identified so that people will not trip over or fall on them. A recommended practice is to locate a fence, where possible, to prevent people from coming into contact with stakes and guy wires.

Exhibit 25.1

Membrane structure. (Courtesy of Denver International Airport)

25.1.3.3 Tent stakes adjacent to any means of egress from any tent open to the public shall be railed off, capped, or covered so as not to present a hazard to the public.

25.1.3.4 New facilities shall comply with the means of egress provisions of NFPA *101* for the applicable occupancies.

25.1.3.5 Existing facilities shall comply with the means of egress provisions of NFPA *101* for the applicable occupancies.

25.1.4 Flammable Liquids and Gases.

Δ **25.1.4.1** Where required by the provisions of Chapters 11 through 43 in NFPA *101*, occupancies with storage and handling of hazardous materials shall comply with the following codes unless otherwise modified by other provisions of NFPA *101:* Chapter 66 for flammable and combustible liquids, NFPA 54, Chapter 66 for compressed gases and cryogenic fluids, Chapter 69 for liquefied petroleum gases and liquefied natural gases, NFPA 400, and NFPA 495. [***101:***8.7.3.1]

25.1.4.2* No storage, use, or handling of hazardous materials shall be permitted in any location where such storage, use, or handling would jeopardize egress from the structure, unless otherwise permitted by a document listed in 25.1.4.1. [***101:***8.7.3.2]

A.25.1.4.2 NFPA 58 permits the use of portable butane-fueled appliances in restaurants and in attended commercial food catering operations where fueled by a maximum of two 10 oz (0.28 kg) LP-Gas capacity, nonrefillable butane containers with a water capacity not in excess of 1.08 lb (0.4 kg) per container. Containers are required to be directly connected to the appliance, and manifolding of containers is not permitted. Storage of cylinders is also limited to 24 containers, with an additional 24 permitted where protected by a 2-hour fire resistance–rated barrier. *(See 4.1.3 of NFPA 101 and Annex C of NFPA 101 for referenced documents on hazardous materials.)* [***101:***A.8.7.3.2]

Subsection 25.1.4 has been updated for the 2018 edition of the *Code* to provide a more comprehensive approach to hazardous materials as well as to bridge a gap between NFPA *101®, Life Safety Code®,* and the other NFPA codes and standards addressing hazardous materials.

Generators, heaters, propane cylinders, and similar items should not be in proximity to the means of egress. If problems occur with the functioning of these types of equipment, the means of egress could be blocked, preventing or delaying egress.

Equipment using flammable liquids should be located outside the structure, at a safe distance from the structure, and in an area that will not directly affect any other structures or operations. Where fuel-fired equipment is permitted to be used indoors, refueling should take place outside at a safe distance from the structure.

25.1.4.3 Refueling of equipment with liquids having flash points below 100°F (38°C) shall not be permitted within the structure.

25.1.5 Fire Hazards.

25.1.5.1 The finished ground level enclosed by the structure, and the surrounding finished ground level not less than 10 ft (3050 mm) outside of the structure, shall be cleared of all flammable or combustible material and vegetation. [**5000:**32.3.5.1.1]

Care should be taken when erecting structures in open fields to ensure that dried vegetation is not a fuel source. Many times, tents or temporary membrane structures are set up in fields. The field or other setup areas should be mowed to remove excessive and tall combustible vegetation from the site. If the tent or membrane structure will be in place for an extended period of time, additional cuttings might be necessary to keep the combustible vegetation to a minimum.

25.1.5.2 Where prohibited by the AHJ, smoking shall not be permitted in any temporary membrane structure. [***101:***11.10.2.2]

See Section 10.9 for additional smoking prohibitions.

25.1.5.3 Hay, straw, shavings, or similar combustible materials that have not been treated to make them flame retardant to a degree acceptable to the AHJ shall not be permitted within any structure used as an assembly occupancy.

Exception: Animal bedding and fodders in quantities approved by the AHJ.

The quantity of combustible materials in an assembly occupancy addressed by Chapter 25 should be limited. Where combustible materials are permitted, they must be treated to make them flame retardant. However, bedding materials used for animals are exempt from treatment because the flame retardant could cause irritation. Depending on the type and amount of materials present, the authority having jurisdiction (AHJ) might require additional protection, standby personnel, or both. (See 1.7.17 for additional information on standby fire personnel.)

25.1.5.4 Open Flame Devices and Pyrotechnics. Use of open flame devices and pyrotechnics shall comply with 20.1.5.3.

25.1.6 Extinguishment Requirements.

Δ **25.1.6.1** Enclosed stadiums, arenas, and similar structures shall be protected throughout by an approved, electrically supervised automatic sprinkler system in accordance with Section 13.3, unless otherwise permitted by the following:

(1) Where the ceiling or roof, whichever is lower, of the playing/activity area is more than 55 ft (16.7 m) above the floor, sprinklers shall not be required above the playing/activity area where permitted by the AHJ.
(2) Sprinklers shall not be required above seating areas that view the playing/activity area.

[**5000:**32.3.5.2]

25.1.6.2 An enclosed area shall be protected by an approved sprinkler system in accordance with Section 13.3, unless such an area is one of the following:

(1) Enclosed stadiums, arenas, and similar structures
(2) Press boxes of less than 1000 ft^2 (93 m^2)
(3) Storage facilities of less than 1000 ft^2 (93 m^2), if enclosed with minimum 1-hour fire resistance–rated construction
(4) Enclosed areas underneath grandstands or bleachers that comply with 16.4.9.5 of *NFPA 5000*

[**5000:**32.3.5.3]

Enclosed areas are required to be provided with automatic sprinkler protection unless they are small in area, as outlined in 25.1.6.2. A fire in an enclosed area can grow unnoticed for an extended period of time. Such fires can adversely affect occupant response and the functioning of various protection features, such as means of egress routes and structural integrity.

Additional automatic sprinkler protection might be required where combustible materials are used. Exhibit 25.2 shows sprinklers installed under a grandstand with wooden structural elements.

Exhibit 25.2

Sprinklers installed under a grandstand.

25.1.6.3 Portable fire extinguishers shall be installed in assembly occupancies in accordance with Section 13.6, unless otherwise permitted by one of the following:

(1) The requirement of 25.1.6.3 shall not apply to seating areas.
(2) The requirement of 25.1.6.3 shall not apply to floor areas used for contests, performances, or entertainment.
(3) The requirement of 25.1.6.3 shall not apply to outside assembly occupancy areas.
(4) Portable extinguishers shall be permitted to be located in secure locations accessible to staff.

[**5000:**16.3.5.3]

25.1.6.4 Fire-extinguishing equipment shall be maintained in accordance with Section 13.6.

25.1.6.5 Employees shall be trained to operate fire-extinguishing equipment and shall be required to exhibit their skill when requested by the AHJ.

25.1.7 Detection, Alarm, and Communications Systems. Detection, alarm, and communications systems shall comply with Section 13.7 where required by 13.7.2.1 or 13.7.2.2.

New assembly occupancies having an occupant load of more than 300 must be provided with a fire alarm system, regardless of the type of structure in which the assembly occupancy is located. Where the AHJ determines the installation of a complete fire alarm in accordance with *NFPA 72®, National Fire Alarm and Signaling Code®,* is impracticable, an alternative arrangement to provide notification of an emergency to occupants might be permitted using the provisions for equivalency in Section 1.4.

25.1.8* Fire Detail. See 1.7.17 for fire detail requirements.

A.25.1.8 Because of the variety of types of places of assembly covered by this *Code*, no general requirement for patrols or fire watchers has been included. The committee fully recognizes the importance of this feature of fire protection, however, and believes that a system of well-trained patrols or fire watchers should be maintained in every place of assembly where fire hazards might develop. Such locations would include, among others, the spaces underneath grandstands and the areas inside and outside tents and air-supported structures. The fire watchers serve to detect incipient fires and to prevent an accumulation of materials that will carry fire. The number of such watchers required will, of course, vary for the different types of assembly occupancies, depending upon the combustibility of the construction and the number of persons accommodated. Provided with an adequate supply of portable fire-extinguishing equipment located at readily accessible points, such a fire watch or detail should be able to prevent small fires from reaching serious proportions.

Standby personnel are often required due to the size of a structure, the types of hazards present, or the large numbers of occupants.

25.1.9 Electrical Installations.

Because electrical wiring might require a complicated system or array involving many specifications and design details, the *Code* does not repeat them; rather, it references *NFPA 70®, National Electrical Code®* for design and installation requirements.

The requirements for emergency lighting addressed by Section 7.9 of NFPA *101*, particularly by 7.9.2.3, with respect to independence of the emergency lighting source and distribution network, are more stringent than the more general requirements of *NFPA 70*. See the commentary throughout Section 7.9 of NFPA *101*.

25.1.9.1 Electrical Systems. Electrical wiring and equipment shall be in accordance with Section 11.1, unless such installations are approved existing installations, which shall be permitted to be continued in service. [***101:***9.1.2]

25.1.9.2 The electrical system shall be installed, maintained, and operated in a safe and professional manner. When in use, portable electrical systems shall be inspected daily by a qualified person representing the owner, and any defects found shall be corrected before the public is admitted.

25.1.9.3 The electrical system and equipment shall be isolated from the public by proper elevation or guarding, and all electrical fuses and switches shall be enclosed in approved enclosures. Cables on the ground in areas traversed by the public shall be placed in trenches or protected by approved covers.

Electrical wires and installations should be placed beyond the normal travel routes and away from immediate public access. Wires that cross paths of travel should be suspended overhead at a minimum height of 7 ft (2.1 m), as shown in Exhibit 25.3, and higher if the path of travel is used as a fire department access road (see 18.2.3). Another option is to place electrical wires under an approved device. Exhibit 25.4 shows an incorrect installation of electrical wiring across a path of travel.

25.1.10 Heating Devices.

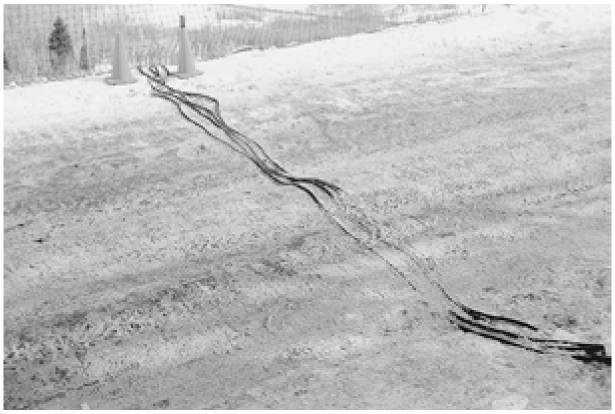
25.1.10.1 Fired Heaters.

25.1.10.1.1 Heating devices shall comply with Sections 11.2 and 11.5.

Exhibit 25.3

Elevated electrical system.

Exhibit 25.4



Incorrect electrical system installation in a roadway.

25.1.10.1.2 Only labeled heating devices shall be used. [***101:***11.9.5.1.1]

25.1.10.1.3 Fuel-fired heaters and their installation shall be approved by the AHJ. [***101:***11.9.5.1.2]

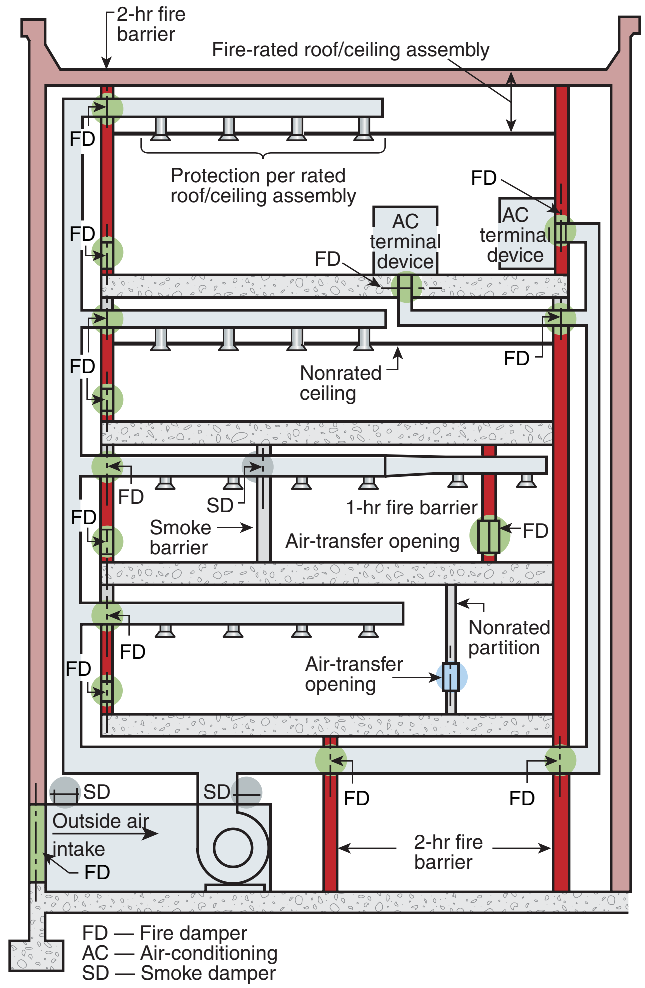
Portable heaters can be placed within tents and membrane structures. All other heaters should be placed outside and ducted into the structure, unless otherwise approved by the AHJ. Exhibit 25.5 depicts portable heaters located outside a membrane structure. Although the *Code* does not require carbon monoxide (CO) detection in assembly occupancies, its installation — to ensure that CO levels are within an acceptable range — would be beneficial.

25.1.10.1.4 Air-Conditioning, Heating, Ventilating Ductwork, and Related Equipment. Air-conditioning, heating, ventilating ductwork, and related equipment shall be in accordance with 11.2.1, as applicable, unless such installations are approved existing installations, which shall be permitted to be continued in service. [***101:***9.2.1]

Exhibit 25.5

Portable heaters placed outside membrane structure.

Exhibit 25.6



Partition and fire barrier penetration protection.

For the proper installation of HVAC systems, 25.1.10.1.4 refers the *Code* user to NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems.* For occupancies with small overall volumes, such as one- and two-family dwellings, the *Code* refers the user to NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.*

For example, NFPA 90A addresses fire damper requirements for both ductwork and air-transfer grilles that penetrate fire barriers. NFPA 90A also prohibits means of egress corridors in health care, detention and correctional, and residential occupancies from being used as a portion of a supply-, return-, or exhaust-air system serving adjoining areas. Exhibit 25.6 identifies some of the areas where fire dampers and smoke dampers would be required by NFPA 90A.

25.1.10.1.5 Ventilating or Heat-Producing Equipment. Ventilating or heat-producing equipment shall be in accordance with 11.2.2, as applicable, unless such installations are approved existing installations, which shall be permitted to be continued in service. [***101:***9.2.2]

25.1.10.1.6 Containers for liquefied petroleum gases shall be installed not less than 5 ft (1.5 m) from any tent or temporary membrane structure and shall be in accordance with the provisions of Chapter 69.

25.1.10.1.7 Tanks shall be secured in the upright position and protected from vehicular traffic.

Fuel tanks must be secured in accordance with 25.1.10.1.7 to prevent them from tipping over. If a fuel tank tips over while in use, liquid fuel, instead of vapors, will be introduced into the heating unit, resulting in a larger flame in the heater.

25.1.10.2 Electric Heaters.

25.1.10.2.1 Electric heaters shall comply with 25.1.10.2 and Section 11.5.

25.1.10.2.2 Only labeled heaters shall be permitted. [***101:*** 11.9.5.2.1]

25.1.10.2.3 Electric heaters, their placement, and their installation shall be approved by the AHJ. [***101:***11.9.5.2.2]

25.1.10.2.4 Heaters shall be connected to electricity by electric cable that is suitable for outside use and is of sufficient size to handle the electrical load. [***101:***11.9.5.2.3]

25.1.11 Cooking. Cooking operations shall comply with Chapter 50.

25.1.12 Generators.

25.1.12.1 Generators and other internal combustion power sources shall be separated from temporary membrane structures and tents by a minimum of 5 ft (1.5 m) and shall be protected from contact by fencing, enclosure, or other approved means.

Due to the location and temporary nature of tents and membrane structures, generators are often used to provide electrical power. Generators and other combustion engines must be placed a minimum of 5 ft (1.5 m) from such structures. Generators should be located away from public access. Based on the size of the generating unit, the 5 ft (1.5 m) distance requirement of 25.1.12.1 might need to be increased to prevent exhaust gas containing CO from entering the structure. Fencing or other approved means should be placed around the generator and other heat-producing appliances to prevent unauthorized access and inadvertent contact with electrical connections and hot surfaces. The AHJ should discuss with the operator the precautions to be taken when refueling the generators. The generator should not be refueled during events or while the structure is occupied by the public.

25.1.12.2 Fueling. Fuel tanks shall be of adequate capacity to permit uninterrupted operation during normal operating hours. Refueling shall be conducted only when not in use.

25.1.12.3 Fire Extinguishers. A minimum of one portable fire extinguisher with a rating of not less than 2-A:10-B:C shall be provided.

25.2 Tents

A tent is considered a temporary structure composed of a pliable covering material that achieves its support by mechanical means, such as beams, columns, poles, or arches, or by rope or cables, or both. A tent could also include a temporary tensioned-membrane structure.

25.2.1 General.

25.2.1.1 Tents shall be permitted only on a temporary basis. [***101:***11.11.1.2]

Tents are intended to remain in place for a period of 180 consecutive days or less. Tents must comply with Chapter 25 of this *Code*; NFPA *101*; NFPA 102, *Standard for Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures*; and the applicable requirements of *NFPA 5000®*, *Building Construction and Safety Code®*.

An application for use of a tent should include not less than the following information:

1. Start and finish dates of the event/activity.
2. Venue name, address, and telephone number.
3. Applicant's mailing address and telephone number.
4. Size of the tent and the area that it will cover on the premises. (See 25.2.1.2.)
5. Description of the activities that will take place within the tent (e.g., use of the tent as a place of assembly for a circus, carnival, show, theater, skating rink, dance hall, concert or for dining or other place of assembly in or under which persons gather for any purpose).
6. Dates of the use period (dates tent is erected and dismantled).
7. Construction documents that show the structural design loads, flame resistance of the fabric material (25.2.2), electrical installation needs (25.1.9), and heating appliances if used (25.1.10).
8. Documentation from a licensed structural engineer regarding structural stability. Tents and their appurtenances must be adequately roped, braced, and anchored to withstand the elements of weather and prevent unintentional collapse.
9. Certificate executed by an approved testing laboratory certifying that the tent(s) and its appurtenances, sidewalls, canopies, tarpaulins, floor coverings, bunting, combustible decorative materials, and effects are as follows:
   a. Composed of flame-resistant material or treated with a flame retardant in an approved manner
   b. Meet the requirements for flame resistance as determined in accordance with NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*
   c. Flame resistance in accordance with NFPA 701 is effective for the use period of the tent (tents required to have a permanently affixed label bearing the identification of size and fabric or material type, per 25.2.2

10. Certification of the flame resistance of the tent fabric material, including names and addresses of the owners of the structure, date the fabric was last treated with flame-resistant solution, trade name or type of chemical used in treatment, name of person or firm treating the material, and name of testing agency and test standard by which the fabric was tested. (See 25.2.2.2.)
11. Detailed site and floor plan for each tent that identifies the means of egress facilities, seating capacity, seating arrangement, location and type of heating equipment, and location and type of electrical equipment. Seating arrangements are among the most common reasons for rejection of tent applications. The AHJ should be given the opportunity to review the plan early in the application process. (See 25.1.3 and Chapter 14. Also see Section 1.12 and Section 10.14.)

The applicant must also do the following:

1. Indicate to the AHJ whether any connecting corridors will be provided between the tents. If tents are to be joined together by means of corridors, exit doors should be provided at the end of each such corridor. The appropriate size of openings, as required by NFPA *101*, must be provided. (See 25.1.3, 25.2.3, and Chapter 14.)
2. Indicate to the AHJ the placement of tents. The placement of tents relative to other structures is at the discretion of the AHJ. Care must be taken by the AHJ to ensure that tents are not located too close to lot lines, buildings, other structures and tents, parked vehicles, or internal combustion engines. (See Exhibit 25.7.) The AHJ must also consider the required distances and separation requirements for support ropes and guy wires. (See 25.1.3.2, 25.1.4, 25.1.12, and 25.2.3.)
3. Indicate to the AHJ whether any outside fireworks display will take place, such that appropriate measures and precautions can be put in place. Tents must not be placed within the fallout zone of fireworks or any other pyrotechnic displays. (See 25.1.5.4.)
4. Indicate to the AHJ whether any spot or effect lighting will be provided. Spot and/or effect lighting, as shown in Exhibit 25.8, must be powered by electricity, and all combustible construction must be located away from such equipment and be protected with approved noncombustible insulation in accordance with *NFPA 70*. (See 25.1.9.)
5. Provide portable fire extinguishers in all tent structures in accordance with Section 13.6. (See 25.1.6.3, 25.1.6.4, 25.1.6.5, and 25.2.5.)
6. Ensure that the required means of egress widths for exits, aisles, and other means are maintained at all times. Care must be taken to ensure that wires, ropes, and other support members do not obstruct the means of egress. The means of egress must be maintained clear and free of any obstructions at all times. (See Section 14.4 and 25.1.3.2.)
7. Ensure that adequate means of egress illumination and markings are provided and visible from all areas within the structure.

The AHJ, owner, and fire department should consider the following factors when reviewing a permit application for an inspection:

1. The permit applicant, owner, or agent must inspect the tent at regular intervals to determine that the installation is maintained in accordance with Chapter 25 and the permit approval conditions.
2. Fire and other emergency vehicles must be able to reach a point no greater than 150 ft (46 m) from any portion of the exterior wall of any structure. Emergency access roads must have an unobstructed width of 20 ft (6 m) and an unobstructed vertical clearance of 13 ft 6 in. (4 m). The AHJ must determine turning radius minimums due to varying equipment needs. Dead-end roadways having lengths greater than 150 ft (46 m) require AHJ approval and verification of acceptable turning provisions. (See 18.2.3.)
3. The ground enclosed by any structure and the ground outside the structure for a reasonable distance, but not less

Exhibit 25.7

Placement of membrane structure near fire department access.

Exhibit 25.8

Effect lighting inside a tent. (Brett Pellitier/Dreamstime.com) than 10 ft (3 m) from each structure, must be kept clear of all flammable and combustible materials or combustible vegetation. Care must also be given to guy ropes or other obstructions that are needed to maintain all sides of the tent. (See 25.1.3.2 and 25.1.5.)

4. Combustible materials should not be permitted under stands or seats at any time. Combustible trash must be removed at least daily from the structure during the period the tent is occupied by the public. (See 25.1.5.)
5. Special precautions should be taken for tents used for cooking. Care must be taken when locating cooking tents next to other buildings, temporary structures, other tents, parked vehicles, or internal combustion engines. (See 25.1.11 and 25.1.12.)
6. Smoking should be prohibited in and around all tents. The AHJ should verify that the appropriate number of No Smoking signs are located throughout and around the tent area. (See Section 10.10 and 25.1.5.2.)
7. The AHJ should not approve any type of open flame device or any other type of device that emits a flame. Flammable or combustible liquids, gas, charcoal, or any other unapproved devices should not be allowed by the AHJ inside or outside the tent, within a reasonable distance, while open to the public, unless approved by the AHJ. Any type of open flame or device capable of igniting combustibles cannot be used without obtaining a hot work permit from the AHJ. (See Section 1.12 and 25.1.4.2.)
8. Exit signs, such as the one shown in Exhibit 25.9, must be installed at required exit doorways and where otherwise necessary to indicate clearly the direction of egress, as required by NFPA *101*. Exit signs can be self-luminous or supplied from a power source as required by NFPA *101*. Fixtures provided for means of egress illumination must be supplied with power in accordance with NFPA *101*. (See Sections 14.12, 14.13, and 14.14.)
9. Heating equipment, tanks, piping, hose, fittings, valves, tubing, and other related components must be installed as specified by NFPA 54, *National Fuel Gas Code*; NFPA 58, *Liquefied Petroleum Gas Code*; and the applicable mechanical code. Gas, liquid, and solid fuel–burning equipment designed to be vented must be vented to the outside air, with vents equipped with approved spark arresters where required by the AHJ. (See 25.1.4, 25.1.9, 25.1.10, and 25.1.12.)
10. Liquefied petroleum gas (LP-Gas) equipment, such as tanks, piping, hoses, fittings, valves, tubing, and other related components, must be approved by the AHJ and in accordance with NFPA 58. LP-Gas containers must be located outside the structure. Safety release valves must be pointed away from the tent. Portable LP-Gas containers must be separated from the container and tent structure in accordance with NFPA 58. Portable LP-Gas containers, piping, valves, and fittings that are located outside and that are being used to fuel equipment inside the tent must be protected to prevent tampering, damage by vehicles, or other hazards and must be placed in a location approved by the AHJ. Portable LP-Gas containers must be securely fastened in place to prevent unauthorized movement. (See 25.1.4 and 25.1.10.)
11. Cooking and heating equipment must not be located near exits or combustible materials. Tents in which cooking is performed must be separated from other tents and structures. Outdoor cooking that produces sparks or grease-laden vapors must not be performed next to tents or other structures. Operations such as warming of foods, cooking demonstrations, and similar operations that use devices using solid flammable fuel, butane, or other similar devices that do not pose an ignition hazard must be approved by the AHJ. Electrical heating and cooking equipment must comply with *NFPA 70*. (See 25.1.6.3, 25.1.9, and 25.1.11.)
12. Flammable liquid–fueled equipment should not be used inside tents. Flammable and combustible liquids must be stored outside in a manner approved by the AHJ. Storage must be in accordance with NFPA 30, *Flammable and Combustible Liquids Code*. Refueling must be performed outside the tent at a location approved by the AHJ. (See 25.1.4.)
13. Standby personnel might be required due to the number of occupants present when potentially hazardous conditions or a reduction in a life safety feature exists because of the type of performance, display, exhibit, occupancy, or contest or activity. The AHJ might also require crowd managers in accordance with NFPA *101*. The owner, agent, or lessee must employ one or more qualified persons, as required and approved by the AHJ, for such purpose. (See 1.7.17 and 25.1.8.)

Exhibit 25.9

Exit sign inside a tent.

25.2.1.2 Tents shall be erected to cover not more than 75 percent of the premises, unless otherwise approved by the AHJ. [***101:***11.11.1.3]

25.2.2 Flame Propagation Performance.

Δ **25.2.2.1** All tent fabric shall meet the flame propagation performance criteria contained in Test Method 2 of NFPA 701. [***101:***11.11.2.1]

Δ **25.2.2.2** One of the following shall serve as evidence that the tent fabric materials have the required flame propagation performance:

(1) The AHJ shall require a certificate or other evidence of acceptance by an organization acceptable to the AHJ.
(2) The AHJ shall require a report of tests made by other inspection authorities or organizations acceptable to the AHJ.

[***101:***11.11.2.2]

25.2.2.3 Where required by the AHJ, confirmatory field tests shall be conducted using test specimens from the original material, which shall have been affixed at the time of manufacture to the exterior of the tent. [***101:***11.11.2.3]

Refer to NFPA 705, *Recommended Practice for a Field Flame Test for Textiles and Films*, for guidance to enforcement officials for the field application of an open flame to textiles and films for which reliable laboratory data are not available.

25.2.3 Location and Spacing.

25.2.3.1 There shall be a minimum of 10 ft (3050 mm) between stake lines. [***101:***11.11.3.1]

25.2.3.2 Adjacent tents shall be spaced to provide an area to be used as a means of emergency egress. Where 10 ft (3050 mm) between stake lines does not meet the requirements for means of egress, the distance necessary for means of egress shall govern. [***101:***11.11.3.2]

The specified minimum distances between stake lines and adjacent tents ensure adequate egress routes for occupants while exiting. In tents with larger numbers of occupants, the specified 10 ft (3050 mm) minimum distance might need to be increased, based on calculations similar to those for determining the minimum width of an aisle. (See 14.8.3.4.)

25.2.3.3 Tents not occupied by the public and not used for the storage of combustible material shall be permitted to be erected less than 10 ft (3050 mm) from other structures where the AHJ deems such close spacing to be safe from hazard to the public. [***101:***11.11.3.3]

25.2.3.4 Tents, each not exceeding 1200 ft^2 (112 m^2) in finished ground level area and located in fairgrounds or similar open spaces, shall not be required to be separated from each other, provided that safety precautions meet the approval of the AHJ. [***101:***11.11.3.4]

25.2.3.5 The placement of tents relative to other structures shall be at the discretion of the AHJ, with consideration given to occupancy, use, opening, exposure, and other similar factors. [***101:***11.11.3.5]

25.2.4 Fire Hazards.

25.2.4.1 The finished ground level enclosed by any tent, and the finished ground level for a reasonable distance, but for not less than 10 ft (3050 mm) outside of such a tent, shall be cleared of all flammable or combustible material or vegetation that is not used for necessary support equipment. The clearing work shall be accomplished to the satisfaction of the AHJ prior to the erection of such a tent. The premises shall be kept free from such flammable or combustible materials during the period for which the premises are used by the public. [***101:***11.11.4.1]

See the commentary following 25.1.5.1 for further details on fire hazards.

25.2.4.2 Smoking.

See Section 10.9 for additional prohibitions on smoking.

25.2.4.2.1 Smoking shall not be permitted in any tent, unless approved by the AHJ. [***101:***11.11.4.2.1]

25.2.4.2.2 In rooms or areas where smoking is prohibited, plainly visible signs shall be posted that read as follows:

NO SMOKING

[***101:***11.11.4.2.2]

25.2.5 Fire-Extinguishing Equipment. Portable fire-extinguishing equipment of approved types shall be furnished and maintained in tents in such quantity and in such locations as directed by the AHJ. [***101:***11.11.5]

See Section 13.6 for additional requirements concerning portable fire extinguishers.

25.3 Grandstands

Grandstands are structures that provide tiered or stepped seating. Exhibit 25.10 shows an example of a temporary grandstand. Temporary grandstands can pose many challenges to the AHJ. These challenges include providing proper distances for seating, proper dimensions for the rise and run of stair treads, and the required means of egress. Temporary grandstands must conform to the requirements of Section 25.3, along with the requirements of NFPA *101*. Exhibit 25.11 shows the back view of a temporary grandstand with enclosed spaces above.

25.3.1 Seating.

25.3.1.1 Where grandstand seating without backs is used indoors, rows of seats shall be spaced not less than 22 in. (560 mm) back-to-back. [***101:***12.4.9.2.1]

Exhibit 25.10

Large temporary grandstand.

Exhibit 25.11

Temporary grandstand with enclosed spaces above.

25.3.1.2 The depth of footboards and seat boards in grandstands shall be not less than 9 in. (230 mm); where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided. [***101:***12.4.9.2.2]

25.3.1.3 Seats and footrests of grandstands shall be supported securely and fastened in such a manner that they cannot be displaced inadvertently. [***101:***12.4.9.2.3]

25.3.1.4 Individual seats or chairs shall be permitted only if secured in rows in an approved manner, unless seats do not exceed 16 in number and are located on level floors and within railed-in enclosures, such as boxes. [***101:***12.4.9.2.4]

The requirements of 25.3.1.4 are intended to ensure that individual chairs do not become an impediment to egress during an emergency. The requirement that chairs be secured in rows can be accomplished by fastening the chairs to the floor or by fastening them together in groups of not fewer than three.

25.3.1.5 The maximum number of seats permitted between the farthest seat in an aisle in grandstands and bleachers shall not exceed that shown in Table 25.3.1.5. [***101:***12.4.9.2.5]

TABLE 25.3.1.5 *Maximum Number of Seats Between Farthest Seat and an Aisle*

Application	Outdoors	Indoors
Grandstands	11	6
Bleachers *[See 12.2.5.6.1.2 of NFPA 101]*	20	9

[***101:***Table 12.4.9.2.5]

25.3.2 Special Requirements — Wood Grandstands.

Δ **25.3.2.1** An outdoor wood grandstand shall be erected within not less than two-thirds of its height and, in no case, within not less than 10 ft (3050 mm) of a building, unless otherwise permitted by one of the following:

(1) The distance requirement shall not apply to buildings having minimum 1-hour fire resistance–rated construction with openings protected against the fire exposure hazard created by the grandstand.
(2) The distance requirement shall not apply where a wall having minimum 1-hour fire resistance–rated construction separates the grandstand from the building.

[***101:***12.4.9.3.1]

Δ **25.3.2.2** An outdoor wood grandstand unit shall not exceed 10,000 ft^2 (929 m^2) in finished ground level area or 200 ft (61 m) in length, and all of the following requirements also shall apply:

(1) Grandstand units of the maximum size shall be placed not less than 20 ft (6100 mm) apart or shall be separated by walls having a minimum 1-hour fire resistance rating.
(2) The number of grandstand units erected in any one group shall not exceed three.
(3) Each group of grandstand units shall be separated from any other group by a wall having minimum 2-hour fire resistance–rated construction extending 24 in. (610 mm) above the seat platforms or by an open space of not less than 50 ft (15 m).

[***101:***12.4.9.3.2]

Δ **25.3.2.3** The finished ground level area or length required by 25.3.2.2 shall be permitted to be doubled where one of the following criteria is met:

(1) Where the grandstand is constructed entirely of labeled fire-retardant-treated wood that has passed the standard rain test, ASTM D2898, *Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing*
(2) Where the grandstand is constructed of members conforming to dimensions for heavy timber construction [Type IV (2HH)]

[***101:***12.4.9.3.3]

25.3.2.4 The highest level of seat platforms above the finished ground level or the surface at the front of any wood grandstand shall not exceed 20 ft (6100 mm). [***101:***12.4.9.3.4]

25.3.2.5 The highest level of seat platforms above the finished ground level, or the surface at the front of a portable grandstand within a tent or membrane structure, shall not exceed 12 ft (3660 mm). [***101:***12.4.9.3.5]

25.3.2.6 The height requirements specified in 25.3.2.4 and 25.3.2.5 shall be permitted to be doubled where constructed entirely of labeled fire-retardant-treated wood that has passed the standard rain test, ASTM D2898, or where constructed of members conforming to dimensions for heavy timber construction [Type IV (2HH)]. [***101:***12.4.9.3.6]

25.3.3 Special Requirements — Portable Grandstands.

25.3.3.1 Portable grandstands shall conform to the requirements of Section 25.3 for grandstands and the requirements of 25.3.3.2 through 25.3.3.7. [***101:***12.4.9.4.1]

25.3.3.2 Portable grandstands shall be self-contained and shall have within them all necessary parts to withstand and restrain all forces that might be developed during human occupancy. [***101:***12.4.9.4.2]

25.3.3.3 Portable grandstands shall be designed and manufactured so that, if any structural members essential to the strength and stability of the structure have been omitted during erection, the presence of unused connection fittings shall make the omissions self-evident. [***101:***12.4.9.4.3]

25.3.3.4 Portable grandstand construction shall be skillfully accomplished to produce the strength required by the design. [***101:***12.4.9.4.4]

25.3.3.5 Portable grandstands shall be provided with base plates, sills, floor runners, or sleepers of such area that the permitted bearing capacity of the supporting material is not exceeded. [***101:***12.4.9.4.5]

25.3.3.6 Where portable grandstands rest directly on a base of such character that it is incapable of supporting the load without appreciable settlement, mud sills of suitable material, having sufficient area to prevent undue or dangerous settlement, shall be installed under base plates, runners, or sleepers. [***101:***12.4.9.4.6]

25.3.3.7 All bearing surfaces of portable grandstands shall be in contact with each other. [***101:***12.4.9.4.7]

Δ **25.3.4 Spaces Underneath Grandstands.** Spaces underneath a grandstand shall be kept free of flammable or combustible materials, unless protected by an approved, supervised automatic sprinkler system in accordance with Section 13.3 or unless otherwise permitted by one of the following:

(1) This requirement shall not apply to accessory uses of 300 ft^2 (28 m^2) or less, such as ticket booths, toilet facilities, or concession booths where constructed of noncombustible or fire-resistive construction in otherwise nonsprinklered facilities.
(2) This requirement shall not apply to rooms that are enclosed in not less than 1-hour fire resistance–rated construction and are less than 1000 ft^2 (93 m^2) in otherwise nonsprinklered facilities.

[***101:***12.4.9.5]

Paragraph 25.3.4 recognizes the dangers associated with dried vegetation, combustible debris, or both, located underneath grandstands. This situation is of particular concern where the ground beneath the grandstand is not level but has a slope that is parallel to the slope of seating, causing the accumulation of trash at one point. Many large fire incidents have occurred in which combustible materials under a grandstand have ignited and burned down the grandstands and injured many people.

The requirement to separate or sprinkler enclosed spaces under grandstands is similar to those required in 25.1.6.2. When a fire occurs in an enclosed area, the fire can grow unnoticed for an extended period of time. Such fires can adversely affect occupant response and the functioning of various protection features, such as means of egress routes and structural integrity.

25.3.5 Guards and Railings.

25.3.5.1 Railings or guards not less than 42 in. (1065 mm) above the aisle surface or footrest or not less than 36 in. (915 mm) vertically above the center of the seat or seat board surface, whichever is adjacent, shall be provided along those portions of the backs and ends of all grandstands where the seats are more than 48 in. (1220 mm) above the floor or the finished ground level. [***101:***12.4.9.6.1]

25.3.5.2 The requirement of 25.3.5.1 shall not apply where an adjacent wall or fence affords equivalent safeguard. [***101:***12.4.9.6.2]

25.3.5.3 Where the front footrest of any grandstand is more than 24 in. (610 mm) above the floor, railings or guards not less than 33 in. (825 mm) above such footrests shall be provided. [***101:***12.4.9.6.3]

25.3.5.4 The railings required by 25.3.5.3 shall be permitted to be not less than 26 in. (660 mm) high in grandstands or where the front row of seats includes backrests. [***101:***12.4.9.6.4]

25.3.5.5 Cross aisles located within the seating area shall be provided with rails not less than 26 in. (660 mm) high along the front edge of the cross aisle. [***101:***12.4.9.6.5]

25.3.5.6 The railings specified by 25.3.5.5 shall not be required where the backs of the seats in front of the cross aisle project 24 in. (610 mm) or more above the surface of the cross aisle. [***101:***12.4.9.6.6]

25.3.5.7 Vertical openings between guardrails and footboards or seat boards shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening. [***101:***12.4.9.6.7]

25.3.5.8 An opening between the seat board and footboard located more than 30 in. (760 mm) above the finished ground level shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening. [***101:***12.4.9.6.8]

25.3.6 Maintenance of Outdoor Grandstands.

25.3.6.1 The owner shall provide for not less than annual inspection and required maintenance of each outdoor grandstand to ensure safe conditions. [***101:***12.7.10.1]

The owner is responsible for having an inspection of the outdoor grandstands conducted annually in accordance with 25.3.6.1. These inspections should ensure that outdoor grandstands are structurally sound and meet the provisions of Section 25.3.

25.3.6.2 At least biennially, the inspection shall be performed by a professional engineer, registered architect, or individual certified by the manufacturer. [***101:***12.7.10.2]

The owner is responsible for having outdoor grandstands inspected every other year by a professional engineer, a registered architect, or a person certified by the manufacturer. This inspection and subsequent report ensure that the grandstand is structurally sound, meets the requirements of Section 25.3, and is safe for continued use. Copies of the report should be made available when requested by the AHJ.

25.3.6.3 Where required by the AHJ, the owner shall provide a copy of the inspection report and certification that the inspection required by 25.3.6.2 has been performed. [***101:***12.7.10.3]

25.4 Folding and Telescopic Seating

Folding and telescopic seating is usually found in multipurpose rooms in schools and other buildings. The seating is pulled out to allow for seating at events, such as basketball games or concerts, and then pushed back in for storage to provide additional floor space during normal use of the space.

25.4.1 Seating.

Δ **25.4.1.1** The horizontal distance of seats, measured back-to-back, shall be not less than 22 in. (560 mm) for seats without backs, and all of the following requirements shall also apply:

(1) There shall be a space of not less than 12 in. (305 mm) between the back of each seat and the front of each seat immediately behind it.
(2) If seats are of the chair type, the 12 in. (305 mm) dimension shall be measured to the front edge of the rear seat in its normal unoccupied position.
(3) All measurements shall be taken between plumb lines.

[***101:***12.4.10.2.1]

25.4.1.2 The depth of footboards (footrests) and seat boards in folding and telescopic seating shall be not less than 9 in. (230 mm). [***101:***12.4.10.2.2]

25.4.1.3 Where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided. [***101:***12.4.10.2.3]

25.4.1.4 Individual chair-type seats shall be permitted in folding and telescopic seating only if firmly secured in groups of not less than three. [***101:***12.4.10.2.4]

25.4.1.5 The maximum number of seats permitted between the farthest seat in an aisle in folding and telescopic seating shall not exceed that shown in Table 25.3.1.5. [***101:***12.4.10.2.5]

25.4.2 Guards and Railings.

25.4.2.1 Railings or guards not less than 42 in. (1065 mm) above the aisle surface or footrest or not less than 36 in. (915 mm) vertically above the center of the seat or seat board surface, whichever is adjacent, shall be provided along those portions of the backs and ends of all folding and telescopic seating where the seats are more than 48 in. (1220 mm) above the floor or the finished ground level. [***101:***12.4.10.3.1]

25.4.2.2 The requirement of 25.4.2.1 shall not apply where an adjacent wall or fence affords equivalent safeguard. [***101:***12.4.10.3.2]

25.4.2.3 Where the front footrest of folding or telescopic seating is more than 24 in. (610 mm) above the floor, railings or guards not less than 33 in. (825 mm) above such footrests shall be provided. [***101:***12.4.10.3.3]

25.4.2.4 The railings required by 25.4.2.3 shall be permitted to be not less than 26 in. (660 mm) high where the front row of seats includes backrests. [***101:***12.4.10.3.4]

25.4.2.5 Cross aisles located within the seating area shall be provided with rails not less than 26 in. (660 mm) high along the front edge of the cross aisle. [***101:***12.4.10.3.5]

25.4.2.6 The railings specified by 25.4.2.5 shall not be required where the backs of the seats in front of the cross aisle project 24 in. (610 mm) or more above the surface of the cross aisle. [***101:***12.4.10.3.6]

25.4.2.7 Vertical openings between guardrails and footboards or seat boards shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening. [***101:***12.4.10.3.7]

25.4.2.8 An opening between the seat board and footboard located more than 30 in. (760 mm) above the finished ground level shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening. [***101:***12.4.10.3.8]

25.4.3 Maintenance and Operation of Folding and Telescopic Seating.

25.4.3.1 Instructions in both maintenance and operation shall be transmitted to the owner by the manufacturer of the seating or his or her representative. [***101:***12.7.11.1]

Δ **25.4.3.2** Maintenance and operation of folding and telescopic seating shall be the responsibility of the owner or his or her duly authorized representative and shall include all of the following:

(1) During operation of the folding and telescopic seats, the opening and closing shall be supervised by responsible personnel who shall ensure that the operation is in accordance with the manufacturer's instructions.
(2) Only attachments specifically approved by the manufacturer for the specific installation shall be attached to the seating.
(3) An annual inspection and required maintenance of each grandstand shall be performed to ensure safe conditions.
(4) At least biennially, the inspection shall be performed by a professional engineer, registered architect, or individual certified by the manufacturer.

[***101:***12.7.11.2]

Maintenance and inspection of folding and telescopic seating is important to ensure that such seating is safe for use. Folding and telescopic seating is set up and taken down many times during the year, placing additional wear on the structure and parts. Persons responsible for folding and telescopic seating should know the required frequency of maintenance and inspection and correct setup and takedown procedures.

The owner is responsible for having an inspection of the folding and telescopic seating conducted annually. This inspection should ensure that the seating is structurally sound and meets the provisions of Section 25.4. Copies of the inspection report should be made available when requested by the AHJ.

25.5 Permanent Membrane Structures

Permanent membrane structures are those that are intended to remain in place for more than 180 consecutive days. Membrane structures include buildings or portions of buildings incorporating air-inflated, air-supported, tensioned-membrane structures; membrane roofs; or membrane-covered rigid frames. (See Exhibit 25.1.) The most common use of a membrane structure incorporates a membrane-covered rigid frame or membrane roof to provide weather protection for an occupied rooftop or exterior patios, tennis courts, or athletic fields during inclement weather.

25.5.1 Application.

Δ **25.5.1.1 Use of Membrane Roofs.** Membrane roofs shall be used in accordance with the following:

(1) Membrane materials shall not be used where fire resistance ratings are required for walls or roofs.
(2) Where every part of the roof, including the roof membrane, is not less than 20 ft (6100 mm) above any floor, balcony, or gallery, a noncombustible or limited-combustible membrane shall be permitted to be used as the roof in any construction type.
(3) With approval of the AHJ, membrane materials shall be permitted to be used where every part of the roof membrane is sufficiently above every significant fire potential, such that the imposed temperature cannot exceed the capability of the membrane, including seams, to maintain its structural integrity.

[***101:***11.9.1.2]

25.5.1.2 Testing. Testing of membrane materials for compliance with the requirements of Section 25.5 for use of the categories of noncombustible and limited-combustible materials shall be performed on weathered-membrane material as defined in 3.3.171.5 of NFPA *101*. [***101:***11.9.1.3]

25.5.1.3 Flame Spread Index. The flame spread index of all membrane materials exposed within the structure shall be Class A in accordance with Section 12.5. [***101:***11.9.1.4]

25.5.1.4 Roof Covering Classification. Roof membranes shall have a roof covering classification, as required by the applicable building codes, when tested in accordance with ASTM E108, *Standard Test Methods for Fire Tests of Roof Coverings*; or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings*. [***101:***11.9.1.5]

25.5.1.5 Flame Propagation Performance.

Δ **25.5.1.5.1** All membrane structure fabric shall meet the flame propagation performance criteria contained in Test Method 2 of NFPA 701. [***101:***11.9.1.6.1]

Δ **25.5.1.5.2** One of the following shall serve as evidence that the fabric materials have the required flame propagation performance:

(1) The AHJ shall require a certificate or other evidence of acceptance by an organization acceptable to the AHJ.
(2) The AHJ shall require a report of tests made by other inspection authorities or organizations acceptable to the AHJ.

[***101:***11.9.1.6.2]

25.5.1.5.3 Where required by the AHJ, confirmatory field tests shall be conducted using test specimens from the original material, which shall have been affixed at the time of manufacture to the exterior of the structure. [***101:***11.9.1.6.3]

25.5.2 Tensioned-Membrane Structures.

A tensioned-membrane structure incorporates a membrane and a structural support system of arches, columns and cables, or beams whereby the stress developed in the tensioned membrane interacts with the stresses in the structural support so that the entire assembly acts together to resist the applied loads.

25.5.2.1 The design, materials, and construction of the building shall be based on plans and specifications prepared by a licensed architect or engineer knowledgeable in tensioned-membrane construction. [***101:***11.9.2.1]

25.5.2.2 Material loads and strength shall be based on physical properties of the materials verified and certified by an approved testing laboratory. [***101:***11.9.2.2]

25.5.2.3 The membrane roof for structures in climates subject to freezing temperatures and ice buildup shall be composed of two layers separated by an air space through which heated air can be moved to guard against ice accumulation. As an alternative to the two layers, other approved methods that protect against ice accumulation shall be permitted. [***101:***11.9.2.3]

25.5.2.4 Roof drains shall be equipped with electrical elements to protect against ice buildup that can prevent the drains from functioning. Such heating elements shall be served by on-site standby electrical power in addition to the normal public service. As an alternative to such electrical elements, other approved methods that protect against ice accumulation shall be permitted. [***101:***11.9.2.4]

25.5.3 Air-Supported and Air-Inflated Structures.

An air-inflated structure differs from an air-supported structure. The shape of an air-inflated structure is maintained by air pressure within cells or tubes forming the enclosure, and the occupants are not within the pressurized areas used to support the structure. The shape of an air-supported structure is maintained by air pressure, and the occupants are within the elevated pressure area. Exhibit 25.12 depicts an air-supported structure.

25.5.3.1 General. In addition to the general provisions of 25.5.1, the requirements of 25.5.3 shall apply to air-supported and air-inflated structures. [***101:***11.9.3.1]

Δ **25.5.3.2 Pressurization (Inflation) System.** The pressurization system shall consist of one or more operating blower units. The

Exhibit 25.12

Air-supported structure.

system shall include automatic control of auxiliary blower units to maintain the required operating pressure. Such equipment shall meet the following requirements:

(1) Blowers shall be powered by continuous-rated motors at the maximum power required.
(2) Blowers shall have personnel protection, such as inlet screens and belt guards.
(3) Blower systems shall be weather protected.
(4) Blower systems shall be equipped with backdraft check dampers.
(5) Not less than two blower units shall be provided, each of which has capacity to maintain full inflation pressure with normal leakage.
(6) The blowers shall be designed to be incapable of overpressurization.
(7) The auxiliary blower unit(s) shall operate automatically if there is any loss of internal pressure or if an operating blower unit becomes inoperative.
(8) The design inflation pressure and the capacity of each blower system shall be certified by a professional engineer.

[***101:***11.9.3.2]

25.5.3.3 Standby Power System.

25.5.3.3.1* A fully automatic standby power system shall be provided. The system shall be either an auxiliary engine generator set capable of running the blower system or a supplementary blower unit that is sized for 1 times the normal operating capacity and is powered by an internal combustion engine. [***101:***11.9.3.3.1]

Δ **A.25.5.3.3.1** The requirements of 25.5.3.3.1 can be considered as a Class 4, Type 60 system per NFPA 110. [***101:***A.11.9.3.3.1]

25.5.3.3.2 The standby power system shall be fully automatic to ensure continuous inflation in the event of any failure of the primary power. The system shall be capable of operating continuously for a minimum of 4 hours. [***101:***11.9.3.3.2]

25.5.3.3.3 The sizing and capacity of the standby power system shall be certified by a professional engineer. [***101:***11.9.3.3.3]

25.5.4 Maintenance and Operation.

25.5.4.1 Instructions in both operation and maintenance shall be transmitted to the owner by the manufacturer of the tensioned-membrane, air-supported, or air-inflated structure. [***101:***11.9.4.1]

25.5.4.2 Annual inspection and required maintenance of each structure shall be performed to ensure safety conditions. At least biennially, the inspection shall be performed by a professional engineer, registered architect, or individual certified by the manufacturer. [***101:***11.9.4.2]

The owner is responsible for having an inspection of tensioned-membrane, air-supported, or air-inflated structures conducted annually. These inspections should ensure that such structures are structurally sound and meet the provisions of Section 25.5. The owner is responsible for having the tensioned-membrane, air-supported, or air-inflated structure inspected every other year by a professional engineer, a registered architect, or a person certified by the manufacturer. This inspection and subsequent report should ensure that the structure is structurally sound, meets the requirements of Section 25.5, and is safe for continued use. Copies of the inspection report should be made available when requested by the AHJ.

25.6 Temporary Membrane Structures

25.6.1 Application.

25.6.1.1 Required Approval. Membrane structures designed to meet all the requirements of Section 25.6 shall be permitted to be used as temporary buildings subject to the approval of the AHJ. [***101:***11.10.1.2]

25.6.1.2 Alternative Requirements. Temporary tensioned-membrane structures shall be permitted to comply with Section 25.2 instead of Section 25.6. [***101:***11.10.1.3]

25.6.1.3 Roof Covering Classification. Roof membranes shall have a roof covering classification, as required by the applicable building codes, when tested in accordance with ASTM E108 or ANSI/UL 790. [***101:***11.10.1.4]

25.6.1.4 Flame Propagation Performance.

Δ **25.6.1.4.1** All membrane structure fabric shall meet the flame propagation performance criteria contained in Test Method 2 of NFPA 701. [***101:***11.10.1.5.1]

Δ **25.6.1.4.2** One of the following shall serve as evidence that the fabric materials have the required flame propagation performance:

(1) The AHJ shall require a certificate or other evidence of acceptance by an organization acceptable to the AHJ.
(2) The AHJ shall require a report of tests made by other inspection authorities or organizations acceptable to the AHJ.

[***101:***11.10.1.5.2]

25.6.1.4.3 Where required by the AHJ, confirmatory field tests shall be conducted using test specimens from the original material, which shall have been affixed at the time of manufacture to the exterior of the structure. [***101:***11.10.1.5.3]

25.6.2 Fire Hazards.

25.6.2.1 The finished ground level enclosed by any temporary membrane structure, and the finished ground level for a reasonable distance but for not less than 10 ft (3050 mm) outside of such a structure, shall be cleared of all flammable or combustible material or vegetation that is not used for necessary support equipment. The clearing work shall be accomplished to the satisfaction of the AHJ prior to the erection of such a structure. The premises shall be kept free from such flammable or combustible materials during the period for which the premises are used by the public. [***101:***11.10.2.1]

For a discussion of fire hazards, see the commentary following 25.1.5.1.

25.6.2.2 Where prohibited by the AHJ, smoking shall not be permitted in any temporary membrane structure. [***101:***11.10.2.2]

See Section 10.9 for additional prohibitions on smoking.

25.6.3 Fire-Extinguishing Equipment. Portable fire-extinguishing equipment of approved types shall be furnished and maintained in temporary membrane structures in such quantity and in such locations as directed by the AHJ. [***101:***11.10.3]

See Section 13.6 for requirements concerning portable fire extinguishers.

25.6.4 Tensioned-Membrane Structures.

A tensioned-membrane structure incorporates a membrane and a structural support system of arches, columns and cables, or beams whereby the stress developed in the tensioned membrane interacts with the stresses in the structural support so that the entire assembly acts together to resist the applied loads.

25.6.4.1 The design, materials, and construction of the building shall be based on plans and specifications prepared by a licensed architect or engineer knowledgeable in tensioned-membrane construction. [***101:***11.10.4.1]

25.6.4.2 Material loads and strength shall be based on physical properties of the materials verified and certified by an approved testing laboratory. [***101:***11.10.4.2]

25.6.4.3 The membrane roof for structures in climates subject to freezing temperatures and ice buildup shall be composed of two layers separated by an air space through which heated air can be moved to guard against ice accumulation. As an alternative to the two layers, other approved methods that protect against ice accumulation shall be permitted. [***101:***11.10.4.3]

25.6.4.4 Roof drains shall be equipped with electrical elements to protect against ice buildup that can prevent the drains from functioning. Such heating elements shall be served by on-site standby electrical power in addition to the normal public service. As an alternative to such electrical elements, other approved methods that protect against ice accumulation shall be permitted. [***101:***11.10.4.4]

25.6.5 Air-Supported and Air-Inflated Structures.

25.6.5.1 General. In addition to the general provisions of 25.6.1, the requirements of 25.6.5 shall apply to air-supported and air-inflated structures. [***101:***11.10.5.1]

Δ **25.6.5.2 Pressurization (Inflation) System.** The pressurization system shall consist of one or more operating blower units. The system shall include automatic control of auxiliary blower units to maintain the required operating pressure. Such equipment shall meet the following requirements:

(1) Blowers shall be powered by continuous-rated motors at the maximum power required.
(2) Blowers shall have personnel protection, such as inlet screens and belt guards.
(3) Blower systems shall be weather protected.
(4) Blower systems shall be equipped with backdraft check dampers.
(5) Not less than two blower units shall be provided, each of which has capacity to maintain full inflation pressure with normal leakage.
(6) The blowers shall be designed to be incapable of overpressurization.
(7) The auxiliary blower unit(s) shall operate automatically if there is any loss of internal pressure or if an operating blower unit becomes inoperative.
(8) The design inflation pressure and the capacity of each blower system shall be certified by a professional engineer.

[***101:***11.10.5.2]

25.6.5.3 Standby Power System.

25.6.5.3.1 A fully automatic standby power system shall be provided. The system shall be either an auxiliary engine generator set capable of running the blower system or a supplementary blower unit that is sized for 1 times the normal operating capacity and is powered by an internal combustion engine. [***101:***11.10.5.3.1]

25.6.5.3.2 The standby power system shall be fully automatic to ensure continuous inflation in the event of any failure of the primary power. The system shall be capable of operating continuously for a minimum of 4 hours. [***101:***11.10.5.3.2]

25.6.5.3.3 The sizing and capacity of the standby power system shall be certified by a professional engineer. [***101:***11.10.5.3.3]

25.6.6 Maintenance and Operation.

25.6.6.1 Instructions in both operation and maintenance shall be transmitted to the owner by the manufacturer of the tensioned-membrane, air-supported, or air-inflated structure. [***101:***11.10.6.1]

25.6.6.2 Annual inspection and required maintenance of each structure shall be performed to ensure safety conditions. At least biennially, the inspection shall be performed by a professional engineer, registered architect, or individual certified by the manufacturer. [***101:***11.10.6.2]

The owner is responsible for having an inspection of each tensioned-membrane, air-supported, or air-inflated structure conducted annually. These inspections should ensure that the structures are structurally sound and meet the provisions of Section 25.6. The owner is responsible for having the structure inspected every other year by a professional engineer, a registered architect, or a person certified by the manufacturer. This inspection and subsequent report should ensure that the structure is structurally sound, meets the requirements of Section 25.6, and is safe for continued use. Copies of the inspection report should be made available when requested by the AHJ.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.

NFPA 54, *National Fuel Gas Code*, 2018 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2017 edition.

NFPA 70®, *National Electrical Code*®, 2017 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*®, 2016 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2018 edition.

NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*, 2018 edition.

NFPA *101*®, *Life Safety Code*®, 2018 edition.

NFPA 102, *Standard for Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures*, 2016 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, 2015 edition.

NFPA 705, *Recommended Practice for a Field Flame Test for Textiles and Films*, 2013 edition.

NFPA 5000®, *Building Construction and Safety Code*®, 2018 edition.

26 Laboratories Using Chemicals

Chapter 26 contains general requirements for laboratories using chemicals. These types of laboratories pose a variety of hazards. In addition to ordinary hazards found in laboratories, such as crowded research space, other hazards are present, such as flammable and combustible liquids storage, handling and use of hazardous chemicals, compressed and liquefied gases, radiological hazards, and biological hazards. Risk management involves the systematic identification, evaluation, and control of hazards that can result in loss of life and property damage. Risk management of laboratories requires recognizing possible risks, evaluating their frequency and the magnitude of their consequences, and determining appropriate measures for preventing or reducing such risks from a cost-benefit viewpoint.

Critical to risk management of laboratories using chemicals are design and construction, fire protection, explosion hazard protection, ventilation, and safe storage and handling of chemicals and compressed and liquefied gases. Each laboratory is unique in its operation, risks, and associated needs and should be evaluated as such.

26.1 General

Δ **26.1.1** The handling or storage of chemicals in laboratory buildings, laboratory units, and laboratory work areas whether located above or below grade shall comply with this chapter. Construction and protection of new laboratories shall also comply with NFPA 45.

The purpose of NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, is to provide basic requirements for the protection of life and property through prevention and control of fires and explosions involving the use of chemicals in laboratory-scale operations. NFPA 45 is designed to control hazards and protect personnel from the toxic, corrosive, or other harmful effects of chemicals to which they might be exposed as a result of fire or explosion. The goal is to achieve a comprehensive laboratory fire prevention and protection program by limiting injury to the occupants at the point of fire origin, limiting injury to emergency response personnel, and limiting property loss to a maximum of a single laboratory unit. NFPA 45 does not intend to address financial losses such as business interruption or property loss when the loss of a laboratory unit is unacceptable.

The provisions of NFPA 45 are necessary to provide a reasonable level of protection from loss of life and property from fires and explosions in laboratories using chemicals. The provisions of NFPA 45, unless otherwise noted, are not intended to be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of NFPA 45, except in those cases where the authority having jurisdiction (AHJ) has determined that the existing situation involves a distinct hazard to life or property.

Exhibit 26.1 provides guidance for applying NFPA 45 to a laboratory setting.

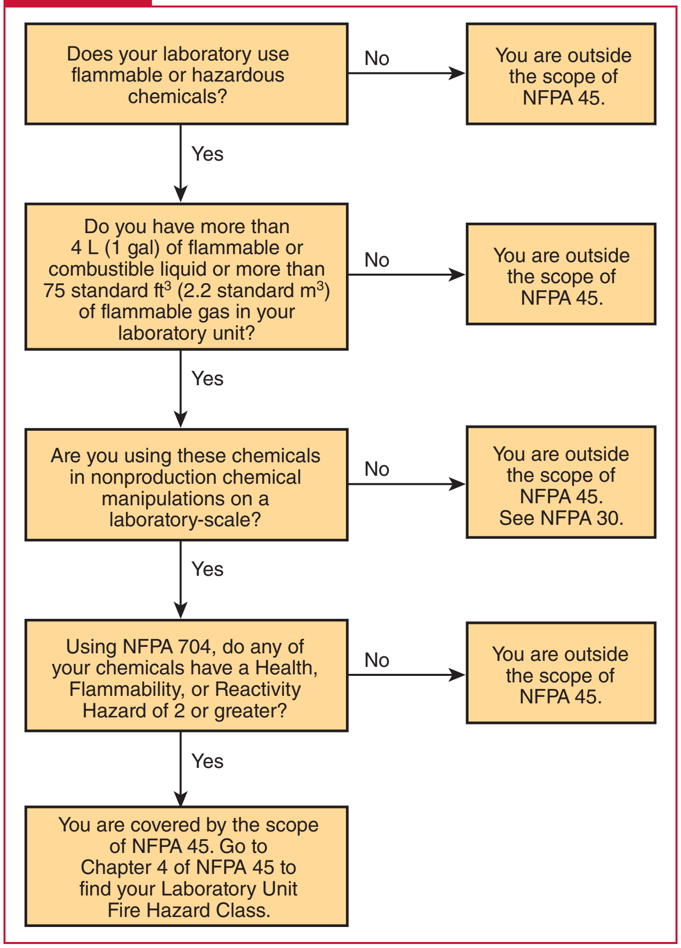
26.1.2 Chapter 26 shall apply to laboratory buildings, laboratory units, and laboratory work areas whether located above or below grade in which chemicals, as defined in NFPA 704 with one or more of the following hazard ratings are handled or stored: health — 2, 3, or 4; flammability — 2, 3, or 4; or instability — 2, 3, or 4. *(See also Section B.2 of NFPA 45.).* [**45:**1.1.1]

N **26.1.3** Chapter 26 shall apply to all educational laboratory units and instructional laboratory units in which any quantity of chemicals, as defined in NFPA 704 with one or more of the following hazard ratings, is handled or stored: health — 2, 3, or 4: flammability — 2, 3, 4; or instability — 2, 3, 4. *(See also Section B.2 of NFPA 45).* [**45:**1.1.2]

The 2015 edition of NFPA 45, referenced in this edition of the *Code*, added a statement to its scope to clarify that it applies to all educational laboratories and instructional laboratories, regardless of the quantity of chemicals that are handled or stored. Educational laboratory units and instructional laboratory units are defined in NFPA 45 as follows:

> ***Educational Laboratory Unit.*** A laboratory unit that is under direct supervision of an instructor and used for educational purposes for students through the twelfth grade.
> ***Instructional Laboratory Unit.*** A laboratory unit under the direct supervision of an instructor that is used for purposes of instruction for students beyond the twelfth grade.

Exhibit 26.1



Determining the applicability of NFPA 45 to a laboratory setting.

Δ **26.1.4** With the exception of 26.1.3, Chapter 26 shall not apply to the following:

(1)* Laboratories for which the following conditions apply:
 (a) Laboratory units that contain less than or equal to 1 gal (4 L) of flammable or combustible liquid
 (b) Laboratory units that contain less than 75 scf (2.2 standard m^3) of flammable gas, not including piped-in low-pressure utility gas installed in accordance with NFPA 54

Δ **A.26.1.4(1)** Either condition of 26.1.4(1) meeting the minimum quantity will bring the lab within the scope of Chapter 26. A school lab with a low pressure natural gas system supplying Bunsen burners (with less than the minimum quantities of combustible or flammable liquids and less than the minimum quantities of other flammable gases) is an example of a lab outside the scope of Chapter 26. [**45:**A.1.1.3(1)]

Note that the quantities of hazardous materials cited in either of the conditions in 26.1.4(1)(a) or (b) are minimum quantities of flammable and combustible liquid or flammable gas that would qualify the lab for coverage under NFPA 45. The minimum quantity of flammable gas does not include low pressure utility gas installed in accordance with NFPA 54, *National Fuel Gas Code*.

(2)* Pilot plants

A.26.1.4(2) The hazards of pilot plants are primarily based on the process, the chemistry, and the equipment, not the laboratory environment. [**45:**A.1.1.3(2)]

(3) Laboratories that handle only chemicals with a hazard rating of 0 or 1 for all of the following: health, flammability, and instability, as defined by NFPA 704
(4) Laboratories that are primarily manufacturing plants
(5) Incidental testing facilities
(6) Physical, electronic, instrument, laser, or similar laboratories that use chemicals only for incidental purposes, such as cleaning
(7)* Hazards associated with radioactive materials, as covered by NFPA 801

Δ **A.26.1.4(7)** NFPA 801 provides direction for controlling hazards associated with radioactive materials. NFPA 801 should be used only for issues related to radioactive materials in a laboratory. All other nonradioactive, laboratory issues are covered by NFPA 45. [**45:**A.1.1.3(7)]

(8) Laboratories that work only with explosive material, as covered by NFPA 495
(9) A laboratory work area containing an explosion hazard great enough to cause property damage outside that laboratory work area or injury outside that laboratory work area requiring medical treatment beyond first aid

[**45:**1.1.3]

Δ **26.1.5** Chapter 26 contains requirements, but not all-inclusive requirements, for handling and storage of chemicals where laboratory-scale operations are conducted and shall not cover the following:

(1) The special fire protection required when handling explosive materials *(See NFPA 495.)*
(2) The special fire protection required when handling radioactive materials

[**45:**1.1.6]

26.1.6 Plans and Procedures.

26.1.6.1* Fire prevention, maintenance, and emergency action plans and procedures shall be established.

A.26.1.6.1 Laboratory buildings, laboratory units, and laboratory work areas need to have clearly developed plans for fire prevention, maintenance, and emergency procedures. Guidance of the development of these plans and procedures can be found in NFPA 45.

26.2 Permits

Permits, where required, shall comply with Section 1.12.

Table 1.12.8(a) requires a permit for construction, alteration, or operation of laboratories.

Additional permits might be required for certain operations involving flammable gases, flammable or combustible liquids, or industrial ovens. Other hazardous materials, including the following, would require permits as called for by this *Code* (see 1.12.8):

1. Compressed gases
2. Cryogens
3. Flammable and combustible liquids
4. Hazardous materials
5. Industrial ovens
6. Laboratories
7. Liquefied petroleum gases (LP-Gas)
8. Organic peroxide formulations
9. Oxidizers

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids* Code, 2018 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, 2015 edition.

NFPA 54, *National Fuel Gas Code*, 2018 edition.

NFPA 99, *Health Care Facilities Code*, 2018 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2017 edition.

Manufactured Home and Recreational Vehicle Sites

27

Chapter 27 prescribes minimum fire safety requirements for manufactured home sites and recreational vehicle parks and campgrounds by providing mandatory references to NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities*, and NFPA 1194, *Standard for Recreational Vehicle Parks and Campgrounds*. NFPA 501A addresses site fuel supply requirements, electrical systems, life safety/fire safety requirements for manufactured home sites, community buildings and accessory buildings, and site access roads. NFPA 1194 contains similar requirements for recreational vehicle parks and campgrounds and also includes provisions for environmental health and sanitation.

27.1 General

27.1.1 Manufactured home and recreational vehicle sites shall meet the requirements of this chapter.

Δ **27.1.2** This chapter shall not apply to recreational vehicles as defined in NFPA 1192 or to park trailers as defined in RVIA/ANSI A.119.5, *Park Model Recreational Vehicle Standard*.

27.1.3 This chapter shall not cover the design of recreational vehicles or other forms of camping units or the operational and maintenance practices of recreational vehicle parks and campgrounds.

Δ 27.2 Manufactured Home Sites

The fire safety requirements for the installation of manufactured homes and manufactured home sites, including accessory buildings, structures, and communities, shall comply with NFPA 501A.

NFPA 501A does not apply to recreational vehicles as defined in NFPA 1192, *Standard on Recreational Vehicles*, or to park trailers as defined in RVIA/ANSI A.119.5, *Park Model Recreational Vehicle Standard*.

In 1.3.1.1 of NFPA 501A *manufactured homes* are described as follows: "A structure, transportable in one or more sections, that in the traveling mode is 8 body-ft (2.4 m) or more in width or 40 body-ft (12.2 m) or more in length or that on site is 320 ft^2 (29.7 m^2) or more, is built on a permanent chassis, is designed to be used as a dwelling with or without a permanent foundation, whether or not connected to the utilities, and includes plumbing, heating, air-conditioning, and electrical systems contained therein. Such terms shall include any structure that meets all the requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the regulatory agency. Calculations used to determine the number of square feet (square meters) in a structure are based on the structure's exterior dimensions, include all expandable rooms, cabinets, and other projections containing interior space, but do not include bay windows."

NFPA 501A goes on to define *manufactured home site* as a "parcel of land for the accommodation of one manufactured home, its accessory building or structures, and accessory equipment for the exclusive use of the occupants."

Δ 27.3 Recreational Vehicle Parks and Campgrounds

The construction of recreational vehicle parks and campgrounds that offer temporary living sites for use by recreational vehicles and camping units shall comply with NFPA 1194.

NFPA 1194 does not cover the design of recreational vehicles, recreational park trailers, other forms of camping units, or operational and maintenance practices for recreational vehicle parks and campgrounds. NFPA 1192 is a companion standard on which the provisions of NFPA 1194 are largely based.

NFPA 1194 was developed to serve as a basis for regulation by authorities having jurisdiction (AHJs) over the facilities provided in new recreational vehicle parks and campgrounds and additions to existing facilities only. Facilities provided in existing recreational vehicle parks and campgrounds are permitted to be continued in use, provided that such facilities do not constitute a recognized health or safety hazard.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities*, 2017 edition.

NFPA 1192, *Standard on Recreational Vehicles*, 2018 edition.

NFPA 1194, *Standard for Recreational Vehicle Parks and Campgrounds*, 2018 edition.

RVIA/ANSI A.119.5, *Park Model Recreational Vehicle Standard*, 2015, Recreational Vehicle Industry Association, Reston, VA.

Marinas, Boatyards, Marine Terminals, Piers, and Wharves

28

Chapter 28 covers marinas, boatyards, yacht clubs, boat condominiums, docking facilities associated with residential condominiums, multiple-docking facilities at multiple-family residences, and all associated piers, docks, and floats. This chapter also addresses construction and fire protection at marine terminals, piers, and wharves.

28.1 Marinas, Boatyards, and Other Recreational Marine Facilities

28.1.1 Scope. The construction and operation of marinas, boatyards, yacht clubs, boat condominiums, docking facilities associated with residential condominiums, multiple-docking facilities at multiple-family residences, and all associated piers, docks, and floats shall comply with NFPA 303 and Section 28.1. [**303:**1.1]

Jurisdictions might have other regulatory requirements that can be imposed on marinas and boatyards, including environmental regulations or zoning ordinances. NFPA 303, *Fire Protection Standard for Marinas and Boatyards*, and all applicable federal, state, and local regulations should be followed. The specified chapters of NFPA 303 cover the following:

1. Chapter 4 provides direction to the marina facility management on basic fire safety practices and procedures.
2. Chapter 5 covers marina electrical wiring and equipment.
3. Chapter 6 addresses fire protection within the marina and boatyard, including portable and fixed extinguishing systems.
4. Chapter 7 covers boat berthing and storage for wet, dry, and rack arrangements.
5. Chapter 8 addresses operational hazards, such as fueling and vessel maintenance involving paints, solvents, and various hot work processes.

In addition to safe practices for fueling boats, the provisions for the fueling facility within a marina or boatyard can be found in NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, and Section 42.9 of this *Code*.

Unless otherwise noted, the provisions of NFPA 303 are not intended to be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of the document, except in those cases where the authority having jurisdiction (AHJ) determines that the existing situation involves a distinct hazard to life or adjacent property.

N **28.1.1.1** Section 28.1 also applies to support facilities and structures used for construction, repair, storage, hauling and launching, or fueling of vessels if fire on a pier would pose an immediate threat to these facilities, or if a fire at a referenced facility would pose an immediate threat to a docking facility. [**303:**1.1.1]

N **28.1.1.2** Section 28.1 applies to marinas and facilities servicing small recreational and commercial craft, yachts, and other craft of not more than 300 gross tons. [**303:**1.1.2]

N **28.1.1.3** Section 28.1 shall not apply to private, non-commercial docking facility constructed or occupied for the use of the owners or residents of an associated single-family dwelling. [**303:**1.1.3]

28.1.1.4 No requirement in this chapter is to be construed as reducing applicable building, fire, and electrical codes. [**303:**1.1.4]

• **28.1.2 Fire Protection.**

28.1.2.1 Portable Fire Extinguishers.

28.1.2.1.1 Placement.

28.1.2.1.1.1 Placement of portable fire extinguishers shall be in accordance with Chapter 5 of NFPA 10 unless otherwise permitted by 28.1.2.1.1.1.1, 28.1.2.1.1.1.2, or 28.1.2.1.1.1.3. [**303:**6.2.1.1.1]

Δ **28.1.2.1.1.1.1** Placement of portable fire extinguishers on piers and along bulkheads where vessels are moored or are permitted to be moored shall meet the following criteria:

(1) Extinguishers listed for Class A, Class B, and Class C fires shall be installed at the pier/land intersection on a pier that exceeds 25 ft (7.62 m) in length.
(2) Additional fire extinguishers shall be placed such that the maximum travel distance to an extinguisher does not exceed 75 ft (22.86 m).
(3) Extinguishers shall be protected from environmental exposures to prevent damage and lack of operability.

[**303:**6.2.1.1.1.1]

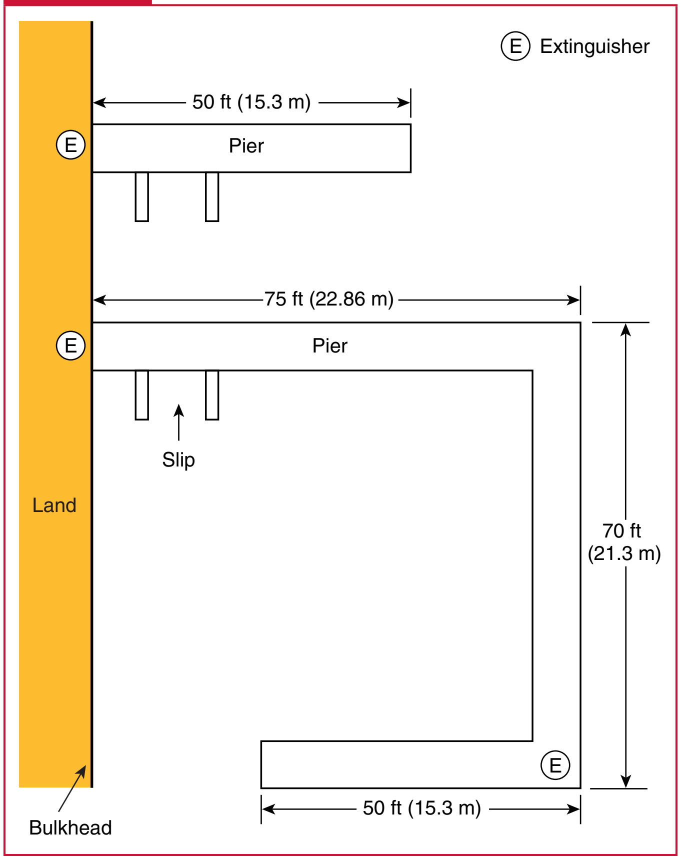
The pier/land intersection has been established as a reference point from which to define the minimum requirements for portable fire extinguishers. Paragraph 28.1.2.1.1.1.1 requires a portable fire extinguisher at the pier/land intersection for those piers greater than 25 ft (7.62 m) in length. If the pier structure running parallel to the land has finger piers extending perpendicular from that structure, each finger pier could be required to have a portable fire extinguisher at the pier/land intersection, depending on the travel distance to extinguishers. Enough portable fire extinguishers will be required to be positioned so that the travel distance from any point on the pier to a fire extinguisher does not exceed 75 ft (22.86 m). See Section 13.6 of this *Code* and NFPA 10, *Standard for Portable Fire Extinguishers*, for additional information on requirements for the selection and locations of portable fire extinguishers.

Exhibit 28.1 illustrates extinguisher requirements on a finger pier. The top portion of the exhibit shows the extinguisher at the pier/land intersection because the pier is greater than 25 ft (7.62 m) in length. The bottom portion shows additional extinguishers on the pier to keep the travel distance to an extinguisher no greater than 75 ft (22.86 m).

28.1.2.1.1.1.2 Fuel-Dispensing Areas.

(A) Portable fire extinguishers that meet the minimum requirements of Chapter 5 of NFPA 10 for extra (high) hazard type shall be installed on two sides of a fuel-dispensing area. [**303:**6.1.1.1.2.1]

Exhibit 28.1



Extinguisher requirements on finger pier.

(B) On piers or bulkheads where long fueling hoses are installed for fueling vessels, additional extinguishers installed on piers or bulkheads shall meet the requirements of Chapter 5 of NFPA 10 for extra (high) hazard type and 28.1.2.1.1.1.1. [**303:**6.1.1.1.2.2]

28.1.2.1.1.1.3 All extinguishers installed on piers shall meet the rating requirements set forth in Chapter 5 of NFPA 10 for ordinary (moderate) hazard type. [**303:**6.1.1.1.3]

Δ **28.1.2.1.2 Visibility and Identification.** All portable fire extinguishers shall be clearly visible and marked. [**303:**6.2.2]

28.1.2.2* Fixed Fire-Extinguishing Systems.

A.28.1.2.2 Where fixed fire-extinguishing system components are installed in areas subjecting these components to corrosion or other atmospheric damage, special considerations might be necessary. Corrosion-resistant types of pipe, fittings, and hangers or protective corrosion-resistant coatings should be used where corrosive conditions exist. [**303:**A.6.2]

28.1.2.2.1 Buildings on Piers.

28.1.2.2.1.1 Buildings in excess of 500 ft² (46 m²) that are constructed on piers shall be protected by an approved automatic fire-extinguishing system unless otherwise permitted by 28.1.2.2.1.2 or 28.1.2.2.1.3. [**303:**6.2.1.1]

Δ **28.1.2.2.1.2** Buildings of Type I or Type II construction, as specified in NFPA 220 and without combustible contents shall not be required to be protected by an automatic fire-extinguishing system. [**303:**6.2.1.2]

28.1.2.2.1.3* Existing facilities shall not be required to be protected by an automatic fire-extinguishing system where acceptable to the AHJ. [**303:**6.2.1.3]

A.28.1.2.2.1.3 Where clearly impractical for economic or physical reasons, the AHJ could permit the omission of an automatic fire-extinguishing system when considering water supply availability and adequacy and size of facility. [**303:**A.6.2.1.3]

28.1.2.2.2* Buildings Exceeding 5000 ft² (465 m²).

A.28.1.2.2.2 It is not the intent of this paragraph to limit the types of fire protection systems to automatic sprinklers in order to comply with the requirements of 28.1.2.2.2. Other types of automatic fire-extinguishing systems, such as foam/water, expanded foam, or clean agents, can be used for compliance provided that the system is applicable to the hazard present; automatically provides for the detection, control, and extinguishment of fires involving the hazards that might be present in the building; and is acceptable to the AHJ. The combustibility of the boats in storage should be considered in determining the hazard classification for appropriate sprinkler system design. [**303:**A.6.2.2]

28.1.2.2.2.1 Marina and boatyard buildings in excess of 5000 ft² (465 m²) in total area shall be protected by an approved automatic fire-extinguishing system unless otherwise permitted by 28.1.2.2.2.2. [**303:**6.2.2.1]

28.1.2.2.2.2* Existing facilities shall not be required to be protected by an automatic fire-extinguishing system where acceptable to the AHJ. [**303:**6.2.2.2]

A.28.1.2.2.2.2 See A.28.1.2.2.1.3. [**303:**A.6.3.2.2]

28.1.2.2.3 Combustible Piers and Substructures.

Δ **28.1.2.2.3.1** Combustible piers and substructures in excess of 25 ft (7.62 m) in width or in excess of 5000 ft^2 (465 m^2) in area, or within 30 ft (9.14 m) of other structures or superstructures required to be so protected, shall be protected in accordance with Section 4.3 of NFPA 307 unless otherwise permitted by 28.1.2.2.3.2, 28.1.2.2.3.3, or 28.1.2.2.3.4. [**303:**6.2.3.1]

Paragraph 28.1.2.2.3.1 differentiates between the types of facilities covered by NFPA 303 and those intended for coverage by NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*. NFPA 307 provides much more extensive treatment of the actual construction requirements for the piers and substructures more commonly associated with commercial cargo operations at marine terminals, piers, and wharves.

28.1.2.2.3.2 Fixed piers shall not be required to be protected as specified in 28.1.2.2.3.1 where the vertical distance from the surface of mean high water level to the underside of the pier surface does not exceed 36 in. (914 mm). [**303:**6.2.3.2]

28.1.2.2.3.3 Floating piers shall not be required to be protected as specified in 28.1.2.2.3.1 where the vertical distance from the surface of the water to the underside of the pier surface does not exceed 36 in. (914 mm). [**303:**6.2.3.3]

28.1.2.2.3.4* Existing facilities shall not be required to be protected by an automatic fire-extinguishing system where acceptable to the AHJ. [**303:**6.2.3.4]

A.28.1.2.2.3.4 See A.28.1.2.2.1.3. [**303:**A.6.3.3.4]

28.1.2.2.4 Indoor Rack Storage.

See the commentary following 28.1.3.2.3.2(4).

28.1.2.2.4.1* Where boats are stored on multilevel racks in buildings, an approved automatic fire-extinguishing system shall be installed throughout the building unless otherwise permitted by 28.1.2.2.4.2 or 28.1.2.2.4.3. [**303:**6.2.4.1]

A.28.1.2.2.4.1 Compliance with the requirements of Chapter 12 of NFPA 13 for the protection of Group A plastics stored on solid shelves should be considered for the design and installation of automatic sprinkler systems provided for the protection of buildings housing boats stored on multilevel racks. The combustibility of the boats in storage should be considered in determining hazard classifications. Plan view configuration of the boats in storage should be reviewed to determine whether in-rack sprinklers are needed and to aid in the proper design of the in-rack portion of the sprinkler system. Sound engineering judgment is necessary in selecting sprinkler spacing, placement, and design criteria. [**303:**A.6.2.4.1]

Δ **28.1.2.2.4.2** An automatic fire-extinguishing system shall not be required for buildings less than 5000 ft^2 (465 m^2) having multilevel racks where provided with one of the following:

(1) An automatic fire detection and alarm system supervised by a central station complying with *NFPA 72*
(2) An automatic fire detection and alarm system supervised by a local protective signaling system complying with *NFPA 72*, if the provisions of 28.1.2.2.4.2(1) are not technically feasible
(3) A full-time watch service if the provisions of 28.1.2.2.4.2(1) are not technically feasible

[**303:**6.2.4.2]

28.1.2.2.4.3* Existing facilities shall not be required to be protected by an automatic fire-extinguishing system where acceptable to the AHJ. [**303:**6.2.4.3]

A.28.1.2.2.4.3 See A.28.1.2.2.1.3. [**303:**A.6.2.4.3]

28.1.2.2.5* An approved water supply shall be provided within 100 ft (30 m) of the pier/land intersection or fire department connection serving fire protection systems. [**303:**6.2.5]

A.28.1.2.2.5 To comply with this requirement, water supplies can consist of a hydrant that is part of an approved water supply system, drafting hydrant, or drafting site. [**303:**A.6.2.5]

28.1.2.2.6 Access between water supplies and pier/land intersections or fire department connections shall be by roadway acceptable to the AHJ. [**303:**6.2.6]

28.1.2.3* Fire Standpipe Systems.

A.28.1.2.3 Where standpipe system components are installed in areas subjecting these components to corrosion or other atmospheric damage, special considerations might be necessary. Corrosion-resistant types of pipe, fittings, and hangers or protective corrosion-resistant coatings should be used where corrosive conditions exist. [**303:**A.6.43]

Paragraph 28.1.2.3 addresses the requirements for standpipe systems. Standpipe systems are required to be installed wherever access to piers, bulkheads, or buildings is limited. If the distance from fire apparatus to any of these structures exceeds 150 ft (45.8 m), a Class I standpipe system is required to ensure that adequate fire-fighting water is easily accessible and available in the event of a fire in these structures.

These requirements represent efforts to balance the fire protection and the practical limitations associated with the weight of the piping on piers or docks. Many piers or docks float and might not support the weight of the standpipe system piping. These requirements include options to use flexible connections and nonferrous piping, subject to approval by the AHJ and their listing. Because of vandalism and potential misuse by marina residents, hose racks, hoses, and standpipe cabinets are not required to be located on the piers or bulkheads. See Section 13.2 and NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, for additional information on standpipe systems.

28.1.2.3.1 Class I standpipe systems shall be provided for piers, bulkheads, and buildings where the hose lay distance from the fire apparatus exceeds 150 ft (45 m). [**303:**6.3.1]

28.1.2.3.2 Class I standpipes shall be provided in all buildings used for the rack storage of boats. [**303:**6.4.2]

Δ **28.1.2.3.3** Standpipe systems, where installed, shall be in accordance with NFPA 14, except for the provisions identified in 28.1.2.3.4 through 28.1.2.3.7. [**303:**6.3.3]

28.1.2.3.4 Hose racks, hoses, and standpipe cabinets shall not be required on piers and bulkheads. [**303:**6.3.4]

28.1.2.3.5 Supply piping for standpipes on piers and bulkheads shall be sized for the minimum flow rate of 300 gpm (1136 L/min). [**303:**6.3.5]

Paragraph 28.1.2.3.5 requires that the standpipe system be sized for Class II flow rate due to weight considerations on the pier structure. Essentially the standard is requiring a Class II system with a permanently attached water supply and no hose.

28.1.2.3.6 Manual dry standpipes shall be permitted. [**303:**6.3.6]

28.1.2.3.7 Flexible connections shall be permitted on floating piers where acceptable to the AHJ. [**303:**6.3.7]

28.1.2.4 In-Out Dry Storage and Rack Storage. Water supply and hoses or portable fire extinguishers and wheeled cart assemblies equipped with discharge nozzles capable of reaching all boats on the highest racks shall be provided. [**303:**6.4]

Δ **28.1.2.5 Hydrants and Water Supplies.** Hydrants and water supplies for fire protection in marinas and boatyards shall be provided in accordance with NFPA 13, NFPA 14, and NFPA 24. [**303:**6.5]

28.1.2.6 Fire Detectors.

Δ **28.1.2.6.1** Fire detection devices and installation shall be in accordance with *NFPA 72*. [**303:**6.9.1]

Δ **28.1.2.6.2** Fire detectors shall be installed in the following interior or covered locations unless those locations are protected by a fixed automatic sprinkler system installed in accordance with NFPA 13:

(1) Rooms containing combustible storage or goods
(2) Rooms containing flammable liquid storage or use
(3) Rooms containing battery storage or maintenance
(4) Rooms containing paint and solvent storage or use
(5) Areas used for enclosed or covered storage of vessels
(6) Areas used for enclosed or covered maintenance of vessels
(7) Areas used for public assembly, dining, or lodging
(8) Kitchens and food preparation areas
(9) Dust bins and collectors
(10) Inside trash storage areas
(11) Rooms used for storing janitor supplies or linens
(12) Laundry rooms
(13) Furnace rooms

[**303:**6.9.2]

28.1.3 Berthing and Storage.

28.1.3.1 Wet Storage and Berthing.

28.1.3.1.1 Each berth shall be arranged such that a boat occupying the berth can be removed in an emergency without the necessity of moving other boats. [**303:**7.1.1]

28.1.3.1.2 Access to all piers, floats, and wharves shall be provided for municipal fire-fighting equipment. [**303:**7.1.2]

28.1.3.1.3* Electrical lighting shall be provided to ensure adequate illumination of all exterior areas, piers, and floats. [**303:**7.1.3]

A.28.1.3.1.3 It is recommended that an auxiliary power supply be provided to ensure lighting in the event of a power failure. [**303:**A.7.1.3]

28.1.3.1.4 Electrical lighting shall not interfere with navigation or aids to navigation. [**303:**7.1.4]

28.1.3.1.5 Only listed 120/240 V ac electrical equipment shall be operated unattended. [**303:**7.1.5]

28.1.3.2 Dry Storage.

28.1.3.2.1 General.

28.1.3.2.1.1 Heaters.

28.1.3.2.1.1.1 The use of portable heaters in boat storage areas shall be prohibited except where necessary to accomplish repairs. [**303:**7.2.1.1.1]

28.1.3.2.1.1.2 Portable heaters used in accordance with 28.1.3.2.1.1.1 shall be used only when personnel are in attendance. [**303:**7.2.1.1.2]

28.1.3.2.1.1.3 Open flame heaters shall not be used in boat storage areas. [**303:**7.2.1.1.3]

28.1.3.2.1.2 Ladders long enough to reach the deck of any stored boat shall be provided and readily available. [**303:**7.2.1.2]

28.1.3.2.1.3 The use of blow torches or flammable paint remover shall be prohibited unless permitted by 8.7.1 of NFPA 303. [**303:**7.2.1.3]

28.1.3.2.1.4 The use of gasoline or other flammable solvents for cleaning purposes shall be prohibited. [**303:**7.2.1.4]

Δ **28.1.3.2.1.5** Where a boat is to be dry-stored for the season or stored indoors for an extended period of time, such as while awaiting repairs, the following precautions shall be taken:

(1) The vessel shall be inspected for any hazardous materials or conditions that could exist, and corrective action shall be taken.
(2) Liquefied petroleum gas (LPG) and compressed natural gas (CNG) cylinders, reserve supplies of stove alcohol or kerosene, and charcoal shall be removed from the premises or stored in a separate, designated safe area.

(3) All portable fuel tanks shall be removed from the premises or emptied and, if emptied, the cap shall be removed and the tank left open to the atmosphere.
(4)* Permanently installed fuel tanks shall be stored at least 95 percent full.

[**303:**7.2.1.5]

Paragraph 28.1.3.2.1.5 addresses necessary precautions for boat storage — either dry-stored for the season or while awaiting repairs. An inspection of the marina or boatyard storage area should be conducted to identify the presence of any auxiliary fuel sources (LP-Gas or CNG cylinders, charcoal, or stove fuels like kerosene or alcohol) and primary fuel in either portable or permanently installed fuel tanks. Where a boat has a permanently installed fuel tank, the boat must be stored with the tank approximately 95 percent full, which is often not apparent. This condition causes the vapor space in the tank to be above the upper flammable limit (UFL). The tank contents would be in a too-rich condition and, therefore, not capable of being ignited. If stored with less fuel, the vapor space that exists in the tank might be within the flammable range and thus be ignitable.

Δ **A.28.1.3.2.1.5(4)** Where fuel tanks and fuel systems are susceptible to damage by certain fuel additives or fuel blends, special considerations might be required to prevent damage to tanks and fuel systems that could lead to fuel leaks. Such considerations might include, but are not limited to, completely emptying and purging the fuel tank and/or more frequent inspections to detect damage and leakage from the fuel tank and fuel system that are stored at least 95 percent full in accordance with NFPA 303. [**303:**A.7.2.1.5(4)]

28.1.3.2.1.6 No unattended electrical equipment shall be in use aboard boats. [**303:**7.2.1.6]

Paragraph 28.1.3.2.1.6 addresses unattended equipment, which is not permitted to be in use aboard boats while in storage. Unattended electrical equipment can produce sources of ignition that might cause a fire to move beyond the incipient stage in a stored boat until detected by a fire detection system (where provided) or a watch service on scheduled rounds that might notice the fire.

28.1.3.2.1.7 All storage areas shall be routinely raked, swept, or otherwise policed to prevent the accumulation of rubbish. [**303:**7.2.1.7]

28.1.3.2.1.8 Fire Department Access.

28.1.3.2.1.8.1 Access to boats stored outside shall be such that the hose-lay distance from the fire apparatus to any portion of the boat shall not exceed 150 ft (45 m). [**303:**7.2.1.8.1]

28.1.3.2.1.8.2 Access to buildings in which boats are stored shall be such that the hose-lay distance from the fire apparatus to all exterior portions of the building shall not exceed 150 ft (45 m). [**303:**7.2.1.8.2]

28.1.3.2.1.8.3 Wet standpipe systems shall be permitted to be used to meet the requirement in 28.1.3.2.1.8.1 or 28.1.3.2.1.8.2. [**303:**7.2.1.8.3]

Paragraphs 28.1.3.2.1.8.1 and 28.1.7.2.1.8.2 emphasize the importance of ensuring that access for emergency response is provided for both outside storage (where boats are frequently stored in cradles) and for storage in buildings. To have adequate fire protection, fire apparatus needs to readily reach and operate in all parts of the marina or boatyard. The land approach to the marina or boatyard needs to be by way of an improved road. For outside storage, the arrangement of aisles is an important consideration. For buildings, the use of fire department access lanes around the building should be considered to facilitate fire apparatus access as close to the building as possible. In each instance, wet standpipe systems can be used to meet the minimum requirements. Access to and from land to piers and floats needs to be arranged and maintained to permit municipal or other fire-fighting equipment to be located where the hose lines can be extended to the full length of the pier or floats. See 18.2.3 for additional requirements and information regarding fire department access roads.

28.1.3.2.2 Indoors.

28.1.3.2.2.1 When work is being carried out onboard a vessel in an unsprinklered storage building, management shall require an inspection of the vessel at the end of the day to ensure that no hazards resulting from the day's work are present. [**303:**7.2.2.1]

28.1.3.2.2.2 If a guard is employed, vessels addressed in 28.1.3.2.2.1 shall be included in the regular rounds. [**303:**7.2.2.2]

28.1.3.2.2.3 Class I flammable liquids shall not be stored in an indoor boat storage area. [**303:**7.2.2.3]

28.1.3.2.2.4 Work performed on boats stored indoors shall be performed by qualified personnel. [**303:**7.2.2.4]

28.1.3.2.2.5 Facility management shall maintain control over all personnel access to storage facilities and boats stored indoors. [**303:**7.2.2.5]

28.1.3.2.3 In-Out Dry Storage and Rack Storage.

28.1.3.2.3.1 Where boats are stored either inside or outside in single- or multiple-level racks, those boats shall have unimpeded vehicular access at one end, and equipment shall be available to remove any stored boat. [**303:**7.2.3.1]

Δ **28.1.3.2.3.2** Where boats are stored in multilevel racks, either inside or outside, for seasonal storage or for in-out operation, the following precautions shall be taken:

(1) Drain plugs shall be removed (in sprinklered buildings).
(2) Batteries shall be disconnected or the master battery switch turned off.
(3) Fuel tank valves shall be closed.
(4) For seasonal storage, the requirements of 28.1.3.2.1 shall apply.

[**303:**7.2.3.2]

Exhibit 28.2

Rack storage of boats without protection. (Courtesy of Brewer Onset Bay Marina)

Paragraph 28.1.3.2.3.2 addresses the fire prevention provisions for multilevel rack storage of boats, such as those shown in Exhibit 28.2. For the fire protection requirements for boats stored in multilevel racks in buildings, refer to 28.1.2.2.4 for the specific requirements for sprinkler protection for indoor rack storage. See NFPA 13, *Standard for the Installation of Sprinkler Systems*, for additional information on determining hazard classification for sprinkler system design, installation, and maintenance. Design of automatic sprinkler protection based on NFPA 13 is needed, because testing of protection strategies for rack storage of boats is under development but has not yet been determined. See 28.1.2.2.4.2 for the acceptable alternative provisions addressing the use of automated fire detection or the use of a full-time watch service.

Multilevel rack storage of boats is no longer just a seasonal activity. Today, multilevel rack storage is used year round as an additional means of storing boats awaiting use. Boats in this situation are ready to use and include all the items associated with boats tied to slips or docks, such as fuel, combustible storage, and electronics. In order to get a boat out of multilevel rack storage, the marina must be notified that the boat is needed at a specific time. The marina will remove the boat from the rack and put it in the water. Upon return, the marina will place the boat back in the rack.

28.1.3.2.3.3 Repairs to boats that are on racks or that are inside an in-out dry storage building shall be prohibited. [**303:**7.2.3.3]

28.1.3.2.3.4 Portable power lines, such as drop cords, shall be prohibited from use on boats in an in-out dry storage building. [**303:**7.2.3.4]

28.1.3.2.3.5 The charging of batteries shall be prohibited in the in-out dry storage building. [**303:**7.2.3.5]

Δ **28.1.3.2.4* Battery Storage.** Where due to size and weight the removal of batteries for storage or charging is impractical, batteries shall be permitted to remain onboard provided the following conditions are met:

(1) The battery compartment is arranged to provide adequate ventilation.
(2) A listed battery charger is used to provide a suitable charge.
(3) The power connection to the charger consists of a three-wire cord of not less than No. 14 AWG conductors connected to a source of 110 V to 125 V single-phase current, with a control switch and approved circuit protection device designed to trip at not more than 125 percent of the rated amperage of the charger.
(4) There is no connection on the load side of the charger to any other device except the battery, and the boat battery switch is turned off.
(5) The battery is properly connected to the charger, and the grounding conductor effectively grounds the charger enclosure.
(6) Unattended battery chargers are checked at intervals not exceeding 8 hours while in operation.

[**303:**7.2.4]

A.28.1.3.2.4 Batteries should be removed for storage and charging wherever practical. [**303:**A.7.2.4]

28.1.4 Operational Hazards.

28.1.4.1* Conditions on Individual Boats.

Δ **A.28.1.4.1** Marinas and boatyard owners and operators are encouraged to be familiar with the requirements of NFPA 302. It is recommended that marina and boatyard owners and operators encourage vessel owners and occupants to practice proper fire prevention aboard moored and stored vessels. [**303:**A.8.1]

28.1.4.1.1 The management shall have an inspection made of each boat received for major repair or storage as soon as practicable after arrival of a boat and before commencement of any work aboard. [**303:**8.1.1]

Δ **28.1.4.1.2** The inspection required in 28.1.4.1.1 shall include the following determinations:

(1) Presence of combustible vapors in any compartment
(2) General maintenance and cleanliness, and location of any combustible materials that require removal or protection for the safe accomplishment of the particular work involved
(3) Quantity, type, and apparent condition of fire-extinguishing equipment onboard
(4) Listed and appropriate shore power inlet(s) and ship-to-shore cable(s), when present

[**303:**8.1.2]

28.1.4.1.3 The management shall, as a condition to accepting a boat received for major repair or storage, require the owner to correct any inadequacies found in 28.1.4.1.2 or to authorize management to do so. [**303:**8.1.3]

28.1.4.2 General Precautions.

28.1.4.2.1 Smoking in the working area shall be prohibited. [**303:**8.2.1]

See Section 10.9 for additional requirements related to smoking.

28.1.4.2.2 Loose combustibles in the area of any hazardous work shall be removed. [**303:**8.2.2]

28.1.4.2.3 Unprotected battery terminals shall be covered to prevent inadvertent shorting from dropped tools or otherwise, and the ungrounded battery lead shall be disconnected. [**303:**8.2.3]

28.1.4.2.4 Personnel employed in the removal or installation of storage batteries shall be qualified. [**303:**8.2.4]

28.1.4.2.5 Where electric service is provided to boats in storage, the receptacle providing the power shall be protected with a ground-fault circuit-interrupter. [**303:**8.2.5]

28.1.4.2.6 The marina or boatyard operator shall post in a prominent location, or provide to boat operators using a marina or boatyard for mooring, repair, servicing, or storage, a list of safe operating procedures containing at least the following information:

(1) A prohibition against the use of any form of hibachis, charcoal, wood, or gas-type portable cooking equipment, except in specifically authorized areas that are not on the docks, on boats in the berthing area, or near flammables
(2) Procedures for disposal of trash
(3) Designation of nonsmoking areas
(4) Location of fire extinguishers and hoses
(5) Procedures for turning in a fire alarm
(6) Fueling procedures
(7)* Emergency contact information and marina address for notifying emergency services to respond to an incident

[**303:**8.2.6]

A.28.1.4.2.6(7) For the purpose of this requirement, the emergency contact information should only include the means to contact the fire department or emergency services and the marina or boatyard address. [**303:**A.8.2.6(7)]

An inspection is required for boats that are accepted for storage or major repair in accordance with 28.1.4.1.1. Many marina and boatyard operators use 28.1.4.2.6 as the basis for preparing a checklist of "dos and don'ts" while boats are in their facilities. A number of fires have been caused by the use of hibachis or portable charcoal cooking equipment on individual boats. A boat sitting at the dock can become unstable due to the wakes of other boats passing by within or near the marina. This action can cause portable cooking equipment to overturn and ignite the boat and, in some instances, boats in adjacent berths. Boats that use the marina for permanent berthing or mooring or transient overnight docking need to observe these safe operating procedures as well.

Δ **28.1.4.2.7** The information on fueling procedures referred to in 28.1.4.2.6(6) shall include at least the following information:

(1) Procedures before fueling
  (a) Stop all engines and auxiliaries
  (b) Shut off all electricity, open flames, and heat sources
  (c) Check bilges for fuel vapors
  (d) Extinguish all smoking materials
  (e) Close access fittings and openings that could allow fuel vapors to enter the boat›s enclosed spaces
  (f) Remove all personnel from the boat except the person handling the fueling hose
(2) Procedures during fueling
  (a) Maintain nozzle contact with fill pipe
  (b) Attend fuel-filling nozzle at all times
  (c) Wipe up spills immediately
  (d) Avoid overfilling
(3) Procedures after fueling and before starting engine
  (a) Inspect bilges for leakage or fuel odors
  (b) Ventilate until odors are removed

[**303:**8.2.7]

Fueling or refueling continues to be one of the most dangerous activities associated with the operation of a pleasure boat. Paragraph 28.1.4.2.7 provides the steps that all boaters and marina operators should follow before, during, and after fueling. Marina operators should consider posting safety information near the fueling area to reinforce the steps for boaters and marina and boatyard personnel.

28.2 Marine Terminals, Piers, and Wharves

28.2.1 Section 28.2 shall apply to marine terminals as defined herein. Special use piers and wharf structures that are not marine terminals, such as public assembly, residential, business, or recreational occupancies that differ in design and construction from cargo handling piers, require special consideration. The general principles of NFPA 307 for the construction and fire protection of piers and wharves shall be applicable to such structures and shall comply with NFPA 307 and Section 28.2.

The provisions of NFPA 307 are essential to provide a reasonable level of protection from loss of life and property from fire and explosion in marine terminals, piers, and wharves. NFPA 307 covers the following:

1. Chapter 4 addresses pier and wharf construction, automatic sprinkler protection, and other fire protection requirements based on the construction materials of the pier or wharf.
2. Chapter 5 addresses the construction and protection of terminal buildings.
3. Chapter 6 addresses the safe operation of the terminal yards.
4. Chapter 7 addresses the water supply for fire protection.
5. Chapter 8 addresses hazardous materials storage.
6. Chapter 9 addresses general terminal operations, which cover fire organization, fire safety plans, vessels, and shipboard and terminal cargo handling and storage.
7. Chapter 10 addresses miscellaneous installations and operations, such as tractors, lift trucks, cranes, and other material-handling equipment; automotive and railroad equipment; electrical installations; heating equipment;

processes; fumigation; pallets and dunnage; packaging and recoopering; incinerators; maintenance; repairs and housekeeping; and hot work.

Unless otherwise noted, the provisions of NFPA 307 are not intended to be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of the document, except in those cases where the AHJ determines that the existing situation involves a distinct hazard to life or adjacent property.

28.2.1.1 Marine terminals, piers, and wharves shall comply with 28.1.4.2.7.

Bunkering (fueling) of vessels at a marine terminal must be done in accordance with all applicable laws, ordinances, and regulations, and the authority having jurisdiction as stated in NFPA 307, Section 9.4.5.

Paragraph 28.2.1.1 applies specifically to the transfer of fuel to or from a marine vessel at a marine terminal. When the transfer of fuel or any hazardous material is being carried out, the vessel operator and the terminal operator must, at a minimum, comply with applicable regulations, which include 33 CFR 156, "Oil and Hazardous Material Transfer Operations," and any local requirements established by the AHJ.

28.2.2* Section 28.2 shall not apply to marinas and boatyards. *(See Section 28.1.)* [**307:**1.3.2]

Δ **A.28.2.2** See NFPA 303. [**307:**A.1.3.2]

Δ **28.2.3** Section 28.2 shall not apply to the handling of the following:

(1)* Flammable or combustible liquids in bulk (*See Chapter 66.*)
(2)* Liquefied gases in bulk *(See Chapter 69.)*
[**307:**1.3.3]

Δ **A.28.2.3(1)** See NFPA 30. [**307:**A.1.3.3(1)]

Δ **A.28.2.3(2)** See NFPA 59A or NFPA 58. [**307:**A.1.3.3(2)]

28.2.4 Nothing in Section 28.2 shall supersede any of the regulations of governmental or other regulatory authority. [**307:**1.1.2]

28.3 Construction, Conversion, Repair, and Lay-Up of Vessels

28.3.1* The construction, conversion, repair, or lay-up of vessels shall comply with NFPA 312 and Section 28.3.

A.28.3.1 Many vessels undergoing construction, conversion, or repairs, and vessels laid up in a shipyard or elsewhere are readily vulnerable to fire, due to the quantity and character of combustible materials used in building. Long passageways, unenclosed stairways, hatches, and hoistways facilitate the rapid spread of fire throughout the vessel. Often the location of the vessel is isolated so that private protection is the main source of fire-fighting services. Even where major municipal protection is available, material damage or complete destruction before effective means of extinguishment are brought into action often results from the following:

(1) Possible delayed response, due either to late discovery of the fire or to the absence of means for quick notification
(2) Lack of special equipment in many municipal fire departments for combating shipboard fires
(3) An unfamiliarity with ship construction due to the transitory nature of the risk

[**312:**A.1.2]

Unless otherwise noted, the provisions of NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up*, are not intended to be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of the document, except in those cases where the AHJ determines that the existing situation involves a distinct hazard to life or adjacent property.

NFPA 306, *Standard for the Control of Gas Hazards on Vessels*, contains additional relevant safeguards to be applied during construction, conversion, repair, lay-up, and shipbreaking.

28.3.2 Nothing in Section 28.3 shall be construed as prohibiting the immediate dry-docking of a vessel whose safety is imperiled, as by being in a sinking condition or by being seriously damaged. [**312:**1.2.2]

28.3.3 In such cases, all necessary precautionary measures shall be taken as soon as practicable. [**312:**1.2.3]

Δ **28.3.4** Section 28.3 shall not apply to situations where it is in conflict with or superseded by requirements of any government regulatory agency. [**312:**1.1.2]

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2016 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2018 edition.

NFPA 303, *Fire Protection Standard for Marinas and Boatyards*, 2016 edition.

NFPA 306, *Standard for the Control of Gas Hazards on Vessels*, 2014 edition.

NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*, 2016 edition.

NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up*, 2016 edition.

Title 33, Code of Federal Regulations, Navigation and Navigable Waters, Part 156, "Oil and Hazardous Material Transfer Operations," U.S. Government Publishing Office, Washington, D.C. 20402.

29

Parking Garages

Chapter 29 covers parking garages and structures that include buildings, structures, or portions thereof used for the parking or storage, or both, of motor vehicles. A parking structure is permitted to be enclosed or open, to use ramps, and to use mechanical control push button–type elevators to transfer vehicles from one floor to another. Motor vehicles are permitted to be parked by the driver or an attendant and are permitted to be parked mechanically in automatic facilities. Where automatic parking is provided, the operator of such a facility is permitted either to remain at the entry level or to travel to another level. No specific requirements are included for mechanical parking structures where cars are moved to parking places by lifts or other devices instead of being driven. A typical open parking structure is shown in Exhibit 29.1.

29.1 General

29.1.1 The protection of new and existing parking garages, as well as the control of hazards in open parking structures, enclosed parking structures, and basement and underground parking structures shall comply with this chapter and Section 42.8 of NFPA *101*.

The provisions of Section 42.8 of NFPA *101*®, *Life Safety Code*®, which address life safety requirements for parking structures, must be met, in addition to those found in NFPA 88A, *Standard for Parking Structures*. NFPA 88A covers the construction and protection of, as well as the control of hazards in, open and enclosed parking structures. NFPA 88A does not apply to one- and two-family dwellings. NFPA 88A covers the following topics:

1. Chapter 4 addresses means of egress.
2. Chapter 5 addresses construction requirements.

Exhibit 29.1

Parking structure. (Eric Krouse/Dreamstime.com)

3. Chapter 6 covers building service and fire protection, including lighting and power; heating; ventilation; sprinkler systems; standpipes; and detection, alarm, and communications systems.
4. Chapter 7 addresses special hazard protection, including storage, use, handling, and dispensing of fuels and lubricants.
5. Chapter 8 addresses housekeeping.
6. Chapter 9 addresses special structures, including automated-type parking structures.

Unless otherwise noted within NFPA 88A, the provisions of NFPA 88A are not intended to be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of the document, except where the authority having jurisdiction (AHJ) determines that the existing situation involves a distinct hazard to life or adjacent property.

Δ **29.1.2** Construction and protection of new parking garages shall also comply with NFPA 88A.

N **29.1.3** The storage of self-propelled vehicles powered by GH_2 or LH_2 shall be in accordance with NFPA 2.

29.1.4 Chapter 29 shall not apply to parking garages in one- and two-family dwellings.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 88A, *Standard for Parking Structures*, 2018 edition.

NFPA *101*®, *Life Safety Code*®, 2018 edition.

Motor Fuel Dispensing Facilities and Repair Garages

30

Chapter 30 applies to motor fuel dispensing facilities, marine/motor fuel dispensing facilities, and motor fuel dispensing facilities located inside buildings. This chapter also applies to motor vehicle repair garages. Chapter 30 does not apply, however, to those motor fuel dispensing facilities where only liquefied natural gas (LNG), liquefied petroleum gas (LP-Gas), or compressed natural gas (CNG) is dispensed as motor fuel.

Facilities that dispense only hydrogen are covered directly by NFPA 2, *Hydrogen Technologies Code.* Facilities that dispense only LNG or CNG are covered directly by NFPA 52, *Vehicular Natural Gas Fuel Systems Code*. Facilities that dispense only LP-Gas are covered directly by NFPA 58, *Liquefied Petroleum Gas Code*. However, the NFPA Standards Council has given the Technical Committee on Automotive and Marine Service Stations responsibility for developing appropriate requirements for refueling vehicles with alternative gaseous fuels where these are dispensed along with liquid fuels. Facilities that dispense both gaseous and liquid fuels are, therefore, covered by NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*. Most of the requirements for the use of gaseous fuels at mixed fuel facilities are addressed by referencing the primary document for the fuel, such as NFPA 2 for hydrogen and NFPA 52 LNG, and CNG.

The 2018 edition of NFPA 1, *Fire Code*, derives its extracted text from the 2018 edition of NFPA 30A.

30.1 Motor Fuel Dispensing Facilities

30.1.1 Application.

30.1.1.1 Motor fuel dispensing facilities, marine/motor fuel dispensing facilities, motor fuel dispensing facilities located inside buildings, and fleet vehicle motor fuel dispensing facilities shall comply with Sections 30.1 and 30.3 and NFPA 30A. Hydrogen fueling facilities shall comply with NFPA 2.

The following terms are defined in NFPA 30A:

- *Motor Fuel Dispensing Facility* — That portion of a property where motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles or marine craft or into approved containers, including all equipment used in connection therewith.
- *Fleet Vehicle Motor Fuel Dispensing Facility* — A motor fuel dispensing facility at a commercial, industrial, governmental, or manufacturing property where motor fuels are dispensed into the fuel tanks of motor vehicles that are used in connection with the business or operation of that property by persons within the employ of such business or operation.
- *Marine Motor Fuel Dispensing Facility* — A motor fuel dispensing facility at or adjacent to shore, a pier, a wharf, or a floating dock where motor fuels are dispensed into the fuel tanks of marine craft.
- *Motor Fuel Dispensing Facility Located Inside a Building* — That portion of a motor fuel dispensing facility located within the perimeter of a building or building structure that also contains other occupancies.

30.1.1.2 This chapter shall not apply to refueling operations. *(For refueling operations, see Chapter 42.)*

30.1.1.3 Permits. Permits, where required, shall comply with Section 1.12.

30.1.2 Occupancy Classification. The occupancy classification of a motor fuel dispensing facility that is located inside a building or structure shall be a special purpose industrial occupancy as defined in NFPA *101* or as determined in accordance with the adopted building code. [**30A:**7.3.1]

For the 2012 edition of the *Code*, the technical committee responsible for NFPA 30A clarified 30.1.2 by deleting *low hazard* and replacing it with *special purpose* to correlate 30.1.3 on means of egress with the occupancy classification and means of egress for repair garages under 30.2.2 and 30.2.4. The intent of the committee was always to provide the proper occupancy classifications for motor fuel dispensing facilities and repair garages that correlate with the appropriate requirements in NFPA *101*®, *Life Safety Code*®, as well as *NFPA 5000*®, *Building Construction and Safety Code*®.

30.1.3 Means of Egress. In a motor fuel dispensing facility that is located inside a building or structure, the required number, location, and construction of means of egress shall meet all applicable requirements for special purpose industrial occupancies, as set forth in NFPA *101* or as determined in accordance with the adopted building code. [**30A:**7.3.3]

30.1.4 Drainage. Where Class I or Class II liquids are dispensed, provisions shall be made to prevent spilled liquids from flowing into the interior of buildings. Such provisions shall be made by grading driveways, raising door sills, or other equally effective means. [**30A:**7.3.4]

30.1.5 Fixed Fire Protection.

30.1.5.1* For an unattended, self-serve, motor fuel dispensing facility, additional fire protection shall be provided where required by the AHJ. [**30A:**7.3.5.1]

A.30.1.5.1 Additional fire protection considerations can include items such as fixed suppression systems, automatic fire detection, manual fire alarm stations, transmission of alarms to off-site locations, and limiting volume delivered per transaction. [**30A:**A.7.3.5.1]

Paragraph 30.1.5.1 allows the authority having jurisdiction (AHJ) to require other fire protection systems or features as a condition of approval of an unattended self-service station. The additional provisions, if any, might vary considerably, depending on the specific installation.

30.1.5.2 Where required, an automatic fire suppression system shall be installed in accordance with the appropriate NFPA standard, manufacturers' instructions, and the listing requirements of the systems. [**30A:**7.3.5.2]

See Section 13.8 for additional guidance on fire protection systems other than automatic sprinkler systems.

30.1.6 Fuel Dispensing Areas Inside Buildings.

Subsection 30.1.6 applies to the unusual fire hazards posed by the presence of a fuel dispensing operation inside a building. NFPA 30A requires that the dispensing operation be completely cut off from the rest of the building (see 30.1.6.1, 30.1.6.3, and 30.1.6.4), that it be relatively close to the entrance (see 30.1.6.5), and that the dispensing operation be limited in size (see 30.1.6.6).

30.1.6.1 The fuel dispensing area shall be separated from all other portions of the building by walls, partitions, floors, and floor–ceiling assemblies having a fire resistance rating of not less than 2 hours. [**30A:**7.3.6.1]

30.1.6.2 Interior finish shall be of noncombustible materials or of approved limited-combustible materials, as defined in this *Code* and NFPA 220. [**30A:**7.3.6.2]

30.1.6.3 Door and window openings in fire-rated interior walls shall be provided with listed fire doors having a fire protection rating of not less than 1½ hours. Doors shall be self-closing. They shall be permitted to remain open during normal operations if they are designed to close automatically in a fire emergency by means of listed closure devices. Fire doors shall be installed in accordance with NFPA 80. They shall be kept unobstructed at all times. [**30A:**7.3.6.3]

30.1.6.4 Openings for ducts in fire-rated interior partitions and walls shall be protected by listed fire dampers. Openings for ducts in fire-rated floor or floor–ceiling assemblies shall be protected with enclosed shafts. Enclosure of shafts shall be with wall or partition assemblies having a fire resistance rating of not less than 2 hours. Openings for ducts into enclosed shafts shall be protected with listed fire dampers. [**30A:**7.3.6.4]

30.1.6.5 The fuel dispensing area shall be located at street level, with no dispenser located more than 50 ft (15 m) from the vehicle exit to, or entrance from, the outside of the building. [**30A:**7.3.6.5]

30.1.6.6 The fuel dispensing area shall be limited to that required to serve not more than four vehicles at one time.

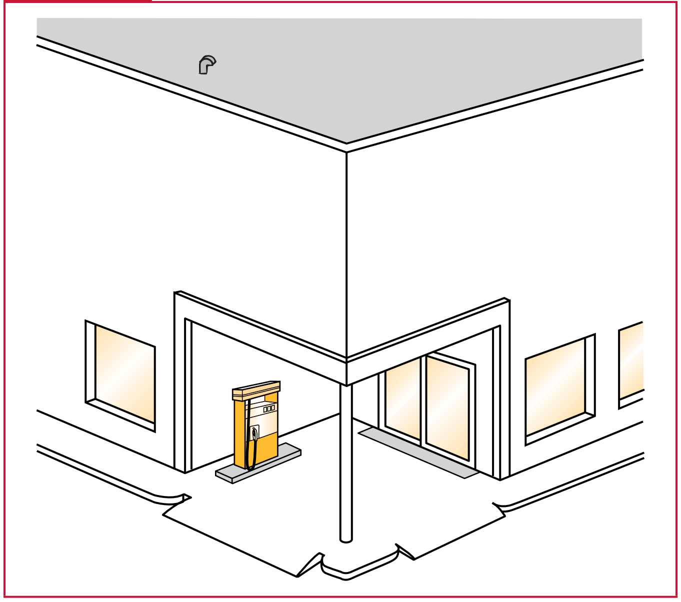
*Exception: At a fleet vehicle motor fuel dispensing facility inside a building, where only Class II and Class III liquids are dispensed, the number of vehicles serviced at any one time shall be permitted to be increased to 12. [**30A:**7.3.6.6]*

Some large fleet service and refueling buildings can have up to 12 interior refueling lanes to accommodate the large number of vehicles being served. The Technical Committee on Automotive and Marine Service Stations agreed that this number was reasonable for this special type of operation, because the general public does not have access.

30.1.6.7* A mechanical exhaust system that serves only the fuel dispensing area shall be provided. This system shall meet all of the following requirements:

(1) The system shall be interlocked with the dispensing system so that airflow is established before any dispensing device can operate. Failure of airflow shall automatically shut down the dispensing system.
(2) The exhaust system shall be designed to provide air movement across all portions of the floor of the fuel dispensing area and to prevent the flowing of ignitible vapors beyond the dispensing area.
(3) Exhaust inlet ducts shall not be less than 3 in. (76 mm) or more than 12 in. (305 mm) above the floor. Exhaust ducts shall not be located in floors or penetrate the floor of the dispensing area. Exhaust ducts shall discharge to a safe location outside the building.
(4) The exhaust system shall provide ventilation at a rate of not less than 1 $ft^3/min/ft^2$ (0.3 $m^3/min/m^2$) of floor area, based on the fuel dispensing area.
(5) The exhaust system shall meet all applicable requirements of NFPA 91.

Exhibit 30.1



Motor fuel dispensing area located in the portico of a building.

*Exception: The provisions of 30.1.6.7 shall not apply to a fuel dispensing area located inside a building if two or more sides of the dispensing area are open to the building exterior. [**30A:**7.3.6.7]*

A.30.1.6.7 Natural ventilation can normally be expected to dissipate any fuel vapors before they reach ignitible concentrations if at least two sides of the dispensing area are open to the building exterior. [**30A:**A.7.3.6.7]

The intent of 30.1.6.7 is to provide a sweep of clean air across the floor of the dispensing area to pick up any fugitive vapors and carry them to the exterior of the building. The exception waives the ventilation requirement for dispensing areas that are basically outside the building but within its footprint, such as the situation depicted in Exhibit 30.1.

30.1.6.8 The floor of the dispensing area shall be liquidtight. Where Class I liquids are dispensed, provisions shall be made to prevent spilled liquids from flowing out of the fuel dispensing area and into other areas of the building by means of curbs, scuppers, special drainage systems, or other means acceptable to the AHJ. [**30A:**7.3.6.8]

30.1.6.9* Oil drainage systems shall be equipped with approved oil/water traps or separators if they connect to public sewers or discharge into public waterways. [**30A:**7.3.6.9]

A.30.1.6.9 Oil/water separators might not be designed to remove or separate flammable or combustible liquids other than oil. [**30A:**A.7.3.6.9]

30.2 Repair Garages

30.2.1 Application. The construction and protection of, as well as the control of hazards in, garages used for major repair and maintenance of motorized vehicles and any sales and servicing facilities associated therewith shall comply with Sections 30.2 and 30.3 and NFPA 30A.

NFPA 30A separates repair garages into two categories:

1. The term *major repair garage* is defined as "a building or portions of a building where major repairs, such as engine overhauls, painting, body and fender work, and repairs that require draining of the motor vehicle fuel tank are performed on motor vehicles, including associated floor space used for offices, parking, or showrooms."
2. The term *minor repair garage* is defined as "a building or portions of a building used for lubrication, inspection, and minor automotive maintenance work, such as engine tune-ups, replacement of parts, fluid changes (e.g., oil, antifreeze, transmission fluid, brake fluid, air conditioning refrigerants, etc.), brake system repairs, tire rotation, and similar routine maintenance work, including associated floor space used for offices, parking, or showrooms."

N **30.2.1.1** Repair garages servicing self-propelled vehicles powered by GH_2 or LH_2 shall comply with NFPA 2.

30.2.1.2 Permits. Permits, where required, shall comply with Section 1.12.

30.2.2 Occupancy Classification. The occupancy classification of a repair garage shall be a special purpose industrial occupancy as defined in NFPA *101*, or as determined in accordance with the adopted building code. [**30A:**7.4.1]

NFPA *101* defines the term *special-purpose industrial occupancy* as "an industrial occupancy in which ordinary and low hazard industrial operations are conducted in buildings designed for, and suitable only for, particular types of operations, characterized by a relatively low density of employee population, with much of the area occupied by machinery or equipment."

30.2.3 General Construction Requirements. In major repair garages, where CNG-fueled vehicles, hydrogen-fueled vehicles, LNG-fueled vehicles, or LP-Gas-fueled vehicles are repaired, all applicable requirements of NFPA 2, NFPA 52, or NFPA 58, whichever is applicable, shall be met. [**30A:**7.4.2]

30.2.4 Means of Egress. In a repair garage, the required number, location, and construction of means of egress shall meet all applicable requirements for special purpose industrial occupancies, as set forth in NFPA *101*, or as determined in accordance with the adopted building code. [**30A:**7.4.3]

30.2.5 Drainage. In areas of repair garages used for repair or servicing of vehicles, floor assemblies shall be constructed of noncombustible materials or, if combustible materials are used in the assembly, they shall be surfaced with approved, nonabsorbent, noncombustible material, except as indicated in 30.2.5.1. [**30A:**7.4.4]

N **30.2.5.1** Slip-resistant, nonabsorbent, interior floor finishes having a critical radiant flux not more than 9.87 Btu/in.^{2} (0.45 W/cm^2), as determined by NFPA 253, shall be permitted. [**30A:**7.4.4.1]

30.2.5.2 Floors shall be liquidtight to prevent the leakage or seepage of liquids and shall be sloped to facilitate the movement of water, fuel, or other liquids to floor drains. [**30A:**7.4.4.2]

30.2.5.3 In areas of repair garages where vehicles are serviced, any floor drains shall be properly trapped and shall discharge through an oil/water separator to the sewer or to an outside vented sump. [**30A:**7.4.4.3]

Note that 30.2.5.2 and 30.2.5.3 do not mandate installation of floor drains; they only establish certain provisions to be followed where floor drains are present. The requirement to install floor drains would be the purview of the applicable plumbing code.

30.2.6 Pits, Belowgrade Work Areas, and Subfloor Work Areas.

Subsection 30.2.6 addresses the lower-level work areas of quick-lube service stations and similar facilities. Due to the number of vehicles capable of being serviced on a daily basis by these facilities, servicing the vehicles from the lower-level area is more efficient and actually safer than raising the vehicle on a lift. Service pits, subfloor work areas, and belowgrade work areas are below the level of the surface on which the vehicle to be serviced is located.

The difference between a service pit or subfloor work area and a belowgrade work area is that a service pit or subfloor work area is generally much smaller, usually extending only under the vehicle being serviced, while a belowgrade work area tends to be the same size as the building's footprint. The belowgrade work area, in addition to being larger, usually is subject to the same building code requirements as a floor or story of a building, including requirements for fixed lighting, ventilation, minimum headroom, and alternative means of egress. Exhibit 30.2 depicts a belowgrade work area.

Exhibit 30.2

Belowgrade work area of a lube-only facility. (Courtesy of Jiffy-Lube)

30.2.6.1 Pits, belowgrade work areas, and subfloor work areas used for lubrication, inspection, and minor automotive maintenance work shall comply with the provisions of this chapter, in addition to other applicable requirements of NFPA 30A. [**30A:**7.4.5.1]

30.2.6.2 Walls, floors, and structural supports shall be constructed of masonry, concrete, steel, or other approved noncombustible materials. [**30A:**7.4.5.2]

All structural elements of pits, belowgrade work areas, and subfloor work areas must be of noncombustible material. Floor and wall surfaces should be capable of being easily cleaned and should not absorb spills. Floor surfaces should provide adequate traction to minimize personnel injuries from slipping and falls. This requirement is not intended to restrict the use of interior finishes or floor finishes that meet the requirements of NFPA *101*, such as approved rubberized nonslip floor finishes over a concrete floor. (For further information, see also 30.2.5.1.)

30.2.6.3 In pits, belowgrade work areas, and subfloor work areas, the required number, location, and construction of means of egress shall meet the requirements for special purpose industrial occupancies in Chapter 40 of NFPA *101*, or in accordance with the adopted building code. [**30A:**7.4.5.3]

Means of egress from belowgrade and subfloor work areas must comply with the provisions for special-purpose industrial occupancies, as set forth in 40.1.2.1.2 of NFPA *101*. A special-purpose industrial occupancy is characterized as being of low or ordinary hazard and having few employees. The number of means of egress required from these areas is based on the total travel distance to an exit. If the total travel distance does not exceed 50 ft (15 m), only one means of egress is required, as allowed by 40.2.4.1.2 of NFPA *101*. Most quick-lube operations have vehicles located over unprotected floor openings. Subsection 40.3.1(1) of NFPA *101* requires that at least one of the exits from the lower level be an enclosed stairway or similar type of exit that is protected against obstruction by fire or smoke that could enter the lower level from the open service bays.

30.2.6.4 Pits, belowgrade work areas, and subfloor work areas shall be provided with exhaust ventilation at a rate of not less than 1 ft^3/min/ft^2 (0.3 m^3/min/m^2) of floor area at all times that the building is occupied or when vehicles are parked in or over these areas. Exhaust air shall be taken from a point within 12 in. (0.3 m) of the floor. [**30A:**7.4.5.4]

Paragraph 30.2.6.4 addresses ventilation of pits, belowgrade work areas, and subfloor work areas. Experience with these facilities shows that a vehicle seldom has a leak in its fuel system or fuel tank. When a leak is present, the odor of the fuel is obvious and the vehicle will be removed from the building. The Technical Committee on Automotive and Marine Service Stations reviewed ventilation rates required by NFPA 30, *Flammable and Combustible Liquids Code*; NFPA 88B, *Standard for Repair Garages* (which was incorporated into the 2000 edition of NFPA 30A); and *NFPA 70®*, *National Electrical Code®*, as well as several mechanical codes. The committee also reviewed the calculation procedure to determine dilution rates, which are described in *NFPA's Fire Protection Handbook*®. Using this method, a spill of about 1 pt (about ½ L) of gasoline would require 800 ft^3 to 1050 ft^3 (23 m^3 to 30 m^3) of air to dilute the mixture to 25 percent of the lower flammable limit (LFL), the point that is traditionally considered minimally safe. Based on this result, it was determined that the traditionally accepted ventilation rate required by NFPA 30 and other codes — 1 ft^3 per minute per ft^2 (0.3 m^3 per minute per m^2) of floor area — would be more than adequate. This ventilation rate provides at least six air changes per hour, based on an assumed ceiling height of 10 ft (3 m), without causing excessive heat loss in the winter months.

Make-up air supplied in excess of that which is actually exhausted should be avoided, because any flammable vapors that are released might be driven above the exhaust duct inlets and into overhead electrical fixtures. Usually, sufficient make-up air is provided by normal leakage around service bay doors.

The user is cautioned that the ventilation rate specified is adequate for small spills only. A larger spill would require much more ventilation capacity; for example, 6300 ft^3 to 8400 ft^3 per minute per ft^2 (180 m^3 to 240 m^3 per minute per m^2) for a 1 gal (3.8 L) spill. Therefore, compliance with Chapter 9 of NFPA 30A is just as important for these facilities as it is for traditional service stations.

Δ **30.2.7 Fixed Fire Protection.** Automatic sprinkler protection installed in accordance with the requirements of Section 13.3 shall be provided throughout all buildings containing major repair garages, as herein defined, when any one of the following conditions exist:

(1) The building housing the major repair garage is two or more stories, including basements, and the aggregate area of the major repair garage exceeds 10,000 ft^2 (930 m^2).
(2) The major repair garage is one story and exceeds 12,000 ft^2 (1115 m^2).
(3) The major repair garage is servicing vehicles parked in the basement of the building.

[**30A:**7.4.6]

30.2.8 Gas Detection System. Repair garages used for repair of vehicle engine fuel systems fueled by nonodorized gases shall be provided with an approved flammable gas detection system. Gas detection systems in repair garages for hydrogen vehicles shall be in accordance with NFPA 2. [**30A:**7.4.7]

Certain gaseous fuels cannot be odorized because the mercaptans typically used as odorants damage the system in which the fuel is to be used. For example, mercaptans can poison the platinum catalysts used in hydrogen fuel cells.

Detectors should be located to account for both the buoyancy of the gas and the possibility that it can disperse into spaces that might be enclosed or partially enclosed. These types of spaces would be of particular concern because of the possibility of gas accumulating sufficiently to reach concentrations in the flammable range.

30.2.8.1 System Design. The flammable gas detection system shall be calibrated to the types of fuels or gases used by vehicles to be repaired. The gas detection system shall be designed to activate when the level of flammable gas exceeds 25 percent of the lower flammable limit (LFL). Gas detection shall also be provided in lubrication or chassis repair pits of repair garages used for repairing non-odorized LNG/CNG-fueled vehicles. [**30A:**7.4.7.1]

Δ **30.2.8.2 Operation.** Activation of the gas detection system shall result in all of the following:

(1) Initiation of distinct audible and visual alarm signals in the repair garage
(2) Deactivation of all heating systems located in the repair garage
(3) Activation of the mechanical ventilation system, when the system is interlocked with gas detection

[**30A:**7.4.7.2]

30.2.8.3 Failure of the Gas Detection System. Failure of the gas detection system shall result in the deactivation of the heating system and activation of the mechanical ventilation system and, where the ventilation system is interlocked with gas detection, shall cause a trouble signal to sound in an approved location. [**30A:**7.4.7.3]

30.2.8.4 System Integrity. The circuits of the detection system required by 30.2.8 shall be monitored for integrity in accordance with *NFPA 72*. [**30A:**7.4.7.4]

Circuits required by 30.2.8 must be monitored for integrity. Given the fact that the gas detection system is a safety system, integrity monitoring in accordance with *NFPA 72*®, *National Fire Alarm and Signaling Code*®, is justified. If a fault is on the circuit wiring, a trouble signal will be generated at the protected premises.

30.2.9* Heating, Ventilating, and Air-Conditioning.

A.30.2.9 The ventilation requirements contained in this section do not consider exhaust emissions from motor vehicle engines. An appropriate professional should be consulted to determine precautions necessary to protect against this health hazard. [**30A:**A.7.5]

30.2.9.1* Forced air heating, air-conditioning, and ventilating systems serving a fuel dispensing area inside a building or a repair garage shall not be interconnected with any such systems serving other occupancies in the building. Such systems shall be installed in accordance with NFPA 90A. [**30A:**7.5.1]

A.30.2.9.1 Manual control switches for supply and exhaust ventilating systems should be located close to the entrance to the area served. In buildings protected by automatic sprinklers or fire alarm systems, it is recommended that the necessary interlocks be provided to shut down supply and exhaust fans when the sprinklers or fire alarms operate. For service facilities for CNG-fueled vehicles and LNG-fueled vehicles, see NFPA 52. [**30A:**A.7.5.1]

The requirement in 30.2.9.1 eliminates the possibility of vapors from a fuel spill being dispersed to adjacent spaces of the building.

30.2.9.2 Return air openings in areas of repair garages used for the repair or servicing of vehicles or in a fuel dispensing area shall be not less than 18 in. (455 mm) above floor level measured to the bottom of the openings. [**30A:**7.5.2]

30.2.9.3 Combined ventilation and heating systems shall not recirculate air from areas that are below grade level. [**30A:**7.5.3]

Because such a system serves the combined purposes of conditioning the space and removing fugitive vapors from it, this requirement is needed to ensure that the system does not allow buildup of vapors.

30.2.9.4* Exhaust duct openings shall be located so that they effectively remove vapor accumulations at floor level from all parts of the floor area. Where lighter-than-air gaseous fuel vehicles are repaired, exhaust duct openings shall be located so that they effectively remove vapor accumulations at the ceiling level. [**30A:**7.5.4]

N **A.30.2.9.4** Lighter-than-air fuels include fuels such as hydrogen and natural gas, but not LPG. [**30A:**A.7.5.4]

30.2.10 Heat-Producing Appliances.

30.2.10.1 Heat-producing appliances shall be installed in accordance with the requirements of 30.2.10. They shall be permitted to be installed in the conventional manner except as provided in 30.2.10. [**30A:**7.6.1

30.2.10.2 Heat-producing appliances shall be of an approved type. Solid fuel stoves, improvised furnaces, salamanders, or space heaters shall not be permitted in areas of repair garages used for repairing or servicing of vehicles or in a fuel dispensing area.

Exception No. 1: Unit heaters, when installed in accordance with Chapter 7 of NFPA 30A, need not meet this requirement.

*Exception No. 2: Heat-producing equipment for any lubrication room or service room where there is no dispensing or transferring of Class I or Class II liquids or LP-Gas, when installed in accordance with Chapter 7 of NFPA 30A, need not meet this requirement. [**30A:**7.6.2]*

Salamanders, space heaters, and similar types of heaters are often found in repair garages. Misuse of these heaters is an increasing concern for fire inspectors. The use of unapproved heaters in garage settings can result in the ignition of flammable and combustible liquids from spilled or open containers or in the ignition of the flammable or combustible vapors created by the repair work itself.

30.2.10.3 Heat-producing appliances shall be permitted to be installed in a special room that is separated from areas that are classified as Division 1 or Division 2, in accordance with Chapter 8 of NFPA 30A, by walls that are constructed to prevent the transmission of vapors, that have a fire resistance rating of at least 1 hour, and that have no openings in the walls that lead to a classified area within 8 ft (2.4 m) of the floor. Specific small openings through the wall, such as for piping and electrical conduit, shall be permitted, provided the gaps and voids are filled with a fire-resistant material to resist transmission of vapors. All air for combustion purposes shall be taken from outside the building. This room shall not be used for storage of combustible materials, except for fuel storage as permitted by the standards referenced in 30.2.10.9. [**30A:**7.6.3]

30.2.10.4 Heat-producing appliances using gas or oil fuel shall be permitted to be installed in a lubrication or service room where there is no dispensing or transferring of Class I liquids, including the open draining of automotive gasoline tanks, provided the bottom of the combustion chamber is at least 18 in. (455 mm) above the floor and the appliances are protected from physical damage. [**30A:**7.6.4]

30.2.10.5 Heat-producing appliances using gas or oil fuel listed for use in garages shall be permitted to be installed in lubrication rooms, service rooms, or fuel dispensing areas where Class I liquids are dispensed or transferred, provided the equipment is installed at least 8 ft (2.4 m) above the floor. [**30A:**7.6.5]

30.2.10.6* Where major repairs are conducted on lighter-than-air-fueled vehicles, open flame heaters or heating equipment with exposed surfaces having a temperature in excess of 750°F (399°C) shall not be permitted in areas subject to ignitible concentrations of gas. [**30A:**7.6.6]

A.30.2.10.6 Enclosed rooms or spaces storing CNG- or LNG-fueled vehicles should prohibit the transmission of gases to other areas of the building. Other areas outside of the enclosure, if not used for repairing or storing CNG- or LNG-fueled vehicles, can use other heating methods. Note that, according to A.1.1 of NFPA 52, CNG weighs about two-thirds as much as air and, therefore, as a gas, will rise in a room. LNG at a temperature of less than or equal to –170°F (–112°C) is heavier than ambient air [at 60°F (15°C)], but as the LNG's temperature rises, the gas becomes lighter than air. Determination of the potential for gas accumulation should be based on an engineering analysis. (Guidance for classification of hazardous locations is available in NFPA 497.) [**30A:**A.7.6.6]

30.2.10.7 Electrical heat-producing appliances shall meet the requirements of Chapter 8 of NFPA 30A. [**30A:**7.6.7]

30.2.10.8 Fuels used shall be of the type and quality specified by the manufacturer of the heating appliance. Crankcase drainings shall not be used in oil-fired appliances, unless the appliances are specifically approved for such use. [**30A:**7.6.8]

See Section 11.5 for additional requirements for heating appliances.

Δ **30.2.10.9** Heat-producing appliances shall be installed to meet the requirements of NFPA 31, NFPA 54, NFPA 82, NFPA 90A, and NFPA 211 as applicable, except as hereinafter specifically provided. [**30A:**7.6.9]

30.3 Operational Requirements

Operations conducted in motor fuel dispensing facilities and repair garages shall comply with Section 42.7.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2018 edition.

NFPA 52, *Vehicular Natural Gas Fuel Systems Code*, 2016 edition.

NFPA 54, *National Fuel Gas Code*, 2018 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2017 edition.

NFPA 59, *Utility LP-Gas Plant Code*, 2018 edition.

NFPA 70®, *National Electrical Code*®, 2017 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*®, 2016 edition.

NFPA 88B, *Standard for Repair Garages,* 1997 edition (incorporated into 2000 edition of NFPA 30A).

NFPA *101*®, *Life Safety Code*®, 2018 edition.

NFPA 1192, *Standard on Recreational Vehicles*, 2018 edition.

NFPA 5000®, *Building Construction and Safety Code*®, 2018 edition.

Fire Protection Handbook®, 20th edition.

Forest Products and Biomass Feedstocks

31

Chapter 31 contains provisions for the storage, manufacturing, and processing of timber, lumber, plywood, veneers, biomass feedstock, and by-products of forest products. Fires in these types of facilities pose special problems for fire-fighting operations.

Δ 31.1* General

The storage, manufacturing, and processing of timber, lumber, plywood, veneers, biomass feedstock, and by-products shall be in accordance with this chapter and NFPA 664.

A.31.1 Each individual property has its own special conditions of stock handling, exposure, and topography. For this reason, only basic fire protection principles are discussed herein and are intended to be applied with due consideration of all local factors involved. The AHJ should be consulted.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, establishes the minimum requirements for fire and explosion prevention and protection of industrial, commercial, or institutional facilities that process wood or manufacture wood products; that use wood or other cellulosic fiber as a substitute for, or additive to, wood fiber; and that process wood, creating wood chips, particles, or dust. Woodworking and wood processing facilities include, but are not limited to, wood flour plants, industrial woodworking plants, furniture plants, plywood plants, composite board plants, lumber mills, and production-type woodworking shops and carpentry shops that are incidental to facilities that would not otherwise fall within the scope of NFPA 664. NFPA 664 applies to woodworking operations that occupy areas of more than 5000 ft^2 (465 m^2) or where dust-producing equipment requires an aggregate dust collection flow rate of more than 1500 ft^3/min (2549 m^3/hr).

31.2 Permits

Permits, where required, shall comply with Section 1.12.

Table 1.12.8(a) requires a permit for the storage of lumber exceeding 100,000 board feet. A permit is also required to store chips, hogged material, lumber, or plywood in excess of 200 ft^3 (5.7 m^3) in accordance with Table 1.12.8(a).

31.3 Protection of Storage of Forest Products

The outdoor storage of forest products involves many arrangements of storage, from retail lumber outlets to the large cold decks found at wood processing facilities. Storage also involves a wide range of products, from wood chips and plywood to large tree logs for logging operations. If any of these types of storage goes unchecked, a fire could mean large product losses for the company and vast amounts of resources expended by the responding fire department. Therefore, the requirements for the outdoor storage of forest products are aimed at minimizing the likelihood of fire, controlling a fire if one occurs, and ensuring rapid fire department access to the site should a fire occur.

The fire department, authorities having jurisdiction (AHJs), and users should be familiar with the site and pre-plan for fire incidents involving various scenarios. Some of the requirements among the different types of storage are common; therefore, review of all the outdoor forest products storage commentary is recommended.

31.3.1 Application.

31.3.1.1 The requirements of this chapter shall apply to the outside storage of the following:

(1) Lumber and wood panel products at retail and wholesale lumber storage yards
(2) Lumber and wood panel products at other than retail and wholesale storage yards
(3) Ties, poles, piles, posts, and other similar forest products at pressure-treating plant yards
(4) Outside storage of wood chips, hogged material, and wood by-products
(5) Logs
(6) Outside storage of biomass feedstocks

Indoor storage areas should comply with NFPA 664 and Chapter 34 of this *Code*.

For the 2018 edition of this Code, Chapter 31 has been updated to include the outside storage of biomass feedstocks in its application. See the commentary on 31.3.10 for more information on the protection of biomass feedstocks.

Δ **31.3.1.2** The requirements of this chapter shall not apply to forest products stored on piers and wharves as addressed in NFPA 307.

31.3.2 General Fire Protection. The requirements in this subsection shall apply to all facilities regulated by 31.3.3 through 31.3.8 except as modified by those subsections.

31.3.2.1 Operational Fire Prevention.

31.3.2.1.1* Combustible waste materials such as bark, sawdust, chips, and other debris shall not be permitted to accumulate in a quantity or location that constitutes an undue fire hazard.

A.31.3.2.1.1 Good housekeeping should be maintained at all times, including regular and frequent cleaning of materials-handling equipment.

If combustible materials are allowed to accumulate around lumber piles or in equipment, a fire could quickly spread beyond the fire-fighting capabilities of the responding fire department. Combustible waste materials generally are more easily ignited than whole pieces of lumber or logs.

Good housekeeping also includes dealing with weeds throughout storage areas. The precautions identified in A.31.3.2.1.1, 31.3.2.2.2, and 10.13.10 should be applied to all forest product storage areas. Processing by-products should be removed at regular intervals to prevent buildup. The by-products should be stored in approved areas with the appropriate protection. (See 31.3.6.)

31.3.2.1.2 Smoking shall be prohibited except in specified safe locations approved by the AHJ.

See Section 10.9 for additional requirements related to smoking.

31.3.2.1.2.1 Signs that read "No Smoking" shall be posted in those areas where smoking is prohibited.

31.3.2.1.2.2 Signs indicating areas designated as safe for smoking shall be posted in those locations where smoking is permitted.

31.3.2.1.2.3 Smoking areas shall be provided with approved, noncombustible ash receptacles.

31.3.2.1.2.4 Smoking shall be specifically prohibited in and around railroad cars.

A cigarette carelessly disposed among forest products could smolder for an extended period of time before igniting a fire. Railroad cars could transport an incipient fire to some other location before the occurrence of flaming ignition. The careless disposal of cigarettes is one of the major causes of fires in lumberyards. For additional requirements related to smoking, see Section 10.9.

31.3.2.1.3 Access into yard areas by unauthorized persons shall be prohibited.

31.3.2.1.4 Storage areas shall be enclosed with a fence equipped with effective gates located as necessary to allow the entry of fire department apparatus.

A fence is perhaps the best means of preventing unauthorized access to a site. In accordance with Chapter 18, gates should be provided at the main entrance and at other locations around the perimeter to permit fire department apparatus to gain immediate access to all areas.

The outdoor storage of forest products typically involves large quantities of combustibles visible from the street, making such storage areas the targets of arson and requiring appropriate security measures. Fires of incendiary and suspicious origin are among the leading causes of fires in lumberyards. However, security measures should not prevent fire department access to the site. See Chapter 18 for fire department access requirements.

31.3.2.1.5 Miscellaneous occupancy hazards such as vehicle storage and repair shops, cutting and welding operations, flammable liquid storage, liquefied petroleum gas storage, and similar operations shall be safeguarded in accordance with recognized good practice and this *Code*.

Fire prevention and fire protection requirements in this *Code* and other NFPA codes and standards must be followed for hazardous operations and installations within lumber storage yards to reduce the risk of exposure fires and ignition sources.

The following chapters provide additional guidance and requirements:

1. Chapter 30 for motor fuel dispensing
2. Chapter 41 for hot work operations
3. Chapter 66 for handling and use of flammable and combustible liquids
4. Chapter 69 for handling and use of liquefied petroleum gas (LP-Gas) and liquefied natural gas (LNG)

31.3.2.1.6 Vehicles and other power devices shall be of an approved type and shall be safely maintained and operated.

31.3.2.1.6.1* Vehicle fueling operations shall be conducted in specified safe locations, isolated from storage areas and principal operating buildings.

Δ **A.31.3.2.1.6.1** See NFPA 505.

31.3.2.1.6.2 Diesel- or gasoline-fueled vehicles that operate on hogged material or chip piles, in log storage areas, or in lumber storage areas shall be equipped with fixed fire-extinguishing systems of a type approved for off-road vehicles.

31.3.2.1.7 All electrical equipment and installations shall conform to the provisions of Section 11.1.

31.3.2.1.8 Salamanders, braziers, open fires, and similar dangerous heating arrangements shall be prohibited.

31.3.2.1.9 Heating devices shall be limited to approved-type equipment installed in an approved manner.

31.3.2.1.10 Suitable safeguards shall be provided to minimize the hazard of sparks caused by equipment such as refuse burners, boiler stacks, vehicle exhausts, and locomotives.

In addition to sparks from locomotives, the combustion process of locomotives traveling through a storage area is also a concern. Diesel locomotives should be equipped with spark arresters or other devices to prevent the escape of glowing carbon particles from the exhaust. Steam locomotives, where still used, should have a means to prevent hot ashes (coal-fired) or burning oil (oil-fired) from dropping out of the locomotive.

31.3.2.1.10.1* Burning of shavings, sawdust, and refuse materials shall be conducted only in an approved, enclosed refuse burner equipped with an approved spark arrester and located at a safe distance from the nearest point of any yard. *(See Section 10.10.)*

Δ **A.31.3.2.1.10.1** See NFPA 82 for small rubbish burners.

Section 10.10 provides additional guidance on, and requirements for, open burning.

31.3.2.1.10.2 The design and location of large burners presents special problems, and the AHJ shall be consulted.

31.3.2.1.11 Stacks from solid fuel-burning furnaces and boilers shall be equipped with spark-arresting equipment to prevent hot sparks from reaching the ground, and consideration shall be given to spark hazard in determining the height of such stacks.

31.3.2.1.12 Cutting, welding, or other use of open flames or spark-producing equipment shall not be permitted in the storage area unless by an approved permit system.

Chapter 41 provides additional guidance on, and requirements for, hot work operations.

31.3.2.2 Exposure Protection. Exposure to the yard shall be protected in accordance with the requirements of 31.3.2.2.1 through 31.3.2.2.2.2.

31.3.2.2.1* Yard areas shall be separated from plant operations and other structures so that fire exposure into the yard is minimized.

This *Code* requires adequate separation between buildings and yard storage so that the risk of a building fire starting a fire in outdoor forest products storage is minimized. The clearance between the outdoor storage and the building must be increased for unsprinklered buildings, because a fire in such a facility is expected to result in a greater exposure hazard.

Δ **A.31.3.2.2.1** Saw mills, planing mills, treating plants, adzing mills, and similar buildings without blank walls should be separated from yard storage by a clear space in accordance with the recommendations of NFPA 80A.

Unsprinklered manufacturing buildings and other large structures with combustible contents represent a severe exposure to yard storage, unless the exterior walls have the necessary fire resistance to act as a fire separation and are essentially absent of unprotected openings.

Providing an adequate clear space between piles, exposures, and other combustible material is no different from that for houses threatened by wildland fires. A clear space must be maintained that will not burn and spread fire to the forest products storage from the wildland area or from the forest products storage to the wildland area. See 10.13.10 for additional provisions for exterior vegetation.

31.3.2.2.1.1 Minimum separation shall be by means of a clear space permanently available for fire-fighting operations.

31.3.2.2.1.2 The width of the clear space shall be based on the severity of exposure, which varies with the area, height, occupancy, construction, and protection of the exposing structure and the type of stacking and height of adjacent stacks.

31.3.2.2.2* Forest, brush, and grass fire exposure shall be minimized by providing adequate clear space that is carefully kept free of combustible vegetation.

A.31.3.2.2.2 Weeds, grass, and similar vegetation should be prevented throughout the entire yard, and any vegetation growth should be sprayed as often as needed with an herbicide or ground sterilizer, or should be grubbed out. Dead weeds should be removed after destruction. Weed burners should not be used.

31.3.2.2.2.1 Clear space of a width at least equivalent to the fire department access road shall be provided for grass exposures, and clear space of a width not less than 100 ft (30 m) shall be provided for light brush exposures.

31.3.2.2.2.2 In forested areas, a wider clear space than in 31.3.2.2.2.1 shall be provided.

31.3.2.3* Fire Detection and Extinguishment. A reliable means for prompt transmission of fire alarms to public fire departments and plant emergency organizations shall be provided.

A.31.3.2.3 Where practical, some form of fixed system of alarm notification or communication equipment should be provided within the storage yard (e.g., telephones, radios).

Portable fire extinguishers suitable for the fire hazard involved should be provided at convenient, conspicuously accessible locations in the yard. Approved portable fire-extinguishing equipment should be located so that the travel distance to the nearest unit is not more than 75 ft (23 m). See Section 13.6. Approved fire extinguishers suitable for the fire hazard involved should be provided on all power vehicles and units, including haulage or private locomotives in the yard.

The property owner is required to provide a means for early detection of a fire and a reliable means to notify both on-site and public emergency response organizations. The requirement of 31.3.2.3 is performancebased and must be discussed with the AHJ. The term *detection* in 31.3.2.3 does not necessarily imply a requirement for electronic fire or smoke detection equipment, although such equipment could provide the required protection.

31.3.3 Outside Storage of Lumber and Wood Panel Products at Retail and Wholesale Storage Yards.

31.3.3.1 Application.

31.3.3.1.1 The requirements of 31.3.3 shall apply to the following areas:

(1) Retail lumberyards handling forest products and other building materials
(2) Wholesale lumber storage yards, including distribution, holding, and transshipment areas

31.3.3.1.2* The requirements of 31.3.4 shall apply to other than large outside wholesale and retail distribution yards.

A.31.3.3.1.2 The type of operations at properties where the provisions of 31.3.4 apply vary widely. Retail lumber and building material operations are often characterized by large area buildings with minor outside storage areas. On the other hand, wholesale and distribution yards can involve large outside storage areas that present fire protection problems similar to mill yards.

31.3.3.2 General.

31.3.3.2.1* The fire hazard potential inherent in lumber storage operations with large quantities of combustible materials shall be controlled by a positive fire prevention program under the direct supervision of upper level management that shall include the following:

(1) Selection, design, and arrangement of storage yard areas and materials-handling equipment based upon proven fire prevention and protection principles
(2) Means for early fire detection, transmission of alarm, and fire extinguishment
(3) Fire department access roads to separate large stacks and provide access for effective fire-fighting operations
(4) Separation of yard storage from yard buildings and other exposing properties
(5) Effective fire prevention maintenance program, including regular yard inspections by trained personnel

A.31.3.3.2.1 Fire loss experience in lumberyards indicates that the following are the principal factors that allow lumberyard fires to reach serious proportions:

(1) Large, undivided stacks
(2) Congested storage conditions
(3) Delayed fire detection
(4) Inadequate fire protection
(5) Ineffective fire-fighting tactics

31.3.3.2.2* Water supplies shall be provided in accordance with this *Code*.

Δ **A.31.3.3.2.2** It is recognized that retail and wholesale lumber storage yards are normally located within municipal system boundaries, where the system should be capable of supplying not less than four 2½ in. (65 mm) hose streams simultaneously [1000 gpm (4000 L/min)]. Where large-scale fire-fighting operations can be expected, larger water supplies are needed. Where protection from municipal water supplies and hydrant systems is not provided or is not considered adequate by the AHJ, a yard fire hydrant system should be provided and installed in accordance with NFPA 24.

See Sections 18.3, 18.4, and 18.5 for additional requirements for water supplies, fire flow, and fire hydrant locations and distribution.

31.3.3.3 Open Yard Storage.

31.3.3.3.1* Lumber stacks shall be on stable ground, and paved or surfaced with materials such as cinders, fine gravel, or stone.

A.31.3.3.3.1 Where the danger of underground fire is present, refuse-filled or sawdust-filled land should not be used.

31.3.3.3.2 The method of stacking shall be stable and in an orderly and regular manner.

31.3.3.3.3* The height of stacks shall not exceed 20 ft (6 m) with consideration for stability.

A.31.3.3.3.3 Air-dried stickered stacks are subject to rapid-fire spread through the air spaces and should therefore be kept as low as practicable.

31.3.3.3.4 Where stacks are supported clear of the ground, 6 in. (150 mm) of clearance shall be provided for cleaning operations under the stacks.

Exhibit 31.1 shows outdoor storage at a retail lumberyard. Several design considerations must be met to help minimize the impact of a fire on adjacent lumber stacks and/or fire fighter operations. Lumber stacks must be on stable ground and must be stacked in an orderly and regular manner. Should a fire occur, unstable stacks can easily collapse, causing obstructions to access roads and spreading the fire to adjacent areas. Unstable lumber stacks can also mean dangerous conditions for fire fighter operations. In addition, the height of storage stacks cannot exceed 20 ft (6 m). Storage stacks taller than 20 ft (6 m) can significantly impede handheld hose stream operations by fire suppression personnel.

Exhibit 31.1

Outdoor storage at a retail lumberyard. (Thinkstock)

31.3.3.3.5 Fire department access roads shall be spaced so that a grid system of not more than 50 ft × 150 ft (15 m × 46 m) is produced.

Storage stacks wider than 50 ft × 150 ft (15 m × 46 m) can significantly impede handheld hose stream operations by fire suppression personnel.

31.3.3.3.6 Fire department access roads shall comply with Section 18.2.

31.3.3.3.7 Stacking limits shall be designated to indicate yard area and alleyway limits in accordance with 31.3.3.3.7.1 or 31.3.3.3.7.2.

31.3.3.3.7.1 The stacking limits shall be designated with boundary posts having signs that indicate stacking limits unless otherwise permitted by 31.3.3.3.7.2.

31.3.3.3.7.2 Where yards have paved areas, painted boundary limits shall be permitted to be used to designate stacking limits.

31.3.3.4 Exposure Protection.

31.3.3.4.1 Exposure to the Yard.

Automatic sprinkler protection in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, should be considered for all buildings that might constitute an exposure to outside lumber storage.

31.3.3.4.1.1 Open yard stacking shall be located with not less than 15 ft (4.6 m) clear space to buildings.

31.3.3.4.1.2 Boundary posts with signs designating stacking limits shall be provided to designate the clear space to unsprinklered buildings in which hazardous manufacturing or other operations take place.

31.3.3.4.2* Exposure from the Yard.

A.31.3.3.4.2 Because of the large quantities of material generally involved in lumberyard fires, some form of exposure protection for adjoining properties is recommended. Clear spaces or walls capable of providing fire barriers between yard storage and the exposed properties should be used. The responsibility for the protection of properties adjoining a lumberyard is often a joint responsibility to be worked out between the lumberyard and adjoining property owners. The AHJ should be consulted.

31.3.3.4.2.1 Open yard stacking shall be located with not less than 15 ft (4.6 m) clear space to adjacent property lines.

31.3.3.4.2.2 Alternative forms of exposure protection shall be permitted where approved by the AHJ.

31.3.4 Outside Storage of Lumber and Wood Panel Products at Other Than Retail and Wholesale Storage Yards.

31.3.4.1* Application. The requirements of 31.3.4 shall apply to large yard storage areas containing lumber, wood panels, and other similar wood products not intended for retail or wholesale distribution at the site.

A.31.3.4.1 Each individual property has its own special conditions of yard use, material-handling methods, and topography. For this reason, only basic fire protection principles are discussed herein and are intended to be applied with due consideration of all local factors involved. The AHJ should be consulted.

31.3.4.2* General. The fire hazard potential inherent in forest product storage operations with large quantities of combustible materials shall be controlled by a positive fire prevention program under the direct supervision of upper level management that shall include the following:

(1) Selection, design, and arrangement of storage yard areas and materials-handling equipment based on sound fire prevention and protection principles
(2) Means for early fire detection, transmission of alarm, and fire extinguishment
(3) Fire department access roads to separate large stacks and provide access for effective fire-fighting operations
(4) Separation of yard storage from mill or other plant operations and other exposing properties
(5) Effective fire prevention maintenance program, including regular yard inspections by trained personnel

A.31.3.4.2 Fire loss experience in lumber storage yards indicates that the following are the principal factors that allow lumberyard fires to reach serious proportions:

(1) Large, undivided stacks
(2) Congested storage conditions
(3) Delayed fire detection
(4) Inadequate fire protection
(5) Ineffective fire-fighting tactics

31.3.4.3* Open Yard Storage.

A.31.3.4.3 Refuse-filled or sawdust-filled land, swampy ground, or areas where the hazard of underground fire is present should not be used as a storage site.

31.3.4.3.1* Water supplies shall be provided in accordance with this *Code*.

A.31.3.4.3.1 For basic fire protection, the hydrant system should be capable of supplying not less than four 2½ in. (65 mm) hose streams simultaneously [1000 gpm (4000 L/min)] while maintaining a positive residual pressure in the fire protection hydrant system of not less than 20 psi (1.38 bar).

Where large-scale fire-fighting operations can be expected, larger water supplies with adequate mains are needed.

For early extinguishment with basic fire protection, hydrants should be spaced with sufficient 2½ in. (65 mm) hose attached to allow rapid hose laying to all parts of the stacking areas. For this reason, the hydrants should be spaced at about 250 ft (76 m) intervals so that any part of the yard can be reached with 250 ft (60 m) of hose. Hydrants preferably should be located at fire department access road intersections. A hydrant hose house with not less than 250 ft (60 m) of fire hose and auxiliary equipment should be provided at each hydrant. *(See NFPA 24.)*

31.3.4.3.2 Access to the plant and yard from public highways shall be provided by all-weather roadways capable of supporting fire department apparatus.

Unlike typical retail and wholesale yards, forest product processing facilities might not be accessible by public roadways. In many instances, they are accessed by dirt roads of considerable length.

31.3.4.3.3 The storage site shall be reasonably level, on solid ground, and paved or surfaced with materials such as cinders, fine gravel, or stone.

31.3.4.3.4 Stack height shall be limited to 20 ft (6 m).

31.3.5 Outside Storage of Ties, Poles, Piles, Posts, and Other Similar Forest Products at Pressure-Treating Plant Yards.

31.3.5.1 Application.

31.3.5.1.1* The requirements of 31.3.5 shall apply to yard storage areas containing treated and untreated ties, poles, piles, posts, and other similar forest products in yards connected with pressure-treating plants.

A.31.3.5.1.1 Each individual property has its own special conditions of yard use, stock-handling methods, and topography. For this reason, only basic fire protection principles are discussed herein, and are intended to be applied with due consideration of all local factors involved. Ties, as used herein, include ties, poles, piles, posts, and other similar forest products. Treated ties are ties that are pressure impregnated with preservatives.

31.3.5.1.2 The requirements of 31.3.5 shall not apply to pressure-treating buildings, processes, or storage of treating materials.

31.3.5.2* General. The fire hazard potential inherent in tie storage operations with large quantities of combustible materials shall be controlled by a positive fire prevention program under the direct supervision of upper level management that shall include the following:

(1) Selection, design, and arrangement of storage yard areas and materials-handling equipment based upon sound fire prevention and protection principles
(2) Means for early fire detection, transmission of alarm, and fire extinguishment
(3) Fire department access roads to separate large stacks and provide access for effective fire-fighting operations
(4) Separation of yard storage from mill buildings and other exposing properties
(5) Effective fire prevention maintenance program, including regular yard inspections by trained personnel

A.31.3.5.2 Fire loss experience in tie storage yards indicates that the following are the principal factors that allow fires to reach serious proportions:

(1) Large, undivided stacks
(2) Congested storage conditions
(3) Delayed fire detection
(4) Inadequate fire protection
(5) Ineffective fire-fighting tactics

31.3.5.3* Tie Yard Protection.

A.31.3.5.3 Refuse-filled or sawdust-filled land, swampy ground, or areas where the hazard of underground fire is present should not be used as storage site.

31.3.5.3.1* Unobstructed alleyways of sufficient width for hand or cart fire hose laying operations shall be provided between piles.

A.31.3.5.3.1 With relatively open stacking (that is, stacking that allows for penetration of fire-extinguishing streams), sufficient alleyway width can usually be accomplished by providing a not-less-than 4 ft (1.2 m) alleyway width between alternate rows of tie stacks. *[See Figure A.31.3.5.3.1(a).]* Flat crib-style stacking without space between the stacks that forms solid packed rows should require a not-less-than 4 ft (1.2 m) alleyway width between each row. *[See Figure A.31.3.5.3.1(b).]*

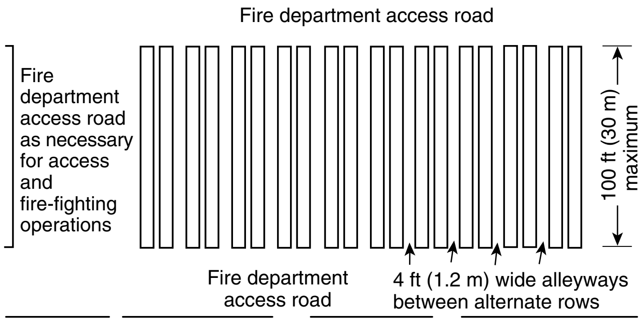


FIGURE A.31.3.5.3.1(a) Relatively Open Stacking Methods.

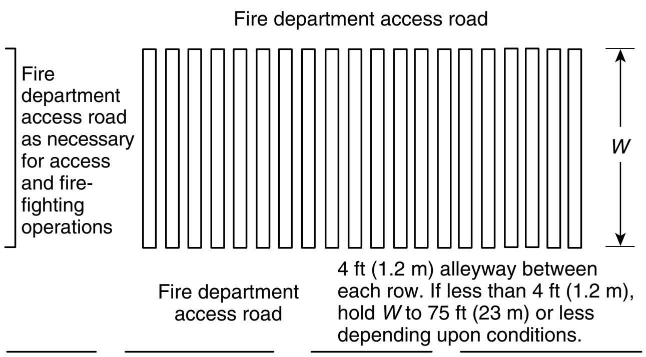


FIGURE A.31.3.5.3.1(b) Crib-Style Stacking into Solid Rows.

31.3.5.3.1.1 Alleyways shall not be less than 2 ft (0.6 m) in width.

31.3.5.3.1.2 Where a minimum alleyway width of 4 ft (1.2 m) is provided, the length of the rows shall be not more than 100 ft (30 m).

31.3.5.3.1.3 Where an alleyway width less than 4 ft (1.2 m) is provided, the length of the rows shall be not more than 75 ft (23 m).

31.3.5.3.2* Water supplies shall be provided in accordance with this *Code*.

A.31.3.5.3.2 For basic fire protection, the hydrant system should be capable of supplying not less than four 2½ in. (65 mm) hose streams simultaneously [not less than 1000 gpm (4000 L/min)] while maintaining a positive residual pressure in the fire protection hydrant system of not less than 20 psi (1.38 bar).

Where large-scale fire-fighting operations can be expected, larger water supplies with adequate mains are needed.

For early extinguishment with basic fire protection, hydrants should be spaced with sufficient 2½ in. (65 mm) hose attached to allow rapid hose laying to all parts of the stacking areas. For this reason, hydrants should be spaced at about 250 ft (76 m) intervals so that any part of the yard can be reached with 200 ft (60 m) of hose. Hydrants preferably should be located at fire department access road intersections. A hydrant hose house with not less than 200 ft (60 m) of fire hose and auxiliary equipment should be provided at each hydrant. *(See NFPA 24.)*

31.3.5.3.3 Access to the plant and yard from public highways shall be provided by all-weather roadways capable of supporting fire department apparatus.

31.3.5.3.4 The storage site shall be reasonably level, on solid ground, and paved or surfaced with materials such as cinders, fine gravel, or stone.

31.3.5.3.5* Stack heights shall be limited to 20 ft (6 m).

A.31.3.5.3.5 Heights in excess of 20 ft (6 m) seriously restrict effective extinguishing operations.

31.3.6 Outside Storage of Wood Chips and Hogged Material.

31.3.6.1* Application. The requirements of 31.3.6 shall apply to yard storage areas containing wood chips and hogged material.

A.31.3.6.1 Each individual property has its own special conditions of yard use, stock-handling methods, and topography. It is recognized that climate conditions, wood species, and the age of piles are all factors affecting fire safety. For these reasons, only basic fire protection principles are discussed herein, and are intended to be applied with due consideration of all local factors involved. Except for the surface layer, the moisture content of a pile of wood chips or hogged material is quite high, so surface fires do not generally penetrate more than a few inches into the pile. Fire tests indicate that, for areas of average humidity conditions, the flame propagation over the surface is relatively slow. These conditions allow ready extinguishment, provided that there is early detection and good access. It is expected that, in areas where long periods of low humidity prevail, faster surface flame spread can be anticipated, increasing the importance of early detection and good access.

Hogged material, shown in Exhibit 31.2, is defined in 3.3.155 as mill waste consisting mainly of hogged bark but possibly including a mixture of bark, chips, dust, or other by-products from trees; it also includes material designated as hogged fuel. Exhibit 31.3 shows outside storage of wood chips.

31.3.6.2 General.

31.3.6.2.1* The fire hazard potential inherent in storage piles shall be controlled by a positive fire prevention program under the direct supervision of upper level management that shall include the following:

(1) Selection, design, and arrangement of storage yard areas and materials-handling equipment based upon sound fire prevention and protection principles
(2) Establishment of control over the various factors that lead to spontaneous heating, including provisions for monitoring the internal condition of the pile
(3) Means for early fire detection and extinguishment
(4) Fire department access roads around the piles and access roads to the top of the piles for effective fire-fighting operations
(5) Facilities for calling the public fire department and facilities needed by the fire department for fire extinguishment
(6) Effective fire prevention maintenance program, including regular yard inspections by trained personnel

A.31.3.6.2.1 Fire experience and fire tests indicate that two completely different types of fires can occur in storage piles — surface

Exhibit 31.2

Hogged material. (Courtesy of Advanced Biomass Consulting, Inc.)

Exhibit 31.3

Outside storage of wood chips. (Thinkstock) fires and internal fires. Fire prevention activities and fire protection facilities should, therefore, include preparations for coping with both situations.

Internal heating is a hazard inherent to long-term bulk storage of chips and hogged material that progresses to spontaneous combustion under certain pile conditions. Internal fires are difficult to detect and extinguish. Unless provisions are made for measuring internal temperatures, such fires can burn for long periods before emission of smoke at the surface indicates an internal fire.

Extinguishment then becomes a lengthy and expensive loss-control and operating problem requiring equipment and manpower to move large portions of the pile, either by digging out the burning portions or removing the unburned portions of the pile. Experience has shown that these conditions create very large losses, and special attention should be given to the prevention of spontaneous combustion and to pre-fire planning where evaluating how best to handle an imminent or actual fire in a particular pile.

Spontaneous combustion can also occur in smaller wood chip piles typically found at retail and commercial landscaping supply yards.

31.3.6.2.2* The following items shall be addressed when establishing operating procedures:

A.31.3.6.2.2 Prevention of internal fires requires an understanding of the factors that cause exothermic oxidation so that steps can be taken to minimize this hazard and to provide means of monitoring temperature conditions inside the pile. Refuse and old chips should not be permitted in the chip pile base. The storage site should be thoroughly cleaned before starting a new pile.

The quality of chip supplies should be controlled in terms of percentage of fines. The concentration of fines should not be allowed during pile buildup.

Pneumatic systems produce an air classification of stored materials that should be recognized, and appropriate steps should be taken to minimize concentration of fines.

It is preferable to spread new stored materials in a relatively even layer over the pile.

Vehicles used on all piles should be of a type that minimizes compaction.

Veneer chip piles should be limited to 50 ft (15 m) in height.

(1) The storage site shall be reasonably level, solid ground, or shall be paved with blacktop, concrete, or other hard-surface material.
(2) Sites shall be cleaned before transferring wood products to the site.
(3) Operating plans for the buildup and reclaiming of the pile shall be based on a turnover time of not more than 1 year under ideal conditions.
(4)* Piles containing other than screened chips made from cleaned and barked logs shall be minimized.

A.31.3.6.2.2(4) For example, whole-tree chip piles containing bark, leaves, and other extraneous or hogged material can be subject to greater degrees of spontaneous heating and thermal degradation and should be reclaimed more frequently.

Where deep-seated fires in large piles occur, the fire department could spray water on the pile for long periods of time with little result, unless a means is available on site to dig through the pile and spread the burning material. The problems associated with extinguishing such fires are similar to those in large trash or scrap tire piles, some of which have been known to burn for years.

(5)* The pile size shall be limited.

A.31.3.6.2.2(5) Fundamentally, several small piles are better than one large pile.

(6) Pile heights shall be kept low, particularly piles that inherently carry a larger percentage of fines and are subject to greater compaction.
(7) Thermocouples shall be installed during pile buildup, or other means for measuring temperatures within the pile shall be provided with regular (normally weekly) reports to management.
(8)* The pile shall be wetted regularly to help keep fines from drying out and help maintain the moisture content of the surface layer of the pile.

A.31.3.6.2.2(8) Minimizing the diffusion of water from wet, stored material into dry fires is important to reduce exothermic heating caused by adsorption effects. Maintaining surface moisture content is also important so as to reduce the hazard of surface fires during periods of hot, dry weather.

31.3.6.3* Pile Protection.

A.31.3.6.3 A high standard of housekeeping should be maintained around all potential heat sources.

Care should be exercised to prevent tramp metal from entering the piles, or sections of blower pipes from being buried in the piles.

31.3.6.3.1* Piles shall be constructed with an access roadway to the top of the pile in order to reach any part of the pile.

A.31.3.6.3.1 For very large piles, two or more access roadways should be provided on opposite sides of the pile.

31.3.6.3.2* Piles shall not exceed 60 ft (18 m) in height, 300 ft (90 m) in width, and 500 ft (150 m) in length.

A.31.3.6.3.2 Narrow, low piles facilitate fire extinguishment.

31.3.6.3.2.1 Where pile height and width are such that all portions of the pile cannot be reached by direct hose streams from the ground, arrangements shall be made to provide fire-fighting service in these areas, and small fire stream supplies shall be available on the top of the pile for handling small surface fires and for wetting the pile in dry weather.

31.3.6.3.2.2 When more than one pile exists, they shall be subdivided by fire department access roads having not less than 30 ft (9 m) of clear space at the base of the piles.

31.3.6.3.2.3 Low barrier walls around piles shall be provided to clearly define pile perimeters, prevent creeping, and facilitate cleanup of fire department access roads.

Barrier walls around piles prevent materials from encroaching on the fire department access road or from expanding too close to other piles.

31.3.6.3.3 Where suitable, a small, motorized vehicle amply equipped with portable extinguishing equipment or a water tank and pump shall be provided.

31.3.6.3.3.1 Lightweight ladders that can be placed against the side of the pile shall be placed at convenient locations throughout the yard for use by the plant emergency organization.

31.3.6.3.3.2 Training of the plant emergency organization also shall include procedures and precautions to be observed by yard crews employing power equipment in fighting internal fires.

31.3.6.3.4* Portable fire extinguishers for Class A fires shall be provided in accordance with Section 13.6 on all vehicles operating on the pile in addition to the normal Class B units for the vehicle.

A.31.3.6.3.4 Due to the size and configuration of piles, providing portable fire extinguishers within 75 ft (23 m) of travel distance to any point is not practical.

31.3.6.3.5* Water supplies shall be provided in accordance with this *Code*.

A.31.3.6.3.5 Fire hydrants connected to yard mains should be provided so that any part of the pile(s) can be reached by hose equipment provided in each hydrant hose house. Each hydrant hose house should be equipped with a complement of 2½ in. (65 mm) and 1½ in. (38 mm) hose, a 2½ in. (65 mm) and 1½ in. (38 mm) gated wye, and 1½ in. (38 mm) combination nozzles.

Hydrants should be spaced at about 250 ft (76 m) intervals so that any part of the yard can be reached with 200 ft (60 m) of hose.

Where pile configurations are such that all parts of the pile cannot be reached by the hose, a fire hose cart(s) equipped with an ample supply of hose and nozzles should be strategically placed in the storage area.

The amount of water needed to control a pile fire varies substantially depending on the size of the pile. Weather conditions, operating methods, geographic location, type of material stored, and the degree to which wetting can be employed affect the potential for a large area surface fire. Experience indicates that exposure to long periods of hot, dry weather with no regular surface wetting creates conditions under which fast-spreading surface fires, which require many hose streams for control depending on the size of the pile, can occur.

Likewise, the frequency of pile turnover and operating methods affect the potential for serious internal fires. Piles built using methods that allow a concentration of fines and piles stored for long periods of time with no turnover are subject to internal heating that, if undetected, can create intense internal fires.

A flow of not less than 500 gpm (2000 L/min) should be provided at any fire hydrant in the pile area. Additional flows should be provided as needed where conditions are likely to produce serious surface fires or large internal fires. Fire mains should be engineered to deliver the recommended gallonage plus allowance for operational uses and special extinguishing equipment at a residual pressure of 60 psi to 100 psi (4.1 bar to 6.9 bar) at the hydrants.

See Sections 18.3, 18.4, and 18.5 for additional requirements on water supplies, fire flow, and fire hydrant locations and distribution.

31.3.6.3.6 All motor and switchgear enclosures shall be provided with approved, portable fire extinguishers suitable for the hazard involved in accordance with Section 13.6.

31.3.6.3.7* Power-operated, shovel-type or scoop-type vehicles, dozers, or similar equipment shall be available for use in moving stored material for fire fighting.

A.31.3.6.3.7 With the use of the equipment specified in 31.3.6.3.7, surface types of pile fires can usually be removed from the affected areas and extinguished.

Where deep-seated fires occur within the pile or under the pile in tunnels or other enclosures, this equipment is invaluable in breaking down the entire pile and spreading it out in a safe yard area, which allows fire fighters using hand hose lines or deluge units to extinguish both the pile and ground-spread stored material.

31.3.6.3.8 Temporary conveyors and motors on the surface or adjacent to the piles shall not be permitted.

31.3.6.3.9 Physical protection shall be provided to prevent heat sources such as steam lines, air lines, electrical motors, and mechanical drive equipment from becoming buried or heavily coated with combustible material.

31.3.6.3.10 Tramp metal collectors or detectors shall be required on all conveyor and blower systems.

31.3.6.4 Exposure Protection.

31.3.6.4.1* Incinerators or open refuse burning shall not be permitted in any area where sparks could reach the storage piles.

A.31.3.6.4.1 Experience indicates that radiated heat from exposing fires in storage piles does not ordinarily pose a serious ignition threat to other piles, provided that recommended clear spaces are maintained. Flying brands from exposing fires, especially during high winds, do present a hazardous ignition source. Upwind forest or brush fires can also present a problem in relation to flying sparks and brands.

31.3.6.4.2* A clear space of not less than 15 ft (4.6 m) shall be maintained between piles and exposing structures, yard equipment, or stock, depending on the degree of exposure hazard.

A.31.3.6.4.2 Buildings or other structures near storage piles can pose a serious exposure hazard to the pile.

31.3.6.4.3* Pile-to-pile clearance of not less than 30 ft (9 m) at the base of the pile shall be provided.

A.31.3.6.4.3 Greater clearance is desirable when piles are high and side slopes are greater than 60 degrees.

31.3.6.5 Emergency Action Plan. The facility shall have an emergency action plan for monitoring, controlling, and extinguishing spot fires.

31.3.7* Storage and Processing of Wood Chips, Hogged Material, Fines, Compost, and Raw Products at Yard Waste Recycling Facilities.

A.31.3.7 This type of chip has a much higher aliphatic hydrocarbon (sugar) content and spontaneously ignites readily. Lumber chips are debarked and thus lose the cambium layer associated with stored sugars. It is these sugars that start the bacterial decomposition that proceeds to spontaneous ignition.

31.3.7.1 The storage and processing of wood chips, hogged material, fines, compost, and raw products produced from yard waste recycling facilities shall comply with 31.3.6 and 31.3.7.

31.3.7.2 When not protected by a fixed fire-extinguishing system in accordance with Chapter 13, piles shall not exceed 25 ft (7.6 m) in height, 150 ft (45 m) in width, and 250 ft (76.2 m) in length.

31.3.7.3 Static Pile Protection.

31.3.7.3.1 Static piles shall be monitored by an approved means to measure temperatures within the piles.

31.3.7.3.2 Internal pile temperatures shall be recorded weekly.

31.3.7.3.3 Records shall be kept on file at the facility and made available for inspection.

31.3.7.3.4 The facility shall have an operational plan indicating procedures and schedules for the inspection, monitoring, and restricting of excessive internal temperatures in static piles.

31.3.7.4 Fire Protection.

31.3.7.4.1 Conveyor tunnels and combustible enclosures that pass under a pile shall be protected with automatic sprinklers complying with Section 13.3.

31.3.7.4.2 Combustible or enclosed conveyor systems shall be protected with automatic sprinklers complying with Section 13.3.

Yard waste (also referred to as green waste) is vegetative material and organic brush resulting from landscaping and maintenance of yards, lawns, or gardens. It includes grass clippings, leaves, tree stumps and large branches, garden remnants, and clippings from pruned bushes. It can also include Christmas trees. The constant seasonal care and maintenance of landscaping or cleanup from a weather event such as a windstorm, blizzard, or hurricane can generate massive amounts of yard waste. The waste is transported by consumers or hired professionals to a recycling facility. Yard waste can be composted at the private residence or at a recycling facility, or it can be processed into mulch. The provisions of 31.3.6 and 31.3.7 work together to ensure safe storage and fire protection practices at such facilities.

31.3.8 Outside Storage of Logs.

31.3.8.1 Application.

31.3.8.1.1* The requirements of 31.3.8 shall apply to log yard storage areas containing saw, plywood veneer, or pulpwood logs stored in ranked piles commonly referred to as cold decks.

A.31.3.8.1.1 Each individual property has its own special conditions for yard use, stock-handling methods, and topography. For this reason, only basic fire protection principles are discussed herein, and are intended to be applied with due consideration of all local factors involved.

31.3.8.1.2 The requirements of 31.3.8 shall not apply to cordwood.

31.3.8.2* General. The fire hazard potential inherent in log storage operations with large quantities of combustible materials shall be controlled by a positive fire prevention program under the direct supervision of upper level management that shall include the following:

(1) Selection, design, and arrangement of storage yard areas and materials-handling equipment based on sound fire prevention and protection principles
(2) Means for early fire detection, transmission of alarm, and fire extinguishment
(3) Fire department access roads to separate large piles and provide access for effective fire-fighting operations
(4) Separation of yard storage from mill operations and other exposing properties
(5) Effective fire prevention maintenance program, including regular yard inspections by trained personnel

A.31.3.8.2 Fire loss experience in outside storage of logs indicates that the following are the principal factors that allow log pile fires to reach serious proportions:

(1) Large, undivided piles
(2) Congested storage conditions
(3) Delayed fire detection
(4) Inadequate fire protection
(5) Ineffective fire-fighting tactics

31.3.8.3* Log Yard Protection.

A.31.3.8.3 Refuse-filled or sawdust-filled land, swampy ground, or areas where the hazard of underground fire is present should not be used as a storage site.

31.3.8.3.1 The storage site shall be reasonably level, on solid ground, and paved or surfaced with materials such as cinders, fine gravel, or stone.

31.3.8.3.2 Access to the plant and yard from public highways shall be provided by all-weather roadways capable of supporting fire department apparatus.

31.3.8.3.3* All sides of each cold deck shall be accessible by means of fire department access roads.

A.31.3.8.3.3 Where practical, greater widths should be provided to minimize the effects of radiated heat, particularly in high-piled yards.

31.3.8.3.3.1 A fire department access road width of 1½ times the pile height but not less than 20 ft (6 m) shall be provided, with fire department access roads between alternate rows of two pile groups providing a clear space of at least 100 ft (30 m).

31.3.8.3.3.2* Each cold deck shall not exceed 500 ft (150 m) in length, 300 ft (90 m) in width, and 20 ft (6 m) in height.

A.31.3.8.3.3.2 Heights in excess of 20 ft (6 m) seriously restrict effective extinguishing operations, since successful extinguishment of log pile fires requires penetration of the pile from the side by hose streams.

31.3.8.3.3.3* Fire department access roads for access across each end, with a clear space of not less than 100 ft (30 m) to adjacent pile rows or other exposed property, shall be provided.

A.31.3.8.3.3.3 See Figure A.31.3.8.3.3.3.

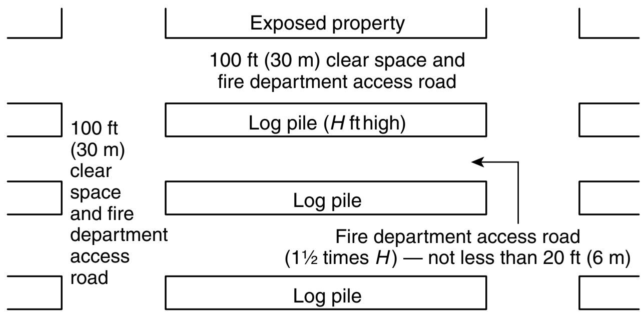


FIGURE A.31.3.8.3.3.3 *Layout of Log Storage Yard.*

31.3.8.3.3.4* The size of cold decks shall be permitted to be increased where additional fire flow and fixed fire protection equipment is provided and the approval of the AHJ is obtained.

A.31.3.8.3.3.4 For basic fire protection, the hydrant system should be capable of supplying not less than four 2½ in. (65 mm) hose streams simultaneously [not less than 1000 gpm (4000 L/min)] while maintaining a positive residual pressure in the fire protection hydrant system of not less than 20 psi (1.38 bar).

Where large-scale fire-fighting operations can be expected, larger water supplies with adequate mains are needed.

For early extinguishment with basic fire protection, hydrants should be spaced with sufficient 2½ in. (65 mm) hose attached to allow rapid hose laying to all parts of the piling areas. For this reason, hydrants should be spaced at about 250 ft (76 m) intervals so that any part of the yard can be reached with 200 ft (60 m) of hose. Hydrants should be located at fire department access road intersections. A hydrant hose house with not less than 200 ft (60 m) of fire hose and auxiliary equipment should be provided at each hydrant. *(See NFPA 24.)*

31.3.8.3.4 Water supplies shall be provided in accordance with this *Code*.

31.3.8.3.5 Dynamite shall never be used as a means to reclaim frozen log piles.

31.3.8.3.6* During dry weather, piles shall be wet down.

A.31.3.8.3.6 The installation of a portable piping system equipped with irrigation or lawn-type sprinklers on the top of each log pile is recommended.

31.3.9 Wood Processing and Woodworking Facilities. Dust control shall be in accordance with NFPA 664 for combustible dust-producing operations that occupy areas of more than 5000 ft^2 (464 m^2), or to areas where dust-producing equipment requires an aggregate dust collection flow rate of more than 1500 ft^3/min (2549 m^3/hr).

N **31.3.10 Outside Storage of Biomass Feedstock.**

Subsection 31.3.10 is new to the 2018 edition of the *Code*. According to the U.S. Office of Energy Efficiency and Renewable Energy, a *biomass* is defined as "any renewable, biological material that can be used directly as a fuel or converted to another form of fuel or energy product." Biomass is the plant and animal material used as a source of fuel. Biomass feedstocks are the raw materials used to derive fuels like ethanol, butanol, biodiesel, and other hydrocarbon fuels. Examples include corn starch, sugarcane juice, purpose-grown grass crops, and woody plants. Biomass fuel is a renewable energy source and its relevance is sure to increase as society becomes more reliant on renewable energy.

The new provisions of this subsection provide for the safe storage of biomass feedstock at biomass-to-ethanol manufacturing facilities. While some similar hazards and safety concerns exist, the requirements of Chapter 31 in previous editions for the storage of agricultural products were not sufficient for these types of operations. The requirements for securing the site in an approved manner and for the provision of lightning protection recognize the two main causes of fires in this type of storage: arson and lightning strikes.

N **31.3.10.1** The fire hazard potential inherent in biomass feedstock storage operations with large quantities of combustible materials shall be controlled by a positive fire prevention program under the direct supervision of upper level management that shall include the following:

(1) Selection, design, and arrangement of storage yard areas and materials-handling equipment based upon proven fire prevention and protection principles
(2) Means for early fire detection, transmission of alarm, and fire extinguishment
(3) Establishment of control over the various factors that lead to spontaneous heating, including provisions for monitoring the internal condition of the pile
(4) Fire department access roads to separate large stacks and provide access for effective fire-fighting operations
(5) Separation of yard storage from yard buildings and other exposing properties
(6) Effective fire prevention maintenance program, including regular yard inspections by trained personnel

N **31.3.10.2** Bale stacks shall not exceed 25 ft (7.6 m) in height, 150 ft (45 m) in width, and 250 ft (76.2 m) in length.

N **31.3.10.3** The storage site shall be reasonably level, on solid ground.

N **31.3.10.4** Access to the plant and yard from public highways shall be provided by all-weather roadways capable of supporting fire department apparatus.

N **31.3.10.5** All sides of each storage site shall be accessible by means of fire department access roads.

N **31.3.10.6** Where more than one pile exists, they shall be subdivided by fire department access roads having not less than 30 ft (9 m) of clear space at the base of the piles.

N **31.3.10.7** Power-operated, shovel-type or scoop-type vehicles, dozers, bale movers, or similar equipment shall be available for use in moving stored material for fire fighting.

N **31.3.10.8** Training of the plant emergency organization also shall include procedures and precautions to be observed by yard crews employing power equipment in fighting internal fires.

N **31.3.10.9** Portable fire extinguishers for Class A fires shall be provided in accordance with Section 13.6 on all vehicles operating in the storage yard in addition to the normal Class B units for the vehicle.

N **31.3.10.10** Lightning protection shall be provided for the outside storage yard in accordance with NFPA 780.

N **31.3.10.11** Outside storage yards shall be secured against unauthorized access in an approved manner.

N **31.3.10.12** Water supplies shall be provided in accordance with this *Code*.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, 2017 edition.

Office of Energy Efficiency & Renewable Energy. www.energy.gov.

Motion Picture and Television Production Studio Soundstages and Approved Production Facilities

32

This chapter provides additional requirements to address the unique hazards of motion picture and television production studio soundstages and production facilities. These facilities still require an occupancy classification (see Chapter 6). Typically, these types of facilities fall into the industrial occupancy category. However, careful consideration needs to be given to the individual facility to determine the occupancy classification. The presence of an audience and the size of that audience will affect the classification. For example, if more than 50 people are present, the facility should be considered an assembly occupancy. Chapter 32 contains provisions for production locations, as well as requirements for motion picture and television production studio soundstages and production facilities.

Certain practices are unique to the motion picture and television industries that require the application of NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations*. These practices include the ability to make the areas sound and light free, filming from various locations, building temporary sets and constructing temporary buildings within buildings, creating special effects, and filming in front of live audiences. These practices create unique challenges for fire and life safety, due to means of egress sometimes being moved or obstructed from view, sprinklers being obstructed, installed fire protection systems being placed out of service, and special effects being executed indoors.

Filming on location creates additional fire and life safety issues. Chapter 5 of NFPA 140 is extracted in this chapter (see Section 32.5) to provide guidance to the authority having jurisdiction (AHJ) for working with film and production companies on locations away from studios.

Chapter 32 applies to the following:

1. New buildings, or portions thereof, used as soundstages or approved production facilities in motion picture and television industry productions
2. Existing buildings, or portions thereof, used as soundstages or approved production facilities in motion picture and television industry productions to the extent specifically required by other portions of this document
3. Additions to buildings used as soundstages or approved production facilities in motion picture and television industry productions
4. Alterations, modernizations, or renovations of existing buildings used as soundstages or approved production facilities in motion picture and television industry productions
5. Existing buildings, or portions thereof, upon change of occupancy for use as soundstages or approved production facilities in motion picture and television industry productions
6. Production locations used in motion picture and television industry productions

Section 32.6, on operating features, applies to new and existing soundstages, approved production facilities, and production locations.

Existing soundstages, approved production facilities, and production locations that are in conformance with the requirements of the AHJ at the time of the adoption of this *Code* are permitted to remain in use under the following conditions:

1. The occupancy classification and use remain the same.
2. No serious hazards to life safety exist that would constitute an imminent hazard.

Chapter 32 does not apply to facilities used exclusively for radio broadcasts, theaters and auditoriums, live broadcasts of news or sporting events, or post-production facilities.

32.1 General

The design, construction, operation, and maintenance of soundstages and approved production facilities used in motion picture and television industry productions shall comply with NFPA 140 and Chapter 32.

32.2 Permits

Permits, where required, shall comply with Section 1.12.

32.3 Housekeeping

Soundstages and approved production facilities shall maintain housekeeping in accordance with Chapters 10 and 19 where applicable.

Housekeeping is an important issue due to construction, temporary installations, and the amount of wiring, cables, and combustible materials present. Housekeeping is especially critical during the use of special effects.

32.4 Soundstages and Approved Production Facilities

32.4.1 General. Section 32.4 shall apply to new and existing motion picture and television soundstages and approved production facilities. [**140:**4.1]

32.4.2 Permits. Where required by the AHJ, a permit shall be obtained for any of the activities that follow:

(1) Use of pyrotechnic special effects
(2) Use of open flames
(3) Welding
(4) Use of flammable or combustible liquids or gases
(5) Use of aircraft
(6) Presence of motor vehicles within a building
(7) Productions with live audiences
(8)* Change of use or change of occupancy classification

[**140:**4.2]

A.32.4.2(8) An example of a *change of use* would be a soundstage with audience facilities for 50 persons being used for a preview party for 500 persons. An example of a *change of occupancy classification* would be a soundstage without audience facilities being used for a preview party for 500 persons. [**140:**A.4.2(8)]

Depending on the production being filmed, some permits are issued on an annual basis. Other permits, such as those for open flames, live audiences, and pyrotechnics, are issued for each event by the AHJ and sometimes require standby fire personnel to be present during some or all of the production. The specifications for standby fire personnel are at the discretion of the AHJ. See 1.7.17 for additional guidance on standby fire personnel.

32.4.3 Pyrotechnic Special Effects and Open Flames.

32.4.3.1* The use of pyrotechnic special effects and open flames shall be subject to the approval of the AHJ. [**140:**4.3.1]

A.32.4.3.1 Particular attention needs to be given to combustible materials used in close proximity to pyrotechnic and open-flame special effects. On-site verification of the fire retardant properties of set components, furnishings, props, and other combustible materials is essential to ensure the safety of pyrotechnic and open-flame special effects. The provisions of 32.4.5 address the need to render drapes, greens, foamed plastics, and other combustible materials fire retardant. [**140:**A.4.3.1]

A comprehensive safety meeting should be conducted to define the intended scope of a special effect and establish appropriate safe areas. The safe areas need to be sized in consideration of the variable predictability of the materials used in the special effect. The safety meeting should include the participation of all persons who will be present during the special effect. The meeting discussion should also include consideration of the following:

(1) Conducting a test in an approved location of all devices and materials intended to be used in the special effect
(2) Excluding nonessential persons from the area of the effect until special effects personnel and a representative of the AHJ declare the area to be safe
(3) Evaluating the potential impact of the special effect on the uninvolved public
(4) Establishing an emergency plan that includes initial actions to take if the special effect exceeds its intended size, intensity, or duration
(5) Maintaining safe escape routes from the special effects area
(6) Developing methods of communication to be used during the special effect
(7) Identifying the individuals authorized to require that emergency actions be taken
(8) Specifying the licensing requirements for the individuals initiating the special effect
(9) Specifying the clothing to be worn by all special effects and safety personnel
(10) Evaluating the assignments and required abilities of all special effects and safety personnel
(11) Assigning the appropriate number of safety personnel to implement the plan
(12) Determining adequate and appropriate fire protection tailored to the materials used
(13) Establishing primary and backup methods of requesting additional fire suppression resources
(14) Identifying a definitive point when the special effect is complete

[**140:**A.4.3.1]

Δ **32.4.3.2** When an audience is present, NFPA 1126 shall be used to regulate any pyrotechnic use. [**140:**4.3.2]

Section 65.3 provides requirements for the use of pyrotechnics before a proximate audience, including requirements for permits.

Δ **32.4.3.3** When an audience is present, NFPA 160 shall be used to regulate any flame effects use. [**140:**4.3.3]

Section 65.4 provides requirements for use of flame effects before an audience, including requirements for permits.

32.4.4 Standby Fire Personnel.

32.4.4.1 Where required by the AHJ, standby fire personnel shall be provided for soundstages and approved production facilities where pyrotechnic special effects are used. [**140:**4.4.1]

Subsection 1.7.17 provides additional requirements for standby fire personnel.

32.4.4.2 Other Hazards. Where required by the AHJ, standby fire personnel shall be provided for hazardous operations, other than pyrotechnic special effects. [**140:**4.4.2]

32.4.5 Decorative Materials.

Δ **32.4.5.1** Foamed plastic materials used for decorative purposes, scenery, sets, or props shall have a heat release rate not exceeding 100 kW where tested in accordance with UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, or where tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source. [**140:**4.5.1]

32.4.5.2 Combustible drapes, drops, and any other similar combustible hangings or vertically placed materials shall comply with one of the following options:

(1) The materials meet the requirements of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.
(2) The materials exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.
(3) The materials are present in such limited quantity that a hazard of fire development or spread is minimal.
(4)* The materials are considered by the AHJ to exhibit acceptable fire performance.

A.32.4.5.2(4) It is important that combustible drapes, drops, and similar materials exhibit adequate fire performance. The AHJ might be able to make a judgment of adequate fire performance without requiring testing of the materials. [**140:**A.4.5.2(4)]

(5)* Approved interim measures are provided for the period during which the combustible materials are present.

[**140:**4.5.2]

A.32.4.5.2(5) Examples of interim measures that could be approved by the AHJ include, but are not limited to, the following:

(1) Providing a fire watch
(2) Removing the combustible materials at the end of the day's filming
(3) Keeping lighting and other heat-producing sources away from the combustible materials
(4) Providing baffles around heat-producing sources

[**140:**A.4.5.2(5)]

32.4.5.3 Cut greens shall be treated with an approved or listed fire retardant, and the process shall be repeated as often as necessary to maintain its effectiveness. [**140:**4.5.3]

Cut greens are vegetation separated from the live portion of the plant. Particular attention needs to be given to combustible materials used in close proximity to pyrotechnic and open flame special effects. On-site verification of the fire-retardant properties of set components, furnishings, props, and other combustible materials is essential to ensure the safety of pyrotechnic and open flame special effects. The provisions of 32.4.5 address the need to render drapes, drops, cut greens, foamed plastics, and other combustible materials fire retardant. The five options specified in 32.4.5.2 offer prescriptive and performance-based measures for determining whether drapes and other loosely hanging materials are flame retardant.

32.4.6 Smoking.

32.4.6.1 Smoking shall be prohibited on soundstages and in approved production facilities unless otherwise provided in 32.4.6.2 or 32.4.6.3. [**140:**4.6.1]

Section 10.9 provides additional requirements for regulating smoking.

32.4.6.2 Smoking shall be permitted when it is a necessary part of a performance, and only when the smoker is a member of the cast. [**140:**4.6.2]

32.4.6.3 Except where prohibited by the AHJ, smoking shall be permitted where all of the following conditions are met:

(1) The smoking area is outdoors.
(2) Hazardous materials are not present.
(3) Approved ash trays or receivers are provided.

[**140:**4.6.3]

32.4.7 Structural Loads.

32.4.7.1 Approved production facilities and soundstages shall be designed, constructed, or altered to sustain all structural load combinations in accordance with the local building code. [**140:**4.7.1]

32.4.7.2 Where the anticipated loads exceed those specified in the local building code for the purpose of suspending sets, ceilings, backings, and other heavy production set pieces, the building shall be designed and constructed for the additional loads. [**140:**4.7.2]

32.4.8 Electrical Requirements.

32.4.8.1 Electrical equipment shall be in accordance with Section 11.1. [**140:**4.8.1]

32.4.8.2* Soundstages and approved production facilities shall be provided with a minimum of 35 W/ft2 (377 W/m2) dedicated for production lighting and power. [**140:**4.8.2]

A.32.4.8.2 This requirement does not prohibit the use of mobile generators for auxiliary power. [**140:**A.4.8.2]

Δ **32.4.8.3** The electrical distribution equipment used shall comply with UL 1640, *Standard for Portable Power-Distribution Equipment*, and the provisions of Article 530 of NFPA 70. [**140:**4.8.3]

Δ **32.4.8.4** The wiring method to electrical distribution equipment shall comply with the provisions of Article 530 of NFPA 70. [**140:**4.8.4]

32.4.8.5 The location of portable, mobile, or stationary power-generating equipment shall be subject to the approval of the AHJ. [**140:**4.8.5]

See 10.14.10 and 11.7.2 for additional requirements for locating generators.

32.4.8.6 Exterior penetrations shall be located near the predesignated location for portable and mobile power-generating equipment. [**140:**4.8.6]

32.4.8.7 Auxiliary power cables supplied from mobile generators or adjacent buildings shall not be routed through fire-rated windows and doors. [**140:**4.8.7]

Δ **32.4.8.8** Portable feeder cables shall be permitted to temporarily penetrate fire-rated walls, floors, or ceilings, provided that all of the following apply:

(1) The opening is of noncombustible material.
(2) When in use, the penetration is sealed with a temporary seal of a listed firestop material.
(3) When not in use, the opening shall be capped with a material of equivalent fire rating.

[**140:**4.8.8]

32.4.8.9 Where the penetration utilizes a conduit, metal-threaded caps shall be attached to the pipe by means of chain or cable and shall effectively cap the conduit when not in use. [**140:**4.8.9]

Δ **32.4.8.10** The lighting equipment used shall comply with UL 1573, *Standard for Stage and Studio Luminaires and Connector Strips*, and the provisions of Article 530 of NFPA 70. [**140:***4.8.10*]

32.4.9 Fire Department Access. Fire department access shall be maintained as required by the AHJ. [**140:**4.9]

Section 18.2 provides detailed requirements for fire department access.

32.4.10 Means of Egress.

Δ **32.4.10.1** Means of egress shall be in accordance with NFPA *101* unless otherwise modified by 32.4.10.2 through 32.4.10.6. [**140:**4.10.1]

32.4.10.2 The maximum travel distance to an exit within the soundstage shall be 150 ft (45 m). [**140:**4.10.2]

32.4.10.3 Soundstages and approved production facilities shall have an aisle along the perimeter of the soundstage or facility as approved by the AHJ unless otherwise provided in 32.4.10.3.2. [**140:**4.10.3]

32.4.10.3.1 A clear unobstructed aisle height of 7 ft (2.1 m) shall be maintained. [**140:**4.10.3.1]

32.4.10.3.2 A soundstage or approved production facility with a gross area not exceeding 1500 ft² (139 m²) shall be exempt from the perimeter aisle requirement of 32.4.10.3 provided there is a minimum of two means of egress. [**140:**4.10.3.2]

Δ **32.4.10.4** Emergency lighting shall be provided for the means of egress in accordance with NFPA *101*. [**140:**4.10.4]

32.4.10.5 Any door in a required means of egress from an area having an occupant load of 100 or more persons shall be permitted to be provided with a latch or lock only if it is panic hardware or fire exit hardware. [**140:**4.10.5]

32.4.10.6 Means of egress shall be kept clear of obstructions and tripping hazards. [**140:**4.10.6]

Section 32.4.10 refers back to NFPA *101*®, *Life Safety Code*®, for means of egress and emergency lighting requirements. The means of egress and emergency lighting requirements of the appropriate occupancy in NFPA *101* apply unless modified by 32.4.10.2 through 32.4.10.6. Emergency egress perimeter aisles required by 32.4.10.3 must be identified and kept clear. Where conduit or wires pass through such areas, they must be elevated above the 7 ft (2.1 m) height as required by 32.4.10.3.1 or provided with a clearly identified ramp over the installations. See Exhibit 32.1 for an example of cables properly protected in an aisle.

Δ **32.4.10.7** When an audience is present, an announcement shall be made notifying the audience of the following:

(1) The location of exits to be used in case of fire or other emergency
(2) The means that will be used to notify the audience of fire or other emergency

[**140:**4.10.7]

Exhibit 32.1

Example of properly protected cables in an aisle.

The requirement of 32.4.10.7 is consistent with the requirements of NFPA *101*, which also require emergency instructions to be provided to audience members prior to the commencement of theatrical performances. See 12.7.7.3 and 13.7.7.3 of NFPA *101*.

32.4.11 Fire Protection.

32.4.11.1 Extinguishment Requirements.

32.4.11.1.1 Existing soundstages and existing approved production facilities equipped with automatic sprinkler systems shall maintain those systems in accordance with 13.3.3. [**140:**4.11.1.1]

32.4.11.1.2 A new soundstage or new approved production facility shall be equipped with an approved, supervised automatic sprinkler system. [**140:**4.11.1.2]

32.4.11.1.3 The automatic sprinkler system required by 32.4.11.1.2 shall be installed in accordance with Section 13.3, unless otherwise provided in 32.4.11.1.3.1 or 32.4.11.1.3.2. [**140:**4.11.1.3]

32.4.11.1.3.1* The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed. [**140:**4.11.1.3.1]

A.32.4.11.1.3.1 Paragraphs 32.4.11.1.3.1 and 32.4.11.1.3.2 recognize motion picture and television industry practices that require sets to change constantly and that sets are "temporary" construction not subject to building codes or standards. Solid ceilings that obstruct the stage sprinklers are "flown" (moved) in or out to permit special shooting angles or lighting requirements, often on a scene-by-scene basis. With temporary walls and ceilings, it would be impractical to install a sprinkler system in a constantly changing structure. Therefore, one or more of the following mitigation techniques should be used to compensate for the areas shielded from sprinkler spray by solid or hard ceilings or platforms:

(1) Approved and listed heat detectors or smoke detectors can be installed beneath such solid or hard ceilings in excess of 600 ft^2 (55.7 m^2) in area and platforms in excess of 600 ft^2 (55.7 m^2) in area and 3 ft (0.9 m) in height. Detectors should be connected to an approved and listed central, proprietary, or remote station service or to a local alarm that will provide an audible signal (i.e., a bell or horn) at a constantly attended location. The detector system, including the alarm panel, is defined as a portable system because it is intended to be reinstalled when platforms or sets are changed. The detectors that are secured to standard outlet boxes and the listed fire alarm panels can be temporarily supported by sets, platforms, or pedestals. Spacing of detectors should be per manufacturers' requirements.
(2) The ceiling can be positioned to allow for the operation of the building's automatic fire sprinkler system after videotaping, filming, or broadcasting of programs has been completed for the day.
(3) A fire watch should be provided when the set is not in use.
(4) No combustible materials should be stored under any platforms. Consideration should be given to secure such covered areas with screen wire or other materials that will permit visual inspection and emergency access.
(5) Approved/listed fire retardants can be applied beneath combustible platforms.
(6) Approved/listed fire retardants can be applied to scenery, props, framework and deck of combustible platforms, and the hard-ceilings of combustible sets.

[**140:**A.4.11.1.3.1]

Motion picture and television productions need the ability to film from a multitude of angles. This need for flexibility requires the construction of platforms to elevate the actors and stages, as well as the use of movable walls and ceilings, which are constantly repositioned during filming.

In the example provided in A.32.4.11.1.3.1, smoke detectors are positioned according to the main wood platform manufacturer's specifications. When the ceiling is removed or "flown" away, as shown in Exhibit 32.2, the smoke detector wiring remains operational. Automatic sprinklers for theatrical purposes are also shown in Exhibit 32.3. The AHJ should inspect such installations

Exhibit 32.2

Smoke detector above a grid ceiling.

Exhibit 32.3

Automatic sprinklers on a production set.

Exhibit 32.4

Platform protected from storage being placed underneath.

to determine whether the sprinklers are operational or nonfunctioning set components. Exhibit 32.4 shows a platform side with a screen wall to prevent the placement of storage beneath it.

32.4.11.1.3.2* The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2. [**140:**4.11.1.3.2]

A.32.4.11.1.3.2 See A.32.4.11.1.3.1. [**140:**A.4.11.1.3.2]

32.4.11.1.4 The automatic sprinkler system required by 32.4.11.1.2 shall be maintained in accordance with 13.3.3. [**140:**4.11.1.4]

32.4.11.1.5 Portable fire extinguishers shall be installed and maintained in accordance with Section 13.6. [**140:**4.11.1.5]

Δ **32.4.11.2 Fire Alarm System.** Fire alarm system notification appliances within soundstages and approved production facilities shall be permitted to be deactivated with the approval of the AHJ during videotaping, filming, or broadcasting of programs provided the following conditions exist:

(1) In the event of alarm system activation, notification appliances shall activate at a location that is constantly attended during the videotaping, filming, or broadcasting of programs.
(2) The attendants of the location identified in 32.4.11.2(1) shall be provided with a means of communicating with the fire command center for the building, where one is provided, and with the occupants of the soundstage to initiate emergency action.
(3) Deactivation of notification appliances shall cause activation of a visual signal at an approved location, which shall remain illuminated while notification appliances on the soundstage are deactivated.
(4) The visual signal shall be identified by a sign that shall read, "When Illuminated, Soundstage Fire Alarm System Notification Appliances Are Deactivated."

[**140:**4.11.2]

32.4.12 Air Conditioning, Heating, and Ventilating. Air-conditioning, heating, and ventilating ductwork and related equipment shall be in good working order and in compliance with the requirements of the AHJ. [**140:**4.12]

32.5 Production Locations

32.5.1 General. Section 32.5 shall apply to production locations. [**140:**5.1]

Δ **32.5.2 Permits.** A permit shall be obtained, unless waived by the AHJ, for any of the following activities:

(1)* Use of the site as a production location

A.32.5.2(1) The AHJ might waive the production location permit provided the AHJ is notified that the site is to be used as a production location. [**140:**A.5.2(1)]

(2) Use of pyrotechnic special effects
(3) Use of open flames
(4) Welding
(5) Use of flammable or combustible liquids or gases
(6) Use of aircraft
(7) Presence of motor vehicles within a building

[**140:**5.2]

Depending on the production being filmed, some permits are issued on an annual basis. Other permits, such as for open flames, live audiences, and pyrotechnics, are issued by the AHJ for each event and sometimes require the presence of standby fire personnel during some or all of the production. See 1.7.17 for additional guidance on standby fire personnel.

32.5.3 Pyrotechnic Special Effects and Open Flames.

32.5.3.1 The use of pyrotechnic special effects and open flames shall be subject to the approval of the AHJ. [**140:**5.3.1]

32.5.3.2 When an audience is present, NFPA 1126 shall be used to regulate any pyrotechnic use. [**140:**5.3.2]

32.5.3.3 When an audience is present, NFPA 160 shall be used to regulate any flame effects use. [**140:**5.3.3]

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*, and NFPA 160, *Standard for the Use of Flame Effects Before an Audience*, apply only when an audience is present; however, in all situations, the safe use of pyrotechnic special effects and open flames must be determined by the AHJ in accordance with 32.5.3.1. See Section 65.3 for additional requirements for pyrotechnics before a proximate audience. See Section 65.4 for additional requirements for flame effects before an audience.

32.5.4 Standby Fire Personnel.

32.5.4.1 Pyrotechnics. Standby fire personnel shall be required for production locations where pyrotechnic special effects are used, unless otherwise waived by the AHJ. [**140:**5.4.1]

Subsection 1.7.17 provides additional requirements for standby fire personnel.

32.5.4.2 Other Hazards. Where required by the AHJ, standby fire personnel shall be provided for hazardous operations, other than pyrotechnic special effects. [**140:**5.4.2]

32.5.5 Foamed Plastic Materials. Foamed plastic materials used for decorative purposes, scenery, sets, or props shall have a heat release rate not exceeding 100 kW when tested in accordance with UL 1975, *Fire Tests for Foamed Plastics Used for Decorative Purposes*, or where tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source. [**140:**5.5]

32.5.6 Smoking.

32.5.6.1 Smoking shall be prohibited in production location buildings unless otherwise provided in 32.5.6.2 or 32.5.6.3. [**140:**5.6.1]

See Section 10.9 for additional guidance on smoking prohibitions.

32.5.6.2 Smoking shall be permitted when it is a necessary part of a performance, and only when the smoker is a member of the cast. [**140:**5.6.2]

Δ **32.5.6.3** Except where prohibited by the AHJ, smoking shall be permitted where all of the following conditions are met:

(1) The smoking area is outdoors.
(2) Hazardous materials are not present.
(3) Approved ash trays or receivers are provided.

[**140:**5.6.3]

32.5.7 Structural Loads.

32.5.7.1 Sets, scenery, and other equipment shall not impact the structural integrity of existing buildings. [**140:**5.7.1]

32.5.7.2 Additional loads applied onto the building shall require the approval of the AHJ. [**140:**5.7.2]

32.5.8 Electrical Requirements.

32.5.8.1 Electrical power connections made to the site electrical service shall be made by an approved electrician under permit from the AHJ. [**140:**5.8.1]

32.5.8.2 Portable cables shall be positioned to allow for emergency egress as approved by the AHJ. [**140:**5.8.2]

32.5.8.3* Auxiliary power cables supplied from mobile generators or adjacent buildings shall be permitted to be routed through fire-rated windows and doors with the approval of the AHJ. [**140:**5.8.3]

A.32.5.8.3 The AHJ might approve the routing of power cables through fire-rated windows or doors if standby fire personnel or other approved safeguards are provided during such periods. [**140:**A.5.8.3]

Δ **32.5.8.4** Where power from both mobile generators and site electrical services are used to energize equipment in the same proximate location at production locations, grounds for the two systems shall be bonded in accordance with *NFPA 70*. [**140:**5.8.4]

32.5.9* Fire Department Access. Fire department access shall be maintained as required by the AHJ. [**140:**5.9]

A.32.5.9 The AHJ, when granting a permit to a production company to film on location should consider the placement of the support equipment. Typically, the production support vehicles are numerous, and unregulated placement of these vehicles could impede emergency access or egress. Additionally, the types of support vehicles need to be arranged so that a hazardous operation (e.g., fueling or special effects) is distant from sources of ignition and crew gathering areas (e.g., catering locations). The location permit should include a plot plan so the AHJ can adequately assess potential problems. [**140:**A.5.9]

32.5.10* Means of Egress. The production location shall be provided with means of egress appropriate for the intended use as approved by the AHJ. [**140:**5.10]

A.32.5.10 Where a production company films *on location*, such activity might interfere with, or prevent, the normal use of the facility or area. As such, the facility being occupied as a production location is often used for a purpose different from that of its normal use. Where the production company filming causes the facility or area to curtail normal operations, the facility should not be required to meet the life safety provisions applicable to the normal occupancy. Rather, life safety features should be maintained consistent with provisions required for the temporary use. For example, consider a single story assembly occupancy building with occupant load of 600 persons that has three exits for compliance with the provision of NFPA *101*, that requires a minimum of three exits where the occupant load of a floor exceeds 500 persons. The assembly occupancy building is used as a production location for a total of 200 persons. The production crew presents, for approval of the AHJ, a plan to block off one of the three exits while maintaining compliance with the requirements for egress width, travel distance, common path of travel, and dead-end corridors. The AHJ approves the proposed means of egress as appropriate for the intended use as required by 32.5.10. [**140:**A.5.10]

32.5.11 Fire Protection.

32.5.11.1* Building areas used as production locations shall be designed, constructed, and maintained to protect the occupants not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place. [**140:**5.11.1]

A.32.5.11.1 The phrase "intimate with the initial fire development" refers to the person(s) at the ignition source or first materials burning, not to all persons within the same room or area. [**140:**A.5.11.1]

The occupant protection requirement of 32.5.11.1 is the same as that required for all occupancies by NFPA *101*. The activities associated with filming at a production location without an audience are characteristic of the occupancy classification of industrial occupancy. Industrial occupancies are not required by NFPA *101* to be sprinklered. The objective of protecting occupants not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place is accomplished for industrial occupancies by prescriptive provisions not dependent on sprinkler protection. [**140:**A.5.11.1]

Where production location filming occurs in a building area not provided with the life safety systems required for industrial occupancies (e.g., in a tower with a single means of egress provided by an unenclosed stair), sprinklers, a fire alarm system, or other mitigation techniques acceptable to the AHJ will need to be employed for compliance with 32.5.11.1. Where sprinklers are provided, see 32.5.11.2 and 32.5.11.6. [**140:**A.5.11.1]

32.5.11.2 Where an automatic sprinkler system is provided for compliance with 32.5.11.1, the automatic sprinkler system shall be installed in accordance with Section 13.3, unless otherwise provided in 32.5.11.4 or 32.5.11.5. [**140:**5.11.2]

32.5.11.3 In any production location building protected by an existing automatic sprinkler system, where solid- or hard-ceiling sets or platforms are introduced to create an obstruction to sprinkler discharge, the provisions of 32.5.11.4 or 32.5.11.5 shall be met. [**140:**5.11.3]

32.5.11.4* The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed. [**140:**5.11.4]

A.32.5.11.4 See A.32.4.11.1.3.1. [**140:**A.5.11.4]

Where a production company installs a platform or solid-ceiling set in a building at a production location that is protected by an automatic sprinkler system, one or more of the mitigation techniques outlined in A.32.4.11.1.3.1 should be used to compensate for the areas shielded from sprinkler spray.

32.5.11.5* The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2. [**140:**5.11.5]

A.32.5.11.5 See A.32.4.11.1.3.1. [**140:**A.5.11.5]

32.5.11.6 Automatic sprinkler systems, where provided, shall be maintained in accordance with 13.3.3. [**140:**5.11.6]

32.5.11.7 Portable fire extinguishers shall be provided as required by the AHJ. [**140:**5.11.7]

32.5.11.8 Fire Hydrants and Fire Appliances. Hydrants, standpipes, and fire department connections (FDCs) shall not be obstructed, blocked, or rendered inoperable unless approved by the AHJ. [**140:**5.11.8]

32.6 Operating Features

32.6.1 Waste or Refuse. Waste or refuse shall not be allowed to accumulate in any area or in any manner that creates a fire hazard. [**140:**6.1]

Chapter 19 provides additional requirements for waste removal.

32.6.2 Flammable or Combustible Liquids.

32.6.2.1 The use, mixing, dispensing, and storage of flammable or combustible liquids shall be in accordance with this *Code* and the following codes, as applicable, unless otherwise permitted by 32.6.2.2:

(1) NFPA 30, *Flammable and Combustible Liquids Code (See Chapter 66.)*

(2) NFPA 58, *Liquefied Petroleum Gas Code (See Chapter 69.)* [**140:**6.2.1]

Chapter 66 regulates the storage, use, and handling of flammable and combustible liquids. Chapter 69 regulates the storage, use, and handling of liquefied petroleum gas (LP-Gas).

32.6.2.2 Approved flammable or combustible liquids and liquefied petroleum gases used for special effects shall be permitted. [**140:**6.2.2]

Δ **32.6.3 Welding.** Welding shall be in accordance with NFPA 51 and NFPA 51B. *(See Chapter 41.)* [**140:**6.3]

Chapter 41 provides additional requirements for welding, cutting, and other hot work.

32.6.4* Audience Life Safety. When an audience is present during productions, provisions for life safety and means of egress shall be subject to the approval of the AHJ. [**140:**6.4]

A.32.6.4 Special attention should be focused on any possible obstructions to the means of egress. The means of egress and the marking of it might be confusing to the audience due to the numerous bright lights, scenery, video and film cameras, and other equipment in and around the soundstage. [**140:**A.6.4]

Where 50 or more audience members are present, the production facility takes on the life safety risks of an assembly occupancy. As such, the requirements of Chapters 12 and 13 of NFPA *101*, applicable to new and existing assembly occupancies, respectively, must be followed to ensure audience safety. Audience members might not be familiar with the facility's means of egress arrangement or the potential hazards associated with the production. For such assembly uses, the presence of at least one trained crowd manager is of paramount importance. See 20.1.5.6 and NFPA *101* for additional details on the requirements for crowd managers.

32.6.5 Emergency Services Notification. The production company shall provide a procedure acceptable to the AHJ for notifying the public emergency services of emergency incidents. [**140:**6.5]

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA *101*®, *Life Safety Code*®, 2018 edition.

NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations*, 2018 edition.

NFPA 160, *Standard for the Use of Flame Effects Before an Audience*, 2016 edition.

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*, 2016 edition.

33

Outside Storage of Tires

Chapter 33 addresses new and existing outside storage piles of tires and altered tire material, as well as emergency response planning, fire control measures, site access, and signs and security for these areas.

33.1* General

Δ **A.33.1** Fire service professionals who have managed major scrap tire piles believe that the best approach is to allow the tire pile to burn while protecting exposures like buildings, heavy equipment, and surrounding tire piles. Once the tire pile is in a smoldering stage, heavy equipment can be used to pull the pile apart and the tire material can be extinguished incrementally. For additional information, see *Rings of Fire: Tire Fire Prevention and Suppression*.

33.1.1 Facilities storing more than 500 tires outside shall be in accordance with Chapter 33.

The outdoor storage of tire piles of not more than 500 tires can be typically found behind retail tire stores. Standard fire-fighting operational guidelines using water and/or foam for tire piles of fewer than 500 tires will effectively extinguish fires in such small piles in most cases.

Chapter 33 covers outdoor tire pile storage of more than 500 tires and the potential for large-scale environmental disasters, such as the 1999 Westley tire fire in California, shown in Exhibit 33.1. A lightning strike ignited the pile, which contained an estimated 7 million scrap tires. The fire burned for 30 days and significantly impacted the environment due to the runoff of pyrolitic oil and contaminated fire-fighting water. The cost of the fire to the U.S. Environmental Protection Agency was $3.5 million.

Exhibit 33.1

Large tire fire.

33.1.2 Permits. Permits, where required, shall comply with Section 1.12.

Per Table 1.12.8(a), permits are required to use an open area or portion thereof to store tires in excess of 500 tires.

33.1.3 Fire department access roads to separate tire piles and for effective fire-fighting operations shall be in accordance with Table 33.1.3.

Table 33.1.3 was developed from research conducted by the University of California, Berkeley, and sponsored by the California State Fire Marshal's Office. Whole, bundled, and shredded tires were burned to study the radiant heat flux from the various tire pile configurations. The data collected were then computer modeled to develop the specified separation distances.

Exhibit 33.2 shows 100 whole tires being tested for radiant heat by UC Berkeley.

The requirement for fire department access roads provides two functions: (1) to provide access to the tire piles by fire apparatus and (2) to provide a fuel break between tire piles to prevent fire spread. See 18.2.3 for more information on fire department access roads.

33.1.4 Separation of yard storage from buildings, vehicles, flammable materials, and other exposures shall be in accordance with Table 33.1.3.

33.1.5 Trees, plants, and vegetation within the separation areas shall be managed in accordance with Section 10.13.

Off-site vegetation fires have been known to start tire pile fires. Proper maintenance of vegetation at the facility perimeter, as well as between tire piles, helps to mitigate this risk.

***TABLE 33.1.3** Representative Minimum Exposure Separation Distances in Feet (Meters) for Tire Storage*

Exposed Face Dimension		Pile Height													
ft	m	8 ft	2.4 m	10 ft	3 m	12 ft	3.7 m	14 ft	4.3 m	16 ft	4.9 m	18 ft	5.5 m	20 ft	6.1 m
25	7.6	56	17	62	19	67	20	73	22	77	23	82	25	85	26
50	15.2	75	23	84	26	93	28	100	30	107	33	113	34	118	36
100	30	100	30	116	35	128	39	137	42	146	44	155	47	164	50
150	45	100	30	116	35	128	39	137	42	146	44	155	47	164	50
200	61	100	30	116	35	128	39	137	42	146	44	155	47	164	50
250	75	100	30	116	35	128	39	137	42	146	44	155	47	164	50

Exhibit 33.2

Tires being tested for radiant heat.

33.1.6 Ignition Sources.

All ignition sources should be prohibited within the tire storage facility. Where ignition sources must be present for operational purposes, such as vehicles or equipment, additional safeguards should be required to prevent ignition of the tire storage piles. Safeguards, such as spark arresters on vehicle and equipment exhaust systems, along with fire extinguishers mounted on vehicles, are appropriate fire control measures. See Section 13.6 and NFPA 10, *Standard for Portable Fire Extinguishers*, for additional details on portable fire extinguishers. Also see Section 10.17 and NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, for additional details on powered industrial trucks.

33.1.6.1 Smoking shall be prohibited within the tire storage area.

33.1.6.2 Sources of ignition such as cutting and welding, heating devices, and open fires shall be prohibited within the tire storage area.

33.1.6.3 Safeguards shall be provided to minimize the hazard of sparks from equipment such as refuse burners, boiler stacks, and vehicle exhaust when such hazards are located near the tire storage area.

33.1.7 Piles of tires or altered tire material shall not be located beneath power lines or structures.

The requirement of 33.1.7, which prohibits the storage of tires under power lines, serves two purposes. First, it eliminates downed electrical power lines as a source of ignition in tire piles. Second, it prevents the radiant heat from large tire pile fires from burning through power lines, disrupting service.

The roadside storage of whole tires beneath power lines and in a storm drain, as shown in Exhibit 33.3, is not considered *Code* compliant.

33.1.8 Piles of tires or altered tire material shall be at least 50 ft (15 m) from the perimeter fence.

33.1.9 Provisions for surface water drainage and measures to provide protection of pyrolitic oil runoff shall be directed around and away from the outdoor tire storage site to an approved location.

An average passenger car tire has been estimated to contain up to 2 gal (7.6 L) of pyrolitic oil. Much of the pyrolitic oil is burned off when the stored tire pile is allowed to freely burn. Once the tire pile begins to smolder, or if the combustion process is hampered by suppression efforts, the tires melt and release pyrolitic

Exhibit 33.3

Tire storage configuration that is not code compliant.

Exhibit 33.4

Westley, California, tire fire.

Exhibit 33.5

Tire pile and fire in abandoned quarry.

oil. The Westley, California, tire pile fire, for example, generated at least 250,000 gal (946,000 L) of pyrolitic oil. The Westley tire pile was located in a box canyon, as shown in Exhibit 33.4. The cogeneration plant that burned tires for electricity is seen in the background; the containment dam full of pyrolitic oil is shown in the foreground.

33.1.10 Tires shall be removed from rims immediately upon arrival at the storage site.

Tires stored on rims can reinflate to the point of bursting in the extreme temperatures generated by tire fires. Rims involved in a tire fire will contribute heavy metals, such as chromium and cadmium, to the smoke and ash. Rims can also be made from combustible metals, such as magnesium and titanium, which provide additional hazards and challenges to fire-fighter safety and fire extinguishment. Tires are required to be removed from their rims prior to being placed in storage to mitigate such hazards.

33.1.11 Tires shall not be stored on wetlands, flood plains, ravines, canyons, or steeply graded surfaces.

Site location of tire storage is an important consideration. Tires should not be stored where runoff control is impractical, such as on steeply graded surfaces, ravines, and canyons. Similarly, the potential pyrolitic oil runoff precludes the storage of tires in areas that are proximate to surface and groundwater sources, such as wetlands and flood plains. Tires and tire piles stored on inclines have the potential to become unstable under fire conditions, causing tires to roll down the incline and spread fire to other piles or buildings.

The tire pile shown in Exhibit 33.5 was sited in an abandoned sand and gravel quarry in Tracy, California. A grass fire ignited the tires at the facility in 1998, and the resulting fire was allowed to burn for more than 2 years to prevent the pyrolitic oil from entering the underground water supply, which was located only 80 ft (24 m) from the bottom of the quarry.

33.2 Individual Piles

The tire storage arrangements specified in Section 33.2 provide a measure of safety for employees and for fire fighters working at a tire pile fire. Limitations on pile size impact the size of the fuel package, which leads to smaller fires and facilitates rapid extinguishment.

33.2.1 New Outside Tire Storage Sites and Piles.

33.2.1.1 New individual outside tire storage piles containing more than 500 tires shall be limited in volume to 125,000 ft^3 (3540 m^3).

33.2.1.2 The dimensions of new tire storage piles shall not exceed 10 ft (3 m) in height, 50 ft (15 m) in width, and 250 ft (75 m) in length.

33.2.1.3 Individual piles shall be separated in accordance with Table 33.1.3.

33.2.2 Existing Individual Piles.

The *Code* recognizes that many tire storage facilities are existing facilities. Such existing facilities that do not meet the requirements for existing tire piles must bring their tire piles into compliance. All existing tire piles must be brought into compliance with the new outside tire storage site and pile requirements of 33.2.1 within 5 years of the adoption of this *Code*. If a previous edition of NFPA 1, *Fire Code,* was adopted in the jurisdiction, the *Code's* intent is to require compliance within 5 years of the adoption of that previous edition where the previous edition contains such requirement. The 5-year compliance requirement first appeared in the 2006 edition of NFPA 1. The *Code's* intent is to not permit an additional 5-year grace period each time a new edition of the *Code* is adopted by the jurisdiction.

33.2.2.1 Existing outside tire storage piles shall be in accordance with the provisions of 33.2.1 within 5 years of the adoption of this *Code*.

33.2.2.2 Existing individual outside tire storage piles containing more than 500 tires shall be limited in volume to 250,000 ft^3 (7080 m^3).

33.2.2.3 Existing pile dimensions shall not exceed 20 ft (6 m) in height, 50 ft (15 m) in width, and 250 ft (75 m) in length.

33.2.2.4 Individual piles shall be separated in accordance with Table 33.1.3.

33.3 Emergency Response Plan

Fire departments that have large tire piles in their jurisdictions should be actively involved in the development of emergency response plans. Effective preplanning for potential tire fire emergencies will save time and energy if resources and contact information are identified in advance.

33.3.1 The operator of the outside tire storage facility shall develop an emergency response plan and submit it for approval by the AHJ.

33.3.2 The AHJ shall retain a copy of the approved emergency response plan.

33.3.3 The operator of the outside tire storage facility shall keep a copy of the approved emergency response plan at the facility.

33.3.4 The AHJ shall be immediately notified of and approve any proposed changes to the emergency response plan.

33.4 Fire Control Measures

Measures to aid in the control of fire shall be in accordance with Section 33.4.

The requirements of Section 33.4 are intended to provide the employees of a tire storage facility the tools to mitigate a tire fire in its incipient stage. This section gives the authority having jurisdiction (AHJ) the flexibility to require the additional equipment and/or supplies it deems necessary to manage a fire in a particular facility. The quicker manual fire-fighting operations commence, the easier extinguishment will be. Personnel should be familiar with, and trained on, the emergency plan, locations and operation of fire-fighting equipment, and operating procedures for the machinery used to separate piles. Personnel should know how to notify the fire department and should be aware of the need to notify the fire department as soon as possible.

33.4.1 Manual Fire-Fighting Equipment.

33.4.1.1 At a minimum, the following items shall be maintained on site and in working order:

(1) One 2-A:10-B:C fire extinguisher
(2) One 2.5 gal (10 L) water extinguisher
(3) One 10 ft (3 m) long pike pole
(4) One rigid rake
(5) One round point shovel
(6) One square point shovel

33.4.1.2 One dry chemical fire extinguisher with a minimum rating of 4-A:40-B:C shall be carried on each piece of fuel-powered equipment used to handle scrap tires.

33.4.1.3 On-site personnel shall be trained in the use and function of this equipment to mitigate tire pile ignition.

33.4.2 An approved water supply capable of supplying the required fire flow to protect exposures and perform fire suppression and overhaul operations shall be provided.

Large volumes of water are essential for quick extinguishment of tire fires. See Sections 18.3 and 18.4 for additional information on providing an adequate water supply.

33.4.3* The AHJ shall be permitted to require additional tools and equipment for fire control and the protection of life and property.

A.33.4.3 This can include but is not limited to the availability of earth-moving equipment or other approved means of controlling a fire.

33.5 Site Access

33.5.1 Access to the site and each tire storage yard and pile shall be in accordance with Section 18.2 and this section.

Section 18.2 addresses fire department access roads and access boxes. Fire department access is important to ensure that fire-fighting apparatus and equipment can reach the site in a timely manner in the event of an emergency.

33.5.2 Accesses shall be maintained clear of combustible waste or vegetation and shall remain accessible to the fire department at all times.

Access gates should be kept clear of vegetation, combustible waste, and other materials that can prevent their use. Many times, due to the size of tire storage facilities, multiple access points are provided.

33.6 Signs and Security

Access by unauthorized persons and security of the site shall be in accordance with Section 33.6.

Steps should be taken to prohibit unauthorized individuals from entering tire storage sites. Complete fencing of the site can help to prevent unauthorized access.

33.6.1 Signs bearing the name of the operator, the operating hours, emergency telephone numbers, and site rules shall be posted at site entrances.

33.6.2 The facility shall have noncombustible fencing at least 10 ft (3 m) high with intruder controls on top, in accordance with local laws, around the entire perimeter of the property.

33.6.3 Access.

33.6.3.1 Access to the facility shall be in accordance with Section 18.2.

33.6.3.2 An attendant shall be on site at all times when the site is open.

33.7 Outdoor Storage of Altered Tire Material

Outdoor storage of altered tire material in the form of chunks, chips, or crumbs shall be protected in accordance with 33.7.1 through 33.7.5.

Tires are often chipped into smaller pieces to aid in future processing and removal. These pieces present a unique fire problem compared to intact tires, due to their compact size and tighter packing. During the chipping process, certain portions of the tires that are not normally exposed to the air are exposed (e.g., steel belts). If these materials are exposed to moisture, they will oxidize and could spontaneously combust.

33.7.1 A 10 ft (3 m) fence shall be maintained around the altered tire material storage area.

33.7.2 Altered tire material piles shall be kept 50 ft (15 m) from perimeter fencing.

33.7.3 Potential ignition sources such as welding, smoking, or other open flame uses shall not be allowed within 20 ft (6 m) of the altered tire pile.

33.7.4 Individual altered tire material piles shall not be located on site in excess of 90 days.

33.7.5* Individual altered tire material piles shall be kept sheltered from precipitation.

A.33.7.5 Altered tire material piles have been known to spontaneously combust after a heavy precipitation. Investigators have considered anaerobic action and potential heat from oxidation of steel belts as the source of exothermic reaction.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, 2013 edition.

CSFM Publication, Rings of Fire: Fire Prevention & Suppression of Outdoor Tire Piles, 1st edition, Office of the California State Fire Marshal, Sacramento, CA, 1993.

Shane, D. M., *Westley Tire Fire, Westley, Stanislaus County, California*, Freshwater Spills Symposium, U.S. EPA Region IX, San Francisco, CA, 2000.

General Storage

34

Chapter 34 addresses fire protection for general storage facilities. The term *storage occupancy* is defined in 3.3.192.31 as "an occupancy used primarily for the storage or sheltering of goods, merchandise, products, or vehicles." These occupancies contain a wide variety of stored material, including materials from commodity Class I through Class IV (as defined by NFPA 13, *Standard for the Installation of Sprinkler Systems*), plastics, rubber tires, rolled paper, and other special commodities. The requirements of Chapter 34 originally came from NFPA 230, *Standard for the Fire Protection of Storage*, which was withdrawn in 2005.

34.1 General

34.1.1 Application. This chapter shall apply to the indoor and outdoor storage of materials representing the broad range of combustibles, including plastics, rubber tires, and roll paper.

34.1.1.1 Storage configurations shall include palletized storage, solid-piled storage, and storage in bin boxes, on shelves, or on racks.

34.1.1.2 Chapter 34 shall not apply to the following:

(1) Storage of commodities that, with their packaging and storage aids, would be classified as noncombustible
(2) Unpackaged bulk materials such as grain, coal, or similar commodities but excluding wood chips and sawdust, which are addressed in Chapter 31
(3) Inside or outside storage of commodities covered by this *Code*, except where specifically mentioned herein (e.g., pyroxylin plastics)

See Chapter 33 for requirements for outdoor tire storage.

(4) Storage of high-hazard materials covered by this *Code*, except where specifically mentioned herein

See Chapters 60 through 75 for additional storage requirements for hazardous materials.

(5) Storage on plastic shelves on racks
(6)* Miscellaneous tire storage

A.34.1.1.2(6) The limitations on the type and size of storage are intended to identify those situations where tire storage is present in limited quantity and incidental to the main use of the building. Occupancies such as aircraft hangars, automobile dealers, repair garages, retail storage facilities, automotive and truck assembly plants, and mobile home assembly plants are types of facilities where miscellaneous tire storage could be present. The fire protection sprinkler design densities specified by NFPA 13 are adequate to provide protection for the storage heights indicated. Storage beyond these heights or areas presents hazards that are addressed by this *Code* and are outside the scope of NFPA 13.

(7) Combustible fiber storage, which is covered in Chapter 45

The *Code* defines the term *miscellaneous tire storage* as the storage of rubber tires that is incidental to the main use of the building and does not exceed 2000 ft² (186 m²). On-tread storage piles, regardless of storage method, must not exceed 25 ft (7.6 m) in the direction of the wheel holes. Acceptable miscellaneous tire storage arrangements include the following:

1. On-floor, on-side storage up to 12 ft (3.7 m) high
2. On-floor, on-tread storage up to 5 ft (1.5 m) high
3. Double-row or multirow fixed or portable rack storage, on-side or on-tread, up to 5 ft (1.5 m) high
4. Single-row fixed or portable rack storage, on-side or on-tread, up to 12 ft (3.7 m) high
5. Laced tires in racks up to 5 ft (1.5 m) high

The miscellaneous storage of car or truck tires in facilities such as automobile service centers presents significant fire safety concerns. Burning tires tend to create very hot and smoky fires that are difficult to control and extinguish. Because of tire geometry, inherent flue spaces permit unobstructed air supply during a fire. Additionally, fires burning on the interior surface of tires are often obstructed from sprinkler system discharge.

See Exhibit 34.1 through Exhibit 34.4 for examples of different types of tire storage.

34.1.2 Permits. Permits, where required, shall comply with Section 1.12.

Exhibit 34.1

On-side tire storage on portable racks. (Courtesy of Ford Motor Company)

Exhibit 34.2

On-tread tire storage on racks.

Exhibit 34.3

Pyramid tire storage.

Exhibit 34.4

Laced tire storage on portable racks. (Courtesy of Ford Motor Company)

34.2 Classification of Commodities

34.2.1 Commodity classification and the corresponding protection requirements shall be determined based on the makeup of individual storage units (i.e., unit load, pallet load). [**13:**5.6.1.1.1]

N **34.2.1.1** The type and amount of materials used as part of the product and its primary packaging as well as the storage pallet shall be considered in the classification of the commodity. [**13:**5.6.1.1.1.1]

34.2.2 When specific test data of commodity classification by a nationally recognized testing agency are available, the data shall be permitted to be used in determining classification of commodities. [**13:**5.6.1.1.2]

One of the main reasons that specific test data are required when determining the commodity classification of a new or unknown commodity is that the current ability of an engineering analysis is incapable of defining sprinkler suppression characteristics.

34.2.3 Mixed Commodities.

In many cases, fire testing for storage of mixed commodities has shown that the fire takes on the characteristics of the higher commodity. For that reason, the requirements of 34.2.3 were developed to provide guidance on choosing the appropriate commodity classification to govern sprinkler system design. Exhibit 34.5 shows a mixed commodity arrangement typical of any big-box home improvement store.

34.2.3.1 Protection requirements shall not be based on the overall commodity mix in a fire area. [**13:**5.6.1.2.1]

34.2.3.2 Unless the requirements of 34.2.3.3 or 34.2.3.4 are met, mixed commodity storage shall be protected by the requirements for the highest classified commodity and storage arrangement. [**13:**5.6.1.2.2]

34.2.3.3 The protection requirements for the lower commodity class shall be permitted to be utilized where all of the following are met:

(1) Up to 10 pallet loads of a higher hazard commodity, as described in 34.2.5 and 34.2.6, shall be permitted to be present in an area not exceeding 40,000 ft^2 (3720 m^2).

Exhibit 34.5

Mixed commodity arrangement in a retail warehouse.

(2) The higher hazard commodity shall be randomly dispersed with no adjacent loads in any direction (including diagonally).
(3) Where the ceiling protection is based on Class I or Class II commodities, the allowable number of pallet loads for Class IV or Group A plastics shall be reduced to five.

[**13:**5.6.1.2.3]

34.2.3.4 Mixed Commodity Segregation. The protection requirements for the lower commodity class shall be permitted to be utilized in the area of lower commodity class, where the higher hazard material is confined to a designated area and the area is protected to the higher hazard in accordance with the requirements of this *Code*. [**13:**5.6.1.2.4]

The fire area anticipated during sprinkler design is often mistakenly assumed to be the same as the sprinkler operating area. In fact, the fire area for successfully controlled storage fires seldom exceeds 200 ft^2 (18.6 m^2) during testing and often is less than 100 ft^2 (9.3 m^2). Regardless of the overall mix of commodities in a storage area, the possibility that 100 ft^2 to 200 ft^2 (9.3 m^2 to 18.6 m^2) of the highest hazard commodity will accumulate always exists.

34.2.4 Pallet Types.

34.2.4.1 General. When loads are palletized, the use of wood or metal pallets, or listed pallets equivalent to wood, shall be assumed in the classification of commodities. [**13:**5.6.2.1]

In addition to wood and metal, as described in 34.2.4.1, pallets are constructed of various reinforced and nonreinforced plastics. The effect on the commodity classification of the plastic-type pallets exhibiting different fire characteristics requires consideration. The requirements in 34.2.4.2 through 34.2.4.7 reflect the results of available test data regarding this issue. Properly identifying plastic pallets as reinforced or unreinforced can have a significant impact on the hydraulic requirements for sprinkler systems. The use of reinforced plastic pallets requires an increase of two commodity classes, which can have a large impact on the amount of water required to meet the intent of the systems. In some cases, this increase in commodity classification can result in the need for major changes to a facility's proposed fire protection, such as modifications to the sprinkler system itself and/or possible upgrades to the water supply (potential need for a fire pump); therefore, proper classification can have a significant financial effect on a project.

34.2.4.2* Unreinforced Plastic Pallets. For Class I through Class IV commodities, when unreinforced polypropylene or unreinforced high-density polyethylene plastic pallets are used, the classification of the commodity unit shall be increased one class. [**13.**5.6.2.2]

A.34.2.4.2 For example, Class III will become Class IV, and Class IV will become a cartoned unexpanded Group A plastic commodity. [**13:**A.5.6.2.2]

34.2.4.2.1 Unreinforced polypropylene or unreinforced high-density polyethylene plastic pallets shall be marked with a permanent symbol to indicate that the pallet is unreinforced. [**13:**5.6.2.2.1]

34.2.4.3* For Class I through Class IV commodities, when reinforced polypropylene or reinforced high-density polyethylene plastic pallets are used, the classification of the commodity unit shall be increased two classes except for Class IV commodity, which shall be increased to a cartoned unexpanded Group A Plastic commodity. [**13:**5.6.2.3]

A.34.2.4.3 For example, Class II will become Class IV, and Class III and Class IV will become a cartoned unexpanded Group A plastic commodity. [**13:**A.5.6.2.3]

34.2.4.3.1 Pallets shall be assumed to be reinforced if no permanent marking or manufacturer's certification of non-reinforcement is provided. [**13:**5.6.2.3.1]

34.2.4.4 No increase in the commodity classification shall be required for Group A plastic commodities stored on plastic pallets. [**13:**5.6.2.4]

34.2.4.5 For ceiling-only sprinkler protection, the requirements of 34.2.4.2 and 34.2.4.3 shall not apply where plastic pallets are used and where the sprinkler system uses spray sprinklers with a minimum K-factor of K-16.8 (240). [**13:**5.6.2.5]

The requirements associated with the impact of the use of plastic pallets on commodity class have been expanded based on available test results. Several types of plastic pallets, including reinforced and nonreinforced polypropylene and high-density polyethylene pallets, have been tested using large-scale calorimeter fire testing.

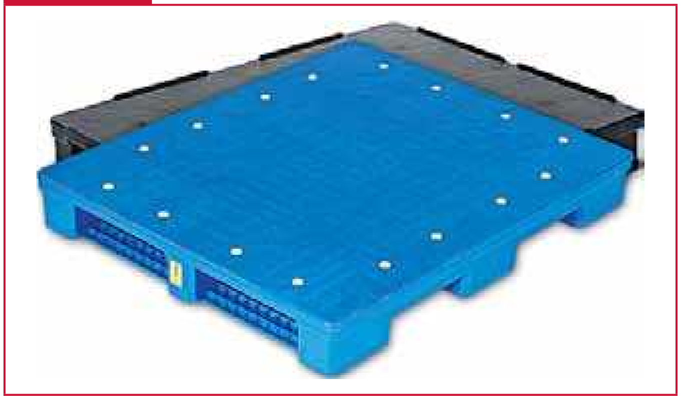
For many pallets, there is no external way to determine if the pallet is reinforced or nonreinforced, so 34.2.4.3 requires that the pallet be assumed to be reinforced. Therefore, a two commodity increase would be required, unless the pallet has a permanent marking or manufacturer's certification of nonreinforcement.

Exhibit 34.6 illustrates a nonreinforced plastic pallet. See also Exhibit 34.7 and Exhibit 34.8 for examples of other plastic pallets.

Exhibit 34.6

Nonreinforced plastic pallet. (Courtesy of ORBIS Corporation)

Exhibit 34.7



Reinforced 40 in. × 48 in. solid deck plastic pallet. (Courtesy of ORBIS Corporation)

Exhibit 34.8

Repairable nonreinforced 40 in. × 40 in. plastic pallet. (Courtesy of ORBIS Corporation)

34.2.4.6 The requirements of 34.2.4.2 through 34.2.4.7 shall not apply to nonwood pallets that have demonstrated a fire hazard that is equal to or less than wood pallets and are listed as such. [**13:**5.6.2.6]

Available full-scale test data for K-16.8 orifice sprinkler devices demonstrated no need for an increase in commodity classification for plastic pallets, as stated in 34.2.4.6.

34.2.4.7 For Class I through Class IV commodities stored on plastic pallets, when other than wood, metal, or polypropylene or high-density polyethylene plastic pallets are used, the classification of the commodity unit shall be determined by specific testing conducted by a national testing laboratory or shall be increased two classes. [**13:**5.6.2.7]

The requirements for adjustments in the commodity classification due to the use of different types of plastic pallets are based on UL 2335, *Standard for Fire Tests of Storage Pallets,* and ANSI/FM 4996, *American National Standard for Classification of Idle Plastic Pallets as Equivalent to Wood Pallets,* large-scale calorimeter tests. Listed plastic pallets are available that exhibit fire performance similar to that of wood pallets in these tests and can be treated as equivalent to wood pallets for commodity classification (see Exhibit 34.9). Actual fire test data from recognized testing laboratories such as FM Global and UL should be reviewed and taken into account to determine if any unique design requirements are needed to protect a specific plastic pallet.

Exhibit 34.9

Classified fire-retardant plastic pallet (40 in. × 48 in.) equivalent to a wood pallet. (Courtesy of ORBIS Corporation)

34.2.5* Commodity Classes.

A.34.2.5 See Table A.34.2.5 [**13:**A.5.6.3].

For the 2016 edition of NFPA 13, Table A.34.2.5 was reformatted. The commodities previously listed in Table A.34.2.5 were reviewed and are now alphabetized under a grouping indicated as the "Product Heading." The previous heading of "Commodity" was changed to "Product," and those items are also alphabetized. Further, products indicated as Group A are listed as either "Expanded" or "Nonexpanded" when the physical state of the plastic is inconsequential. If a product is listed simply as "Group A Plastic" and is not indicated as either "Expanded" or "Nonexpanded," then the physical state of the plastic determines whether to treat it as either expanded or nonexpanded.

Paragraph 34.2.4.7 refers to nonwood pallets that have demonstrated a fire hazard that is equal to or less than that of wood pallets. Plastic pallets present a unique challenge for sprinkler protection. Recent studies and product development, along with significant fire testing, have shown that some plastic pallets have been tested and have demonstrated a fire hazard that is equivalent to or less than the fire hazard presented by wood pallets. Plastic pallets meeting these requirements are specifically listed as such.

The NFPA 13 technical committee conducted a thorough review of all the commodities previously listed in Table A.34.2.5 as well as commodities listed in other codes and standards, such as those from FM Global and XL Gaps and the *International Building Code* (*IBC*). That review resulted in a few changes to the products now listed in Table A.34.2.5, including the introduction of new products such as the following:

1. Appliances with no appreciable exterior plastic but appreciable interior plastic
2. Plastic PET (polyethylene terephthalate) bottles greater than 5 gal (20 L) filled with noncombustible liquids
3. Mineral spirit impregnated charcoal
4. Gypsum board
5. Snack foods

N ***TABLE A.34.2.5*** *Alphabetical Listing of Commodity Classes*

Product Heading	Product	NFPA 13
Batteries	Dry cells (excludes lithium, lithium-ion, and other similar exotic metals or combustible electrolyte); without blister packing (if blister packed refer to commodity classification definitions)	Class I
	Vehicle; any size (e.g., automobile or truck); empty plastic casing	Group A Nonexpanded
	Vehicle; large (e.g., truck or larger); dry or wet (excludes lithium-ion and other cells containing combustible electrolyte) cells	Group A Nonexpanded
	Vehicle; small (e.g., automobile); wet (excludes lithium-ion and other cells containing combustible electrolyte) cells	Class I
Empty Containers	Noncombustible	Class I
	PET, bottles or jars	Class IV
	Rigid plastic (not including PET), up to 32 oz. (1 L)	Group A Nonexpanded
	Rigid plastic (not including PET), greater than 32 oz. (1 L)	Group A Expanded
	Wood; solid sided (e.g., crates, boxes)	Class II
Film Rolls, Including Photographic	Film (polypropylene, polyesther, polyethylene); rolled on any reel type	Group A Nonexpanded
	Film; 35 mm metal film cartridges in polyethylene cans; cartoned	Class III
	Film; motion picture or bulk rolls in polycarbonate, polyethylene or in metal cans; polyethylene bagged; cartoned	Class II
	Film; rolls in polycarbonate plastic cassettes; cartoned	Class IV
	Photographic paper; sheets; bagged in polyethylene; cartoned	Class III
Flammable/Combustible Liquids	Aerosol; Level 1	Class III
	Lighters; butane; blister-packed; cartoned	Group A Nonexpanded
	Liquids; up to 20 percent alcohol (e.g. alcoholic beverages, flavoring extracts); greater than 5 gallon (20 L) plastic containers with wall thickness greater than ¼ in. (6 mm)	Group A Nonexpanded
	Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); metal, glass or ceramic containers	Class I
	Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); plastic containers greater than 5 gallons (20 L) and wall thickness up to ¼ in. (6 mm)	Class II
	Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); up to 5 gallons (20 L) plastic bottles or jars	Class I
	Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); wood containers	Class II
Food Products — Frozen	Frozen foods; nonwaxed or nonplastic packaging	Class I
	Frozen foods; plastic trays	Class III
	Frozen foods; waxed or plastic-coated paper packaging	Class II

(continues)

N *TABLE A.34.2.5 Continued*

Product Heading	Product	NFPA 13
Food Products — Non-Frozen	Butter (stick or whipped spread) or margarine (up to 50 percent oil)	Class III
	Dry foods (such as baked goods, candy, cereals, cheese, chocolate, cocoa, coffee, grains, granular sugar, nuts, etc.); bagged or cartoned	Class III
	Foods (e.g., coffee, fish products, fruit, meat products, nuts, poultry, etc.); metal cans	Class I
	Fruits and vegetables (noncombustible semi-liquids); crushed; plastic containers up to 5 gallons (20 L)	Class I
	Fruits and vegetables; fresh; wood spacers, nonplastic trays or containers	Class I
	Margarine; over 50 and up to 80 percent oil	Group A Nonexpanded
	Meat; fresh; no plastic packaging; uncartoned	Class I
	Meat; fresh; no plastic packaging; cartoned	Class II
	Meat; fresh; plastic trays	Class III
	Milk; any container; stored in solid plastic crates	Group A Nonexpanded
	Milk; paper containers, or plastic bottles or jars up to 5 gallons (20 L) plastic bottles or jars	Class I
	Salt; bagged	Class I
	Salt; cartoned	Class II
	Snack foods (e.g., potato chips); plasticized aluminum bags; cartoned	Group A Nonexpanded
	Syrup; wooden container	Class II
Furniture and Bedding	Furniture and bedding; with foam cushioning	Group A Expanded
	Furniture; metal (e.g., file cabinets or desks with plastic trim); cartoned	Class I
	Furniture; wood (e.g., doors, windows, cabinets, etc.); no plastic coverings or foam cushioning	Class III
	Furniture; wood; plastic coverings nonexpanded plastic trim	Class IV
	Box spring; standard (minimal plastic materials)	Class III
	Box spring; wrapped in plastic cover	Class IV
	Mattress; foam (in finished form)	Group A Expanded
Housing Materials/Appliances	Appliances; major (e.g., stoves, refrigerators); no appreciable plastic interior or exterior trim; cartoned	Class II
	Appliances; major (e.g., stoves, refrigerators); no appreciable plastic interior or exterior trim; uncartoned	Class I
	Appliances; no appreciable plastic exterior trim (interior of unit can have appreciable plastic)	Class III
	Carpet tiles; cartoned	Group A Nonexpanded
	Fiberglass insulation; paper-backed rolls; bagged or unbagged	Class IV
	Floor coverings; vinyl, stacked tiles	Class IV
	Floor coverings; vinyl; rolled	Group A Nonexpanded
	Gypsum board	Class I
	Housing materials (such as sinks, countertops, etc.); noncombustible, cartoned or crated	Class II
	Paint; oil-based; friction-top metal containers; cartoned	Class IV
	Paint; water-based (latex); friction-top metal containers; cartoned	Class I
	Roofing shingles; asphalt-coated fiberglass	Class III
	Roofing shingles; asphalt-impregnated felt	Class IV

N ***TABLE A.34.2.5*** *Continued*

Product Heading	Product	NFPA 13
Miscellaneous	Ammunition; small arms and shotgun; cartoned	Class IV
	Charcoal; mineral spirit impregnated; bagged	Group A Expanded
	Charcoal; standard (non-mineral spirit impregnated); bagged	Class III
	Leather hides; baled	Class II
	Leather; finished products (e.g., shoes, jackets, gloves, bags, luggage, belts)	Class III
	Motors; electric	Class I
	Shock absorbers; metal dust cover	Class II
	Shock absorbers; plastic dust cover	Class III
	Skis; composite materials (plastic, fiberglass, foam, etc.)	Class IV
	Tobacco products; cartoned	Class III
	Toys; stuffed; foam or synthetic	Group A Expanded
	Transformer; dry or empty (i.e., void of oil)-filled	Class I
Noncombustible Liquids	Liquids or semi-liquids; PET containers greater than 5 gallon (20 L) having a nominal wall thickness greater than 0.25 in (6 mm)	Class IV
	Liquids or semi-liquids; PET containers up to 5 gallon (20 L) or greater than 5 gallon (20 L) having a nominal wall thickness up to 0.25 in (6 mm)	Class I
	Liquids or semi-liquids (e.g., crushed fruits and vegetables); plastic containers up to 5 gallon (18.9 L) capacity	Class I
	Liquids or semi-liquids; plastic (except PET) containers greater than 5 gallon (20 L) capacity having a nominal wall thickness greater than 0.25 in. (6 mm)	Group A Nonexpanded
	Liquids or semi-liquids; plastic (except PET) containers greater than 5 gallon (20 L) capacity having a nominal wall thickness up to 0.25 in. (6 mm)	Class II
	Liquids; cardboard drink boxes, plastic-coated, wax-coated, and/or aluminum-lined; uncartoned or on corrugated carton trays with plastic sheeting.	Class I
	Liquids; cardboard drink boxes, plastic-coated, wax-coated, and/or aluminum-lined; stored in plastic containers	Group A Nonexpanded
	Liquids; glass bottles or jars; cartoned	Class I
	Liquids; pharmaceuticals (nonflammable); glass bottles or jars; cartoned	Class II
	Liquids; plastic bottles or jars; stored in open or solid plastic crates	Group A Nonexpanded
Paper Products	Book signatures (paper part of book without hard cover)	Class II
	Cartons (i.e., cardboard flats); corrugated; partially assembled	Class IV
	Cartons (i.e., cardboard flats); corrugated; unassembled in neat piles	Class III
	Cartons; wax-coated, single-walled corrugated	Group A Nonexpanded
	Cellulosic paper products; nonwax-coated (e.g., books, cardboard games, cartoned tissue products, magazines, newspapers, paper cups, paper plates, paper towels, plastic-coated paper food containers, stationery)	Class III
	Cellulosic paper products; wax-coated (e.g., paper plates, cups); loosely packed; cartoned	Group A Nonexpanded
	Cellulosic paper products; wax-coated (e.g., paper plates, cups.); nested; cartoned	Class IV
	Matches; paper-type; cartoned	Class IV
	Matches; wooden; cartoned	Group A Nonexpanded
	Rolled; lightweight; in storage racks	Class IV
	Rolled; medium or heavyweight; in storage racks or on-side	Class III
	Tissue products; plastic-wrapped; cartoned	Class III
	Tissue products; plastic-wrapped; uncartoned	Group A Nonexpanded

(continues)

N ***TABLE A.34.2.5*** *Continued*

Product Heading	Product	NFPA 13
Plastic/Rubber	ABS (Acrylonitrile-butadiene-styrene copolymer)	Group A Nonexpanded
	Acetal (polyformaldehyde)	Group A Nonexpanded
	Acrylic (polymethyl methacrylate)	Group A Nonexpanded
	Automobile bumpers and dashboards	Group A Expanded
	Butyl rubber	Group A Nonexpanded
	Cellulose Acetate	Class IV
	Cellulose Acetate Butyrate	Group A Nonexpanded
	Chloroprene rubber	Class IV
	Containers; nonexpanded plastic gridded or solid; collapsed or nested with no air spaces	Group A Nonexpanded
	ECTFE (ethylene-chlorotrifluoro-ethylene copolymer)	Class IV
	EPDM (ethylene-propylene rubber)	Group A Nonexpanded
	ETFE (ethylene-tetrafluoroethylene copolymer)	Class IV
	Ethyl Cellulose	Group A Nonexpanded
	FEP (fluorinated ethylene-propylene copolymer)	Class IV
	FRP (fiberglass-reinforced polyester)	Group A Nonexpanded
	Melamine (melamine formaldehyde)	Class III
	Nitrile Rubber (acrylonitrile-butadiene rubber)	Group A Nonexpanded
	Nylon (nylon 6, nylon 6/6)	Group A Nonexpanded
	PCTFE (polychlorotrifluoroethylene)	Class III
	PET (Polyethylene Terephthalate — thermoplastic polyester)	Group A Nonexpanded
	Phenolic	Class III
	Plastics; stored in fully closed and solid (no openings), metal containers	Class I
	Polybutadiene	Group A Nonexpanded
	Polycarbonate	Group A Nonexpanded
	Polyester elastomer	Group A Nonexpanded
	Polyethylene	Group A Nonexpanded
	Polypropylene	Group A Nonexpanded
	Polystyrene; foam products (plates, cups, etc.)	Group A Expanded
	Polystyrene; rigid products	Group A Nonexpanded
	Polyurethane	Group A Expanded
	PTFE (polytetrafluoroethylene)	Class III
	PVC (polyvinyl chloride) products, up to 20% plasticizer	Class III
	PVC (polyvinyl chloride) products, greater than 20% plasticizer	Group A Nonexpanded
	PVC resins; bagged	Class III
	PVDC (polyvinylidene chloride)	Class III
	PVDF (polyvinylidene fluoride)	Class III
	PVF (polyvinyl fluoride)	Group A Nonexpanded
	Rubber; natural in blocks; cartoned	Group A Nonexpanded
	Rubber; natural; expanded	Group A Expanded
	Rubber; natural; nonexpanded	Group A Nonexpanded
	Rubber; synthetic (santoprene)	Group A Nonexpanded
	SAN (styrene acrylonitrile)	Group A Nonexpanded
	SBR (styrene-butadiene rubber)	Group A Nonexpanded
	Silicone rubber	Class IV
	Urea (urea formaldehyde)	Class III

N *TABLE A.34.2.5 Continued*

Product Heading	Product	NFPA 13
Plastic Containers	Bottles or jars (except PET) greater than 1 gallon (4 L) containing noncombustible solids	Group A Nonexpanded
	Bottles or jars (except PET) up to 1 gallon (4 L) containing noncombustible solids	Group A, cartoned (treat as cartoned even if uncartoned) Nonexpanded
Powders/Pills	Pharmaceutical pills; glass bottles or jars; cartoned	Class II
	Pharmaceuticals pills; plastic bottles or jars; cartoned	Class IV
	Polyvinyl Alcohol (PVA) resins; bagged	Class IV
	Powders; combustible (ordinary such as sugar or flour); free-flowing; bagged	Class II
	Powders; noncombustible free-flowing powdered or granular materials (cement, calcium chloride, clay, iron oxide, sodium chloride, sodium silicate, etc.)	Class I
	Powders; noncombustible; glass bottles or jars; cartoned	Class I
	Powders; noncombustible; PET bottles or jars	Class II
	Powders; noncombustible; plastic (other than PET) bottles or jars; uncartoned	Group A Nonexpanded
	Powders; noncombustible; plastic bottles or jars greater than 1 gallon (4 L) capacity	Group A Nonexpanded
	Powders; noncombustible; plastic bottles or jars up to 1 gallon (4 L) capacity; cartoned	Class IV
Textile Materials/Products	Cloth; natural fibers; baled	Class III
	Cloth; synthetic cloth	Class IV
	Clothing; natural fibers (e.g., wool, cotton) and viscose	Class III
	Cotton; cartoned	Class III
	Diapers; cotton or linen	Class III
	Diapers; plastic or nonwoven fabric; cartoned	Class IV
	Diapers; plastic or nonwoven fabric; plastic-wrapped; uncartoned	Group A Nonexpanded
	Fabric; rayon and nylon	Class IV
	Fabric; synthetic (except rayon and nylon); greater than 50/50 blend	Group A Nonexpanded
	Fabric; synthetic (except rayon and nylon); up to 50/50 blend	Class III
	Fabric; vinyl-coated (e.g. tablecloth); cartoned	Group A Nonexpanded
	Fibers; rayon and nylon; baled	Class IV
	Fibers; synthetic (except rayon and nylon); baled	Group A Nonexpanded
	Thread or yarn; rayon and nylon; wood or paper spools	Class IV
	Thread or yarn; rayon or nylon; plastic spools	Group A Nonexpanded
	Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; paper or wood spools	Class IV
	Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; plastic spools	Group A Nonexpanded
	Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; plastic spools	Group A Nonexpanded
	Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; wood or paper spools	Class III
Wax Products	Candles	Group A Expanded
	Paraffin or petroleum wax; blocks	Group A Expanded

(continues)

N ***TABLE A.34.2.5*** *Continued*

Product Heading	Product	NFPA 13
Wire/Cable/Spools	Spools; plastic; empty	Group A Nonexpanded
	Spools; wood; empty	Class III
	Wire or cable; PVC insulated; metal or wood spools	Class II
	Wire or cable; PVC insulated; plastic spools	Class IV
	Wire; bare; metal spools, uncartoned	Class I
	Wire; bare; metal spools; cartoned	Class II
	Wire; bare; plastic spools; cartoned	Class IV
	Wire; bare; plastic spools; uncartoned	Group A Nonexpanded
	Wire; bare; wood or cardboard spools	Class II
Wood Products	Wood patterns	Class IV
	Wood products (e.g., fiberboard, lumber, particle board, plywood, pressboard with smooth ends and edges); bundled solid blocks	Class II
	Wood products (e.g., fiberboard, lumber, particle board, plywood, pressboard with smooth ends and edges); unbundled or non-solid blocks	Class III
	Wood products (e.g., toothpicks, clothespins and hangers)	Class III

34.2.5.1 Class I. A Class I commodity shall be defined as a noncombustible product that meets one of the following criteria:

(1) Placed directly on wood pallets
(2) Placed in single-layer corrugated cartons, with or without single-thickness cardboard dividers, with or without pallets
(3) Shrink-wrapped or paper-wrapped as a unit load with or without pallets

[**13:**5.6.3.1]

See Table A.34.2.5 for examples of Class I commodities.

34.2.5.2 Class II. A Class II commodity shall be defined as a noncombustible product that is in slatted wooden crates, solid wood boxes, multiple-layered corrugated cartons, or equivalent combustible packaging material with or without pallets. [**13:**5.6.3.2]

See Table A.34.2.5 for examples of Class II commodities.

34.2.5.3 Class III.

34.2.5.3.1 A Class III commodity shall be defined as a product fashioned from wood, paper, natural fibers, or Group C plastics with or without cartons, boxes, or crates and with or without pallets. [**13:**5.6.3.3.1]

For the 2016 edition of NFPA 13, 34.2.5.3 was revised to clarify the guidelines for Class III commodities. The requirement in 34.2.5.3.2 was modified to clarify that (1) the percentages of plastic were equal to or less than 5, (2) the indicated values for weight applied to unexpanded Group A plastic, and (3) the indicated values for volume applied to expanded Group A plastic.

34.2.5.3.2 A Class III commodity shall be permitted to contain a limited amount (5 percent or less by weight of unexpanded plastic or 5 percent or less by volume of expanded plastic) of Group A or Group B plastics. [**13:**5.6.3.3.2]

N **34.2.5.3.3** Commodities containing a mix of both Group A expanded and unexpanded plastics shall comply with Figure 5.6.3.4.2. [**13:**5.6.3.3.3]

34.2.5.4 Class IV.

Where a designer is considering classifying a commodity mixed with plastics, the designer needs to consider the location of the plastic commodity within a carton. A cartoned commodity that is 15 percent plastic by weight, where all of the nonplastic content is surrounded by plastic, behaves as a plastic commodity in a fire. Likewise, a heavy metal item encased in expanded plastic packaging that occupies 25 percent of the carton behaves as an expanded plastic commodity in a fire.

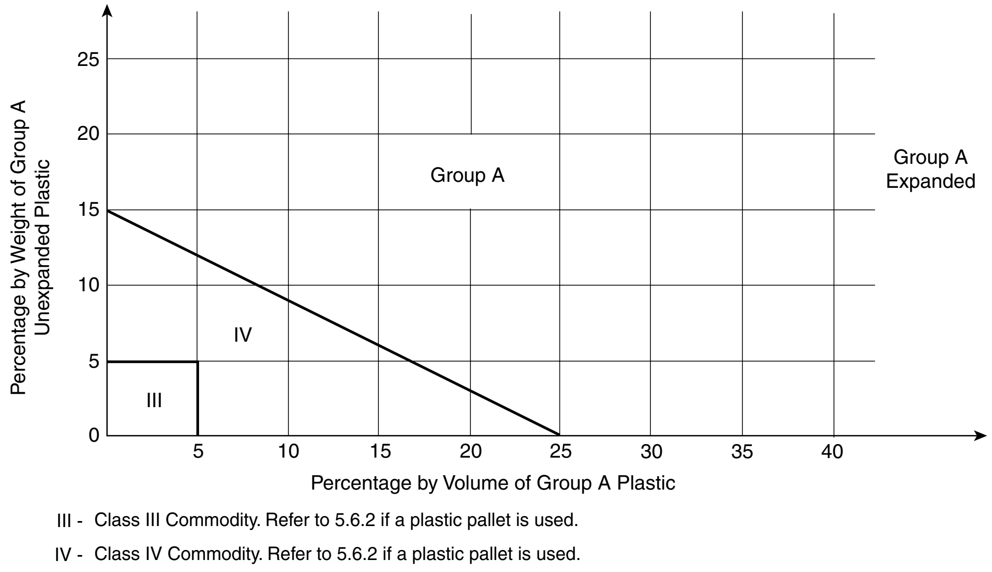
34.2.5.4.1 A Class IV commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:

(1) Constructed partially or totally of Group B plastics
(2) Consists of free-flowing Group A plastic materials
(3) Contains within itself or its packaging an appreciable amount (greater than 5 to 15 percent by weight of Group A unexpanded plastic or greater than 5 percent to 25 percent by volume of expanded Group A plastic) of Group A plastics

[**13:**5.6.3.4.1]

34.2.5.4.2 Commodities containing a mix of both Group A expanded and unexpanded plastics shall comply with Figure 34.2.5.4.2. [**13:**5.6.3.4.2]

N **34.2.5.4.3** The remaining materials shall be permitted to be metal, wood, paper, natural or synthetic fibers, or Group B or Group C plastics. [**13:**5.6.3.4.3]



N ***FIGURE 34.2.5.4.2*** *Commodities Containing a Mixture of Expanded and Unexpanded Group A Plastics*

34.2.6 Classification of Plastics, Elastomers, and Rubber. Plastics, elastomers, and rubber shall be classified as Group A, Group B, or Group C. [**13:**5.6.4]

Δ **34.2.6.1 Group A.** The following materials shall be classified as Group A:

(1) ABS (acrylonitrile-butadiene-styrene copolymer)
(2) Acetal (polyformaldehyde)
(3) Acrylic (polymethyl methacrylate)
(4) Butyl rubber
(5) Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)
(6) EPDM (ethylene-propylene rubber)
(7) FRP (fiberglass-reinforced polyester)
(8) Natural rubber
(9) Nitrile-rubber (acrylonitrile-butadiene-rubber)
(10) Nylon (nylon 6, nylon 6/6)
(11) PET (thermoplastic polyester)
(12) Polybutadiene
(13) Polycarbonate
(14) Polyester elastomer
(15) Polyethylene
(16) Polypropylene
(17) Polystyrene
(18) Polyurethane
(19) PVC (polyvinyl chloride — highly plasticized, with plasticizer content greater than 20 percent) (rarely found)
(20) PVF (polyvinyl fluoride)
(21) SAN (styrene acrylonitrile)
(22) SBR (styrene-butadiene rubber)

[**13:**5.6.4.1]

For the 2016 edition of NFPA 13, some of the listings for Group A, Group B, and Group C plastics were modified so that they were consistent with their indicated heat of combustion. This change resulted in cellulosics, natural rubber (not expanded), and nylon being moved from Group B to Group A, along with PVF being moved from Group C to Group A. Although some of the listings have been changed, it is important to understand that these listings are generally for plastics in their chemical state and have not taken into consideration the effect on their commodity classification for their physical state as a product. See Table A.34.2.5 for general guidance on the commodity classification of a Group A plastic product in its finished form.

If a tenant is storing one of the plastics in the Group A list, and the plastic has been modified with fire retardants, the AHJ might be presented with a question to accept a lesser hazard commodity classification than Group A plastics. Without laboratory testing that demonstrates that the modified Group A plastic can be classified as a lesser hazard classification, plastics appearing on the Group A list need to be considered as Group A plastics.

N **34.2.6.1.1** Group A plastics shall be further subdivided as either expanded or unexpanded. [**13:**5.6.4.1.1]

N **34.2.6.1.1.1** If a cartoned commodity is more than 40 percent (by volume) expanded plastic, it shall be protected as a cartoned expanded plastic. [**13:**5.6.4.1.1.1]

N **34.2.6.1.1.2** Exposed commodities containing greater than 25 percent by volume expanded plastic shall be protected as an exposed expanded plastic. [**13:**5.6.4.1.1.2]

Based on the definition in 3.9.1.12 of NFPA 13, expanded plastics are those with air pockets embedded within the plastic, such as foam coolers, exercise mats, foam presentation boards, shipping peanuts, and foam insulation boards found at home improvement stores. If the plastic does not fit that description, it would be considered a nonexpanded (or unexpanded) plastic, such as plastic totes or plastic water bottles.

34.2.6.2 Group B. The following materials shall be classified as Group B:

(1) Chloroprene rubber
(2) Fluoroplastics (ECTFE — ethylene-chlorotrifluoro-ethylene copolymer; ETFE — ethylene tetrafluoroethylene copolymer; FEP — fluorinated ethylene-propylene copolymer)
(3) Silicone rubber [**13:**5.6.4.2]

34.2.6.3 Group C. The following materials shall be classified as Group C:

(1) Fluoroplastics (PCTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene)
(2) Melamine (melamine formaldehyde)
(3) Phenolic
(4) PVC (polyvinyl chloride — flexible — PVCs with plasticizer content up to 20 percent)
(5) PVDC (polyvinylidene chloride)
(6) PVDF (polyvinylidene fluoride)
(7) Urea (urea formaldehyde) [**13:**5.6.4.3]

•
Where the specific plastic commodity cannot be determined, the most conservative approach is to use the highest plastic hazard, Group A plastics. Designing the system to a lesser hazard might lead to insufficient water getting to the fire, allowing the fire to spread and overwhelm the system.

34.2.7* Classification of Rolled Paper Storage. For the purposes of this *Code*, the classifications of paper described in 34.2.7.1 through 34.2.7.4 shall apply and shall be used to determine the sprinkler system design criteria. [**13:**5.6.5]

Δ **A.34.2.7** *Paper Classification.* These classifications were derived from a series of large-scale and laboratory-type small-scale fire tests. It is recognized that not all paper in a class burns with exactly the same characteristics. [**13:**A.5.6.5]

Paper can be soft or hard, thick or thin, or heavy or light and can also be coated with various materials. The broad range of papers can be classified according to various properties. One important property is basis weight, which is defined as the weight of a sheet of paper of a specified area. Two broad categories of paper are recognized by industry — paper and paperboard. Paperboard normally has a basis weight of 20 lb (9.1 kg) or greater measured on a 1000 ft^2 (93 m^2) sheet. Stock with a basis weight less than 20 lb/1000 ft^2 (0.1 kg/m^2) is normally categorized as paper. The basis weight of paper is usually measured on a 3000 ft^2 (278.7 m^2) sheet. The basis weight of paper can also be measured on the total area of a ream of paper, which is normally the case for the following types of printing and writing papers:

(1) *Bond paper* — 500 sheets, 17 in. × 22 in. (425 mm × 550 mm) = 1300 ft^2 (121 m^2) per ream
(2) *Book paper* — 500 sheets, 25 in. × 38 in. (635 mm × 950 mm) = 3300 ft^2 (310 m^2) per ream
(3) *Index paper* — 500 sheets, 25½ in. × 30½ in. (640 mm × 765 mm) = 2700 ft^2 (250.8 m^2) per ream
(4) *Bristol paper* — 500 sheets, 22½ in. × 35 in. (565 mm × 890 mm) = 2734 ft^2 (254 m^2) per ream
(5) *Tag paper* — 500 sheets, 24 in. × 36 in. (600 mm × 900 mm) = 3000 ft^2 (280 m^2) per ream

[**13:**A.5.6.5]

For the purposes of this *Code*, all basis weights are expressed in lb/1000 ft^2 (kg/93 m^2) of paper. To determine the basis weight per 1000 ft^2 (93 m^2) for papers measured on a sheet of different area, the following formula should be applied:

$$\frac{\text{Basis weight}}{1000\ \text{ft}^2} = \text{basis weight} \times 1000\ \text{measured area}$$

Example: To determine the basis weight per 1000 ft^2 (93 m^2) of 16 lb (7.3 kg) bond paper:

$$\left(\frac{16\ \text{lb}}{1300\ \text{ft}^2}\right)1000 = \frac{12.3\ \text{lb}}{1000\ \text{ft}^2}$$

Large- and small-scale fire tests indicate that the burning rate of paper varies with the basis weight. Heavyweight paper burns more slowly than lightweight paper. Full-scale roll paper fire tests were conducted with the following types of paper:

(1) *Linerboard* — 42 lb/1000 ft^2 (0.2 kg/m^2) nominal basis weight
(2) *Newsprint* — 10 lb/1000 ft^2 (0.05 kg/m^2) nominal basis weight
(3) *Tissue* — 5 lb/1000 ft^2 (0.2 kg/m^2) nominal basis weight

[**13:**A.5.6.5]

The rate of firespread over the surface of the tissue rolls was extremely rapid in the full-scale fire tests. The rate of fire spread over the surface of the linerboard rolls was slower. Based on the overall results of these full-scale tests, along with additional data from small-scale testing of various paper grades, the broad range of papers has been classified into three major categories as follows:

(1) *Heavyweight* — Basis weight of 20 lb/1000 ft^2 (0.098 kg/m^2) or greater
(2) *Mediumweight* — Basis weight of 10 lb to 20 lb/1000 ft^2 (0.05 kg to 0.098 kg/m^2)
(3) *Lightweight* — Basis weight of less than 10 lb/1000 ft^2 (0.05 kg/m^2) and tissues regardless of basis weight

[**13:**A.5.6.5]

The following SI units were used for conversion of U.S. customary units:

(1) 1 lb = 0.454 kg
(2) 1 in. = 25.4 mm
(3) 1 ft = 0.3048 m; 1 ft^2 = 0.0929 m^2

[**13:**A.5.6.5]

The various types of papers normally found in each of the four major categories are provided in Table A.34.2.7. [**13:**A.5.6.5]

TABLE A.34.2.7 Paper Classification

Heavyweight	Mediumweight	Lightweight	Tissue
Linerboards	Bond and reproduction	Carbonizing tissue	Toilet tissue
Medium	Vellum	Cigarette	Towel tissue
Kraft roll wrappers	Offset	Fruit wrap	
Milk carton board	Tablet	Onion skin	
Folding carton board	Computer		
Bristol board	Envelope		
Tag	Book		
Vellum bristol board	Label		
Index	Magazine		
Cupstock	Butcher		
Pulp board	Bag		
	Newsprint (unwrapped)		

[**13:** Table A.5.6.5]

The material in A.34.2.7 applies to the classification of large rolls of paper stored on-end or on-side in piles greater than 10 ft (3.0 m) high. This type of paper storage is typically found in the finished goods storage warehouses at paper mills, in the raw stock storage warehouses of manufacturing plants that convert paper into finished products, or in other warehouses of similar occupancy. Fire experience and full-scale fire testing of this type of paper storage demonstrate unique burning characteristics that vary with the type of paper and the method of wrapping. The classifications for this type of paper storage are based on a series of full-scale and small-scale fire tests as described in A.34.2.7.

34.2.7.1 Heavyweight Class. Heavyweight class shall be defined so as to include paperboard and paper stock having a basis weight [weight per 1000 ft^2 (92.9 m^2)] of 20 lb (9.1 kg). [**13:**5.6.5.1]

34.2.7.2 Mediumweight Class. Mediumweight class shall be defined so as to include all the broad range of papers having a basis weight [weight per 1000 ft^2 (92.9 m^2)] of 10 lb to 20 lb (4.5 kg to 9.1 kg). [**13:**5.6.5.2]

34.2.7.3 Lightweight Class. Lightweight class shall be defined so as to include all papers having a basis weight [weight per 1000 ft^2 (92.9 m^2)] of less than 10 lb (4.5 kg). [**13:**5.6.5.3]

34.2.7.4 Tissue.

34.2.7.4.1 Tissue shall be defined so as to include the broad range of papers of characteristic gauzy texture, which, in some cases, are fairly transparent. [**13:**5.6.5.4.1]

34.2.7.4.2 For the purposes of this *Code*, tissue shall be defined as the soft, absorbent type, regardless of basis weight — specifically, crepe wadding and the sanitary class including facial tissue, paper napkins, bathroom tissue, and toweling. [**13:**5.6.5.4.2]

34.3 Building Construction

Δ **34.3.1* Construction Type.** Buildings used for storage of materials that are stored and protected in accordance with this chapter shall be permitted to be of any of the types described in NFPA 220.

A.34.3.1 With protection installed in accordance with this *Code*, fire protection of overhead steel and steel columns might not be necessary. Consideration should be given to subdividing large area warehouses in order to reduce the amount of merchandise that could be affected by a single fire.

Walls or partitions are recommended to be provided to separate the storage area from mercantile, manufacturing, or other occupancies to prevent the possibility of transmission of fire or smoke between the two occupancies. Door openings should be equipped with automatic-closing fire doors appropriate for the fire resistance rating of the wall or partition.

While storage occupancies can be located in buildings of any type of construction, combustible construction adds to the fire load and can create combustible concealed spaces that contribute to fire spread. Lightweight steel and wood truss construction, now commonly used in newer buildings, can or might be susceptible to early structural collapse. The height and area limitations provided in *NFPA 5000®, Building Construction and Safety Code®*, restrict the type of construction permitted.

Additional protection of steel columns and overhead steel might be required to ensure that the structural integrity of the building is maintained during sprinkler system operation. This added protection could be provided by way of fireproofing or sprinkler protection. NFPA 13 provides requirements for protection of steel in rack storage arrangements.

In some buildings with rack systems, the structural framework of the racks themselves supports the building's exterior walls and roof. Buildings up to 100 ft (9.3 m) high used for rack storage are not uncommon. Fire involving upper portions of high rack storage can present severe risks to fire fighters. Access to the upper portions for complete extinguishment and overhaul is very limited, and the use of ground ladders inside buildings can be extremely difficult and dangerous.

34.3.2 Fire-Fighting Access. Access shall be provided to all portions of the premises for fire-fighting purposes.

Perimeter access doors should be placed not only with occupant means of egress in mind but also with consideration for fire suppression efforts. Additional doors might be required beyond those provided for egress purposes. Door placement should take into account specific hazards located in the building. Advancing hose lines through the interior of a burning warehouse is time consuming and dangerous. Standpipe hose connections are required in storage occupancies, and initial placement should be made at each exterior perimeter door, with additional hose stations installed as required, so that all portions of the storage area can be reached. Placement of hose stations at exterior perimeter doors allows quick access for fire department personnel and, hence, faster water application to the fire. See 18.2.3.2 for additional information on fire department building access requirements.

34.3.3* Emergency Smoke and Heat Venting.

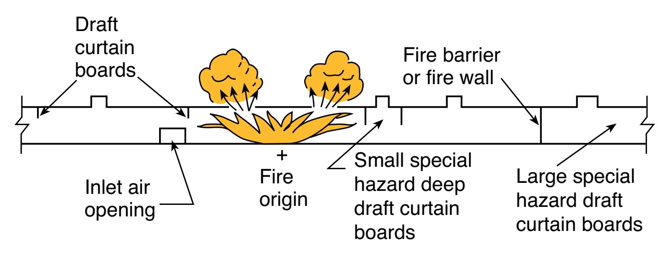
The following list provides a general description of the significant phenomena that occur during a fire when a fire-venting strategy is implemented:

1. Due to buoyancy, hot gases rise vertically from the combustion zone and flow horizontally below the roof until blocked by a vertical barrier (a wall or draft curtain), thus forming a layer of hot gases below the roof.
2. The volume and temperature of gases to be vented are a function of the fire's rate of heat release and the amount of air entrained into the buoyant plume produced.
3. As the depth of the layer of hot gases increases, the layer temperature continues to rise and the vents open.
4. The operation of vents within a curtained area enables some of the upper layer of hot gases to escape and thus slows the thickening rate of the layer of hot gases. With sufficient venting area, the thickening rate of the layer can be arrested and even reversed. The rate of discharge through a vent of a given area is primarily determined by the depth of the layer of hot gases and the layer temperature. Adequate quantities of replacement inlet air from air inlets located below the hot upper layer are needed if the products of combustion-laden upper gases are to be exhausted according to design. See Exhibit 34.10 for an illustration of the behavior of fire under a vented and curtained roof, and see Exhibit 34.11 for an example of a roof with vents.

Objectives of the vent system should be defined and considered. Objectives can include the following:

1. Provide for fire fighter safety and facilitate post-fire smoke removal by the fire department. The two key issues include activation type (remote or manual removal at roof level by fire fighters) and vent ratio (gross vent area to roof area). Remote activation is a preferred method; however, manual activation at roof level does considerably reduce the time a fire fighter must spend on the roof (versus cutting a hole in the roof) and might be considered acceptable.
2. Allow extended egress travel distances.
3. Reduce smoke damage to the contents. Design features such as ganging all vents within a sprinkler zone and automatically activating all the vents within one zone following sprinkler activation might achieve objectives 2 and 3; however, additional research is needed to validate this concept.

Exhibit 34.10



Behavior of combustion products under vented and curtained roof.

Exhibit 34.11

View of roof vents on building.

Chapter 11 of NFPA 204, *Standard for Smoke and Heat Venting*, provides a design methodology for smoke and heat venting in sprinklered buildings. Designers are strongly cautioned that use of venting with automatic sprinklers is an area of ongoing research to determine its benefit and effect in conjunction with automatic suppression.

The Fire Protection Research Foundation organized large-scale tests to study the interaction of sprinklers, roof vents, and draft curtains [McGrattan et al., 1998] involving heptane spray fires and arrays of cartoned plastic commodity of a standard configuration. The test space was ventilated by a smoke abatement system. As a result of the research, the following guidelines are provided for the design of venting systems in those areas of a building protected with an automatic sprinkler system designed and installed in accordance with NFPA 13 for the specific occupancy hazard:

1. Draft curtains and open vents of venting systems should not adversely affect sprinklers that are capable of discharging water onto the fire, either in time of operation or in the water discharge pattern.
2. Vents that are open prior to sprinkler operations in a region surrounding the ignition point, within a radius of one and one-half sprinkler spacings, can interfere with the opening of sprinklers capable of delivering water to the fire. The vent system design should consider the following:
   a. This interference is likely to be a factor if the total vent area is divided among many closely spaced vents, as in the investigation by Hinkley et al. (1992) and commented on by Gustafsson (1992).
   b. If the vent spacing is several times as large as the sprinkler spacing, model fire tests simulating a 4.0 ft × 4.0 ft (1.2 m × 1.2 m) vent in a 25 ft (7.6 m) high building [Heskestad, 1995] showed that sprinkler operations were significantly delayed whenever ignition occurred anywhere under the area of an open vent. Otherwise, the delay was minimal. This delay can be important for systems with early suppression fast-response (ESFR) sprinklers.
   c. Use of high-temperature, heat-responsive actuation mechanisms, compared to the sprinklers, can mitigate the problem of open vents. For example, for 165°F (74°C) rated ESFR sprinklers, a minimum 356°F (180°C) activation temperature should be provided for vents. Another approach would be to provide gang operation of the vents at the moment a conservative number of sprinklers are operating.
   d. The vent system design should consider the effects of the venting system on the ceiling jet.
3. The location of draft curtains should be determined considering the following:
   a. Draft curtains can delay or prevent operation and can interfere with the discharge of sprinklers capable of delivering water to the fire. In practice, sprinklers capable of delivering water to the fire can be considered to be those that are within one and one-half sprinkler spacings of the ignition point.
   b. Draft curtains should be located in aisles and should be horizontally separated from combustible contents.
   c. The layout of the sprinkler protection and the width of the aisle below the draft curtain should be sufficient to prevent the fire from jumping the aisle space. Accordingly, if a draft curtain is positioned midway between two sprinklers, the nearest possible ignition point should be at least three quarters of one sprinkler spacing away from the draft curtain. In other words, no storage of combustible material can be within three quarters of one sprinkler spacing of a draft curtain. Aisles free of combustible storage, centered under draft curtains, should be at least one and one-half sprinkler spacings wide [e.g., a minimum of 15 ft (4.57 m) aisle for 10 ft (3.05 m) sprinkler spacing in the direction perpendicular to the draft curtain]. For situations where such an aisle width is not practical, the aisle space can be reduced to a minimum of 8 ft (2.44 m), if a line of sprinklers is provided on each side of the draft curtain, 4 in. to 12 in. (101.6 mm to 304.8 mm) horizontally from the face of the draft curtain. For existing sprinkler installations, the sprinklers near the draft curtain might need to be staggered horizontally with respect to an adjacent line of sprinklers in order to maintain the minimum separation required by NFPA 13 and to prevent sprinkler skipping.
   d. Where aisles of sufficient width cannot be maintained, full-height partitions can be used in lieu of draft curtains.
4. The design fire's rate of heat release rate–time history should account for the operation of the sprinkler system.
5. Determination of the smoke layer temperature should take into account the operation of the control mode sprinkler system. (See Section F.3 in NFPA 204.)
6. The vent flow, smoke movement, and position of the smoke layer boundary should take into account the down-drag effect produced by operation of the sprinkler system.
7. The effect of control mode sprinkler cooling may limit the number of vents opening if control of the vent is only by fusible link or if drop-out panels are used. If the fusible link or drop-out panel operating temperature is equal to or higher than the control mode sprinkler fusible element operating temperature, vents outside the outer ring of operating control mode sprinklers are unlikely to open. This could significantly limit the effectiveness of the smoke vent system. Use of ganged vents operated from detectors or a sprinkler flow switch is a way to avoid this situation.

Δ **A.34.3.3** Since most of the fire tests were conducted without heat and smoke venting and draft curtains, protection specified in NFPA 13 was developed without their use.

For guidance on smoke and heat venting, see NFPA 204.

Smoke removal is important to manual fire fighting and overhaul. Vents through eave-line windows, doors, monitors, or gravity or mechanical exhaust systems facilitate smoke removal after control of the fire is achieved.

Results of tests organized by the Fire Protection Research Foundation and the Retail Committee on Group A Plastics to study the interaction of sprinklers, vents, and draft curtains indicate that the impact of automatic vents on sprinkler performance is neutral when automatic sprinkler discharge is adequate for the hazard and that draft curtains are potentially negative. Test results show that the placement of sprinklers and the thermal sensitivity of sprinklers and vents should be considered. Care should be exercised in the placement of draft curtains. Where required to be installed, draft curtains should be aligned where possible with aisles or other clear spaces in storage areas. Draft curtains where positioned over storage could adversely affect sprinkler operations. The number of operating sprinklers increased and led to a fire that consumed more commodity compared to other tests with fires ignited away from the draft curtains.

34.3.3.1 Protection outlined in this chapter shall apply to buildings with or without smoke and heat vents.

34.3.3.2 Protection outlined in this chapter shall apply to buildings with or without draft curtains.

Draft curtains are recommended only to separate ESFR sprinklers from control mode sprinklers.

34.3.3.3 Where local codes require smoke and heat vents in buildings protected by early suppression fast response (ESFR) sprinklers, the vents shall be manually operated or have an operating mechanism with a standard response fusible element rated not less than 360°F (182°C).

The requirement for the 360°F (182°C) rated fusible element ensures that the ESFR sprinklers will operate before the vents. If everything works correctly, the vents should never open at all.

Some codes and fire departments require manual vents to be installed on roofs to assist the fire department in ventilating a building in the event of a fire. Where manual vents are provided, consideration should be given to a means to operate the vents from a location other than the roof so that fire fighters do not have to go up on the roof to activate the vents.

34.4 Storage Arrangement

Storage configuration and arrangement has a major impact on how a fire will behave in a storage situation. Therefore, a commodity's storage arrangement must be considered in the preparation of the fire protection plan. Important factors to consider for storage arrangements that affect fire behavior and the difficulty of controlling a fire are as follows:

1. Storage height
2. Storage depth
3. Aisle width
4. Commodity classification
5. Flue space
6. Commodity encapsulation

Storage height affects the ability of the sprinkler water to reach the base of a fire if the fire starts at lower levels. In rack storage, higher racking arrangements may require the installation of in-rack sprinklers. Deep storage arrangements allow for fire to spread from pile to pile and require more water for fire control and pre-wetting. The narrower the aisle, the more likely the fire can jump the aisle and spread to storage arrays on the other side of the aisle. Commodity classification is discussed in Section 34.2.

Storage configurations create horizontal and vertical air spaces. Air passes through flue spaces, increasing air entrainment to the fire. Flue spaces are a key component for the proper operation of the sprinkler system, and they should not be obstructed where present. Property owners/operators and fire prevention personnel must ensure that flue spaces, where provided, are not obstructed. To ensure that flue spaces do not become obstructed, a permanent means to prevent blockage should be installed. Obstructed flue spaces can prevent heat and combustion products from reaching sprinklers and can also prevent water from reaching the fire. Encapsulation is defined as a method of packaging using a plastic sheet that completely encloses all sides and the top of the pallet load. Encapsulation prevents pre-wetting of the combustible commodity. When the fire burns through the plastic, it has access to fresh, dry fuel.

The most common types of storage arrangements used are as follows:

1. Bulk storage
2. Solid pile storage
3. Palletized pile storage
4. Rack storage (See Section 34.7.)

Solid pile storage arrangements are loads of storage that do not have voids within the load and that burn only on the exterior of the load. Water is generally able to reach most surfaces available to burn. Solid pile storage is piled on the floor of the area and not on racks or shelves.

Piles are further categorized into stable and unstable piles. Stable piles are those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces is not likely to occur soon after initial fire development. Pile stability performance can be a difficult factor to judge prior to a pile being subjected to an actual fire. Storage on pallets, compartmented storage, and plastic components that are held in place by materials that do not deform readily under fire conditions are examples of stable storage. Unstable piles are those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development. Examples of unstable piles are leaning stacks, crushed bottom cartons, and reliance on combustible bands for stability. Additionally, an increase in pile height tends to increase instability.

Palletized storage is the storage of commodities on pallets or other storage aids that form horizontal spaces between tiers of storage. Palletized storage can be found in solid pile storage or in rack storage.

34.4.1* Piling Procedures and Precautions.

A.34.4.1 Commodities that are particularly susceptible to water damage should be stored on skids, dunnage, pallets, or elevated platforms in order to maintain at least 4 in. (100 mm) clearance from the floor.

34.4.1.1 Any commodities that are hazardous in combination with each other shall be stored so they cannot come into contact with each other.

34.4.1.2 Safe floor loads shall not be exceeded.

34.4.1.3 Where storing water-absorbent commodities, normal floor loads shall be reduced to take into account the added weight of water that can be absorbed during fire-fighting operations.

34.4.2 Commodity Clearance.

An 18 in. (457 mm) minimum clearance between a sprinkler deflector and the top of storage is the base requirement and provides for discharge pattern development and standardization between sprinklers. If another standard specifies a greater clearance, that standard should be followed.

Additionally, a minimum clearance to storage of 36 in. (0.9 m) is required for special sprinklers and where rubber tires are stored. Special sprinklers are intended for the protection of specific hazards or construction features. Subsection 8.4.8 of NFPA 13 provides more information on special sprinklers. A minimum clearance to storage of less than 18 in. (457 mm) between the top of storage and ceiling sprinkler deflectors is permitted where proven by successful large-scale fire tests for the particular hazard.

The clearance between the storage and the roof/ceiling is also an important factor for control mode density/area. High clearance affects sprinkler performance in two ways. First, as the clearance increases, the size of the fire before sprinklers operate also increases. Second, as the clearance increases, the fire plume that the sprinkler discharge must penetrate to reach the burning materials also increases. These two factors together significantly reduce the effectiveness of sprinklers.

Implicit in storage protection requirements is that the protection for a given storage height in a building of a given height can fluctuate widely over both the short and the long term. Clearances greater than 20 ft (6 m) are beyond the scope of testing used to develop the protection requirements for control mode density/area sprinklers. Therefore, protection adequate for a storage height that results in a clearance of less than 20 ft (6 m) will be adequate for lesser storage heights, despite the fact that clearance exceeds 20 ft (6 m).

34.4.2.1 The clearance between top of storage and sprinkler deflectors shall conform to NFPA 13.

34.4.2.2* If the commodity is stored above the lower chord of roof trusses, not less than 1 ft (0.3 m) of clear space shall be maintained to allow wetting of the truss, unless the truss is protected with 1-hour fireproofing.

A.34.4.2.2 Protection for exposed steel structural roof members could be needed and should be provided as indicated by the AHJ.

Subsection 14.3.6 in NFPA 13 eliminates special protection for building steel under certain storage configurations.

Δ **34.4.2.3** Storage clearance from ducts shall be maintained in accordance with NFPA 91.

34.4.2.4 The clearance between stored materials and unit heaters, radiant space heaters, duct furnaces, and flues shall not be less than 3 ft (0.9 m) in all directions or shall be in accordance with the clearances shown on the approval agency label.

34.4.2.5* Clearance shall be maintained to lights or light fixtures to prevent ignition.

A.34.4.2.5 Incandescent light fixtures should have shades or guards to prevent the ignition of commodity from hot bulbs where possibility of contact with storage exists.

34.4.2.6 Clearance shall be maintained around the path of fire door travel to ensure the door's proper operation and inspection.

34.4.2.7 Operation and inspection clearance shall be maintained around fire-extinguishing and fire protection equipment.

34.4.3 Aisles.

34.4.3.1 For the storage of commodities that expand with the absorption of water, such as roll paper, wall aisles not less than 24 in. (0.6 m) wide shall be provided.

34.4.3.2 Aisles shall be maintained to retard the transfer of fire from one pile to another and to allow convenient access for fire fighting, salvage, and removal of storage.

Aisles should separate storage so that piles are not more than 50 ft (15.2 m) wide, or 25 ft (7.6 m) wide if they abut a wall. This separation allows effective reach by hose streams. Main aisles and cross-aisles should be located opposite window or door openings in exterior walls. Such aisle location is of particular importance in buildings where few exterior openings exist. Aisle width should be at least 8 ft (2.4 m). Aisle spacing and frequency should be given consideration to judge the adequacy of existing sprinkler protection and manual fire suppression efforts (including the efforts of the local fire department).

34.4.4 Flammable and Combustible Liquids. Storage of flammable or combustible liquids shall be in accordance with Chapter 60.

34.5 General Fire Protection

34.5.1* Sprinkler Systems. Sprinkler systems installed in buildings used for storage shall be in accordance with Section 13.3.

A.34.5.1 Wet systems are recommended for storage occupancies. Dry systems are permitted only where it is impractical to provide heat. Preaction systems should be considered for storage occupancies that are unheated, particularly where in-rack sprinklers are installed or for those occupancies that are highly susceptible to water damage.

Where dry pipe sprinkler systems are used, the delay in water discharge from the earliest operating sprinkler will allow heat to spread and open a larger number of sprinklers beyond the immediate fire than would be the case with a wet pipe system. A review of fire loss data by FM Global showed that about 30 percent more sprinklers operate with a dry pipe system than with a wet pipe system.

34.5.2 High-Expansion Foam.

Δ **34.5.2.1** High-expansion foam systems installed in addition to automatic sprinklers shall be installed in accordance with NFPA 11 except where modified by other requirements in this chapter.

While automatic high-expansion foam extinguishing systems can be an independent means of fire suppression, a reluctance persists in the industry for using them as the sole means of automatic fire control. They are expensive, are complicated (relative to sprinkler systems), require more maintenance and testing, do not protect the roof structure until foam reaches that level, involve the entire contents of a protected area regardless of the fire's size, and present the problem of foam residue removal after discharge.

Such extinguishing systems have found acceptance as a partner to automatic sprinklers for certain high-challenge storage occupancies, such as those storing rubber tires, roll paper, exposed plastics, and pallets. The sprinklers are needed to help maintain the structural integrity of the building columns and roof structure by keeping them relatively cool while foam covers the fire. Note that sprinkler discharge breaks down the foam, a fact that needs to be taken into account when the system is being designed. Very few tests have been conducted using high-expansion foam in conjunction with sprinkler protection.

34.5.2.2 High-expansion foam used to protect idle pallets shall have a fill time of not more than 4 minutes.

34.5.2.3 High-expansion foam systems shall be automatic in operation.

34.5.2.4 Detectors for high-expansion foam systems shall be listed and shall be installed at the ceiling at not more than one-half the listed spacing in accordance with *NFPA 72*.

34.5.2.5 Detection systems, concentrate pumps, generators, and other system components essential to the operation of the system shall have an approved standby power source.

34.5.3 Manual Protection.

34.5.3.1 Portable Fire Extinguishers.

34.5.3.1.1 Portable fire extinguishers shall be provided in accordance with Section 13.6, unless 34.5.3.1.2 applies.

Section 13.6 and NFPA 10, *Standard for Portable Fire Extinguishers*, specify minimum requirements for proper placement, use, and maintenance of portable fire extinguishers. To ensure the usability of fire extinguishers, storage facility managers should ensure that the following criteria are met:

1. Extinguishers are visible, accessible, and not blocked by storage or equipment.
2. Extinguishers are near normal paths of travel.
3. Extinguishers are protected from accidental or malicious damage.
4. Extinguishers are properly charged with extinguishing agent.
5. Extinguisher lock pins and tamper seals are not damaged.
6. Extinguisher discharge nozzles are free from obstructions.
7. Extinguisher inspection tags indicate that proper inspections and maintenance have been performed.

Employees expected to use fire extinguishers are required to meet certain training and safety standards established by the U.S. Department of Labor Occupational Safety & Health Administration (OSHA).

34.5.3.1.2 Where 1½ in. (38 mm) hose lines are available to reach all portions of areas with Class A fire loads, up to one-half of the portable fire extinguishers required by Section 13.6 shall be permitted to be omitted.

Hose stations are required to be installed and located throughout the building so that the fire department does not have to stretch its own fire hose from outside the building to the fire. These hose stations are similar to standpipe systems in high-rise buildings, with the only difference being that they are installed horizontally instead of vertically in the building. Only fire department personnel or employees that have received special training should use the hose lines.

Charged hose lines are difficult to control and maneuver, especially when fed by a fire pump. Additionally, employees should only be expected to use hose lines on relatively small fires. As with fire extinguishers, employees expected to fight fires with hose lines are required to meet certain training and safety standards established by OSHA.

34.5.3.2 Hydrants. At locations without public hydrants, or where hydrants are not within 250 ft (75 m), private hydrants shall be installed in accordance with Section 13.5.

Buildings of moderate area close to city hydrants present no special problem. However, where the small dimension of a building exceeds about 250 ft (75 m), hose lays from public hydrants to the far side of the building can be a serious problem. Private hydrants around the perimeter of a warehouse with access doors near them then become important.

34.5.4 Fire Organization.

34.5.4.1 Arrangements shall be made to allow rapid entry into the premises by the municipal fire department, police department, or other authorized personnel in case of fire or other emergency.

Section 18.2 provides requirements for access boxes.

34.5.4.2* Due to the unique nature of storage fires and the hazards associated with fighting such fires, facility emergency personnel shall be trained to have knowledge of the following:

(1) Pile and building collapse potential during fire-fighting and mop-up operations due to sprinkler water absorption, use of hose streams, and the undermining of piles by fire that is likely to cause material or piles to fall (especially roll tissue paper), resulting in injury
(2) Operation of sprinkler systems and water supply equipment

(3) Location of the controlling sprinkler valves so that the correct sprinkler system can be turned on or off as necessary
(4) Correct operation of emergency smoke and heat vent systems where they have been provided
(5) Use of material-handling equipment while sprinklers are operating to effect final extinguishment
(6) Procedure for summoning outside aid immediately in an emergency
(7) Maintenance of the security features of the premises
(8) Operation of foam systems, evacuation procedures, and safety precautions during all foam operations

A.34.5.4.2 See Annex B of NFPA 13E.

34.5.4.3 A fire watch shall be maintained when the sprinkler system is not in service.

34.5.5 Alarm Service.

Warehouse facilities typically experience rapidly growing fires and include large open areas and relatively few employees, so alarm systems are needed to provide prompt fire department and employee responses.

34.5.5.1 Automatic sprinkler systems and foam systems, where provided, shall have approved central station, auxiliary, remote station, or proprietary waterflow alarm service unless otherwise permitted by 34.5.5.1.1 or 34.5.5.1.2.

34.5.5.1.1 Local waterflow alarm service shall be permitted when recorded guard service also is provided.

34.5.5.1.2 Local waterflow alarm service shall be permitted where the storage facilities are occupied on a 24-hour basis.

34.5.5.2 Alarm service shall comply with *NFPA 72*.

Δ **34.5.6 Security Service.** Security service, where provided, shall comply with NFPA 601.

While a warehouse facility is in operation, most areas of the building will probably be occupied, and the occupants will provide a measure of fire surveillance. During operation, an employee's discovery of a fire at an early stage might lead to the fire's prompt extinguishment before it grows out of control. However, because many arson fires originate while a facility is not in operation, premises security is important, not only from the standpoint of theft and security of contents but also from a fire protection standpoint. A security service is an effective tool used to guard against arson-type fires.

See NFPA 730, *Guide for Premises Security*, and NFPA 731, *Standard for the Installation of Electronic Premises Security Systems*, for additional guidance.

34.6 Building Equipment, Maintenance, and Operations

34.6.1 Industrial Trucks.

Δ **34.6.1.1** Power-operated industrial trucks and their use shall comply with NFPA 505.

34.6.1.2 Industrial trucks using liquefied petroleum gas (LP-Gas) or liquid fuel shall be refueled outside of the storage building at a location designated for the purpose.

The importance of fueling industrial trucks outside the warehouse is magnified by the economic impracticality of installing sprinkler protection that will handle a liquid spill fire in typical rack storage. If industrial trucks were fueled inside, a fuel spill and potential fire could spread to the storage, causing unnecessary losses. Fueling of all vehicles and equipment is best suited for outdoors, away from any buildings or other hazards.

34.6.2 Building Service Equipment. Electrical equipment shall be installed in accordance with the provisions of Section 11.1.

34.6.3 Cutting and Welding Operations.

34.6.3.1 Where welding or cutting operations are necessary, the requirements of Chapter 41 shall apply.

Repair or replacement of steel racks or overhead structures sometimes necessitates cutting and welding operations. Hot sparks from such operations are a fire hazard. Proper hot work procedures and the requirements of Chapter 41 should be followed. In Kaukauna, Wisconsin, in a roll-paper warehouse fire, sparks from an arc welding unit used on the second floor fell onto cardboard boxes on the first floor below, which caught fire. There was no fire watch on the first floor, and when the fire was discovered 15 minutes later, employees could not put it out. They called the fire department, but the actions were too late to save the two-story building of ordinary construction. The facility and its contents were a $1.6 million loss.

34.6.3.2* Welding, soldering, brazing, and cutting shall be permitted to be performed on building components or contents that cannot be removed, provided that no storage is located below and within 25 ft (7.6 m) of the working area and flameproof tarpaulins enclose the area.

A.34.6.3.2 The use of welding, cutting, soldering, or brazing torches in the storage areas introduces a severe fire hazard and, when possible, should be relocated to a designated area. The use of mechanical fastenings and mechanical saws or cutting wheels is recommended.

34.6.3.3 During any of the operations identified in 34.6.3.2, all of the following shall apply:

(1) The sprinkler system shall be in service.
(2) Extinguishers suitable for Class A fires with a minimum rating of 2-A shall be located in the working area.
(3) Where inside hose lines are available, charged and attended inside hose lines shall be located in the working area.
(4) A fire watch shall be maintained during the operations specified in 34.6.3.2 and for not less than 30 minutes following completion of open-flame operation.

34.6.4 Waste Disposal.

34.6.4.1 Approved containers for rubbish and other trash materials shall be provided.

34.6.4.2 Rubbish, trash, and other waste material shall be disposed of at regular intervals.

The importance of good housekeeping cannot be overstated. Packing or unpacking goods usually results in quantities of loose combustibles, such as foamed polystyrene beads, cocoons of foamed plastic, shredded paper, excelsior, and straw. Other combustibles, such as baled fibers and detached labels or tags, can act as kindling to ignite stored materials. Containers should be emptied after each shift or more often as needed due to operations.

See Chapter 19 for additional guidance on rubbish and trash handling and containers.

34.6.5 Smoking.

Smoking should always be controlled. Control of smoking requires management's sincere effort to enforce observance of permissible and prohibited smoking areas for employees and visitors. Smoking should be confined to specific areas separated from storage that are kept clean and are provided with proper disposal containers. Loading docks can be a particular area of concern, because truck drivers who smoke do not always properly extinguish cigarettes before starting to unload. See Section 10.9 for additional requirements on smoking.

34.6.5.1 Smoking shall be prohibited except in locations designated as smoking areas.

34.6.5.2 Signs that read "No Smoking" shall be posted in prohibited areas.

34.6.6* Maintenance and Inspection.

A.34.6.6 Periodic inspections of all fire protection equipment should be made in conjunction with regular inspections of the premises. Unsatisfactory conditions should be reported immediately and necessary corrective measures taken promptly.

34.6.6.1 Fire walls, fire doors, and floors shall be maintained in functional condition at all times.

34.6.6.2* All water-based fire protection systems and the water supplies shall be inspected, tested, and maintained in accordance with NFPA 25.

Δ **A.34.6.6.2** All fire-fighting and safety personnel should realize the great danger in shutting off sprinklers once opened by heat from fire. Shutting off sprinklers to locate fire could cause a disaster. Ventilation, use of smoke masks, smoke removal equipment, and removal of material are more safe. *(See NFPA 1620.)*

Sprinkler water should be shut off only after the fire is extinguished or completely under the control of hose streams. Even then, rekindling is a possibility. To be ready for prompt valve reopening if fire rekindles, a person stationed at the valve, a fire watch, and dependable communications between them are needed until automatic sprinkler protection is restored.

Prefire emergency planning is important and should be done by management and fire protection personnel, and the action to be taken discussed and correlated with the local fire department personnel. The critical time during any fire is in the incipient stage, and the action taken by fire protection personnel upon notification of fire can allow the fire to be contained in its early stages.

Pre-emergency planning should incorporate the following:

(1) Availability of hand fire-fighting equipment for the height and type of commodity involved
(2) Availability of fire-fighting equipment and personnel trained for the type of storage arrangement involved
(3) Assurance that all automatic fire protection equipment, such as sprinkler systems, water supplies, fire pumps, and hand hose, is in service at all times

Sprinkler protection installed as required in this *Code* is expected to protect the building occupancy without supplemental fire department activity. Fires that occur in rack storage occupancies protected in accordance with this *Code* are likely to be controlled. Fire department activity can, however, minimize the extent of loss. The first fire department pumper arriving at a rack storage–type fire should connect immediately to the sprinkler system's fire department connection and start pumping operations.

In the test series for storage up to 25 ft (7.6 m), the average time from ignition to smoke obscuration in the test building was about 13 minutes. The first sprinkler operating time in these same fires averaged about 3 minutes. Considering response time for the waterflow device to transmit a waterflow signal, approximately 9 minutes remains between the time of receipt of a waterflow alarm signal at fire department headquarters and the time of smoke obscuration within the building as an overall average.

In the test series for storage over 25 ft (7.6 m), the visibility time was extended. If the fire department facility emergency personnel arrive at the building in time to have sufficient visibility to locate the fire, suppression activities with small hose lines should be started. (Self-contained breathing apparatus is recommended.) If, on the other hand, the fire is not readily visible, hose should be laid to exterior doors or exterior openings in the building and charged lines provided to these points, ready for ultimate mop-up operations. Manual fire-fighting operations in such a warehouse should not be considered a substitute for sprinkler protection.

Important: The sprinkler system should be kept in operation during manual fire-fighting and mop-up operations.

During the testing program, the installed automatic extinguishing system was capable of controlling the fire and reducing all temperatures to ambient within 30 minutes of ignition. Ventilation operations and mop-up were not started until this point. The use of smoke removal equipment is important.

Smoke removal capability should be provided. Examples of smoke removal equipment include the following:

(1) Mechanical air-handling systems
(2) Powered exhaust fans
(3) Roof-mounted gravity vents
(4) Perimeter gravity vents

Whichever system is selected, it should be designed for manual actuation by the fire department, thus allowing personnel to coordinate the smoke removal (ventilation) with mop-up operations.

See also NFPA 600 and Annex B of NFPA 13E and NFPA 1031.

34.6.7 Refrigeration Systems. Refrigeration systems, if used, shall be in accordance with ASHRAE 15, *Safety Code for Mechanical Refrigeration*.

34.6.8 Lighting. Where metal halide lighting is installed, it shall be selected, installed, and maintained such that catastrophic failure of the bulb shall not ignite materials below.

34.7 Protection of Rack Storage

34.7.1 Application. Section 34.7 shall apply to the indoor storage of normal combustibles (Class I through Class IV) and plastics that are stored on racks.

34.7.2 Building Construction.

34.7.2.1 Fire protection of roof steel shall not be required when sprinkler systems are installed in accordance with Section 13.3.

In tests that were conducted with roof (steel) sprinkler densities that were in accordance with the design curves specified by NFPA 13, no critical temperatures were recorded in bar joists 12½ ft (3.8 m) from the ignition source. Therefore, where sprinkler systems designed in accordance with NFPA 13 are used, fireproofing of roof steel should not be necessary.

34.7.2.2 Fire protection of steel building columns and vertical rack members that support the building shall not be required when ceiling sprinklers and in-rack sprinklers are installed in accordance with Section 13.3.

34.7.2.3 For sprinklered buildings with rack storage of over 15 ft (4.6 m) in height and only ceiling sprinklers installed, steel building columns within the rack structure and vertical rack members that support the building shall have a fire resistance rating not less than 1 hour, unless the installation meets the requirements of 16.1.4 of NFPA 13.

Protection of steel columns is necessary, primarily to ensure that the structural integrity of the building is maintained during sprinkler system operation.

34.7.3 Storage Arrangement.

34.7.3.1* Rack Structure. Rack configurations shall be approved.

A.34.7.3.1 Rack storage as referred to in this *Code* contains commodities in a rack structure, usually steel. Many variations of dimensions are found. Racks can be single-row, double-row, or multiple-row, with or without solid shelves. The standard commodity used in most of the tests was 42 in. (1.07 m) on a side. The types of racks covered in this *Code* are as follows:

(1) Double-row racks, in which pallets rest on two beams parallel to the aisle. Any number of pallets can be supported by one pair of beams. *[See Figure A.34.7.3.1(a) through Figure A.34.7.3.1(d).]*
(2) Automatic storage-type rack, in which the pallet is supported by two rails running perpendicular to the aisle. *[See Figure A.34.7.3.1(e).]*

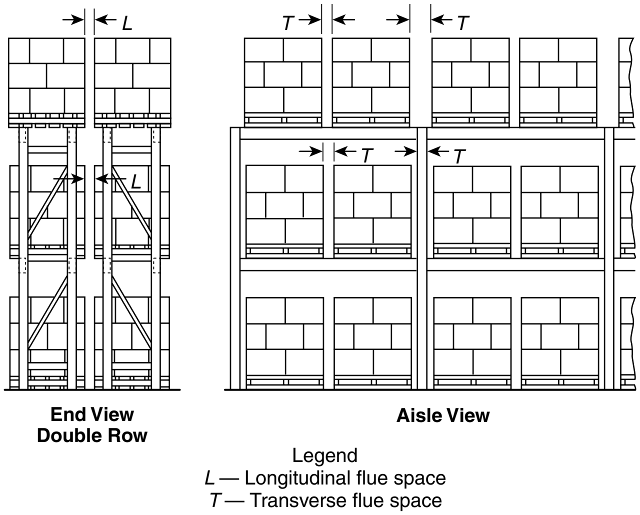


FIGURE A.34.7.3.1(a) *Conventional Pallet Rack.*

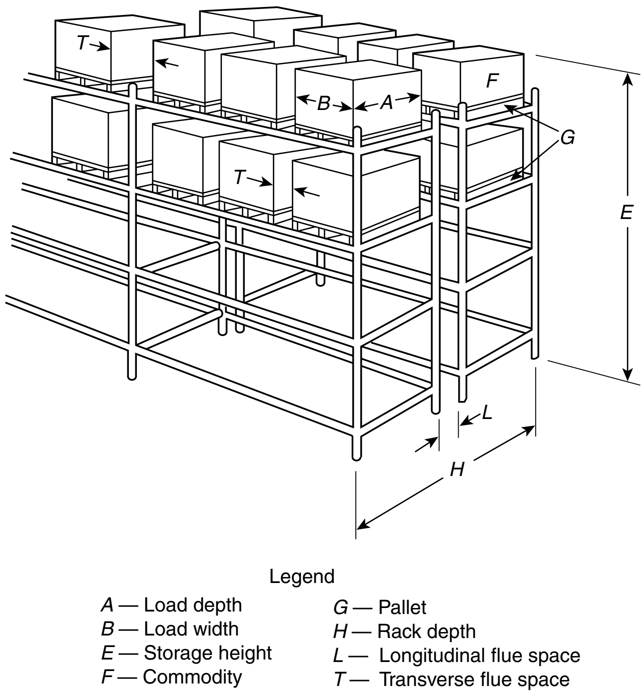


FIGURE A.34.7.3.1(b) *Double-Row Racks Without Solid or Slatted Shelves.*

(3) Multiple-row racks more than two pallets deep, measured aisle to aisle, which include drive-in racks, drive-through racks, flow-through racks, and portable racks arranged in the same manner, and conventional or automatic racks with aisles less than 42 in. (1.07 m) wide. *[See Figure A.34.7.3.1(f) through Figure A.34.7.3.1(j).]*
(4) Movable racks, which are racks on fixed rails or guides. They can be moved back and forth only in a horizontal two-dimensional plane. A moving aisle is created as abutting racks

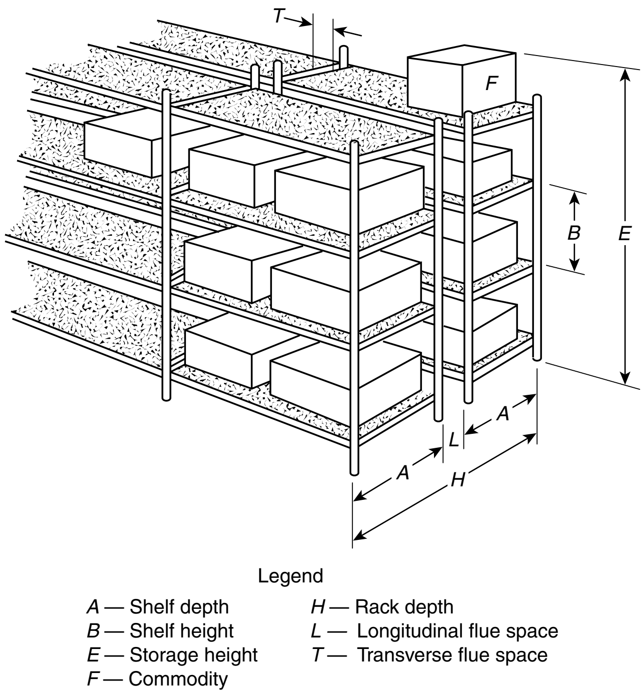


FIGURE A.34.7.3.1(c) *Double-Row Racks with Solid Shelves.*

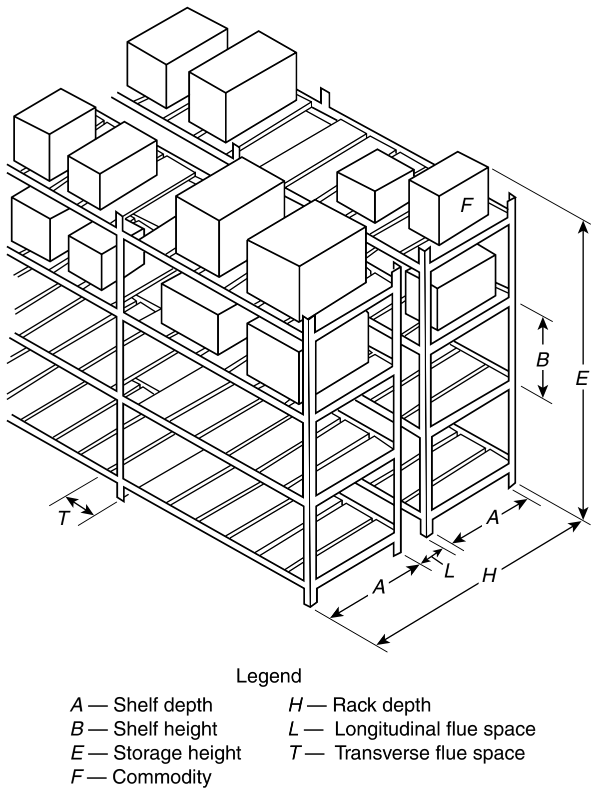


FIGURE A.34.7.3.1(d) *Double-Row Racks with Slatted Shelves.*

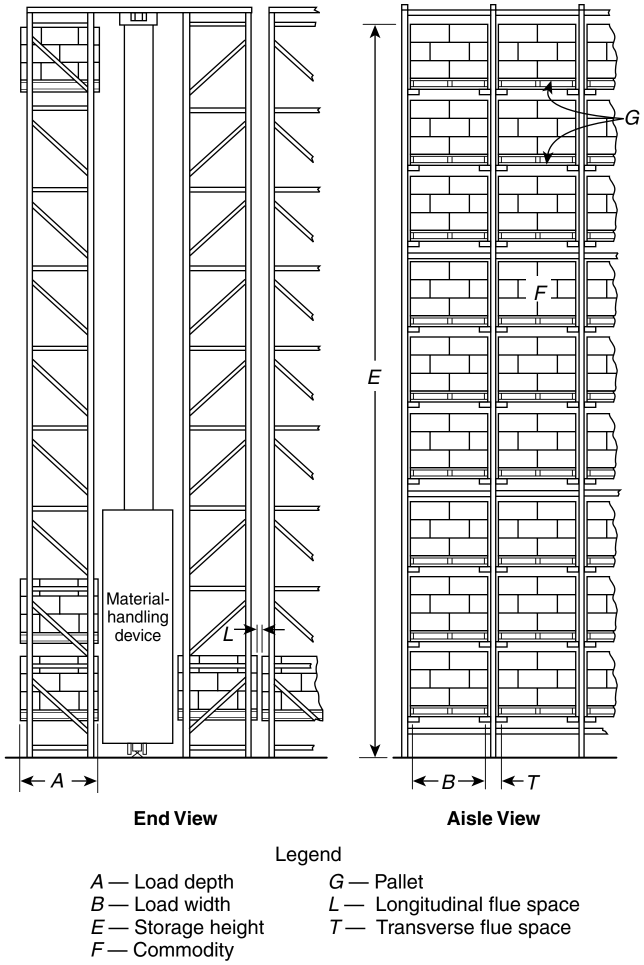


FIGURE A.34.7.3.1(e) *Automatic Storage-Type Rack.*

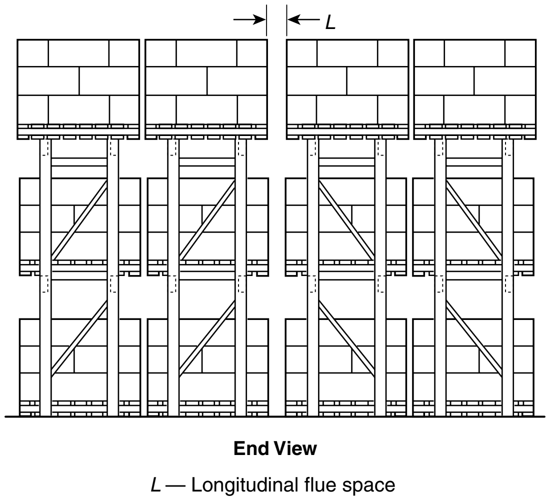


FIGURE A.34.7.3.1(f) *Multiple-Row Rack to be Served by a Reach Truck.*

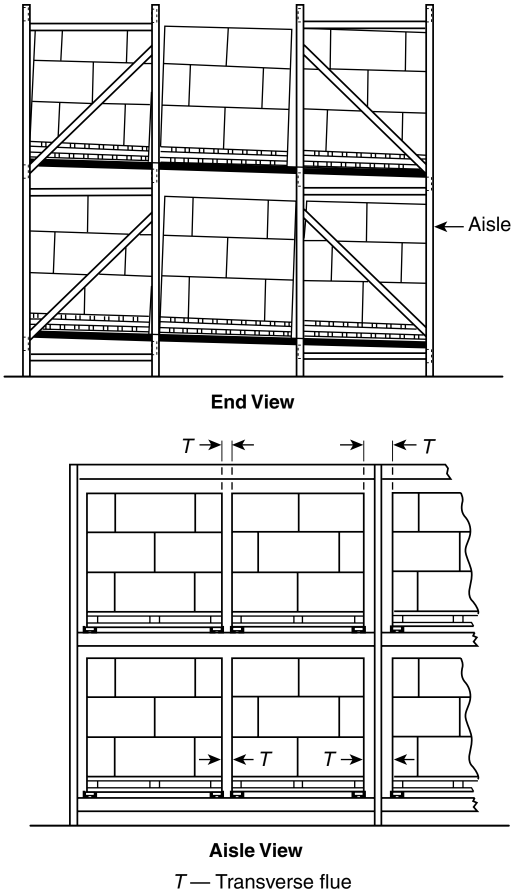


FIGURE A.34.7.3.1(g) Flow-Through Pallet Rack.

are either loaded or unloaded, then moved across the aisle to abut other racks. *[See Figure A.34.7.3.1(k).]*

(5) Solid shelving, which are conventional pallet racks with plywood shelves on the shelf beams *[see Figure A.34.7.3.1(c) and Figure A.34.7.3.1(d)]*. These are used in special cases.

(6) Cantilever rack, in which the load is supported on arms that extend horizontally from columns. The load can rest on the arms or on the shelves supported by the arms. *[See Figure A.34.7.3.1(l).]*

Load depth in conventional or automatic racks should be considered a nominal 4 ft (1.22 m). *[See Figure A.34.7.3.1(b).]*

34.7.3.2* Rack Loading. Racks shall not be loaded beyond their design capacity.

A.34.7.3.2 Fixed rack structures should be designed to facilitate removal or repair of damaged sections without resorting to flame cutting or welding in the storage area. Where sprinklers are to be installed in racks, rack design should anticipate the additional clearances necessary to facilitate installation of sprinklers. The rack structure should be anchored to prevent damage to sprinkler lines and supply piping in racks.

Rack structures should be designed for seismic conditions in areas where seismic resistance of building structure is required.

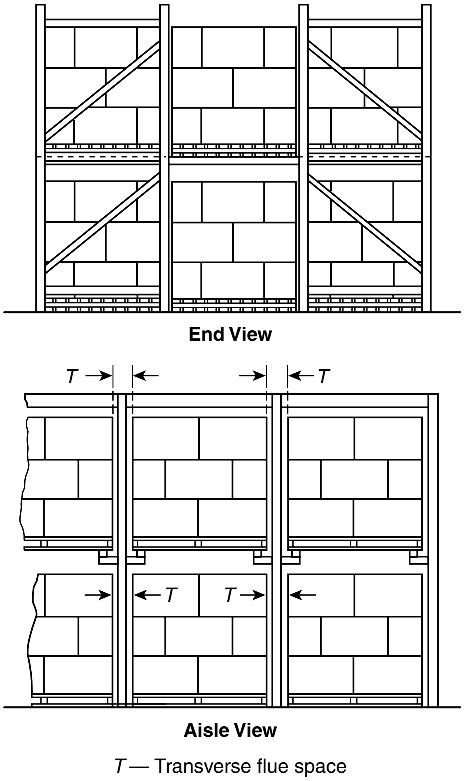


FIGURE A.34.7.3.1(h) Drive-In Rack — Two or More Pallets Deep (Fork Truck Drives into the Rack to Deposit and Withdraw Loads in the Depth of the Rack).

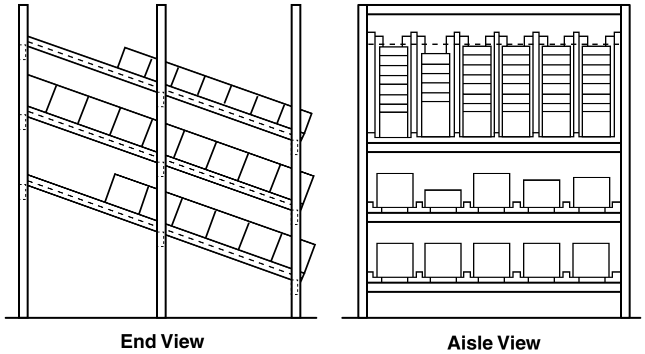


FIGURE A.34.7.3.1(i) Flow-Through Rack.

34.7.3.3* Aisle Widths.

A.34.7.3.3 Storage in aisles can render protection ineffective and should be discouraged.

Aisles must be kept free of product. If product is allowed to be stored in the aisle, a fire could spread easily from one rack to another and overtax the sprinkler system.

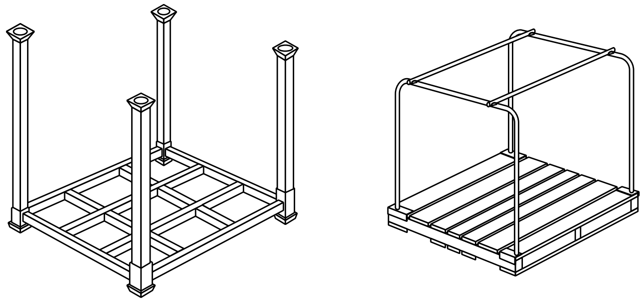


FIGURE A.34.7.3.1(j) Portable Racks.

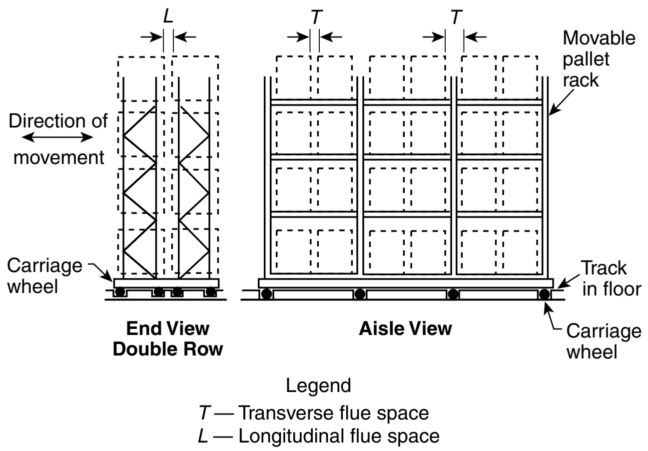


FIGURE A.34.7.3.1(k) Movable Rack.

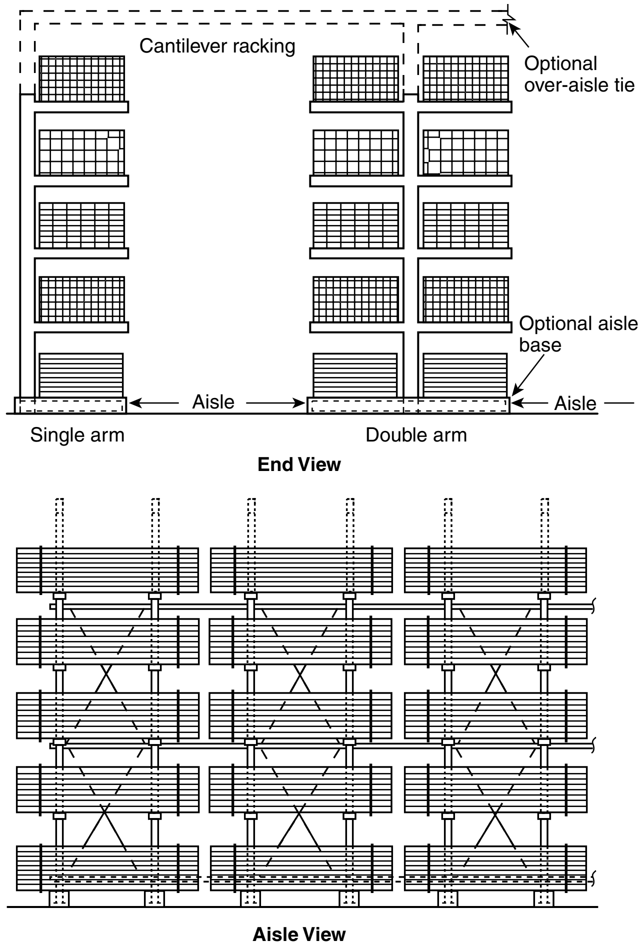


FIGURE A.34.7.3.1(l) Cantilever Rack.

34.7.3.3.1 Aisle widths and depth of racks shall be determined by material-handling methods.

34.7.3.3.2 The width of aisles shall be considered in the design of the protection system.

Aisle spaces between stored materials permit water from the ceiling sprinklers to reach the fire and restrict its spread from one rack to another. Wider aisles give greater benefits to the effectiveness of the fire protection system. In addition, aisles provide access for fire-fighting and salvage operations. Aisle widths are also a key factor in determining whether the rack arrangement is single, double, or multiple rows.

34.7.3.3.3* Aisle widths shall be maintained by either fixed rack structures or control in placement of portable racks.

A.34.7.3.3.3 See Chapter 12 of NFPA 13.

For rack storage up to 25 ft (7.6 m) high, aisle widths significantly impact sprinkler system requirements. NFPA 13 provides sprinkler criteria for single- and double-row racks with 4 ft (1.2 m) and 8 ft (2.4 m) aisles. Racks incorporating 4 ft (1.2 m) aisles require greater sprinkler protection than those using 8 ft (2.4 m) aisles. Aisles wider than 8 ft (2.4 m) provide no more benefit than do 8 ft (2.4 m) wide aisles, and, therefore, no reduction in sprinkler criteria is required. If aisles are less than 3½ ft (1 m) in width, then the rack arrangement is considered multiple row. Multiple-row racks demand a more powerful sprinkler system than double-row racks. The narrow aisles increase the likelihood of a fire spreading from rack to rack by jumping the aisle.

34.7.3.3.4 Any decrease in aisle width shall require a review of the adequacy of the protection system.

34.7.3.4 General Fire Protection.

34.7.3.4.1 High-Expansion Foam.

34.7.3.4.1.1* Where high-expansion foam systems are installed, they shall be automatic in operation and shall be in accordance with NFPA 11, except when modified by 34.7.3.4.

A.34.7.3.4.1.1 Detection systems, concentrate pumps, generators, and other system components essential to the operation of the system should have an approved standby power source.

34.7.3.4.1.2 When high-expansion foam systems are used in combination with ceiling sprinklers, in-rack sprinklers shall not be required.

While automatic high-expansion foam extinguishing systems can be an independent means of fire suppression, a reluctance persists in the industry for using them as the sole means of automatic fire control. They are expensive, are complicated (relative to sprinkler systems), require more maintenance and testing, do not protect the roof structure until foam reaches that level, involve the entire contents of a protected area regardless of the fire's size, and present the problem of foam residue removal after discharge.

Such extinguishing systems have found acceptance as a partner to automatic sprinklers for certain high-challenge storage occupancies, such as those storing rubber tires, roll paper, exposed plastics, and pallets. The sprinklers are needed to help maintain the structural integrity of the building columns and roof structure by keeping them relatively cool while foam covers the fire. Note that sprinkler discharge breaks down the foam, a fact that needs to be taken into account when the system is being designed. Very few tests have been conducted using high-expansion foam in conjunction with sprinkler protection.

34.7.3.4.1.3 Detectors shall be listed and shall be installed in one of the following configurations:

(1) At one-half listed linear spacing [e.g., 15 ft × 15 ft (4.6 m × 4.6 m) rather than 30 ft × 30 ft (9.1 m × 9.1 m)] when the following conditions exist:
  (a) Detectors are installed at the ceiling only.
  (b) The clearance from the top of storage does not exceed 10 ft (3 m).
  (c) The height of storage does not exceed 25 ft (7.6 m).
(2) At the ceiling at listed spacing and on racks at alternate levels
(3) Where listed for rack storage installation and installed in accordance with ceiling detector listing to provide response within 1 minute after ignition using an ignition source equivalent to that used in a rack storage testing program

Quick detection of a fire in a warehouse protected by high-expansion foam is essential. The foam requires a period of time to cover the burning stock. The faster the foam is discharged onto the fire, the less damage that will occur. Reducing the detector spacing at the ceiling by one-half of what is typically required helps ensure faster response of the foam system.

34.7.3.4.2 High-Expansion Foam Submergence.

34.7.3.4.2.1 The following requirements shall apply to storage of Class I, Class II, Class III, and Class IV commodities, as classified in Section 34.2, up to and including 25 ft (7.6 m) in height:

(1)* When high-expansion foam systems are used without sprinklers, the submergence time shall be not more than 5 minutes for Class I, Class II, or Class III commodities.
(2) When high-expansion foam systems are used without sprinklers, the submergence time shall be not more than 4 minutes for Class IV commodities.
(3) When high-expansion foam systems are used in combination with ceiling sprinklers, the submergence time shall be not more than 7 minutes for Class I, Class II, or Class III commodities.
(4) When high-expansion foam systems are used in combination with ceiling sprinklers, the submergence time shall be not more than 5 minutes for Class IV commodities.

A.34.7.3.4.2.1(1) Where high-expansion foam is contemplated as the protection media, consideration should be given to possible damage to the commodity from soaking and corrosion. Consideration also should be given to the problems associated with removal of foam after discharge.

34.7.3.4.2.2 The following requirements shall apply to storage of Class I, Class II, Class III, and Class IV commodities stored over 25 ft (7.6 m) high up to and including 35 ft (10.7 m) in height:

(1) Ceiling sprinklers shall be used in combination with the high-expansion foam system.
(2) The submergence time for the high-expansion foam shall be not more than 5 minutes for Class I, Class II, or Class III commodities.
(3) The submergence time for the high-expansion foam shall be not more than 4 minutes for Class IV commodities.

34.8 Protection of Rubber Tires

Rubber tires are defined as pneumatic tires for passenger automobiles, aircraft, light and heavy trucks, trailers, farm equipment, construction equipment (i.e., off-the-road), and buses. This commodity presents its own unique hazards, not only for the different storage arrangements but also for the by-products of burned tires, which include oil. Additionally, because of their structure, tires possess inherent air spaces that provide a sufficient amount of air for combustion. Fires burning on the interior surface of a tire are usually shielded from sprinkler discharge.

34.8.1* Application.

A.34.8.1 Illustrations of some, but not necessarily all, tire storage arrangements are shown in Figure A.34.8.1(a) through Figure A.34.8.1(g).

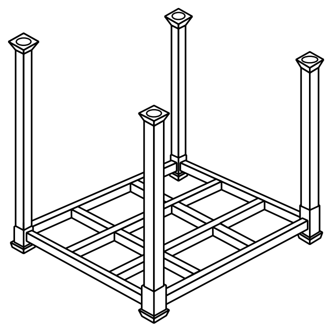


FIGURE A.34.8.1(a) *Typical Open Portable Rack Unit.*

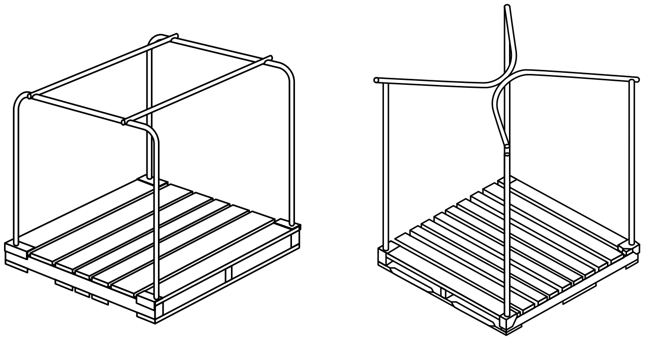


FIGURE A.34.8.1(b) *Typical Palletized Portable Rack Units.*

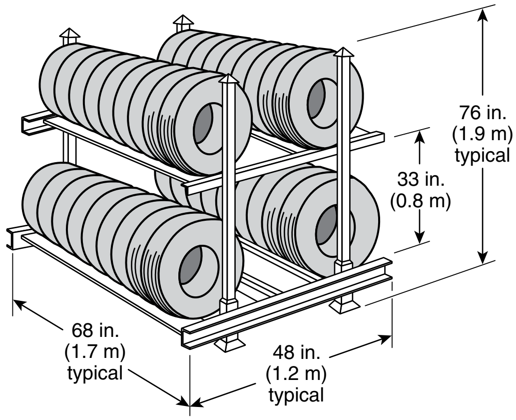


FIGURE A.34.8.1(c) *Open Portable Tire Rack.*

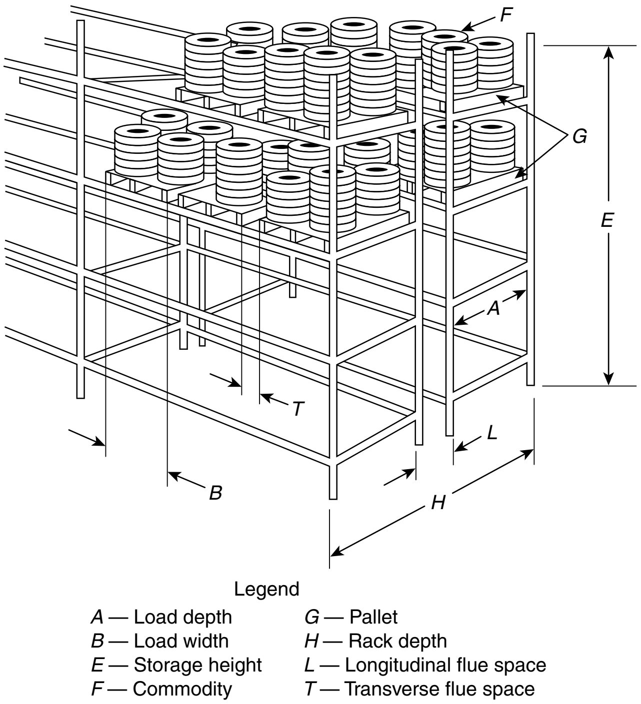


FIGURE A.34.8.1(d) *Double-Row Fixed Rack Tire Storage.*

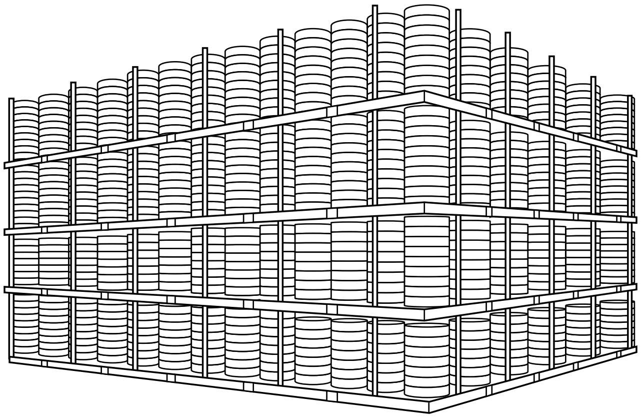


FIGURE A.34.8.1(e) *Palletized Portable Rack On-Side Tire Storage Arrangement (Banded or Unbanded).*

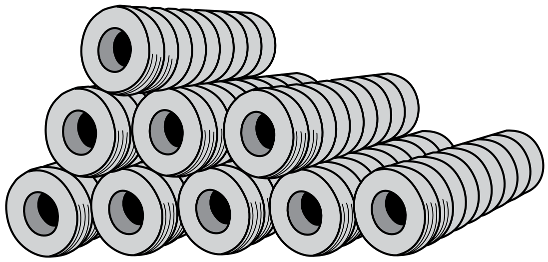


FIGURE A.34.8.1(f) *On-Tread, On-Floor Tire Storage Arrangement (Normally Banded).*

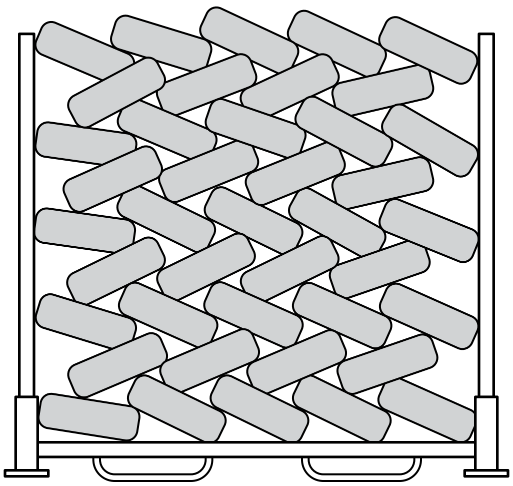


FIGURE A.34.8.1(g) *Typical Laced Tire Storage.*

34.8.1.1 Section 34.8 shall apply to new facilities with indoor storage of usable tires and to existing facilities being converted to the indoor storage of usable tires.

34.8.1.2 Existing buildings storing rubber tires shall be exempted from complying with Section 34.8.

34.8.1.3 This section shall not apply to scrap tire storage.

Scrap tire storage (whether whole or in fragments) is not the same as miscellaneous tire storage. The term *miscellaneous tire storage* is defined in 3.3.258.7. Any indoor storage of scrap tires, however, should be removed from the building daily and disposed of in a safe manner outside the building. The level of fire safety is greatly improved when good housekeeping is practiced. See Chapter 33 for outside storage of tires.

34.8.2 Building Arrangement.

34.8.2.1 Steel Columns. Steel columns shall be protected as follows unless protected in accordance with 16.1.4 of NFPA 13:

(1) For storage exceeding 15 ft to 20 ft (4.6 m to 6 m) in height, columns shall have 1-hour fireproofing.
(2) For storage exceeding 20 ft (6 m) in height, columns shall have 2-hour fireproofing for the entire length of the column, including connections with other structural members.

34.8.2.2 Fire Walls.

34.8.2.2.1 Four-hour fire walls shall be provided between the tire warehouse and tire manufacturing areas.

Δ **34.8.2.2.2** Fire walls shall be designed in accordance with NFPA 221.

34.8.2.3* Travel Distance to Exits. Travel distance to exits shall be in accordance with NFPA *101*.

A.34.8.2.3 NFPA *101* accurately reflects the travel distance requirements as follows:

(1) Tire storage is classified as ordinary hazard.
(2) Tire fires begin burning slowly. In combination with an acceptable automatic sprinkler system, this slower burning allows time for egress.
(3) Tire storage warehouses have a low occupant load.
(4) Large aisle widths [8 ft (2.4 m) minimum] required in 34.8.3.1.4 of this *Code* facilitate egress.

34.8.3 Storage Arrangement.

34.8.3.1 Piling Procedures.

34.8.3.1.1* Piles that are not adjacent to or located along a wall shall be not more than 50 ft (15 m) in width.

A.34.8.3.1.1 Limiting the pile length is not intended. *(See Figure A.34.8.3.1.1.)*

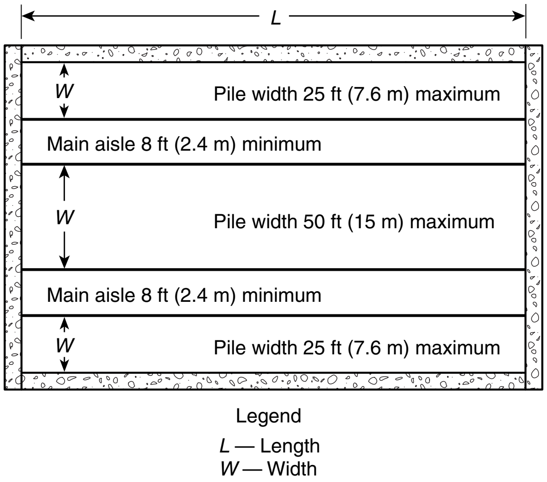


***FIGURE A.34.8.3.1.1** Typical Tire Piling Arrangement.*

34.8.3.1.2 Tires stored adjacent to or along one wall shall not extend more than 25 ft (7.6 m) from the wall.

34.8.3.1.3 Where tires are stored on-tread, the dimension of the pile in the direction of the wheel hole shall be not more than 50 ft (15 m).

34.8.3.1.4 The width of the main aisles between piles shall be not less than 8 ft (2.4 m).

Aisles should separate storage so that piles are not more than 50 ft (15 m) wide. This distance allows effective reach by hose streams. Main aisles and cross-aisles should be located opposite window or door openings in exterior walls. Such location is of particular importance in buildings where few exterior openings exist. Aisle width should be at least 8 ft (2.4 m). Aisle spacing and frequency should be given consideration in an evaluation of the adequacy of existing sprinkler protection and manual fire suppression efforts, including the response capability of the local fire department.

34.8.3.2 Clearances.

34.8.3.2.1 Storage clearance from roof structures shall be not less than 18 in. (470 mm) in all directions.

34.8.3.2.2 A clearance of not less than 24 in. (610 mm) shall be maintained around the path of fire door travel unless a barricade is provided.

34.8.3.2.3 Where protection in accordance with this chapter is provided, stored tires shall be segregated from other combustible storage by aisles not less than 8 ft (2.4 m) wide.

34.9 Protection of Roll Paper

34.9.1 Application. Section 34.9 shall apply to new facilities with indoor storage of roll paper, and to existing facilities being converted to the indoor storage of roll paper, except for the following types of roll paper:

(1) Waxed paper
(2) Synthetic paper
(3) Palletized roll paper storage other than that stored on a single floor pallet or raised floor platform

34.9.2* Building Construction. The protection outlined in Section 34.9 shall apply to buildings with or without fireproofing or other modes of steel protection, unless modified by the requirements of 34.4.2.2.

A.34.9.2 With protection installed in accordance with this *Code*, fire protection of overhead steel and steel columns is not necessary. However, some lightweight beams and joists can distort and necessitate replacement, particularly following fires involving plastic-wrapped rolls stored 20 ft (6.1 m) and higher.

The maximum challenge to sprinkler protection is presented by uninsulated structural steel. Fire spread and development are unusually severe and rapid and can quickly raise exposed building steel to temperatures at which it fails structurally. Steel failure can rupture sprinkler piping and deprive roll paper of fire protection at a time of maximum need.

34.9.3 Storage Arrangement. The floor load design shall take into account the added weight of water that could be absorbed by the commodity during fire-fighting operations.

The most common rolled paper storage arrangement is where the center core is stored vertically, such as the storage arrangement shown in Exhibit 34.12. The fire challenge created by this style of storage is fire spreading up the side of a paper column, which quickly burns through the outer ply; the rolled paper then unwinds and peels away from the rolls. Peeled-away material greatly and quickly increases the burning surfaces. Rolls continually shed outer layers wet by sprinkler discharge, thereby exposing dry paper and fresh fuel for the fire. Peeled material also spreads fire by contact with adjacent paper columns. Methods used to reduce this hazard include tightly banding the rolled paper with metal banding or enclosing the paper rolls with fire retardant–treated, tight paper wrappers. Because rolled paper tends to absorb water from a discharging sprinkler and swell in size, it should be stored with sufficient clearance from walls.

Storing rolls of paper on-side avoids dangerous peeling; they can be nested between the rolls of a lower tier. A fire in this location, which is well shielded from fire-fighting efforts, can involve a large portion of the storage and become quite intense in the vertical flues created between roll ends.

Exhibit 34.12

Rolled paper storage. (Thinkstock)

34.10 Storage of Idle Pallets

34.10.1* General. Idle pallets shall be stored outside or in a separate building designated for pallet storage, unless permitted by 34.10.2.

A.34.10.1 Idle pallet storage introduces a severe fire condition. Stacking idle pallets in piles is the best arrangement of combustibles to promote rapid spread of fire, heat release, and complete combustion. After pallets are used for a short time in warehouses, they dry out and edges become frayed and splintered. In this condition they are subject to easy ignition from a small ignition source. Again, high piling increases considerably both the challenge to sprinklers and the probability of involving a large number of pallets when fire occurs. Therefore storing idle pallets outdoors where possible is preferable. A fire in idle plastic or wooden pallets is one of the greatest challenges to sprinklers. The undersides of the pallets create a dry area on which a fire can grow and expand to other dry or partially wet areas. This process of jumping to other dry, closely located, parallel, combustible surfaces continues until the fire bursts through the top of the stack. Once this happens, very little water is able to reach the base of the fire. The only practical method of stopping a fire in a large concentration of pallets with ceiling sprinklers is by means of prewetting. In high stacks, prewetting cannot be done without abnormally high water supplies. The storage of idle pallets should not be permitted in an unsprinklered warehouse containing other storage.

34.10.2 Indoor Storage. Idle pallets shall be permitted to be stored in a building used for other storage or other purpose if the building is sprinklered in accordance with Section 13.3.

See 34.2.4 for requirements related to the use of plastic pallets.

34.10.3* Outdoor Storage.

A.34.10.3 The practice that some materials are stored on pallets in an open yard is recognized. Since stacks of idle pallets present a severe fire problem, attention needs to be paid to the storage arrangements of the pallets. Manual outside open sprinklers generally are not a reliable means of protection unless property is attended to at all times by plant emergency personnel. Open sprinklers with a deluge valve are preferred.

• *N* **34.10.3.1** The storage of wood and wood composite pallets or listed pallets equivalent to wood at pallet manufacturing and pallet recycling facility sites shall comply with 34.10.4.

N **34.10.3.2** Idle pallets stored outside shall be stored in accordance with Table 34.10.3.2(a) and Table 34.10.3.2(b).

34.10.3.3 Idle pallet stacks shall not exceed 15 ft (4.6 m) in height nor shall cover an area of greater than 400 ft^2 (37 m^2). Pallet stacks shall be arranged to form stable piles. A distance of not less than 8 ft (2.4 m) shall separate stacks. Piles shall be no closer than 8 ft (2.4 m) to any property line.

N **34.10.4 Outside Storage at Pallet Manufacturing and Pallet Recycling Facilities.**

N **34.10.4.1*** The outside storage of wood and wood composite pallets or listed pallets equivalent to wood on the same site as a pallet manufacturing or pallet recycling facility shall comply with 34.10.4.

N **A.34.10.4.1** Pallets staged outdoors at pallet manufacturing and recycling facilities should not be defined as idle (i.e., not active or not in use) considering that these facilities stage work-in-process pallets in an active management environment according to the following:

(1) Pallets are the primary business activity at these manufacturing and recycling facilities.
(2) Pallet inventories are organized in a specific manner based on size and quality.
(3) Pallet inventories are rotated on a routine basis.
(4) Personnel are a frequent presence in the staging area during hours of operation.

Combustible pallets listed and labeled to ANSI/FM 4996, *Classification of Pallets and Other Material Handling Products as Equivalent to Wood Pallets,* or to UL 2335, *Standard for Fire Tests of Storage Pallets*, should be treated as wood pallets.

Subsection 34.10.4, which is new for the 2018 edition of the *Code*, addresses the outside storage of wood and wood composite pallets and those listed pallets equivalent to wood, specifically at pallet manufacturing and pallet recycling facilities. It is not the intent of this subsection that it apply to pallets that are not wood or not a listed equivalent.

UL 2335 and ANSI/FM 4996 are large-scale calorimeter tests. Listed plastic pallets are available that exhibit fire performance

***TABLE 34.10.3.2(a)** Required Clearance Between Outside Idle Pallet Storage and Other Yard Storage*

Pile Size	Minimum Distance ft	Minimum Distance m
Under 50 pallets	20	6
50–200 pallets	30	9
Over 200 pallets	50	15

***TABLE 34.10.3.2(b)** Required Clearance Between Outside Idle Pallet Storage and Building*

	Minimum Distance of Wall from Storage					
	Under 50 Pallets		50 to 200 Pallets		Over 200 Pallets	
Wall Construction	ft	m	ft	m	ft	m
Masonry with no openings	0	0	0	0	15	4.6
Masonry with wired glass in openings, outside sprinklers, and 1-hour doors	0	0	10	3	20	6
Masonry with wired or plain glass, outside sprinklers, and ¾-hour doors	10	3	20	6	30	9
Wood or metal with outside sprinklers	10	3	20	6	30	9
Wood, metal, or other	20	6	30	9	50	15

similar to that of wood pallets in these tests and can be treated as equivalent to wood pallets for commodity classification (see Exhibit 34.9).

Outdoor pallet storage areas for manufacturing and recyclers of pallets are treated differently from the storage of idle pallets currently in the *Code* because pallets at those facilities are not idle, nor are they managed in a manner like idle pallets. Pallet manufacturers and recyclers have intimate knowledge of their pallet inventory, because it is considered an asset. The storage areas are fluid environments in which pallets are being moved and replaced on a daily basis.

The outdoor storage area of pallet manufacturing and recycling facilities is an active management environment. Personnel are a constant presence within the storage area so that fire hazards can be identified and reported, and immediate corrective action can occur. Storage yards are organized by pallet type and into recycle streams for high operational efficiency and are kept sufficiently free of waste and debris, and perimeters are well maintained. The intent of the new requirement in 34.10.4 is to reduce the likelihood of fire at pallet manufacturing and recycling facilities through best practices. In the event that a fire does occur, measures are described that will mitigate the spread of fire to adjoining structures and properties through the establishment of pallet pile spacing between buildings and property lines.

N **34.10.4.2** Each site shall maintain a current site plan. The site plan shall be submitted to the authority having jurisdiction for review and approval and shall include all of the following:

(1) Lot lines
(2) Utilities
(3) Size, location, and type of construction of the buildings on the property
(4) Presence of fire protection systems
(5) Water supply sources for fire-fighting purposes
(6) Locations of hazardous material storage areas
(7) Location of pallet storage
(8) Equipment protected with a dust collection system
(9) Fire department access routes
(10) Designated smoking areas
(11) Locations of fire alarm control panels

N **34.10.4.3** The owner or designated representative shall submit a fire prevention plan for review and approval by the authority having jurisdiction that includes all of the following:

(1) Frequency of walk-through inspections to verify compliance with the approved fire prevention plan
(2) Hot work permit process in accordance with Chapter 41
(3) Preventive maintenance program for equipment associated with the pallet activities
(4) Inspection, testing, and maintenance of fire protection systems in accordance with Chapter 13
(5) Frequency of walk-through inspections to verify pallet stack height, area, and setbacks are in compliance with 34.10.4

N **34.10.4.4** The owner or designated representative shall prepare and train employees in an approved emergency action plan in accordance with Section 10.8.

N **34.10.4.5** The owner or designated representative shall prepare a security management plan based on a security risk assessment and shall make the plan and assessment available to the AHJ upon request.

N **34.10.4.6** Unless permitted by 34.10.4.11, stacks of pallets shall not be stored within 0.75 times the stack height or 8 ft (2.4 m), whichever is greater, of any property line.

N **34.10.4.7** Unless permitted by 34.10.4.11, stacks of pallets shall not be stored within 0.75 times the stack height of any important building on site.

N **34.10.4.8** Pallet stacks shall not exceed 20 ft (6 m) in height.

Example 1

A facility has pallet stacks that are the maximum 20 ft (6 m) in height.

Paragraph 34.10.4.6 would limit the stacks from being located within 16 ft (4.9 m) of any property line:

$$20 \text{ ft } (6 \text{ m}) \times 0.75 = 16 \text{ ft } (4.9 \text{ m})$$

Paragraph 34.10.4.7 would limit the stacks from being located within 16 ft (4.9 m) from any important building on site:

$$20 \text{ ft } (6 \text{ m}) \times 0.75 = 16 \text{ ft } (4.9 \text{ m})$$

Example 2

A facility has pallet stacks that are 9 ft (2.7 m) in height.

Per 34.10.4.6, the stacks cannot be stored within 8 ft (2.4 m) of any property line.

9 ft (2.7 m) × 0.75 = 6.75 ft (2.06 m), but 34.10.4.6 permits 0.75 times the stack height or 8 ft (2.4 m), whichever is greater.

Per 34.10.4.7, the stacks cannot be stored within 8 ft (2.4 m) of any important building on site.

9 ft (2.7 m) × 0.75 = 6.75 ft (2.06 m), but 34.10.4.6 permits 0.75 times the stack height or 8 ft (2.4 m), whichever is greater.

The term *important building* is defined in 3.3.29.7 as "a building that is considered not expendable in any exposure fire."

N **34.10.4.9*** The size of pallet arrays shall comply with one of the following:

(1) Where the access to the pallet array is less than 20 ft (6 m) in width but at least 8 ft (2.4 m) in width, the nearest edge of any individual pallet stack shall be no more than 30 ft (9 m) from the access.
(2) Where the access to the pallet array is by a fire department access route complying with Section 18.2, the nearest edge of any individual pallet stack shall be no more than 50 ft (15 m) from the access.
(3) The individual pallet stack depth from access within pallet arrays at existing facilities that exceed 34.10.4.9(1) or 34.10.4.9(2) shall be as approved by the AHJ.

N **A.34.10.4.9** The access to the individual pallet stacks within a pallet array is based upon water stream reach. The 30 ft (9 m) depth in 34.10.4.9(1) using an 8 ft (2.4 m) wide aisle is based upon hand hose line stream reach. The 50 ft (15 m) depth in 34.10.4.9(2) is based upon master stream reach whether from a deck gun mounted upon an engine or from an aerial device.

The arrangement can be in any configuration as long the measurement to the individual pallet stack within the pallet array meets 34.10.4.9(1) or 34.10.4.9(2). The configuration can be with 8 ft or 50 ft (2.4 m or 15 m) aisle on one side, an 8 ft or 50 ft (2.4 m or 15 m) aisles on both sides, or a combination of aisle widths.

Paragraph 34.10.4.9 controls the depth of a pallet array based upon effective fire stream discharge. Where the discharge may be from hand lines or surface master stream devices, the depth of the individual pallet stack within the pallet array is restricted by requiring that no pallet be more than 30 ft (9 m) from the access provided to the pallet arrays. Where the discharge may be by engine-mounted or aerial master stream devices, the depth of the pallet array is restricted such that no pallet is more than 50 ft (15 m) from the fire department access route complying with Section 18.2 [20 ft (6 m) in width].

Exhibit 34.13 shows an aerial view of wood pallet storage governed by 34.10.4. The stacks are arranged to provide adequate fire department access in accordance with 34.10.4.9. The stacks would be limited to a height of not more than 20 ft (6 m) in accordance with 34.10.4.8.

Exhibit 34.13

Wood pallet storage arrays. (© 2016 Google)

N **34.10.4.10*** Fire flow requirements for the site shall be determined by the AHJ.

N **A.34.10.4.10** The required fire flow should be based on available water supplies, fire department response capabilities, and exposure hazards.

N **34.10.4.11** Portable fire extinguishers shall be selected, installed, and maintained in accordance with Section 13.6.

N **34.10.4.12** The AHJ shall be permitted to allow pallet stacks closer to a property line or structure on site where additional fire protection is provided, including, but not limited to, the following:

(1) The storage yard areas and materials-handling equipment selection, design, and arrangement are based upon an approved risk assessment.
(2) Automatic fire detection transmits an alarm signal to a supervising station in accordance with *NFPA 72*.
(3) Fire department access roads are provided around all storage areas.

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UL 2335, *Standard for Fire Tests of Storage Pallets*, 2010, Underwriters Laboratories Inc., Northbrook, IL.

UL Project No. 01NK20682, R18834, *Commodity Hazard Comparison Testing of HDPE Plastic Pallets Beneath Class 2 Commodity to Standard Class 3 and 41/2 Commodity,* Underwriters Laboratories Inc., Northbrook, IL.

UL Project No. 01NK31019, NC4354, *Plastic Pallet Fire Products Collector Testing,* Underwriters Laboratories Inc., Northbrook, IL.

Animal Housing Facilities

35

N 35.1 General

General. Animal housing facilities shall comply with NFPA 150 and this chapter.

N 35.2 Permits

Permits, where required, shall comply with Section 1.12.

Chapter 35 is new to the 2018 edition of the *Code* and mandates compliance with NFPA 150, *Standard on Fire and Life Safety in Animal Housing Facilities*. The edition of NFPA 150 referenced by this *Code* is the 2016 edition. NFPA 150 provides the minimum requirements for the design, construction, fire protection, and classification of animal housing facilities. Animal housing facilities are to be designed, constructed, and maintained in accordance with the adopted building, fire, and life safety codes in addition to the provisions of NFPA 150. In addition, NFPA 150 also addresses the protection of the animal handlers (life safety) who work within animal housing facilities.

Reference Cited in Commentary

NFPA 150, *Standard on Fire and Life Safety in Animal Housing Facilities,* 2016 edition.

Telecommunication Facilities and Information Technology Equipment

36

Chapter 36 provides mandatory references to NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*, and NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities,* recognizing the unique hazards posed by, and risks to, such facilities from fire. Neither NFPA 75 nor NFPA 76 is intended to be applied retroactively to existing facilities (i.e., facilities constructed prior to the adoption date of this *Code* by the jurisdiction) unless specifically indicated by the applicable reference standard.

36.1 General

Δ **36.1.1** Telecommunication facilities shall comply with NFPA 76.

NFPA 76 is not intended to be applied to telecommunications rooms used to provide private telecommunications services. The facilities intended to be regulated by NFPA 76 are referred to by NFPA *101*®, *Life Safety Code*®, and *NFPA 5000*®, *Building Construction and Safety Code*®, as telephone exchanges.

Δ **36.1.2** Information technology equipment and information technology equipment areas shall comply with NFPA 75.

NFPA 75 defines the term *ITE [information technology equipment] system* as "any electronic digital or analog computer, along with all peripheral, support, memory, programming, or other directly associated equipment, records, storage, and activities." The application of NFPA 75 is based on the risk considerations outlined in Chapter 4 of that standard. The mere presence of information technology equipment should not constitute the need to invoke the requirements of NFPA 75.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*, 2017 edition.

NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities,* 2016 edition.

NFPA *101*®, *Life Safety Code*®, 2018 edition.

NFPA 5000®, *Building Construction and Safety Code*®, 2018 edition.

Fixed Guideway Transit and Passenger Rail Systems

37

Chapter 37 provides a mandatory reference to NFPA 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems*. NFPA 130 addresses life safety from fire and fire protection requirements for underground, surface, and elevated fixed guideway transit and passenger rail systems, including, but not limited to, stations, trainways, emergency ventilation systems, vehicles, emergency procedures, communications, and control systems. A subway station, such as the one pictured in Exhibit 37.1, would be regulated by NFPA 130.

Exhibit 37.1

Subway station. (Thinkstock)

Δ 37.1 General

Fixed guideway transit and passenger rail system facilities shall comply with NFPA 130.

NFPA 130 applies to new fixed guideway transit and passenger rail systems and to extensions of existing systems. The portion of the standard dealing with emergency procedures applies to new and existing systems.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems*, 2017 edition.

Marijuana Growing, Processing, or Extraction Facilities

38

Chapter 38 is new to the 2018 edition of the *Code*. It was developed in response to a request from jurisdictions that are seeing an increase in facilities processing marijuana, either growing, harvesting, or extracting tetrahydrocannabinol (THC) oils from the plant to use in other marijuana based products. Over the past few years, the number of states that recognize the legal use of marijuana, on either a medicinal or a recreational level, has increased. As a result, more facilities, either newly constructed or moving into existing buildings, are being used for marijuana production. Prior to Chapter 38, no NFPA code or standard addressed the hazards specific to marijuana production facilities. This new chapter addresses the hazards unique to these types of facilities and processes while also recognizing other necessary fire protection measures addressed elsewhere in the *Code*. It is not intended to create a new occupancy; rather, it highlights those requirements necessary for fire inspectors to help ensure the safety of building occupants, property protection, and fire fighter safety where the growing or processing or marijuana occurs.

The September/October 2016 issue of NFPA Journal featured a lead article on the commercial marijuana industry and the fire and life safety lessons learned by industry experts in the field. The article and other features provide expert insight into an unlikely industry and their need for standardization. This article should be referenced for additional information along with the commentary contained in this Chapter.

N 38.1* Application

N **A.38.1** Processing of other agricultural products not addressed by this chapter should comply with other applicable sections of this *Code*.

N **38.1.1*** Chapter 38 shall apply to the growing and processing of marijuana within new and existing buildings.

N **A.38.1.1** For the purposes of this *Code*, the term *marijuana* includes all forms of cannabis, including hemp.

N **38.1.2** The use, storage, transfilling, and handling of hazardous materials shall comply with this chapter, and other applicable provisions of this *Code*.

Hazardous materials are used throughout the production of marijuana, mainly during the extraction of THC. Chapter 38 does not regulate the storage, use, and handling of these hazardous materials but references the other chapters of the *Code* that contain requirements for these materials. Requirements for hazardous materials include limitations on the maximum allowable quantities (MAQs), protection of areas using excessive quantities of hazardous materials, separation of areas using hazardous material, and safe practices for those materials in use. See Chapters 60 through 75 for additional details as necessary.

N **38.1.3** Chapter 38 shall not apply to the retail sale of marijuana where growing and processing does not occur.

N **38.1.4** Where a material, its use, or associated process poses multiple hazards, all hazards shall be addressed in accordance with applicable requirements of this *Code*.

N **38.1.5*** The occupancy of buildings or portions of buildings where the growing or processing of marijuana occurs shall be in accordance with Chapter 6 and the applicable building code.

N **A.38.1.5** Occupancy classification should take into consideration the hazards associated with the process occurring in the facility and the quantities of high-hazard contents.

Marijuana growing, processing, and extraction facilities are not a separate occupancy classification. The occupancy classification of the facility should be based on the occupancy definitions found in Chapter 6 of this Code and the applicable building code. Depending on the facility, likely occupancy classifications for marijuana growing, processing, and extraction facilities are industrial or storage occupancies. A facility that does not grow, process, or use marijuana in an extraction process but does sell marijuana and associated products should not utilize the provisions of this chapter, which do not apply to the retail sale of marijuana. An occupancy used for the display and sale of merchandise is defined as a mercantile occupancy. See Chapter 6 for additional details on occupancy classification.

N 38.2 Permits

Permits, where required, shall comply with Section 1.12.

N 38.3 Fire Protection Systems

Fire protection systems shall be provided in accordance with Chapter 13.

N 38.4* Means of Egress

Means of egress shall be in accordance with Chapter 14.

N **A.38.4** Due to security of growing and processing operations, access control, electromagnetic locks, and other locking arrangements are used. Chapter 14 addresses the installation of specialized locking devices.

Marijuana growing facilities, in particular, can be crowded because much of the space is occupied by plants. Growing facilities can be very large and are set up with various rooms or partitioned areas of plants sorted by their stage in the grow cycle. It can be easy for the plants to overtake the designated egress facilities or for a grow setup to block or obstruct access to exits. One of the more common egress issues with grow facilities is obstruction of egress or lack of signage to identify the egress paths. Compliance with Chapter 14 of this *Code* ensures that egress is continuously maintained free of obstructions or impediments to full instant use in the case of fire or other emergency and also that appropriate signage is provided to guide both occupants and fire fighters to the required exits. Like other industrial-type facilities, egress capacity is generally not a concern since occupant load is relatively low and most of the space is occupied by plants or equipment. See Chapter 14 for additional requirements for means of egress.

N 38.5 Growing or Production of Marijuana

N **38.5.1 Ventilation for Light Fixtures.** Light fixture ductwork shall be installed in accordance with the manufacturer and NFPA 90A.

Exhibit 38.1 shows the sophisticated arrangement of light fixtures in a marijuana growing facility. Marijuana plants are grown in a controlled environment and rely heavily on special grow lights for the most efficient growth and for healthy plants. The grow lights, as well as other equipment such as heating, ventilating, and air-conditioning (HVAC) units for climate control can place a high demand on electrical systems. Light fixture ductwork must be installed in accordance with the manufacturer's instructions as well as the provisions of NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*. For additional requirements for electrical fire safety, including wiring, fixtures and equipment, see Section 11.1 of this *Code*.

Exhibit 38.1

Complex arrangement of light fixtures in marijuana growing area.

N **38.5.2 Odor Control.** The use of ozone generators used for odor control shall comply with Chapter 54.

N **38.5.3 Interior Finish, Contents, and Furnishings.**

N **38.5.3.1** Interior finish, including the use of any plastic, mylar, or other thin film sheeting to enclose rooms or cover any walls or ceilings shall be in accordance with Sections 12.5 and 12.6.

N **38.5.3.2** Hanging of plastic from ceiling or from suspended overhead structures to create wall dividers shall not be permitted.

N **38.5.4 Fumigation.**

N **38.5.4.1* General.** Any marijuana growing facility that is fumigated shall comply with 38.5.4.

N **A.38.5.4.1** Fumigation for marijuana growing, processing, or extraction facility includes the production or use of sulfur dioxide.

The quality and integrity of the marijuana plants are critical to the success of the product. An infestation of insects or invasion from mold or fungi could result in millions of dollars lost. Fumigants often are used during the grow process to control invasive pests and plant diseases. Some fumigants may be flammable and some can be toxic or poisonous, which can be dangerous to both occupants and fire fighters. A common fumigation method is the use of sulfur burners to control mildew. Sulfur burners create sulfur dioxide, which can be harmful to respiratory systems.

Subsection 38.5.4 addresses issues with fumigation such as reduction or elimination of ignition sources, notification of the local authority having jurisdiction (AHJ) or fire department when fumigation occurs, warning signage, watch personnel, occupancy during the fumigation process, and clean up.

N **38.5.4.2* Sources of Ignition.** Sources of ignition shall be shut off during the fumigation activity and remain shut off until the required ventilation is completed.

N **A.38.5.4.2** Fires, open flames, and similar sources of ignition should be eliminated from the space under fumigation or insecticidal fogging. Electricity in any part of the building, structure, or space where operation of switches or electrical devices, equipment, or systems could serve as a source of ignition should be shut off. In addition, electronic devices, including portable equipment and cellular phones, should be shut off and telephone lines should be disconnected from telephones.

N **38.5.4.3 Notification.**

N **38.5.4.3.1** The AHJ and fire department shall be notified in writing not less than 48 hours before the building, structure, or space is to be closed in connection with the utilization of any toxic or flammable fumigant.

N **38.5.4.3.2** Notification, as required by 38.5.4.3.1, shall include the following:

(1) The location of the enclosed space to be fumigated or fogged
(2) The occupancy
(3) The fumigants or insecticides to be utilized
(4) The person or persons responsible for the operation
(5) The date and time at which the operation will begin

N **38.5.4.3.3** Written notice of any fumigation or insecticidal fogging operation shall be given to all affected occupants of the building, structure, or space in which such operations are to be conducted with sufficient advance notice to allow the occupants to evacuate the building, structure, or space.

N **38.5.4.3.4** Written notice, as required by 38.5.4.3.3, shall inform the occupants as to the purposes, anticipated duration, and hazards associated with the fumigation or insecticidal fogging operation.

N **38.5.4.4 Signage.**

N **38.5.4.4.1** Approved warning signs indicating the danger, type of chemical involved, and necessary precautions shall be posted on all doors and entrances to the premises, including interior rooms and areas.

N **38.5.4.4.2** Signage shall be located at the exterior main entry and at the entries to those areas being fumigated indicating the duration of the fumigation.

N **38.5.4.5 Watch Personnel.**

N **38.5.4.5.1** During the period fumigation is in progress a watchperson shall remain on duty at the entrance or entrances to the enclosed fumigated space until after the fumigation is completed and the building, structure, or space is properly ventilated and safe for occupancy.

N **38.5.4.5.2** Sufficient watchpersons shall be provided to prevent any person from entering the enclosed space under fumigation unobserved.

N **38.5.4.6 Occupancy During Fumigation.** Occupants of the building, structure, or space to be fumigated, except the personnel conducting the fumigation, shall be evacuated from such building, structure, or space prior to commencing fumigation operations.

N **38.5.4.7 Sealing of Building Structure, or Space.** Paper, and other similar materials, used to wrap or cover a building, structure, or space in excess of that required for the sealing of cracks, casements, and similar openings shall meet the flame propagation performance criteria of Test Method 1 or Test Method 2 of NFPA 701.

N **38.5.4.8 Maintenance of Openings.** All openings to the building, structure, or space to be fumigated or fogged shall be kept securely closed during such operation.

N **38.5.4.9 Venting and Cleanup.** At the end of the exposure period the following procedures shall be followed:

(1) Fumigators shall safely and properly ventilate the premises and contents.
(2) Fumigant containers, residues, debris, and other materials used for such fumigation shall be properly disposed.
(3) Obstructions shall be cleared from gas-fired appliance vents.

N **38.5.5 Pesticide Application.**

N **38.5.5.1** A warning sign shall be provided to indicate that pesticides have been applied.

Pesticides, like fumigants, are used to prevent an infestation from insects or other organisms that could cause damage to and risk loss of the marijuana crop.

N **38.5.5.2** A record of pesticide application shall be provided and shall include the following:

(1) The pesticide product or chemical used
(2) The date and time the pesticide was applied
(3) When the room or area is safe to reoccupy

N 38.6* Processing or Extraction

N **A.38.6** Flammable or combustible liquids, flammable gases, liquefied petroleum gases, or nonflammable gases used in extraction processing of oils and fats are hereinafter referred to as “solvents.”

The extraction process includes extracting the oils and fats by use of a solvent, desolventizing the raw material and producing the miscella, distilling the solvent from the miscella, and recovering the solvent.

Another phase in marijuana cultivation and production is extraction. During the extraction process, THC is separated from the plant and processed into an oil that can be used in products. Extraction of the THC-based oils from the plants utilizes specialty equipment and solvents. One of the biggest hazards during the extraction process is the use of flammable/combustible liquids, liquefied petroleum gases, and carbon dioxide (CO_2).

Section 38.6 addresses general requirements for extraction, including the construction and protection of the extraction room, staffing of extraction areas and equipment, equipment operator training, signage, and equipment.

N **38.6.1 General.**

N **38.6.1.1 Extraction Room.**

N **38.6.1.1.1** Extraction rooms in a marijuana extraction facility shall be constructed in accordance with the building code and this *Code*.

N **38.6.1.1.2*** For other than CO_2 and nonhazardous extraction process, the marijuana extraction equipment and process shall be located in a room of noncombustible construction dedicated to the extraction process and the room shall not be used for any other purpose.

N **A.38.6.1.1.2** The dedicated room should not be used for any other purpose, including storage. Materials that might interfere with the operation of exhaust systems should be prohibited, such as acoustical ceiling tiles.

The requirement to locate the extraction equipment and the process area in a room of noncombustible construction helps to isolate the hazards associated with the process and provide a separation between the extraction process and the remainder of the building should an emergency occur during extraction.

N **38.6.1.1.3** Marijuana extraction shall not be located in any building containing assembly, educational, day care, health care, ambulatory health care, residential board and care, residential, or detention and correctional facilities.

N **38.6.1.1.4* Means of Egress.** For extraction rooms using hazardous materials, each room shall be provided with at least one exit access door complying with the following:

(1) The door shall swing in the direction of egress travel.
(2) The door shall be provided with a self-closing or automatic closing device.
(3) The door shall be equipped with panic or fire exit hardware.

N **A.38.6.1.1.4** Examples of rooms using hazardous materials for extraction are those using flammable and combustible liquids and CO_2.

When an emergency occurs where hazardous materials are being used, there is little time for egress. The requirements in 38.6.1.1.4(1) through (3) ensure that personnel who are in the extraction room are not held up by attempting to operate an egress door. Doors that swing in the direction of egress travel and are equipped with panic or fire exit hardware require only the force of an occupant(s) to release the latch and open the door. The presence of self-closing or automatic closing devices ensures that the door will close on its own and protect the opening to the extraction room.

N **38.6.1.2 Staffing.**

N **38.6.1.2.1*** For other than approved, unattended processes, the extraction process shall be continuously staffed.

N **A.38.6.1.2.1** Nonhazardous processes might not warrant constant attendance by trained personnel.

The marijuana extraction process is a specialized process utilizing equipment designed specifically for that process. Because a majority of the THC extraction process involves the use of flammable and combustible liquids and gases, it is critical that the process be continuously staffed to monitor for any safety issues, leaks, system malfunctions, or incidents requiring immediate response or reporting.

N **38.6.1.2.2*** Staff monitoring the extraction process shall be trained in the following:

(1) The extraction process
(2)* The transfer of solvents, where applicable

N **A.38.6.1.2.2(2)** The transfer of solvent includes LPG liquid transfilling.

(3) All emergency procedures

N **A.38.6.1.2.2** Staff monitoring the extraction process do not need to meet the training requirements of 38.6.1.3.

N **38.6.1.2.3** All staff training records shall be maintained on-site and made available to the AHJ upon request.

N **38.6.1.3 Operator Training.**

N **38.6.1.3.1** In addition to the provisions of 38.6.1.2, the operator of the marijuana extraction equipment shall also receive training in safe operation of the equipment.

N **38.6.1.3.2*** Documentation of training required by 38.6.1.3.1 shall be maintained on-site and made available to the AHJ upon request.

N **A.38.6.1.3.2** Examples of these programs include, but are not limited to, the following:

(1) Training programs developed by extraction equipment manufacturers
(2) Compressed Gas Association CGA P-1, *Safe Handling of Compressed Gases in Containers*, for operators of CO_2 equipment
(3) Programs by governmental organizations

N **38.6.1.4 Signage.**

N **38.6.1.4.1** All applicable safety data sheets (SDS) shall be posted in the extraction room.

Exhibit 38.2 shows the material safety data sheets available posted in the extraction facility.

N **38.6.1.4.2** The NFPA 704 hazard rating diamond sign and no smoking signs shall be posted on the exterior of the extraction room door.

Exhibit 38.2

Safety data sheets posted in extraction area.

N **38.6.1.4.3** Applicable hazard warning signage shall be posted throughout the facility as applicable for emergency equipment.

N **38.6.1.5 Systems, Equipment, and Processes.**

N **38.6.1.5.1 General.**

N **38.6.1.5.1.1** Systems, equipment, and processes shall be in accordance with 38.6.1.5.1 through 38.6.1.5.6.3.

N **38.6.1.5.1.2** Systems, equipment, and processes shall include, but are not limited to, vessels, chambers, containers, cylinders, tanks, piping, tubing, valves, fittings, and pumps.

N **38.6.1.5.1.3** In addition to the requirements in 38.6.1.5, systems, equipment, and processes shall also comply with 60.5.1.6, other applicable provisions of this *Code*, the building code, and NFPA 90A.

N **38.6.1.5.1.4** Systems or equipment used for the extraction of marijuana/cannabis oils and products from plant material shall be performed using equipment that has been listed or approved.

N **38.6.1.5.2 Equipment.**

N **38.6.1.5.2.1** Where an explosion condition exists, heating equipment such as vacuum ovens, heating mantels, heat guns, or other equipment shall not be used to heat flammable or combustible liquids or oils containing liquefied petroleum gasses.

N **38.6.1.5.2.2** Refrigerators, freezers, and other cooling equipment used to store or cool flammable liquids shall be listed for the storage of flammable/combustible liquids or be listed for Class I, Division 1 locations, as described in Article 501 of *NFPA 70*.

N **38.6.1.5.2.3*** LPG tanks shall comply with 69.2.1.

N **A.38.6.1.5.2.3** The provisions for container (i.e., tank) construction are applicable to the working tank or the supply tank that is connected to the extraction equipment.

N **38.6.1.5.3 Approval for Systems and Equipment with No Listing.**

N **38.6.1.5.3.1** Where the system used for extraction of marijuana oils and products from plant material is not listed, the system shall have a designer of record.

N **38.6.1.5.3.2** The designer of record shall be a registered design professional.

N **38.6.1.5.4* Documentation for Equipment with No Listing.** For systems and equipment not listed for the specific use, a technical report in accordance with Section 1.15 documenting the design or peer review of the equipment shall be prepared and submitted to the AHJ for review and approval.

N **A.38.6.1.5.4** The technical report documenting the design or peer review should be submitted for review and approval to the AHJ prior to the equipment being located or installed at the facility.

Where a technical report is required to be submitted for review and approval by the AHJ, the following should occur:

(1) Prior to submittal of the technical report, the engineer should submit to the AHJ any educational background and professional experience specific to the review and approval of system, equipment, and processes with like hazards of those associated with the marijuana extraction system.
(2) Once the proof of qualifications are found acceptable by the AHJ, the engineer of record should produce the technical report and the report should be signed and sealed in accordance with respective state requirements.

All of, but not limited to, the following items should be included in the technical report:

(1) Manufacturer information.
(2) Engineer of record information.
(3) Date of review and report revision history
(4) Signature page, which should include the following:
    (a) Author of the report
    (b) Date of report
    (c) Seal, date, and signature of engineer of record performing the design or peer review
    (d) Date and signature of the engineer performing the engineering check of the report (which cannot be performed by the authoring engineer though it can be from the same firm as the authoring engineer)
(5) Model number of the item evaluated. If the equipment is provided with a serial number, the serial number should be included for verification at time of site inspection.
(6) Methodology of the design or peer review process used to determine minimum safety requirements. Methodology should consider the basis of design, and should include a code analysis and code path to demonstrate the reason as to why specific code or standards are applicable or not.
(7) Equipment description. A list of all components and subassemblies of the system or equipment, indicating the materials, solvent compatibility, maximum temperature, and pressure limits.

(8) A general flow schematic or general process flow diagram (PFD) of the process. All primary components of the process equipment should be identified and match the aforementioned list. Operating temperatures, pressures, and solvent state of matter should be identified in each primary step or component. A piping and instrumentation diagram (PID or PI&D) might be provided but is not required.
(9) Analysis of the vessel(s) if pressurized beyond standard atmospheric pressure. Analysis should include purchased and fabricated components.
(10) Structural analysis for the frame system supporting the equipment.
(11) Process safety analysis of the extraction equipment, from the introduction of raw product to the end of the extraction process.
(12) Comprehensive process hazard analysis considering failure modes and points of failure throughout the process. This portion of the review should include review of emergency procedure information provided by the manufacturer of the equipment or process and not that of the facility, building, or room.
(13) Review of the assembly instructions, and operational and maintenance manuals provided by the manufacturer.
(14) Findings and observations of the analysis.
(15) List of references used in the analysis.

If the technical report or manufacturer's literature indicate specific requirements for the location, room, space, or building where the extraction process is to occur, the engineer of record, as approved, should review the construction documents of such location, room, space, or building and provide a report of their findings and observations to the AHJ.

The findings and observations should include the following:

(1) Process safety analysis of the entire process from raw material to finished product.
(2) Comprehensive process hazard analysis considering failure modes and points throughout the process and a review of emergency procedures as related to the equipment or process and the facility.

One of the biggest challenges to fire inspectors with marijuana extraction facilities in their jurisdictions is understanding and evaluating the extraction equipment setup. Paragraph 38.6.1.5.1.4 requires that systems or equipment used for the extraction of marijuana/cannabis oils and products from plant material be performed using equipment that has been listed or approved. However, at this time, no standard for which to list this equipment that is used exclusively for the extraction of THC from marijuana plants exists. Marijuana extraction equipment on the market has not been extensively tested or listed by large-scale testing laboratories. Fire inspectors and AHJs are often faced with enforcing regulations for facilities that may have different types of equipment setups for the extraction process. Because the marijuana production industry is so new, there is a lack of expertise in understanding the equipment to determine if it is safe to use in day-to-day operations. As the industry evolves, it is almost certain that further regulation and standardization will follow. It is the intent of this Chapter 38 of this Code to reference those standards as they become available.

For now, the purpose of 38.6.1.5.3 and 38.6.1.5.4 is to offer detailed requirements to offset the lack of formal listing standards for equipment. Where the system used for extraction of marijuana oils and products from plant material is not listed, the system must have a designer of record who is a registered design professional. A registered design professional (RDP), is defined in the *Code* as an individual who is registered or licensed to practice his or her design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

For systems and equipment not listed for the specific use, a technical report in accordance with Section 1.15 documenting the design or peer review of the equipment shall be prepared and submitted to the AHJ for review and approval. A minimum of the 15 items listed in A.38.6.1.5.4 should be included in the technical report to aid the AHJ in evaluating the equipment design. When developing the provisions for this new chapter, the Technical Committee took very seriously the level of detail offered by A.38.6.1.5.4. Because there is a lack of regulation for extraction equipment, this information is what AHJs will use to make their judgement as to the safety of the extraction equipment. This is an essential piece to enforcing marijuana production regulations and the safety of occupants, the property, and fire fighters.

N **38.6.1.5.5 Change of Extraction Medium.**

N **38.6.1.5.5.1** Where the medium of extraction or solvent is changed from the material indicated in the technical report or as required by the manufacturer, the technical report shall be revised at the cost of the facility owner and submitted for review and approval by the AHJ prior to the use of the equipment with the new medium or solvent.

N **38.6.1.5.5.2** If the original designer of record is not available, then the new designer of record shall comply with 38.6.1.5.3.1.

An example of a change in extraction medium or solvent would be from liquid butane to another flammable or combustible liquid or to CO_2. Because the hazards associated with the new solvent will change, the technical report must be revised to reflect the impact that the new solvent will have on the extraction process and any associated safety requirements

N **38.6.1.5.6 Equipment Field Verification.**

N **38.6.1.5.6.1** Prior to operation of the extraction equipment, the designer of record for the equipment shall inspect the site of the extraction process once equipment has been installed for compliance with the technical report and the building analysis.

N **38.6.1.5.6.2** The designer of record performing the field verification shall provide a report of findings and observations of the site inspection to the AHJ for review and approval prior to the approval of the extraction process.

N **38.6.1.5.6.3** The field inspection report authored by designer of record shall include the serial number of the equipment used in the process and shall confirm the equipment installed is the same model and type of equipment identified in the technical report.

N **38.6.2 Liquified Petroleum Gas (LPG) Extraction.**

The remainder of Chapter 38 addresses the requirements for each specific solvent/extraction medium used in the extraction process. Different solvents present different hazards. This chapter does not attempt to rewrite requirements for hazardous materials that are found elsewhere in the *Code*; rather, it makes references to those requirements and highlights additional provisions that are necessary for the marijuana extraction process.

Extraction facilities are required to comply with 38.6.1 for general provisions as well as the additional requirements set forth in 38.6.2, 38.6.3, or 38.6.4, depending on the solvent being used in the extraction process.

N **38.6.2.1 General.** Marijuana extraction facilities using liquefied petroleum gas solvents shall comply with 38.6.1 and 38.6.2.

Butane is one of the most common solvents used to extract THC oils from the marijuana plants. It is used in its liquid form. While butane is one of the most common solvents used in the extraction process, it is also the cause of many residential incidents in which inexperienced consumers have used butane improperly, leading to explosions and even fatalities. Other hydrocarbons such as propane and hexane are also used.

N **38.6.2.2 Exhaust.**

N **38.6.2.2.1** An approved exhaust system shall be provided for LPG extractions.

N **38.6.2.2.2** The exhaust systems shall be installed and maintained accordance with NFPA 91 or the mechanical code.

N **38.6.2.2.3** All LPG extraction operations, including processes for off-gassing spent plant material and oil retrieval, shall be conducted within a chemical fume hood or enclosure in compliance with NFPA 91 or the mechanical code.

N **38.6.2.3 Electrical.**

N **38.6.2.3.1** All conductive equipment and conductive objects within the exhaust room shall be bonded and grounded with a resistance of less than 1.0 × 106 ohms in accordance with *NFPA 70*.

N **38.6.2.3.2** The area within a hood or enclosure used for LPG extractions shall be classified as a Class I, Division 1 hazardous location in accordance with *NFPA 70*.

Class I locations are those in which flammable gases, flammable liquid–produced vapors, or combustible liquid–produced vapors are or may be present in the air in quantities sufficient to produce explosive or ignitible mixtures. The following definition of a Class I, Division 1 location is from *NFPA 70*®, *National Electrical Code*®, Article 500.5(B)(1):

Class I, Division 1. A Class I, Division 1 location is a location:

(1) In which ignitible concentrations of flammable gases, flammable liquid–produced vapors, or combustible liquid–produced vapors can exist under normal operating conditions, or

(2) In which ignitible concentrations of such flammable gases, flammable liquid–produced vapors, or combustible liquids above their flash points may exist frequently because of repair or maintenance operations or because of leakage, or

(3) In which breakdown or faulty operation of equipment or processes might release ignitible concentrations of flammable gases, flammable liquid–produced vapors, or combustible liquid–produced vapors and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition

N **38.6.2.3.3** Areas adjacent to Class I, Division 1 locations shall be classified in accordance with *NFPA 70*.

N **38.6.2.3.4** All electrical components within the extraction room shall be interlocked with the hazardous exhaust system such that room lighting and other extraction room electrical equipment will only operate when the exhaust system is in operation.

N **38.6.2.3.5** An automatic emergency power system shall be provided for the following items, when installed:

(1) Extraction room lighting
(2) Extraction room ventilation system
(3) Solvent gas detection system

N **38.6.2.4 Extraction Room Gas Detection System.**

N **38.6.2.4.1** An approved continuous gas detection system shall be provided.

A continuous gas detection system provides continuous operation, and the interval between samplings of any point generally does not exceed 30 minutes.

N **38.6.2.4.2*** The gas detection system shall alert the extraction operator in an approved manner at a gas detection threshold no greater than 25 percent of the gas LEL/LFL.

N **A.38.6.2.4.2** The purpose of alerting the extraction operator is to provide notification that the operator is in a flammable environment because the LP gas used is not odorized. This could be in the form of a visual warning, local alarm, or other approved means. However, it is not intended for evacuation or to dispatch the fire department.

N **38.6.2.4.3** Gas detection systems shall be provided with constant noninterlocked power.

N **38.6.2.5 Protection.** An automatic suppression system shall be provided within hoods or enclosures, including ductwork, in accordance with the following:

(1) An automatic water sprinkler system that meets all applicable requirements of NFPA 13
(2) A carbon dioxide extinguishing system that meets all applicable requirements of NFPA 12

(3) A dry chemical extinguishing system that meets all applicable requirements of NFPA 17
(4) A gaseous agent extinguishing system that meets all applicable requirements of NFPA 2001

N **38.6.2.6 Storage.** LPG containers not in use shall not be stored within extraction rooms.

For additional information on the storage of LPG containers, see Section 69.5 of this *Code*.

N **38.6.2.7 Facility Piping Systems.** LPG liquid piping systems shall be in compliance with NFPA 58.

N **38.6.3 Flammable and Combustible Liquid Extraction.**

N **38.6.3.1 General.** Marijuana extraction facilities using flammable and combustible liquid solvents shall comply with 38.6.1 and 38.6.3.

An example of a flammable and combustible liquid used as a solvent for marijuana extraction is alcohol (ethanol).

N **38.6.3.2 Exhaust.**

N **38.6.3.2.1*** Extraction and post oil processing operations, including dispensing of flammable liquids between containers, shall be performed in one of the following locations:

(1) A chemical fume hood in accordance with Chapter 7 of NFPA 45
(2) An approved exhaust system installed in accordance with NFPA 91 or the mechanical code

N **A.38.6.3.2.1** The intent of this section is to require an exhaust system utilization to capture velocities across the work area. Standard laboratory capture velocity is between 80 and 100 ft/min (24 and 30 m/min).

Most flammable liquid extractions and post oil processing are bench-top process that can be conducted in a chemical fume hood. Larger operations might need larger hoods or special full-room exhaust systems in compliance with NFPA 91 or the mechanical code. The exception is intended for small unheated processes where plant material might be soaked in flammable liquid and directly transferred to a food product.

N **38.6.3.2.2** Unheated processes at atmospheric pressure using less than 16 oz (473 ml) of flammable liquids shall not be required to comply with 38.6.3.2.1.

N **38.6.3.2.3** Classified electrical systems shall be in accordance with *NFPA 70*.

N **38.6.3.2.4** All electrical components within the chemical fume hood or exhausted enclosure shall be interlocked such that the exhaust system shall be in operation for lighting and components to be used.

N **38.6.3.3 Storage and Handling.** The storage, use, and handling of flammable liquids shall be in compliance with this chapter and Chapter 66.

N **38.6.3.4** Heating of flammable or combustible liquids over an open flame shall be prohibited.

N **38.6.4 Carbon Dioxide Extraction.**

N **38.6.4.1 General.** Marijuana extraction facilities using carbon dioxide solvents shall comply with 38.6.1 and 38.6.4.

Using CO_2 in the extraction process eliminates the need for a chemical-based solvent. (Generally, the term *solvent* refers to a chemical solvent. For the purposes of the extraction processes discussed in this chapter, CO_2 is considered a solvent.)

N **38.6.4.2 Storage and Handling.** All CO_2 compressed gas cylinders shall be secured to a fixed object to prevent falling.

N **38.6.4.3 CO_2 Gas Detection.**

N **38.6.4.3.1** An approved, listed CO_2 detector shall be installed in the CO_2 extraction room.

N **38.6.4.3.2** Auto calibrating and self-zeroing devices or detectors shall be prohibited.

N **38.6.4.3.3** The detector shall be set to alarm at 5000 ppm of CO_2.

N **38.6.4.4* CO_2 Discharges.** The extraction equipment pressure relief devices and blow-off valves shall be piped to the exterior of the building.

N **A.38.6.4.4** Exhaust piping can be of the flexible type as long as the piping or hose is capable of handling the force of the exhaust. Relief devices include spring-loaded pressure relief valves or rupture disks.

N 38.7* Transfilling

Filling LPG extraction equipment supply containers shall be in compliance with 69.3.5, 69.4.2, and NFPA 58.

N **A.38.7** The intent of this section is for filling the working container (i.e., tank) connected to the extraction equipment.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 70®, *National Electrical Code®*, 2017 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2018 edition.

Roman, J., "Welcome to the Jungle," *NFPA Journal*, Sept/Oct 2016.

39

Reserved

In the 2018 edition of NFPA 1, *Fire Code,* Chapter 39 is reserved for future use.

Dust Explosion and Fire Prevention

40

Chapter 40 applies to environments in which operations involve the potential for dust explosions due to hazardous dust concentrations and refers the code official to a group of NFPA standards that prescribe requirements for protecting life and property from fire and explosion.

The average inspector responsible for code enforcement is more likely than ever to have the opportunity to inspect many of the types of facilities governed by the standards referenced in this chapter. Ensuring proper compliance with the appropriate standard is imperative. Fires in facilities that are subject to dust explosions can develop rapidly. Significant dust explosions can occur when accumulated combustible dust becomes airborne fuel by becoming suspended in air. These factors increase the potential for serious injury or death to both plant employees and fire fighters.

Eight NFPA standards, which are listed in Section 40.1, address the prevention of dust explosions. An additional standard, NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, addresses generic dust collection systems, including ductwork for dust conveying. NFPA 652, *Standard on the Fundamentals of Combustible Dust*, was issued in 2016 and, along with commodity-specific documents, addresses specific hazards, including agricultural dusts, coal, combustible metals, sulfur, chemicals and pharmaceuticals, and wood dusts. The scope and application of each referenced standard are described in the commentary that follows the complete list. This list is intended to assist the user of this handbook in determining the applicability of each standard to a particular type of facility.

NFPA 652 is the fundamental document for combustible dust. It establishes minimum requirements for managing combustible dust hazards. It directs the user to other NFPA standards for industry- and commodity-specific requirements, which are listed below:

- NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*
- NFPA 484, *Standard for Combustible Metals*
- NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*
- NFPA 655, *Standard for the Prevention of Sulfur Fires and Explosions*
- NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*

Chapter 1 of NFPA 652 contains provisions on how to deal with conflicts between NFPA 652 and the industry- and commodity-specific standards. If a requirement in NFPA 652 differs from the requirement in an industry- or commodity-specific standard, either can be used. If the industry- or commodity-specific standard prohibits a requirement in NFPA 652, the prohibition stands. If the industry- or commodity-specific standard neither prohibits nor provides a requirement, the requirement contained in NFPA 652 applies.

Δ 40.1 Application

Equipment, processes, and operations that involve the manufacture, processing, blending, repackaging, or handling of combustible particulate solids or combustible dusts regardless of concentration or particle size shall be installed and maintained in accordance with this chapter.

N **40.1.1** All facilities and operations that manufacture, process, blend, convey, repackage, generate, or handle combustible dusts or combustible particulate solids shall be in compliance with NFPA 652 and, as applicable, NFPA 61, NFPA 69, NFPA 85, NFPA 120, NFPA 484, NFPA 654, NFPA 655, and NFPA 664.

The commentary that follows summarizes the standards listed in Section 40.1.1.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities.* NFPA 61 applies to the following:

1. Facilities that receive, handle, process, dry, blend, use, mill, package, store, or ship dry agricultural bulk materials or their by-products or dusts that include grains, oilseeds, agricultural seeds, legumes, sugar, flour, spices, feeds, dry dairy/food powders, and other related materials
2. Facilities designed for manufacturing and handling starch, including drying, grinding, conveying, processing, packaging, and storage of dry or modified starch and dry products and dusts generated from these processes
3. Seed preparation and meal-handling systems of oilseed processing plants not covered by NFPA 36, *Standard for Solvent Extraction Plants*
4. Facilities covered by NFPA 61, including, but not limited to, the following:
   a. Bakeries
   b. Grain elevators
   c. Feed mills
   d. Flour mills
   e. Corn milling (dry and wet) plants
   f. Rice milling plants
   g. Dry milk processing
   h. Mix plants
   i. Soybean and other oilseed preparation operations
   j. Cereal processing
   k. Snack food processing
   l. Tortilla plants
   m. Chocolate processing
   n. Pet food processing
   o. Cake mix processing
   p. Sugar refining and processing
   q. Seed plants

NFPA 61 does not apply to oilseed extraction plants; such plants are covered by NFPA 36.

Unless otherwise noted within NFPA 61, its provisions are not intended to be applied to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the *Code*, except in those cases where the authority having jurisdiction (AHJ) determines that the existing situation involves a distinct hazard to life or adjacent property.

Significant changes were made to the 2017 edition of NFPA 61 to align its organization and contents with NFPA 652. The purpose of those changes was to make it easier for the user to compare requirements between NFPA 652 and NFPA 61. Dust hazard analyses (DHAs) are now required for agricultural facilities. NFPA 61 requires that a DHA be performed for existing bucket elevators, conveyors, grinding equipment, spray dryer systems, and dust collection systems within five years of the effective date of the standard (i.e., by June 2, 2021). A DHA must be performed for new processes as part of the project. The 2017 edition also adds a chapter on performance-based design as an alternative to the prescriptive requirements contained in the standard.

Additional requirements can be found in 29 CFR, Part 1910.272, "Grain Handling Facilities."

NFPA 69, *Standard on Explosion Prevention Systems.* NFPA 69 applies to the design, installation, operation, maintenance, and testing of systems for the prevention of explosions by means of the following methods:

1. Control of oxidant concentration
2. Control of combustible concentration
3. Predeflagration detection and control of ignition sources
4. Explosion suppression
5. Active isolation
6. Passive isolation
7. Deflagration pressure containment
8. Passive explosion suppression

In general, explosion prevention systems are used to protect processing operations, storage, and materials-handling equipment.

NFPA 69 provides minimum requirements for installing systems for the prevention of explosions in enclosures that contain flammable concentrations of flammable gases, vapors, mists, dusts, or hybrid mixtures. Basic information is provided for design engineers, operating personnel, and AHJs. The provisions of NFPA 69 are considered necessary for a reasonable level of protection from loss of life and property from fire and explosion. Where techniques to prevent explosion are applied to rooms, buildings, or other enclosures where personnel are present, consideration must be given to life safety.

NFPA 69 does not apply to the following:

1. Devices or systems designed to protect against detonations
2. Design, construction, and installation of deflagration vents that are addressed by NFPA 68, *Standard on Explosion Protection by Deflagration Venting*
3. Protection against overpressure due to phenomena other than internal deflagrations
4. Chemical reactions other than combustion processes
5. Unconfined deflagrations, such as open-air explosions or vapor cloud explosions
6. Rock dusting of coal mines, as covered by 30 CFR, Part 75
7. General use of inert gas for fire extinguishment
8. Preparation of tanks, piping, or other enclosures for hot work, such as cutting and welding, which is covered by NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, and NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*
9. Ovens or furnaces handling flammable or combustible atmospheres, which are covered by NFPA 86, *Standard for Ovens and Furnaces*

10. Marine vapor control systems regulated by 33 CFR, Part 154
11. Marine vessel tanks regulated by 46 CFR, Parts 30, 32, 35, and 39

Unless otherwise noted within NFPA 69, the provisions of the document are not intended to be applied to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard, except in those cases where the AHJ determines that the existing situation involves a distinct hazard to life or adjacent property. NFPA 69 recognizes two classes of techniques for the prevention of explosions. One technique is based on preventing combustion (prevention); the other is based on preventing or limiting damage after combustion occurs (control). However, other methods for preventing combustion are available, including changing the process itself to eliminate combustible material used in, or generated by, the process.

NFPA 85, *Boiler and Combustion Systems Hazards Code.* Chapter 9 of NFPA 85 specifies the requirements for pulverized fuel systems. Pulverized fuel systems begin with the raw fuel bunker, which is located upstream of the pulverizer and is the point at which primary air enters the pulverizing system, and terminate at the point where pressure can be relieved by fuel being burned or collected in a device that is built in accordance with NFPA 85. The pulverized fuel system includes the primary air ducts upstream of the pulverizer and continues to a point where pressure can be relieved by application of a suitable vent or other means.

Chapter 9 of NFPA 85 covers only fuels having a volatile content of 8 percent on a moisture-free basis. Systems with an oxygen content greater than 21 percent are not covered by NFPA 85 and require special attention.

The purpose of Chapter 9 of NFPA 85 is to establish minimum standards for design, installation, operation, maintenance, and personnel safety in connection with pulverized fuel systems; to contribute to operating safety; to minimize the probability of pulverized fuel system explosions; and to minimize the effects of explosions that do occur. The provisions of Chapter 9 of NFPA 85 are considered necessary to provide a reasonable level of protection from loss of life and property from fire and explosion.

Chapter 9 of NFPA 85 applies to new installations and to major alterations or extensions of existing equipment for the preparation and burning of fuel in pulverized form that were contracted for subsequent to the effective date of NFPA 85. NFPA 85 is not retroactive. However, Chapter 9 of NFPA 85 does apply to any retrofit program that involves replacement of the entire pulverized fuel system described in 9.4.1.1 and 9.5.1.1 of NFPA 85. For less than total system replacement, the components must meet the requirements of Chapter 9 of NFPA 85 or the original code or standard of construction for the pulverized fuel system.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines.* NFPA 120 contains minimum requirements for reducing the potential for loss of life and property from fire and explosion in coal preparation plants. Only plants designed to prepare coal for shipment are included in NFPA 120. Other equipment and processes, such as coal pulverizers, that are used to condition coal for firing in boilers at power-generating plants or gasification plants or for utilization in certain special processes are not covered in NFPA 120.

NFPA 120 is not retroactive, but operators are urged to avail themselves of any information that prevents dust dispersions, eliminates sources of ignition, or otherwise reduces fire and explosion hazards by improving conditions in their plants.

Because of the wide range of chemical and structural characteristics of coals, comprehensively rating the spontaneous ignition characteristics of coals is not possible. In general, coals of lower volatility do not ignite readily. Coals of higher sulfur content and higher oxygen content ignite more readily. Experience with a given coal is generally the only way to understand how it should be handled and compacted and how long it can be stored before it begins to heat significantly. As new mines open for mining lower-rank coals in the western United States, the problems of spontaneous ignition and fires in stored coal can be expected to increase.

NFPA 484, *Standard for Combustible Metals.* NFPA 484 was created with the purpose of incorporating six separate combustible metal standards into a single comprehensive combustible metal fire safety document.

The purpose of NFPA 484 is to minimize the occurrence of, and resulting damage from, fire and explosion hazards in areas where combustible metals or metal dusts are produced, processed, finished, handled, stored, and used. Therefore, NFPA 484 provides safety requirements for all combustible metals, including processing, storage, handling, dust collection, housekeeping, and fire protection.

NFPA 484 applies to the production, processing, finishing, handling, storage, and use of all metals and alloys that are in a form capable of combustion or explosion. The standard also applies to operations where metals or metal alloys are subjected to processing or finishing operations that produce combustible powder or dust. Metals and metal alloy parts and those materials, including scrap, that exhibit combustion characteristics of aluminum, lithium, magnesium, niobium, tantalum, titanium, or zirconium are subject to the requirements for the metal whose combustion characteristics they most closely match.

NFPA 484 does not apply to the transportation of metals in any form on public highways and waterways, by air, or by rail. It also does not apply to the primary production of aluminum, magnesium, and lithium metal. NFPA 484 addresses the following topics:

1. Chapter 11 covers the handling, processing, and storage of lithium and other alkali metals; the hazards of lithium were previously addressed by NFPA 485, *Standard for the Storage, Handling, Processing, and Use of Lithium Metal.*
2. Chapter 12 covers facilities where aluminum dusts, pastes, and/or powders are produced or handled, which were previously addressed by NFPA 651, *Standard for the Machining*

and Finishing of Aluminum and the Production and Handling of Aluminum Powders.

3. Chapter 13 covers facilities where magnesium dusts, pastes, and/or powders are handled, which were previously addressed by NFPA 480, *Standard for the Storage, Handling, and Processing of Magnesium Solids and Powders*.
4. Chapter 14 covers the hazards of niobium production and powder handling and storage.
5. Chapter 15 covers the hazards of tantalum production and powder handling and storage.
6. Chapter 16 covers the processing, handling, machining, and fabrication of titanium, which were previously addressed by NFPA 481, *Standard for the Production, Processing, Handling, and Storage of Titanium*.
7. Chapter 17 covers the processing, handling, machining, and fabrication of zirconium, which were previously addressed by NFPA 482, *Standard for the Production, Processing, Handling, and Storage of Zirconium*.
8. Chapter 18 addresses combustible metals not covered by one of the metal-specific chapters.
9. Chapter 19 addresses recycling and waste management facilities

In the United States, regulations for the domestic shipment of dangerous goods, which include combustible metals and metal powders, are issued by the U.S. Department of Transportation, 49 CFR, Parts 100–199, which has specific responsibility for promulgating the regulations. The United Nations, the International Air Transport Association, the International Maritime Organization, and other international agencies regulate international shipments.

See Commentary Table 40.1 for information on specific combustible metals.

Exhibit 40.1 and Exhibit 40.2 show examples of typical configurations of liquid precipitation separators for both fixed and portable dust-producing equipment. Exhibit 40.3 illustrates five

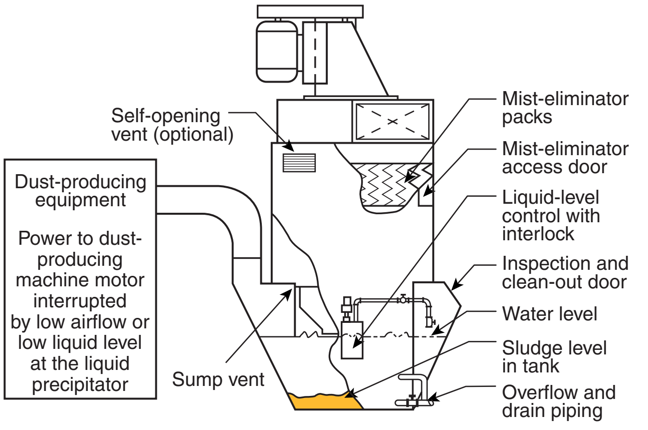
COMMENTARY TABLE 40.1 *Metal Properties — Key Temperatures*

Metal	Melting Point (°C)	Boiling Point (°C)	Solid Metal Ignition (°C)	Max. Adiabatic Flame Temperature* (°C)
Aluminum	660	2452	555	3790
Barium	725	1140	175	—
Boron	2300	2550		3030
Calcium	824	1440	704	—
Chromium	1857	2672		2900
Copper	1085	2567		1250
Hafnium	2223	5399		4580
Iron	1535	3000	930	2220
Lithium	186	1336	180	—
Magnesium	650	1110	623	3340
Manganese	1246	1962		—
Molybdenum	2617	4612		2390
Nickel	1453	2732		2130
Niobium	2468	4927		3270
Plutonium	640	3315	600	—
Potassium	62	760	69	—
Silicon	1410	2355		2970
Sodium	98	880	115	—
Strontium	774	1150	720	1980
Tantalum	2996	5425	—	3490
Thorium	1845	4500	500	—
Titanium	1727	3260	1593	3720
Tungsten	3422	5660		2830
Uranium	1132	3815	3815	—
Zinc	419	907	900	1800
Zirconium	1830	3577	1400	—

Note: °C × 9/5 + 32 = °F

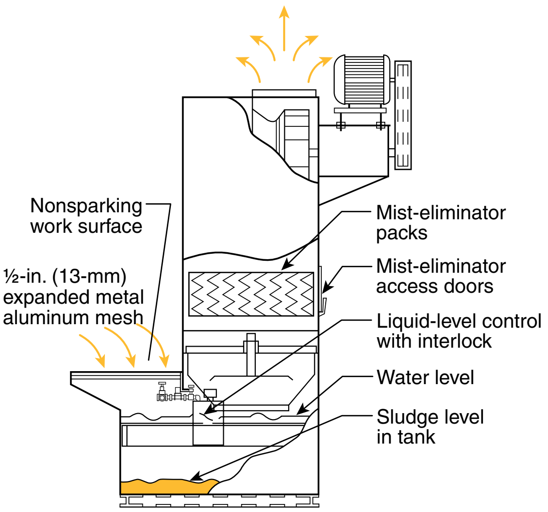
Source: NFPA 484, 2015, Table A.1.1.3(a).

Exhibit 40.1



Typical liquid precipitation collector for fixed dust-producing equipment.

Exhibit 40.2

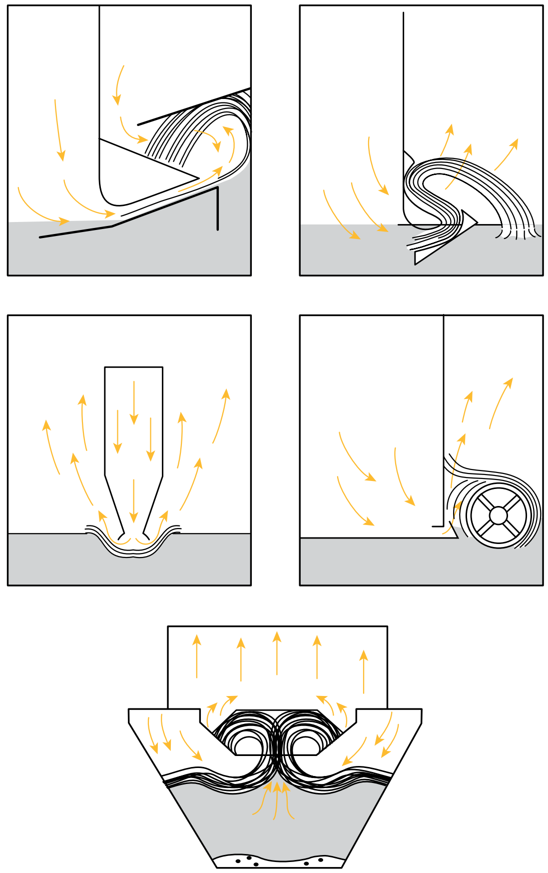


Typical liquid precipitation collector for portable dust-producing equipment.

methods of precipitating dust for solving dust problems involving aluminum and tantalum dust.

NFPA 654, Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids. NFPA 654 contains a unified approach for protecting facilities handling most combustible particulate solids. NFPA 654 applies to all phases of the manufacturing, processing, blending, conveying, repackaging, and handling of combustible particulate solids or hybrid mixtures, regardless of concentration or particle size, where the materials present a fire or explosion hazard. NFPA 654 prescribes technical requirements for safety to life and property from fire and explosion and for minimizing the resulting damage from a fire or an

Exhibit 40.3



Five methods of precipitating dust in precipitators.

explosion. The standard is used to supplement the requirements established by NFPA 652.

The requirements for pneumatic conveying systems are found throughout NFPA 654. NFPA 91 does not apply to material transfer systems or dust control systems covered by NFPA 654. In addition, 1.4.3 of NFPA 654 states that NFPA 654 does not apply to materials covered by the following documents, unless specifically referenced by the applicable document:

1. NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*
2. NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
3. NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*
4. NFPA 85, *Boiler and Combustion Systems Hazards Code*
5. NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*
6. NFPA 400, *Hazardous Materials Code*
7. NFPA 484, *Standard for Combustible Metals*
8. NFPA 495, *Explosive Materials Code*
9. NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*

10. NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*

11. NFPA 1125, *Code for the Manufacture of Model Rocket and High-Power Rocket Motors*

NFPA 654 applies to facilities on which construction or in which installation was begun subsequent to the effective date of the standard.

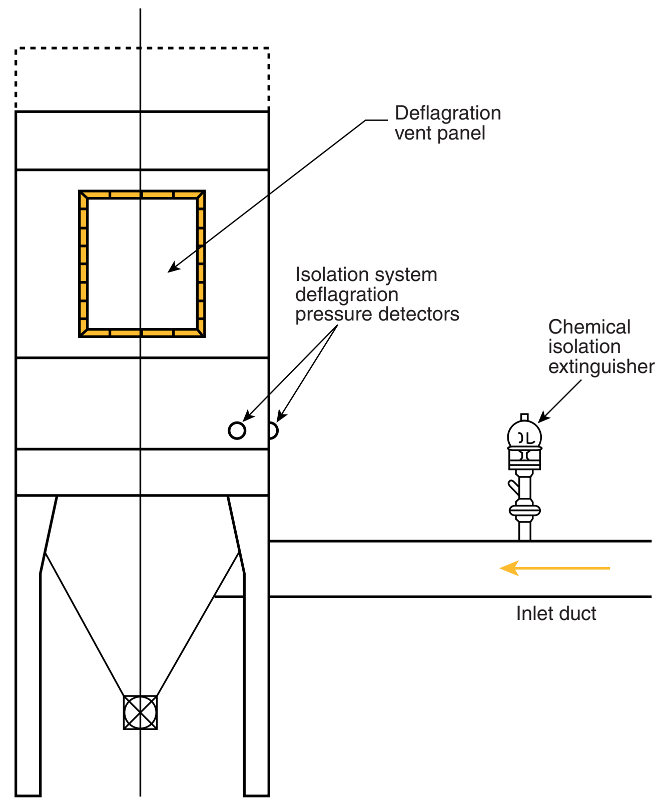
See Exhibit 40.4 through Exhibit 40.10 for examples of dust collectors with fire prevention features installed and illustrated explanations of how the various features function.

NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions.* NFPA 655 applies to the size reduction of sulfur and its handling in any form. NFPA 655 provides requirements to eliminate or reduce the hazards of explosion and fire inherent in the processing and handling of sulfur. The document does not apply to the mining of sulfur, recovery of sulfur from process streams, or transportation of sulfur. NFPA 655 is intended to be used in conjunction with the requirements of NFPA 654; if any conflicts exist between the two documents, the provisions of NFPA 655 apply. NFPA 655 applies to facilities on which construction was begun subsequent to the effective date of the standard.

Sulfur differs from most other combustible materials found in industry in that it has a relatively low melting point and ignition point. The normal handling temperature of liquid sulfur is 250°F to 309°F (121°C to 154°C), which is slightly above the melting point of 246°F (119°C). At the melting point, sulfur is a transparent, mobile liquid. As the temperature of the liquid is raised, it darkens, becoming deep orange in hue. Up to about 320°F (160°C), the viscosity drops with rising temperature. Above this point, the viscosity increases with rising temperature. At 370°F (188°C), the viscosity reaches a tremendously high maximum that practically prevents it from flowing, and the liquid is so intensely colored as to be nearly opaque. Above 370°F (188°C), it again acts in a more normal fashion, with its viscosity falling somewhat as the temperature continues to rise.

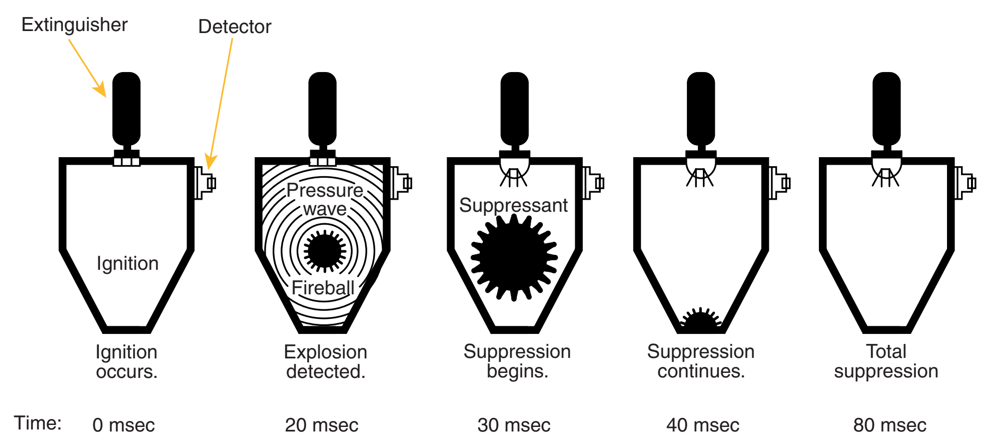
At the normal handling temperature of liquid sulfur [250°F to 309°F (121°C to 154°C)], the vapor concentration above the pure sulfur, free of hydrocarbons or hydrogen sulfide (H_2S), is too low to form a flammable mixture in air. While the flash point of liquid sulfur varies with purity, it is always higher than the normal handling temperature. For pure sulfur, the flash point can

Exhibit 40.4



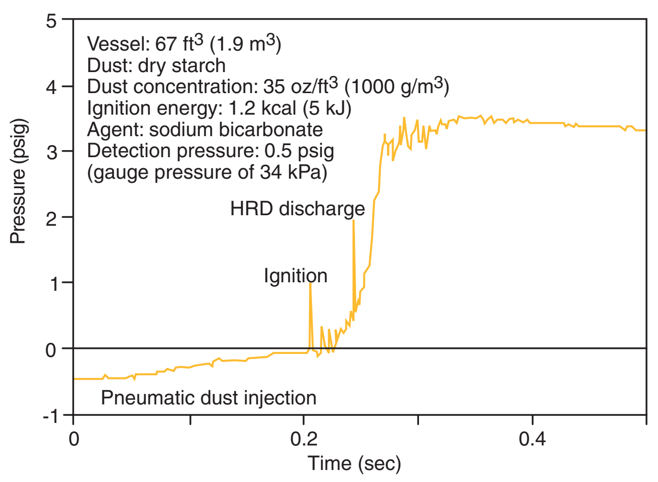
Example of a vented dust collector.

Exhibit 40.5



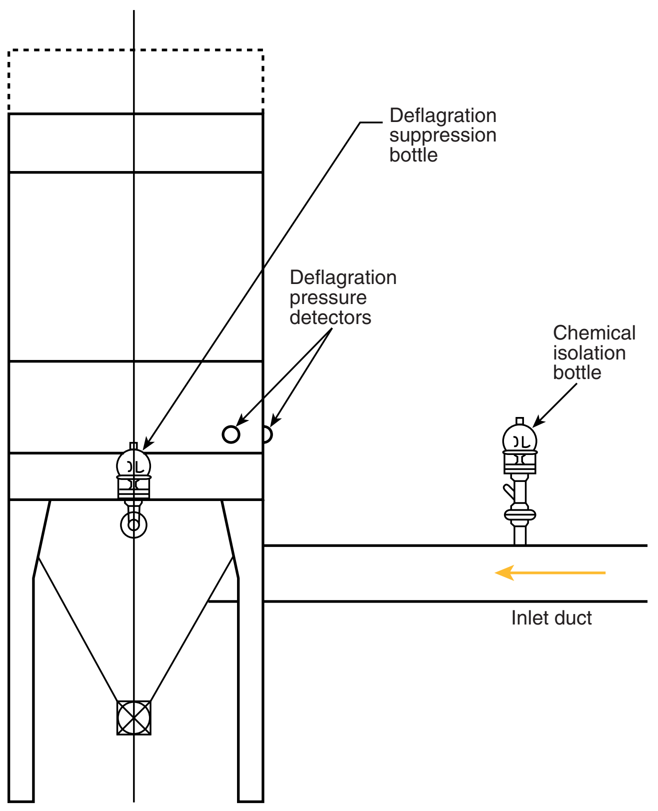
Deflagration suppression sequence of starch in a 35 ft³ (1 m³) vessel.

Exhibit 40.6



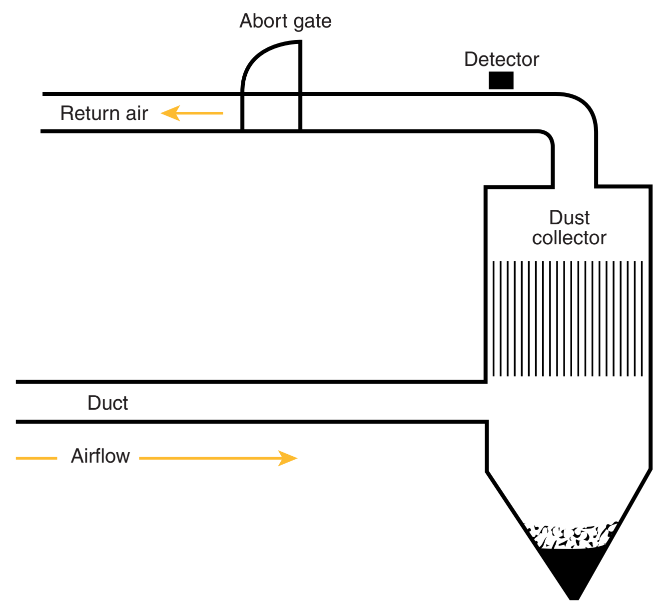
Pressure vs. time: suppressed deflagration.

Exhibit 40.7



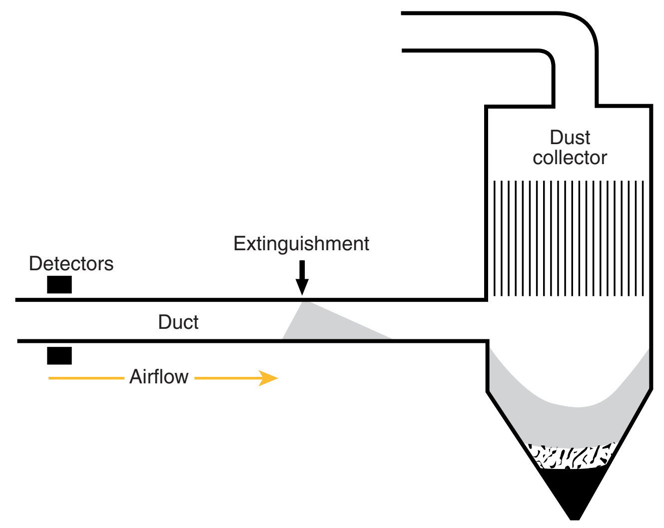
Example of a dust collector suppression system.

Exhibit 40.8



Spark detector and abort gate.

Exhibit 40.9

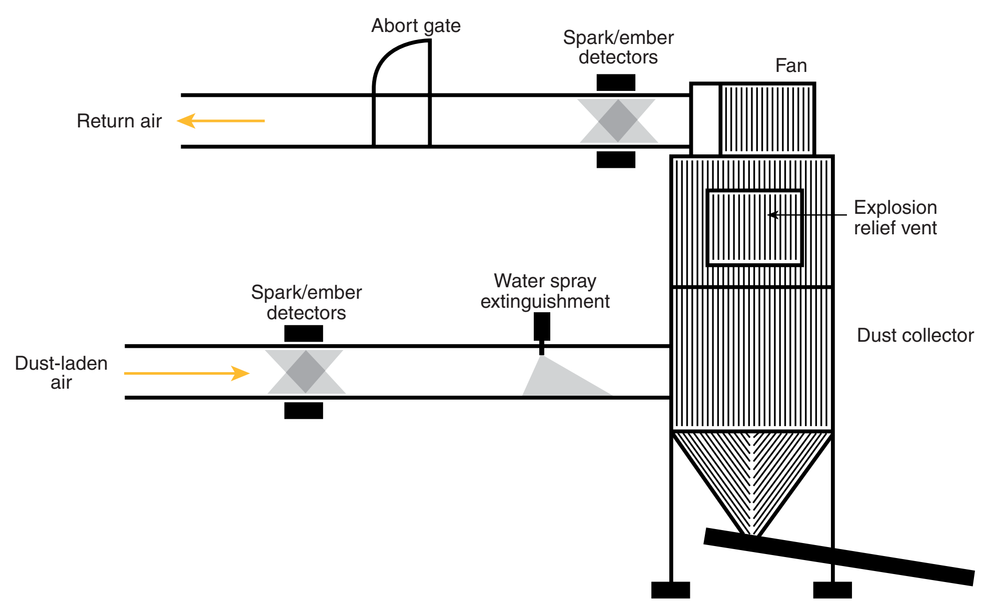


Typical spark detection and extinguishment system.

be as low as 370°F (188°C); for relatively impure crude sulfur, the flash point can be as low as 334°F (168°C).

The relatively low ignition temperature of sulfur and the possible presence of H_2S are the primary fire and explosion hazards of liquid sulfur. Impure sulfur (sometimes referred to as "dark sulfur") contains hydrocarbons, which react slowly with the liquid sulfur to form H_2S. Recovered sulfur, such as that produced from petroleum gas streams containing hydrogen sulfide, using the Claus process, often contains dissolved H_2S, which will be liberated slowly from a quiescent body of liquid sulfur. Agitation of such liquid sulfur causes rapid evolution of H_2S, which can create a flammable atmosphere within the storage tank. In the temperature range at which liquid sulfur is normally handled, the lower flammable limit for H_2S is about 3.4 percent compared to 4.3 percent at room temperature.

Exhibit 40.10



Basic spark detection and extinguishment system for a single air-material separator.

Case Study

On February 7, 2008, a series of sugar dust explosions at the Imperial Sugar Company manufacturing facility in Port Wentworth, Georgia, resulted in 14 worker fatalities. In addition to the 14 fatalities, 36 workers were treated for serious burns and injuries, some of which caused permanent, life altering conditions. The explosions and subsequent fires destroyed the sugar packing buildings, palletizer room, and silos and severely damaged the bulk train car loading area and parts of the sugar refining process areas. The Imperial Sugar manufacturing facility housed a refinery for converting raw cane sugar into granulated sugar. Through a system of conveyors and elevators, the raw sugar was transported from grain silos to sugar processing machines, and the final sugar products were stored in buildings surrounding the silos.

In its investigation report released in September 2009, the U.S. Chemical Safety Board (CSB) found that an initial dust explosion originated in the enclosed steel belt conveyor located below the sugar silos where high concentrations of sugar dust had accumulated inside the enclosure. The initial explosion stirred up sugar dust that had built up on the floors and other surfaces, causing a chain reaction of additional dust explosions through the buildings. Fires resulting from the explosions destroyed the packing buildings, silos, and palletizer building and severely damaged parts of the refinery and sugar loading area.

Many contributing factors to the explosions were identified, including the following:

- Equipment that was not designed or maintained to minimize the release of sugar and sugar dust into the work area
- Inadequate housekeeping practices, which resulted in accumulations of combustible sugar and sugar dust on the floors and other elevated surfaces throughout the packing buildings
- Accumulation of airborne combustible sugar dust above the maximum explosible concentration
- Inadequate evacuation plans

The investigation conducted by the CSB highlighted many safety concerns regarding buildings where dust explosions are a risk and resulted in a list of recommendations to ensure that buildings at risk for dust explosions reduce that risk and even prevent such explosions from occurring. Additional information on the Imperial Sugar Company explosion and fire, as well as the CSB investigation report, in its entirety, can be found online at http://www.csb.gov/investigations/detail.aspx?SID=6.

Exhibit CS40.1

(Courtesy of the U.S. Chemical Safety Board)

Pure sulfur will not generate a flammable atmosphere in the normal temperature range of the liquid. Transfer of liquid sulfur using air pressure should be avoided. If air pressure is applied to the vapor space of an enclosure containing molten sulfur with high concentrations of H_2S, there is a danger that the H_2S–air mixture will become flammable. Transfer by pressure should be restricted to using an inert gas. Use of pumps is the preferred transfer method.

Because impurities can cause generation of H_2S or pyrophoric iron sulfides, testing each incoming batch for carbon content and H_2S should be performed. These impurities should be kept to a minimum.

The finely divided sulfur produced during size reduction is the most hazardous from an explosion standpoint. Also, mixtures containing finely divided elemental sulfur can be just as hazardous if the sulfur is present in sufficient quantity. Some explosion and fire hazards also accompany the handling and processing of sulfur in bulk in coarse sizes due to the fine dust present.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities.* NFPA 664 addresses all the fire hazards associated with wood processing facilities (the occupancy), not just the dust (the commodity). The requirements contained in Chapters 4 though 9 do not apply to woodworking operations that occupy less than 5000 ft^2 (465 m^2) and where the dust producing equipment requires an aggregate dust collection flow rate less than 1500 ft^3/min (2549 m^3/hr). Note that the requirements of Chapters 10 and 11 (Human Element and Housekeeping) apply to all woodworking operations, regardless of size. It is used to supplement the requirements of NFPA 652.

NFPA 664 contains minimum requirements for fire and explosion prevention and protection of industrial, commercial, or institutional facilities that process wood or manufacture wood products using wood or other cellulosic fiber as a substitute for, or additive to, wood fiber; and that process wood, creating wood chips, particles, or dust. Woodworking and wood processing facilities include, but are not limited to, wood flour plants, industrial woodworking plants, furniture plants, plywood plants, composite board plants, lumber mills, and production-type woodworking shops and carpentry shops.

The purpose of NFPA 664 is to provide minimum requirements for the design, operation, and maintenance of woodworking and wood processing facilities for safety to life, property protection, and mission continuity from fire and explosion.

Commentary Table 40.2, which is extracted from NFPA 664, lists commonly used isolation devices; Commentary Table 40.3 outlines minimum testing and maintenance frequency for spark detection and extinguishing systems.

Unless otherwise noted in NFPA 664, the provisions of the standard are not intended to be applied to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the document, except in those cases where the AHJ determines that the existing situation involves a distinct hazard to life or adjacent property.

COMMENTARY TABLE 40.2 *Commonly Used Isolation Devices*

Isolation Device	Application	Limitations
Diversion Devices		
Abort gate	Fire and deflagration	Used on pneumatic conveying ducts. Most practical on positive pressure pneumatic systems (two abort gates needed for negative pressure systems).
Pant leg gate	Fire and deflagration	Used on gravity flow chutes at material transfer points.
Slide gate	Fire only	Used on the bottom of mechanical conveyors that slide material through the conveyor enclosure (e.g., screw and flight conveyors).
Reversing conveyor	Fire only	Used with mechanical conveyors (usually screw conveyors). Not effective with dusty material unless other blocking devices (e.g., rotary feeders) are also used.
Flame front diverter	Deflagration only	Used on pneumatic conveying ducts.
Blocking Devices		
Rotary feeders	Fire and deflagration	Must have metal-tipped vanes with narrow wall gap 0.007 in. (0.18 mm). Rubber-tipped vanes cannot be relied on. Must be stopped to remain effective.
Slide gate	Fire and deflagration	Used to block pneumatic ducts, chutes, and so forth. Usually actuated with high-pressure gas cylinder.
Flame front extinguishers	Deflagration only	Single-shot pressurized chemical extinguishers, typically used on ducts or enclosed conveyors.
Backblast dampers	Deflagration only	Used on pneumatic systems to prevent flow counter to normal flow.
Material chokes	Deflagration only	Normally used on mechanical screw conveyors or at material transfer points.

Note: NFPA 654 also discusses various types of explosion isolation devices.

Source: NFPA 664, 2017, Table A.8.2.4.3.

COMMENTARY TABLE 40.3 *Minimum Testing and Maintenance Frequency for Spark Detection and Extinguishing Systems*

Item	Operation	Weekly	Monthly	Semiannually	Comments
Control panel	Clean	X			Visual inspection of all warning/operational lights.
Emergency power	Test			X	See manufacturer's battery test procedure.
Detector and spray nozzle	Test	X[1]			See manufacturer's detector and spray nozzle test procedure. Remove and inspect strainers.
Detectors/test lights	Maintenance	X[2]			Inspect and clean.
Water lines	Flush		X		Flush for 2 minutes. Remove and inspect strainer.
Booster pump (if provided)	Test		X		See manufacturer's booster pump test procedure.
Freeze protection	Inspect		X		Check at plant winterization and monthly during freezing.
Rapid speed abort gates	Test			X	See manufacturer's test procedure.

[1]See manufacturer's test procedure. Where daily automatic detector response testing is provided by external means (test lights), monthly inspection is acceptable.

[2]The frequency of cleaning should be adjusted, based on the experience at each detector point. Detectors found to be dirty during scheduled cleaning should have their cleaning frequency increased, and those found to be clean can have their cleaning frequency decreased.

Source: NFPA 664, 2017, Table A.9.1.2.

40.2 Permits

Permits, where required, shall comply with Section 1.12.

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A number of permits might be required, depending on the operations to be performed. The principal permit that applies to the hazards covered in Chapter 40, however, is a permit for dust-producing operations. [See Table 1.12.8(a).] The permit is required for the installation, modification, or operation of the following:

1. Dust-producing operations
2. Grain storage or elevators
3. Starch, flour, and feed mills
4. Malt houses
5. Lumberyards and woodworking plants
6. Wood flour manufacturing plants
7. Aluminum, coal, cocoa, magnesium, spice, and sugar facilities, or other facilities that pulverize materials subject to dust explosion
8. Central dust collection systems
9. Equipment that produces significant quantities of a dust that is subject to explosion

N 40.3 Retroactivity

This chapter shall apply to new and existing facilities and processes. [**652:**9.1]

N **40.3.1** Existing facilities shall perform a dust hazards analysis (DHA) in accordance with Chapter 7 of NFPA 652.

NFPA 652 requires that a DHA be performed for new processes as part of the project. For existing processes that are undergoing material modifications, the DHA must also be performed as part of the project. NFPA 652 defines a material modification as modifications or maintenance or repair activities that exceed 25 percent of the original cost.

For existing processes, the 2016 edition of NFPA 652 requires that a DHA be completed within 3 years of the effective date of that standard, which was September 7, 2015. That means that all DHAs must be completed by September 7, 2018.

The 2017 editions of the other industry- and commodity-specific standards (NFPA 61, NFPA 654, and NFPA 664) contain varying timelines for the completion of DHAs. NFPA 654 and NFPA 664 have contained the requirement to perform a hazard analysis since the mid 2000s. Those facilities and processes that were built to more recent editions of NFPA 654 and NFPA 664 should have conducted DHAs. Older facilities would have been grandfathered. Note that NFPA 61 did not require DHAs until the 2017 edition.

The 2017 editions of both NFPA 654 and NFPA 664 have DHA requirements for existing facilities that differ from those of NFPA 652. NFPA 654 has a 5-year deadline from the effective date of the standard, which will be June 2, 2021. NFPA 61 has the same deadline. Because NFPA 664 does not contain any requirements, the timeline defaults to NFPA 652, the deadline of which is September 7, 2018.

N 40.4* General

The procedures and training in this chapter shall be delivered in a language that the participants can understand. [**652:**9.2]

N **A.40.4** See ANSI/AIHA Z10, *Occupational Health and Safety Management Systems.* [**652:**A.9.2]

N 40.5 Operating Procedures and Practices

N **40.5.1*** The owner/operator shall establish written procedures for operating its facility and equipment to prevent or mitigate fires, deflagrations, and explosions from combustible particulate solids. [**652:**9.3.1]

N **A.40.5.1** The operating procedures should address both the normal operating conditions and the safe operating limits. Where possible, the basis for establishing the limits and the consequences of exceeding the limits should also be described. [**652:**A.9.3.1]

The operating procedures should address all aspects of the operation, including the following (as applicable):

(1) Normal startup
(2) Continuous operation
(3) Normal shutdown
(4) Emergency shutdown
(5) Restart after normal or emergency shutdown
(6) Anticipated process upset conditions
(7) System idling
[**652:**A.9.3.1]

For manual operations, the procedures and practices should describe techniques, procedural steps, and equipment that are intended to minimize or eliminate combustible dust hazards. [**652:**A.9.3.1]

Operating procedures and practices should be reviewed on a periodic basis, typically annually, to ensure they are current and accurate. [**652:**A.9.3.1]

N **40.5.2*** The owner/operator shall establish safe work practices to address hazards associated with maintenance and servicing operations. [**652:**9.3.2]

N **A.40.5.2** Safe work practices include, but are not limited to, hot work, confined space entry, and lockout/tagout, and the use of personal protective equipment. *(See NFPA 51B.)* Consideration for extending the duration of the fire watch could be warranted based on characteristics of the material, equipment configuration, and conditions. For example, the PRB Coal Users' Group practice for hot work suggests fire watches could be warranted for 2 to 12 hours following the completion of hot work due to the exothermic chemical reaction of subbituminous coals. In addition to the hazards of combustible dust, safe work practices should address the hazards of mitigation systems such as inerting and suppression. [**652:**A.9.3.2]

N **40.5.2.1** The safe work practices shall apply to employees and contractors. [**652:**9.3.2.1]

N 40.6 Inspection, Testing, and Maintenance

N **40.6.1*** Equipment affecting the prevention, control, and mitigation of combustible dust fires, deflagrations, and explosions shall be inspected and tested in accordance with the applicable NFPA standard and the manufacturers' recommendations. [**652:**9.4.1]

N **A.40.6.1** Process interlocks and protection systems should be inspected, calibrated, and tested in the manner in which they are intended to operate, with written records maintained for review. In this context, "test" implies a nondestructive means of verifying that the system will operate as intended. For active explosion protection systems, this can involve the disconnection of final elements (i.e., suppression discharge devices or fast-acting valve actuators) and the use of a simulated signal to verify the correct operation of the detection and control system. Testing can also include slow-stroke activation of fast acting valves to verify unrestricted travel. Some devices, such as explosion vent panels, suppression discharge devices, and some fast-acting valve actuators, cannot be functionally "tested" in a nondestructive manner, and so only periodic, preventive, and predictive inspection, maintenance, and replacement (if necessary) are applied. [**652:**A.9.4.1]

Inspection and maintenance requirements for explosion vents and other explosion protection systems are found in NFPA 68, and NFPA 69, respectively. [**652:**A.9.4.1]

N **40.6.2** The inspection, testing, and maintenance program shall include the following:

(1) Fire and explosion protection and prevention equipment in accordance with the applicable NFPA standards
(2) Dust control equipment
(3) Housekeeping
(4) Potential ignition sources
(5)* Electrical, process, and mechanical equipment, including process interlocks

N **A.40.6.2(5)** Process interlocks should be calibrated and tested in the manner in which they are intended to operate, with written test records maintained for review by management. Testing frequency should be determined in accordance with the *AIChE Guidelines for Safe Automation of Chemical Processes*. [**654:**A.12.1.2(5)] [**652:**A.9.4.2(5)]

(6) Process changes
(7) Lubrication of bearings
[**652:**9.4.2]

N **40.6.3** The owner/operator shall establish procedures and schedules for maintaining safe operating conditions for its facility and equipment in regard to the prevention, control, and mitigation of combustible dust fires and explosions. [**652:**9.4.3]

N **40.6.4*** Where equipment deficiencies that affect the prevention, control, and mitigation of dust fires, deflagrations, and explosions are identified or become known, the owner/operator shall establish and implement a corrective action plan with an explicit deadline. [**652:**9.4.4]

N **A.40.6.4** Corrective actions should be expedited on high-risk hazards (those that could result in a fatality or serious injury). Where in-kind repairs cannot be promptly implemented, consideration should be given to providing alternate means of protection. [**652:**A.9.4.4]

N **40.6.5*** Inspections and testing activities that affect the prevention, control, and mitigation of dust fires, deflagrations, and explosions shall be documented. [**652:**9.4.5]

N **A.40.6.5** See Section 9.10 for information regarding document retention. [**652:**A.9.4.5]

N **40.6.6** A thorough inspection of the operating area shall take place on an as-needed basis to help ensure that the equipment is in safe operating condition and that proper work practices are being followed. [**652:**9.4.6]

N 40.7 Training and Hazard Awareness

N **40.7.1*** Employees, contractors, temporary workers, and visitors shall be included in a training program according to the potential exposure to combustible dust hazards and the potential risks to which they might be exposed or could cause. [**652:**9.5.1]

N **A.40.7.1** Safety of a process depends on the employees who operate it and the knowledge and understanding they have of the process. It is important to maintain an effective and ongoing training program for all employees involved. Operator response and action to correct adverse conditions, as indicated by instrumentation or other means, are only as good as the frequency and thoroughness of training provided. [**652:**A.9.5.1]

N **40.7.2*** General safety training and hazard awareness training for combustible dusts and solids shall be provided to all affected employees. [**652:**9.5.2]

N **A.40.7.2** All plant personnel, including management; supervisors; and operating, housekeeping, and maintenance personnel should receive general awareness training for combustible dust hazards, commensurate with their job responsibilities, including training on locations where hazards can exist on site, appropriate measures to minimize hazards, and response to emergencies. [**652:**9.5.2]

N **40.7.2.1*** Job-specific training shall ensure that employees are knowledgeable about fire and explosion hazards of combustible dusts and particulate solids in their work environment. [**652:**9.5.2.1]

N **A.40.7.2.1** Safe work habits are developed and do not occur naturally. The training program should provide enough background information regarding the hazards of the materials and the process so that the employees can understand why it is important to follow the prescribed procedures. Training should address the following:

(1) The hazards of their working environment and procedures in case of emergencies, including fires, explosions, and hazardous materials releases
(2) Operating, inspection, testing, and maintenance procedures applicable to their assigned work
(3) Normal process procedures as well as emergency procedures and changes to procedures
(4) Emergency response plans, including safe and proper evacuation of their work area and the permissible methods for fighting incipient fires in their work area
(5) The necessity for proper functioning of related fire and explosion protection systems
(6) Safe handling, use, storage, and disposal of hazardous materials used in the employees' work areas
(7) The location and operation of fire protection equipment, manual pull stations and alarms, emergency phones, first-aid supplies, and safety equipment
(8) Equipment operation, safe startup and shutdown, and response to upset conditions

[**652:**9.5.2.1]

N **40.7.2.2** Employees shall be trained before taking responsibility for a task. [**652:**9.5.2.2]

N **40.7.2.3*** Where explosion protection systems are installed, training of affected personnel shall include the operations and potential hazards presented by such systems. [**652:**9.5.2.3]

N **A.40.7.2.3** The extent of this training should be based on the level of interaction the person is expected to have with the system. For example, operators need to be aware of the hazards presented by explosion suppression systems but might not need to know how to operate the suppression system (e.g., interfacing with the system control panel or locking out devices).

Maintenance personnel, on the other hand, might need to know how and when to lock out the devices and how to return the system to its operational state. [**652:**A.9.5.2.3]

N **40.7.3** Refresher training shall be provided as required by the AHJ and as required by other relevant industry- or commodity-specific NFPA standards. [**652:**9.5.3]

N **40.7.4** The training shall be documented. [**652:**9.5.4]

N 40.8 Contractors

N **40.8.1** Owner/operators shall ensure the requirements of Section 40.8 are met. [**652:**9.6.1]

N **40.8.2*** Only qualified contractors shall be employed for work involving the installation, repair, or modification of buildings (interior and exterior), machinery, and fire and explosion protection equipment that could adversely affect the prevention, control, or mitigation of fires and explosions. [**652:**9.6.2]

N **A.40.8.2** Qualified contractors should have proper credentials, which include applicable American Society of Mechanical Engineers (ASME) stamps, professional licenses, and so forth. [**652:**A.9.6.2]

N **40.8.3*** **Contractor Training.**

N **A.40.8.3** It is suggested that annual meetings be conducted with regular contractors to review the facility's safe work practices and policies. Some points to cover include to whom the contractors would report at the facility, who at the facility can authorize hot work or fire protection impairments, and smoking and nonsmoking areas. The owner/operator does not necessarily need to provide the training to the contractor. [**652:**A.9.6.3]

N **40.8.3.1** Contractors operating owner/operator equipment shall be trained and qualified to operate the equipment and perform the work. [**652:**9.6.3.1]

N **40.8.3.2** Contractor training shall be documented. [**652:**9.6.3.2]

N **40.8.3.3*** Contractors working on or near a given process shall be made aware of the potential hazards from and exposures to fires and explosions. [**652:**9.6.3.3]

N **A.40.8.3.3** In addition to the combustible dust fire and explosion hazards, contractors should also be made aware of other potential process and occupational hazards. There can be combustible materials other than combustible dusts in the equipment or immediate vicinity where contractors might be working. Combustion of dusts can generate toxic products, and some combustible dusts are acutely toxic. [**652:**A.9.6.3.3]

N **40.8.3.4** Contractors shall be trained and required to comply with the facility's safe work practices and policies in accordance with 40.5.2. [**652:**9.6.3.4]

N **40.8.3.5** Contractors shall be trained on the facility's emergency response and evacuation plan, including, but not limited to, emergency reporting procedures, safe egress points, and evacuation area. [**652:**9.6.3.5]

Prior to the addition of 40.8.3.5, NFPA 654 and this *Code* provided inadequate guidance on the qualifications of those people employed for work involving the installation, repair, or modification of buildings, and/or the commissioning, repair, or modification of explosion protection equipment. It is important to establish requirements applicable to contractors and subcontractors. Industry statistics demonstrate that contractors and subcontractors contribute to incidents involving dust fires and explosions and must be aware of practices and safeguards in place to prevent such incidents.

N 40.9 Emergency Planning and Response

N **40.9.1*** A written emergency response plan shall be developed for preparing for and responding to work-related emergencies including, but not limited to, fire and explosion. [**652:**9.7.1]

N **A.40.9.1** All plant personnel, including management, supervisors, and maintenance and operating personnel, should be trained to participate in plans for controlling plant emergencies.

The emergency plan should contain the following elements:

(1) A signal or alarm system
(2) Identification of means of egress
(3) Minimization of effects on operating personnel and the community
(4) Minimization of property and equipment losses
(5) Interdepartmental and interplant cooperation
(6) Cooperation of outside agencies
(7) The release of accurate information to the public

[**652:**A.9.7.1]

Emergency drills should be performed annually by plant personnel. Malfunctions of the process should be simulated and emergency actions undertaken. Disaster drills that simulate a major catastrophic situation should be undertaken periodically with the cooperation and participation of public fire, police, and other local community emergency units and nearby cooperating plants. [**652:**A.9.7.1]

Specialized training for public fire department(s) and industrial fire brigades can be warranted due to facility specific hazards where the methods to control and extinguish a fire can be outside of their normal arena of traditional fire fighting. [**652:**A.9.7.1]

N **40.9.2** The emergency response plan shall be reviewed and validated at least annually. [**652:**9.7.2]

N 40.10* Incident Investigation

N **A.40.10** To thoroughly assess the risks, analyze the incident, and take any corrective steps necessary, investigations should be conducted promptly based on the nature of the incident and in coordination with the AHJ (as applicable). [**652:**A.9.8]

The investigation should include root cause analysis and should include a review of existing control measures and underlying systemic factors. Appropriate corrective action should be taken to prevent recurrence and to assess and monitor the effectiveness of actions taken. [**652:**A.9.8]

Such investigations should be carried out by trained persons (internal or external) and include participation of workers. All investigations should conclude with a report on the action taken to prevent recurrence. [**652:**A.9.8]

Investigation reports should be reviewed with all affected personnel and their representatives (including contract employees where applicable) whose job tasks are relevant to the incident findings, and with the health and safety committee, to make any appropriate recommendations. Any recommendations from the safety and health committee should be communicated to the appropriate persons for corrective action, included in the management review, and considered for continual improvement activities. [**652:**A.9.8]

A system should be established to promptly address and resolve the incident report findings and recommendations. [**652:**A.9.8]

Corrective actions resulting from investigations should be implemented in all areas where there is a risk of similar incidents and subsequently checked to avoid repetition of injuries and incidents that gave rise to the investigation. [**652:**A.9.8]

Reports produced by external investigation agencies should be acted upon in the same manner as internal investigations. [**652:**A.9.8]

Incident investigation reports should be made available to affected employees and their representatives at no cost. [**652:**A.9.8]

N **40.10.1*** The owner/operator shall have a system to ensure that incidents that result in a fire, deflagration, or explosion are reported and investigated in a timely manner. [**652:**9.8.1]

N **A.40.10.1** Events where there are injuries, equipment damage, or significant business interruption are subject to investigation. [**652:**A.9.8.1]

In addition to investigation of fires and explosions, it is also a good practice to investigate near misses (events that could have resulted in fires or explosions under different circumstances) and all activations of active fire and explosion mitigation systems. It is important to educate facility personnel on the concept of what a near miss is and to clearly communicate their responsibility for reporting both incidents and near misses. [**652:**A.9.8.1]

Near-miss events often indicate an underlying problem that should be corrected. See NFPA 654 for additional information. Barriers to reporting should be removed, as described in ANSI/AIHA Z10, *Occupational Health and Safety Management Systems.* Investigations should include workers and their representatives, as appropriate. [**652:**A.9.8.1]

N **40.10.2** The investigation shall be documented and include findings and recommendations. [**652:**9.8.2]

N **40.10.3** A system shall be established to address and resolve the findings and recommendations. [**652:**9.8.3]

N **40.10.4*** The investigation findings and recommendations shall be reviewed with affected personnel. [**652:**9.8.4]

N **A.40.10.4** The term *affected personnel* is intended to include members of employee organizations such as safety committees and employee representatives of various types. [**652:**A.9.8.4]

N 40.11 Management of Change

N **40.11.1*** Written procedures shall be established and implemented to manage proposed changes to process materials, staffing, job tasks, technology, equipment, procedures, and facilities. [**652:**9.9.1]

N **A.40.11.1** It is essential to have thorough written documentation, as the slightest changes to procedures, processes, resources, staffing, and equipment, including equipment from suppliers, can have a dramatic impact on the overall hazard analysis. Change includes something as benign as process materials sourcing from a different manufacturer, the same raw material manufacturer using new methods to produce the product, or changes in formulation. These changes from a supplier's end can impact the characteristics of the processes and materials. Individuals involved should include those involved in the process such as maintenance, engineering, and purchasing personnel, and all others as deemed necessary. Staffing and job tasks are not intended for shift changes, but for overall staff and their representative tasks. For reference, see the documentation form in ANSI/AIHA Z10, *Occupational Health and Safety Management Systems.* [**652:**A.9.9.1]

The following changes in material or process should warrant a management of change review per Section 9.9, and new samples should be collected and analyzed:

(1) New process equipment is installed that presents new hazards.
(2) New operating conditions for existing equipment create a new hazard.
(3) A new material is used in the process.

[**652:**A.9.9.1]

N **40.11.2** The procedures shall ensure that the following are addressed prior to any change:

(1)* The basis for the proposed change

N **A.40.11.2(1)** The proposed change and why it is needed should be described. It should include sufficient technical information to facilitate review by the approvers, address adverse effects that could occur, and describe how such effects would be mitigated by the proposed change. [**652:**A.9.2.(1)]

(2)* Safety and health implications

N **A.40.11.2(2)** Some fire and explosion protection systems introduce additional hazards into the process environment. These hazards can include, but are not limited to, energy in suppression canisters, asphyxiation hazards from inert gases, and mechanical laceration/amputation hazards from explosion isolation systems. While these are not fire or explosion hazards, they should be addressed as part of the management of change review per this document so that appropriate controls can be applied. [**652:**A.9.9.2(2)]

(3) Whether the change is permanent or temporary, including the authorized duration of temporary changes
(4) Modifications to operating and maintenance procedures
(5) Employee training requirements
(6) Authorization requirements for the proposed change
(7) Results of characterization tests used to assess the hazard, if conducted

[**652:**9.9.2]

N **40.11.3*** Implementation of the management of change procedure shall not be required for replacements-in-kind. [**652:**9.9.3]

N **A.40.11.3** While implementation of the management of change procedure is not required for replacement in kind, it is critical that only qualified personnel are the ones who determine if the replacement is "in kind." These qualified personnel should be intimately familiar with the items listed in 9.9.2, as well as the broad scope of hazards associated with the particular process. [**652:**A.9.9.3]

Replacement "in kind" for raw materials. Care must be taken when substituting raw materials. There have been cases where a seemingly equivalent material substitution resulted in a large change in the process hazard. Not all safety properties of a material are characterized in, for example, an MSDS. Chemical composition might be identical, but quite different static ignition hazards due to bulk resistivity and charge relaxation rate can appreciably increase the hazard. Flowability differences can affect the hazard probability too. Differences in natural raw materials are generally less of a concern than manufactured materials in this regard.

N **40.11.4** Design and procedures documentation shall be updated to incorporate the change. [**652:**9.9.4]

N 40.12* Documentation Retention

N **A.40.12** The creation and retention of documentation is necessary in order to implement and periodically evaluate the effectiveness of the management systems presented in this standard. Documentation in any form (e.g., electronic) should remain legible and be readily identifiable and accessible. The documentation should be protected against damage, deterioration, or loss, and retained for the applicable period specified in this standard. [**652:**A.9.10]

N **40.12.1** The owner/operator shall establish a program and implement a process to manage the retention of documentation, including, but not limited to, the following:

(1) Training records
(2) Equipment inspection, testing, and maintenance records
(3)* Incident investigation reports

N **A.40.12.1(3)** Incident investigation reports should be maintained for review during cyclical hazards evaluation reviews at least until the changes are incorporated in the dust hazard analysis and for compliance with other regulatory requirements. [**652:**A.9.10.1(3)]

(4) Dust hazards analyses
(5)* Process and technology information

N **A.40.12.1(5)** Process and technology information includes process performance parameters, properties of the materials being handled, and documents such as design drawings, design codes and standards used as the basis for both the process and the equipment, equipment manufacturers' operating and maintenance manuals, standard operating procedures, and safety systems operation. [**652:**A.9.10.1(5)]

(6)* Management of change documents

N **A.40.12.1(6)** Management of change documents should be retained until the changes are incorporated into the next dust hazards analysis. [**652:**A.9.10.1(6)]

(7) Emergency response plan documents
(8)* Contractor records

[**652:**9.10.1]

N **A.40.12.1(8)** Contractor records typically include information such as the contract documentation with scope of work and necessary insurance coverage, the contractor's safety programs, records demonstrating the contractor's safety performance, qualifications and certifications necessary for the work to be done, periodic evaluations of the contractor's work performance, and records demonstrating that the employees of the contractor have been trained to safely perform the assigned work. [**652:**A.9.10.1(8)]

N 40.13 Management Systems Review

N **40.13.1** The owner/operator shall evaluate the effectiveness of the management systems presented in this standard by conducting a periodic review of each management system. [**652:**9.11.1]

N **40.13.2** The owner/operator shall be responsible for maintaining and evaluating the ongoing effectiveness of the management systems presented in this standard. [**652:**9.11.2]

N 40.14* Employee Participation

Owner/operators shall establish and implement a system to consult with and actively involve affected personnel and their representatives in the implementation of this standard. [**652:**9.2]

N **A.40.14** Effective employee participation is an essential element of the Occupational Health and Safety Management System (OHSMS) to achieve continuous improvement in risk reduction, as described in ANSI/AIHA Z10-2012, *Occupational Health and Safety Management Systems.* The OHSMS ensures that employees and their authorized representatives are involved, informed, and trained on all aspects of health associated with their work, including emergency arrangements. Employee participation includes items such as, but not limited to, the following:

(1) Involving employees and their authorized representatives, where they exist, in establishing, maintaining, and evaluating the OSHMS
(2) An occupational health and safety committee
(3) Access to safety and health information
(4) Risk assessment, implementation, and review of risk control measures
(5) Incident and near-miss investigations
(6) Inspections and audits
(7) Reporting unsafe conditions, tools, equipment, and practices
(8) Mentoring of new employees, apprentices, and for onsite orientation
(9) Identifying hazards with strong emphasis on high-risk jobs and the application of the hierarchy of controls
(10) In accordance with established and maintained procedures, appropriate arrangements to ensure that concerns, ideas, and input that employees and their representatives share are received, considered, and responded to
(11) Employees removing themselves from work situations that they have reasonable justification to believe present an imminent and serious danger to their safety or health

[**652:**A.9.12]

Employees who justifiably take those actions by notifying their supervisor should be protected from discrimination by removing those barriers as outlined in the OSHMS. [**652:**A.9.12]

Where this standard and annex refer to employees and their representatives (where representatives exist), the intention is that they should be consulted as the primary means to achieve appropriate participation in the development and implementation of all aspects of the OHSMS. In some instances, it might be appropriate to involve all employees and all representatives. [**652:**A.9.12]

Employee participation is a key component of an OHSMS. When employees and their representatives are engaged and their contributions are taken seriously, they tend to be more satisfied and committed to the OHSMS, and the system is more effective. Engaging employees and their representatives in dialogue with management and each other about safety and health can lead to improved relationships, better overall communication, improved compliance, and reduced rates of injury, illness, and death. The improved morale translates to greater safety and health results. [**652:**A.9.12]

Employees and their representatives need to be trained about how the OHSMS works and to evaluate it periodically to determine whether improvements need to be made. The information needs to be presented in a form and language that employees and their representatives easily understand.

(See also A.40.10.4.)

[**652:**A.9.12]

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NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials,* 2016 edition.
NFPA 36, *Standard for Solvent Extraction Plants*, 2017 edition.
NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2014 edition.
NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, 2017 edition.
NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2013 edition.
NFPA 69, *Standard on Explosion Prevention Systems*, 2014 edition.
NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2015 edition.
NFPA 86, *Standard for Ovens and Furnaces*, 2015 edition.
NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, 2015 edition.
NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*, 2015 edition.
NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, 2015 edition.
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NFPA 482, *Standard for the Production, Processing, Handling, and Storage of Zirconium,* withdrawn, incorporated into NFPA 484.
NFPA 484, *Standard for Combustible Metals*, 2018 edition.
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NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*, 2017 edition.
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NFPA 1125, *Code for the Manufacture of Model Rocket and High-Power Rocket Motors*, 2017 edition.

Report No. 2008-05-I-GA, "Investigation Report: Sugar Dust Explosion and Fire, Imperial Sugar Company," U.S. Chemical Safety and Hazard Investigation Board, September 2009, available at http://www.csb.gov/investigations/detail.aspx?SID=6.

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Title 29, Code of Federal Regulations, Part 1910.272, "Grain Handling Facilities."
Title 30, Code of Federal Regulations, Part 75.
Title 33, Code of Federal Regulations, Part 154.
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Title 49, Code of Federal Regulations, Parts 100–199.

Welding, Cutting, and Other Hot Work

41

Chapter 41 covers provisions related to welding, cutting, and other hot work, including permitting requirements, parties responsible for the work, fire prevention precautions and practices, operators of hot work, and public exhibitions and demonstrations of the work. Chapter 41 references NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work, which* includes the following considerations:

- New definitions and requirements for designated and permitted areas
- Modified scope to clarify that the document is also concerned with preventing injuries and not just loss of life during hot work operations
- Revised purpose to clarify that the document provides requirements and not just guidance and that it applies to all those who are involved with hot work operations
- New requirement for welding blankets, pads, and curtains to be both listed and approved
- New requirement stating the maximum period for which a permit is valid is limited to a 24-hour period

These updates are incorporated in the 2018 edition of NFPA 1, *Fire Code*.

41.1 General

According to the NFPA report "Structure Fires Started by Hot Work," torches, soldering equipment, and burners were involved in an average of 4440 structure fires per year during 2010–2014. During those years, torches, soldering equipment, and burners were the equipment involved in ignition in 1860 home structure fires and 2590 non-home structure fires in the United States. Cutting or welding torches accounted for 68 percent of the non-home hot work fires, but only 44 percent of such incidents occurred in the home. Fourteen percent of the home fires were burner fires, reported as fires confined to a cooking vessel, which may have involved stovetop burners rather than the stand-alone burners anticipated by the burner designation under equipment involved in ignition. Most of the non-home cutting or welding torch fires could have been prevented with safer practices. For example, excluding fires reported as confined fires, 68 percent of the non-home structure hot work fires reported proximity of combustibles as a factor that contributed to ignition. Other specific factors contributing to ignition included improperly operated equipment, equipment unintentionally turned on or not turned off, unattended equipment, equipment used for a purpose never intended, mechanical failure or malfunction, and improper startup. The variety of factors leading to reported torch fires are mostly behavioral errors, which points to the substantial need for education and training, whether formal or on the job.

Many fires can originate because hot work is performed in areas not designed or permitted for such work. A single session of hot work can produce hundreds or thousands of potential ignition sources in the form of sparks and hot slag (globules of molten material), in addition to the dangers from the heat and flame of the torch itself. Any combustible or flammable material is susceptible to ignition during hot work. According to "Structure Fires Started by Hot Work," the materials most frequently ignited first in non-home cutting or welding torch fires are structural members and framing, insulation within the structural area, exterior wall coverings or finish, flammable and combustible liquids and gases, piping or filters, and exterior roof coverings. Sparks and slag can fly through the air horizontally as far as 35 ft (11 m) and, anecdotally, have been reported to travel in excess of 250 ft (76 m) vertically, while retaining heat and potentially igniting any combustible material they contact. Figure A.41.3.5.1(1)(b) shows work from an elevated location, considering spark travel as well as the potential need for multiple fire watches. Sparks and slag can fall through cracks, pipe holes, or other small openings in floors and partitions. Other forms of hot work, such as grinding or burning, can heat combustibles through conduction, convection, or radiation.

Fires can also start when hot work is done on containers that hold or have held combustibles and have not been cleaned and purged. Such containers are often fuel storage tanks, but they can also be individual gasoline and diesel fuel tanks on vehicles.

The heat of the metal that is being welded or cut can cause fires when the hot pieces are allowed to rest or fall on combustible materials such as wood shavings and wooden floors. Fires and explosions also result when heat is transmitted through metal (in the case of a container) to a flammable atmosphere or to combustibles within the container. This condition can occur not only when the container itself is being worked on, but when the metal is being removed from, or added to, the exterior of the container. An example of such a scenario is the removal of brackets or appendages from a tank or container by means of cutting.

Even though cutting and welding are statistically the most dangerous types of hot work, other types of hot work present the same dangers as cutting and welding and are controlled by the same precautions and regulatory requirements. Other types of hot work include heat treating, grinding, pipe thawing, use of powder-driven fasteners, hot riveting, and welding and allied processes (open flame soldering, brazing, thermal spraying, oxygen cutting, and arc cutting). Other similar applications — such as grinding, chipping, or abrasive blasting — that produce a spark, a flame, or heat should also be considered during an inspection.

Hot work operations are hazardous for a number of reasons. First, they can use flames burning at temperatures of 4000°F to 5000°F (2200°C to 2760°C) or electric arcs that are estimated by some to be hotter than the surface of the sun. They frequently take place in areas where combustible materials are present, in cramped or elevated areas, or in areas cluttered with tools and equipment that might hinder movement during an emergency. Molten metal and sparks are created that can cause burns and other injuries. Many types of hot work emit radiation that can harm improperly protected eyes.

41.1.1 Hot work shall comply with NFPA 51B and this chapter.

NFPA 51B provides basic requirements to prevent injury, loss of life, and loss of property from fire or explosion as a result of hot work. The scope of NFPA 51B was updated to emphasize the importance of addressing personal safety during hot work operations. Without proper precautions, hot work that results in a fire can be a source of injury such as burns. The scope was expanded to clarify that the document currently has provisions that prevent injuries and not just loss of life during hot work operations. According to the NFPA report "Structure Fires Started by Hot Work," such fires caused an average of 12 civilian deaths, 208 civilian injuries, and $287 million in direct property damage per year. In addition, five fire fighters were fatally injured from 2001–2015 in fires started unintentionally by torches. Compliance with the requirements in this chapter can reduce the number of injuries and fatalities.

41.1.2 Chapter 41 shall apply to the following hot work processes:

(1) Welding and allied processes
(2) Heat treating
(3) Grinding
(4) Thawing pipe
(5) Powder-driven fasteners
(6) Hot riveting
(7)* Torch-applied roofing in conjunction with the requirements of Section 16.6

A.41.1.2(7) There are more detailed, and in some cases more stringent, requirements for torch-applied roofing found in Section 16.6 and NFPA 241. [**51B:**A.1.3.1(7)]

(8) Similar applications producing or using a spark, flame, or heat [**51B:**1.3.1]

Hot work processes performed during construction, alteration, demolition, or repairs should be consistent with the requirements of Chapter 16 of this *Code*.

Δ **41.1.3** Chapter 41 shall not apply to the following:

(1) Candles
(2) Pyrotechnics or special effects
(3) Cooking operations
(4) Electric soldering irons
(5) Design and installation of gas cutting equipment and welding equipment covered in NFPA 51
(6) Additional requirements for hot work operations in confined spaces
(7) Lockout/tagout procedures during hot work

[**51B:**1.3.2]

Δ **41.1.4** Acetylene cylinder charging plants shall comply with NFPA 55.

Chapter 15 of NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, provides safety requirements for the design, construction, and installation of acetylene cylinder charging plants to provide safeguards for the protection of the plant, its employees, and the public. The standard also applies to plants engaged in the generation and compression of acetylene and in the charging of acetylene cylinders, either as their sole operation or in conjunction with facilities for charging other compressed gas cylinders. These requirements were found in NFPA 51A, *Standard for Acetylene Cylinder Charging Plants*, prior to the standard being withdrawn and incorporated into NFPA 55 in 2013.

Chapter 15 of NFPA 55 does not apply to plants that only produce and compress acetylene for chemical operations or to plants that only produce and compress acetylene below a gauge pressure of 15 psi (103 kPa). (Refer to NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes*, for requirements covering acetylene-generating plants where the acetylene is used with oxygen for welding, cutting, heating, and heat-treating operations.)

An existing plant that is not in strict compliance with the provisions of this *Code* and NFPA 55 is permitted to continue operations where such use does not constitute a distinct hazard to life or adjoining property.

41.1.5 Permits.

41.1.5.1 Permits, where required, shall comply with Section 1.12.

41.1.5.2 Where an approved facility hot work permit program exists that meets the requirements of Chapter 41, the permit shall be permitted to be issued for an entire facility.

A permit is not always required. Figure A.41.3.4 shows a decision tree to assist in the decision process to determine whether a permit is needed. See Figure A.41.3.4.1 for a sample hot work permit.

The local jurisdiction may also require an additional permit process to the one described in this chapter. For example, in Boston, Massachusetts, before beginning any hot work, the hot work team must apply for and receive a permit from the Department of Fire Prevention. Because of a fire in March 2014 in which two fire fighters lost their lives after unpermitted hot work took place, the Boston City Council now requires that all hot work permit applicants receive a Hot Work Safety Certification prior to applying for the permit and conducting hot work. The permit authorizing individual (PAI) should be knowledgeable about any local or state ordinances before approving work.

41.2 Responsibility for Hot Work

41.2.1* Management. Management or a designated agent shall be responsible for the safe operations of hot work activity. [**51B:**4.1]

A.41.2.1 The Technical Committee on Hot Work Operations (NFPA 51B) recognizes that management might not always have expertise in hot work and, therefore, would need a knowledgeable designated agent or contractor to act on its behalf. Examples of those who might not have the expertise can include owners of small retail shops, a small apartment complex manager, or a grocery store owner who has no knowledge of hot work safe practices. [**51B:**A.4.1]

Management should ensure that the contractor has evidence of financial responsibility, which can take the form of an insurance certificate or other document attesting to coverage or responsibility. [**51B:**A.4.1]

41.2.1.1 Management shall establish permissible areas for hot work. [**51B:**4.1.1]

41.2.1.2 Management shall designate a permit authorizing individual (PAI). [**51B:**4.1.2]

41.2.1.3 All equipment shall be examined to ensure it is in a safe operating condition. [**51B:**4.1.3]

41.2.1.4 When found to be incapable of reliable safe operation, the equipment shall be repaired by qualified personnel prior to its next use or be withdrawn from service and tagged out of service. [**51B:**4.1.4]

41.2.1.5 Management shall ensure that only approved apparatus, such as torches, manifolds, regulators or pressure-reducing valves, and acetylene generators, are used. [**51B:**4.1.5]

41.2.1.6 Management shall ensure that all individuals involved in the hot work operations, including contractors, are familiar with the provisions of Chapter 41. [**51B:**4.1.6]

41.2.1.6.1 Individuals involved in hot work operations shall be trained in the safe operation of their equipment and in the safe use of the process. [**51B:**4.1.6.1]

41.2.1.6.2 Individuals involved in hot work operations shall have an awareness of the inherent risks involved and understand the emergency procedures in the event of a fire. [**51B:**4.1.6.2]

41.2.1.7 Management shall advise all contractors about site-specific flammable materials, hazardous processes or conditions, or other potential fire hazards. [**51B:**4.1.7]

41.2.2 Permit Authorizing Individual (PAI). In conjunction with management, the PAI shall be responsible for the safe operation of hot work activities. [**51B:**4.2]

The term *permit authorizing individual (PAI)* is used throughout this chapter. The PAI is defined in NFPA 51B as "the individual designated by management to authorize hot work."

The PAI is permitted to be, among others, the supervisor, foreperson, property owner or representative, or health and safety administrator. The PAI cannot be the hot work operator, except as permitted in Section 41.4 and Chapter 6 of NFPA 51B. The PAI is aware of the fire hazards involved and is familiar with the provisions of this *Code* and NFPA 51B.

41.2.2.1* The PAI shall consider the safety of the hot work operator and fire watch with respect to personal protective equipment (PPE) for other special hazards beyond hot work. (*See 41.3.1.*) [**51B:**4.2.1]

A.41.2.2.1 Other special hazards can include, but are not limited to, lead, noise, and radiation. Sometimes these special hazards require disposable outer garments that can catch fire. [**51B:**A.4.2.1]

41.2.2.2 The PAI shall determine site-specific flammable materials, hazardous processes, or other potential fire hazards that are present or likely to be present in the work location. [**51B:**4.2.2]

41.2.2.3 The PAI shall ensure the protection of combustibles from ignition by the following means:

(1)* Considering alternative methods to hot work
(2) Moving the work to a location that is free from combustibles
(3) If the work cannot be moved, moving the combustibles to a safe distance or having the combustibles properly shielded against ignition
(4) Scheduling hot work so that operations that could expose combustibles to ignition are not begun during hot work operations

[**51B:**4.2.3]

A.41.2.2.3(1) Alternatives to hot work can include the following:

(1) Mechanical removal and relocation of frozen piping to a heated area
(2) Manual hydraulic shears

(3) Mechanical bolting
(4) Screwed, flanged, or clamped pipe
(5) Reciprocating saw
(6) Mechanical pipe cutter
(7) Approved self-drilling or compressed air-actuated fasteners

[**51B:**A.4.2.3(1)]

Δ **41.2.2.4** If the criteria of 41.2.2.3(1) through 41.2.2.3(4) cannot be met, hot work shall not be performed. [**51B:**4.2.4]

41.2.2.5 The PAI shall determine that fire protection and extinguishing equipment are properly located at the site. [**51B:**4.2.5]

41.2.2.6 Where a fire watch is required *(see 41.3.5)*, the PAI shall be responsible for ensuring that a fire watch is at the site. [**51B:**4.2.6]

41.2.2.7* Where a fire watch is not required, the PAI shall make a final check ½ hour after the completion of hot work operations to detect and extinguish smoldering fires. [**51B:**4.2.7]

A.41.2.2.7 The inspection is usually made ½ hour after the completion of hot work to detect and extinguish possible smoldering fires. The inspector should be alert for circumstances that can require an extension of the final inspection interval. [**51B:**A.4.2.7]

Generally, if a fire develops from hot work, evidence of smoldering or fire occurs within 30 minutes. However, if the cutting was done in an area that contains a large quantity of finely divided or lightweight combustibles, even though the combustibles were shielded, a longer fire watch might be appropriate. Likewise, if sparks or slag could have entered a crack in a wall or floor, or if unusual conditions or hazards exist, a longer fire watch should be maintained.

Also, see the commentary following 41.3.4.2(2) for additional guidance on reference standards that address fire and explosion hazards of various combustible particulate solids.

Δ **41.2.3 Hot Work Operator.** The hot work operator shall handle equipment safely and use it as follows so as not to endanger lives and property:

(1) The operator shall have the PAI's approval before starting hot work operations.
(2) All equipment shall be examined to ensure it is in a safe operating condition, and, if found to be incapable of reliable safe operation, the equipment shall be repaired by qualified personnel prior to its next use or be withdrawn from service.
(3) The operator shall cease hot work operations if unsafe conditions develop and shall notify management, the area supervisor, or the PAI for reassessment of the situation.

[**51B:**4.3]

41.2.4 Fire Watch.

A fire watch is an individual(s) assigned to work with hot work operators for the purpose of watching for fire that could result from hot work. Fire watches normally watch for fires in areas that cannot be easily observed by the operator, such as the opposite sides of walls, levels below the work area, spaces behind the operator, or hidden areas. The fire watch should also keep a lookout to make sure that any clothing or personal protective equipment (PPE) worn by the operator does not ignite. Finally, they also observe an area after the hot work operations have stopped. It can be confusing to decide whether a fire watch is necessary; Figure A.41.3.5.1 is a decision tree that assists in determining whether one or more fire watches are needed.

41.2.4.1* The fire watch shall be trained to understand the inherent hazards of the work site and of the hot work. [**51B:**4.4.1]

A.41.2.4.1 The fire watch duties can be assigned to anyone who understands the hazard of the hot work being performed and the limitations placed on that hot work operation by the person issuing the hot work permit (PAI). The fire watch has the responsibility to make certain the hot work area is maintained in a fire-safe condition throughout performance of the hot work and has the authority to stop the hot work if unsafe conditions are observed. The fire watch must understand the basic hazards of any combustible construction involved with the hot work area, the fire exposure hazard hot work creates to occupancies adjacent to or below the hot work operation, the hazards associated with the occupancy, and the need to maintain proper isolation of all hot work operations from combustible or flammable materials. The fire watch should also be properly trained in use of manual, portable fire extinguishers and emergency notification procedures within the facility. The fire watch is not a replacement for proper planning to prevent conditions that allow a fire to develop, regardless of the fire-fighting equipment available and the capabilities of the individuals involved. [**51B:**A.4.4.1]

41.2.4.2 The fire watch shall ensure that safe conditions are maintained during hot work operations. [**51B:**4.4.2]

41.2.4.3 The fire watch shall have the authority to stop the hot work operations if unsafe conditions develop. [**51B:**4.4.3]

41.2.4.4* The fire watch shall have fire-extinguishing equipment readily available and shall be trained in its use. [**51B:**4.4.4]

A.41.2.4.4 The fire watch should have experience with test fires. [**51B:**A.4.4.4]

41.2.4.5 The fire watch shall be familiar with the facilities and procedures for sounding an alarm in the event of a fire. [**51B:**4.4.5]

41.2.4.6 The fire watch shall watch for fires in all exposed areas and try to extinguish them only when the fires are obviously within the capacity of the equipment available. If the fire watch determines that the fire is not within the capacity of the equipment, the fire watch shall sound the alarm immediately. [**51B:**4.4.6]

41.2.4.7* The fire watch shall be permitted to perform additional tasks, but those tasks shall not distract him or her from his or her fire watch responsibilities, except as outlined in Section 41.4. [**51B:**4.4.7]

A.41.2.4.7 These tasks might include moving partitions relating to the hot work, sweeping in the immediate area, and minimal assistance to the operator. [**51B:**A.4.4.7]

41.2.5* Contractors. Before starting any hot work, contractors and their clients shall discuss the planned project completely, including the type of hot work to be conducted and the hazards in the area. [**51B:**4.5]

A.41.2.5 The trend toward outsourcing facility maintenance and renovations can influence the risks associated with hot work. A contractor may have the technical expertise to perform hot work but is not likely to have a full understanding of fire prevention or of the specific combustible hazards within a client property. Additional safeguards to be considered include, but are not be limited to, how the hot work should be isolated to prevent fire hazards; who will be assigned as the fire watch for the hot work operations; the facility emergency notification procedures; available manual fire fighting tools (like portable fire extinguishers and small hose stations); identification of all areas where hot work is not allowed; connecting hot work equipment to existing utility systems (gas or electricity); and review of any requirements for completion of hot work by a certain time each day. [**51B:**A.4.5]

Hot work loss incidents involving contractors occur with regular frequency. For many of these incidents, facility management has not implemented a process for managing the fire hazards associated with the proposed contract work activity, views the contractor's personnel as the recognized subject matter expert, and is either ignorant of potential fire hazards with the planned contract activity or presumes the contractor is expert in all associated safety regulations and requirements and will address hazards accordingly. [**51B:**A.4.5]

41.2.6 Mutual Responsibility. Management, contractors, the PAI, the fire watch, and the operators shall recognize their mutual responsibility for safety in hot work operations. [**51B:**4.6]

41.3 Fire Prevention Precautions

NFPA 51B provides requirements for restricting hot work to designated areas or to permit-required areas. Provisions are also made for establishing a written permit system to ensure that the area is made safe by removing or protecting combustibles, making available fire-extinguishing equipment, and, under some conditions, requiring a fire watch. (See 41.2.4.)

Hot work fires can be prevented by separating combustibles from ignition sources, by shielding combustibles from the source of flame or heat, and by protecting combustibles anywhere that sparks and slag can travel.

NFPA 51B provides requirements for hot work operators, fire watches, supervisors (including outside contractors), and the management of property where hot work is performed. Chapter 16 of NFPA 1 provides requirements whenever construction, alterations, demolition, or repairs are conducted that might involve hot work processes.

All individuals involved in hot work should be aware of some relatively common circumstances in which fires, explosions, or severe injuries are likely. Some considerations include the following:

1. The proximity or the flammable nature of nearby combustible solids, liquids, or dusts
2. The presence or development of possibly explosive mixtures of flammable gases or vapors and air
3. The presence or nature of an oxygen-enriched atmosphere where the work is to be performed

Management, the PAI, the hot work operator, and the fire watch share responsibility for safe hot work procedures. The specific responsibilities of each individual for the safe use of hot work are described in Section 41.2 and Chapter 4 of NFPA 51B. An abbreviated form of these responsibilities follows.

Management has the following responsibilities:

1. Be responsible for the safe operations of hot work activity
2. Establish permissible areas for hot work
3. Designate a PAI
4. Ensure that only approved apparatus — such as torches, manifolds, regulators, pressure-reducing valves, and acetylene generators — are used
5. Ensure that all individuals involved in the hot work operations, including contractors, are familiar with the provisions of NFPA 51B and the safe operation of their equipment and process and that they understand emergency procedures to follow in the event of a fire
6. Advise all contractors about site-specific flammable materials and hazardous processes or other hazardous conditions

The PAI has the following responsibilities:

1. Be responsible for the safe operations of hot work activity
2. Consider the safety of the hot work operator and fire watch with respect to PPE for other special hazards beyond hot work
3. Identify site-specific flammable materials, hazardous processes, or other hazardous conditions present or likely to be present in the work location
4. Ensure the protection of combustibles from ignition by the following means and, if one or more of the following means cannot be met, not perform hot work:
   a. Ensure that work is moved to a location free of combustibles
   b. If the work cannot be moved, ensure that the combustibles are moved to a safe distance or are properly shielded
   c. Ensure that hot work is scheduled such that operations that could expose combustibles to ignition are not started during hot work operations

5. Determine that fire protection and extinguishing equipment are properly located at the site
6. Where a fire watch(es) is required, ensure that the fire watch is available at the site
7. Where a fire watch is not required, make a final check 30 minutes after the completion of hot work operations to detect and extinguish possible smoldering fires

The hot work operator has the following responsibilities:

1. Handle the equipment safely and use it so as not to endanger lives and property
2. Obtain the PAI's approval before starting hot work operations
3. Cease hot work operations if unsafe conditions develop or conditions change from those under which the permit was granted and notify the PAI for reassessment of the site

The fire watch has the following responsibilities:

1. Be aware of the inherent hazards of the work site and of the hot work
2. Ensure that safe conditions are maintained during hot work and stop hot work if conditions change and unsafe conditions develop
3. Have extinguishing equipment readily available and be trained in its use
4. Be familiar with the facility and the procedures for sounding an alarm in the event of a fire
5. Watch for fires in all exposed areas and extinguish only those fires within the capacity of the fire watch; if not within the capacity of the fire watch, sound the alarm immediately

Other non–fire safety requirements for many types of hot work are covered in ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*. U.S. Department of Labor Occupational Safety and Health Administration (OSHA) regulations — in 29 CFR, Part 1910, Subpart Q, "Welding, Cutting and Brazing," and, for construction, 29 CFR, Part 1926, Subpart J, "Welding and Cutting" — are based on the requirements of NFPA 51, NFPA 51B, and ANSI Z49.1.

41.3.1* Personal Protective Clothing. Clothing shall be selected to minimize the potential for ignition, burning, trapping hot sparks, and electric shock. [**51B:**5.1]

A.41.3.1 At a work site, hazards other than hot work, such as radiation, lead, or noise, are often present. Any additional PPE donned for protection against these other hazards should also be appropriate for hot work. Heavier materials, such as woolen clothing or heavy cotton, are preferable to lighter materials because they

Case Study

On July 29, 2008, in Tomahawk, Wisconsin, three workers at the Packaging Corporation of America (PCA) fiberboard manufacturing facility were killed and one worker was injured while they were attempting to weld a temporary metal clamp to stabilize a damaged flange connection. The welding occurred on top of an 80-foot tall storage tank that at the time held recycled water and fiber waste.

The presence of or risk for development of possibly explosive mixtures of flammable gases or vapors and air can be a deadly combination when hot work is being performed; sparks from the hot work can potentially ignite the explosive gases and vapors, especially those that have gone undetected. At the PCA, facility workers were unaware of the potential risk of the development of flammable gas from the decomposition of the material in the tank. In this case, combustible gas monitoring was not present, nor was it typically performed prior to starting the work. A description of the incident states that, at the time of the accident, three workers were on a catwalk above the tank. One worker began welding the flange into place when sparks from the hot work ignited the flammable vapors in the tank. The explosion occurred in the tank, and the force of the explosion ripped the tank lid off. The flying tank lid and the explosion knocked two of the workers from the tank to the ground, 80 ft (24.4 m) below. A fourth worker, who was observing the work from a distance away from the tank, was injured.

The U.S. Chemical Safety and Hazard Investigation Board (CSB) performed an investigation into this accident and determined, after an analysis of the tank contents, that bacteria inside the tank had multiplied and likely produced hydrogen, which ignited and exploded during the welding operation. In its report, "Seven Key Lessons to Prevent Worker Deaths During Hot Work In and Around Tanks," the CSB documented that, at the time of the accident, personnel at PCA were unaware of the risks of flammable gas production from this tank. Hazard analyses and risk analyses should be conducted at sites where hot work is being performed to reduce the risk of an incident such as this occurring, as well as to ensure that gas monitoring is used where necessary. See the CSB website for additional information on this and other incidents occurring from hot work accidents.

Exhibit CS41.1

(Courtesy of the U.S. Chemical Safety Board)

are more difficult to ignite. Cotton clothing, if used for protection, should be chemically treated to reduce its combustibility. Clothing treated with flame-resistant materials can lose some of its protective characteristics after repeated washing or cleaning. Materials that can melt and cause severe burns should not be used as clothing when the wearer will be welding or cutting. [**51B:**A.5.1]

Sparks can lodge in rolled-up sleeves, pockets of clothing, or cuffs of overalls or trousers. Therefore, it is recommended that sleeves and collars be kept buttoned and pockets be eliminated from the front of clothing. Where pockets are present, they should be emptied of flammable or readily combustible materials. Trousers or overalls should not have cuffs and should not be turned up on the outside. Trousers should overlap shoe tops to prevent spatter from getting inside shoes. [**51B:**A.5.1]

Frayed clothing is particularly susceptible to ignition and burning and should not be worn when welding or cutting. [**51B:**A.5.1]

41.3.2 Permissible Areas.

The two permissible areas for hot work are designated areas (see 41.3.2.2.1) and permit-required areas. Hot work should preferably be done in specially designated areas that have been designed and constructed to minimize fire risk and are, therefore, theoretically inherently safe.

41.3.2.1 General. Hot work shall be permitted only in areas that are or have been made fire safe. [**51B:**5.2.1]

41.3.2.2 Designated or Permit-Required Areas. Hot work shall be performed in either designated areas or permit-required areas. [**51B:**5.2.2]

A *designated area* is defined in 3.3.14.9.1 as "a specific location designed and approved for hot work operations that is maintained fire safe such as a maintenance shop or a detached outside location that is of noncombustible or fire-resistive construction, essentially free of combustible and flammable contents, and suitably segregated from adjacent areas." A *permit-required area* is defined in 3.3.14.9.2 as "any location other than a designated area that is approved for hot work . . . [and] is made fire-safe by removing or protecting combustibles from ignition sources.

41.3.2.2.1 Designated Areas.

41.3.2.2.1.1 In order for a location to be a designated area, the area shall meet the requirements in 41.3.4.2. [**51B:**5.2.2.1.1]

41.3.2.2.1.2 Prior to the start of any hot work in a designated area, at a minimum, the hot work operator shall perform the following:

(1) The location is verified as fire resistant.
(2) The requirements of 41.3.4.2(3) are met.
(3) Fire extinguishers are in working condition and readily available.
(4) Ventilation is working properly.
(5) Equipment is in working order.

[**51B:**5.2.2.1.3]

41.3.2.2.1.3 Permanent areas designated for hot work shall be reviewed at least annually by the PAI. [**51B:**5.2.2.1.3]

There were limited requirements on designated areas in NFPA 51B prior to the 2014 edition. The industry identified the need for some general requirements regarding designated areas; thus, some additional requirements were developed for users and authorities having jurisdiction (AHJs) to better understand the use of designated areas for hot work and emphasize that these areas, just like permitted areas, need to be fire safe.

41.3.2.2.2 Signs shall be posted designating hot work areas as deemed necessary by the PAI. [**51B:**5.2.2.2]

Δ **41.3.3* Nonpermissible Areas.** Hot work shall not be permitted in the following areas:

(1) In areas not authorized by management

Management or its agents should always be aware of any hot work activity. Good management practices reduce the chance of inadvertent fires.

(2) In sprinklered buildings where sprinklers are impaired, unless the requirements of NFPA 25 are met

Hot work is permitted in many nonsprinklered buildings. However, a building in which the sprinklers are out of service is not the same situation as a nonsprinklered building. If the building was initially deemed to require sprinklers, they are required to be in working order during any hot work, because the hazards or value warrants sprinkler protection.

(3) In the presence of explosive atmospheres (i.e., where mixtures of flammable gases, vapors, liquids, or dusts with air exist)
(4) In the presence of uncleaned or improperly prepared equipment, drums, tanks, or other containers that have previously contained materials that could develop explosive atmospheres

All containers should be considered unsafe for hot work unless they have been rendered safe or have been declared safe by a qualified authority. Containers that are presumed to be empty could contain materials that are hidden in cracks and crevices and that can release hazardous fumes when heated. The by-products of corrosion can result in an explosive atmosphere (hydrogen) within a container. Consequently, even a water tank should be considered hazardous unless it has been declared safe for hot work.

(5) In areas with an accumulation of combustible dusts that could develop explosive atmospheres

[**51B:**5.3]

Finely divided bulk materials, such as bulk flour and its dust, that normally are considered safe in small bulk quantities can be explosive when suspended in air in sufficient concentrations if ignition sources are present, such as during hot work.

Δ **A.41.3.3** For additional information on cutting and welding of containers that have held flammable materials, see NFPA 326 and ANSI/AWS F-4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting Containers and Piping*. [**51B:**A.5.3]

Additional consideration should be given when hot work is performed in areas near the storage of large quantities of exposed, readily ignitable materials such as bulk sulfur, baled paper, or cotton.

For additional information on welding and cutting in storage areas, refer to Chapter 34 and NFPA 655. [**51B:**A.5.3]

41.3.4* Hot Work Permit.

A.41.3.4 The decision tree in Figure A.41.3.4 can be used to determine if a hot work permit is necessary. [**51B:**A.5.4]

Table 1.12.8(a) requires a permit for hot work operations within the jurisdiction. Where hot work is performed on a regular, ongoing basis at a particular site (such as in an auto body shop or steel fabrication plant), a permit can be issued to cover the ongoing hot work procedure at the site, assuming no conditions change from the time the permit is issued.

Where the processes are performed repeatedly, additional written authorization for hot work is not always required. For example, managerial or supervisory control in the workplace can serve as an equivalent means of authorization (like a blanket permit) once a general permit is issued. However, for specific one-time operations, a written permit for each operation is required, with a time period for which the permit is valid. Paragraph 41.3.4.4 limits the hot work permit period to 24 hours (see the commentary following 41.3.4.4 for an explanation as to why). If the circumstances change (with either one-time or blanket-type permits), the existing permit would be void, and a new permit should be required.

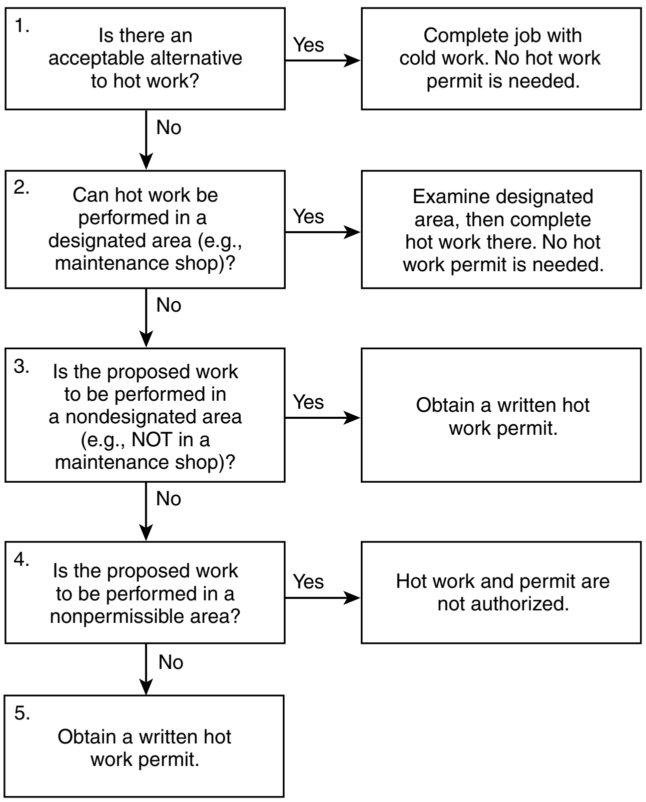


***FIGURE A.41.3.4** Hot Work Permit Decision Tree. [**51B:** Figure A.5.4]*

The operations described in 41.3.3 are typically conducted in areas that contain combustible materials. Therefore, special attention must be paid to protecting combustibles from accidental ignition. Providing members of the plumbing and painting trades and other trades likely to use torches with periodic reminders might be necessary to ensure that proper fire prevention measures are implemented on a regular basis. See the commentary and case study at the beginning of Section 41.3.

41.3.4.1* Before hot work operations begin in a nondesignated location, a written hot work permit by the PAI shall be required. [**51B:**5.4.1]

A.41.3.4.1 An example of a hot work permit is shown in Figure A.41.3.4.1. This permit can be modified to suit local conditions. [**51B:**A.5.4.1]

Paragraph 41.3.4.1 requires management to designate a PAI responsible for authorizing (permitting) hot work operations in areas not specifically designated for such processes. The PAI's responsibilities are outlined in the commentary at the beginning of Section 41.3 and following 41.2.2 and include familiarity with the provisions of NFPA 51B.

41.3.4.2 Before a hot work permit is issued, the following conditions shall be verified by the PAI:

(1) The hot work equipment to be used shall be in satisfactory operating condition and in good repair.

Hot work equipment can be the source of inadvertent ignition if it is in poor repair. For example, electrical current flowing through poor connections can melt the metal of the contacts, and poor insulation can permit arcing between conductors. Gas equipment can leak flammable gases or oxygen. A system of routine inspection and maintenance minimizes such hazards.

(2) Where combustible materials, such as paper clippings, wood shavings, or textile fibers, are on the floor, the floor shall be swept clean for a radius of 35 ft (11 m) and the following criteria also shall be met:
   (a) Combustible floors shall be kept wet, covered with damp sand, or protected by a listed welding blanket, welding pad, or equivalent.
   (b) Where floors have been wet down, personnel operating arc welding equipment or cutting equipment shall be protected from possible shock.

Many types of hot work can produce slag and spatter. Slag and spatter can be ejected from the work zone by the forces inherent in the processes, or they can fall to the floor and spread by rolling or by bouncing. NFPA 51B requires that flammable and combustible materials be cleared from within a minimum horizontal 35 ft (11 m) radius of the work area. However, vertical distances must also be considered. Anecdotally, sparks and slag have been reported to travel over 250 ft (76 m) vertically. Any place spark or slag can travel should be considered. Heat (radiation, conduction, or convection) produced from hot work must also be considered.

HOT WORK PERMIT

Seek an alternative/safer method if possible!

Before initiating hot work, ensure precautions are in place as required by NFPA 51B and ANSI Z49.1.
Make sure an appropriate fire extinguisher is readily available.

This Hot Work Permit is required for any operation involving open flame or producing heat and/or sparks. This work includes, but is not limited to, welding, brazing, cutting, grinding, soldering, thawing pipe, torch-applied roofing, or chemical welding.

Date	Hot work by ❑ employee ❑ contractor
Location/Building and floor ______________	Name (print) and signature of person doing hot work ______________
Work to be done ______________	I verify that the above location has been examined, the precautions marked on the checklist below have been taken, and permission is granted for this work.
Time started ________ Time completed ________ THIS PERMIT IS GOOD FOR ONE DAY ONLY	Name (print) and signature of permit-authorizing individual (PAI) ______________

❑ Available sprinklers, hose streams, and extinguishers are in service and operable.

❑ Hot work equipment is in good working condition in accordance with manufacturer's specifications.

❑ Special permission obtained to conduct hot work on metal vessels or piping lined with rubber or plastic.

Requirements within 35 ft (11 m) of hot work
❑ Flammable liquid, dust, lint, and oily deposits removed.
❑ Explosive atmosphere in area eliminated.
❑ Floors swept clean and trash removed.
❑ Combustible floors wet down or covered with damp sand or fire-resistive/noncombustible materials or equivalent.
❑ Personnel protected from electrical shock when floors are wet.
❑ Other combustible storage material removed or covered with listed or approved materials (welding pads, blankets, or curtains; fire-resistive tarpaulins), metal shields, or noncombustible materials.
❑ All wall and floor openings covered.
❑ Ducts and conveyors that might carry sparks to distant combustible material covered, protected, or shut down.

Requirements for hot work on walls, ceilings, or roofs
❑ Construction is noncombustible and without combustible coverings or insulation.
❑ Combustible material on other side of walls, ceilings, or roofs is moved away.

Requirements for hot work on enclosed equipment
❑ Enclosed equipment is cleaned of all combustibles.
❑ Containers are purged of flammable liquid/vapor.
❑ Pressurized vessels, piping, and equipment removed from service, isolated, and vented.

Requirements for hot work fire watch and fire monitoring
❑ Fire watch is provided during and for a minimum of 30 min. after hot work, including any break activity.
❑ Fire watch is provided with suitable extinguishers and, where practical, a charged small hose.
❑ Fire watch is trained in use of equipment and in sounding alarm.
❑ Fire watch can be required in adjoining areas, above and below.
❑ Yes ❑ No Per the PAI/fire watch, monitoring of hot work area has been extended beyond the 30 min.

 NFPA 51B

Δ ***FIGURE A.41.3.4.1*** *Sample of a Hot Work Permit. [**51B:**Figure A.5.4.1]*

See Chapter 40 for other NFPA documents that address the fire and explosion hazards of combustible particulate solids, including the following:

1. Agricultural dusts, covered by NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*
2. Coal dust, addressed by NFPA 85, *Boiler and Combustion Systems Hazards Code*, and NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*
3. Combustible metal dusts, covered by NFPA 484, *Standard for Combustible Metals*
4. Combustible particulate solids, addressed by NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*
5. Sulfur dust, addressed by NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*
6. Wood shavings and sawdust, covered by NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*

(3)* All combustibles shall be relocated at least 35 ft (11 m) in all directions from the work site, and the following criteria also shall be met:
  (a) If relocation is impractical, combustibles shall be protected by a listed welding blanket, welding pad, or equivalent.
  (b) To prevent the entrance of sparks, the edges of covers at the floor shall be tight including at the point at which several covers overlap where a large pile is being protected.

A.41.3.4.2(3) When hot work is performed at an elevated level, it should be noted that the sparks or slag can fall at a trajectory and land further than 35 ft (11 m) horizontally from a point directly under the hot work operator. [**51B:**A.5.4.2(3)]

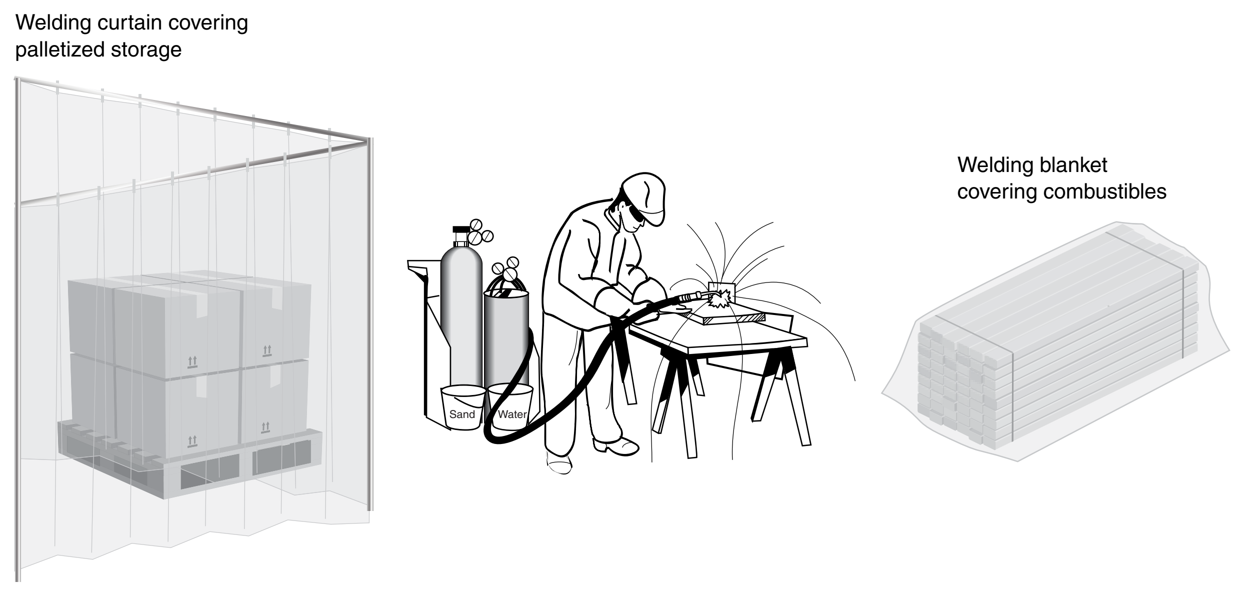
Moving combustibles away from hot work is not always possible. In such cases, protecting combustibles with listed welding blankets, pads, or curtains is important, as illustrated in Exhibit 41.1. Hot work cannot be performed safely on a metal wall, on a partition to which combustible material has been fastened on one side, or on a sandwich-type partition that contains combustible materials within the sandwiched portions.

Paint on metal walls or partitions can release toxic fumes when heated by conduction from hot work performed on the opposite side. This result is especially true for freshly painted surfaces. If the potential for release of toxic fumes exists, workers should not be allowed in the area while hot work is performed, and the operator and fire watch (if present) should use proper respiratory protection.

(4) Openings or cracks in walls, floors, or ducts within 35 ft (11 m) of the site shall be covered or sealed with listed fire-rated or noncombustible material to prevent the passage of sparks to adjacent areas.

Openings for the passage of piping and conduits can allow sparks, slag, flame, or heat to reach hidden or adjoining areas. Insulation or dust that covers the tops of pipes and conduits can act as a fuse or a wick that permits smoldering material, once ignited, to burn into hidden or adjacent areas. Many areas are often overlooked as potential passages for slag and spatter, such as elevator shafts, open doors, or windows. All such areas should be tightly covered to prevent the passage of sparks.

Exhibit 41.1



Safe hot work procedures.

(5) Ducts and conveyor systems that might carry sparks to distant combustibles shall be shielded, or shut down, or both.

(6) If hot work is done near walls, partitions, ceilings, or roofs of combustible construction, they shall be protected by a listed welding curtain, welding blanket, welding pad, or equivalent.

(7) If hot work is done on one side of a wall, partition, ceiling, or roof, one of the following criteria shall be met:
   (a) Precautions shall be taken to prevent ignition of combustibles on the other side by relocating the combustibles.
   (b) If it is impractical to relocate combustibles, a fire watch shall be provided on the side opposite from where the work is being performed.

If a fire watch is used on the side opposite from where work is performed, a system of communication should be established such that the fire watch can signal if the operator should stop the hot work. This action can be as simple as a bang on the wall or as complex as a two-way radio.

(8) Hot work shall not be attempted on a partition, wall, ceiling, or roof that has a combustible covering or insulation, or on walls or partitions of combustible sandwich-type panel construction.

Hot work cannot be performed safely on a metal wall, on a partition to which combustible material has been fastened on one side, or on a sandwich-type partition that contains combustible materials within the sandwiched portions, because heat can be radiated through the metal surface and expose the combustible materials to elevated temperatures that could cause a fire.

See the commentary following 41.3.4.2(2) for additional reference standards addressing fire and explosion hazards of various combustible particulate solids.

(9) Hot work that is performed on pipes or other metal that is in contact with combustible walls, partitions, ceilings, roofs, or other combustibles shall not be undertaken if the work is close enough to cause ignition by conduction.

(10) Fully charged and operable fire extinguishers that are appropriate for the type of possible fire shall be available immediately at the work area.

Fire-extinguishing equipment appropriate for any hazard in the area where hot work is to occur should be readily available in the work area before work begins. The fire watch should be trained in its use. An extinguisher located on a truck or outside the immediate work area is of limited value, because it might be inaccessible during an emergency. Even a simple garden hose connected and pressurized for immediate use or a bucket of water can be useful, depending on the potential size of a fire.

Distribution of portable fire extinguishers must be in accordance with this chapter and Section 13.6.

(11) If existing hose lines are located within the hot work area defined by the permit, they shall be connected and ready for service but shall not be required to be unrolled or charged.

(12) The following shall apply to hot work done in close proximity to a sprinkler head:
   (a) A wet rag shall be laid over the sprinkler head and then removed at the conclusion of the welding or cutting operation.
   (b) During hot work, special precautions shall be taken to avoid accidental operation of automatic fire detection or suppression systems (e.g., special extinguishing systems or sprinklers).

The accidental operation of sprinklers caused by the heat of hot work can be hazardous to persons using electrical equipment, because the water released by the sprinkler can create a serious shock hazard. If a sprinkler system is accidentally activated, hot work should stop until the system is fully restored.

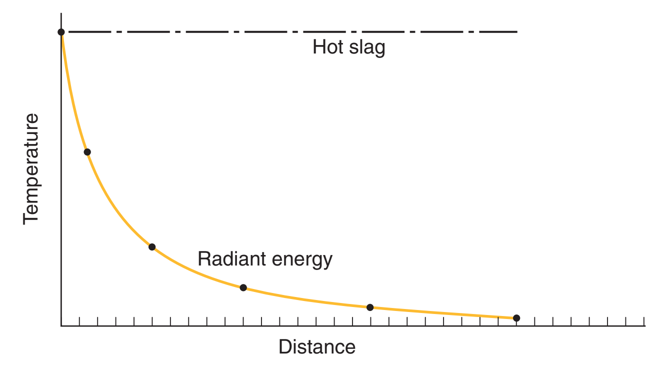
In addition, the activation of a sprinkler system, special hazard system, or fire detection system can send an alarm to the fire department, needlessly deploying responders and equipment and increasing the chance of an injury or a death if an accident occurs during the response. Accidental activation of a special hazard system also wastes extinguishing agent and can cause the fire protection system to be out of service. A careful inspection should be conducted when a system is activated to ensure that the activation was accidental and not the result of a fire that was started by the hot work. If any doubt persists, those on the site and the fire department should make a thorough inspection of the area.

(13) The operator and nearby personnel shall be suitably protected against dangers such as heat, sparks, and slag.

Although radiation energy decreases in proportion to the square of the distance from the source of the fire, as illustrated in Exhibit 41.2, the slag and spatter can continue to be hazardous after the radiation is no longer a threat. PPE is required for personnel working near welding and cutting processes.

(14)* In instances where the scope of work and the tools used to conduct hot work result in possible travel of slag, sparks, spatter, or similar mobile sources of ignition farther than 35 ft

Exhibit 41.2



Decrease in radiation energy relative to the square of the distance from the source.

(11 m), the PAI shall be permitted to extend the distances and areas addressed in 41.3.4.2(2) through 41.3.4.2(4).

A.41.3.4.2(14) Hot work operations that might fall into the category where the 35 Foot Rule could be enlarged include, but are not limited to, elevated hot work and windy areas. [**51B:**A.5.4.2(14)]

(15)* In instances where the scope of work and tools used to conduct hot work are known to be incapable of generating slag, sparks, spatter or similar mobile sources of ignition capable of leaving the immediate area of the applied hot work, the PAI shall be permitted to do the following:
   (a) Reduce the distances and areas addressed in 41.3.4.2(2) through 41.3.4.2(4) to distances and areas that he or she considers fire safe for the intended operation.
   (b) Describe those distances and areas on the hot work permit.

[**51B:**5.4.2]

A.41.3.4.2(15) Hot work operations that might fall into the category where the 35 Foot Rule could be reduced include, but are not limited to, torch soldering, gas tungsten arc welding, heat gun operations, and handheld pen-type soldering. [**51B:**A.5.4.2(15)]

41.3.4.3 The PAI shall determine the length of the period for which the hot work permit is valid. [**51B:**5.4.3]

41.3.4.4 The hot work permit shall not be valid for a period exceeding 24 hours. [**51B:**5.4.3.1]

For a period exceeding 24 hours, the chance for a change in personnel and/or conditions is significant. Due to the change in personnel and conditions, routine re-evaluation is essential to ensure a fire-safe environment during hot work operations.

41.3.4.5 The area shall be inspected by the PAI at least once per shift while the hot work permit is in effect to ensure that it is a fire-safe area. [**51B:**5.4.4]

41.3.5 Fire Watch.

Fire watches might have minimal additional duties in the immediate area; however, these other duties must not interfere with their fire watch responsibilities.

Δ **41.3.5.1*** A fire watch shall be required by the PAI when hot work is performed in a location where other than a minor fire might develop or where the following conditions exist:

(1)* Combustible materials in building construction or contents are closer than 35 ft (11 m) to the point of operation.
(2) Combustible materials are more than 35 ft (11 m) away from the point of operation but are easily ignited by sparks.
(3) Wall or floor openings within an 35 ft (11 m) radius expose combustible materials in adjacent areas, including concealed spaces in walls or floors.
(4) Combustible materials are adjacent to the opposite side of partitions, walls, ceilings, or roofs and are likely to be ignited.

[**51B:**5.5.1]

A.41.3.5.1 The decision tree in Figure A.41.3.5.1 can be used to determine if a fire watch is necessary. [**51B:**A.5.5.1]

Δ **A.41.3.5.1(1)** Figure A.41.3.5.1(1)(a) and Figure A.41.3.5.1(1)(b) demonstrate the hot work 35 Foot Rule. [**51B:**A.5.5.1(1)]

41.3.5.2 A fire watch shall be maintained for at least ½ hour after completion of hot work operations in order to detect and extinguish smoldering fires. The duration of the fire watch shall be extended if the PAI determines the fire hazards warrant the extension. [**51B:**5.5.2]

Generally, if a fire develops from hot work, evidence of smoldering or fire occurs within 30 minutes. However, if the cutting was done in an area that contains a large quantity of finely divided or lightweight combustibles, even though the combustibles were shielded, a longer fire watch might be appropriate and should be required by the PAI. Likewise, if sparks or slag could have entered a crack in a wall or floor, or if other conditions or hazards are unusual, a longer fire watch should be maintained.

See the commentary following 41.3.4.2(2) for additional guidance on reference standards addressing the fire and explosion hazards of various combustible particulate solids.

41.3.5.3* More than one fire watch shall be required if combustible materials that could be ignited by the hot work operation cannot be directly observed by the initial fire watch. [**51B:**5.5.3]

A.41.3.5.3 An additional fire watch(es) might be necessary in certain situations, such as where hot work is performed near open shafts, or at elevated heights or where sparks can travel through spaces such as openings. [**51B:**A.5.5.3]

41.3.6* Hot Tapping. Hot tapping or other cutting and welding on a flammable gas or liquid transmission or distribution utility pipeline shall be performed by a crew that is qualified to make hot taps. [**51B:**5.6]

A.41.3.6 For hot tapping on a gas pipeline, see ANSI/ASME B31.8, *Gas Transmission and Distribution Piping Systems*. [**51B:**A.5.6]

41.3.7 Cylinders. Cylinder use and storage shall be in accordance with Chapter 63. [**51B:**5.7]

41.4 Sole Proprietors and Individual Operators

41.4.1* Assignment of PAI and Fire Watch. In a site where hot work operations are not under the control of another authority, the individual hot work operator shall be permitted to serve as PAI and fire watch, provided that the operator is trained and follows the provisions of Chapter 41. [**51B:**6.1]

A.41.4.1 A common example of a situation where Section 41.4 would apply is work performed in a single-dwelling home by a plumber sweating a pipe. Another example is the repair of a wrought iron railing used for steps in a single-dwelling home. A third example is welding performed on construction or agricultural equipment on site. The NFPA 51B committee recognizes that it is not always practical to have more than one individual present,

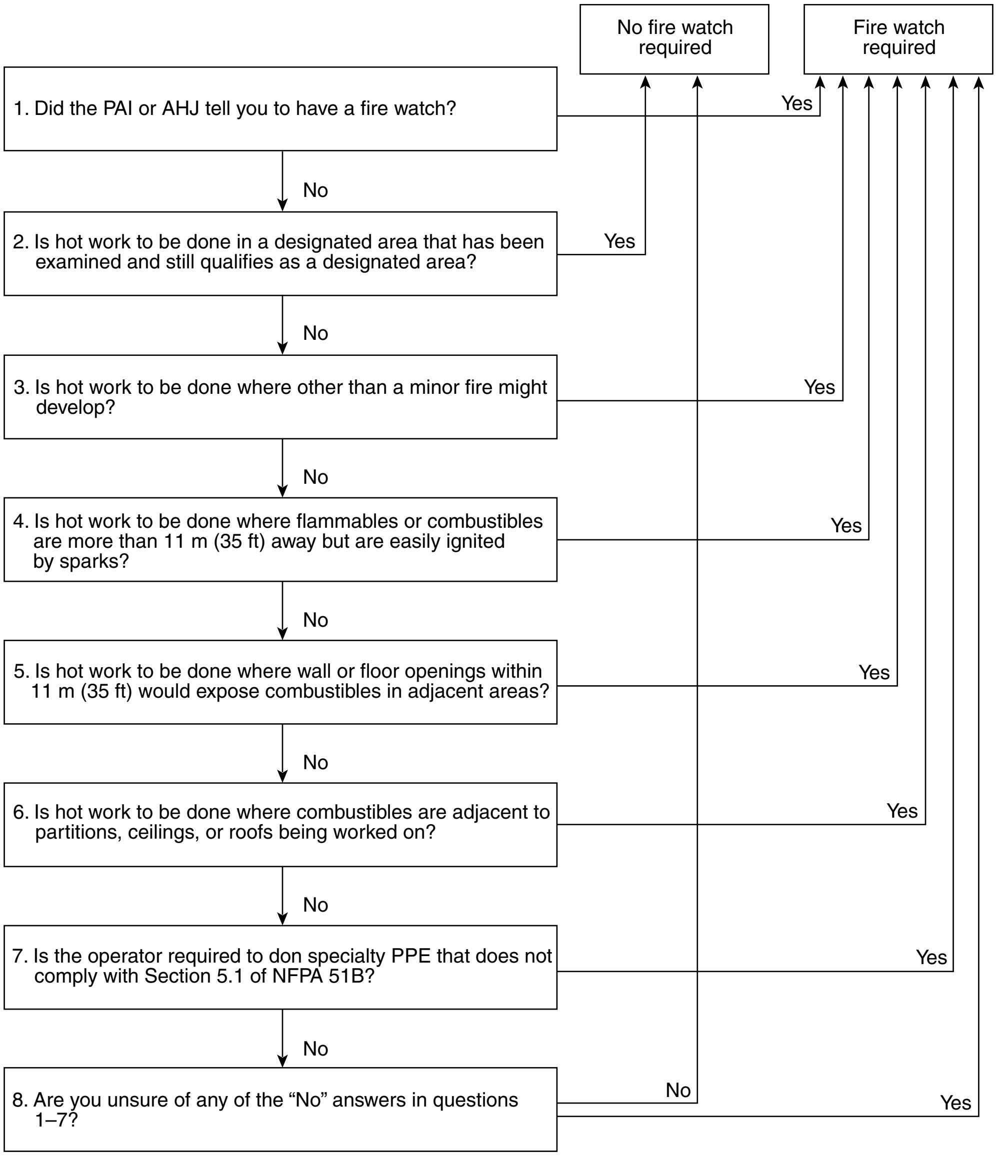


FIGURE A.41.3.5.1 *Fire Watch Decision Tree. [**51B:**Figure A.5.5.1]*

and completing a job with one person is a common practice. The NFPA 51B committee stresses that it is always better to have more than one individual present to ensure fire safety, but realizes that it is not always practical to do so. [**51B:**A.6.1]

41.4.2 Written Hot Work Permit. A checklist shall be permitted to serve as the written hot work permit. [**51B:**6.2]

41.5 Public Exhibitions and Demonstrations

41.5.1 Application. The provisions of Section 41.5 shall apply to oxy–fuel gas welding and cutting operations at public exhibitions, demonstrations, displays, and trade shows, referred to hereinafter as the “site,” in order to promote the safe use of compressed gases in public gatherings. [**51B:**7.1]

41.5.2 Supervision. Installation and operation of welding, cutting, and related equipment shall be done by, or under the supervision of, a competent operator, to ensure the personal protection of viewers and demonstrators as well as the protection from fire of materials in and around the site and the building itself. [**51B:**7.2]

41.5.3 Site.

41.5.3.1 Location. Sites involving the use and storage of compressed gases shall be located so as not to interfere with egress during an emergency. [**51B:**7.3.1]

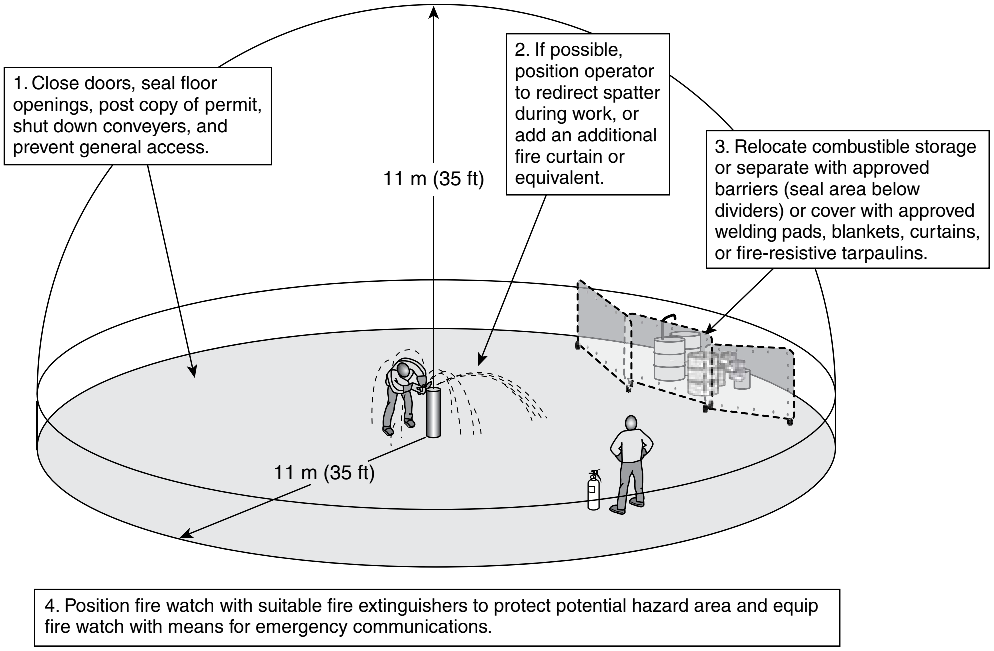


FIGURE A.41.3.5.1(1)(a) *The 35 Foot Rule Illustrated. [**51B:**Figure A.5.5.1(1)(a)]*

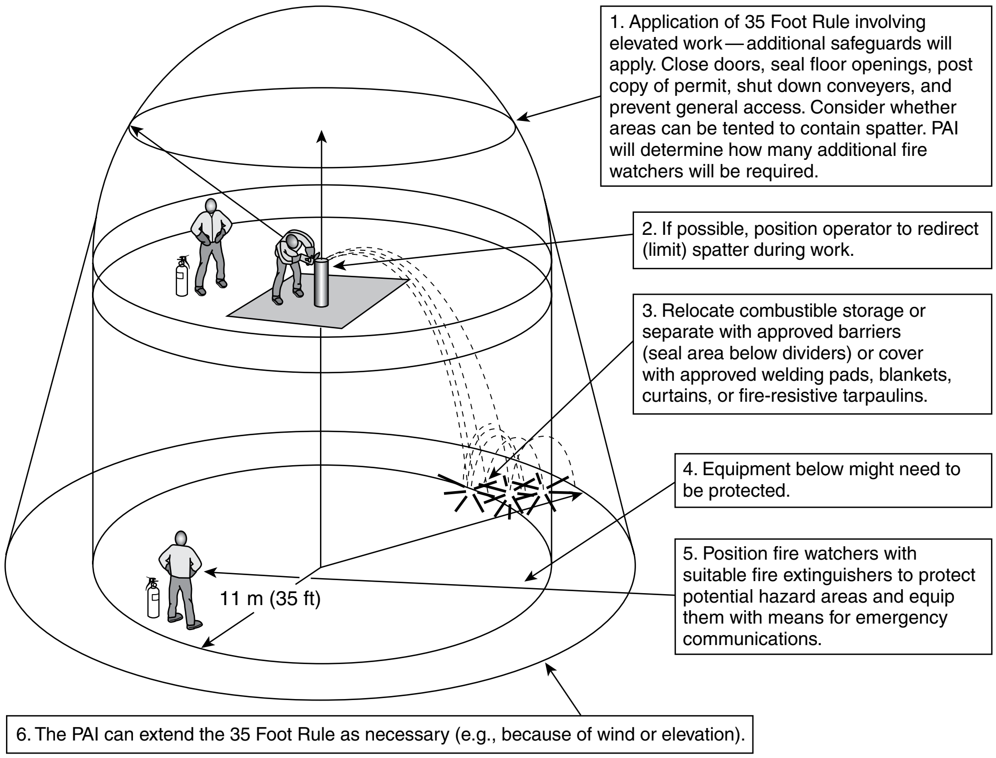


FIGURE A.41.3.5.1(1)(b) *Example of Where Multiple Fire Watches Are Needed. [**51B:**Figure A.5.5.1(1)(b)]*

41.5.3.2 Design. The site shall be constructed, equipped, and operated in such a manner that the demonstration minimizes the possibility of injury to viewers. [**51B:**7.3.2]

41.5.4 Fire Protection.

41.5.4.1 Fire Extinguishers. Each site shall be provided with a portable fire extinguisher of appropriate size and type in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*. [**51B:**7.4.1]

41.5.4.2 Shielding. The public, combustible materials, and compressed gas cylinders at the site shall be protected from flames, sparks, and molten metal. [**51B:**7.4.2]

41.5.4.3 Fire Department Notification. The fire department shall be notified in advance of the use of a site for public exhibitions, demonstrations, and trade shows. [**51B:**7.4.3]

41.5.5 Cylinders.

Compressed gas cylinders used in welding and cutting processes usually contain gases at pressures of approximately 2500 psi (17,237 kPa). However, these pressures can be significantly higher. Gases at these higher pressures are dangerous if not properly handled. The requirements in 41.5.5.1 through 41.5.5.7 are intended to ensure that gas cylinders are properly constructed and stored to prevent the development of a situation that might cause them to leak or ignite.

41.5.5.1 Gas Capacity Limitation.

41.5.5.1.1 Cylinders containing compressed gases for use at the site shall not be charged in excess of one-half their maximum permissible content. [**51B:**7.5.1.1]

41.5.5.1.2 Cylinders of nonliquefied gases and acetylene shall be charged to not more than one-half their maximum permissible charged gauge pressure [psi (kPa)]. [**51B:**7.5.1.2]

41.5.5.1.3 Cylinders of liquefied gases shall be charged to not more than one-half the maximum permissible capacity [lb (kg)]. [**51B:**7.5.1.3]

41.5.5.2 Storage.

41.5.5.2.1 Cylinders located at the site shall be connected for use. [**51B:**7.5.2.1]

41.5.5.2.2 A sufficient number of additional cylinders shall be permitted to be stored at the site to furnish approximately one day's consumption of each gas used. [**51B:**7.5.2.2]

41.5.5.2.3* Other cylinders shall be stored in an approved storage area, but not near a building exit. [**51B:**7.5.2.3]

A.41.5.5.2.3 The preferred location for cylinder storage is in an approved storage area outdoors. [**51B:**A.7.5.2.3]

41.5.5.3 Transporting Cylinders. Cylinders in excess of 40 lb (18 kg) total weight being transported to or from the site shall be carried on a hand truck or motorized truck. [**51B:**7.5.3]

41.5.5.4 Process Hose. Process hose shall be located and protected so that they will not be physically damaged. [**51B:**7.5.4]

41.5.5.5 Cylinder Valves. Cylinder valves shall be closed when equipment is unattended. [**51B:**7.5.5]

41.5.5.6 Valve Caps. If cylinders are designed to be equipped with valve protection caps, such caps shall be in place, except when the cylinders are in service or are connected and ready for service. [**51B:**7.5.6]

41.5.5.7 Cylinder Protection. Cylinders shall be secured so that they cannot be knocked over. [**51B:**7.5.7]

41.6 Arc Welding Equipment

41.6.1 Installation. Electrical equipment shall be of an approved type and shall be installed and used in accordance with Section 11.1 and manufacturers' requirements.

41.6.2 Damaged cables shall be removed from service until repaired or replaced.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

Ahrens, M., "Structure Fires Started by Hot Work," NFPA Fire Analysis and Research Division, September 2016, PDF available for download at http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/fire-causes/appliances-and-equipment/structure-fires-started-by-hot-works

NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 2018 edition.

NFPA 51A, *Standard for Acetylene Cylinder Charging Plants*, 2012 edition (withdrawn 2016).

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2014 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2016 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, 2017 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2015 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*, 2015 edition.

NFPA 484, *Standard for Combustible Metals*, 2015 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2017 edition.

NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*, 2017 edition.

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ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes, 2012, American National Standards Institute, Inc., New York, NY.

U.S. Chemical Safety Board, "Seven Key Lessons to Prevent Worker Deaths During Hot Work In and Around Tanks," February 2010, available on-line at www.csb.gov.

U.S. Government Publishing Office, Washington, DC 20402.

Title 29, Code of Federal Regulations, Part 1910, Subpart Q, "Welding, Cutting and Brazing."

Title 29, Code of Federal Regulations, Part 1926, Subpart J, "Welding and Cutting."

Refueling

42

42.1 General

Chapter 42 shall apply to refueling of automotive vehicles, marine vessels, and aircraft.

Chapter 42 addresses refueling of all automotive vehicles, including passenger cars, trucks, and vans; marine vessels; and aircraft using traditional hydrocarbon and alternative fuels. This chapter and NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, also apply to motor fuel dispensing facilities that are not engaged in the retail sale of motor fuels and are not patronized by the general public. These motor fuel dispensing facilities include refueling facilities at municipal garages, police and fire stations, industrial plants, motor freight terminals, and other private businesses, as well as private marinas.

NFPA 30A defines the term *motor fuel dispensing facility* as "that portion of a property where motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles or marine craft or into approved containers, including all equipment used in connection therewith."

42.2 Automotive Fuel Servicing

42.2.1 Applicability.

42.2.1.1 Fueling processes at automotive service stations, service stations located inside buildings, and fleet vehicle service stations shall comply with NFPA 30A and Sections 42.2 through 42.8.

42.2.1.2 If approved by the AHJ, mobile fleet fueling at commercial, industrial, and governmental sites shall be conducted in accordance with 42.7.6.

42.2.1.3* Sections 42.2 through 42.8 shall not apply to those motor fuel dispensing facilities where only liquefied petroleum gas (LP-Gas), liquefied natural gas (LNG), or compressed natural gas (CNG) is dispensed as motor fuel. [**30A:**1.1.3]

A.42.2.1.3 See NFPA 52 and NFPA 58 for requirements for facilities where only these fuels are dispensed. [**30A:**A.1.1.3]

Facilities that dispense only hydrogen, liquefied natural gas (LNG), or compressed natural gas (CNG) are covered directly by NFPA 2, *Hydrogen Technologies Code*, or NFPA 52, *Vehicular Natural Gas Fuel Systems Code*. Facilities that dispense only LP-Gas are covered directly by NFPA 58, *Liquefied Petroleum Gas Code*. However, the NFPA Standards Council has given the Technical Committee on Automotive and Marine Service Stations responsibility for developing appropriate requirements for refueling vehicles with gaseous fuels where those fuels are dispensed along with traditional liquid fuels (i.e., gasoline and diesel fuel). Facilities that dispense both gaseous and liquid fuels are, therefore, covered by NFPA 30A. Most of the requirements for the use of gaseous fuels at mixed fuel facilities are addressed by reference to the primary document for the fuel, such as NFPA 2 for hydrogen or NFPA 52 for LNG and CNG. Facilities that dispense both gaseous and liquid fuels are, therefore, covered by NFPA 30A.

42.2.2 General Requirements.

42.2.2.1 Permits. Permits, where required, shall comply with Section 1.12.

Table 1.12.8(a) requires a permit for the operation of repair garages and service stations. Table 1.12.8(a) also requires facilities to obtain a permit to do the following:

1. Store, handle, or use Class I, Class II, or Class IIIA flammable or combustible liquids inside buildings
2. Provide automotive fuel servicing
3. Provide marine craft fuel servicing
4. Provide aircraft fuel servicing or operate aircraft refueling vehicles
5. Store, use, handle, or dispense LP-Gas inside buildings
6. Remove Class I or Class II liquids from an underground storage tank used for fueling motor vehicles by any means other than the approved, stationary on-site pumps normally used for dispensing purposes
7. Install, alter, remove, abandon, place temporarily out of service, or otherwise dispose of a flammable or combustible liquid tank
8. Display, compete, or demonstrate liquid- or gas-fueled vehicles or equipment in assembly buildings

42.2.2.2 Plans and Specifications. Plans and specifications shall be submitted for review and approval prior to the installation or construction of a motor vehicle fuel dispensing station.

42.2.2.2.1 A site plan shall be submitted that illustrates the location of flammable and combustible liquids, LP-Gas or CNG storage vessels, and their spatial relation to each other, property lines, and building openings.

42.2.2.2.2 Aboveground and underground storage vessels shall be shown on plans.

42.2.2.2.3 For each type of fuel dispensing facility, plans and specifications shall also include, but not be limited to, the following:

(1) Type and design of underground and aboveground liquid storage tanks
(2) Quantity and types of liquids to be stored
(3) Location and design of the fuel dispensers and dispenser nozzles
(4) Distances from dispensers to tanks, property lines, and buildings
(5) Vehicle access
(6) Fire appliances
(7) Vehicle impact protection
(8) Method of storage and dispensing
(9) Overfill prevention
(10) Spill containment
(11) Vents
(12) Vapor recovery
(13) Other equipment and accessories
(14) Seismic design in accordance with the building code
(15) Secondary containment
(16) Design and specifications for related piping, valves, and fittings
(17) Location and classification of electrical equipment, including emergency fuel shutdown devices
(18) Specifications for fuel storage and venting components
(19) Other information as required by the AHJ

42.3 Storage of Liquids

42.3.1 Scope. Section 42.3 shall apply to the storage of liquid fuels and to the storage of related materials, such as lubricating oils and greases, cleaning solvents, and windshield washer solvents. [**30A:**4.1]

42.3.2 General Requirements.

Δ **42.3.2.1** Liquids shall be stored in the following:

(1) Approved closed containers that do not exceed 60 gal (227 L) capacity and are located outside buildings
(2) Tanks or approved closed containers located inside motor fuel dispensing facilities or repair garages

The quantity of liquid allowed to be stored indoors is covered in 42.3.3.9. Indoor storage still requires approved closed containers or storage tanks. Closed storage prevents evaporation of volatile materials and release of vapors that can accumulate in locations where there might be a source of ignition. Closed storage is also of particular concern where workers could be exposed to toxic materials.

(3) Aboveground tanks, underground tanks, and containers in accordance with the requirements of 42.3.3
(4) Tanks supplying marine service stations in accordance with 42.9.2.

[**30A:**4.2.1]

42.3.2.2 A motor fuel dispensing facility located at a bulk plant shall be separated from areas in which bulk plant operations are conducted by a fence or other approved barrier. Dispensing devices at the motor fuel dispensing facility shall not be supplied by aboveground tanks located in the bulk plant. Storage tanks at motor fuel dispensing facilities shall not be connected by piping to aboveground tanks located in the bulk plant. [**30A:**4.2.2]

The first sentence of 42.3.2.2 requires physical separation of the dispensing facility from the bulk plant (terminal). The separation is intended to prevent patrons from inadvertently driving into the bulk plant area and interfering with its operations. This safety measure takes into account that portions of the piping system at a bulk plant, particularly at loading racks, are exposed and subject to impact. The restriction forbidding connection of bulk storage tanks to service station tanks or dispensers is deemed necessary in order to reduce the likelihood of overfilling the service station tanks or unrestricted siphon flow due to a break in a pipeline leading to a dispenser. The intent is that bulk storage tanks must not be used to supply service station dispensers, either directly or indirectly, via underground tanks. See Exhibit 42.1.

Exhibit 42.1

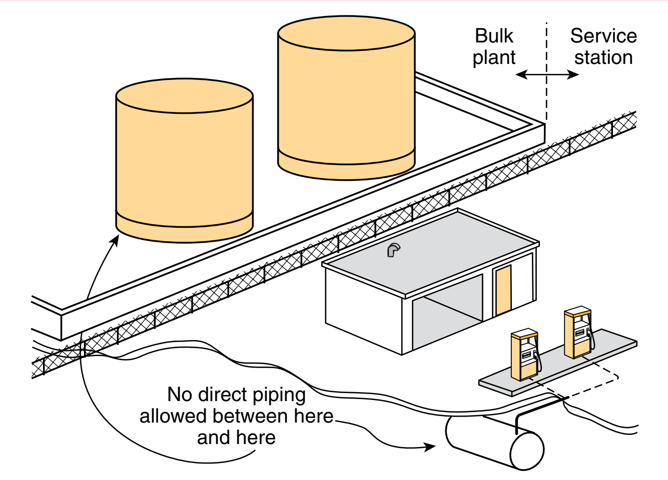


Diagram illustrating the separation requirements of the dispensing facility from the bulk plant.

42.3.2.3 Class I liquids shall not be stored or handled in a building that has a basement or pit into which ignitible vapors can travel, unless the basement or pit is provided with ventilation that will prevent the accumulation of vapors. The ventilation system shall be capable of providing at least 1 ft^3/min of exhaust per ft^2 of floor area (0.3 $m^3/min/m^2$), but not less than 150 ft^3/min (4 m^3/min). [**30A:**4.2.3]

For the purposes of 42.3.2.3, ventilation is considered adequate if the concentration of vapors in the exhaust air stream is maintained at not more than 25 percent of the lower flammable limit (LFL). Such a mixture is "too lean" to be ignited. The minimum ventilation rate required here, 1 cfm/min/ft^2 (0.3 m^3/min/m^2) of floor area, is sufficient to provide six air changes per hour, assuming a 10 ft (3 m) ceiling height.

Ventilation is vital to the prevention of flammable liquid fires and explosions; it collects vapors, dilutes them to a safe concentration, and then removes them to a safe location, usually outdoors. Ventilation can be accomplished by natural or forced air movement.

42.3.2.4 Where tanks are at an elevation that produces a gravity head on the dispensing device, the tank outlet shall be equipped with a device, such as a normally closed solenoid valve, positioned adjacent to and downstream from the valve specified in 22.13.1 of NFPA 30 that is installed and adjusted so that liquid cannot flow by gravity from the tank if the piping or hose fails when the dispenser is not in use. [**30A:**4.2.4]

The solenoid valve required by 42.3.2.4 is needed because even a small leak will eventually result in the loss of all, or a substantial portion of, the liquid in the tank by siphon flow. The valve required by 66.22.13.1, is typically manually operated, but it could be automatically operated. In the latter case, however, the valve is typically not a normally closed type, so it would not be considered a means of complying with 66.22.13.1. Exhibit 42.2 illustrates a situation that would be addressed by 42.3.2.4.

42.3.3 Storage of Liquids.

42.3.3.1 Underground Tanks. Underground storage tanks shall meet all applicable requirements of Chapters 21 and 23 of NFPA 30. [**30A:**4.3.1]

Compared with aboveground tanks, underground tanks offer absolute protection from accidental impact. However, if underground tanks leak, they can present greater remediation problems, particularly if the leak goes undetected for a long period of time. Also, the fuel released from the leak can have greater impact on groundwater and, therefore, presents difficult recovery problems. The fuel can also find its way to subterranean spaces or basements.

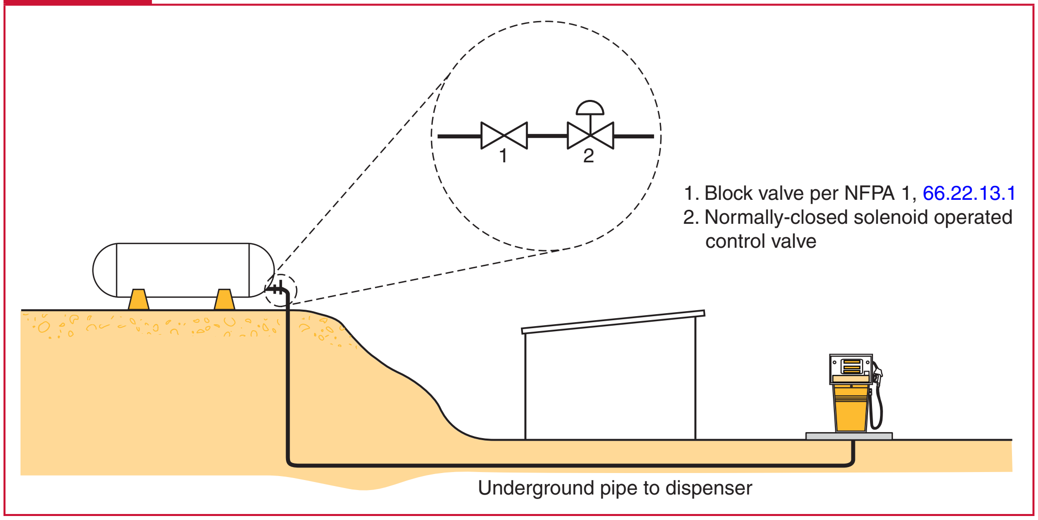
Exhibit 42.3 shows an underground tank being installed; in this case, the tank is being lowered into its excavation. Exhibit 42.4 shows a typical underground fuel storage system at a motor fuel dispensing facility and the components connected to it.

Any liquid storage system where 10 percent or more of the storage capacity is below grade is regulated as an underground tank by the U.S. Environmental Protection Agency (EPA). Thus, a relatively small fuel tank with a long run of underground piping could be considered an underground storage system, at least by the EPA. In this case, "system" includes all liquid-handling components, including the piping. The following publications are recommended as sources of information: STI R892, *Recommended Practice for Corrosion Protection of Underground Piping Networks Associated with Liquid Storage and Dispensing Systems*, from the Steel Tank Institute; and API RP1632, *Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems, from* the American Petroleum Institute.

42.3.3.2* Aboveground Storage Tanks. Except as modified by the provisions of this subsection, aboveground storage tanks shall meet all applicable requirements of Chapters 21 and 22 of NFPA 30. [**30A:**4.3.2]

It is important to understand that the installations allowed by 42.3.3.2 are not considered to be equivalent to an underground installation, although a vaulted tank probably comes closest in terms of fire protection and environmental protection. For example, aboveground tanks are subject to significant changes in ambient temperature, almost on a daily basis, that result in the evolution of vapors. Although underground tanks also respond to temperature changes of the surrounding ground, these changes are not nearly as great and occur more gradually

Exhibit 42.2



Fuel storage tank that can impose a gravity head on the dispensers.

Exhibit 42.3

Installation of an underground tank. (Courtesy of Fairfield Ledger)

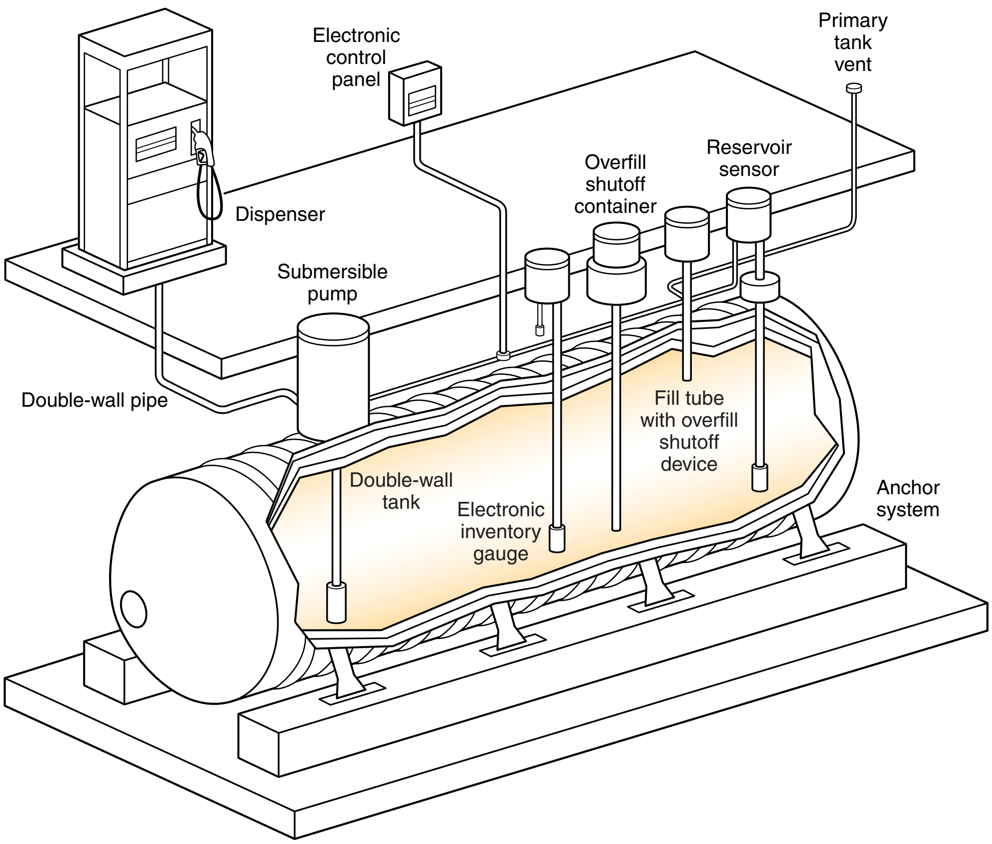
over time. However, the requirements that follow do provide a reasonable degree of fire safety that is commensurate with the hazards of aboveground storage tank installations.

Δ **A.42.3.3.2** PEI RP200, *Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling*, provides information on proper installation, inspection, and maintenance of aboveground storage systems for motor vehicle fueling, including associated devices and components. The U.S. Environmental Protection Agency's regulation for Spill Prevention Control and Countermeasure (SPCC) Plans found in 40 CFR 112, provides additional requirements. [**30A:**A.4.3.2]

Paragraph 42.3.3.2 requires that aboveground storage tanks meet the provisions of NFPA 30, *Flammable and Combustible Liquids Code*, for tank design and construction. These provisions include the following:

1. Basic design and construction of the tank itself
2. Shell-to-shell spacing for multiple tank installations
3. Spill control
4. Basic requirements for vent piping
5. Sizing and installation of emergency vents
6. Supports and anchoring

Exhibit 42.4



Typical underground tank system for motor fuel dispensing.

7. Overfill prevention
8. Testing and maintenance

PEI RP200, *Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling*, from the Petroleum Equipment Institute and referenced in A.42.3.3.2, provides detailed information on the proper installation of aboveground tank systems and is directed at the installation contractor. It is a valuable source of information for regulatory officials charged with approving such installations.

42.3.3.2.1 The use of aboveground storage tanks at motor fuel dispensing facilities, fleet vehicle motor fuel dispensing facilities, and marine motor fuel dispensing facilities shall be permitted when installed in accordance with the requirements of this subsection and with all applicable requirements of Chapters 21, 22, and 27 of NFPA 30 and, for tanks other than tanks in vaults, when the specific installation has been approved by the AHJ. [**30A:**4.3.2.1]

42.3.3.2.2 Tanks designed and built for underground use shall not be installed for aboveground use. [**30A:**4.3.2.2]

The provision of 42.3.3.2.2 prohibits the installation of an underground tank above ground, because the design of an underground tank assumes even support of the tank shell by the surrounding backfill.

42.3.3.2.3 Tanks storing liquid motor fuels at an individual site shall be limited to a maximum individual capacity of 12,000 gal (45,400 L) and aggregate capacity of 48,000 gal (181,700 L) unless such tanks are installed in vaults complying with 42.3.3.3, in which case the maximum individual capacity shall be permitted to be 15,000 gal (57,000 L). [**30A:**4.3.2.3]

The maximum capacities in 42.3.3.2.3 were deliberately chosen on the basis of typical underground systems in use, with due regard for fire safety. The maximum individual capacity accommodates the largest delivery of a single product grade that might be expected. The maximum aggregate capacity allows the facility owner or operator the flexibility needed to offer a full range of fuel products. These tank storage capacities are typical of automotive service stations, which usually have two or three 12,000 gal (45,400 L) tanks for different grades of gasoline and smaller tanks for kerosene or diesel fuel.

If tanks are installed in vaults, the maximum individual capacity is allowed to be increased by 25 percent, recognizing the superior safety provided by a vaulted installation.

In the 2012 edition, this paragraph was revised by replacing “Class I and Class II liquids” with “liquid motor fuels” to allow the use of alternative liquid fuels that are Class III liquids.

42.3.3.2.4 Tanks shall be located in accordance with Table 42.3.3.2.4. [**30A:**4.3.2.4]

A 50 ft (15 m) minimum separation between a single-wall bare steel aboveground tank and the dispensers is believed to be adequate to protect the tanks from a fire originating at

Δ ***TABLE 42.3.3.2.4*** *Minimum Separation Requirements for Aboveground Tanks*

		Minimum Distance (ft)				
Tank Type	**Individual Tank Capacity (gal)**[a]	**From the Nearest Important Building on the Same Property**	**From Nearest Fuel Dispensing Device**[b]	**From Lot Line That Is or Can Be Built Upon**[c]	**From the Nearest Side of Any Public Way**	**Between Tanks**
Tanks in vaults[d]	0–15,000	0	0	0	0	Separate compartments required for each tank
Protected aboveground tanks	Less than or equal to 6,000	5	0	15	5	3
	6,001–12,000	15	0	25	15	3
Fire-resistant tanks	0–12,000	25	25	50	25	3
Other tanks meeting the requirements of NFPA 30	0–12,000	50	50	100	50	3

For SI units, 1 ft = 0.30 m; 1 gal = 3.8 L.

[a]See 42.3.3.2.3 and 42.3.3.2.5.

[b]See 42.3.3.2.6.

[c]Including the opposite side of a public way.

[d]The separation distances given for vaults are measured from the outer perimeter of the vault.

[**30A:** Table 4.3.2.4]

the dispensers. This same 50 ft (15 m) distance was used for separation to the near side of a public road and to the nearest important building on the property. These separation distances are far greater than would be required by NFPA 30 for tanks of equal capacity. Similarly, the 100 ft (30 m) minimum separation specified between the tank and the property lines is more than three times what NFPA 30 would require, again under the most adverse conditions.

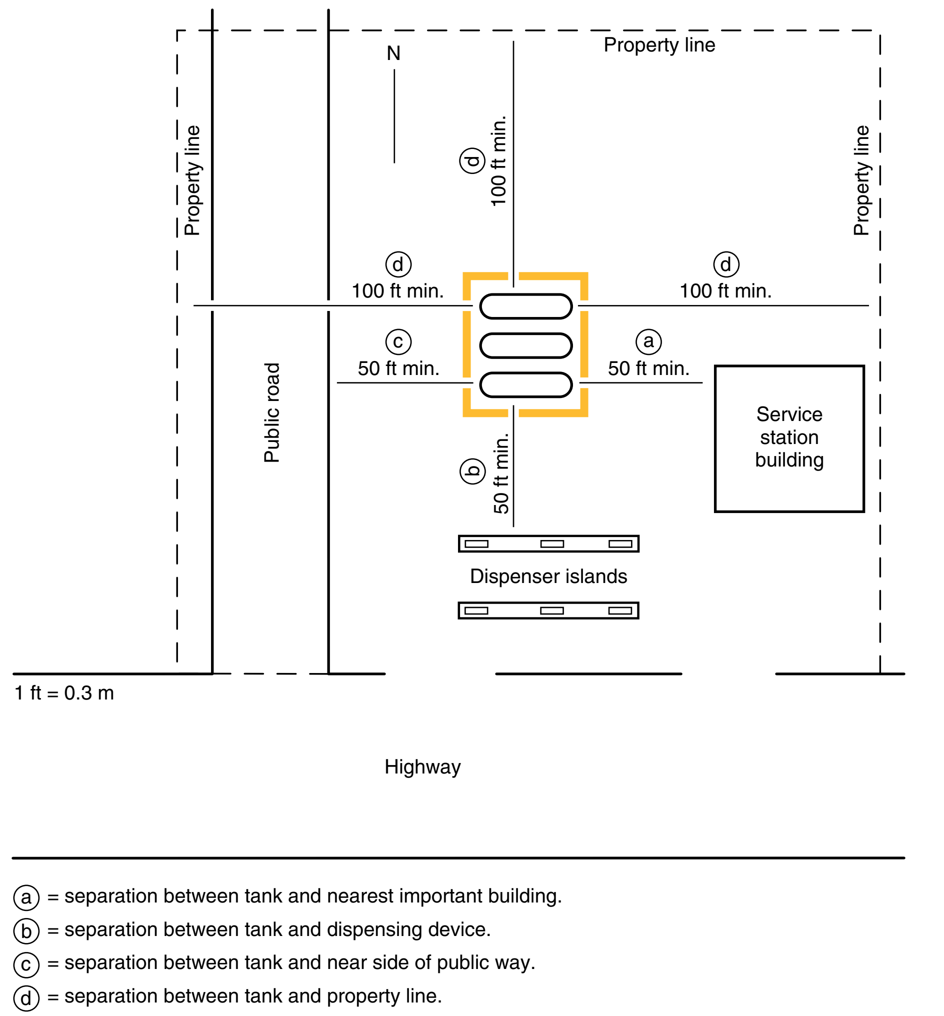
These distances were considered to be the minimum separations that could be safely used with traditional aboveground tanks in an environment where the public has ready access. These distances can be decreased only if the tanks are inherently more fire safe or are installed in a vault.

Exhibit 42.5 illustrates the separation required for bare steel tanks. Note that the 50 ft (15 m) distance required by Table 42.3.3.2.4 applies only where the near side of a public way lies inside the property line, as might arise due to a public easement through the property. In the situation depicted in Exhibit 42.5, if the west property line were on the east side of the road, the tanks would have to be situated twice as far from the road. As the diagram illustrates, use of such aboveground tanks requires a large site — at least 40,000 ft^2 (approximately 3700 m^2). Installations such as these are unlikely to be used in urban or densely populated areas.

42.3.3.2.5 The maximum individual tank capacity of 12,000 gal (45,400 L), where indicated in Table 42.3.3.2.4, shall be permitted to be increased to 20,000 gal (75,700 L) for Class II and Class III liquids at a fleet vehicle motor fuel dispensing facility and an aggregate capacity of 80,000 gal (304,000 L). [**30A:**4.3.2.5]

Note that the increased capacities in 42.3.3.2.5 apply only to fleet vehicle motor fuel dispensing facilities — that is, facilities where the vehicles and refueling systems are under common ownership or control. Aboveground fuel storage at large public truck

Exhibit 42.5



Separation distances for aboveground storage tank installation using bare steel tanks. For fire-resistant tanks, the separation distances shown can be halved.

stop facilities that would typically have storage requirements well above the 48,000 gal (181,700 L) aggregate maximum capacity specified in 42.3.3.2.3 have not been addressed. To date, no proposals have been made to amend NFPA 30A to address that situation.

42.3.3.2.6 At fleet vehicle motor fuel dispensing facilities, no minimum separation shall be required between the dispensing device and a tank in a vault, a protected aboveground tank, or a fire-resistant tank. [**30A:**4.3.2.6]

Paragraph 42.3.3.2.6 allows a fuel dispenser at a fleet fuel dispensing facility to be mounted immediately on or adjacent to the tank, if the tank is installed in a vault or the tank is a listed fire-resistant tank or protected tank. If the tank is a traditional bare steel tank, then the 15 m (50 ft) separation distance called for in Table 42.3.3.2.4 would apply. An island-type dispenser should not be located within a diked area or within a vault.

Δ **42.3.3.2.7** The provisions of this subsection shall not prohibit the dispensing of liquid motor fuels in the open from a fuel dispensing system supplied by an existing aboveground tank, not to exceed 6000 gal (22,710 L), located at commercial, industrial, government, or manufacturing establishments, and intended for fueling vehicles used in connection with their business. Such dispensing shall be permitted provided the following conditions are met:

(1) An inspection of the premises and operations has been made and approval has been granted by the AHJ.
(2) The tank is safeguarded against collision, spillage, and overfill to the satisfaction of the AHJ.
(3) The tank system is listed or approved for such aboveground use.
(4) The tank complies with requirements for emergency relief venting, the tank and dispensing system meet the electrical classification requirements of NFPA 30A, and the tank complies with the provisions of 42.3.2.4.
(5) The tank storage complies with Chapter 22 of NFPA 30.

[**30A:**4.3.2.7]

The authority having jurisdiction (AHJ) can allow two tanks if the operator requires two classes of fuel — Class I (gasoline) and Class II (diesel fuel). In addition, note that this paragraph is also applicable to the refueling of "nonregistered" vehicles that are operated only on site, such as industrial trucks. Exhibit 42.6 illustrates collision protection for an aboveground storage tank.

In the 2012 edition, 42.3.3.2.7 was revised by replacing the words "Class I and Class II liquids" in the first sentence with "liquid motor fuels" to allow the use of alternative liquid fuels that are Class III liquids.

42.3.3.2.8 Aboveground tanks shall be provided with spill control that meets the requirements of 66.21.7.1 and 66.22.11. Tank fill connections shall be provided with a noncombustible spill containment device.

*Exception: Tanks installed in vaults that meet the requirements of 42.3.3.3 need not meet this requirement. [**30A:**4.3.2.8]*

Exhibit 42.6

Collision protection for an aboveground storage tank. (Courtesy of Steel Tank Institute)

NFPA 30 provides three options for spill control: remote impounding, open diking, or closed-top diking. Of these, only the latter two are practical for a motor fuel dispensing facility. The required containment capacity is based on the volume of the largest tank and the type of material being stored in the area for which the spill control is being provided. Also note that the EPA Spill Prevention, Control, and Countermeasure (SPCC) Rule (40 CFR 112) applies to any aboveground storage tank system that exceeds 1320 gal (5000 L) aggregate capacity or any single tank that is greater than 660 gal (2500 L) capacity and that is located near surface waters, or to any underground storage exceeding 42,000 gal (159,000 L) aggregate capacity and also located near surface waters.

A storage tank vault does not have to meet this provision of NFPA 30A, because it completely encloses the tank. A secondary containment-type tank that meets the provisions of 66.22.11.4 would also not need to have separate diking provisions.

42.3.3.3 Vaults for Aboveground Tanks.

Of the types of aboveground storage systems allowed, a vaulted installation probably presents the greatest degree of equivalence to an underground buried tank in terms of both fire protection and environmental safety. The vault itself has the advantage of being located above grade, partially above and partially below grade, or completely below grade, with its top either at or below the surface. The vault provides suitable thermal protection from an exposure fire and suitable protection from impact. The tank and all piping connections can be inspected and repairs effected, as necessary.

Compliance with the ventilation requirements and the liquid and vapor detection requirements ensures rapid response to a leak or spill from the primary vessel. Most important, if a release does occur, it is totally contained, and immediate action can be taken to mitigate it. This degree of safety and the ability to detect and respond immediately to a release are the vaulted tank's most significant benefits.

42.3.3.3.1 Scope. Paragraph 42.3.3.3 shall apply to installation of aboveground tanks in vaults and design and installation of such vaults. [**30A:**4.3.3.1]

42.3.3.3.2 General. Aboveground tanks shall be permitted to be installed in vaults that meet the requirements of 42.3.3.3. Except as modified by the provisions of 42.3.3.3, vaults shall meet all other applicable provisions of NFPA 30A. Vaults shall be constructed and listed in accordance with UL 2245, *Standard for Below-Grade Vaults for Flammable Liquid Storage Tanks*. Vaults shall be permitted to be either above or below grade. [**30A:**4.3.3.2]

42.3.3.3.3* Construction and Installation of Storage Tank Vaults.

A.42.3.3.3.3 Some of the specifications for vault design and construction include the following:

(1) The walls and floor of the vault are to be constructed of reinforced concrete at least 6 in. (50 mm) thick.
(2) The top and floor of the vault and the tank foundation must be designed to withstand all anticipated loading, including loading from vehicular traffic, where applicable.
(3) The walls and floor of a belowgrade vault must be designed to withstand anticipated soil and hydrostatic loading.
(4) The vault must be liquidtight.
(5) The vault enclosure must have no openings except those necessary for access to, inspection of, and filling, emptying, and venting of the tank.
(6) The vault shall be provided with connections to permit ventilation to dilute, disperse, and remove any vapors prior to personnel entering the vault.
(7) The vault must be provided with a means for personnel entry.
(8) The vault must be provided with an approved means to admit a fire suppression agent.

[**30A:**A.4.3.3.3]

42.3.3.3.3.1 Construction Requirements. Vaults shall be designed and constructed in accordance with 42.3.3.3.3.1.1 through 42.3.3.3.3.1.4. [**30:**25.5.1]

The construction requirements for vaults are patterned after — in fact, they replaced — an old set of requirements for "special enclosures" that were part of NFPA 30A until the 2000 edition. The special enclosures were dedicated rooms within a building in which fuel storage tanks were installed. They never had wide application except for some installations in large cities. The construction requirements specified in 42.3.3.3.3.1 are intended to ensure that vaults are of substantial construction, that they are capable of withstanding any anticipated loads and stresses, and, for vaults installed at or above grade, that they can withstand the effects of an exposure fire.

Note that 42.3.3.3.3.1.1 requires that the top of an abovegrade vault be built of noncombustible material, thus allowing lightweight construction. It also requires that the top be able to vent an internal explosion, as unlikely as that might be. Paragraph 42.3.3.3.3.1.2, however, allows an option for vaults with tops that are at grade or that are entirely subterranean because they can be designed to contain an explosion. In allowing the "design to contain" option, consideration was given to the fact that many of these vaults are subject to vehicular traffic, particularly those that are used as replacements for underground tanks at small service station sites, where the vaults are located partly or completely underneath the normal path of vehicle traffic into and out of the service station. In such cases, either the top of the vault constitutes part of the service station driveway or the vault lies directly beneath the driveway. In any event, no practical means exists to vent an internal explosion, and, in fact, with all the requirements imposed on vaulted tanks, an internal explosion is unlikely.

42.3.3.3.3.1.1 The top of an abovegrade vault that contains a tank storing Class I liquid or Class II or Class III liquid stored at a temperature above its flash point shall be constructed of noncombustible material and shall be designed to be weaker than the walls of the vault to ensure that the thrust of any explosion occurring inside the vault is directed upward before destructive internal pressure develops within the vault. [**30A:**4.3.3.3.1.1]

42.3.3.3.3.1.2 The top of an at-grade or belowgrade vault that contains a tank storing Class I liquid or Class II or Class III liquid stored at a temperature above its flash point shall be designed to relieve or contain the force of any explosion occurring inside the vault. [**30A:**4.3.3.3.1.2]

To effectively vent an explosion within a belowgrade vault, the design has to incorporate a duct that extends to a safe distance above grade. This duct has to be strong enough so that it does not fail before the deflagration vent can operate. See NFPA 68, *Standard on Explosion Protection by Deflagration Venting*. Alternatively, the vault can be designed to withstand the overpressure of an explosion. This technique is known as *deflagration pressure containment* and is the option almost universally chosen. See Chapter 13 of NFPA 69, *Standard on Explosion Prevention Systems*.

42.3.3.3.3.1.3 Adjacent vaults shall be permitted to share a common wall. [**30:**25.5.1.3]

42.3.3.3.3.1.4 Where required, the vault shall be wind and earthquake resistant, in accordance with recognized engineering standards. [**30:**25.5.1.4]

42.3.3.3.3.2 Installation Requirements. Storage tank vaults shall be installed in accordance with the requirements of 42.3.3.3.3.2.1 and 42.3.3.3.3.2.2. [**30:**25.5.2]

42.3.3.3.3.2.1 Each vault and its tank shall be anchored to resist uplifting by groundwater or flooding, including when the tank is empty. [**30:**25.5.2.1]

42.3.3.3.3.2.2 Vaults that are not resistant to damage from the impact of a motor vehicle shall be protected by collision barriers. [**30:**25.5.2.2]

42.3.3.3.4 Tank Selection and Arrangement.

42.3.3.3.4.1 Tanks installed in storage tank vaults shall be listed for aboveground use. [**30:**25.3.1.4]

Even though the storage tank vault itself might be located underground, the tank within it must be an aboveground tank. An underground tank cannot be used because there is no backfill to properly support it.

42.3.3.3.4.2 Each tank shall be in its own vault and shall be completely enclosed by the vault. [**30:**25.3.1.5]

42.3.3.3.4.3 Sufficient clearance between the tank and the vault shall be provided to allow for visual inspection and maintenance of the tank and its appurtenances. [**30:**25.3.1.6]

42.3.3.3.4.4 Backfill shall not be permitted around the tank. [**30:**25.3.1.7]

42.3.3.3.5 Tank Appurtenances.

42.3.3.3.5.1 Vent pipes that are provided for normal tank venting shall terminate outside the vault and at least 12 ft (3.6 m) above ground level and shall meet the requirements of 66.27.8.1. [**30A:**4.3.3.5.1]

The requirement in 42.3.3.3.5.1 is based on a similar requirement in 66.25.13 and is intended to ensure adequate dispersal of vapors that are released through the vent whenever the tank is filled or there are increases in ambient temperature.

42.3.3.3.5.2 Emergency vents shall be vaportight and shall be permitted to discharge inside the vault. Long-bolt manhole covers shall not be permitted for this purpose. [**30A:**4.3.3.5.2]

Emergency vent devices must be vaportight to prevent the occurrence of nuisance shutdowns triggered by the vapor detection system. Long-bolt manway covers (also known as loose-bolt manhole covers) are prohibited, because they leak vapors too readily.

42.3.3.3.5.3 An approved means of overfill protection shall be provided for tanks. The use of ball float valves shall be prohibited. [**30A:**4.3.3.5.3]

42.3.3.3.5.4 Fill connections for vaults installed inside buildings shall comply with 66.22.13.4. [**30A:**4.3.3.5.4]

42.3.3.3.6 Ventilation Systems for Storage Tank Vaults.

[**30:**25.10]

The provision in 42.3.3.3.6 is a fundamental personnel safety requirement related to confined space entry rules. For further information, see 29 CFR, Part 1910.146, "Permit Required Confined Spaces."

Because some seepage of liquid at pipe joints, fittings, pump packing glands, and so forth, is anticipated, continuous ventilation is required to remove resulting vapors. If a sizable leak occurs, the concentration of vapors would likely exceed 25 percent of the lower flammable limit, and the detection system would shut down the delivery of fuel, minimizing the release of fuel while, at the same time, warning the operator of a problem. Note that fuel would probably be fed to the dispensers by a pump installed at the tank. Thus, the piping system would be pressurized and any leak that occurs would have the potential to release a large quantity of liquid, especially while the pump is running.

42.3.3.3.6.1 Vaults that contain tanks storing Class I liquids shall be ventilated at a rate of not less than 1 cfm/ft^2 of floor area (0.3 m^3/min/m^2), but not less than 150 cfm (4 m^3/min). [**30:**25.10.1]

42.3.3.3.6.2 Such ventilation shall operate continuously or shall be designed to operate upon activation of a vapor and liquid detection system. [**30:**25.10.2]

42.3.3.3.6.3 Failure of the exhaust airflow shall automatically shut down the dispensing system. [**30:**25.10.3]

42.3.3.3.6.4 The exhaust system shall be designed to provide air movement across all parts of the vault floor. [**30:**25.10.4]

42.3.3.3.6.5 Supply and exhaust ducts shall extend to within 3 in. (75 mm), but not more than 12 in. (300 mm) of the floor. [**30:**25.10.5]

Paragraphs 42.3.3.3.6.4 and 42.3.3.3.6.5 are intended to result in a "sweep" of ventilation air across the floor of the vault from one side to the other.

Δ **42.3.3.3.6.6** The exhaust system shall be installed in accordance with the provisions of NFPA 91. [**30:**25.10.6]

42.3.3.3.7 Vapor and Liquid Detection Systems.

42.3.3.3.7.1 Each vault shall be provided with an approved vapor and liquid detection system that is equipped with on-site audible and visual warning devices with battery backup. [**30:**25.15.1]

42.3.3.3.7.2 The vapor detection system shall sound an alarm when the system detects vapors that reach or exceed 25 percent of the lower flammable limit of the liquid stored. [**30:**25.15.2]

42.3.3.3.7.3 Vapor detectors shall be located no higher than 12 in. (300 mm) above the lowest point in the vault. [**30:**25.15.3]

42.3.3.3.7.4 The liquid detection systems shall sound an alarm upon detection of any liquid, including water. [**30:**25.15.4]

The liquid detection system is intended to sound an alarm not just for a spill but also for any infiltration of groundwater into the vault, which could indicate failure of the vault's floor, wall, or top or failure of a seal at the wall-to-top joint.

42.3.3.3.7.5 Liquid detectors shall be located in accordance with the manufacturer's instructions. [**30:**25.15.5]

42.3.3.3.7.6 Activation of either vapor detection system or liquid detection system shall cause a signal to be sounded at an approved, constantly attended location within the facility serving the tanks or at an approved location. [**30:**25.15.6]

Δ **42.3.3.3.8** In lieu of the separation distance requirements given in 66.22.4, separation distances between the vault and any of the following shall be permitted to be reduced to 0 ft (0 m), as measured from the outer perimeter of the vault wall:

(1) Any property line that is or can be built upon
(2) The near and far sides of a public way
(3) The nearest important building on the same property

[**30:**25.4]

42.3.3.3.9 Inspection and Maintenance of Storage Tank Vaults and Equipment. Vaults and their required equipment shall be maintained in accordance with the requirements of 42.3.3.3. [**30:**25.16]

42.3.3.4 Additional Requirements for Fire-Resistant Aboveground Storage Tanks.

42.3.3.4.1 Fire-resistant tanks shall be tested and listed in accordance with UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*. [**30:** 22.9.1]

Δ **42.3.3.4.2** Fire-resistant tanks shall also meet both of the following requirements:

(1) The construction that provides the required fire-resistive protection shall reduce the heat transferred to the primary tank in order to limit the temperature of the primary tank to an average maximum rise of 800°F (430°C) and a single point maximum rise of 1000°F (540°C) and to prevent release of liquid, failure of the primary tank, failure of the supporting structure, and impairment of venting for a period of not less than 2 hours when tested using the fire exposure specified in UL 2080.
(2) Reduction in sizing of the emergency vents in accordance with 22.7.3.5 of NFPA 30 shall not be permitted.

[**30:**22.9.2]

42.3.3.5 Protected Tanks. Protected aboveground tanks shall be tested and listed in accordance with ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids.* [**30:**22.10.1]

Δ **42.3.3.5.1** Protected tanks shall also meet both of the following requirements:

(1) The construction that provides the required fire-resistive protection shall reduce the heat transferred to the primary tank in order to limit the temperature of the primary tank to an average maximum rise of 260°F (144°C) and a single point maximum rise of 400°F (204°C) and to prevent release of liquid, failure of the primary tank, failure of the supporting structure, and impairment of venting for a period of not less than 2 hours when tested using the fire exposure specified in ANSI/UL 2085.
(2) Reduction in sizing of the emergency vents in accordance with 22.7.3.5 of NFPA 30 shall not be permitted.

[**30:**22.10.2]

42.3.3.6 Additional Requirements for All Aboveground Tanks.

42.3.3.6.1 All openings shall be located above the maximum liquid level. [**30A:**4.3.6.1]

The intent of this requirement is not only to reduce the chance of a spill from a broken pipe connection below the normal liquid level in the tank but also to eliminate the potential for a spill from any other opening to the tank, for example, from the connection for a liquid level gauge.

42.3.3.6.2 Means shall be provided for determining the liquid level in each tank, and this means shall be accessible to the delivery operator. [**30A:**4.3.6.2]

42.3.3.6.3 Means shall be provided to sound an audible alarm when the liquid level in the tank reaches 90 percent of capacity. Means shall also be provided either to automatically stop the flow of liquid into the tank when the liquid level in the tank reaches 98 percent capacity or to restrict the flow of liquid into the tank to a maximum flow rate of 2.5 gpm (9.5 L/min) when the liquid in the tank reaches 95 percent capacity. These provisions shall not restrict or interfere with the operation of either the normal vent or the emergency vent. [**30A:**4.3.6.3]

The requirements in 42.3.3.6.3 are intended to prevent an overfill during delivery of fuel to the tank and are consistent with federally mandated rules. As originally conceived, this provision required an alarm at 95 percent of capacity and either automatic stop of liquid flow or flow restriction to 2.5 gpm (9.5 L/min) at 98 percent of capacity, which was in accordance with the federal rules for underground storage tanks at the time. Since then, the federal rules have been changed to mandate completely stopping delivery at 98 percent of full capacity, partly because, for smaller tanks, even a reduced flow of 2.5 gpm (9.5 L/min) into a tank that was already 98 percent full did not leave much time for action to be taken to prevent an overfill. Therefore, both this paragraph and 66.21.7.1.5 were changed to be consistent with the federal rules.

42.3.3.6.4 Means shall be provided to prevent the release of liquid by siphon flow. [**30A:**4.3.6.4]

42.3.3.6.5 Shutoff and check valves shall be equipped with a pressure-relieving device that will relieve the pressure generated by thermal expansion back to the tank. [**30A:**4.3.6.5]

This provision addresses the hazards of "thermal blocking" of liquid in the piping. Liquid in any exposed portion of a pipe expands as ambient temperature increases and as a result of solar heating. Normally, thermal expansion is accommodated in the storage system. If a portion of exposed piping is "blocked in" at both ends by closed valves, however, thermal expansion results in an increase in pressure.

Thermal blocking can result in dramatic increases in pressure, with consequent leaks at fittings, joints, and seals. In extreme cases, thermal blocking has been known to cause the failure of gaskets and seals and, in some cases, the rupture of piping.

42.3.3.6.6 Fuel shall not be dispensed from the tank by either gravity flow or pressurization of the tank. [**30A:**4.3.6.6]

This requirement is intended to prevent uncontrolled flow from the tank should a break in the pipeline between the tank and the dispenser occur.

N **42.3.3.6.7** Storage tank appurtenances shall be installed and calibrated in accordance with the manufacturer's instructions, published industry practices, or equivalent methods approved by the AHJ. [**30A:**4.3.6.7]

Paragraph 42.3.3.6.7 is new to the 2018 edition of the *Code*. Its purpose is to ensure that fittings and appurtenances on storage tanks are installed in accordance with the manufacturer's instructions or recognized industry practices.

42.3.3.7 Physical Protection for All Outside Aboveground Tanks.

The intent of this paragraph is twofold: to protect the tank from being struck by a vehicle and to protect the tank from vandalism.

42.3.3.7.1 Tanks that are not enclosed in vaults shall be enclosed with a chain link fence at least 6 ft (1.8 m) high. The fence shall be separated from the tanks by at least 10 ft (3 m) and shall have a gate that is secured against unauthorized entry.

*Exception: Tanks are not required to be enclosed with a fence if the property on which the tanks are located has a perimeter security fence. [**30A:**4.3.7.1]*

Δ **42.3.3.7.2*** Guard posts or other approved means shall be provided to protect tanks that are subject to vehicular damage. When guard posts are installed, the following design shall be acceptable:

(1) They shall be constructed of steel not less than 4 in. (100 mm) in diameter and shall be filled with concrete.
(2) They shall be spaced not more than 4 ft (1.2 m) on center.
(3) They shall be set not less than 3 ft (0.9 m) deep in a concrete footing of not less than 15 in. (380 mm) diameter.

[**30A:**4.3.7.2]

A.42.3.3.7.2 The top of the posts should be set not less than 3 ft (0.9 m) above ground and should be located not less than 5 ft (1.5 m) from the tank. Other approved means to protect tanks subject to vehicular damage include vehicle impact resistance testing such as that prescribed in ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*, for protected aboveground tanks. [**30A:**A.4.3.7.2]

42.3.3.8* Corrosion Protection. Any portion of a tank or its piping that is in contact with the soil shall have properly engineered, installed, and maintained corrosion protection that meets the requirements of 66.21.4.5. [**30A:**4.3.8]

Δ **A.42.3.3.8** Appropriate corrosion control standards include the following:

(1) STI RP 892, *Recommended Practice for Corrosion Protection of Underground Piping Networks Associated with Liquid Storage and Dispensing Systems*
(2) NACE SP0169, *Recommended Practice for Control of External Corrosion of Underground or Submerged Metallic Piping Systems*
(3) STI RP 1632, *Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems*

[**30A:**A.4.3.8]

Other means of internal corrosion protection include protective coatings and linings and cathodic protection. [**30A:**A.4.3.8]

42.3.3.9 Storage of Liquids Inside Buildings. Storage of flammable and combustible liquids in motor fuel dispensing facility buildings and in repair garage buildings shall meet the requirements of this subsection. [**30A:**4.3.9]

42.3.3.9.1 Class I, II, and IIIA Liquids in Tanks Not Exceeding 120 Gal (454 L) Capacity and in Containers.

The following example demonstrates the application of 42.3.3.9.1 through 42.3.3.9.3.

Example

The building used in this case is a traditional two-bay service station that provides motor fuel dispensing and minor repairs.

- Paragraph 42.3.3.9.1.1 limits the service station operator to 120 gal (454 L) of Class I liquids. This quantity can be stored in containers, or it can be stored in tanks, as long as the tanks do not exceed 120 gal (454 L) capacity. Regardless, the maximum allowable quantity (MAQ) is still 120 gal (454 L).
- Paragraph 42.3.3.9.1.2 allows the service station operator to store up to 120 gal (454 L) each of Class II and Class IIIA liquids. Again, this quantity can be stored in containers, or it can be stored in tanks, as long as the tanks do not exceed the specified capacity, but the MAQ is limited to 240 gal (908 L).
- In accordance with 42.3.3.9.1.3, if no Class I liquids are in the facility (which is highly unlikely), the quantity of Class II liquids permitted is allowed to be doubled to 240 gal (908 L). It should be noted that, in a typical "quick-lube" service center, if a premixed windshield washer fluid (71 percent water to 29 percent methanol would yield a Class II liquid classification) is purchased for use, application of this paragraph would be used to properly store 240 gal (908 L) of this premixed Class II liquid inside the building.
- Paragraph 42.3.3.9.2 allows a tank of greater than 120 gal (454 L) capacity to be situated inside a service station building if the tank is installed inside a vault that meets the criteria of 42.3.3.3. The vault provides a fire cutoff that separates the tank from the rest of the building.
- Paragraph 42.3.3.9.3 provides for unlimited storage of Class IIIB liquids in buildings, recognizing that these liquids are difficult to ignite and pose a low fire risk.

42.3.3.9.1.1 The aggregate quantity of Class I liquids stored in a tank that does not exceed 120 gal (454 L) capacity and in containers shall not exceed 120 gal (454 L). Liquids in storage shall be maintained in tanks or in approved containers that are closed or are fitted with an approved dispensing device that meets the requirements of 42.7.2.4.1. [**30A:**4.3.9.1.1]

42.3.3.9.1.2 Except as permitted under 42.3.3.9.1.3, the aggregate quantity of Class II and Class IIIA liquids stored in a tank that does not exceed 120 gal (454 L) capacity and in containers shall not exceed 240 gal (908 L). The quantity for each class shall not exceed 120 gal (454 L). Liquids in storage shall be maintained in tanks or in approved containers that are closed or are fitted with an approved dispensing device that meets the requirements of 42.7.2.4.1. [**30A:**4.3.9.1.2]

42.3.3.9.1.3 Where there are no Class I liquids stored, the aggregate quantities of Class II liquids shall not exceed 240 gal (908 L). [**30A:**4.3.9.1.3]

42.3.3.9.2 Class I, II, and IIIA Liquids in Tanks Exceeding 120 Gal (454 L) Capacity. Where installation of a tank that exceeds 120 gal (454 L) capacity in accordance with 42.3.3.2 is not practical because of building or property limitations, the tank shall be permitted to be installed in a building if it is enclosed as described in 42.3.3.3 and if the installation is specifically approved by the AHJ. [**30A:**4.3.9.2]

42.3.3.9.3 Class IIIB Liquids. The quantity of Class IIIB liquids in storage shall not be limited. Class IIIB liquids shall be permitted to be stored in and dispensed from tanks and containers that meet the requirements of Chapter 9 and Chapters 21 through 23 of NFPA 30 as applicable. Tanks storing Class IIIB liquids inside buildings shall be permitted to be located at, below, or above grade. Adequate drainage shall be provided. Tanks and containers that contain only crankcase drainings shall be considered as containing Class IIIB liquids. [**30A:**4.3.9.3]

As lubrication-only facilities became popular, so too did the use of tanks for dispensing fresh motor oils and lubricants and for interim storage of used motor oils. The NFPA 30A technical committee believed that some restriction should be placed on the types of containers and tanks used and did so by referencing appropriate parts of NFPA 30. Note, however, that no quantity limit is placed on Class IIIB liquids. Also, note that Chapters 21 through 23 of NFPA 30 allow the use of a tank constructed of a combustible material (e.g., glass fiber–reinforced plastic) for Class IIIB liquids if certain specific conditions are met and if allowed by the AHJ.

The last sentence of 42.3.3.9.3 clearly establishes that used motor oils are considered to be Class IIIB liquids, unless shown otherwise. This classification is based on an extensive test survey sponsored by a major franchiser of lubrication-only service centers in which samples of used motor oil from 279 franchise facilities throughout the continental United States were tested for flash point by an independent testing laboratory. Test results showed that the average flash point of the samples was 343°F (173°C). The range of flash points extended from 296°F to 424°F (147°C to 218°C), but the average was well above 300°F (149°C). The test results compared favorably with the results of earlier tests conducted by the Bartlesville (Oklahoma) Energy Research Center of the U.S. Department of Energy in 1976 and with the range of flash points of virgin motor oils, which is 350°F to 415°F (177°C to 213°C).

Paragraph 42.3.3.9.3 was added to NFPA 30A to address environmental concerns for containing spills of waste motor oil. The NFPA 30A technical committee concluded that, from an environmental viewpoint, storing Class IIIB liquids inside a building is safer than storing them outside or underground. NFPA 30A addresses the fire protection concerns, which have been minimal for Class IIIB liquids. Previous concerns that the flash point of used motor oil might be dangerously low are apparently groundless, except where raw gasoline has been added to a waste oil container. Where that situation is suspected, the AHJ can require that tests be done to determine proper classification.

Δ **42.3.3.10 Temporary Storage of Liquid Fuels.** Aboveground tanks used for dispensing of motor fuels shall not be required to be permanently installed when located on premises not normally accessible to the public provided that all of the following requirements are met:

(1) Approval of the AHJ shall be required prior to bringing the tank to a site in the jurisdiction. In reviewing a proposed installation, the condition of the tank, the site where the tank will be located, installation and testing procedures, and operational procedures shall be evaluated prior to approval.
(2) The approval shall include a definite time limit after which the tank shall be removed from the site and relocated to an approved location.
(3) The tank shall comply with 42.3.3 and all other applicable provisions of NFPA 30A and NFPA 30.
(4) A tank containing liquid shall not be moved unless it has been specifically investigated and approved for movement while full or partially full.

[**30A:**4.3.10]

The provisions of 42.3.3.10 allow for temporary storage of liquid fuels. The codes for gaseous fuels generally do not make any distinction between temporary storage and permanent storage.

42.4 Piping for Liquids

42.4.1 Scope. Section 42.4 shall apply to piping systems consisting of pipe, tubing, flanges, bolting, gaskets, valves, fittings, flexible connectors, the pressure-containing parts of other components such as expansion joints and strainers, and devices that serve such purposes as mixing, separating, snubbing, distributing, metering, controlling flow, or secondary containment of liquids and associated vapors. [**30A:**5.1]

42.4.2 General Requirements for All Piping Systems.

42.4.2.1 The design, fabrication, assembly, test, and inspection of the piping system shall meet the requirements of Section 66.27.

Exception No. 1: Where dispensing is from a floating structure or pier, approved oil-resistant flexible hose shall be permitted to be used between shore piping and the piping on the floating structure or pier and between separate sections of the floating structure to accommodate changes in water level or shoreline, provided that the hose is either resistant to or shielded from damage by fire.

*Exception No. 2: Low melting point rigid piping shall be permitted to be used between underground shore piping and a floating structure or pier and on the floating structure or pier itself, provided that the piping is protected from physical damage and stresses arising from impact, settlement, vibration, expansion, contraction, or tidal action and provided that the hose is either resistant to or shielded from damage by fire exposure. [**30A:**5.2.1]*

Requirements for the design, fabrication, assembly, testing, and inspection of piping systems at service stations are basically the same as those in Chapter 27 of NFPA 30. The major differences are the exceptions to the requirements included for marine motor fuel dispensing facilities as specified in the two exceptions to 42.4.2.1, which allow more liberal use of low melting point piping materials and hose than otherwise would be allowed by NFPA 30.

42.4.2.2 Piping shall be located so that it is protected from physical damage. Piping that passes through a dike wall shall be designed to prevent excessive stresses that could result from settlement or fire exposure. [**30A:**5.2.2]

42.4.2.3 Any portion of a piping system that is in contact with the soil shall be protected from corrosion in accordance with good engineering practice. [**30A:**5.2.3]

42.4.2.4 All piping inside buildings but outside the motor fuel dispensing area shall be enclosed within a horizontal chase or a vertical shaft used only for this piping. Vertical shafts and horizontal chases shall be constructed of materials having a fire resistance rating of not less than 2 hours. [**30A:**5.2.4]

The intent of this requirement is to preserve the isolation of the fuel dispensing operation from the rest of the building.

42.4.2.5 Each fill pipe shall be identified by color code or other marking to identify the product for which it is used. The color code or marking shall be maintained in legible condition throughout the life of the installation. [**30A:**5.2.5]

Color coding of the fill pipe or fill opening is customarily done as a convenience for delivery personnel so that the different grades of gasoline are delivered to their proper tanks. Mixing of different grades of gasoline does not constitute a hazard. However, where diesel fuel or kerosene are also stored, the inadvertent mixing of Class I and Class II liquids, which can produce serious consequences, is a definite risk. One commonly used means for identification is API RP 1637, *Using the API Color-Symbol System to Mark Equipment and Vehicles for Product Identification at Service Stations and Distribution Terminals.* Exhibit 42.7 illustrates the API 1637 color-symbol system.

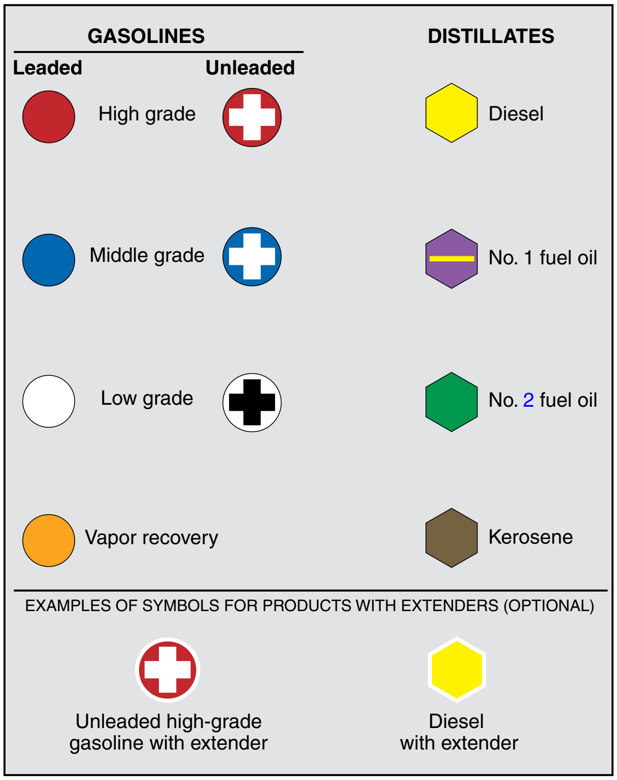
42.4.2.6 Shutoff and check valves shall be equipped with a pressure-relieving device that will relieve any pressure generated by thermal expansion of the contained liquid back to the storage tank. [**30A:**5.2.6]

Δ **42.4.2.7** Piping components made of low melting point materials shall be permitted to be used without backfill with the following sumps:

(1) Belowgrade underground tank sumps that are fitted with a cover
(2) Belowgrade piping connection sumps that are fitted with a cover
(3) Containment sumps, under the following conditions:
  (a) The sump is monitored to detect any leaks.
  (b) Any leaks can be controlled.
  (c) The components are either resistant to or shielded from damage by fire exposure.
(4) Containment sumps, provided the piping components can successfully pass the test procedures described in API 607, *Fire Test for Soft-Seated Quarter-Turn Valves*

[**30A:**5.2.7]

Exhibit 42.7



API color-symbol system for product identification at service stations. (Courtesy of American Petroleum Institute)

The use of nonmetallic piping systems for service station application has become more commonplace because nonmetallic systems provide inherent corrosion protection and are easy to install. One nonmetallic piping system uses double-walled flexible piping (see Exhibit 42.8) to minimize the number of connections needed. Concerns have been raised about the low melting point of nonmetallic piping materials, particularly where they

Exhibit 42.8

One type of double-wall flexible piping for motor fuel dispensing systems. (Courtesy of OPW) are not covered by backfill, such as the open space beneath the dispenser and the remote pump sump at the tank.

The area beneath the dispenser is subject to spills that can be ignited due to the knock-down or pull-down of the dispenser. Although the piping is equipped with an emergency shear valve that stops the flow of fuel to the dispenser (see 42.5.3.9), fire in this area would likely breach the nonmetallic piping upstream of the shear valve. If ignition were to occur while the remote pump was still operating, the outcome could be disastrous.

The same type of exposure does not exist at the remote pump sump or in belowgrade piping connection sumps. Therefore, while recognizing the obvious benefits of nonmetallic piping materials, the hazard of exposed nonmetallic piping and piping components beneath the dispenser has been determined to be severe enough to warrant the requirements imposed by 42.4.2.7(3) and (4).

42.5 Fuel Dispensing Systems

42.5.1 Scope. Section 42.5 shall apply to the system and components that dispense fuel into the tanks of motor vehicles and marine craft. [**30A:**6.1]

42.5.2 General Requirements.

Δ **42.5.2.1** Dispensing devices installed outside at motor fuel dispensing stations shall be located as follows:

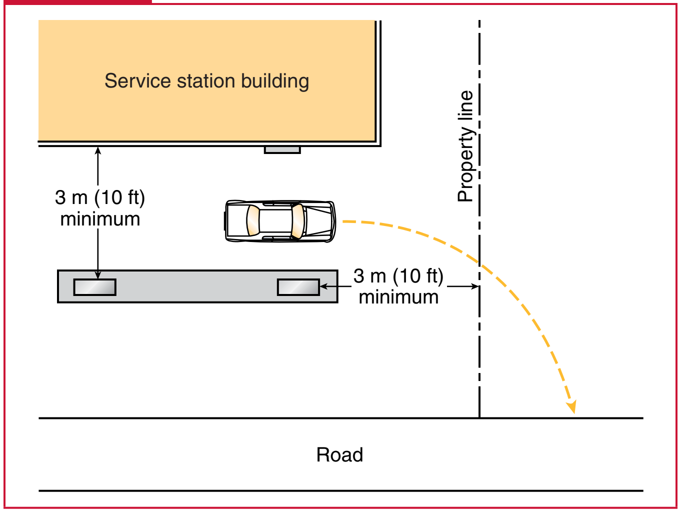
(1) 10 ft (3 m) or more from property lines
(2) 10 ft (3 m) or more from buildings, other than canopies, having combustible exterior wall surfaces or buildings having noncombustible exterior wall surfaces that are not a part of a 1 hr fire-resistive assembly
(3) Such that all parts of the vehicle being served will be on the premises of the service station
(4) Such that the nozzle, when the hose is fully extended, will not reach within 5 ft (1.5 m) of building openings

[**30A:**6.2.1]

Item (1) of 42.5.2.1 ensures that a minor spill or fire at a dispensing device (hereafter referred to as a "dispenser") will not result in a fire threat to adjacent property. Item (2) of 42.5.2.1 ensures that a fire originating at a dispenser will not threaten buildings or other structures on the same property. Both 42.5.2.1(1) and (2) ensure easy access to a dispenser fire by emergency responders and provide for sufficient clear space around dispensers for patrons to maneuver their vehicles. See Exhibit 42.9.

Item (3) of 42.5.2.1 prohibits the installation of dispensers on the sidewalk in front of a service station. The purpose of this requirement is to maintain some separation between the vehicle being fueled and vehicles traveling on the road in front of the station. Exhibit 42.10 shows two dispensers situated right next to a building on the sidewalk along a busy center-of-town road. Note the horizontal piping extending to both sides of the dispensers and the fueling hoses connected to them. The spacing allows two vehicles to be fueled at the same time — on the street.

Exhibit 42.9



Proper spacing of dispensers on a service station property.

Exhibit 42.10

Fuel dispensers situated on a sidewalk, adjacent to a (former) service station building. (Courtesy of Dedham Bike and Leather Co., Dedham, MA)

(The editor was informed by the building tenant — a high-end bicycle dealer and repair shop — that the building housed the first service station in the town, dating from the 1900s, and that the dispensers were still being used as late as 1970. The storage tanks were buried beneath the building.)

The justification for item (4) of 42.5.2.1 is to prevent a stream of fuel from being directed, either accidentally or deliberately, into the adjacent service station building.

42.5.2.2 Liquids shall not be dispensed by applying pressure to drums, barrels, and similar containers. Listed pumps taking suction through the top of the container or listed self-closing faucets shall be used. [**30A:**6.2.2]

Typical containers for liquids are not intended to be pressurized and are not tested for such handling or use. Dispensing from the typical shipping container using pressure risks failure of the container. Therefore, dispensing must be done via gravity, through a self-closing faucet, or by means of a suction pump.

42.5.2.3* Fuel dispensing systems, including dispensers, hoses, nozzles, breakaway fittings, swivels, flexible connectors, dispenser emergency shutoff valves, vapor recovery systems, and pumps that are used for alcohol-blended motor fuels shall be listed or approved for the specific purpose. [**30A:**6.2.3]

This paragraph was added in the 2012 edition of NFPA 30 to address existing dispensing equipment being used to dispense E85 fuel (85 percent ethanol/15 percent gasoline) used by so-called "flex-fuel" vehicles. Flex-fuel vehicles can operate on any mixture of gasoline and ethanol up to 85 percent ethanol by volume. (To reduce ethanol evaporative emissions and to avoid cold weather start problems in winter, the maximum percentage of ethanol allowed in motor fuels in the United States is 85 percent.) The engine of a flex-fuel vehicle has a dedicated sensor that automatically detects the percentage of ethanol in the fuel and adjusts fuel injection and spark timing accordingly, thus allowing mixing of conventional gasoline (maximum 10 percent ethanol) and E85 in any proportion.

Paragraph 42.5.2.3 was crafted to account for the potential for a wide range of ethanol concentrations and for the approval process to allow for technological advances as they emerge.

Δ **A.42.5.2.3** The following can be used to determine compliance with 42.5.2.3:

ANSI/UL 79 *Standard for Power-Operated Pumps for Petroleum Dispensing Products*

UL 87, *Standard for Power-Operated Pumps for Petroleum Dispensing Products*

UL Subject 87A, *Outline of Investigation for Power-Operated Dispensing Devices for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations Up to 85 Percent (E0-E85)*

ANSI/UL 330, *Standard for Hose and Hose Assemblies for Dispensing Flammable Liquids*

ANSI/UL 567, *Standard for Emergency Breakaway Fittings, Swivel Connectors and Pipe-Connection Fittings for Petroleum Products and LP-Gas;*

ANSI/UL 842, *Standard for Valves for Flammable Fluids*

ANSI/UL 2586, *Standard for Hose Nozzle Valves.*

[**30A:**A.6.2.3]

42.5.3 Requirements for Dispensing Devices.

Fuel dispensing devices (dispensers) for retail application consist of a cabinet with two distinct interior sections. The lower section contains the liquid handling components and the upper section contains the electronics, such as the display panel and the point of sale (POS) components that allow the use of credit and debit cards. Exhibit 42.11 shows a modern fuel dispenser, one that is typical of the several in widespread use. This particular unit has one hose and dispensing nozzle for diesel fuel (on the left) and another set for three grades of gasoline (on the right).

Fuel enters the bottom of the cabinet from the storage tank(s) and is then pumped up the side column to a header to which are attached the dispensing hoses. In each hose, near the header, is the emergency breakaway device (to be discussed later). The dispensing nozzles are shown in their bracketed position. The upper portion of the cabinet houses the electronic components and the fuel grade selection buttons (see Exhibit 42.12).

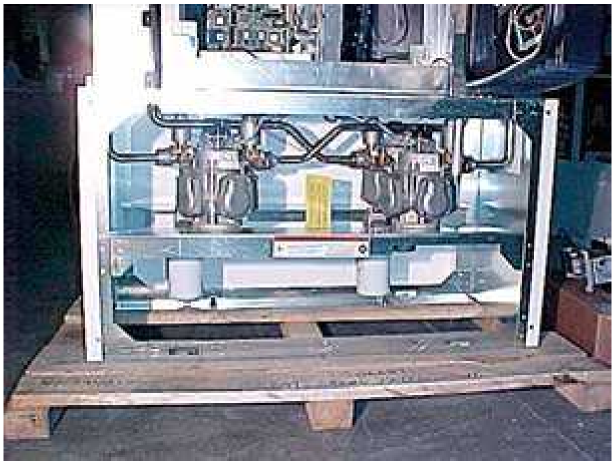
Exhibit 42.11

A modern multi-product retail fuel dispenser. (Courtesy of Bennett Pump Company, Spring Lake, MI)

Exhibit 42.12

Interior view of electronics cabinet of the fuel dispenser shown in Exhibit 42.11. (Courtesy of Bennett Pump Company, Spring Lake, MI)

Exhibit 42.13



Interior view of fuel handling components of the fuel dispenser shown in Exhibit 42.11. (Courtesy of Bennett Pump Company, Spring Lake, MI)

The lower portion contains the fuel filters and blending components for the three grades of gasoline (see Exhibit 42.13).

42.5.3.1 Class I and Class II liquids shall be transferred from tanks by means of fixed pumps designed and equipped to allow control of the flow and prevent leakage or accidental discharge. [**30A:**6.3.1]

This requirement prohibits any dispensing through a system that does not incorporate some type of variable flow valve, such as a dispensing nozzle.

42.5.3.2 Dispensing devices for Class I and II liquids shall be listed. [**30A:**6.3.2]

Dispensers are listed under UL 87, *Standard for Power-Operated Dispensing Devices for Petroleum Products.*

42.5.3.2.1 Existing listed or labeled dispensing devices shall be permitted to be modified provided that the modifications made are "Listed by Report" by an approved testing laboratory or as otherwise approved by the AHJ. Modification proposals shall contain a description of the component parts used in the modification and the recommended methods of installation on specific dispensing devices. Modification proposals shall be made available to the AHJ upon request. [**30A:**6.3.2.1]

Paragraph 42.5.3.2.1 prohibits making any modification to the dispenser that has not been either evaluated by a testing organization or approved by the AHJ. The intent is to prevent any modification that might interfere with or negate the dispenser's built-in safety features or its proper operation.

"Listed by Report," a special form of listing employed by Underwriters Laboratories Inc. (UL), covers products or construction for which no generally recognized installation requirements exist. Information concerning proper field installation is contained in a report identified by a reference number and date shown in the listing, copies of which can be obtained from UL.

42.5.3.3 A control shall be provided that will permit the pump to operate only when a dispensing nozzle is removed from its bracket or normal position with respect to the dispensing device and the switch on this dispensing device is manually actuated. This control shall also stop the pump when all nozzles have been returned to their brackets or to their normal nondispensing position. [**30A:**6.3.3]

42.5.3.4 Dispensing devices shall be mounted on a concrete island or shall otherwise be protected against collision damage by means acceptable to the AHJ. Dispensing devices shall be securely bolted in place. If located indoors, dispensing devices shall also be located in a position where they cannot be struck by a vehicle that is out of control descending a ramp or other slope. Dispensing devices shall be installed in accordance with the manufacturers' instructions. [**30A:**6.3.4]

42.5.3.5 Dispensing devices used to fill portable containers with home heating fuels shall be located at least 20 ft (6 m) from any dispensing devices for motor fuels. [**30A:**6.3.5]

This provision of NFPA 30A is intended to prevent inadvertent dispensing of gasoline into a container used to fill portable kerosene heaters. This mistake has caused numerous fires.

42.5.3.6 Inspections. Dispensing equipment shall be periodically inspected by a person who is knowledgeable in the operation of the equipment to verify that it is in proper working order and is not leaking. [**30A:**6.3.6]

The requirements of 42.5.3.6 through 42.5.3.6.2 were added to the 2012 edition to fill a void in NFPA 30A. In earlier editions, NFPA 30A had not addressed inspection of dispensing systems. With the recent use of E85 fuel in so-called legacy dispensing systems (systems originally evaluated for gasoline service and not for high percentages of alcohol oxygenates) and the anticipation of a future increase in the allowable percentage of ethanol in motor gasoline to 15 percent, the need for a formal inspection program by a qualified individual to identify unexpected deterioration of any components of the dispensing system was acknowledged. Note the emphasis on inspection of fuel handling components in 42.5.3.6.2.

42.5.3.6.1* Exterior Inspection. A visual inspection of the fuel dispenser and its associated hanging hardware (hose nozzle valve, hose, breakaway valve, and hose swivel) shall be conducted at least weekly and shall be documented. Documentation shall be available for review by the AHJ upon request. [**30A:**6.3.6.1]

A.42.5.3.6.1 Useful forms for documentation can be found in PEI/RP500-05, *Recommended Practices for Inspection and Maintenance of Motor Fuel Dispensing Equipment*, and are available at www.pei.org/rp500. [**30A:**A.6.3.6.1]

42.5.3.6.2* Internal Dispenser Cabinet Inspection. An inspection of the fuel dispensing equipment that is located inside the dispenser cabinet shall be conducted. The interior of the fuel dispenser cabinet shall be inspected for signs of leaks, damage, corrosion, or weathering, with particular attention to the sump area and joints and castings of fluid handling components. The inspection shall be conducted at least monthly and shall be documented. Documentation shall be available for review by the AHJ upon request. [**30A:**6.3.6.2]

A.42.5.3.6.2 See A.42.5.3.6.1. [**30A:**A.6.3.6.2]

Δ **42.5.3.6.3 Maintenance.** When maintenance to dispensing devices is necessary and such maintenance is capable of causing accidental release or ignition of liquid, the following precautions shall be taken before such maintenance is begun:

(1) Only persons knowledgeable in performing the required maintenance shall perform the work.
(2) All electrical power to the dispensing devices, to the pump serving the dispensing devices, and to all associated control circuits shall be shut off at the main electrical disconnect panel.
(3) The emergency shutoff valve at the dispenser, if installed, shall be closed.
(4) All vehicular traffic and unauthorized persons shall be prevented from coming within 20 ft (6 m) of the dispensing device.

[**30A:**6.3.6.3]

A fire at a Florida self-serve service station is the basis for the requirements in 42.5.3.6.3. The fire occurred when an attendant attempted to change a fuel filter in the supply line of one of the dispensers without shutting off power to the remote pump. (In a remote pumping system, the pump pressurizes the lines to all dispensers simultaneously.) A customer at an adjacent island began pumping fuel into his vehicle just as the attendant removed the filter from the pipe supplying a dispenser on the same system. The results were predictable and catastrophic — gasoline spewed out of the open supply pipe, causing a sizable spill and fire that resulted in the death of a customer.

42.5.3.7 Motor vehicle traffic patterns at motor fuel dispensing facilities shall be designed to inhibit movement of vehicles that are not being fueled from passing through the dispensing area. [**30A:**6.3.7]

Almost all new motor fuel dispensing facilities have some type of convenience store. Exhibit 42.14 shows one such service station and convenience store that has angled parking between the store and the dispensers. The increased vehicle and pedestrian traffic in these types of facilities makes control of vehicles an important safety concern.

42.5.3.8 At unattended self-serve motor fuel dispensing facilities, coin- and currency–type devices shall be permitted only with the approval of the AHJ. [**30A:**6.3.8]

This requirement intends to restrict dispensing devices at unattended self-serve facilities to those that accept only credit or debit cards or are key-operated.

42.5.3.9 Where liquid is supplied to the dispensing device under pressure, a listed, rigidly anchored, double-poppet type emergency shutoff valve incorporating a fusible link or other thermally actuated device, designed to close automatically in the event of severe

Exhibit 42.14

Typical service station and convenience store.

impact or fire exposure, shall be installed in the supply line at the base of each individual island-type dispenser or at the inlet of each overhead dispensing device. The emergency shutoff valve shall be installed in accordance with the manufacturer's instructions. The emergency shutoff valve shall not incorporate a slip-joint feature.

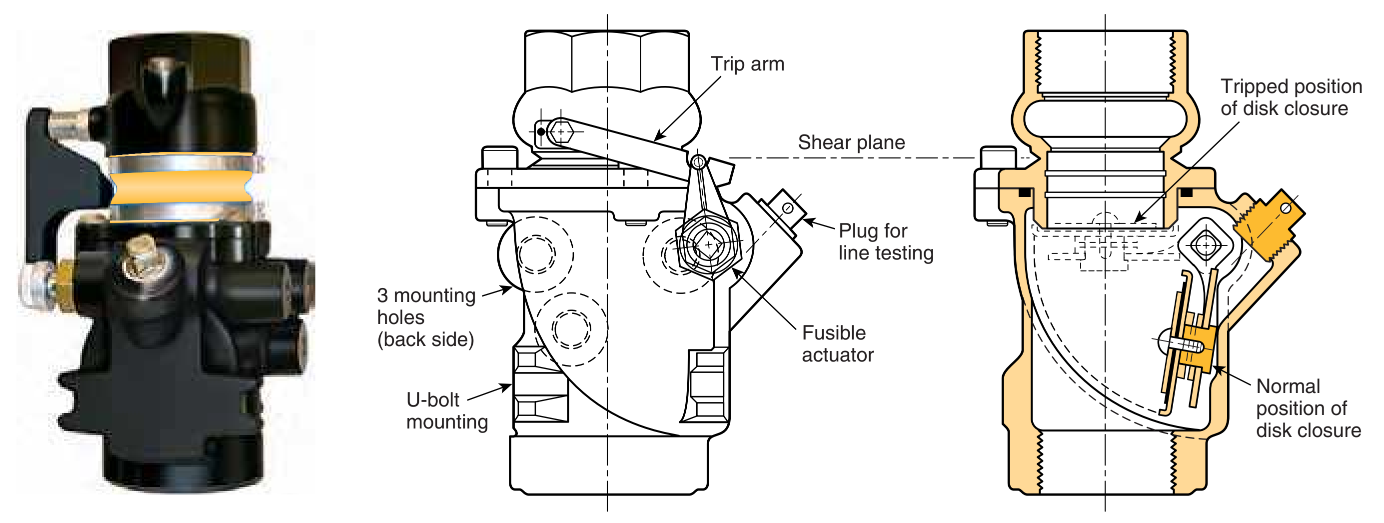
*Exception: As provided for in 42.5.3.10. [**30A:**6.3.9]*

The purpose of the shutoff valve (often referred to as a shear valve) required by 42.5.3.9 is to stop the flow of fuel from the piping that supplies the dispenser if the dispenser is hit or knocked over by a vehicle or if the dispenser is pulled over by a vehicle driving away with the dispensing nozzle still in its tank fill tube. A photo and cutaway drawings of an emergency shutoff valve are shown in Exhibit 42.15. If the dispenser is knocked or pulled over, an internal spring-loaded mechanism closes the valve. Additional protection is provided by a shear section in the valve body that breaks upon impact or severe stress. In addition, a thermally actuated device, such as the fusible actuator shown in Exhibit 42.16, trips the valve if a fire occurs within the dispenser housing.

The shear section of the valve must be installed level with the top of the dispenser island, and the entire assembly must be rigidly anchored to the island to ensure that the piping breaks at the shear section. Alternatively, the valve can be fastened to the dispenser mounting frame as long as the frame is rigidly secured to the island and that it remains in place if the dispenser is displaced. Slip-joint features are not allowed because they are prone to failure. Double backup protection is provided by the breakaway coupling required in 42.5.5.2 and by a shear point on the spout of the dispensing nozzle, both of which are intended to function if a vehicle drives away with the nozzle still inserted in its filler tube.

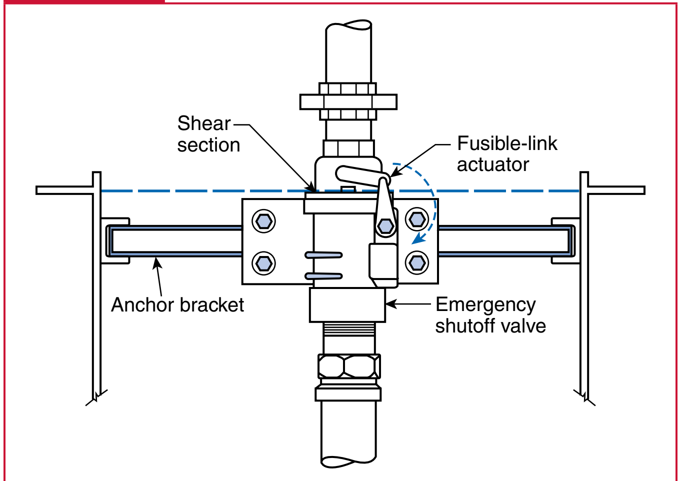
The Technical Committee on Automotive and Marine Service Stations has discussed several times whether the emergency shutoff valve should be of the double-poppet type. A double-poppet shear valve behaves like a dry-break coupling:

Exhibit 42.15



(Left) Photo of a double-poppet type emergency shutoff valve. (Center and right) Line diagram and cutaway of a double-poppet type emergency shutoff valve. (Courtesy of OPW)

Exhibit 42.16



Proper attachment of emergency shutoff valve to fuel dispenser mounting bracket. (from PEI RP100, Recommended Practices for Installation of Underground Liquid Storage Systems. Courtesy of Petroleum Equipment Institute)

a spring-loaded closure is provided on both sides of the shear section, so that liquid is retained on both sides when the valve breaks. Thus, not only will liquid be confined in the supply piping, it will also be prevented from draining from the piping inside the dislodged part of the dispenser.

Two divergent opinions are held among fire safety professionals and the fire service. Some believe that a double-poppet design limits the amount of fuel involved in an accident because the fuel contained in the dispenser itself doesn't spill. Others are of the opinion that, if a fire does occur, it will heat the trapped liquid in the dispenser, possibly to the point where the internal piping will forcefully rupture and result in injuries to emergency response personnel. This issue was discussed again in preparation for the 2018 edition of NFPA 30, and it was decided to require that the shear valve be of a double-poppet type. It is this double-poppet type that is shown in Exhibit 42.15.

42.5.3.9.1 The automatic-closing feature of this valve shall be tested at the time of installation and at least once a year thereafter by manually tripping the hold-open linkage. Records of such tests shall be kept at the premises or shall be made available for inspection by the AHJ within 24 hours of a verbal or written request. [**30A:**6.3.9.1]

42.5.3.10 Where a suction-type dispensing system includes a booster pump or where a suction-type dispensing system is supplied by a tank in a manner that produces a gravity head on the dispensing device, a vacuum-actuated shutoff valve with a shear section or equivalent-type valve listed and labeled in accordance with UL 842, *Standard for Valves for Flammable Fluids*, shall be installed directly under the dispensing device. [**30A:**6.3.10]

42.5.4 Requirements for Remote/Submersible Pumps. Subsection 42.5.4 shall apply to systems for dispensing Class I and Class II liquids where the liquids are transferred from storage to individual or multiple dispensing devices by pumps located other than at the dispensing devices. [**30A:**6.4]

Years ago, fuel dispensers had a single hose that dispensed a single grade of fuel. The pump was located within the dispenser housing, and fuel was pulled from the tank under suction. As fuels with higher vapor pressures became common, suction systems experienced problems due to "vapor locking" and cavitation. This led to the development of the remote pumping system, which pushes fuel to the dispenser rather than pulling it from the storage tank.

Almost all service stations now use remote pumping systems. The pump is located at the tank, almost always installed in the tank itself (it is submersible), occasionally mounted in a separate enclosure, and supplies several dispensers with the same grade of fuel. In many cases, the three grades of fuel are provided with just two tanks and two pumps, the middle grade being a blend of the high and regular octane grades. The supply piping between the tank and the dispensers operates under pressure, and the entire piping system and all the dispensers are pressurized whenever the pump is operating, even if only a single dispenser is actually being used. Remote pumping systems are easier and less expensive to install and maintain. The piping for such systems is also simplified and is less expensive to install. The capital cost does not increase greatly as more dispensers are added to the system, because, instead of a single pump for every dispenser, only one pump per storage tank is needed.

Remote pumping systems have some disadvantages. Because the piping system is under pressure, small leaks in the system can release sizable quantities of liquid. This problem is addressed by the requirement of 42.5.4.2. Also, careless operating procedures can lead to catastrophes, as already described in the commentary to 42.5.3.6.3.

42.5.4.1 Pumps shall be listed and shall be designed or equipped so that no part of the system will be subjected to pressures above its allowable working pressure. [**30A:**6.4.1]

42.5.4.2 Each pump shall have installed on the discharge side a listed leak detection device that restricts or shuts off the flow of product if the piping or a dispenser is leaking. Each leak-detecting device shall be checked and tested at least annually according to the manufacturers' specifications to ensure proper installation and operation.

*Exception: A leak detection device shall not be required if all piping is visible. [**30A:**6.4.2]*

42.5.4.3 Pumps installed above grade outside of buildings shall be located not less than 10 ft (3 m) from lines of adjoining property that can be built upon and not less than 5 ft (1.5 m) from any building opening. Where an outside pump location is impractical, pumps shall be permitted to be installed inside buildings as provided for dispensers in 42.5.3.4 or in sumps as provided in 42.5.4.4. Pumps shall be anchored and protected against physical damage. [**30A:**6.4.3]

The requirements in 42.5.4.3 are intended to prevent the vapors from minor leaks in the packing gland or seal from reaching an ignition source either in an adjacent building or on adjacent property.

42.5.4.4 Sumps for subsurface pumps or piping manifolds of submersible pumps shall withstand the external forces to which they can be subjected without damage to the pump, tank, or piping. The sump shall be no larger than necessary for inspection and maintenance and shall be provided with a fitted cover. [**30A:**6.4.4]

42.5.5 Requirements for Dispensing Hose.

42.5.5.1 Listed hose assemblies shall be used to dispense fuel. Hose length at automotive motor fuel dispensing facilities shall not exceed 18 ft (5.5 m). Where hose length at marine motor fuel dispensing facilities exceeds 18 ft (5.5 m), the hose shall be secured so as to protect it from damage. [**30A:**6.5.1]

The maximum hose length of 18 ft (5.5 m) is identical to the requirements of the Office of Weights and Measures of the U.S. Department of Commerce, as published in NIST *Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*. The purpose of the requirement is to ensure accuracy of the dispenser totalizer and to minimize the effect of thermal expansion of any liquid remaining in the hose. These same regulations allow hose length at marine motor fuel dispensing facilities to be 50 ft (15 m) long.

42.5.5.2 A listed emergency breakaway device designed to retain liquid on both sides of the breakaway point shall be installed on each hose dispensing Class I and II liquids. Such devices shall be installed and maintained in accordance with the manufacturer's instructions. [**30A:**6.5.2]

The requirement for an emergency breakaway device was added to NFPA 30A in response to numerous incidents in which dispensers were pulled over when patrons drove away from the island with the nozzle still in the automobile's filler tube, in some cases, while the pump was still delivering fuel to the vehicle. Almost all the incidents occurred at self-serve islands. In several cases, the shear valve did not function properly and serious fires occurred. In at least one case, an attendant was seriously burned.

An emergency breakaway device is a two-part device installed in the dispenser hose, close to the dispenser, and is designed to come apart when subjected to a specified tension force. If a vehicle drives off with the dispenser nozzle still in its fuel fill tube, the two parts of the breakaway device will separate before enough force is developed to pull the dispenser off its mounting bracket. As mentioned in previous commentary, in a drive-off situation, it is a backup to the shear valve at the base of the dispenser. A cutaway view of an emergency breakaway device is shown in Exhibit 42.17.

42.5.5.3 Where hose are attached to a hose-retrieving mechanism, the listed emergency breakaway device shall be installed between

Exhibit 42.17

Cutaway of emergency breakaway coupling. (Courtesy of Husky Corporation) the point of attachment of the hose-retrieving mechanism to the hose and the hose nozzle valve.

*Exception: Such devices shall not be required at marine motor fuel dispensing facilities. [**30A:**6.5.3]*

The breakaway device is intended to separate before any significant force is transmitted to the dispenser via tension on the hose. If the hose is connected to a retrieving mechanism, the breakaway device must be installed downstream of the point where the retrieving cable is attached to the hose. Otherwise, any tension on the hose will be transmitted to the dispenser via the retrieving cable and not to the breakaway device, as intended.

42.5.6 Requirements for Fuel Delivery Nozzles.

Exhibit 42.18 illustrates the basic components of a fuel delivery nozzle. The spout of the nozzle is sized for the type of fuel to be dispensed: A nozzle for dispensing diesel fuel has a larger spout that is too large to fit into the fuel filler tube of a vehicle that uses gasoline. The nozzle shown has a flexible rubber vapor seal surrounding the spout to prevent the release of vapors and to ensure that vapors are captured by the vapor recovery system.

42.5.6.1 An automatic closing–type hose nozzle valve, with a latch-open device and listed and labeled in accordance with ANSI/UL 842, *Standard for Valves for Flammable Fluids*, or ANSI/UL 2586, *Standard for Hose Nozzle Valves*, shall be provided on island-type dispensing devices used to dispense Class I or Class II liquids. [**30A:**6.6.1]

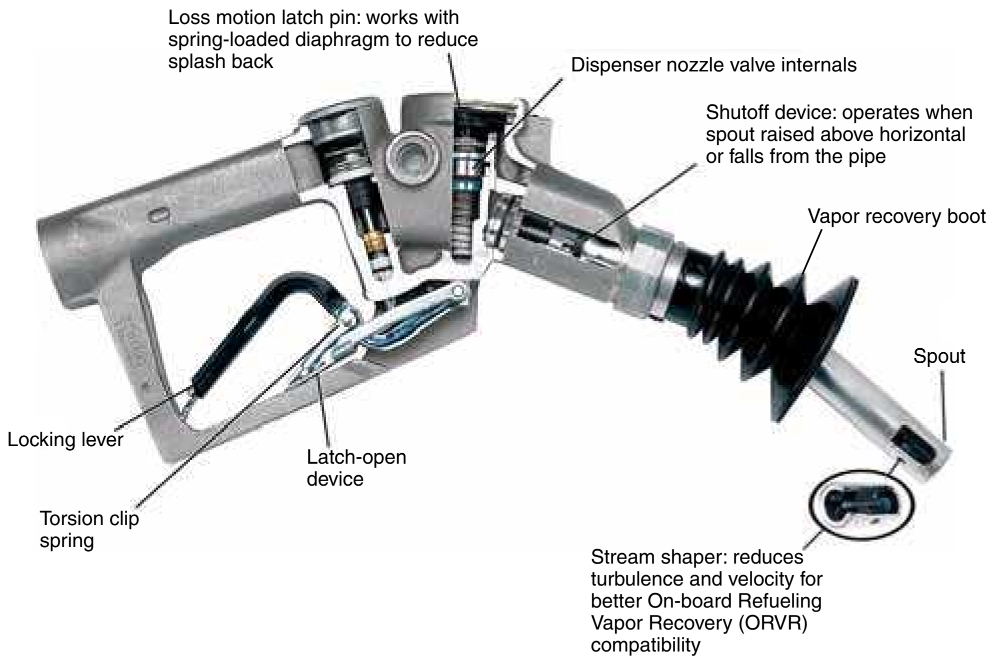
Originally, the requirement for an automatic-closing fuel delivery nozzle applied only to nozzles that dispensed Class I liquids (gasoline). The hazards inherent in refueling were determined to be independent of the class of liquid being dispensed, and a decision was made to broaden the application of the requirement to all refueling nozzles, regardless of the fuel handled.

Prior to 1981, latch-open devices were not permitted on dispenser nozzles unless the dispensing was performed by an attendant (i.e., full service was provided). Use of the latch-open device on a self-service dispensing nozzle was prohibited; the patron had to manually hold the nozzle trigger until dispensing was finished. Enforcing authorities soon began complaining that the prohibition was unenforceable and was even leading to more dangerous situations, because customers would chock open the nozzle with whatever device was at hand, including the automobile's gas cap. Enterprising individuals even marketed combination key holder/latch-open devices for personal use, some of which have even been patented.

The problem was that chocking open the dispenser nozzle sometimes inadvertently defeated its automatic-closing feature, and it would not shut off, leading to a spill. Many fire officials also pointed out that prohibiting the latch-open device inconvenienced consumers, questioned their intelligence, and gave more credit for common sense and concern for safety to the service station attendant than to the public at large.

Enforcement of the ban on latch-open devices proved difficult to justify and the apparent safety problem could not be ignored. With the 1981 edition of NFPA 30, the technical committee decided to make the use of the latch-open device an option to be decided by the local fire official. (At the time, service stations were covered in Chapter 7 of NFPA 30.) With the 2015

Exhibit 42.18



Typical fuel delivery nozzle. (Courtesy of Husky Corporation) edition of NFPA 30A, the Technical Committee on Automotive and Marine Service Stations decided that the safer approach would be to mandate the use of the latch-open device in all cases, except for marine fueling.

Note that, until the 2008 edition, NFPA 30A included the following provision:

> **6.6.2** If a hose nozzle valve is provided with a latch-open device other than the one recommended by the valve manufacturer, the latch-open device shall be an integral part of the valve assembly and such valve/latch-open device combination shall meet all applicable requirements of Section 19A of UL 842, *Standard for Valves for Flammable Fluids*.

The original intent of that paragraph was to prevent the use of makeshift devices as latch-open mechanisms where latch-open devices were not allowed. It required any after-market device to be permanently attached to the dispenser nozzle and to be evaluated to ensure that it would not interfere with any of the safety features of any nozzle with which it was likely to be used. Although many of these after-market products have appeared over the years, whether any have actually been evaluated is doubtful. Therefore, the technical committee decided to remove the requirement.

42.5.6.1.1 Any modification of the dispensing nozzle shall be listed or approved by the manufacturer of the nozzle. [**30A:**6.6.1.1]

42.5.6.2* At any installation where an automatic closing–type dispensing nozzle is used, the nozzle valve shall include a feature that causes or requires the closing of the hose nozzle valve before product flow can be resumed or before the hose nozzle valve can be replaced in its normal position in the dispenser. [**30A:**6.6.2]

A.42.5.6.2 The flow of fuel can be stopped by dispensers used in self-serve motor fuel dispensing facilities. The nozzle can be returned to the dispenser in the latched-open position. Subsequent activation of the dispenser would then immediately release fuel from the latched-open nozzle, creating a hazardous situation. [**30A:**A.6.6.2]

The purpose of 42.5.6.2 is to eliminate the possibility of spills that might occur when a customer pulls the nozzle from its bracket after the previous patron has left it in the latch-open position.

42.5.6.3 Overhead-type dispensing devices shall be provided with a listed, automatic closing–type hose nozzle valve without a latch-open device.

*Exception: A listed, automatic closing–type hose nozzle valve with a latch-open device shall be permitted to be used if the hose nozzle valve will close automatically in the event the valve is released from a fill opening or upon impact. [**30A:**6.6.3]*

42.5.6.4 Dispensing nozzles used at marine motor fuel dispensing facilities shall be of the listed automatic closing–type hose nozzle valve without a latch-open device. [**30A:**6.6.4]

The fuel fill port on a pleasure boat is typically larger than that on a motor vehicle; consequently, the fit of the nozzle spout into the fill port is looser. Therefore, the back pressure from the fill tube is not always great enough to trigger the automatic-closing feature when the tank is near full and an overfill can occur. This can lead to a spill, with spilled fuel draining to the bilge or the interior cabin of the boat. This condition is much more hazardous than a similar spill on the ground. Vapors are more confined, and dispersal takes a longer period of time and requires mechanical ventilation. Control of sources of ignition is also more difficult. Prohibiting the latch-open device means the person dispensing the fuel cannot move away from the boat and might pay greater attention to the task at hand.

42.5.7 Emergency Electrical Disconnects. Fuel dispensing systems shall be provided with one or more clearly identified emergency shutoff devices or electrical disconnects. Such devices or disconnects shall be installed in approved locations but not less than 20 ft (6 m) or more than 100 ft (30 m) from the fuel dispensing devices that they serve. Emergency shutoff devices or electrical disconnects shall disconnect power to all dispensing devices; to all remote pumps serving the dispensing devices; to all associated power, control, and signal circuits; and to all other electrical equipment in the hazardous (classified) locations surrounding the fuel dispensing devices and shall mechanically or electrically isolate other fluid transfer systems serving the fuel dispensing area. When more than one emergency shutoff device or electrical disconnect is provided, all devices shall be interconnected. Resetting from an emergency shutoff condition shall require manual intervention and the manner of resetting shall be approved by the AHJ.

*Exception: Intrinsically safe electrical equipment need not meet this requirement. [**30A:**6.7]*

Subsection 42.5.7 places special significance on the location of emergency power disconnects. They must be close enough to the dispensing island to be quickly accessible to a patron or an attendant, but not so close as to be directly involved in, or blocked by, a fire at the island or to place anyone in jeopardy while trying to access them. Manual reset ensures that operation of the station cannot be resumed automatically. Operations should not be resumed until the person responsible for the facility has rectified whatever emergency condition might exist.

The phrase "clearly identified" means that a sign is to be posted indicating where the disconnects are located. The emergency disconnect should be readily accessible and not blocked by storage of such items as tires or cases of lubricating oil. All service station operators, as well as responding fire fighters, should know the location of the disconnects. Locating the disconnects at least 20 ft (6 m) from the dispenser ensures that no person will be near any danger zone and that the patron or the attendant can reach the disconnects safely.

In this edition of the *Code*, text was modified to require that other electrical utilization equipment, including vacuum cleaners, windshield washer fluid dispensing systems, and compressed air pumps, that is sometimes installed at fuel islands be disconnected from power during emergency stop.

42.5.7.1 At attended motor fuel dispensing facilities, the devices or disconnects shall be readily accessible to the attendant and labeled with an approved sign stating "EMERGENCY FUEL SHUTOFF" or equivalent language. [**30A:**6.7.1]

42.5.7.2 At unattended motor fuel dispensing facilities, the devices or disconnects shall be readily accessible to patrons and at least one additional device or disconnect shall be readily accessible to each group of dispensing devices on an individual island. The device(s) or disconnect(s) shall be labeled with an approved sign stating "EMERGENCY FUEL SHUTOFF" or equivalent language. [**30A:**6.7.2]

42.5.8 Vapor Recovery Systems.

42.5.8.1 Dispensing devices that incorporate vapor recovery shall be listed. [**30A:**6.8.1]

The requirement that vapor recovery systems be listed prevents the use of modified or "home-built" devices or systems that are not specifically intended to provide vapor recovery functions.

42.5.8.2 Hose nozzle valves used on vapor recovery systems shall be listed for the purpose. [**30A:**6.8.2]

42.5.8.3 Means shall be provided in the vapor return path from each dispensing outlet to prevent the discharge of vapors when the hose nozzle valve is in its normal nondispensing position. [**30A:**6.8.3]

This requirement prevents vapors from reaching the interior of the dispenser housing. The interior of the housing is a relatively tight enclosure where vapors can accumulate to ignitible concentration.

42.6 Building Construction Requirements

The construction of buildings and portions of buildings that are motor fuel dispensing facilities or repair garages shall comply with Chapter 30.

42.7 Operational Requirements

Section 42.7 covers the operations associated with motor fuel dispensing facilities and repair garages. The checklist in Exhibit 42.19 is intended to remind users and enforcers of key features that need to be evaluated.

42.7.1 Scope. Section 42.7 shall apply to those requirements that relate to the operation of motor fuel dispensing facilities and fuel dispensing systems. [**30A:**9.1]

42.7.2 Basic Requirements.

42.7.2.1* Inventory Control. Accurate daily inventory records shall be maintained and reconciled for all liquid fuel storage tanks for indication of possible leakage from tanks or piping. The records shall be kept on the premises or shall be made available to the AHJ for inspection within 24 hours of a written or verbal request. The records shall include, as a minimum and by product, daily reconciliation between sales, use, receipts, and inventory on hand. If there is more than one storage system serving an individual pump or dispensing device for any product, the reconciliation shall be maintained separately for each system. [**30A:**9.2.1]

A.42.7.2.1 API RP 1621, *Recommended Practice for Bulk Liquid Stock Control at Retail Outlets*, provides information on this subject. [**30A:**A.9.2.1]

Leaks from underground storage tanks and piping systems present a distinct threat of fire and explosion, especially if the released liquid reaches subterranean or belowgrade structures. At the least, such releases contribute to groundwater contamination that is difficult to identify, isolate, and control. Small leaks can go undetected for months or even years, and identifying the source of a release can be difficult if several tanks are on nearby sites or if the release has spread from its point of origin.

Because of these problems, 42.7.2.1 requires a program of daily inventory reconciliation. If inventory records are maintained and discrepancies reconciled, leaks can often be discovered and corrected before they constitute a major hazard. API RP 1621, *Recommended Practice for Bulk Liquid Stock Control at Retail Outlets,* is the industry standard for maintaining a successful inventory control system and has been in use for years.

The requirement for daily inventory reconciliation is in addition to the leak detection rules established by the EPA in 40 CFR 280, "Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)". The EPA's stated goal is that every underground tank system eventually will have a leak monitoring system using one or a combination of the following:

1. Groundwater monitoring systems
2. Soil vapor monitoring
3. Secondary containment with monitoring of the interstitial space
4. Automatic tank gauging systems

To ease the transition for facility operators, the EPA allows the use of inventory reconciliation combined with periodic tank tightness testing for a 10-year period after installation. Tightness testing can be performed in a number of ways, but all involve rigorous and time-consuming procedures. Any tightness test used must meet the federally mandated performance criteria for detecting a release of 0.1 gal/hr (0.38 L/hr) with a 95 percent probability of accuracy and a ±5 percent probability of error. For further information on the EPA's leak detection requirements, see *Straight Talk on Tanks: A Summary of Leak Detection Methods for Petroleum Underground Storage Tank Systems* (http://www.epa.gov/oust/pubs/straight.htm). State underground storage tank programs can be downloaded from www.epa.gov/oust/states/statcon1.htm.

In cases where a leak is suspected or confirmed, refer to NFPA 329, *Recommended Practice for Handling Releases of*

Exhibit 42.19

SERVICE STATION INSPECTION CHECKLIST

	Dispensing System	Tank	Repair Work Area
Are hoses listed for use?			
Are pumps and nozzles listed for use?			
Are emergency shutoff devices installed correctly?			
Are ignition sources controlled?			
Are emergency shutoff switches present and properly located?			
Are required operating procedures and warnings posted?			
Is electrically safe equipment being used in areas classified for type of electrical equipment?			
Is physical protection in place for pumps and piping?			
Do tanks have adequate spill control?			
Are proper separation distances being followed for operations involving ignition sources and Class I liquids?			
Is housekeeping adequate?			
Is cleanup routinely performed after operations?			
Are flammable liquids stored properly?			
Are other hazardous materials stored in proximity to flammable liquids?			
Are required communication devices working properly?			
Is required egress obstructed?			
Are required fire extinguishers present and properly located?			
For larger repair garages, is sprinkler protection installed?			
Is piping properly color coded?			
Are belowgrade work areas properly ventilated?			
Are fuel dispensing devices in buildings properly located?			
Is any flammable liquid waste properly stored and labeled?			
Are work areas free of combustible waste material?			
Are containers listed for use and properly labeled?			

Recommended inspection checklist for motor fuel dispensing facilities.

Flammable and Combustible Liquids and Gases. NFPA 329 provides guidance in determining the source of a leak, as well as procedures for testing tanks and removing liquids that are trapped underground.

42.7.2.2 Tank Filling and Bulk Delivery.

42.7.2.2.1 Delivery operations shall meet all applicable requirements of NFPA 385 and the requirements of 42.7.2.2.3 through 42.7.2.2.6. [**30A:**9.2.2.1]

N **42.7.2.2.2** No separation shall be required between the delivery vehicle and the fill connection of an underground storage tank. [**30A:**9.2.2.2]

It was not the intent of previous editions of NFPA 30A and this *Code* to impose separation distance between the delivery vehicle and the fill point for an underground tank. However, this was never explicitly stated. Paragraph 42.7.2.2.2 is new to this edition of the *Code* and rectifies that oversight.

42.7.2.2.3 The delivery vehicle shall be separated from any aboveground tank in accordance with Table 42.7.2.2.3.

Originally, a 25 ft (7.6 m) separation was required between the delivery vehicle and any aboveground storage tanks, with exceptions for tanks filled by gravity and for delivery of Class II and Class III liquids. Table 42.7.2.2.3 replaces the previous text and exceptions with separation distances that recognize the reduced risk of tanks that are inherently safer.

N **42.7.2.2.3.1** Separation distances shall be imposed by the use of curbing, guard posts, or other approved methods. [**30A:**9.2.2.3.1]

N **42.7.2.2.3.2*** Means shall be provided to prevent an accidental release originating from the delivery vehicle from flowing under the aboveground tank. [**30A:**9.2.2.3.2]

N ***TABLE 42.7.2.2.3*** *Minimum Separation Distances Between Delivery Vehicles and Aboveground Tanks*

Aboveground Tank Type	Separation Distance Between Delivery Vehicle and Aboveground Tank (ft)
Protected aboveground tanks	0
Tanks in abovegrade vaults (measured from vault wall)	0
Tanks filled by gravity	0
Fire-resistant tanks	15
Other tanks meeting the requirements of NFPA 30 storing Class II or Class III liquids	15
Other tanks meeting the requirements of NFPA 30 storing Class I liquids	25

[**30A:**9.2.2.3]

N **A.42.7.2.2.3.2** If the tank is situated in a dike, the dike wall meets this requirement. For secondary containment-type tanks, drainage, curbing, or other approved means can be used. [**30A:**A.9.2.2.3.2]

42.7.2.2.4 The delivery vehicle shall be located so that all parts of the vehicle are on the premises when delivery is made.

*Exception: This requirement shall not apply to existing fuel dispensing facilities and fuel dispensing facilities inside buildings. [**30A:**9.2.2.4]*

42.7.2.2.5 Tank filling shall not begin until the delivery operator has determined that the tank has sufficient available capacity (i.e., ullage). [**30A:**9.2.2.5]

42.7.2.2.6 Tanks shall be filled through a liquidtight connection. [**30A:**9.2.2.5]

42.7.2.2.6.1 Where an aboveground tank is filled by means of fixed piping, either a check valve and shutoff valve with a quick-connect coupling or a check valve with a dry-break coupling shall be installed in the piping at a point where connection and disconnection is made between the tank and the delivery vehicle. This device shall be protected from tampering and physical damage. [**30A:**9.2.2.5.1]

42.7.2.2.6.2 Underground tanks and tanks in belowgrade vaults shall be filled through a liquidtight connection within a spill container. [**30A:**9.2.2.5.2]

42.7.2.3 Dispensing into Containers.

The provisions of 42.7.2.3 are intended to provide safety not only while the fuel is being dispensed into a portable container, but also while it is being transported to its point of use. The latter operation is addressed by the provisions of 42.7.2.3.1 and 42.7.2.3.2. Portable containers are subject to physical abuse simply because of their portability. If not handled properly and not tightly capped, they are prone to leakage and escape of vapors.

Because the entire contents of a portable container might not be used at the time of purchase, it is important that the container be clearly marked with the name of the contents in order to prevent accidental misuse at a later date. Note that the attendant or operator is permitted to refuse the dispensing of fuel into an unsuitable container.

42.7.2.3.1* Class I or Class II liquids shall not be dispensed into portable containers unless the container is constructed of metal or is approved by the AHJ, has a tight closure, and is fitted with a spout or so designed that the contents can be poured without spilling. The hose nozzle valve shall be manually held open during the dispensing operation. [**30A:**9.2.3.1]

A.42.7.2.3.1 See Chapter 9 of NFPA 30 for further information. [**30A:**A.9.2.3.1]

42.7.2.3.2 No sale or purchase of any Class I, Class II, or Class III liquids shall be made in containers unless such containers are clearly marked with the name of the product contained therein. [**30A:**9.2.3.2]

42.7.2.3.3 Portable containers of 12 gal (45 L) capacity or less shall not be filled while they are in or on a motor vehicle or marine craft. [**30A:**9.2.3.3]

Prior to the 1993 edition, the prohibition in 42.7.2.3.3 applied to filling portable containers that were in the trunk or the passenger compartment of a vehicle for the obvious reason that it would allow vapors to accumulate in a confined space that might contain an ignition source, usually the vehicle's electrical system. In 1993, the prohibition was extended to filling containers that are "on" the vehicle. The amendment is based on dozens of fire incidents identified by the Petroleum Equipment Institute that involved filling containers while they were sitting on plastic-lined beds of pickup trucks. Apparently, containers accumulate a static electric charge (several mechanisms are possible) that cannot be dissipated because the plastic liner insulates the container from ground. Contact between the container and the grounded dispenser nozzle results in an electrostatic discharge that ignites any vapors that are present.

42.7.2.4 Dispensing from a Tank That Does Not Exceed 120 Gal (454 L) and from Containers Inside Buildings. Dispensing of flammable and combustible liquids from a tank not exceeding 120 gal (454 L) capacity and from containers in a motor fuel dispensing facility or in a repair garage building shall meet the requirements of 42.7.2.4.1 and 42.7.2.4.2. *(See 42.3.3.9 for storage quantity limitations.)* [**30A:**9.2.4]

42.7.2.4.1 Not more than one container of Class I liquid shall be permitted to be provided with a dispensing pump inside a building at any one time. The number of tanks or containers of Class II or Class IIIA liquids fitted for dispensing at any one time shall not be limited, except as provided for in 42.3.3.9.2. The number of tanks or containers of Class IIIB liquids fitted for dispensing at any one time shall not be limited. [**30A:**9.2.4.1]

Paragraph 42.3.3.9.1.1 permits storage of Class I liquid up to an aggregate capacity of 120 gal (454 L). This quantity can be stored as follows:

1. In a single 120 gal (454 L) tank
2. In more than one tank (presumably with capacities smaller than 120 gal (454 L)
3. In containers that do not exceed 60 gal (227 L)
4. In some combination of these storage methods

At first glance, there appears to be a discrepancy of 1 gal (3.8 L). However, the 120 gal (454 L) permitted by 42.3.3.9.1.1 is an *aggregate* amount of two or more containers. While the DOT does recognize containers up to 119 gal (450 L), those with a capacity above 60 gal (227 L) are used as recovery drums for leaking shipping containers, not for basic shipping and storage. Paragraph 42.7.2.4.1 adds the additional restriction that only one container or tank of Class I liquid can be provided with a dispensing pump at any one time.

For dispensing of Class II or Class IIIA liquids, 42.7.2.4.1, in combination with 42.3.3.9.1.2, permits storage of an aggregate quantity of 240 gal (908 L). If stored in tanks, the tanks cannot exceed 120 gal (454 L) capacity. If stored in containers, the containers cannot exceed 119 gal (450 L), but practicality dictates that the containers not exceed 60 gal (227 L) for the reasons discussed in the preceding paragraph of this commentary. Note that each class of liquid is restricted to a 120 gal (454 L) upper limit.

No restrictions are placed on storing and dispensing of Class IIIB liquids due to their low fire risk.

42.7.2.4.2 Class I, Class II, and Class IIIA liquids shall not be dispensed by applying pressure to tanks or containers. Listed pumps that take suction through the top of the tank or container or listed self-closing faucets shall be used. [**30A:**9.2.4.2]

This provision prohibits the use of the facility's compressed air system to dispense liquids from containers or tanks.

N **42.7.2.5* Display of Materials.** The storage or placement for display or sale of products shall be prohibited within 20 ft of any fuel dispenser. [**30A:**9.2.5.5]

N **A.42.7.2.5** Many fuel stations display items such as wood, bagged ground cover, cartons of consumable products, and other combustibles that create vision obstructions, excessive fire load, and other hazards in and around dispensing islands and pumps. [**30A:**A.9.2.5.5]

42.7.2.6 Basic Fire Control.

42.7.2.6.1 Sources of Ignition. Smoking materials, including matches and lighters, shall not be used within 20 ft (6 m) of areas used for fueling, servicing fuel systems of internal combustion engines, or receiving or dispensing of Class I and Class II liquids. The motors of all equipment being fueled shall be shut off during the fueling operation except for emergency generators, pumps, and so forth, where continuing operation is essential. [**30A:**9.2.5.1]

The 20 ft (6 m) separation distance is based on the extent of the hazardous (classified) location around a fuel dispenser and can be considered applicable to any source of ignition.

42.7.2.6.2 Fire Extinguishers. Each motor fuel dispensing facility or repair garage shall be provided with fire extinguishers installed, inspected, and maintained as required by Section 13.6. Extinguishers for outside motor fuel dispensing areas shall be provided according to the extra (high) hazard requirements for Class B hazards, except that the maximum travel distance to an 80 B:C extinguisher shall be permitted to be 100 ft (30.48 m). [**30A:**9.2.5.2]

Table 6.3.1.1 of NFPA 10, *Standard for Portable Fire Extinguishers*, calls for a maximum 50 ft (15.25 m) travel distance for an extinguisher having an 80 B:C rating. However, 42.7.2.6.2 allows 100 ft (30.48 m). There is no conflict with NFPA 10, nor does 42.7.2.6.2 violate the provisions of NFPA 10. Table 6.3.1.1 of NFPA 10 provides maximum travel distances for various sizes of fire extinguishers for light (low), ordinary (moderate), and extra (high) hazard *occupancies*, which implies the extinguishers are being installed inside a building. The 100 ft (30.48 m) travel distance allowed in 42.7.2.6.2 applies to an outside motor fuel dispensing facility and applies only to an 80 B:C unit. Because the travel distances specified in NFPA 10 are for indoor application, NFPA 30A can establish its own maximum travel distance for an outdoor application.

42.7.2.6.3 Fire Suppression Systems. Where required, automatic fire suppression systems shall be installed in accordance with the appropriate NFPA standard, manufacturers' instructions, and the listing requirements of the systems. [**30A:**9.2.5.3]

Note that this *Code* does not mandate a fire protection system for a motor fuel dispensing area. This matter should be left to the AHJ.

42.7.2.6.4* Signs. Warning signs shall be conspicuously posted in the dispensing area and shall incorporate the following or equivalent wording:

WARNING:
It is unlawful and dangerous to dispense gasoline into unapproved containers.
No smoking.
Stop motor.
No filling of portable containers in or on a motor vehicle.
Place container on ground before filling.
Discharge your static electricity before fueling by touching a metal surface away from the nozzle.
Do not re-enter your vehicle while gasoline is pumping.
If a fire starts, **do not** remove nozzle — back away immediately.
Do not allow individuals under licensed age to use the pump.

[**30A:**9.2.5.4]

A.42.7.2.6.4 The following language includes both the mandatory requirements and some optional text that could be used to comply with the requirements in 42.7.2.6.4:

WARNING
It is unlawful and dangerous to dispense gasoline into unapproved containers.
No smoking.
Stop motor.
No filling of portable containers in or on a motor vehicle.
Place container on ground before filling.
Discharge your static electricity before fueling by touching a metal surface away from the nozzle.
Before using pump, touch any metal on the car away from your vehicle's fuel filler with bare hand. This will discharge static electricity on your body. Failure to fully discharge may ignite gasoline vapors.
Do not re-enter your vehicle while gasoline is pumping. This can re-charge your body with static electricity. If you must re-enter your vehicle, discharge static electricity again before touching the pump nozzle.
If a fire starts, **do not** remove nozzle — back away immediately and tell attendant. If no attendant is on site, use the emergency shut-off button to stop pump.
Do not allow individuals under licensed age to use the pump.
Only persons of licensed age should use pump.
Keep children away from the pump area.
Do not allow children to use pump.

[**30A:**A.9.2.5.4]

42.7.2.7 Waste Handling.

42.7.2.7.1 Crankcase drainings and waste liquids shall not be dumped into sewers, into streams, or on the ground. They shall be stored in approved tanks or containers outside any building, or in tanks installed in accordance with Chapters 4 and 5 of NFPA 30A, until removed from the premises.

*Exception: As provided for in 42.3.3.9.3. [**30A:**9.2.6.1]*

Small tanks or drums are often used for the storage of crankcase drainings and similar liquids. These waste oils might be contaminated with lower flash point flammable liquids. Thus, waste oils are not to be overlooked when applying regulations. For environmental and safety reasons, crankcase drainings must not be dumped into sewers. The words "or in tanks installed in accordance with Chapters 4 and 5 of NFPA 30A" in 42.7.2.7.1 effectively allow the storage of used motor oils in tanks inside a building. Used motor oil has been determined to be no more hazardous than virgin oil unless contaminated with a low flash point liquid.

Inside storage offers a more secure situation and allows the operator to address some environmental regulations for storing used motor oil now being set by local and state authorities. Fixed piping and stationary storage tanks, as commonly used in "quick-lube" facilities, provide a more effective and secure storage arrangement, from the standpoint of both fire protection and environmental protection, than outside drum storage.

Note that the EPA publication *Restricting Service Station Wastes in Shallow Injection Wells* recommends that motor fuel dispensing facilities and repair garages abandon the practice of disposing waste liquids in septic system drain fields, drywells, or cesspools, even if the waste stream first flows through an oil–water separator, because many of the components of the waste fluids are water soluble and will pass through the separator. This practice leads to groundwater contamination. The EPA urges disposal by safer means.

42.7.2.7.2 The contents of oil separators and traps of floor drainage systems shall be collected at sufficiently frequent intervals to prevent oil from being carried into sewers. [**30A:**9.2.6.2]

42.7.2.8 Housekeeping. The dispensing area and the area within any dike shall be kept free of vegetation, debris, and any other material that is not necessary to the proper operation of the motor fuel dispensing facility. [**30A:**9.2.7]

Although 42.7.2.8 sets requirements restricting the storage of materials not required for dispensing, many facilities still

Exhibit 42.20

Items for sale stacked next to fuel dispensers. (Courtesy of Wisconsin Commerce Department)

stockpile items for sale close to the dispenser. Exhibit 42.20 illustrates an all-too-common situation that is prohibited by 42.7.2.8.

42.7.2.9 Fire Doors. Fire doors shall be kept unobstructed at all times. Appropriate signs and markings shall be used. [**30A:**9.2.8]

N **42.7.2.10 Maintenance of Aboveground Storage Tank Appurtenances.** Storage tank appurtenances shall be maintained and operated in accordance with manufacturer's instructions, published industry practices, or equivalent methods approved by the AHJ. [**30A:**9.2.9]

42.7.3 Operating Requirements for Full-Service Motor Fuel Dispensing Facilities. Each motor fuel dispensing facility shall have an attendant or supervisor on duty whenever the facility is open for business. The attendant or supervisor shall dispense liquids into fuel tanks or into containers, except as covered in 42.7.4 and 42.7.5. [**30A:**9.3]

42.7.4 Operating Requirements for Attended Self-Service Motor Fuel Dispensing Facilities.

42.7.4.1 "Self-service motor fuel dispensing facility" shall mean that portion of a property where liquids used as motor fuels are stored and dispensed from fixed, approved dispensing equipment into the fuel tanks of motor vehicles by persons other than the facility attendant and shall also include, where provided, facilities for the sale of other retail products. [**30A:**9.4.1]

The concept of self-service motor fuel dispensing facilities has almost universal acceptance by both the public and the fire service, with the exceptions of New Jersey and Oregon. For many years, self-service dispensing without an attendant were permitted only at "private" or "not-open-to-the-public" stations. Eventually, requirements were established for self-service fueling and, not long after, for unattended self-service stations.

Based on the fire incident data accumulated over the years, determining the difference in relative safety between full-service and self-service is not possible. Some jurisdictions require self-service facilities to have one set of dispensers dedicated to full-service use for the benefit of those patrons who do not wish to use, or are physically incapable of using, the self-service dispensers. The dispenser at which an incident occurs is often not identified, so it cannot be stated that one is more hazardous than the other. In addition, the nature of the fire problem is very much the same for both. For example, a full-service dispenser can be knocked over by a vehicle just as easily as can a self-service dispenser.

42.7.4.2 There shall be at least one attendant on duty while the self-service facility is open for business. The attendant's primary function shall be to supervise, observe, and control the dispensing of motor fuels. [**30A:**9.4.2]

Compliance with the requirement that the attendant "observe" dispensing has led, in some cases, to the use of closed-circuit video cameras. Communication with the patron is also being provided by intercoms mounted in the dispenser.

In previous editions of the *Code*, this provision applied only to the dispensing of Class I liquids (i.e., gasoline). The technical committee recognized that this provision should apply equally to any motor fuel, especially since retailing of alternative fuels at the same facilities as liquid fuels is becoming more common.

Δ **42.7.4.3** The responsibility of the attendant shall be as follows:

(1) Prevent the dispensing of Class I liquids into portable containers not in compliance with 42.7.2.3.1
(2) Prevent the use of hose nozzle valve latch-open devices that do not comply with 42.5.6.1
(3) Control sources of ignition
(4) Immediately activate emergency controls and notify the fire department of any fire or other emergency
(5) Handle accidental spills and fire extinguishers if needed

[**30A:**9.4.3]

42.7.4.3.1 The attendant or supervisor on duty shall be mentally and physically capable of performing the functions and assuming the responsibility prescribed in 42.7.4. [**30A:**9.4.3.1]

42.7.4.4 Operating instructions shall be conspicuously posted in the dispensing area. [**30A:**9.4.4]

42.7.5 Operating Requirements for Unattended Self-Service Motor Fuel Dispensing Facilities.

Changes in the marketing of motor fuels have led to confusion about what is meant by "open to the public" versus "not open to the public," occasionally leading to a legal dispute between the AHJ and the facility owner or operator. Once unattended self-service motor fuel dispensing was recognized and addressed in NFPA 30A, the ambiguity needed to be addressed. It was decided that by eliminating the phrases "open to the public," "not open to the public," and "private," it could clarify the intended requirements for all types of service station operations. Thus, the addition of 42.7.5 on unattended self-service stations has resulted in small but important changes in 42.7.3 and 42.7.4.

42.7.5.1 Unattended self-service facilities shall be permitted, where approved by the AHJ. [**30A:**9.5.1]

42.7.5.2 Operating instructions shall be conspicuously posted in the dispensing area. The instructions shall include location of emergency controls and a requirement that the user stay outside of his/her vehicle and in view of the fueling nozzle during dispensing. [**30A:**9.5.2]

42.7.5.3 In addition to the warning signs specified in 42.7.2.6.4, emergency instructions shall be conspicuously posted in the dispenser area. The instructions shall incorporate the following or equivalent wording:

Emergency Instructions

In case of fire or spill

(1) Use emergency stop button.

(2) Report accident by calling (*specify local fire number*). Report location.

[**30A:**9.5.3]

42.7.5.4 A listed, automatic closing–type hose nozzle valve with latch-open device shall be provided. The hose nozzle valve shall meet the requirements of 42.5.6.2. [**30A:**9.5.4]

42.7.5.5 A telephone or other approved, clearly identified means to notify the fire department shall be provided on the site in a location approved by the AHJ. [**30A:**9.5.5]

42.7.5.6* Additional fire protection shall be provided where required by the AHJ. [**30A:**9.5.6]

A.42.7.5.6 Additional fire protection considerations can include fixed suppression systems, automatic fire detection, manual fire alarm stations, transmission of alarms to off-site locations, and limitation of the quantity of motor fuel delivered per transaction. [**30A:**A.9.5.6]

42.7.6 Refueling from Tank Vehicles. The dispensing of Class I and Class II liquids in the open from a tank vehicle to a motor vehicle located at commercial, industrial, governmental, or manufacturing establishments and intended for fueling vehicles used in connection with their businesses shall be permitted only if all of the requirements of 42.7.6.1 through 42.7.6.9 have been met. [**30A:**9.6]

Originally, the requirements in 42.7.6 were intended to allow fueling of construction vehicles and equipment at isolated construction sites. Over the years, however, many new types of motorized construction equipment have been developed, and refueling these from a tank vehicle is common at construction sites, whether urban, suburban, or rural. Also, these requirements have been interpreted as allowing the fueling of motor vehicles from a tank vehicle in a parking lot, access to which is limited to employees of the user or owner of the lot.

Because of the ambiguity involving the phrase "open to the public," the NFPA 30A technical committee added the words "located at commercial, industrial, governmental, or manufacturing establishments" to define the facilities covered by these requirements. The phrase "intended for fueling vehicles used in connection with their businesses" further clarifies the intent of this subsection to apply only to vehicles directly related to the function of the facility.

If the vehicles being refueled are connected with the operation of the establishment, they are allowed to be refueled from a tank vehicle, as long as all the conditions of 42.7.6 are met. Also, the vehicles are not restricted to operating only on the site on which they are refueled. Note, however, that this requirement would also apply to refueling of nonregistered vehicles that can be operated only on-site, such as industrial trucks.

42.7.6.1 An inspection of the premises and operations shall be made and operations shall not be conducted unless approved by the AHJ. [**30A:**9.6.1]

42.7.6.2 The tank vehicle shall comply with the requirements of NFPA 385. [**30A:**9.6.2]

42.7.6.3 The dispensing hose shall not exceed 50 ft (15 m) in length. [**30A:**9.6.3]

42.7.6.4 The dispensing nozzle shall be a listed, automatic closing–type without a latch-open device. [**30A:**9.6.4]

42.7.6.5 Nighttime deliveries shall only be made in areas deemed adequately lighted by the AHJ. [**30A:**9.6.5]

42.7.6.6 The tank vehicle flasher lights shall be in operation while dispensing operations are in progress. [**30A:**9.6.6]

42.7.6.7 Expansion space shall be left in each fuel tank to prevent overflow in the event of temperature increase. [**30A:**9.6.7]

N **42.7.6.8** A means for bonding the tank vehicle to the motor vehicle shall be provided. Such bonding means shall be employed during fueling operations. [**30A:**9.6.8]

N **42.7.6.9** A spill kit designed for motor vehicle fuels shall be carried on the tank vehicle and employed in case of a fuel spill. [**30A:**9.6.9]

42.8 Additional Requirements for CNG, LNG, Hydrogen, and LPG

Section 42.8 sets requirements for motor fuel dispensing facilities that handle both gaseous and liquid fuels. For the most part, this section refers back to the fuel-specific codes for safety requirements, including NFPA 2 for hydrogen, NFPA 52 for natural gas, and NFPA 58 for propane.

42.8.1 Scope. Section 42.8 shall apply where CNG, LNG, compressed or liquefied hydrogen, or LP-Gas, or combinations of these, are dispensed as motor vehicle fuels along with Class I or Class II liquids that are also dispensed as motor vehicle fuels. [**30A:**12.1]

Exhibit 42.21

A CNG fuel dispenser at a retail motor fuel dispensing facility. (Courtesy of cleanenergyfuels.com)

Exhibit 42.22

A residential CNG refueling system. (Courtesy of cleanenergyfuels .com)

Chapter 12 of NFPA 30A includes requirements for vehicular hydrogen fueling. The refueling facility shown in Exhibit 42.21 dispenses both liquid and gaseous fuels. Exhibit 42.22 shows a type of gaseous fueling installation — a dedicated home refueling system — that is outside the scope of NFPA 30A. A dedicated home refueling system allows refueling of the vehicle conveniently overnight. The system safely compresses natural gas from the household line to the needed vehicle pressure using a relatively slow (time-fill) refueling rate.

42.8.2 General Requirements.

42.8.2.1 The installation and use of CNG and LNG systems shall meet the requirements of NFPA 52 except as modified by Section 42.8. The installation and use of hydrogen systems shall meet the requirements of NFPA 2 except as modified by Section 42.8. The installation and use of LP-Gas systems shall meet the requirements of NFPA 58 except as modified by Section 42.8. [**30A:**12.2.1]

42.8.2.2 A means shall be provided that connects to the dispenser supply piping and that prevents flow in the event that the dispenser is displaced from its mounting. [**30A:**12.2.2]

42.8.2.3* Dispensing devices for CNG, LNG, hydrogen, and LP-Gas shall be listed or approved. [**30A:**12.2.3]

N **A.42.8.2.3** Not all fuels have equipment that is currently listed. As technology develops, this provision will allow the authorities having jurisdiction (AHJ) the latitude to approve systems and equipment that cannot be currently listed. [**30A:**A.12.2.3]

42.8.2.4* Listed or approved hose assemblies shall be used to dispense fuel. Hose length at automotive motor fuel dispensing facilities shall not exceed 18 ft (5.5 m). [**30A:**12.2.4]

N **A.42.8.2.4** See A.12.2.3. [**30A:**A.12.2.4]

42.8.3 Fuel Storage.

Responsibility for establishing installation criteria for storage of gaseous fuels rests primarily with the codes that are specific to the respective fuels, not with NFPA 30A. NFPA 30A does, however, establish tank-to-tank separation, as indicated in 42.8.3.3, because these criteria are lacking in NFPA 52 and NFPA 58.

42.8.3.1 Aboveground tanks storing CNG or LNG shall be separated from any adjacent property line that is or can be built upon, any public way, and the nearest important building on the same property by not less than the distances given in Section 8.4 of NFPA 52. [**30A:**12.3.1]

42.8.3.2 Aboveground tanks storing hydrogen shall be separated from any adjacent property line that is or can be built upon, any public way, and the nearest important building on the same property by not less than the distances given in NFPA 2. [**30A:**12.3.2]

Exhibit 42.23 shows a propane tank and dispenser for vehicle fueling. The vertical configuration of the propane storage tank allows this system to be installed in a relatively small area. The propane tank separation distances from exposures, such as property lines and important buildings, are given in NFPA 58.

42.8.3.3 Aboveground tanks storing LP-Gas shall be separated from any adjacent property line that is or can be built upon, any public way, and the nearest important building on the same property by not less than the distances given in Section 6.3 of NFPA 58. [**30A:**12.3.3]

Exhibit 42.23

Typical propane storage and dispensing system for fueling vehicles. (Photo: Warren Gretz; Courtesy of DOE/NERL)

42.8.3.4* Aboveground tanks storing CNG, LNG, or LP-Gas shall be separated from each other by at least 20 ft (6 m) and from dispensing devices that dispense liquid or gaseous motor vehicle fuels by at least 20 ft (6 m).

Exception No. 1: This required separation shall not apply to tanks storing or handling fuels of the same chemical composition.

*Exception No. 2: When both the gaseous fuel storage and dispensing equipment are at least 50 ft (15 m) from any other aboveground motor fuel storage or dispensing equipment, the requirements of NFPA 52 or NFPA 58, whichever is applicable, shall apply. [**30A:**12.3.4]*

A.42.8.3.4 The selection of the 20 ft (6 m) separation distance between storage containers of different gaseous fuels is based on long-standing requirements in NFPA 2, NFPA 52, and NFPA 58. The separation distance between containers storing gaseous fuels and liquid motor fuel dispensers is based on the maximum 18-foot length of dispenser hose attached to the liquid fuel dispenser and the potential for a liquid pool fire to affect the gaseous fuel storage containers. [**30A:**A.12.3.4]

42.8.3.5 Aboveground storage tanks for the storage of CNG, LNG, or LP-Gas shall be provided with physical protection in accordance with 42.3.3.7. [**30A:**12.3.5]

42.8.3.6 Horizontal separation shall not be required between aboveground tanks storing CNG, LNG, or LP-Gas and underground tanks containing Class I or Class II liquids, provided the structural limitations of the underground tanks are not exceeded. [**30A:**12.3.6]

42.8.4 Dispenser Installations Beneath Canopies. Where CNG or LNG dispensers are installed beneath a canopy or enclosure, either the canopy or enclosure shall be designed to prevent accumulation or entrapment of ignitable vapors or all electrical equipment installed beneath the canopy or enclosure shall be suitable for Class I, Division 2 hazardous (classified) locations. [**30A:**12.4]

Unlike most other flammable gases and flammable and combustible liquids, whose vapors are more dense than air and tend to hug the ground, natural gas vapors are less dense than air and will rise. If an unexpected release of CNG or LNG occurs, vapors collect beneath the dispensing area canopy or at the top of any enclosure.

42.8.5 Specific Requirements for LP-Gas Dispensing Devices.

42.8.5.1 Dispensing devices for LP-Gas shall meet all applicable requirements of Chapter 69 and NFPA 58. [**30A:**12.5.1]

42.8.5.2 Dispensing devices for LP-Gas shall be located as follows:

(1) At least 10 ft (3 m) from any dispensing device for Class I liquids
(2) At least 5 ft (1.5 m) from any dispensing device for Class I liquids where the following conditions exist:
    (a) The LP-Gas deliver nozzle and filler valve release no more than 0.1 oz (4 cm^3) of liquid upon disconnection.
    (b) The fixed maximum liquid level gauge remains closed during the entire refueling process.

[**30A:**12.5.2]

42.8.6 Electrical Equipment.

The electrical area classification requirements in Table 42.8.6.2 are specific to gaseous fuels and differ somewhat from the criteria in Chapter 8 of NFPA 30A. For CNG and LNG, the requirements take into consideration the lighter-than-air characteristics of the gas. Unlike the requirements for liquid fuels, they establish area classification for the dispenser enclosure itself, because there is no standard equivalent to UL 87 for gaseous fuels.

42.8.6.1 All electrical wiring and electrical utilization equipment shall be of a type specified by, and shall be installed in accordance with, Section 11.1. [**30A:**12.6.1]

42.8.6.2* Table 42.8.6.2 shall be used to delineate and classify areas for the purpose of installation of electrical wiring and electrical utilization equipment. [**30A:**12.6.2]

A.42.8.6.2 The designation of classes and divisions of classified locations is defined in Article 500 of *NFPA 70*. [**30A:**A.12.6.2]

TABLE 42.8.6.2 Electrical Equipment Classified Areas for Dispensing Devices

	Extent of Classified Area	
Dispensing Device	**Class I, Division 1**	**Class I, Division 2**
Compressed natural gas (CNG)	Entire space within the dispenser enclosure	5 ft (1.5 m) in all directions from dispenser enclosure
Liquefied natural gas (LNG)	Entire space within the dispenser enclosure and 5 ft (1.5 m) in all directions from the dispenser enclosure	10 ft (3 m) in all directions from the dispenser enclosure
Liquefied petroleum gas (LP-Gas)	Entire space within the dispenser enclosure; 18 in. (46 cm) from the exterior surface of the dispenser enclosure to an elevation of 4 ft (1.22 m) above the base of the dispenser; the entire pit or open space beneath the dispenser and within 20 ft (6 m) horizontally from any edge of the dispenser when the pit or trench is not mechanically ventilated	Up to 18 in. (46 cm) above ground and within 20 ft (6 m) horizontally from any edge of the dispenser enclosure, including pits or trenches within this area when provided with adequate mechanical ventilation

[**30A:** Table 12.6.2]

42.9 Marine Fueling

42.9.1 Scope.

42.9.1.1 Section 42.9 shall apply to that portion of a property where liquids used as fuels are stored, handled, and dispensed from equipment located on shore or from equipment located on piers, wharves, or floating docks into the fuel tanks of marine craft, including incidental activity, except as covered elsewhere in NFPA 30A or in other NFPA standards. [**30A:**11.1.1]

Δ **42.9.1.2** Section 42.9 shall not apply to the following:

(1) Bulk plant or terminal loading and unloading facilities
(2) Transfer of liquids utilizing a flange-to-flange closed transfer piping system
(3) Marine motor fuel dispensing facilities where liquids used as fuels are stored and dispensed into the fuel tanks of marine craft of 300 gross tons (272 metric tons) or more

[**30A:**11.1.2]

Bulk loading and unloading of flammable and combustible liquid cargoes are covered by Chapter 28 of NFPA 30. Refueling of marine vessels of 300 gross tons (272 metric tons) or more is under the jurisdiction of the U.S. Coast Guard.

42.9.1.3 For the purpose of Section 42.9, the word *pier* shall also mean dock, floating dock, and wharf. [**30A:**11.1.3]

42.9.1.4 Permits. all comply with Section 1.12.

42.9.2 Storage.

42.9.2.1 Liquids shall be stored in tanks or containers complying with 42.3.3. [**30A:**11.2.1]

42.9.2.2* Tanks that supply marine motor fuel dispensing facilities shall be located on shore or on a pier of the solid-fill type. Pumps that are not integral with the dispensing device shall also be located on shore or on a pier of the solid-fill type.

*Exception: Tanks shall be permitted with the approval of the AHJ to be located on a pier, provided the installation meets all applicable requirements of Chapters 4 and 5 of NFPA 30A and 21.6.2 of NFPA 30 and the quantity stored does not exceed 1100 gal (4164 L) aggregate capacity. [**30A:**11.2.2]*

A.42.9.2.2 Cases where the length of the supply line to dispensing devices would result in insufficient pressure for operational purposes or would increase the potential for leakage due to the increased number of fittings or exposure of the line can warrant location of the supply on the pier. [**30A:**A.11.2.2]

Marine fuel dispensing facilities must be located where the water depth is adequate to accommodate the vessels served. Suitable locations are often near steep or rocky shores where excavation to completely bury a tank is difficult. Regardless, a tank should be located above the high water level to avoid accumulation of water in the excavation, possible corrosion, and leakage and to prevent possible dislocation or movement of the tank during a flood event.

42.9.2.3 Where a tank is at an elevation that produces a gravity head on the dispensing device, the tank outlet shall be equipped with a device, such as a normally closed solenoid valve, that will prevent gravity flow from the tank to the dispenser. This device shall be located adjacent to and downstream of the outlet valve specified by 66.22.13.1. The device shall be installed and adjusted so that liquid cannot flow by gravity from the tank to the dispenser if the piping or hose fails when the dispenser is not in use. [**30A:**11.2.3]

42.9.3 Piping Systems.

42.9.3.1 Piping shall be installed in accordance with all applicable requirements of Chapter 5 of NFPA 30A. [**30A:**11.3.1]

42.9.3.2 Piping systems shall be supported and protected against physical damage and stresses arising from impact, settlement, vibration, expansion, contraction, and tidal action. [**30A:**11.3.2]

42.9.3.3 Means shall be provided to ensure flexibility of the piping system in the event of motion of the pier. Flexible piping shall be of a type designed to withstand the forces and pressures exerted upon the piping. [**30A:**11.3.3]

42.9.3.4 Where dispensing is from a floating structure or pier, approved oil-resistant flexible hose shall be permitted to be used between shore piping and the piping on a floating structure or pier and between separate sections of the floating structure to accommodate changes in water level or shoreline, provided that the hose is either resistant to or shielded from damage by fire. [**30A:**11.3.4]

Paragraphs 42.9.3.3 and 42.9.3.4 allow the use of flexible piping and flexible hose in certain applications as follows:

1. Where the fuel piping crosses from one section of floating pier to the next to accommodate the motion of the sections relative to each other due to tide and wave action
2. Where the fuel piping crosses from land to a floating pier

Subsection 11.3.4 of NFPA 30A cites some of the factors that must be considered in the design of piping for marine application and allows flexible hose to be used where piping transits from one section of floating pier to another, as explained therein. It does not, however, mean that flexible hose can be used for the entire run from shore to dispenser. It also does not allow secondary containment-type flexible underground piping to be substituted for flexible hose and piping. Such piping is not designed for exposure to the elements and is not approved for such use.

42.9.3.5 A valve to shut off the liquid supply from shore shall be provided in each pipeline at or near the approach to the pier and at the shore end of each marine pipeline adjacent to the point where each flexible hose is attached. [**30A:**11.3.5]

Additional control valves can be located on the pier and elsewhere in the pipeline; however, the primary shutoff valve must be located on shore, where it is immediately accessible in case of an emergency without putting anyone at risk.

42.9.4 Fuel Dispensing System.

42.9.4.1 All hose shall be listed. Where hose length exceeds 18 ft (5.5 m), the hose shall be secured so as to protect it from damage. [**30A:**11.4.1]

42.9.4.2 Dispensing nozzles shall be of the automatic-closing type without a latch-open device. [**30A:**11.4.2]

If the marine craft has its own internal permanently mounted fuel tanks (as opposed to portable tanks), the fuel filler port is typically located on the gunwale and is typically larger than that on a motor vehicle; consequently, the fit of the nozzle spout into the fill port is looser. That being the case, the back pressure from the fill tube is not always great enough to trigger the automatic closing feature when the tank is near full, which could result in an overfill. An overfill can lead to spilled fuel draining to the bilge or the interior cabin of the boat, which is a much more hazardous condition than a similar spill on the ground, since vapors are more confined, dispersal takes a longer period of time, and mechanical ventilation is required. Control of sources of ignition is also more difficult. Therefore, latch-open devices are prohibited to ensure that the person refueling the vessel does not move away from the boat and pays attention to the task at hand.

42.9.4.3 Dispensing devices shall be permitted to be located on open piers, on shore, or on piers of the solid-fill type and shall be located apart from other structures so as to provide room for safe ingress to and egress from marine craft. [**30A:**11.4.3]

42.9.4.4 Dispensing devices shall be located so that exposure to all other operational marina or pleasure boat berthing area facilities is minimized. Where tide and weather conditions permit, liquid fuel handling shall be outside the main berthing areas. Where located inside marina or pleasure craft berthing areas, fueling facilities shall be located so that, in case of fire aboard a marine craft alongside, the danger to other craft near the facility is minimized. [**30A:**11.4.4]

Refueling facilities are preferably located separately from berthing areas, but this is not always possible, due to the exposure to rough water conditions caused by inclement weather. Therefore, where refueling operations must be located within the berthing area, care must be taken to limit exposure to other vessels should a fire occur.

Evacuation of vessels from their berths cannot always be immediately accomplished, due to the need to purge the engine compartment and bilge prior to starting the engines and the time necessary to untie from the dock. For the same reasons, vessels are prohibited from being berthed at the refueling location unless they are being refueled, and then only for the time necessary to refuel.

42.9.4.5 No vessel or marine craft shall be made fast to any other vessel or marine craft occupying a berth at a fuel dispensing location during fueling operations. [**30A:**11.4.5]

42.9.4.6 A marine motor fuel dispensing facility located at a bulk plant shall be separated by a fence or other approved barrier from areas in which bulk plant operations are conducted. Dispensing devices shall not be supplied by aboveground tanks located in the bulk plant. Marine motor fuel dispensing facility storage tanks shall not be connected by piping to aboveground tanks located in the bulk plant. [**30A:**11.4.6]

42.9.4.7 Each marine motor fuel dispensing facility shall have an attendant or supervisor on duty whenever the facility is open for business. The attendant's primary function shall be to supervise, observe, and control the dispensing of liquids. [**30A:**11.4.7]

42.9.5 Sources of Ignition.

42.9.5.1 All electrical components for dispensing liquids shall be installed in accordance with Chapter 8 of NFPA 30A. [**30A:**11.5.1]

42.9.5.2 All electrical equipment shall be installed and used in accordance with the requirements of Section 11.1 as it applies to wet, damp, and hazardous locations. [**30A:**11.5.2]

42.9.5.3 Clearly identified emergency electrical disconnects that are readily accessible in case of fire or physical damage at any dispensing unit shall be provided on each marine wharf. The disconnects shall be interlocked to shut off power to all pump motors from any individual location and shall be manually reset only from a master switch. Each such disconnect shall be identified by an approved sign stating EMERGENCY PUMP SHUTOFF in 2 in. (50 mm) red capital letters. [**30A:**11.5.3]

Because travel distance to emergency electrical disconnects would likely be longer than for similar situations at a vehicle refueling facility, the requirements in 42.9.5.3 are somewhat more detailed.

42.9.5.4 All electrical wiring for power and lighting shall be installed on the side of the wharf opposite from the liquid piping system. [**30A:**11.5.4]

42.9.5.5 Smoking materials, including matches and lighters, shall not be used within 20 ft (6 m) of areas used for fueling, servicing fuel systems for internal combustion engines, or receiving or dispensing of Class I liquids. Conspicuous NO SMOKING signs shall be posted within sight of the customer being served. [**30A:**11.5.5]

42.9.5.6 The motors of all equipment being fueled shall be shut off during the fueling operation, except for emergency generators, pumps, and so forth, where continuing operation is essential. [**30A:**11.5.6]

42.9.6 Electrical Installations.

42.9.6.1 Where excessive stray currents are encountered, piping handling Class I and Class II liquids shall be electrically isolated from the shore piping. [**30A:**8.5.1]

Isolation of marine service station piping is necessary because shore-based stray currents can be transmitted through a conductive hose to the tank fill opening, which is often grounded to the vessel hull, making sparks at the fill opening possible. This requirement prevents stray currents originating in the vessel's electrical system from causing an electrical arc or spark.

42.9.6.2* Pipelines on piers shall be bonded and grounded. Bonding and grounding connections on all pipelines shall be located on the pier side of hose riser insulating flanges, if used, and shall be accessible for inspection. [**30A:**8.5.2]

A.42.9.6.2 NFPA 77 contains information on this subject. [**30A:**A.8.5.2]

42.9.6.3 The fuel delivery nozzle shall be put into contact with the vessel fill pipe before the flow of fuel commences, and this bonding contact shall be continuously maintained until fuel flow has stopped, to avoid the possibility of electrostatic discharge. [**30A:**8.5.3]

42.9.6.4* Bonding and Grounding.

A.42.9.6.4 Where excessive stray currents are encountered, piping handling Class I and Class II liquids should be electrically isolated from the shore piping. This requirement prevents stray currents originating in the vessel's electrical system from causing an electrical arc or spark. [**30A:**A.11.6]

42.9.6.4.1* Pipelines on piers shall be bonded and grounded. Bonding and grounding connections on all pipelines shall be located on the pier side of hose riser insulating flanges, if used, and shall be accessible for inspection. [**30A:**11.6.1]

A.42.9.6.4.1 NFPA 77 contains information on this subject. [**30A:**A.11.6.1]

Insulating flanges are required to prevent shoreside stray currents from reaching the vessel, where they might cause a spark.

42.9.6.4.2 The fuel delivery nozzle shall be put into contact with the vessel fill pipe before the flow of fuel commences and this bonding contact shall be continuously maintained until fuel flow has stopped to avoid possibility of electrostatic discharge. [**30A:**11.6.2]

This requirement eliminates a possible electrostatic discharge that might cause ignition of vapors in the fuel filler tube by ensuring that the nozzle and the fill pipe are at the same potential.

42.9.7 Fire Control.

42.9.7.1 Each marine motor fuel dispensing facility shall be provided with fire extinguishers installed, inspected, and maintained as required by Section 13.6. Extinguishers for marine motor fuel dispensing areas shall be provided according to the extra (high) hazard requirements for Class B hazards, except that the maximum travel distance to an 80 B:C extinguisher shall be permitted to be 100 ft (31 m). [**30A:**11.7.1]

42.9.7.2 Piers that extend more than 500 ft (152 m) in travel distance from shore shall be provided with a Class III standpipe that is installed in accordance with Section 13.2. [**30A:**11.7.2]

A Class III standpipe provides both 1 in. and 2 in. (25 mm and 50 mm) hose connections for use by marina personnel and the fire department. See NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, for additional information.

42.9.7.3 Materials shall not be placed on a pier in such a manner that they obstruct access to fire-fighting equipment or important piping system control valves. Where the pier is accessible to vehicular traffic, an unobstructed roadway to the shore end of the wharf shall be maintained for access by fire-fighting apparatus. [**30A:**11.7.3]

42.9.8 Containers and Movable Tanks.

42.9.8.1 The temporary use of movable tanks in conjunction with the dispensing of liquids into the fuel tanks of marine craft on premises not normally accessible to the public shall be permitted. Such installations shall only be made with the approval of the AHJ. [**30A:**11.8.1]

Paragraph 42.9.8.1 allows fueling of vehicles by temporary use of a tank that can be moved from site to site. Such practices might be allowed at shoreside construction or earth-moving sites or dredging operations, for example.

42.9.8.2* Class I or Class II liquids shall not be dispensed into a portable container unless the container is constructed of metal or is approved by the AHJ, has a tight closure, and is fitted with a spout or is so designed that the contents can be dispensed without spilling. [**30A:**11.8.2]

A.42.9.8.2 See Section 9.4 of NFPA 30 for further information. [**30A:**A.11.8.2]

• **42.9.8.3** Portable containers of 12 gal (45 L) capacity or less shall not be filled while they are in or on a marine craft. [**30A:**11.8.3]

42.9.9 Cargo Tank Fueling Facilities. The provisions of 42.9.2 shall not prohibit the dispensing of Class II liquids in the open from a tank vehicle to a marine craft located at commercial, industrial, governmental, or manufacturing establishments when the liquid is intended for fueling marine craft used in connection with those establishments' businesses if the requirements of 42.9.9.1 through 42.9.9.7 are met. [**30A:**11.9]

As stated previously, in some areas, refueling larger vessels from a tank vehicle is common practice. However, 42.9.9 limits this practice to situations where the refueling site is not accessible to the general public and access is controlled. Refueling from a tank vehicle at a public marina, for example, is prohibited by this requirement.

42.9.9.1 An inspection of the premises and operations shall be made and approval granted by the AHJ. [**30A:**11.9.1]

42.9.9.2 The tank vehicle shall comply with the requirements of NFPA 385. [**30A:**11.9.2]

42.9.9.3 The dispensing hose shall not exceed 50 ft (15 m) in length. [**30A:**11.9.3]

42.9.9.4 The dispensing nozzle shall be a listed, automatic-closing type without a latch-open device. [**30A:**11.9.4]

42.9.9.5 Nighttime deliveries shall only be made in areas deemed adequately lighted by the AHJ. [**30A:**11.9.5]

42.9.9.6 The tank vehicle flasher lights shall be in operation while dispensing. [**30A:**11.9.6]

42.9.9.7 Fuel expansion space shall be left in each fuel tank to prevent overflow in the event of temperature increase. [**30A:**11.9.7]

42.9.10 Operating Requirements.

Δ **42.9.10.1** The following shall be the responsibilities of the attendant:

(1) Prevent the dispensing of Class I liquids into portable containers that do not comply with 42.9.8.2
(2) Be familiar with the dispensing system and emergency shutoff controls
(3) Ensure that the vessel is properly moored and that all connections are made
(4) Be within 15 ft (4.6 m) of the dispensing controls during the fueling operation and maintain a direct, clear, unobstructed view of both the vessel fuel filler neck and the emergency fuel shutoff control

[**30A:**11.10.1]

This provision establishes the basic responsibilities of the attendant. Note that 42.9.10.1(4) requires that the attendant be in a position to oversee the refueling operation and be within close proximity of the dispensing controls, even if he or she is not personally conducting the refueling.

42.9.10.2 Fueling shall not be undertaken at night except under well-lighted conditions. [**30A:**11.10.2]

42.9.10.3 During fueling operations, smoking shall be forbidden on board the vessel or marine craft and in the dispensing area. [**30A:**11.10.3]

Δ **42.9.10.4** Before opening the tanks of the vessel to be fueled, the following precautions shall be taken:

(1) All engines, motors, fans, and bilge blowers shall be shut down.
(2) All open flames and smoking material shall be extinguished and all exposed heating elements shall be turned off.
(3) Galley stoves shall be extinguished.
(4) All ports, windows, doors, and hatches shall be closed.

[**30A:**11.10.4]

Δ **42.9.10.5** After the flow of fuel has stopped, the following shall occur:

(1) The fill cap shall be tightly secured.
(2) Any spillage shall be wiped up immediately.
(3) If Class I liquid has been delivered, the entire vessel or marine craft shall remain open.

(4) Bilge blowers shall be turned on and allowed to run for at least 5 minutes before starting any engines or lighting galley fires. If bilge blowers are not available, 10 minutes of ventilation shall be required.

[**30A:**11.10.5]

42.9.10.6 No Class I liquids shall be delivered to any vessel having its tanks located below deck unless each tank is equipped with a separate fill pipe, the receiving end of which shall be securely connected to a deck plate and fitted with a screw cap. Such pipe shall extend into the tank. Vessels receiving Class II or Class IIIA liquids shall have the receiving end of the fill pipe securely connected to a deck plate and fitted with a screw cap. Such pipe shall be permitted to connect to a manifold system that extends into each separate tank. Each tank shall be provided with a suitable vent pipe that shall extend from the tank to the outside of the coaming or enclosed rails so that the vapors will dissipate away from the vessel. [**30A:**11.10.6]

Δ **42.9.10.7** Owners or operators shall not offer their vessel or marine craft for fueling unless the following conditions exist:

(1) The tanks being filled are properly vented to dissipate vapors to the outside atmosphere, and the fuel systems are liquidtight and vaportight with respect to all interiors.
(2) All fuel systems are designed, installed, and maintained in compliance with the specifications of the manufacturer of the vessel or marine craft.
(3) Communication has been established between the fueling attendant and the person in control of the vessel or craft receiving the fuel so as to determine the vessel's fuel capacity, the amount of fuel on board, and the amount of fuel to be taken on board.
(4) The electrical bonding and grounding systems of the vessel or craft have been maintained in accordance with the manufacturer's specifications.

[**30A:**11.10.7]

42.9.10.8 A sign with the following legends printed in 2 in. (50 mm) red capital letters on a white background shall be conspicuously posted at the dispensing area:

Before Fueling:

(1) Stop all engines and auxiliaries.

(2) Shut off all electricity, open flames, and heat sources.

(3) Check all bilges for fuel vapors.

(4) Extinguish all smoking materials.

(5) Close access fittings and openings that could allow fuel vapors to enter enclosed spaces of the vessel.

During Fueling:

(1) Maintain nozzle contact with fill pipe.

(2) Wipe up spills immediately.

(3) Avoid overfilling.

(4) Fuel filling nozzle must be attended at all times.

After Fueling:

(1) Inspect bilges for leakage and fuel odors.

(2) Ventilate until odors are removed.

[**30A:**11.10.8]

42.10 Aircraft Fuel Servicing

NFPA 407, *Standard for Aircraft Fuel Servicing*, applies to the fuel servicing of all types of aircraft using liquid petroleum fuel. The standard does not apply to any of the following:

1. In-flight fueling
2. Fuel servicing of flying boats or amphibious aircraft on water
3. Draining or filling of aircraft fuel tanks incidental to aircraft fuel system maintenance operations or manufacturing

Fire prevention provisions for aircraft fuel servicing are directed principally toward the prevention of fuel spillage and the elimination or control of potential ignition sources.

Δ **42.10.1 Application.** Section 42.10 applies to the fuel servicing of all types of aircraft using liquid petroleum fuel in accordance with NFPA 407.

NFPA 407 is not intended to be used as the sole standard for design, construction, operation, and maintenance of aircraft fuel storage and transfer facilities, because it does not address requirements for environmental protection, fuel quality, or other issues not directly related to fire safety. Additional guidance can be obtained from other documents, including, but not limited to, the following: A4A Spec 103, *Standard for Jet Fuel Quality Control at Airports*; ASTM MNL5, *Aviation Fuel Quality Control* Procedures; API 607, *Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats*; API RP 1595, *Design, Construction, Operation, Maintenance, and Inspection of Aviation Pre-Airfield Storage Terminals*; API RP 2003, *Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents*; EI 1529, *Aviation fueling hose and hose assemblies*; EI 1540, *Design, construction, commissioning, maintenance and testing of aviation fuelling facilities*; EI 1550, *Handbook on equipment used for the maintenance and delivery of clean aviation fuel*; EI 1581, *Specifications and laboratory qualification procedures for aviation fuel filter/water separators*; EI 1583, *Laboratory tests and minimum performance levels for aviation fuel filter monitors*; EI 1590, *Specifications and qualification procedures for aviation fuel microfilters*; EI 1596, *Design and construction of aviation fuel filter vessels*; JIG 4, *Aviation Fuel Quality Control and Operating Standards for Smaller Airports*; *NATA Refueling and Quality Control Procedures for Airport Service and Support Operations*; NIST Handbook 44; PEI RP100, *Recommended Practices for Installation of Underground Liquid Storage Systems*; PEI RP200, *Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling*; PEI RP800, *Recommended Practices for Installation* *of Bulk Storage Plants*; PEI RP-1300, *Recommended Practices for the Design, Installation, Service, Repair and Maintenance of Aviation Fueling Systems*; FAA AC-150-5230, *Aircraft Fuel Storage, Handling, Training, and Dispensing on Airports*; OSHA regulations in 29 CFR 1910; and/or EPA regulations in 40 CFR 112 (Oil Pollution Prevention) and 40 CFR 280 (Underground Tanks).

Aircraft fuel servicing involves the transfer of a flammable or combustible liquid fuel between a bulk storage system and the fuel tanks of an aircraft. It includes both fueling and defueling. The transfer is usually accomplished by using a tank vehicle, a hydrant vehicle, a hydrant cart, a fuel servicing cabinet, or a fueling pit. Drums and pumps sometimes are used. The movement of the fuel through the pumps, piping, and filters of the transfer system causes the fuel to be charged electrostatically. If the charge on the fuel is sufficiently high when it arrives at the fuel tank, a static spark could occur that can ignite the fuel vapor.

During overwing fueling, the fuel is discharged into an opening in the aircraft fuel tank using a hose with a handheld nozzle. The flow and splashing of fuel causes the generation of static electricity and the production of flammable mists and vapors. Top loading of tank vehicles creates similar hazards.

Underwing servicing, hydrant servicing, and bottom loading of tank vehicles use hoses or flexible connections of metal tubing or piping, as well as devices to allow temporary connection of fuel transfer lines. These methods minimize the charge generation and misting hazards associated with overwing fueling and top loading.

Other potential sources of ignition that could present a hazard during aircraft fuel servicing include the following:

1. Operating aircraft engines, auxiliary power units, and heaters
2. Operating automotive or other internal combustion engine servicing equipment in the vicinity
3. Arcing of electrical circuits
4. Open flames
5. Energy from energized radar equipment
6. Lightning

The autoignition temperatures of turbine fuels are such that the residual heat of aircraft turbine engines after shutdown or the residual heat of turbine aircraft brakes following hard use can ignite such fuels if they are spilled or sprayed on those surfaces before they have cooled below the autoignition temperatures of the fuels.

Aircraft fuel tank vents usually are located some distance above ground level. Under normal conditions, fuel vapors from the vents are quickly dissipated and diluted safely. Fuel spilling from the vents of an overfilled tank is a much more serious hazard. Spills resulting from leaks or equipment failure also are a hazard.

Fire prevention measures in aircraft fuel servicing are directed principally toward the following:

1. Prevention of fuel spillage
2. Elimination or control of potential ignition sources

The purpose of NFPA 407 is to establish reasonable minimum fire safety requirements for procedures, equipment, and installations for the protection of persons, aircraft, and other property during ground fuel servicing of aircraft using liquid petroleum fuels. These requirements are based upon sound engineering principles, test data, and field experience.

The fire hazard properties of aviation fuels vary; however, the same fire safety precautions are specified for all fuel types.

The provisions of NFPA 407 reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in the standard at the time it was issued. Unless otherwise specified, the design and installation provisions of NFPA 407 are not intended to apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Unless otherwise specified, operations and maintenance activities must meet the current standard. The retroactive requirements of NFPA 407 are permitted to be modified if their application clearly would be impractical in the judgment of the AHJ and only where it is clearly evident that a reasonable degree of safety is provided. In those cases where the AHJ determines that the existing situation presents an unacceptable degree of risk, the AHJ is permitted to apply retroactively any portions of NFPA 407 deemed appropriate.

Δ **42.10.1.1** Section 42.10 does not apply to any of the following:

(1) In-flight fueling
(2) Fuel servicing of flying boats or amphibious aircraft on water

NFPA 30A covers the fuel servicing of flying boats or amphibious aircraft on water.

(3) Draining or filling of aircraft fuel tanks incidental to aircraft fuel system maintenance operations or manufacturing

[**407:**1.1.1]

NFPA 410, *Standard on Aircraft Maintenance*, covers the draining or filling of aircraft fuel tanks incidental to aircraft fuel system maintenance.

42.10.1.2 Permits. Permits, where required, shall comply with Section 1.12.

• *N* **42.10.2 General Requirements.**

N **42.10.2.1 Design and Construction.**

N **42.10.2.1.1 General Requirements.**

N **42.10.2.1.1.1** The requirements of 42.10.2 shall apply to all aviation fueling facilities, aircraft fueling vehicles, rooftop heliport fueling facilities, and self-service aviation fueling facilities. [**407:**4.1.1.1]

N **42.10.2.1.1.2** Aviation fueling facilities shall also comply with the requirements of 42.10.3. [**407:**4.1.1.2]

N **42.10.2.1.1.3** Aircraft fueling vehicles and carts shall also comply with the requirements of 42.10.4. [**407:**4.1.1.3]

N **42.10.2.1.1.4** Rooftop heliport fueling facilities shall also comply with the requirements of 42.10.3 and 42.10.5. [**407:**4.1.1.4]

N **42.10.2.1.1.5** Self-service aviation fueling facilities shall also comply with the requirements of 42.10.3 and 42.10.6. [**407:**4.1.1.5]

For the 2017 edition, NFPA 407 was completely restructured to improve the usability of the standard. Requirements that apply universally to all equipment, facilities, and operations within the scope of NFPA 407 are now contained in Chapter 4 of that standard (42.10.2 in this *Code*). Chapter 5 (42.10.3) contains the requirements that apply to all fixed fueling facilities, including airport fueling systems, rooftop heliport fueling systems, and self-service aviation fueling systems. Any additional requirements that apply only to rooftop heliport fueling systems or self-service aviation fueling systems are now contained in Chapter 7 (42.10.5) and Chapter 8 (42.10.6), respectively. Requirements pertaining to aircraft fueling vehicles are contained in Chapter 6 (42.10.4).

Chapters 4 through 8 of NFPA 407 are each split into two sections: "Design and Construction" and "Operations." The sections use a common subsection structure to simplify navigation of the requirements. This structure as it pertains to this *Code* is illustrated in Commentary Table 42.1.

For example, fire extinguishers at a self-service aviation fueling station must comply with 42.10.2.1.10 (general requirements for fire extinguishers), 42.10.3.1.10 (requirements for fire extinguishers at fixed fueling facilities), and 42.10.6.1.10 (requirements for fire extinguishers at self-service aviation fueling facilities).

Subsections with no requirements are reserved in order to maintain the document structure. One example is 42.10.2.1.2 because there are no requirements that pertain to both fixed storage tanks and tanks on vehicles.

N **42.10.2.1.2 Fuel Storage Tanks. (Reserved)**

N **42.10.2.1.3 Fuel Dispensing Systems.**

N **42.10.2.1.3.1** Any valve that controls the flow of fuel into or from an aircraft fuel servicing vehicle or cart, or into or from an aircraft shall have a deadman control(s). [**407:**4.1.3.1]

NFPA 407 defines a *deadman control* as a device that requires a positive continuing action of a person to allow the flow of fuel.

N **42.10.2.1.3.2** The deadman flow control in the nozzle shall be permitted for overwing fueling. [**407:**4.1.3.2]

COMMENTARY TABLE 42.1 *Topical Structure of Requirements Pertaining to Aircraft Fuel Servicing in 42.10.2 through 42.10.6.*

Section/Subsection Number	*Section/Subsection Topic*
42.10.X.1	**DESIGN AND CONSTRUCTION**
42.10.X.1.1	General Requirements
42.10.X.1.2	Fuel Storage Tanks/Tanks on Vehicles
42.10.X.1.3	Fuel Dispensing Systems/Pumps and Piping Systems
42.10.X.1.4	Fueling Hose and Nozzles
42.10.X.1.5	Electrostatic Hazards and Bonding
42.10.X.1.6	Electrical Systems
42.10.X.1.7	Control of Fuel Flow
42.10.X.1.8	Filters and Ancillary Equipment
42.10.X.1.9	Emergency Fuel Shutoff Systems
42.10.X.1.10	Fire Extinguishers/Fire Protection
42.10.X.1.11	Marking and Labeling
42.10.X.1.12 and greater	[Miscellaneous topics]
42.10.X.2	**OPERATIONS**
42.10.X.2.1	Security
42.10.X.2.2	Training
42.10.X.2.3	Prevention and Control of Spills
42.10.X.2.4	Emergency Fuel Shutoff
42.10.X.2.5	Bonding
42.10.X.2.6	Control and Monitoring of Fuel Flow
42.10.X.2.7	Fire Protection
42.10.X.2.8	Maintenance
42.10.X.2.9	Aircraft Fueling Hose/Occupancy (Chapter 8 only)
42.10.X.2.10 and greater	[Miscellaneous topics]

N **42.10.2.1.3.3** Notches or latches in the handle of an overwing nozzle that could allow the valve to be locked open shall be prohibited. [**407:**4.1.3.3]

N **42.10.2.1.3.4** Nozzles for underwing fueling shall be designed to be attached securely to the aircraft adapter before the nozzle can be opened. [**407:**4.1.3.4]

N **42.10.2.1.3.5** Disengaging the nozzle from the aircraft adapter shall not be possible until the nozzle is fully closed. [**407:**4.1.3.5]

N **42.10.2.1.3.6** Fuel servicing pump mechanisms shall be designed and arranged so that failure or seizure does not cause rupture of the pump housing, of a tank, or of any component containing fuel. [**407:**4.1.3.6]

N **42.10.2.1.3.7** Fuel pressure shall be controlled within the stress limits of the hose and plumbing by means of either an in-line pressure controller or, a system pressure relief valve, or other suitable means. [**407:**4.1.3.7]

N **42.10.2.1.3.8** The working pressure of any system component shall equal or exceed any pressure to which it could be subjected. [**407:**4.1.3.8]

N **42.10.2.1.4* Fueling Hose.**

N **A.42.10.2.1.4** The section on aircraft refueling hose has been altered extensively by referencing EI 1529. NFPA 407 formerly contained many requirements for hose, but these were intended to address only those features that could be related to a fire or the results of a fire. It was not until 1982 that a comprehensive aircraft refueling hose specification was published by the American Petroleum Institute (API). Prior to that time, NFPA 407 was the only document in existence that addressed this subject. In 2010, the API transferred responsibility for aviation fuel-handling standards to the Energy Institute (EI). [**407:**A.4.1.4]

EI 1529 deals with all aspects of hose safety, including the couplings that are acceptable. [**407:**A.4.1.4]

NFPA 407 recognizes the need for an extensive document such as EI 1529 and requires hoses that meet that standard. However, it is important to recognize that EI does not perform testing and that it does not regulate those manufacturers who claim to sell hose that meets EI 1529. The hose user and the cognizant authority having jurisdiction could find it prudent to require hose manufacturers to produce copies of test reports or documents that certify that hoses of identical construction and compounds have been tested and have passed all requirements of EI 1529 satisfactorily. [**407:**A.4.1.4]

N **42.10.2.1.4.1 Performance Requirements.** Hose and couplings shall comply with the requirements of EI 1529. [**407:**4.1.4.1]

N **42.10.2.1.4.2 Fueling Hose Apparatus.** Nozzle receptacles and hose storage shall be arranged to avoid kinks and maintain the hose bend radius within the requirements of EI 1529 and EI 1540. [**407:**4.1.4.2]

N **42.10.2.1.4.3 Additional Requirements.**

N **42.10.2.1.4.3.1** Each coupled length of hose shall be tested at the same minimum proof pressure rating for that grade of hose as defined in EI 1529. [**407:**4.1.4.3.1]

N **42.10.2.1.4.3.2** A test certificate shall be provided for each coupled length of hose and shall state the following:

(1) Manufacturer's name of hose
(2) Manufacturer's name of couplings
(3) Hose type
(4) Hose grade
(5) Size and length of hose
(6) Serial number or reference number of hose
(7) Quarter and year of manufacture of hose
(8) Model number of couplings
(9) Sizes of coupling ferrules
(10) Hydrostatic test pressures
(11) Coupled length serial number
(12) Identification of individual responsible for coupling the hose
(13) Name and address of company responsible for coupling the hose
(14) Date of certification

[**407:**4.1.4.3.2]

N **42.10.2.1.4.3.3** The coupling tests as specified in EI 1529 shall be performed for each hose grade, type, and manufacturer. [**407:**4.1.4.3.3]

N **42.10.2.1.4.3.4** Each coupling of a coupled length of hose shall be permanently marked with a serial number corresponding to its hydrostatic test certificate. [**407:**4.1.4.3.4]

N **42.10.2.1.4.3.5** The hose at the end of each coupling ferrule shall be permanently marked prior to hydrostatic testing to serve as a reference to determine whether a coupling has slipped during testing or while in service. [**407:**4.1.4.3.5]

N **42.10.2.1.4.3.6*** Lengths of hose shall not be spliced together. [**407:**4.1.4.3.6]

A.42.10.2.1.4.3.6 Splicing of a hose with couplings alters the design bend radius of the hose, creating two kinks when the hose is wound on a drum. [**407:**A.4.1.4.3.6]

N **42.10.2.1.4.3.7 Hydrostatic Testing.** Hydrostatic testing shall be in accordance with ASTM D380. [**407:**4.1.4.3.7]

N **42.10.2.1.4.3.7.1** Following a hydrostatic test, all the water shall be drained and the hose shall be dried internally. [**407:**4.1.4.3.7.1]

N **42.10.2.1.4.3.7.2** Following a hydrostatic test, the open ends of the hose, including the threads of the couplings, shall be suitably covered to protect the threads and to prevent contamination. [**407:**4.1.4.3.7.2]

N **42.10.2.1.4.3.7.3** A hose that is recoupled for any reason shall be hydrostatically tested and recertified to the same criteria as a newly coupled hose. [**407:**4.1.4.3.7.3]

N **42.10.2.1.4.3.8** Hose shall be connected to rigid piping or coupled to a hose reel in a manner that prevents kinks or undue bending action or mechanical stress on the hose or hose couplings. [**407:**4.1.4.3.8]

N **42.10.2.1.5 Electrostatic Hazards and Bonding.**

N **42.10.2.1.5.1** A provision for bonding shall be incorporated in the design of fuel servicing vehicles or carts and airport fueling systems to prevent differences in electrostatic potential. [**407:**4.1.5.1]

N **42.10.2.1.5.2** The maximum resistance between the bonding cable clip and the fueling system framework shall not exceed 25 ohms. [**407:**4.1.5.2]

N **42.10.2.1.5.3** Bonding cables shall be constructed of conductive, durable, and flexible material. [**407:**4.1.5.3]

N **42.10.2.1.5.4** Bonding connections shall be electrically and mechanically firm. [**407:**4.1.5.4]

N **42.10.2.1.5.5** Jacks, plugs, clamps, and connecting points shall be clean, unpainted metal to provide a positive electrical connection. [**407:**4.1.5.5]

N **42.10.2.1.5.6** EI 1529 Type C hose (semiconductive) shall be used to prevent electrostatic discharges but shall not be used to accomplish required bonding. [**407:**4.1.5.6]

N **42.10.2.1.5.7** EI 1529 Type A hose that does not have a semiconductive cover shall not be used. [**407:**4.1.5.7]

N **42.10.2.1.5.8** EI 1529 Type F hose (hard wall) and EI 1529 Type CT hose (cold temperature) shall be permitted because they have semiconductive covers. [**407:**4.1.5.8]

N **42.10.2.1.5.9*** The design of airport fueling systems shall incorporate the provision of a 30-second relaxation period following the filter separator, monitors, or other filtration devices discharging into tanks. [**407:**4.1.5.9]

N **A.42.10.2.1.5.9** The charge on the fuel can be reduced by the use of a static dissipater additive that increases the electrical conductivity of the fuel and thereby allows the charge to relax or dissipate more quickly, or by the use of a relaxation chamber that increases the residence time of the fuel downstream of the filter to at least 30 seconds, thereby allowing most of the charge to dissipate before the fuel arrives at the receiving tank. [**407:**A.4.1.5.9]

API RP 2003 recommends a 30-second relaxation time for loading tank trucks and refuelers. However, it has not been a common practice to require a similar relaxation time for aircraft refueling, primarily because of the relatively few electrostatic incidents that have occurred during aircraft fueling. (For additional information on this topic, see CRC Report No. 583.) [**407:**A.4.1.5.9]

In filling tank trucks or storage tanks, API RP 2003 recommends that at least 30 seconds of residence time be provided downstream of a filter in order to allow static charges generated in flowing fuel to relax before fuel enters the tank. [**407:**A.4.1.5.9]

The reason it is possible to fuel aircraft safely with low conductivity fuel without providing 30 seconds of relaxation time is due primarily to the difference in the geometry of aircraft tanks as compared with tank truck compartments. Flow into the aircraft normally is subdivided into several tanks simultaneously and also distributed into adjoining compartments of each tank by a multi-hole inlet. Bachman and Dukek (1972) conducted full-scale research using a simulated large aircraft tank and concluded that none of the tanks or compartments hold sufficient fuel to allow enough charges to accumulate and create large surface voltages. Slower fill rates per compartment also allow more charge to relax. [**407:**A.4.1.5.9]

Additionally, the inlet system of most aircraft tanks directs fuel toward the bottom of the tank to avoid splashing that generates more charge. Finally, while the hoses that connect the fueler to the aircraft provide only a few seconds of residence time for charge relaxation at high rates of flow, the actual relaxation volume in the system is significantly greater where a coated screen is used as a second stage water barrier. In this case, the vessel's volume after the first stage filter coalescer could represent an additional 15 seconds of residence time for charge relaxation. (The coated screen, unlike other water barriers, does not generate charge.) [**407:**A.4.1.5.9]

A flammable vapor space in the tank due to the presence of JET B or JP-4 fuels still constitutes a potential hazard. Therefore, to minimize the chance for static ignition, FAA regulations require that fueling be conducted at half of the rated flow where civil aircraft have used such fuels. [**407:**A.4.1.5.9]

N **42.10.2.1.5.9.1** The relaxation period required by 42.10.2.1.5.9 shall not apply to the actual refueling of an aircraft. [**407:**4.1.5.9.1]

N **42.10.2.1.5.9.2** The relaxation period required by 42.10.2.1.5.9 shall not apply to fuels with static dissipater additives. [**407:**4.1.5.9.2]

N **42.10.2.1.6 Electrical Systems. (Reserved)**

N **42.10.2.1.7 Control of Fuel Flow. (Reserved)**

N **42.10.2.1.8 Filters and Ancillary Equipment.**

N **42.10.2.1.8.1** Filter vessels used in aviation fuel service shall have a functional automatic air vent (AAV) or automatic air eliminator (AAE). [**407:**4.1.8.1]

N **42.10.2.1.8.2** The AAV or AAE shall discharge to a closed system. [**407:**4.1.8.2]

N **42.10.2.1.9 Emergency Fuel Shutoff Systems. (Reserved)**

N **42.10.2.1.10 Fire Extinguishers.**

N **42.10.2.1.10.1** During fueling operations, fire extinguishers shall be available on aircraft servicing ramps or aprons, in accordance with NFPA 410. [**407:**4.1.10.1]

A.42.10.2.1.10.1 Carbon dioxide extinguishers should not be selected due to their limited range and effectiveness in windy conditions. [**407:**A.4.1.6.1]

N **42.10.2.1.10.2** All fire extinguishers shall conform to the requirements of NFPA 10. [**407:**4.1.10.2]

Distribution of portable fire extinguishers must be in accordance with Section 13.6 and NFPA 407.

N **42.10.2.1.10.3*** ABC multipurpose dry chemical fire extinguishers (ammonium phosphate) shall not be placed on aircraft fueling vehicles, airport fuel servicing ramps or aprons, or at airport fuel facilities that are located within 150 m (500 ft) of aircraft operating areas. [**407:**4.1.10.3]

• *N* **A.42.10.2.1.10.3** Multipurpose dry chemical (ammonium phosphate) fire extinguishing agent is known to cause corrosion to aluminum aircraft components. Although the agent is capable of extinguishing fires on or near aircraft, it is likely that the agent will spread to other, uninvolved aircraft, causing damage from corrosion. [**407:**A.42.10.2.1.7.3]

NFPA 407 is the only aviation-related NFPA standard that restricts the use of ABC multipurpose dry chemical fire extinguishers at airport facilities. NFPA 409, *Standard on Aircraft Hangars*; NFPA 410; NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways*; and NFPA 418, *Standard for Heliports* permit the use of multipurpose dry chemical to protect the facilities and operations that are within their respective scopes. However, fire extinguishers used to protect aircraft fuel servicing facilities within 500 ft (150 m) of aircraft operating areas must be charged with BC-rated dry chemical, such as sodium bicarbonate or potassium carbonate (Purple K). This requirement is intended to apply to new installations only. In accordance with the new retroactivity clause in NFPA 407, it is the intent of the technical committee that existing multipurpose fire extinguishers that were approved for installation before this requirement was adopted can remain in service.

N **42.10.2.1.11 Marking and Labeling.**

N **42.10.2.1.11.1** Each emergency fuel shutoff station location shall be placarded EMERGENCY FUEL SHUTOFF in letters at least 50 mm (2 in.) high. [**407:**4.1.11.1]

N **42.10.2.1.11.2** The method of operation shall be indicated by an arrow or by the word PUSH or PULL, as appropriate. [**407:**4.1.11.2]

N **42.10.2.1.11.3** Any action necessary to gain access to the shutoff device (e.g., BREAK GLASS) shall be shown clearly. [**407:**4.1.11.3]

N **42.10.2.1.11.4** Lettering shall be of a color contrasting sharply with the placard background for visibility. [**407:**4.1.11.4]

N **42.10.2.1.11.5** Placards shall be weather resistant. [**407:**4.1.11.5]

N **42.10.2.1.12 Aircraft Fueling Ramps.**

N **42.10.2.1.12.1 Aircraft Radar Equipment.**

N **42.10.2.1.12.1.1** Surveillance radar equipment in aircraft shall not be operated within 90 m (300 ft) of any fueling, servicing, or other operation in which flammable liquids, vapors, or mist could be present. [**407:**4.1.12.1.1]

N **42.10.2.1.12.1.2** Weather-mapping radar equipment in aircraft shall not be operated while the aircraft in which it is mounted is undergoing fuel servicing. [**407:**4.1.12.1.2]

N **42.10.2.1.12.2* Ground Radar Equipment.**

N **A.42.10.2.1.12.2** The beam of radar equipment has been known to cause ignition of flammable vapor–air mixtures from inductive electric heating of solid materials or from electrical arcs or sparks from chance resonant conditions. The ability of an arc to ignite flammable vapor–air mixtures depends on the total energy of the arc and the time lapse involved in the arc's duration, which is related to the dissipation characteristics of the energy involved. The intensity or peak power output of the radar unit, therefore, is a key factor in establishing safe distances between the radar antenna and fueling operations, fuel storage or fuel loading rack areas, fuel tank truck operations, or any operations where flammable liquids and vapors could be present or created. [**407:**A.4.1.12.2]

Most commercially available weather-mapping airborne radar equipment operates at peak power outputs, varying from 25 kW to 90 kW. Normally this equipment should not be operated on the ground. Tests have shown that the beam of this equipment can induce energy capable of firing flash bulbs at considerable distances. If the equipment is operated on the ground for service checking or for any other reason, the beam should not be directed toward any of the hazards described in the previous paragraph that are located within 30 m (100 ft). Higher power radar equipment can require greater distances. [**407:**A.4.1.12.2]

Airport surface detection radar operates under a peak power output of 50 kW. It is fixed rather than airborne equipment. [**407:**A.4.1.12.2]

Airborne surveillance radar of the type currently carried on military aircraft has a high peak power output. Aircraft carrying this type of radar can be readily distinguished by radomes atop or below the fuselage, or both. [**407:**A.4.1.12.2]

Aircraft warning radar installations are the most powerful. Most of these installations are, however, remotely located from the hazards specified in the first paragraph and therefore are not covered herein. Ground radar for approach control or traffic pattern surveillance is considered the most fire hazardous type of radar normally operating at an airport. The latter type of equipment has a peak power output of 5 MW. Where possible, new installations of this type of equipment should be located at least 150 m (500 ft) from any of the hazards described in the first paragraph. [**407:**A.4.1.12.2]

N **42.10.2.1.12.2.1** Antennas of airport flight traffic surveillance radar equipment shall be located so that the beam will not be directed toward any fuel storage or loading racks within 90 m (300 ft). [**407:**4.1.12.2.1]

N **42.10.2.1.12.2.2** Aircraft fuel servicing shall not be conducted within the 90 m (300 ft) distance established by 42.10.2.1.12.2.1. [**407:**4.1.12.2.2]

N **42.10.2.1.12.2.3** Antennas of airport ground traffic surveillance radar equipment shall be located so that the beam will not be directed toward any fuel storage or loading racks within 30 m (100 ft). [**407:**4.1.12.2.3]

N **42.10.2.1.12.2.4** Aircraft fuel servicing or any other operations involving flammable liquids or vapors shall not be conducted within 30 m (100 ft) of antennas of airport ground traffic surveillance radar equipment. [**407:**4.1.12.2.4]

N **42.10.2.1.12.3 Emergency Fire Equipment Accessibility.** Accessibility to aircraft by emergency fire equipment shall be considered in establishing aircraft fuel servicing positions. [**407:**4.1.12.3]

N **42.10.2.1.12.4 Ramp and Apron Drainage.** Aircraft servicing ramps or aprons shall be sloped and drained in accordance with NFPA 415. [**407:**4.1.12.4]

N **42.10.2.1.12.4.1** The ramp or apron shall slope away from the rim or edge of fueling hydrants or fueling pits to prevent flooding. [**407:**4.1.12.4.1]

N **42.10.2.1.12.4.2** Fueling hydrant boxes or fueling pits that are connected to a ramp drainage system shall be fitted with vaporsealing traps. [**407:**4.1.12.4.2]

N **42.10.2.2 Operations.**

N **42.10.2.2.1 Security. (Reserved)**

N **42.10.2.2.2 Training.**

N **42.10.2.2.2.1*** Only personnel trained in the safe operation of the equipment and the fuels they use, the operation of emergency controls, and the procedures to be followed in an emergency shall be permitted to handle fuel. [**407:**4.2.2.1]

N **A.42.10.2.2.2.1** Records should be kept of personnel training. These records should be made available to the authority having jurisdiction upon request. [**407:**A.4.2.2.1]

N **42.10.2.2.2.2*** Fuel servicing personnel shall be trained in the use of the available fire-extinguishing equipment they could be expected to use. [**407:**4.2.2.2]

N **A.42.10.2.2.2.2** Fuel servicing personnel should be given adequate training with extinguishers so that such equipment is used effectively in an emergency. Such training should be given on fires of the type that could be encountered on the job. To ensure prompt action in the event of a spill or other hazardous condition developing during fueling operations, aircraft servicing personnel also should be trained in the operation of emergency fuel shutoff controls. Each new fuel servicing employee should be given indoctrination training covering these and similar safety essentials that are related to the job. Follow-up and advanced training should be given as soon as the employee is sufficiently acquainted with the work to benefit from such training. Supervisors should be given training in the more technical aspects of fire safety so that they understand the reason for these and similar requirements and have an appreciation for the responsibility of a supervisor and the safety of an operation. [**407:**A.4.2.2.2]

N **42.10.2.2.3* Prevention and Control of Spills.**

N **A.42.10.2.2.3** The following actions are appropriate in the event of a fuel spill, although each spill should be treated as an individual case due to such variables as the size of the spill, type of flammable or combustible liquid involved, wind and weather conditions, equipment arrangement, aircraft occupancy, emergency equipment, and personnel available:

(1) The flow of fuel should be stopped, if possible. If the fuel is discovered leaking or spilling from fuel servicing equipment or hoses, the emergency fuel shutoff should be operated at once. If the fuel is discovered leaking or spilling from the aircraft at the filler opening, vent line, or tank seams during fueling operations, fueling should be stopped immediately. Evacuation of the aircraft should be ordered when necessary. The aircraft then should be thoroughly checked for damage or entrance of flammable liquid or vapors into any concealed wing or fuselage area, and corrective action should be taken as necessary before it is returned to normal operational service.
(2) The airport fire crew should be notified if the spill presents a fire hazard. The only routine exceptions are for small spills. Supervisory personnel should be notified to ensure that operations in progress can be continued safely or halted until the emergency is past and that corrective measures can be taken to prevent recurrence of a similar accident.
(3) It could be necessary to evacuate the aircraft if the spill poses a serious fire exposure to the aircraft or its occupants. Walking through the liquid area of the fuel spill should not be permitted. Persons who have been sprayed with fuel or had their clothing soaked with fuel should go to a place of refuge, remove their clothing, and wash. Individuals whose clothing has been ignited should be wrapped in blankets, coats, or other items or should be told to or forced to roll on the ground.
(4) Mobile fueling equipment and all other mobile equipment should be withdrawn from the area or left as is until the spilled fuel is removed or made safe. No fixed rule can be made as fire safety varies with circumstances. Shutting down equipment or moving vehicles can provide a source of ignition if no fire immediately results from the spillage.
(5) Aircraft, automotive, or spark-producing equipment in the area should not be started before the spilled fuel is removed or made safe. If a vehicle or cart engine is running at the time of the spill, it normally is good practice to drive the vehicle away from the hazard area unless the hazard to personnel is judged too severe. Fuel servicing vehicles or carts in operation at the time of the spill should not be moved until a check is made to verify that any fuel hose that could have been in use or connected between the vehicle and the aircraft is safely stowed.
(6) If any aircraft engine is operating at the time of the spill, it normally is good practice to move the aircraft away from the hazard area unless air currents set up by operating power plants would aggravate the extent or the nature of the existing vapor hazard.
(7) If circumstances dictate that operating internal combustion engine equipment within a spill area that has not ignited should be shut down, engine speeds should be reduced to idle prior to cutting ignition in order to prevent backfire.
(8) The volatility of the fuel can be a major factor in the initial severity of the hazard created by a spill. Gasoline and other low flash point fuels at normal temperatures and pressures produce vapors that are capable of forming ignitable mixtures with the air near the surface of the liquid, whereas this condition does not normally exist with kerosene fuels (JET A or JET A-1) except where ambient temperatures are 38°C (100°F) or above or where the liquid has been heated to a similar temperature.
(9) Spills of gasoline and low flash point turbine fuels (JET B) greater than 3 m (10 ft) in any dimension and covering an area of over 5 m^2 (50 ft^2) or that are of an ongoing nature should be blanketed or covered with foam. The nature of the ground surface and the existing exposure conditions dictate the exact

method to be followed. Such fuels should not be washed down sewers or drains. The decision to use a sewer or drain should be made only by the chief of the airport fire brigade or the fire department. If fuels do enter sewers, either intentionally or unintentionally, large volumes of water should be introduced to flush such sewers or drains as quickly as possible to dilute the flammable liquid content of the sewer or drain to the maximum possible extent. Normal operations involving ignition sources (including aircraft and vehicle operations) should be prohibited on surface areas adjacent to open drains or manholes from which flammable vapors could issue due to the introduction of liquids into the sewer system until it can be established that no flammable vapor–air mixture is present in the proximity. (NOTE: NFPA 415 provides further information on aircraft fueling ramp drainage designs to control the flow of fuel that could be spilled on a ramp and to minimize the resulting possible danger.)

(10) Spills of kerosene grades of aviation fuels (JET A or JET A-1) greater than 3 m (10 ft) in any dimension and covering an area of over 5 m^2 (50 ft^2) or that are of an ongoing nature and that have not ignited should be blanketed or covered with foam if there is danger of ignition. If there is no danger of ignition, an absorbent compound or an emulsion-type cleaner can be used to clean the area. Kerosene does not evaporate readily at normal temperatures and should be cleaned up. Smaller spills can be cleaned up using an approved, mineral type, oil absorbent.

(11) Aircraft on which fuel has been spilled should be inspected thoroughly to ensure that no fuel or fuel vapors have accumulated in flap well areas or internal wing sections not designed for fuel tankage. Any cargo, baggage, express, mail sacks, or similar items that have been wetted by fuel should be decontaminated before being placed aboard any aircraft.

[**407:**A.4.2.3]

N **42.10.2.2.3.1** Following fueling of an aircraft or fuel servicing vehicle, all hoses shall be removed, including those from hydrant systems if applicable. [**407:**4.2.3.1]

N **42.10.2.2.3.2** All hoses shall also be properly stowed. [**407:**4.2.3.2]

N **42.10.2.2.3.3** Fuel nozzles shall not be dragged along the ground. [**407:**4.2.3.3]

N **42.10.2.2.3.4** Approved pumps, either hand operated or power operated, shall be used where aircraft are fueled from drums. [**407:**4.2.3.4]

N **42.10.2.2.3.4.1** Pouring or gravity flow shall not be permitted from a container with a capacity of more than 19 L (5 gal). [**407:**4.2.3.4.1]

N **42.10.2.2.3.5 Fuel Spill Procedures.**

N **42.10.2.2.3.5.1** Where a spill is observed, the fuel servicing shall be stopped immediately by release of the deadman controls. [**407:**4.2.3.5.1]

N **42.10.2.2.3.5.2** In the event that a spill continues, the equipment emergency fuel shutoff shall be actuated. [**407:**4.2.3.5.2]

N **42.10.2.2.3.5.3** In the event that a spill continues from a hydrant system, the system emergency fuel shutoff shall be actuated. [**407:**4.2.3.5.3]

N **42.10.2.2.3.5.4** The supervisor shall be notified immediately. [**407:**4.2.3.5.4]

N **42.10.2.2.3.5.5** Cleaning operations shall be performed by personnel trained in accordance with 42.10.2.2.2.1. [**407:**4.2.3.5.5]

The use of properly trained personnel to conduct cleaning operations is essential. Paragraph 42.10.2.2.2.1 provides additional information on the training of personnel.

N **42.10.2.2.3.5.6** Operation shall not be resumed until the spill has been cleared and conditions are determined to be safe. [**407:**4.2.3.5.6]

N **42.10.2.2.3.5.7** The airport fire crew, if established, or the local fire department serving the airport shall be notified if a spill covers over 3 m (10 ft) in any direction or is over 5 m^2 (50 ft^2) in area, continues to flow, or is otherwise a hazard to persons or property. [**407:**4.2.3.5.7]

There are many smaller municipal airports and small private airports and landing strips where no official airport fire crew has been established or is present. In those cases, the local fire department serving the airport area must be notified.

N **42.10.2.2.3.5.8** The spill shall be investigated to determine the cause, to determine whether emergency procedures were properly carried out, and to determine the necessary corrective measures. [**407:**4.2.3.5.8]

N **42.10.2.2.3.5.9** Corrective measures identified by the spill investigation shall be implemented as required by the authority having jurisdiction. [**407:**4.2.3.5.9]

N **42.10.2.2.3.6** Transferring fuel by pumping from one tank vehicle to another tank vehicle within 61 m (200 ft) of an aircraft shall not be permitted. [**407:**4.2.3.6]

N **42.10.2.2.3.7** Not more than one tank vehicle shall be permitted to be connected to the same aircraft fueling manifold, unless means are provided to prevent fuel from flowing back into a tank vehicle due to a difference in pumping pressure. [**407:**4.2.3.7]

N **42.10.2.2.4 Emergency Fuel Shutoff.**

N **42.10.2.2.4.1** Emergency fuel shutoff control stations shall be accessible at all times. [**407:**4.2.4.1]

N **42.10.2.2.4.2** A procedure shall be established to notify the fire department serving the airport in the event of a control station activation. [**407:**4.2.4.2]

N **42.10.2.2.4.3** If the fuel flow stops for an unknown reason, the emergency fuel shutoff system shall be checked first. [**407:**4.2.4.3]

N **42.10.2.2.4.4** The cause of the shutoff shall be identified and corrected before fuel flow is resumed. [**407:**4.2.4.4]

N **42.10.2.2.4.5** Emergency fuel shutoff systems shall be operationally checked at intervals not exceeding 6 months. [**407:**4.2.4.5]

N **42.10.2.2.4.6** Each individual device shall be checked at least once during every 12-month period. [**407:**4.2.4.6]

N **42.10.2.2.4.7** Suitable records shall be kept of tests required by this section. [**407:**4.2.4.7]

N **42.10.2.2.5* Bonding.**

The following information is from the annex material associated with the "Bonding" section in NFPA 407.

Hydrocarbon fuels, such as aviation gasoline and JET A, generate electrostatic charge when passing through the pumps, filters, and piping of a fuel transfer system. (The primary electrostatic generator is the filter/separator that increases the level of charge on a fuel by a factor of 100 or more as compared with pipe flow.) Splashing, spraying, or freefalling of the fuel further enhances the charge. When charged fuel arrives at the receiving tank (cargo tank or aircraft fuel tank), one of two possible events will occur:

(1) The charge will relax harmlessly to ground.
(2) If the charge or the fuel is sufficiently high, a spark discharge can occur. Whether or not an ignition follows depends on the energy (and duration) of the discharge and the composition of the fuel-air mixture in the vapor space (i.e., whether or not it is in the flammable range).

The amount of charge on a fuel when it arrives at the receiving tank, and hence its tendency to cause a spark discharge, depends on the nature and amount of impurities in the fuel, its electrical conductivity, the nature of the filter media (if present), and the relaxation time of the system [i.e., the residence time of the fuel in the system between the filter (separator) and the receiving tank]. The time needed for this charge to dissipate is dependent upon the conductivity of the fuels; it could be a fraction of a second or several minutes.

No amount of bonding or grounding prevents discharges from occurring inside a fuel tank. Bonding ensures that the fueling equipment and the receiving tank (aircraft or fueler) are at the same potential and provides a path for the charges separated in the fuel transfer system (primarily the filter/separator) to combine with and neutralize the charges in the fuel. Also, in overwing fueling and in top loading of cargo tanks, bonding ensures that the fuel nozzle or the fill pipe is at the same potential as the receiving tank, so that a spark does not occur when the nozzle or fill pipe is inserted into the tank opening. For this reason, the bonding wire has to be connected before the tank is opened.

Grounding during aircraft fueling or fuel servicing vehicle loading is no longer required because of the following:

(1) Grounding does not prevent sparking at the fuel surface *(see NFPA 77)*.
(2) Grounding is not required by NFPA 77.
(3) The static wire might not be able to conduct the current in the event of an electrical fault in the ground support equipment connected to the aircraft and could constitute an ignition source if the wire fuses. If ground support equipment is connected to the aircraft or if other operations are being conducted that necessitate electrical earthing, separate connections should be made for this purpose. Static electrical grounding points can have high resistance and, therefore, are unsuitable for grounding. For a more complete discussion of static electricity in fuels, see NFPA 77.

N **42.10.2.2.5.1** Prior to making any fueling connection to an aircraft or fuel servicing vehicle, the fueling equipment shall be bonded to the aircraft or fuel servicing vehicle by use of a cable, thus providing a conductive path to equalize the potential between the fueling equipment and the aircraft. [**407:**4.2.5.1]

N **42.10.2.2.5.1.1** The electrical bond shall be maintained until fueling connections have been removed, thus allowing separated charges that could be generated during the fueling operation to reunite. [**407:**4.2.5.1.1]

N **42.10.2.2.5.1.2** Grounding for the sole purpose of aircraft fueling shall not be permitted. [**407:**4.2.5.1.2]

The requirement in 42.10.2.2.5.1.2 was revised to permit grounding during aircraft fueling only if grounding is necessary for another purpose. As explained in A.42.10.2.2.5, static discharges are prevented through direct bonding of the fuel system components to the aircraft, rather than connecting each one to ground. Prior editions of NFPA 407 expressly forbid grounding during fueling. However, this created a conflict with standard operating procedures for hot-fueling rotary-wing aircraft. Rotating blades can generate a significant static charge, which must be relaxed to ground. In this case, the aircraft is being grounded for a purpose other than fuel servicing, so 42.10.2.2.5.1.2 would now permit grounding during the fueling operation.

N **42.10.2.2.5.2 Bonding for Overwing Fueling.** In addition to the requirements in 42.10.2.2.5.1, where fueling overwing, the nozzle shall be bonded to a metallic component of the aircraft that is metallically connected to the tank filler port. [**407:**4.2.5.2]

Paragraph 42.10.2.2.5.2 requires bonding with the nozzle to ensure that a spark does not occur after the filler cap is removed. If a bond cable and connection point are provided, their use is mandatory. If they are not provided, it is permitted to equalize the potential between the nozzle and the filler port by touching the nozzle to the filler cap before removing the filler cap. The nozzle should be placed in contact with the filler neck prior to commencing fueling and should remain in contact with the filler neck until fueling is completed.

N **42.10.2.2.5.2.1** The bond connection shall be made before the filler cap is removed. [**407:**4.2.5.2.1]

N **42.10.2.2.5.2.2** If a nozzle bond cable and plug receptacle or means for attaching a clip is available, the operator shall attach the nozzle bond cable before removing the cap in order to equalize the potential between the nozzle and the filler port. [**407:**4.2.5.2.2]

N **42.10.2.2.5.2.3** If no plug receptacle or means for attaching a clip is available, the operator shall touch the filler cap with the nozzle spout before removing the cap in order to equalize the potential between the nozzle and the filler port. [**407:**4.2.5.2.3]

N **42.10.2.2.5.2.4** The nozzle spout shall be kept in contact with the filler neck until the fueling is completed. [**407:**4.2.5.2.4]

N **42.10.2.2.5.3** Where a funnel is used in aircraft fueling, it shall be kept in contact with the filler neck as well as the fueling nozzle spout or the supply container to avoid the possibility of a spark at the fill opening. [**407:**4.2.5.3]

N **42.10.2.2.5.3.1*** Only metal funnels shall be used. [**407:**4.2.5.3.1]

N **A.42.10.2.2.5.3.1** Ordinary plastic funnels or other nonconducting materials can increase static generation. The use of chamois as a filter is extremely hazardous. [**407:**A.4.2.5.3.1]

N **42.10.2.2.5.4** Where a hydrant servicer or cart is used for fueling, the hydrant coupler shall be connected to the hydrant system prior to bonding the fuel equipment to the aircraft. [**407:**4.2.5.4]

The intent of 42.10.2.2.5.4 is to prevent a spark caused by a static charge on the aircraft from being produced at the hydrant coupler connection where fuel vapors might be present.

N **42.10.2.2.5.5** Bonding and fueling connections shall be disconnected in the reverse order of connection. [**407:**4.2.5.5]

The fueling connection from a hydrant servicer or truck to the aircraft should always be removed prior to removal of the bonding cable. In the case of a hydrant servicer, the hydrant coupler should be removed last.

N **42.10.2.2.5.6** Conductive hose shall be used to prevent electrostatic discharge but shall not be used to accomplish required bonding. [**407:**4.2.5.6]

N **42.10.2.2.6 Control of Fuel Flow.**

N **42.10.2.2.6.1** Fuel flow shall be controlled by use of a dead-man control device. [**407:**4.2.6.1]

N **42.10.2.2.6.2** The use of any means that defeats the dead-man control shall be prohibited. [**407:**4.2.6.2]

N **42.10.2.2.7 Fire Protection.**

N **42.10.2.2.7.1*** During fueling operations, fire extinguishers shall be available on aircraft servicing ramps or aprons, in accordance with NFPA 410. [**407:**4.2.7.1]

N **A.42.10.2.2.7.1** Portable fire extinguishers for ramps where fueling operations are conducted are intended to provide an immediate means of fire protection in an area likely to contain a high concentration of personnel and valuable equipment. The prominent and strategic positioning of portable fire extinguishers is essential for them to be of maximum value in the event of an emergency. Extinguishers should not be located in probable spill areas. For normal single parking configurations, extinguishers specified for protection of fuel servicing operations should be located along the fence, at terminal building egress points, or at emergency remote control stations of airport fixed-fuel systems. To provide accessibility from adjoining gates, particularly where more than one unit is specified, extinguishers can be permitted to be located approximately midway between gate positions. Where this is done, the maximum distance between extinguishers should not be over 60 m (200 ft). Where the specified extinguishers are not located along the fence but are brought into the servicing area prior to the fueling operation, they should be located upwind not over 30 m (100 ft) from the aircraft being serviced. For protection of fuel servicing of aircraft that are double parked or triple parked, extinguishers should be located upwind not over 30 m (100 ft) from the aircraft being serviced. [**407:**A.4.2.7.1]

Distribution, selection, installation, and servicing of portable or wheeled fire extinguishers must be in accordance with Section 13.6 and Section 42.10.

N **42.10.2.2.7.2*** Extinguishers shall be kept clear of elements such as ice and snow. [**407:**4.2.7.2]

N **A.42.10.2.2.7.2** During inclement weather, extinguishers not in enclosed compartments can be permitted to be protected by canvas or plastic covers. [**407:**A.4.2.7.2]

N **42.10.2.2.7.3** Extinguishers located in enclosed compartments shall be readily accessible, and their location shall be marked clearly in letters at least 50 mm (2 in.) high. [**407:**4.2.7.3]

N **42.10.2.2.7.4** Fuel servicing personnel shall be trained in the use of the available fire-extinguishing equipment they could be expected to use. *(See A.42.10.2.2.2.2.)* [**407:**4.2.7.4]

N **42.10.2.2.8 Maintenance.**

N **42.10.2.2.8.1** Fuel servicing equipment shall be maintained in safe operating condition. [**407:**4.2.8.1]

N **42.10.2.2.8.2** Malfunctioning equipment shall be removed from service. [**407:**4.2.8.2]

N **42.10.2.2.8.3** Where a valve or electrical device is used for isolation during maintenance or modification of a fuel system, it shall be tagged and locked out. [**407:**4.2.8.3]

N **42.10.2.2.8.4** The tag/lock shall not be removed until the operation is completed. [**407:**4.2.8.4]

N **42.10.2.2.8.5** All inspection and maintenance activities shall be recorded. [**407:**4.2.8.5]

N **42.10.2.2.8.6** Inspection and maintenance records shall be retained for a minimum of 12 months. [**407:**4.2.8.6]

N **42.10.2.2.9* Aircraft Fueling Hose.** Any hose found to be defective, in accordance with 42.10.2.2.9.1 through 42.10.2.2.9.4, shall be removed from service. [**407:**4.2.9]

N **A.42.10.2.2.9** Failure of an aircraft fueling hose in service is a potential source of fuel spillage and a potential fire hazard. The principal reasons for failure of aircraft fueling hoses include the following:

(1) Using damaged hoses
(2) Using aged hoses
(3) Exceeding hose pressure limits
(4) Installing hoses improperly
[**407:**A.4.2.9]

N **42.10.2.2.9.1** Suitable records shall be kept of required inspections and hydrostatic tests. [**407:**4.2.9.1]

N **42.10.2.2.9.2** Aircraft fueling hose shall be removed from service after 10 years from the date of manufacture. [**407:**4.2.9.2]

The maximum service life for fuel hose aligns with the requirements of A4A Specification 103.

N **42.10.2.2.9.3** Aircraft fueling hose not placed into service within 2 years of the date of manufacture shall not be used. [**407:**4.2.9.3]

The maximum age for fuel hose being placed into service aligns with the requirements of A4A Specification 103.

N **42.10.2.2.9.4 Daily Inspection.** Aircraft fueling hose shall be inspected before use each day. [**407:**4.2.9.4]

N **42.10.2.2.9.4.1** The hose shall be extended as it normally would be for fueling. [**407:**4.2.9.4.1]

N **42.10.2.2.9.4.2** The hose shall be checked for evidence of any of the following defects:

(1) Blistering
(2) Carcass saturation or separation
(3) Exposure of the reinforcement material
(4) Slippage, misalignment, or leaks at couplings
[**407:**4.2.9.4.2]

N **42.10.2.2.9.5 Monthly Inspection.** At least once each month the hose shall be completely extended and inspected as required in 42.10.2.2.9.4 and 42.10.2.2.9.5. [**407:**4.2.9.5]

N **42.10.2.2.9.5.1*** The hose couplings and the hose shall be examined for structural weakness or soft spots. [**407:**4.2.9.5.1]

N **A.42.10.2.2.9.5.1** Particular attention should be paid to the 305 mm (12 in.) adjacent to the couplings. These areas are prone to premature failure. [**407:**A.4.2.9.5.1]

N **42.10.2.2.9.5.2** With the hose completely extended, it shall be pressurized to the working pressure of the fueling equipment to which it is attached and checked for defects, such as abnormal twisting or blistering. [**407:**4.2.9.5.2]

N **42.10.2.2.9.6 Quarterly Inspection.**

N **42.10.2.2.9.6.1** The nozzle screens shall be examined for evidence of hose deterioration. [**407:**4.2.9.6.1]

N **42.10.2.2.9.7** Kinks or short loops in fueling hose shall be avoided. [**407:**4.2.9.7]

N **42.10.2.2.10* Lightning.** A written procedure shall be established to set the criteria for when and where fueling operations are to be suspended at each airport as approved by the fueling agent and the airport authority. [**407:**4.2.10]

N **A.42.10.2.2.10** Establishing precise rules for fueling is impossible when the electrical storms are in the vicinity of the airport. The distance of the storm from the airport, the direction in which it is traveling, and its intensity are all factors to be weighed in making the decision to suspend fueling operations temporarily. Experience and good judgment are the best guides. Sound travels approximately 322 m/sec (⅕ mi/sec). The approximate number of miles to the storm can be determined by counting the seconds between a flash of lightning and the sound of thunder and dividing by 5. [**407:**A.4.2.10]

Previous editions of NFPA 407 required fuel servicing operations to be suspended "where lightning flashes are in the immediate vicinity of the airport." This requirement was deleted because the criterion was vague and unenforceable. The revised requirement requires the airport to develop appropriate policies.

N **42.10.2.2.11 Aircraft Fuel Servicing.**

N **42.10.2.2.11.1 Location of Aircraft During Fuel Servicing.**

N **42.10.2.2.11.1.1** Aircraft fuel servicing shall be performed outdoors. [**407:**4.2.11.1.1]

N **42.10.2.2.11.1.2** Aircraft fuel servicing incidental to aircraft fuel system maintenance operations shall comply with the requirements of NFPA 410. [**407:**4.2.11.1.2]

N **42.10.2.2.11.1.3*** Aircraft being fueled shall be positioned so that aircraft fuel system vents or fuel tank openings are not closer than 7.6 m (25 ft) to any terminal building, hangar, service building, or enclosed passenger concourse other than a loading walkway. [**407:**4.2.11.1.3]

N **A.42.10.2.2.11.1.3** The precautions in 42.10.2.2.11.1.3 and 42.10.2.2.11.1.4 are intended to minimize the danger of the ignition of any flammable vapors discharged during fueling and of fuel spills by sources of ignition likely to be present in airport terminal buildings. [**407:**A.4.2.11.1.3]

N **42.10.2.2.11.1.4** Aircraft being fueled shall be positioned so that the vent or tank openings are not closer than 15 m (50 ft) of any combustion and ventilation air intake to any boiler, heater, or incinerator room. [**407:**4.2.11.1.4]

N **42.10.2.2.11.1.5** Accessibility to aircraft by emergency fire equipment shall be maintained for aircraft fuel servicing positions. [**407:**4.2.11.1.5]

N **42.10.2.2.11.2 Aircraft Occupancy During Fuel Servicing.**

N **42.10.2.2.11.2.1** If passengers remain on board an aircraft during fuel servicing, at least one qualified person trained in emergency evacuation procedures shall be in the aircraft at or near a door at which there is a passenger loading walkway, integral stairs that lead downward, or a passenger loading stair or stand. [**407:**4.2.11.2.1]

N **42.10.2.2.11.2.1.1** A clear area for emergency evacuation of the aircraft shall be maintained at not less than one additional exit. [**407:**4.2.11.2.1.1]

N **42.10.2.2.11.2.1.2** Where fueling operations take place with passengers on board away from the terminal building, and stairways are not provided, such as during inclement weather (diversions), all slides shall be armed and the aircraft rescue and fire fighting (ARFF) services shall be notified to respond in standby position in the vicinity of the fueling activity with at least one vehicle. [**407:**4.2.11.2.1.2]

N **42.10.2.2.11.2.1.3** Aircraft operators shall establish specific procedures covering emergency evacuation under such conditions for each type of aircraft they operate. [**407:**4.2.11.2.1.3]

N **42.10.2.2.11.2.1.4** All "no smoking" signs shall be displayed in the cabin(s), and the no smoking rule shall be enforced. [**407:**4.2.11.2.1.4]

N **42.10.2.2.11.2.2** For each aircraft type, aircraft operators shall determine the areas through which it could be hazardous for boarding or deplaning passengers to pass while the aircraft is being fueled. [**407:**4.2.11.2.2]

N **42.10.2.2.11.2.2.1** Controls shall be established so that passengers avoid such areas. [**407:**4.2.11.2.2.1]

N **42.10.2.2.12 Fire Hazards on Aircraft Fuel Servicing Ramps.**

Aircraft fuel vent openings are a source of flammable vapors during the fuel servicing operation and can discharge liquid fuel in the event of an accidental overflow. To avoid ignition of the vapors or liquid fuel, NFPA 407 sets limitations on possible ignition sources, such as equipment and vehicles.

N **42.10.2.2.12.1* Electrical Equipment Operated on Aircraft Fuel Servicing Ramps or Aprons.**

N **A.42.10.2.2.12.1** Electric hand lamps used in the immediate proximity of the fueling operation should be of the type approved for use in *NFPA 70*, Class I, Division 1, Group D hazardous locations. No supportable basis exists for requiring, in the petroleum industry, the use of approved, listed, or permitted two- or three-cell flashlights to avoid igniting Class I, Group D vapors. [**407:**A.4.2.12.1]

N **42.10.2.2.12.1.1** Battery chargers on any fueling equipment shall not be connected or disconnected while fuel servicing is performed on an aircraft. [**407:**4.2.12.1.1]

Battery chargers are permitted to be used or present during the fuel servicing operation, but it is not permitted to make or break the electrical connection during the fuel servicing operation.

N **42.10.2.2.12.1.2*** Aircraft ground-power generators or other electrical ground-power supplies shall not be connected or disconnected while fuel servicing is performed on the aircraft. [**407:**4.2.12.1.2]

N **A.42.10.2.2.12.1.2** Aircraft ground-power generators should be located as far as practical from aircraft fueling points and tank vents to reduce the danger of igniting flammable vapors that could be discharged during fueling operations at sparking contacts or on hot surfaces of the generators. [**407:**A.4.2.12.1.2]

Aircraft ground-power generators or other electrical ground-power supplies are permitted to be used or present during the fuel servicing operation, but it is not permitted to make or break the electrical connection during the fuel servicing operation.

N **42.10.2.2.12.1.3** Electric tools or similar tools likely to produce sparks or arcs shall not be used while fuel servicing is performed on an aircraft. [**407:**4.2.12.1.3]

N **42.10.2.2.12.1.4** Other than aircraft fuel servicing vehicles, battery-powered vehicles that do not comply with the provisions of this standard shall not be operated within 3 m (10 ft) of fueling equipment or spills. [**407:**4.2.12.1.4]

N **42.10.2.2.12.1.5*** Communication equipment located outside of the cab of fuel servicing vehicles and used during aircraft fuel servicing operations within 3 m (10 ft) of the fill or vent points of aircraft fuel systems shall be listed as intrinsically safe for Class I, Division 1, Group D hazardous (classified) locations in accordance with ANSI/UL 913. [**407:**4.2.12.1.5]

N **A.42.10.2.2.12.1.5** For further information on intrinsically safe apparatus, see ANSI/UL 913, FM Class 3610, or ANSI/UL 60079-11. [**407:**A.4.2.12.1.5]

N **42.10.2.2.12.2 Open Flames on Aircraft Fuel Servicing Ramps.**

N **42.10.2.2.12.2.1** Entrances to fueling areas shall be posted with "no smoking" signs. [**407:**4.2.12.2.1]

N **42.10.2.2.12.2.2** Open flames on aircraft fuel servicing ramps or aprons within 15 m (50 ft) of any aircraft fuel servicing operation or fueling equipment shall be prohibited. [**407:**4.2.12.2.2]

N **42.10.2.2.12.2.3** The category of open flames and lighted open flame devices shall include, but shall not be limited to, the following:

(1) Lighted cigarettes, cigars, or pipes
(2) Electronic cigarettes (e.g., personal vaporizers or electronic nicotine delivery systems)
(3) Exposed flame heaters, liquid, solid, or gaseous devices, including portable and wheeled gasoline or kerosene heaters
(4) Heat-producing welding or cutting devices and blowtorches
(5) Flare pots or other open-flame lights

[**407:**4.2.12.2.3]

NFPA 407 treats electronic cigarettes the same as traditional cigarettes because it is unknown whether these units are capable of igniting fuel vapors.

N **42.10.2.2.12.2.4** The authority having jurisdiction can establish other locations where open flames and open-flame devices shall not be permitted. [**407:**4.2.12.2.4]

N **42.10.2.2.12.2.5** Personnel shall not carry lighters, matches, or electronic cigarettes on their person while engaged in fuel servicing operations. [**407:**4.2.12.2.5]

N **42.10.2.2.12.2.6** Lighters, matches, or electronic cigarettes shall not be permitted on or in fueling equipment. [**407:**4.2.12.2.6]

N **42.10.2.2.12.2.7** Equipment performing aircraft servicing functions shall not be positioned within a 3 m (10 ft) radius of aircraft fuel system vent openings. [**407:**4.2.12.2.7]

Equipment used for baggage handling, galley restocking, lavatory servicing, or other aircraft preparation is permitted to be used during aircraft fuel servicing, as long as it is located at least 3 m (10 ft) from the vent openings.

N **42.10.2.2.12.3 Operation of Aircraft Engines and Heaters.**

Minimizing possible sources of ignition during a fuel servicing operation is important. Paragraphs 42.10.2.2.12.3.1 through 42.10.2.2.12.3.3 address the control of ignition sources on the aircraft itself. Explosions can occur when fuel from an accidental spill or from equipment failure is sprayed or misted onto heated surfaces.

N **42.10.2.2.12.3.1** Fuel servicing shall not be performed on a fixed wing aircraft while an onboard engine is operating, except as permitted by 42.10.2.2.12.3.2 or 42.10.2.2.14. [**407:**4.2.12.3.1]

N **42.10.2.2.12.3.2** Aircraft auxiliary power units (APUs) that direct exhaust away from the fueling operation shall be permitted to operate during fuel servicing. [**407:**4.2.12.3.2]

Aircraft auxiliary power units (APUs) are commonly operated at airports where ground-provided electrical and heating/air conditioning are not available. The exhausts of these units are generally directed away from fueling operations. At locations where quick-turnarounds of aircraft take place, APUs are necessary to provide lighting and environmental controls inside the cabin of the aircraft to allow passenger boarding/deboarding and cabin cleaning, which generally take place coincidentally with fueling.

N **42.10.2.2.12.3.3** Combustion heaters on aircraft (e.g., wing and tail surface heaters, integral cabin heaters) shall not be operated during fueling operations. [**407:**4.2.12.3.3]

N **42.10.2.2.13 Defueling of Aircraft.**

Paragraphs 42.10.2.2.13.1 and 42.10.2.2.13.2 apply to the removal of fuel from an aircraft as a routine procedure for storage. As specified in 42.10.1.1(3), the removal of fuel for the purpose of aircraft fuel system maintenance or manufacturing is not within the scope of NFPA 407 or 42.10.2.2.13.1 and 42.10.2.2.13.2. Aircraft maintenance operations are covered under NFPA 410.

N **42.10.2.2.13.1** All requirements of this standard shall apply to defueling operations. [**407:**4.2.13.1]

N **42.10.2.2.13.2** Each operator shall establish procedures to prevent the overfilling of the tank vehicle, which is a special hazard when defueling. [**407:**4.2.13.2]

N **42.10.2.2.14 Rapid Refueling.**

Rapid refueling is the practice of refueling an aircraft while the engines are running. This is generally used in operations where the required cycle time for stopping and restarting the aircraft engines cannot be tolerated. Since rapid refueling involves certain additional risks, compared to the standard fueling procedures, NFPA 407 places strict limitations on its use and conditions.

N **42.10.2.2.14.1** Rapid refueling of aircraft shall be limited to the following aircraft types:

(1) Helicopters
(2) Agricultural aircraft actively engaged in aerial application duties
(3) Medical aircraft actively engaged in the transport of medical patients
(4) Fire-fighting and search-and-rescue aircraft actively engaged in emergency operations

[**407:**4.2.14.1]

N **42.10.2.2.14.2** Only turbine engine aircraft fueled with JET A or JET A-1 fuels shall be permitted to be fueled while an onboard engine is operating. [**407:**4.2.14.2]

N **42.10.2.2.14.3** Aircraft permitted to be fueled while an onboard engine is operating shall have all sources of ignition of potential fuel spills located above the fuel inlet port(s) and above the vents or tank openings, including but not limited to the following:

(1) Engines
(2) Exhausts
(3) Auxiliary power units (APUs)
(4) Combustion-type cabin heater

[**407:**4.2.14.3]

N **42.10.2.2.14.4** Aircraft fueling while onboard engines are operating shall be permitted only under the following conditions:

(1) A pilot licensed by the appropriate governmental body shall be at the aircraft controls during the entire fueling operation.
(2) All passengers shall be deboarded to a safe location prior to rapid refueling operations, except as permitted in 42.10.2.2.14.3(3).
(3) Patients on board medical transport aircraft shall be permitted to remain on board the aircraft with medical personnel during rapid refueling operations if, in the opinion of the medical provider, removal from the aircraft would be detrimental to the patient's condition.
(4) Passengers shall not board or deboard during rapid refueling operations.
(5) Only designated personnel, properly trained in rapid refueling operations, shall operate the equipment. Written procedures shall include the safe handling of the fuel and equipment.
(6) All doors, windows, and access points allowing entry to the interior of the aircraft that are adjacent to, or in the immediate vicinity of, the fuel inlet ports shall be closed and shall remain closed during refueling operations.
(7) Fuel shall be permitted to be dispensed by one of the following methods:
    (a) Into an open port from approved deadman-type nozzles with a flow rate not to exceed 227 L/min (60 gpm)
    (b) Through close-coupled pressure fueling ports
(8) Where fuel is dispensed from fixed piping systems, the hose cabinet shall not extend into the rotor space.

(9) Clearance between aircraft fuel servicing vehicles and rotating components shall be maintained by one of the following methods:
  (a) A curb or other approved barrier shall be provided to restrict the fuel servicing vehicle from coming within 3 m (10 ft) of any aircraft rotating components.
  (b) Fuel servicing vehicles shall be kept 6 m (20 ft) away from any aircraft rotating components, and a trained person shall direct fuel servicing vehicle approach and departure.

[**407:**4.2.14.4]

N **42.10.3 Aviation Fueling Facilities.**

Subsection 42.10.3 applies to all fixed fueling facilities, including piping, hydrants, loading racks, self-service fueling stations, rooftop heliport fueling stations, and other aircraft fuel servicing infrastructure. It does not apply to airport fueling vehicles (see 42.10.4).

N **42.10.3.1 Design and Construction.**

N **42.10.3.1.1 General Requirements.**

N **42.10.3.1.1.1** Each installation shall be designed and installed in conformity with the requirements of this standard and with any additional fire safety measures deemed necessary by the authority having jurisdiction. [**407:**5.1.1.1]

It is not possible for this *Code* to address every possible scenario in airport design. The AHJ is permitted to establish additional requirements to address the unique characteristics of an installation.

N **42.10.3.1.1.2** The system and each of its components shall be designed for the working pressure of the system. [**407:**5.1.1.2]

N **42.10.3.1.1.3** The emergency fuel shutoff system shall be designed and installed as an integral part of the airport fuel system. [**407:**5.1.1.3]

N **42.10.3.1.1.4** Operating controls for emergency fuel shutoff of the system shall be located to be readily accessible in the event of an accident or spill. [**407:**5.1.1.4]

N **42.10.3.1.1.5** In establishing each aircraft fuel dispensing location, consideration shall be given to the accessibility of the location in an emergency by fire-fighting personnel and equipment. [**407:**5.1.1.5]

N **42.10.3.1.1.6 System Design and Approval.**

N **42.10.3.1.1.6.1 Design Approval.** Work shall not be started on the construction or alteration of an airport fuel system until the design, plans, and specifications have been approved by the authority having jurisdiction. [**407:**5.1.1.6.1]

This provision allows the AHJ to ensure that all work on airport fuel systems is performed by engineers and contractors qualified to perform the work and to ensure that all requirements of the AHJ are met.

N **42.10.3.1.1.6.2 System Approval.** The authority having jurisdiction shall inspect and approve the completed system before it is put into service. [**407:**5.1.1.6.2]

N **42.10.3.1.1.6.3 Hydrostatic Test.**

N **42.10.3.1.1.6.3.1** After completion of the installation (including fill and paving), new airport fuel piping systems shall be subjected to a temperature-compensated hydrostatic test pressure equal to 150 percent of the system working pressure for at least 4 hours and shall be proven tight before the system is placed into service. [**407:**5.1.1.6.3.1]

N **42.10.3.1.1.6.3.2** For additions or modifications to existing airport fuel piping systems, hydrostatic testing of new piping prior to final tie-in to existing piping shall be permitted, with final closure (tie-in) welds examined in-process in accordance with ASME B31.3. [**407:**5.1.1.6.3.2]

ASME B31.3, *Process Piping*, permits alternative means of testing, such as radiographic or ultrasonic examination, dye penetrant, or magnetic particle. With limited allowable downtime of airport fueling operations (typically overnight), pressure testing of the combined new and existing piping system is not always practical or possible.

N **42.10.3.1.2 Fuel Storage Tanks.**

N **42.10.3.1.2.1*** Fuel storage tanks shall conform to the applicable requirements of NFPA 30. [**407:**5.1.2.1]

N **A.42.10.3.1.2.1** Where pressure tanks are used, details on construction, spacing, and location should be in accordance with industry good practice and approved by the authority having jurisdiction. When AVGAS, MOGAS, or JET B turbine fuels are stored in bulk quantities in aboveground tanks, they should be stored in floating roof-type tanks. Covered floating roof tanks minimize the hazardous flammable vapor–air space above the liquid level. The vapor spaces of underground tanks storing fuels should not be interconnected. [**407:**A.5.1.2.1]

N **42.10.3.1.2.2** The authority having jurisdiction shall determine the clearances required from runways, taxiways, and other aircraft movement and servicing areas to any aboveground fuel storage structure or fuel transfer equipment, with due recognition given to national and international standards establishing clearances from obstructions. [**407:**5.1.2.2]

One possible resource is FAA AC 150/5300, *Airport Design*.

N **42.10.3.1.3 Pumps and Piping Systems.**

N **42.10.3.1.3.1** Underground piping or impact-protected aboveground piping shall be used in the vicinity of aircraft operating areas. [**407:**5.1.3.1]

N **42.10.3.1.3.2** Piping shall be laid on firm supports using clean, noncorrosive backfill. [**407:**5.1.3.2]

N **42.10.3.1.3.3** Transfer piping located within buildings not specifically designed for the purpose of fuel transfer shall be located within a steel casing of a pressure rating equal to that of the carrier pipe. [**407:**5.1.3.3]

N **42.10.3.1.3.3.1** The casing shall extend beyond the building. [**407:**5.1.3.3.1]

N **42.10.3.1.3.3.2** The casing shall terminate at a low point(s) with an automatic leak detection system. [**407:**5.1.3.3.2]

N **42.10.3.1.3.3.3** The casing shall be capable of being drained to a safe location. [**407:**5.1.3.3.3]

N **42.10.3.1.3.4** Piping, valves, and fittings shall be of steel or stainless steel, suitable for aviation fuel service and designed for the working pressure and mechanically and thermally produced structural stresses to which they could be subjected and shall comply with ASME B31.3. [**407:**5.1.3.4]

Deviations from ASME B31.3 should be approved by the AHJ, in accordance with the equivalency clause in 1.4.1.

N **42.10.3.1.3.5** Cast-iron, copper, copper alloy, and galvanized steel piping, valves, and fittings shall not be permitted. [**407:**5.1.3.5]

N **42.10.3.1.3.6** Ductile iron valves shall be permitted. [**407:**5.1.3.6]

N **42.10.3.1.3.7** Aluminum piping, valves, and fittings shall be used only where specifically approved by the authority having jurisdiction. [**407:**5.1.3.7]

N **42.10.3.1.3.8** In the selection of pipe, valves, and fittings, the following shall be considered:

(1) Working pressure
(2) Bending and mechanical strength requirements (including settlement)
(3) Internal and external corrosion
(4) Impact stresses
(5) Method of system fabrication and assembly
(6) Location of piping and accessibility for repair or replacement
(7) Exposure to mechanical, atmospheric, or fire damage
(8) Expected period of service and effect of future operations

[**407:**5.1.3.8]

N **42.10.3.1.3.9** Gaskets in flanged connections shall resist fire temperatures for a duration comparable to the temperature resistance of the flange and bolts. [**407:**5.1.3.9]

N **42.10.3.1.3.10** Flanges and their associated bolts shall be steel or stainless steel. [**407:**5.1.3.10]

N **42.10.3.1.3.10.1** Flanges shall be rated to the ANSI pressure class suitable to the fuel system working pressures but in no cases shall be less than Class 150. [**407:**5.1.3.10.1]

N **42.10.3.1.3.10.2** Joints [and flanges] shall be installed so that the mechanical strength of the joint will not be impaired if exposed to fire. [**30:**27.5.1.2]

N **42.10.3.1.3.11** Allowances shall be made for thermal expansion and contraction by the use of pipe bends, welded elbows, or other flexible design. [**407:**5.1.3.11]

N **42.10.3.1.3.12** Pressure relief valves shall be provided in lines that can be isolated. [**407:**5.1.3.12]

N **42.10.3.1.3.13** Welded joints shall be made by qualified welders in accordance with the standards of the American Welding Society and ANSI/ASME B31.3. [**407:**5.1.3.13]

N **42.10.3.1.3.14*** Isolation valves or devices shall be provided to facilitate dismantling portions of the fueling system. [**407:**5.1.3.14]

N **A.42.10.3.1.3.14** Flanged connections should be provided for ease of dismantling and to avoid cutting and welding after the system has been placed in service. The location of these isolation devices depends upon the size and character of each system, but the following locations generally apply *(see Figure A.42.10.3.1.3.14)*:

(1) At each storage tank
(2) At each pump
(3) At each filter separator
(4) At each hydrant or on each hydrant lateral
(5) At each flow regulator or pressure control valve

[**407:**A.5.1.3.14]

N **42.10.3.1.3.15** Isolation valves shall be capable of being locked closed. [**407:**5.1.3.15]

N **42.10.3.1.3.16** Buried flanges and valves shall not be permitted. [**407:**5.1.3.16]

N **42.10.3.1.3.17*** All fueling systems with underground piping shall have cathodic protection to mitigate corrosion. [**407:**5.1.3.17]

N **A.42.10.3.1.3.17** Cathodic protection is recommended for metal components of airport fueling systems and fuel storage facilities that are in contact with the ground. The two types of cathodic protection are as follows:

(1) Galvanic anode method, which generates its own current
(2) Impressed current method, which has an external current source

[**407:**A.5.1.3.17]

N **42.10.3.1.3.18** A heat-actuated shutoff valve shall be provided in the piping immediately upstream of loading hoses or swing arm connections. [**407:**5.1.3.18]

N **42.10.3.1.4 Hose and Nozzles. (Reserved)**

N **42.10.3.1.5 Bonding. (Reserved)**

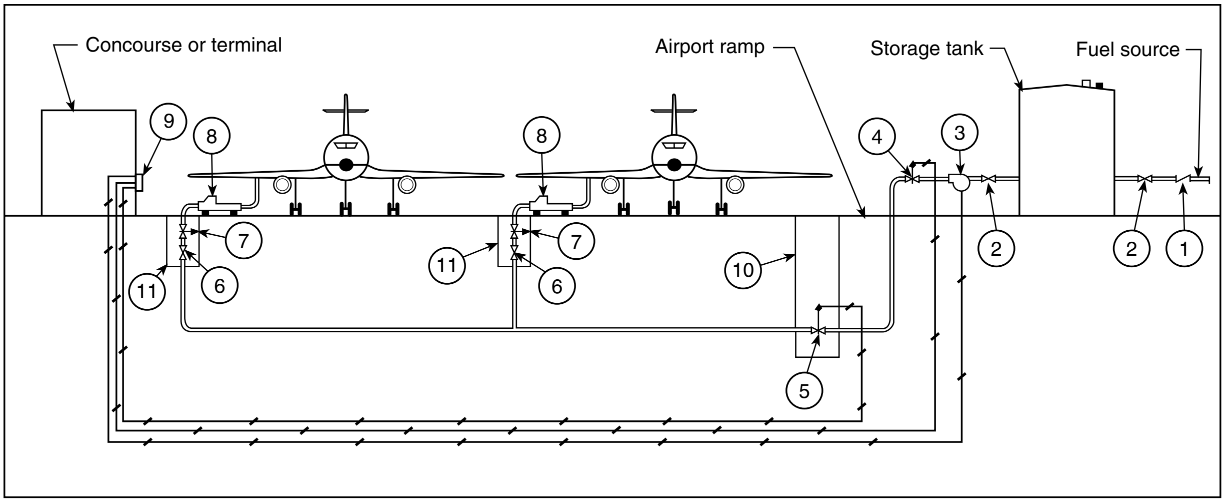
N **42.10.3.1.6 Electrical Systems.**

N **42.10.3.1.6.1 Electrical Equipment.** All electrical equipment and wiring shall comply with the requirements of *NFPA 70*, Article 515, utilizing the Class I liquids requirements for all applications. [**407:**5.1.6.1]

N **42.10.3.1.7 Control of Fuel Flow.**

N **42.10.3.1.7.1* Deadman Controls.**

N **A.42.10.3.1.7.1** Deadman controls should be designed so that the operator can use them comfortably while wearing gloves



Note: No dimensional relationship exists between elements in this figure. Refer to this standard; NFPA 30, *Flammable and Combustible Liquids Code*; *NFPA 70*, *National Electrical Code;* and FAA Regulations for separations and clearances.

Key:
1. Check valve at tank inlet
2. Isolation valve at tank inlet/outlet
3. Pumping system
4. Pump discharge control valve or hydrant system shutoff valve (alternate location)
5. Hydrant system shutoff valve (alternate location)
6. Hydrant shutoff valve
7. Hydrant pit valve
8. Hydrant fueling servicing vehicle
9. Emergency fuel shutoff station
10. Valve box
11. Hydrant pit

FIGURE A.42.10.3.1.3.14 *Typical Fixed Airport Fueling System Isolation Valving Operating and Emergency Controls.*

and hold them for the time needed to complete the operation. A pistol grip deadman device that is squeezed to operate is preferable to a small button that needs to be held by a thumb or finger. [**407:**A.5.1.7.1]

N **42.10.3.1.7.1.1** The valve that controls the flow of fuel to an aircraft or fueling vehicle shall have a deadman control. [**407:**5.1.7.1.1]

N **42.10.3.1.7.1.2** The fuel flow control means shall be one of the following:

(1) The hydrant pit valve
(2) At the feed-side of the fueling hose
(3) A separate valve on the fuel piping system
(4) On the hose nozzle for overwing servicing
(5) An electronic control to stop the pump

[**407:**5.1.7.1.2]

N **42.10.3.1.7.1.3** Deadman controls shall be designed to preclude defeating their intended purpose. [**407:**5.1.7.1.3]

N **42.10.3.1.7.2 Pressure Fuel Servicing System Controls.**

N **42.10.3.1.7.2.1** The system shall be designed to minimize surge pressure. [**407:**5.1.7.2.1]

N **42.10.3.1.7.2.2*** The overshoot shall not exceed 5 percent of actual flow rate in L/min (gal/min) at the time the deadman is released. [**407:**5.1.7.2.2]

N **A.42.10.3.1.7.2.2** The overshoot of pressure control release, *V* max, should be calculated by the following equation:

$$V_{max} = Q \times 1 \text{ min} \times 0.05$$

[A.42.10.3.1.7.2.2]

where:

Q = actual fuel flow rate, L/min (gal/min)

Example

If the actual fuel flow rate at the time of deadman control release is 1500 L/min (400 gpm), total overshoot must not exceed 75 L/min (20 gal/min). [**407:**A.5.1.7.2.2]

N **42.10.3.1.7.2.3** The control valve shall be located and designed so that it will not be rendered inoperative by a surface accident, power failure, or spill. [**407:**5.1.7.2.3]

N **42.10.3.1.7.2.4** The control valve shall be fail-safe by closing completely in the event of control power loss. [**407:**5.1.7.2.4]

N **42.10.3.1.7.3* Hydrant Valves.** Hydrant valves shall be designed so that the flow of fuel shall shut off when the hydrant coupler is closed. [**407:**5.1.7.3]

N **A.42.10.3.1.7.3** Hydrant valves and couplers should be in accordance with EI 1584. [**407:**A.5.1.7.3]

N **42.10.3.1.7.3.1** Hydrant valves shall be of the self-closing, dry-break type. [**407:**5.1.7.3.1]

N **42.10.3.1.7.4 Flow Control Valves.** The flow control valve shall be an integral part of the hydrant valve or coupler. [**407:**5.1.7.4]

N **42.10.3.1.7.4.1** The fuel control valve shall be arranged so that it is not rendered inoperative by a surface accident, spill, or malfunction and shall shut off the flow of fuel if the operating energy fails. [**407:**5.1.7.4.1]

N **42.10.3.1.7.4.2** The fuel control system shall be designed to minimize overshoot. [**407:**5.1.7.4.2]

N **42.10.3.1.7.4.3** The system shall be designed to shut off fuel flow quickly and effectively, even if there is a reduction of pressure downstream of the flow control valve such as could result from a major line or hose break. [**407:**5.1.7.4.3]

N **42.10.3.1.7.4.4** A screen shall be provided ahead of the valve to trap foreign material that could interfere with complete closure of the valve. [**407:**5.1.7.4.4]

N **42.10.3.1.7.4.5** The hydrant valve that allows the flow of fuel to the aircraft shall have a deadman control. [**407:**5.1.7.4.5]

N **42.10.3.1.7.4.6** The use of any means that allows fuel to flow without the operator activating the deadman shall not be permitted. [**407:**5.1.7.4.6]

N **42.10.3.1.7.4.7** The deadman control shall be arranged so that the fueling operator can observe the operation while activating the control. [**407:**5.1.7.4.7]

N **42.10.3.1.7.4.8** Wireless deadman controls shall be permitted. [**407:**5.1.7.4.8]

N **42.10.3.1.7.5* Fuel Pressure.** The pressure of the fuel delivered to the aircraft shall be automatically controlled so that it is not higher than that specified by the manufacturer of the aircraft being serviced. [**407:**5.1.7.5]

N **A.42.10.3.1.7.5** Where surge suppressors are necessary, they should be located so that exposure to vehicular traffic, weather conditions, and the result of accidental rupture is minimized. [**407:**A.5.1.7.5]

N **42.10.3.1.8 Filters and Ancillary Equipment.**

N **42.10.3.1.8.1** All sections of the filtering system shall have electrical continuity with adjoining piping and equipment. [**407:**5.1.8.1]

N **42.10.3.1.8.2** In freezing climates, filter separator sumps and associated piping that could contain water shall be protected to prevent freezing and bursting. [**407:**5.1.8.2]

N **42.10.3.1.8.3** Heaters shall be constructed of noncorrosive materials. [**407:**5.1.8.3]

N **42.10.3.1.8.4** Piping, valves, meters, filters, air eliminators, connections, outlets, fittings, and other components shall be designed to meet the working pressure requirements of the system. [**407:**5.1.8.4]

N **42.10.3.1.9 Emergency Fuel Shutoff Systems.**

N **42.10.3.1.9.1** Each tank vehicle loading station shall be provided with an emergency fuel shutoff system, in addition to the deadman control required by 42.10.3.1.7.4. [**407:**5.1.9.1]

N **42.10.3.1.9.2** The emergency fuel shutoff system shall shut down the flow of fuel in the entire system or in sections of the system. [**407:**5.1.9.2]

N **42.10.3.1.9.3** The emergency fuel shutoff system shall be of a fail-safe design. [**407:**5.1.9.3]

N **42.10.3.1.9.4*** The method of fuel transfer (gravity, pumping, or use of hydraulic or inert gas pressure) shall be considered in the design of the emergency fuel shutoff system and the location of the emergency fuel shutoff valve. [**407:**5.1.9.4]

N **A.42.10.3.1.9.4** Fuel transfer by pumping is the more common procedure and normally is preferred from a fire protection standpoint, since it allows rapid shutdown of fuel flow through pump shutdown. Gravity transfer is the simplest method but normally is limited to relatively low flow rates. Because the static head does exert some pressure in the system, a safety shutdown should include a valve or valves located as close to the tank as practicable. [**407:**A.5.1.9.4]

N **42.10.3.1.9.5** The emergency fuel shutoff system shall include shutoff stations located outside of probable spill areas and near the route that normally is used to leave the spill area or to reach the fire extinguishers provided for the protection of the area. [**407:**5.1.9.5]

N **42.10.3.1.9.6*** At least one emergency shutoff control station shall be accessible to each fueling vehicle loading position or aircraft fueling position. [**407:**5.1.9.6]

N **A.42.10.3.1.9.6** The operation of the emergency shutoff control should sound an alarm at the airport fire crew station and at the fuel storage facility. [**407:**A.5.1.9.6]

N **42.10.3.1.9.7** The emergency fuel shutoff system shall be designed so that operation of a station shuts off fuel flow to all hydrants that have a common exposure. [**407:**5.1.9.7]

N **42.10.3.1.9.8** Emergency fuel shutoff systems shall be designed so that they shut off the flow of fuel if the operating power fails. [**407:**5.1.9.8]

N **42.10.3.1.9.9** Emergency fuel shutoffs shall not be located beneath piping, pumps, vents, or other components containing fuel or fuel vapors. [**407:**5.1.9.9]

N **42.10.3.1.10 Fire Protection.** At least one fire extinguisher, with a minimum rating of 80-B:C, shall be provided at each fueling vehicle loading position or rack. [**407:**5.1.10]

A minimum rating of 80-B:C is typically satisfied by an extinguisher with 10 to 20 lb (4.54 to 9.07 kg) of dry chemical. In accordance with 42.10.2.1.10.3, multipurpose (ABC) dry chemical is not permitted.

N **42.10.3.1.11 Marking and Labeling.**

N **42.10.3.1.11.1** Emergency fuel shutoff signs shall be located at least 2.1 m (7 ft) above grade, measured to the bottom of the placard. [**407:**5.1.11.1]

N **42.10.3.1.11.2** Emergency fuel shutoff signs shall be positioned so that they can be seen readily from a distance of at least 15.2 m (50 ft). [**407:**5.1.11.2]

To ensure that the operator can locate the emergency fuel shutoff, the sign must be visible from the location of the fueling equipment, which typically will be at least 50 ft (15.2 m) from the emergency fuel shutoff. Paragraph 42.10.3.1.13.2 requires fueling hydrants, cabinets, and pits to be located at least 50 ft (15.2 m) from terminal buildings, hangars, service buildings, or enclosed concourses; most emergency fuel shutoff stations are mounted on the building adjacent to the fueling cabinet or hydrant.

N **42.10.3.1.11.3** Systems provided with impressed current cathodic protection shall have appropriate signs, located at points of entry, warning against separation of units without prior deenergization or without proper jumpers across the sections to be disconnected. [**407:**5.1.11.3]

N **42.10.3.1.11.4** Fuel storage tanks shall be labelled in accordance with the requirements of NFPA 704. [**407:**5.1.11.4]

N **42.10.3.1.11.5** Fuel transfer piping shall be marked in accordance with EI 1542 as to the product type conveyed through the pipe and the proper direction of flow of the product. [**407:**5.1.11.5]

N **42.10.3.1.12 Aircraft Fuel Servicing Vehicle Loading and Unloading Racks.**

N **42.10.3.1.12.1** The loading rack shall be equipped with an automatic shutdown system that stops the tank loading operation when the fuel servicing vehicle tank is full. [**407:**5.1.12.1]

N **42.10.3.1.12.2** All fuel servicing tank vehicle primary shutdown systems shall be compatible with the system utilized at the loading rack. [**407:**5.1.12.2]

N **42.10.3.1.12.3** The automatic secondary shutoff control shall not be used for normal filling control. [**407:**5.1.12.3]

N **42.10.3.1.12.4** New and existing loading systems shall comply with 42.10.3.1.12.1 through 42.10.3.1.12.3 within 5 years of the effective date of this edition. [**407:**5.1.12.4]

N **42.10.3.1.13 Fuel Servicing Hydrants, Pits, and Cabinets.**

N **42.10.3.1.13.1** Fueling hydrants and fueling pits that are recessed below a ramp or apron surface and are subject to vehicle or aircraft traffic shall be fitted with a cover designed to sustain the load of vehicles or aircraft that taxi over all or part of them. [**407:**5.1.13.1]

N **42.10.3.1.13.2** Fueling hydrants, cabinets, and pits shall be located at least 15.2 m (50 ft) from any terminal building, hangar, service building, or enclosed passenger concourse (other than loading bridges). [**407:**5.1.13.2]

N **42.10.3.2 Operations.**

N **42.10.3.2.1* Security.** Access to fuel storage and fuel vehicle loading areas shall be secured. [**407:**5.2.1]

N **A.42.10.3.2.1** The airport perimeter fence can be sufficient to meet this requirement. [**407:**A.5.2.1]

N **42.10.3.2.2 Personnel. (Reserved)**

N **42.10.3.2.3 Prevention and Control of Spills. (Reserved)**

N **42.10.3.2.4 Emergency Fuel Shutoff. (Reserved)**

N **42.10.3.2.5 Bonding. (Reserved)**

N **42.10.3.2.6 Control of Fuel Flow.** If a wireless deadman control is used, the operator shall be located at the fueling point during the fueling operation. [**407:**5.2.6]

N **42.10.3.2.7 Fire Protection.** During fueling operations, fire extinguishers shall be available on aircraft servicing ramps or aprons, in accordance with NFPA 410. [**407:**5.2.7]

N **42.10.3.2.8 Maintenance. (Reserved)**

N **42.10.3.2.9 Aircraft Fueling Hose. (Reserved)**

N **42.10.4 Airport Fueling Vehicles.**

This subsection applies to airport fueling vehicles, including aviation fuel tank trucks, hydrant fueling trucks, and hydrant fueling carts. It does not apply to fixed facilities or infrastructure.

N **42.10.4.1 Design and Construction.**

N **42.10.4.1.1 General Requirements.**

N **42.10.4.1.1.1** Aircraft fuel servicing tank vehicles that are operated on public roadways shall comply with the requirements of NFPA 385. [**407:**6.1.1.1]

N **42.10.4.1.1.2** In addition to any specific requirements in this chapter, only materials safe for use in the service intended and compatible with fuel applications shall be used in the construction of aircraft fuel servicing vehicles and hydrant fuel service carts. [**407:**6.1.1.2]

N **42.10.4.1.1.3** Magnesium shall not be used in the construction of any portion of an aircraft fuel servicing vehicle or cart. [**407:**6.1.1.3]

N **42.10.4.1.1.4** Trailer connections shall be designed to secure the trailer firmly and to prevent the towed vehicle from swerving from side to side at the speeds anticipated so that the trailer essentially remains in the path of the towing vehicle. [**407:**6.1.1.4]

N **42.10.4.1.2 Tanks.**

N **42.10.4.1.2.1** Every cargo tank shall be supported by and attached to, or shall be a part of, the tank vehicle upon which it is carried in accordance with NFPA 385. [**407:**6.1.2.1]

N **42.10.4.1.2.2** Cargo tanks shall be constructed in accordance with 49 CFR 178.345, DOT 406, or other equivalent standard for international application. [**407:**6.1.2.2]

N **42.10.4.1.2.3** Aluminum alloys for high-strength welded construction shall be joined by an inert gas arc welding process using filler metals R-GR40A, E-GR40A (5154 alloy), R-GM50A, and EGM50A (5356 alloy) in accordance with AWS A5.10. [**407:**6.1.2.3]

N **42.10.4.1.2.4** Tank outlets shall be of substantial construction. [**407:**6.1.2.4]

N **42.10.4.1.2.5** Tank outlets shall be attached securely to the tank. [**407:**6.1.2.5]

N **42.10.4.1.2.6 Baffles.** Every cargo tank or compartment over 2.3 m (7.5 ft) long shall be provided with baffles, the total number of which shall be such that the distance between any two adjacent baffles, or between any tank head or bulkhead and the baffle closest to it, shall in no case exceed 1.5 m (5 ft). [**407:**6.1.2.6]

N **42.10.4.1.2.6.1** The cross-sectional area of each baffle shall be not less than 80 percent of the cross-sectional area of the tank. [**407:**6.1.2.6.1]

N **42.10.4.1.2.6.2** The thickness of a baffle shall be not less than that required for the heads and bulkheads of the cargo tank in which it is installed. [**407:**6.1.2.6.2]

N **42.10.4.1.2.7** Venting shall be in accordance with 49 CFR, DOT 406. [**407:**6.1.2.7]

N **42.10.4.1.2.8** Cargo draw-off valves or faucets projecting beyond the frame of a tank vehicle shall be protected against damage. [**407:**6.1.2.8]

N **42.10.4.1.2.9 Fill Openings and Top Flashings.**

N **42.10.4.1.2.9.1** Dome covers shall be provided with a forward mounted hinge and self-latching catches and shall be fitted with watertight fuel-resistant seals or gaskets designed to prevent spillage or leakage from overturn and to prevent water entry. [**407:**6.1.2.9.1]

N **42.10.4.1.2.9.2** Dome covers shall automatically close and latch with the forward motion of the vehicle. [**407:**6.1.2.9.2]

N **42.10.4.1.2.9.3** Drains from top flashing shall divert spilled fuel from possible sources of ignition, including the engine, the engine exhaust system, the electrical equipment, or an auxiliary equipment enclosure. [**407:**6.1.2.9.3]

N **42.10.4.1.2.9.4** The tank fill openings shall be protected against overturn damage by a rigid member(s) fixed to the tank and extending a minimum of 25 mm (1 in.) above any dome cover, handle, vent opening, or projection of the unit. [**407:**6.1.2.9.4]

N **42.10.4.1.2.9.5** Overturn protection shall be braced adequately to prevent collapse. [**407:**6.1.2.9.5]

N **42.10.4.1.2.9.6** Overturn protection shall be designed to channel rainwater, snow, or fuel to the exterior of the cargo tank and away from vehicle exhaust components. [**407:**6.1.2.9.6]

N **42.10.4.1.2.10 Tanks for Flammable Liquids Other than Fuel.** Vehicle or cart fuel tanks and containers for other flammable liquids shall be made of metal and shall be designed, constructed, and located in a manner that precludes hazardous arrangements. [**407:**6.1.2.10]

N **42.10.4.1.2.10.1** Tanks shall be substantially protected by their location. [**407:**6.1.2.10.1]

N **42.10.4.1.2.10.2** Fill pipes shall not project beyond the vehicle profile. [**407:**6.1.2.10.2]

N **42.10.4.1.2.10.3** Tanks and containers shall vent away from sources of ignition during filling. [**407:**6.1.2.10.3]

N **42.10.4.1.2.10.4** Any arrangement not protected by location shall be listed for such use. [**407:**6.1.2.10.4]

N **42.10.4.1.2.10.5** The fuel tank arrangement shall allow for drainage without the tank's removal from its mountings. [**407:**6.1.2.10.5]

N **42.10.4.1.2.11 Tests.** Cargo tanks, at the time of manufacture, shall be tested by a minimum air or hydrostatic pressure of 24.4 kg/m^2 (5 psi) applied to the whole tank (or each compartment thereof if the tanks are compartmented) for a period of at least 5 minutes. [**407:**6.1.2.11]

N **42.10.4.1.2.11.1** If the test is by air pressure, the entire exterior surface of all joints shall be coated with a solution of soap and water, heavy oil, or other substance that causes foaming or bubbling that indicates the presence of leaks. [**407:**6.1.2.11.1]

N **42.10.4.1.2.11.2** If the test is by hydrostatic pressure, it shall be gauged at the top of the tank, and the tank shall be inspected at the joints for the issuance of liquid to indicate leaks. [**407:**6.1.2.11.2]

N **42.10.4.1.2.11.3** Any leakage discovered by either of the methods described in 42.10.4.1.2.11.1 and 42.10.4.1.2.11.2, or by any other method, shall be considered evidence of failure to meet these requirements. [**407:**6.1.2.11.3]

N **42.10.4.1.3 Pumps and Piping System.**

N **42.10.4.1.3.1** All portions of the flammable liquid feed system shall be constructed and located to minimize the fire hazard. [**407:**6.1.3.1]

N **42.10.4.1.3.2** Piping and plumbing shall be made of materials not adversely affected by the fluid or by other materials likely to be encountered. [**407:**6.1.3.2]

N **42.10.4.1.3.3** Piping and plumbing shall be of adequate strength for the purpose. [**407:**6.1.3.3]

N **42.10.4.1.3.4** Piping and plumbing shall be secured to avoid chafing or undue vibration. [**407:**6.1.3.4]

N **42.10.4.1.3.5** Piping and plumbing shall be supported adequately. [**407:**6.1.3.5]

N **42.10.4.1.3.6** Product piping shall be metal and rated for the system working pressure or at least 1030 kPa (150 psi), whichever is greater. [**407:**6.1.3.6]

N **42.10.4.1.3.7** Except as provided in 42.10.4.1.3.8, all joints shall be welded. [**407:**6.1.3.7]

N **42.10.4.1.3.8** Flanged connections or approved couplings shall be provided to avoid the need for cutting and welding where components are serviced or replaced. [**407:**6.1.3.8]

N **42.10.4.1.3.9** Gaskets in flanged connections shall be of a material and design that resist fire exposure for a time comparable to the flange and bolts. [**407:**6.1.3.9]

N **42.10.4.1.3.10** Gravity feed systems shall not be used. [**407:**6.1.3.10]

N **42.10.4.1.3.11** At the time of manufacture, the section of the fuel dispensing system that is under pressure during service shall be subjected to a hydrostatic test pressure equal to 150 percent of the working pressure of the system for at least 30 minutes and shall be proven tight before it is placed in service. [**407:**6.1.3.11]

N **42.10.4.1.3.11.1** Hose connections shall be permitted to be plugged during this test. [**407:**6.1.3.11.1]

N **42.10.4.1.3.12 Loading System.**

N **42.10.4.1.3.12.1 Top Loading.**

N **42.10.4.1.3.12.1.1** Drop tubes shall be used. [**407:**6.1.3.12.1.1]

N **42.10.4.1.3.12.1.2** Splash filling shall be prohibited. [**407:** 6.1.3.12.1.2]

N **42.10.4.1.3.12.1.3** Drop tubes used in top loading or overhead loading of tank vehicles shall be designed to minimize turbulence. [**407:**6.1.3.12.1.3]

N **42.10.4.1.3.12.1.4** Drop tubes shall be metallic. [**407:**6.1.3.12.1.4]

N **42.10.4.1.3.12.1.5** Drop tubes shall extend to the bottom of the tank or to the inside of the sump to maintain submerged loading and to avoid splashing of the fuel. [**407:**6.1.3.12.1.5]

N **42.10.4.1.3.12.2 Bottom Loading.**

N **42.10.4.1.3.12.2.1** The bottom-loading connection of a tank truck shall be a dry-break coupler that cannot be opened until it is engaged to the vehicle tank adapter. [**407:**6.1.3.12.2.1]

N **42.10.4.1.3.12.2.2** It shall not be possible to disconnect the hose coupler from the tank vehicle until the coupler valve is fully closed. [**407:**6.1.3.12.2.2]

N **42.10.4.1.3.12.2.3*** The bottom loading fitting of the tank vehicle shall be a spring-loaded check valve that remains in a closed position until opened by connecting the coupler. [**407:**6.1.3.12.2.3]

N **A.42.10.4.1.3.12.2.3** An optional precaution against misfueling of aircraft fuel servicing tank vehicles is to equip the coupler and truck fitting with coded lugs or a mechanical device to ensure product selection and to prevent mixing of products. This might not be feasible on over-the-road-type tank vehicles. [**407:**A.6.1.3.12.2.3]

N **42.10.4.1.3.12.2.4** A float-actuated shutoff or other automatic sensing device shall be provided to close the bottom-loading valve when the tank is filled. [**407:**6.1.3.12.2.4]

N **42.10.4.1.3.12.2.5** Any liquid bled from a sensing device during loading shall be piped to the bottom of the cargo tank. [**407:**6.1.3.12.2.5]

N **42.10.4.1.3.12.2.6** The fill pipe and valving on bottom-loaded tank vehicles shall be arranged to prevent fuel spray and turbulence in the cargo tank. [**407:**6.1.3.12.2.6]

N **42.10.4.1.3.12.2.7** The cargo tank vehicle shall be equipped with an automatic primary shutdown system that stops the tank loading operation when the tank is full, unless an automatic shutdown is provided on the loading rack in accordance with 42.10.3.1.2.1. [**407:**6.1.3.12.2.7]

N **42.10.4.1.3.12.2.8** The cargo tank vehicle shall be equipped with an automatic secondary shutdown system that stops the tank loading operation when the tank is full. [**407:**6.1.3.12.2.8]

This requirement is intended to align with NFPA 30, which requires both a primary and a secondary automatic shutdown for bulk loading of tank vehicles.

N **42.10.4.1.3.12.2.9** The automatic secondary shutoff control shall not be used for normal filling control. [**407:**6.1.3.12.2.9]

N **42.10.4.1.3.13** Each outlet valve shall be provided with a fusible device that causes the valve to close automatically in case of fire. [**407:**6.1.3.13]

N **42.10.4.1.3.14** A shear section shall be provided between shutoff valve seats and discharge outlets that breaks under strain, unless the discharge piping is arranged to afford the same protection and leave the shutoff valve seat intact. [**407:**6.1.3.14]

N **42.10.4.1.3.15** Openings in cargo tank compartments that are connected to pipe or tubing shall be fitted with a spring-loaded check valve, a self-closing valve, or a similar device to prevent the accidental discharge of fuel in case of equipment malfunction or line breakage. [**407:**6.1.3.15]

N **42.10.4.1.3.15.1** Unless the valves required in 42.10.4.1.3.15 are located inside the tank, they shall be equipped with a shear section as described in 42.10.4.1.3.14. [**407:**6.1.3.15.1]

N **42.10.4.1.3.16** The operating mechanism for each tank outlet valve shall be adjacent to the fuel delivery system operating controls. [**407:**6.1.3.16]

N **42.10.4.1.3.16.1** The operating mechanism for each tank outlet valve shall be arranged so that the outlet valve(s) can be closed simultaneously and instantly in the event of a fire or other emergency. [**407:**6.1.3.16.1]

N **42.10.4.1.3.16.2** A means shall be provided to assure proper operation. [**407:**6.1.3.16.2]

N **42.10.4.1.4 Hose and Nozzles. (Reserved)**

N **42.10.4.1.5 Bonding.**

N **42.10.4.1.5.1** All metallic components and vehicle or cart chassis shall be electrically bonded to prevent a difference in their electrostatic potential. [**407:**6.1.5.1]

N **42.10.4.1.5.2** Such bonding shall be inherent to the installation or by physical application of a suitable bonding mechanism. [**407:**6.1.5.2]

N **42.10.4.1.5.3** A provision shall be provided on the vehicle to bond the tank to a fill pipe or loading rack as specified in 42.10.4.2.11.10.1. [**407:**6.1.5.3]

N **42.10.4.1.5.4** Cables shall be provided on the vehicle or cart to allow the bonding operations specified in 42.10.2.2.5. [**407:**6.1.5.4]

N **42.10.4.1.6 Electrical System.**

N **42.10.4.1.6.1 Battery Compartments.** Batteries that are not in engine compartments shall be securely mounted in compartments to prevent accidental arcing. [**407:**6.1.6.1]

N **42.10.4.1.6.1.1** The compartment shall be separate from fueling equipment. [**407:**6.1.6.1.1]

N **42.10.4.1.6.1.2** Suitable shielding shall be provided to drain possible fuel spillage or leakage away from the compartment. [**407:**6.1.6.1.2]

N **42.10.4.1.6.1.3** The compartment shall be provided with a vent at the top of the compartment. [**407:**6.1.6.1.3]

N **42.10.4.1.6.2 Wiring.** Wiring shall be of adequate size to provide the required current-carrying capacity and mechanical strength. [**407:**6.1.6.2]

N **42.10.4.1.6.2.1** Wiring shall be installed to provide protection from physical damage and from contact with spilled fuel either by its location or by enclosing it in metal conduit or other oil-resistant protective covering. [**407:**6.1.6.2.1]

N **42.10.4.1.6.2.2** All circuits shall have overcurrent protection. [**407:**6.1.6.2.2]

N **42.10.4.1.6.2.3** Junction boxes shall be weatherproofed. [**407:**6.1.6.2.3]

N **42.10.4.1.6.2.4** The vehicle shall be equipped with a battery disconnect switch. [**407:**6.1.6.2.4]

The intent of the battery disconnect switch is to provide a means to remove power in the event of an emergency.

N **42.10.4.1.6.3** Spark plugs and other exposed terminal connections shall be insulated to prevent sparking in the event of contact with conductive materials. [**407:**6.1.6.3]

N **42.10.4.1.6.4*** Motors, alternators, generators, and their associated control equipment located outside of the engine compartment or vehicle cab shall be of a type listed for use in accordance with *NFPA 70*, Class I, Division 1, Group D locations. [**407:**6.1.6.4]

N **A.42.10.4.1.6.4** Electrical equipment contained in aircraft fuel servicing vehicles or cart engine compartments and located 460 mm (18 in.) or more above ground can be permitted to be of the general-purpose type. [**407:**A.6.1.6.4]

N **42.10.4.1.6.5** Electrical equipment and wiring located within a closed compartment shall be of a type listed for use in accordance with *NFPA 70*, Class I, Division 1, Group D locations. [**407:**6.1.6.5]

N **42.10.4.1.6.6** Lamps, switching devices, and electronic controls, other than those covered in 42.10.4.1.6.4 and 42.10.4.1.6.5, shall be of the enclosed, gasketed, weatherproof type. [**407:**6.1.6.6]

Electronic controls could include electronic gauges, monitoring devices, and the like.

N **42.10.4.1.6.7** Other electrical components not covered in 42.10.4.1.6.4 through 42.10.4.1.6.6 shall be of a type listed for use in accordance with *NFPA 70*, Class I, Division 2, Group D locations. [**407:**6.1.6.7]

N **42.10.4.1.6.8** Electronic equipment shall not be installed in compartments with other equipment that can produce flammable vapors, unless permitted by *NFPA 70*. [**407:**6.1.6.8]

N **42.10.4.1.6.9 Tractor Trailer Wiring.** Electrical service wiring between a tractor and trailer shall be designed for heavy-duty service. [**407:**6.1.6.9]

N **42.10.4.1.6.9.1** The connector shall be of the positive-engaging type. [**407:**6.1.6.9.1]

N **42.10.4.1.6.9.2** The trailer receptacle shall be mounted securely. [**407:**6.1.6.9.2]

N **42.10.4.1.7 Control of Fuel Flow.**

N **42.10.4.1.7.1*** The valve that controls the flow of fuel to an aircraft shall have a deadman control. [**407:**6.1.7.1]

N **A.42.10.4.1.7.1** See A.42.10.3.1.7.1. [**407:**A.6.1.7.1]

N **42.10.4.1.7.2** The fuel flow control valve shall be one of the following:

(1) The hydrant pit valve
(2) At the tank outlet on a tank vehicle
(3) A separate valve on the tank vehicle
(4) On the hose nozzle for overwing servicing

[**407:**6.1.7.2]

N **42.10.4.1.7.3** Deadman controls shall be designed to preclude defeating their intended purpose. [**407:**6.1.7.3]

N **42.10.4.1.7.4 Pressure Fuel Servicing System Controls.**

N **42.10.4.1.7.4.1** The system shall be designed to minimize surge pressure. [**407:**6.1.7.4.1]

N **42.10.4.1.7.4.2*** The overshoot shall not exceed 5 percent of actual flow rate in L/min (gal/min) at the time the deadman is released. [**407:**6.1.7.4.2]

N **A.42.10.4.1.7.4.2** See A.42.10.3.1.7.2.2. [**407:**A.6.1.7.4.2]

N **42.10.4.1.7.4.3** The control valve shall be located and designed so that it will not be rendered inoperative by a surface accident, power failure, or spill. [**407:**6.1.7.4.3]

N **42.10.4.1.7.4.4** The control valve shall be fail-safe by closing completely in the event of control power loss. [**407:**6.1.7.4.4]

N **42.10.4.1.7.5** On tank full trailer or tank semitrailer vehicles, the use of a pump in the tractor unit with flexible connections to the trailer shall be prohibited unless one of the following conditions exists:

(1) Flexible connections are arranged above the liquid level of the tank in order to prevent gravity or siphon discharge in case of a break in the connection or piping.
(2) The cargo tank discharge valves required by 42.10.4.1.7.1 are arranged to be normally closed and to open only when the brakes are set and the pump is engaged.

[**407:**6.1.7.5]

N **42.10.4.1.7.6 Air Elimination.** Aircraft fuel servicing tank vehicles having a positive displacement product pump shall be equipped with a product tank low-level shutdown system that prevents air from being ingested into the fueling system. [**407:**6.1.7.6]

This paragraph applies only to aircraft fuel servicing tank vehicles that have a positive displacement product pump. A low-level shutdown system is not required for tank vehicles that have a centrifugal pump. Unlike positive displacement pumps, centrifugal pumps lose prime and cavitate when the tank is emptied of product. As air enters the suction port, pump output effectively stops, thus presenting no threat of dispensing air, in lieu of fuel, into the aircraft.

N **42.10.4.1.8 Filters and Ancillary Equipment.**

N **42.10.4.1.8.1 Cabinets.**

N **42.10.4.1.8.1.1** All cabinets, other than those housing electronic equipment, shall be vented to prevent the accumulation of fuel vapors. *(See 42.10.4.1.6.)* [**407:**6.1.8.1.1]

N **42.10.4.1.8.1.2** All cabinets, other than those housing electronic equipment, shall be constructed of noncombustible materials. *(See 42.10.4.1.6.)* [**407:**6.1.8.1.2]

N **42.10.4.1.8.2 Product Recovery Tanks.** The refueling system product recovery tank shall be equipped with a control that shuts down the vehicle's fuel dispensing system when the refueling system product recovery tank is three-quarters full. [**407:**6.1.8.2]

N **42.10.4.1.9 Emergency Fuel Shutoff Systems.**

N **42.10.4.1.9.1** The vehicle shall have at least two emergency shutoff controls, one mounted on each side of the vehicle. [**407:**6.1.9.1]

N **42.10.4.1.9.2** The emergency fuel shutoff controls shall be quick-acting to close the outlet valve in case of emergency. [**407:**6.1.9.2]

N **42.10.4.1.9.3** The emergency fuel shutoff controls shall be remote from the fill openings and discharge outlets and shall be operable from a ground level standing position. [**407:**6.1.9.3]

N **42.10.4.1.9.4** All vehicles or carts equipped with a top deck or elevating platform shall have an additional emergency shutoff control operable from the deck or platform. [**407:**6.1.9.4]

N **42.10.4.1.10 Fire Protection.**

N **42.10.4.1.10.1** Each aircraft fuel servicing tank vehicle shall have two listed fire extinguishers, each having a rating of at least 80-B:C, with one extinguisher mounted on each side of the vehicle. [**407:**6.1.10.1]

N **42.10.4.1.10.2** One listed fire extinguisher having a rating of at least 80-B:C shall be installed on each hydrant fuel servicing vehicle or cart. [**407:**6.1.10.2]

N **42.10.4.1.10.3** Extinguishers shall be readily accessible from the ground. [**407:**6.1.10.3]

N **42.10.4.1.10.4** The area of the paneling or tank adjacent to or immediately behind the extinguisher(s) on fueling vehicles or carts shall be painted a color contrasting with that of the extinguisher. [**407:**6.1.10.4]

N **42.10.4.1.10.5** Extinguishers shall be kept clear of elements such as ice and snow. [**407:**6.1.10.5]

N **42.10.4.1.10.6** Extinguishers located in enclosed compartments shall be readily accessible. [**407:**6.1.10.6]

N **42.10.4.1.10.7** The locations of extinguishers in enclosed compartments shall be marked clearly in letters of a contrasting color at least 50 mm (2 in.) high. [**407:**6.1.10.7]

N **42.10.4.1.10.8 Smoking Equipment.**

N **42.10.4.1.10.8.1*** Smoking equipment, such as cigarette lighter elements and ashtrays, shall not be provided. [**407:**6.1.10.8.1]

N **A.42.10.4.1.10.8.1** It is not the intent of 42.10.4.1.10.8.1 to prohibit 12 V power outlets. The intent is to prohibit glowing elements. [**407:**A.6.1.10.8.1]

N **42.10.4.1.10.8.2** If a vehicle includes smoking equipment, it shall be removed or rendered inoperable. [**407:**6.1.10.8.2]

N **42.10.4.1.10.8.3** Subsection 42.10.4.1.10.8.2 shall be retroactive to existing vehicles. [**407:**6.1.10.8.3]

See the commentary that follows 42.10.1 regarding retroactive requirements.

N **42.10.4.1.11 Marking and Labeling.**

N **42.10.4.1.11.1** Aircraft fueling vehicles shall be marked with the name of the operator or the responsible organization. [**407:**6.1.11.1]

N **42.10.4.1.11.2** The marking shall be approved, legible signs on both sides of the exterior of the vehicle. [**407:**6.1.11.2]

N **42.10.4.1.11.3 Signage.** Each aircraft fuel servicing vehicle or cart shall have a signage viewable from all sides of the vehicle. [**407:**6.1.11.3]

N **42.10.4.1.11.3.1** Signs shall have letters at least 75 mm (3 in.) high. [**407:**6.1.11.3.1]

N **42.10.4.1.11.3.2** Signs shall be of a color contrasting sharply with the sign background for visibility. [**407:**6.1.11.3.2]

N **42.10.4.1.11.3.3** The words "FLAMMABLE," "NO SMOKING," and the name of the product carried, such as JET A, JET B, GASOLINE, or AVGAS, shall appear on each sign. [**407:**6.1.11.3.3]

N **42.10.4.1.11.4 Emergency Fuel Shutoff Signs.**

N **42.10.4.1.11.4.1** Each emergency fuel shutoff station location shall be placarded EMERGENCY FUEL SHUTOFF in letters at least 50 mm (2 in.) high. [**407:**6.1.11.4]

N **42.10.4.1.11.4.2** The method of operation shall be indicated by an arrow or by the word PUSH or PULL, as appropriate. [**407:**6.1.11.4.2]

N **42.10.4.1.11.4.3** Any action necessary to gain access to the shutoff device (e.g., BREAK GLASS) shall be shown clearly. [**407:**6.1.11.4.3]

N **42.10.4.1.11.4.4** Lettering shall be of a color contrasting sharply with the placard background for visibility. [**407:**6.1.11.4.4]

N **42.10.4.1.11.4.5** Placards shall be weather resistant. [**407:**6.1.11.4.5]

N **42.10.4.1.11.5** A "NO SMOKING" sign shall be posted prominently in the cab of every aircraft fuel servicing vehicle. [**407:**6.1.11.5]

N **42.10.4.1.11.6** Hazardous material placards meeting the requirements of 49 CFR 172.504 or equivalent shall be displayed on all four sides of fuel servicing tank vehicles. [**407:**6.1.11.6]

Vehicles that operate only on private property are not usually subject to the requirements of 49 CFR. However, it is accepted industry practice to provide hazardous material placards for the benefit of first responders.

N **42.10.4.1.12 Drive Train.**

N **42.10.4.1.12.1** Propulsion or power engine equipment shall be in a compartment housing that shall minimize the hazard of fire in the event of leakage or spillage of fuel during the servicing of an aircraft. [**407:**6.1.12.1]

N **42.10.4.1.12.2** The engine air intake shall retain the manufacturer's configuration to prevent the emission of flame in case of backfiring. [**407:**6.1.12.2]

N **42.10.4.1.12.3** Where provided, the sediment bowl in the fuel supply line shall be of steel or material of equivalent fire resistance. [**407:**6.1.12.3]

N **42.10.4.1.12.4** Full trailers and semitrailers, except tow carts with a gross vehicle weight rating (GVWR) under 1360 kg (3000 lb), shall be equipped with service brakes on all wheels. [**407:**6.1.12.4]

N **42.10.4.1.12.5** All full trailers and semitrailers, including tow carts with a GVWR under 1360 kg (3000 lb), shall be equipped with parking brakes. [**407:**6.1.12.5]

N **42.10.4.1.12.6** Self-propelled aircraft fuel servicing vehicles shall have an integral system or device that prevents the vehicle from being moved unless all of the following conditions are met:

(1) All fueling nozzles and hydrant couplers are properly stowed.
(2) All mechanical lifts are lowered to their stowed position.
(3) Bottom-loading couplers have been disconnected from the vehicle.

[**407:**6.1.12.6]

N **42.10.4.1.12.7** The vehicle shall have a means to override the system or device required by 42.10.4.1.12.6 so that the vehicle can be moved during an emergency. [**407:**6.1.12.7]

N **42.10.4.1.12.7.1** The override control shall be clearly marked and accessible. [**407:**6.1.12.7.1]

N **42.10.4.1.12.7.2** A light to indicate activation of the override shall be located in the cabin and visible outside. [**407:**6.1.12.7.2]

N **42.10.4.1.12.7.3** The override control shall be secured in the normal position with a breakaway seal. [**407:**6.1.12.7.3]

N **42.10.4.1.12.7.4** The override control shall deactivate the fueling system. [**407:**6.1.12.7.4]

N **42.10.4.1.13 Exhaust System.**

N **42.10.4.1.13.1*** The engine exhaust system shall be designed, located, and installed to minimize the hazard of fire in the event of any of the following:

(1) Leakage of fuel from the vehicle or cart (where applicable) fuel tank or fuel system
(2) Leakage from the fuel dispensing system of the vehicle or cart
(3) Spillage or overflow of fuel from the vehicle or cart (if applicable) fuel tank or the cargo tank
(4) Spillage of fuel during the servicing of an aircraft

[**407:**6.1.13.1]

N **A.42.10.4.1.13.1** Wherever possible, flexible engine exhaust pipe should be avoided due to the potential of breaking. Where used, stainless steel is preferable, and the length should be limited to approximately 460 mm (18 in.). [**407:**A.6.1.13.1]

N **42.10.4.1.13.2** Exhaust system components shall be secured and located clear of components carrying flammable liquids and separated from any combustible materials used in the construction of the vehicle. [**407:**6.1.13.2]

N **42.10.4.1.13.3** Suitable shielding shall be provided to drain possible fuel spillage or leakage away from exhaust system components safely. [**407:**6.1.13.3]

N **42.10.4.1.13.3.1** Diesel particulate filter (DPF) regeneration system piping shall be shielded from the engine discharge manifold to the outlet at the tailpipe. [**407:**6.1.13.3.1]

N **42.10.4.1.13.3.2** DPF regeneration–equipped vehicles shall have a listed diffuser installed at the outlet of the exhaust tailpipe. [**407:**6.1.13.3.2]

N **42.10.4.1.13.4** Exhaust gases shall not be discharged where they could ignite fuel vapors that could be released during normal operations or by accidental spillage or by leakage of fuel. [**407:**6.1.13.4]

N **42.10.4.1.13.4.1** DPF regeneration–equipped vehicles shall have a lockout mode that will prevent automatic regeneration when these vehicles are operated within 30 m (100 ft) of aircraft parking areas. [**407:**6.1.13.4.1]

N **42.10.4.1.13.5** A muffler (or silencer) cutout shall not be provided. [**407:**6.1.13.5]

N **42.10.4.1.13.6** Carbureted gasoline-powered engines on fuel servicing vehicles shall be provided with flame- and spark-arresting exhaust systems. [**407:**6.1.13.6]

N **42.10.4.1.13.7*** Non-turbo-charged diesel engines on fuel servicing vehicles shall be equipped with flame- and spark-arresting exhaust systems. [**407:**6.1.13.7]

N **A.42.10.4.1.13.7** The requirement for spark-arresting exhaust systems is not intended to extend to diesel engines equipped with turbochargers. The USDA Forest Service, the governmental body that regulates the spark arrester standard, clearly identifies that all diesel engines with a turbocharger and no waste gate (also clearly identified therein) are exempt from the requirements to have an additional spark-arresting device. [**407:**A.6.1.13.7]

N **42.10.4.2 Operations.**

N **42.10.4.2.1 Security.**

N **42.10.4.2.1.1 Parking of Aircraft Fuel Servicing Tank Vehicles.** Parking areas for unattended aircraft fuel servicing tank vehicles shall be arranged to provide the following:

(1) Dispersal of the vehicles in the event of an emergency
(2) A minimum of 3 m (10 ft) of clear space between parked vehicles for accessibility for fire control purposes
(3) Prevention of any leakage from draining to an adjacent building or storm drain that is not suitably designed to handle fuel
(4) A minimum of 15 m (50 ft) from any parked aircraft and buildings other than maintenance facilities and garages for fuel servicing tank vehicles

[**407:**6.2.1.1]

N **42.10.4.2.1.2 Parking of Aircraft Fuel Servicing Hydrant Vehicles and Carts.** Parking areas for unattended aircraft fuel servicing hydrant vehicles or carts shall be arranged to provide the following:

(1) Dispersal of the vehicles in the event of an emergency
(2) Prevention of any leakage from draining to an adjacent building or storm drain that is not suitably designed to handle fuel

[**407:**6.2.1.2]

N **42.10.4.2.1.3*** The authority having jurisdiction shall determine the suitability of tunnels, enclosed roadways, or other limited access areas for use by fuel servicing vehicles. [**407:**6.2.1.3]

N **A.42.10.4.2.1.3** The use of tunnels or enclosed roadways is discouraged. Where there is no alternate route, and the fuel servicing vehicle requires the use of a tunnel or enclosed roadway, the authority having jurisdiction should examine the following considerations:

(1) Length
(2) Clearances
(3) Fixed fire suppression or extinguishing systems
(4) Frequency of use
(5) Ventilation
(6) Overlying structures and operations
(7) Other traffic
(8) Fire department access
(9) Emergency egress
(10) Drainage
(11) Other conditions

[**407:**A.6.2.1.3]

With the growth of airports, traffic, and roadways, safeguards are needed to protect the public and airport operations from potential hazards due to an incident involving a fuel servicing vehicle in a tunnel, such as a spill or a fire. The use of tunnels or enclosed roadways is necessary at certain times and locations; however, the AHJ should determine the suitability of using such tunnels, based on various risk factors.

N **42.10.4.2.2 Training. (Reserved)**

N **42.10.4.2.3 Prevention and Control of Spills. (Reserved)**

N **42.10.4.2.4 Emergency Fuel Shutoff. (Reserved)**

N **42.10.4.2.5 Bonding. (Reserved)**

N **42.10.4.2.6 Control of Fuel Flow.**

N **42.10.4.2.6.1** The fueling operator shall monitor the fueling operation. [**407:**6.2.6.1]

N **42.10.4.2.6.2** During overwing fueling, the operator shall monitor the fill port. [**407:**6.2.6.2]

N **42.10.4.2.7 Fire Protection. (Reserved)**

N **42.10.4.2.8 Maintenance.**

N **42.10.4.2.8.1** Aircraft fuel servicing vehicles or carts shall not be operated unless they are in proper repair and free of accumulations of grease, oil, or other combustibles. [**407:**6.2.8.1]

N **42.10.4.2.8.2** Leaking vehicles or carts shall be removed from service, defueled, and parked in a safe area until repaired. [**407:**6.2.8.2]

N **42.10.4.2.8.3** Maintenance and servicing of aircraft fuel servicing vehicles and carts shall be performed outdoors or in a building approved for the purpose. [**407:**6.2.8.3]

N **42.10.4.2.8.4** At least monthly the operator shall perform a check to ensure complete closure of the bottom-loading valve on the tank vehicle. [**407:**6.2.8.4]

N **42.10.4.2.9 Aircraft Fueling Hose. (Reserved)**

N **42.10.4.2.10 Exhaust System.**

N **42.10.4.2.10.1** All vehicles that have engines equipped with an exhaust after-treatment device, such as a DPF, that requires the filter to be cleaned at high temperature (regenerated) while installed on the vehicle shall meet the requirements of 42.10.4.2.10.2 through 42.10.4.2.10.10. [**407:**6.2.10.1]

N **42.10.4.2.10.2** DPF regeneration shall be performed only in area(s) designated by the authority having jurisdiction. [**407:**6.2.10.2]

N **42.10.4.2.10.3** DPF regeneration shall not be performed within 30 m (100 ft) of any aircraft refueling operations. [**407:**6.2.10.3]

N **42.10.4.2.10.4* Vehicle Regeneration Area.**

Aircraft refueling vehicles with diesel particulate filter (DPF) regeneration are being used on airfields. The language addresses the operational issues with the regeneration sequence that will provide a measure of safety for the fuel handlers, as well as the airfields on which they operate. These units have the potential for introducing an ignition source due to the extremely high temperatures generated by the exhaust system. Exhaust gas temperatures, when in the regeneration mode, reach over 1200°F (649°C) inside the system, and exhaust gases are over 700°F (371°C). Both of these temperatures are hot enough to ignite Jet-A vapors or fuel (if dripped onto exhaust system components).

N **A.42.10.4.2.10.4** The size of the DPF regeneration area depends on the equipment being used (fleet size). The authority having jurisdiction should designate the size and number of DPF regeneration pads and determine whether a centralized facility is advantageous. [**407:**A.6.2.10.4]

N **42.10.4.2.10.4.1** The immediate area surrounding the DPF exhaust outlet shall be concrete or other high temperature–resistant material and shall be clear of any grass, soil, or flammable materials. [**407:**6.2.10.4.1]

N **42.10.4.2.10.4.2** The area shall be in a remote location that is a minimum of 30 m (100 ft) from the nearest aircraft parking location, airport terminal, or flammable storage or a minimum of 15 m (50 ft) from any other building. [**407:**6.2.10.4.2]

N **42.10.4.2.10.4.3** The area shall be clearly marked with a minimum 61 cm by 30 cm (2 ft by 1 ft) sign reading “Vehicle DPF Regeneration Area,” which shall have letters at least 75 mm (3 in.) high and shall be of a color contrasting sharply with the sign background for visibility. [**407:**6.2.10.4.3]

N **42.10.4.2.10.5** The regeneration cycle shall be performed only by trained personnel, who shall remain with the vehicle until the regeneration cycle is complete. [**407:**6.2.10.5]

N **42.10.4.2.10.6** The vehicle shall be visually inspected for any signs of fluid leaks under or around the vehicle before regeneration is initiated. [**407:**6.2.10.6]

N **42.10.4.2.10.7** DPF regeneration shall not be initiated if there are any signs of any fluid leaks on or beneath the vehicle. [**407:**6.2.10.7]

N **42.10.4.2.10.8** Once a regeneration cycle is started, it shall be completed without interruption. [**407:**6.2.10.8]

N **42.10.4.2.10.9** After the regeneration process is successfully completed, the vehicle shall be permitted to return to normal service. [**407:**6.2.10.9]

N **42.10.4.2.10.10** Problems occurring during the regeneration cycle shall be corrected prior to the vehicle returning to normal service. [**407:**6.2.10.10]

N **42.10.4.2.10.11** Aircraft refueling operations shall not be initiated if the regenerative system indicates regeneration is required. [**407:**6.2.10.11]

N **42.10.4.2.11 Loading and Unloading.**

N **42.10.4.2.11.1** Aircraft fuel servicing tank vehicles shall be loaded only at an approved loading rack. [**407:**6.2.11.1]

N **42.10.4.2.11.2** Aircraft fuel servicing tank vehicles shall not be loaded from a hydrant pit, unless permitted by the authority having jurisdiction under emergency circumstances. [**407:**6.2.11.2]

N **42.10.4.2.11.3** Filling of the vehicle cargo tank shall be under the observation and control of a qualified and authorized operator at all times. [**407:**6.2.11.3]

N **42.10.4.2.11.4** The required deadman and automatic overfill controls shall be in normal operating condition during the filling operation. [**407:**6.2.11.4]

N **42.10.4.2.11.5** The controls shall not be blocked open or otherwise bypassed. [**407:**6.2.11.5]

N **42.10.4.2.11.6** The engine of the tank vehicle shall be shut off before starting to fill the tank. [**407:**6.2.11.6]

N **42.10.4.2.11.7** To prevent leakage or overflow from expansion of the contents due to a rise in atmospheric temperature or direct exposure to the sun, no cargo tank or compartment shall be loaded to the point where it is liquid full. [**407:**6.2.11.7]

N **42.10.4.2.11.7.1** No cargo tank or compartment shall be loaded above the rated net capacity, as specified by the manufacturer’s data plate. [**407:**6.2.11.7.1]

N **42.10.4.2.11.7.2** Space for thermal expansion, in no case less than 3 percent of the tank volume, shall be provided to prevent leakage. [**407:**6.2.11.7.2]

N **42.10.4.2.11.8** The driver, operator, or attendant of any tank vehicle shall not remain in the vehicle but shall not leave the vehicle unattended during the loading or unloading process. [**407:**6.2.11.8]

N **42.10.4.2.11.8.1** Delivery hose, when attached to a tank vehicle, shall be considered to be a part of the tank vehicle. [**407:**6.2.11.8.1]

N **42.10.4.2.11.9** No fuel shall be transferred to or from any tank vehicle until the parking brake and wheel chocks have been set to prevent motion of the vehicle. [**407:**6.2.11.9]

N **42.10.4.2.11.10 Top Loading.**

N **42.10.4.2.11.10.1** Where loading tank trucks through open domes, a bond shall be established between the loading piping and the cargo tank to equalize potentials. [**407:**6.2.11.10.1]

N **42.10.4.2.11.10.2** The bond connection shall be made before the dome is opened and shall be removed only after the dome is closed. [**407:**6.2.11.10.2]

N **42.10.4.2.11.10.3** Drop tubes attached to loading assemblies extending into the vehicle tank shall extend to the bottom of the tank and shall be maintained in that position until the tank is loaded to provide submerged loading and avoid splashing or free falling of fuel through the tank atmosphere. [**407:**6.2.11.10.3]

N 42.10.4.2.11.10.4 Splash filling shall be prohibited. [**407:**6.2.11.10.4]

N 42.10.4.2.11.10.5 The flow rate into the tanks shall not exceed 25 percent of the maximum flow until the outlet is fully covered. [**407:**6.2.11.10.5]

N 42.10.4.2.11.10.6 Fixed drop tubes permanently mounted in the vehicle tank shall extend to the bottom of the tank or to the inside of the sump to maintain submerged loading and to avoid splashing of the fuel. [**407:**6.2.11.10.6]

N 42.10.4.2.11.10.7 The level in the tank shall be visually monitored at all times during top loading. [**407:**6.2.11.10.7]

N 42.10.4.2.11.11 Bottom Loading.

N 42.10.4.2.11.11.1 A bonding connection shall be made between the cargo tank and the loading rack before any fuel connections are made and shall remain in place throughout the loading operation. [**407:**6.2.11.11.1]

N 42.10.4.2.11.11.2 The operator shall initiate fuel flow by means of a dead-man control device. [**407:**6.2.11.11.2]

N 42.10.4.2.11.11.3 The operator shall ensure that the automatic high-level shutoff system is functioning properly for each compartment shortly after flow has been initiated. [**407:**6.2.11.11.3]

N 42.10.4.2.12 Positioning of Aircraft Fuel Servicing Vehicles and Carts During Fueling.

N 42.10.4.2.12.1 Aircraft fuel servicing vehicles and carts shall be positioned so that a clear path of egress from the aircraft for fuel servicing vehicles shall be maintained. [**407:**6.2.12.1]

N 42.10.4.2.12.2 The propulsion or pumping engine of aircraft fuel servicing vehicles or carts shall not be positioned under the wing of the aircraft during overwing fueling or where aircraft fuel system vents are located on the upper wing surface. [**407:**6.2.12.2]

N 42.10.4.2.12.3 Aircraft fuel servicing vehicles or carts shall not be positioned within a 3 m (10 ft) radius of aircraft fuel system vent openings. [**407:**6.2.12.3]

N 42.10.4.2.12.4 Parking brakes and chocks shall be set on all fuel servicing vehicles or carts before operators begin the fueling operation. [**407:**6.2.12.4]

N 42.10.4.2.12.5 During overwing aircraft fuel servicing where aircraft fuel system vents are located on the upper wing surface, equipment shall not be positioned under the trailing edge of the wing. [**407:**6.2.12.5]

N 42.10.5 Rooftop Heliports.

This subsection, along with 42.10.2 (General Requirements) and 42.10.3 (Aviation Fueling Facilities), applies to fixed fueling facilities used to service aircraft on rooftop heliports. These facilities require special considerations due to the occupancy below the rooftop heliport and inaccessibility to fire fighters. Exhibit 42.24 shows an example of a rooftop heliport.

Exhibit 42.24

Rooftop heliport.

N 42.10.5.1 Design and Construction.

N 42.10.5.1.1 General Requirements.

N 42.10.5.1.1.1 System Design and Approval.

N 42.10.5.1.1.1.1 Fueling on rooftop heliports shall be permitted only where approved by the authority having jurisdiction. [**407:**7.1.1.1.1]

N 42.10.5.1.1.1.2 In addition to the special requirements in this chapter, the heliport shall comply with the requirements of NFPA 418. [**407:**7.1.1.1.2]

N 42.10.5.1.1.1.3 Facilities for dispensing fuel with a flash point below 37.8°C (100°F) shall not be permitted at any rooftop heliport. [**407:**7.1.1.1.3]

Minimizing the vaporization of fuels is important. When facilities that dispense fuels with flash points below 100°F (37.8°C) are exposed to the higher ambient temperatures associated with rooftop heliports, the rate of vaporization and the potential for ignition of the vapors increases.

N 42.10.5.1.1.1.4 In addition to the special requirements of this chapter, the fuel storage, piping, and dispensing system shall comply with the requirements of NFPA 30 and with applicable portions of this standard. [**407:**7.1.1.1.4]

N 42.10.5.1.1.1.5 The entire system shall be designed so that no part of the system is subjected to pressure above its working pressure. [**407:**7.1.1.1.5]

N 42.10.5.1.2 Fuel Storage Tanks.

N 42.10.5.1.2.1 Fuel storage tanks and components shall comply with the requirements of NFPA 30. [**407:**7.1.2.1]

N 42.10.5.1.2.2 The fuel storage system shall be located at or below ground level. [**407:**7.1.2.2]

The location of fuel storage is required to conform to Chapter 66 and NFPA 30. All locations must be approved by the AHJ.

N **42.10.5.1.3 Pumps and Piping Systems.**

N **42.10.5.1.3.1** Pumps and piping systems shall comply with the requirements of NFPA 30. [**407:**7.1.3.1]

N **42.10.5.1.3.2** Pumps shall be located at or below ground level. [**407:**7.1.3.2]

N **42.10.5.1.3.3** Relay pumping shall not be permitted. [**407:**7.1.3.3]

N **42.10.5.1.3.4** Pumps installed outside of buildings shall be located not less than 1.5 m (5 ft) from any building opening. [**407:**7.1.3.4]

Building openings are considered to be any breach in the building envelope that is open to the atmosphere and capable of passing air, vapor, liquid mixtures, or a combination thereof. Building openings include doors, windows, ventilation intakes and discharges, combustion air intakes, conduits, drain lines, and all other wall penetrations.

N **42.10.5.1.3.5** Pumps shall be anchored and protected against physical damage from collision. [**407:**7.1.3.5]

N **42.10.5.1.3.6** Pumps installed within a building shall be in a separate room with no opening into other portions of the building. [**407:**7.1.3.6]

N **42.10.5.1.3.7** The pump room shall be adequately ventilated. [**407:**7.1.3.7]

N **42.10.5.1.3.8** Electrical wiring and equipment in pump rooms shall conform to the requirements of *NFPA 70*, Article 515. [**407:**7.1.3.8]

N **42.10.5.1.3.9** Piping above grade shall be steel and, unless otherwise approved by the authority having jurisdiction, shall be suitably cased or shall be installed in a duct or chase. [**407:**7.1.3.9]

N **42.10.5.1.3.9.1** Such piping duct or chase shall be constructed so that a piping failure does not result in the entry of fuel liquid or vapor entering the building. [**407:**7.1.3.9.1]

N **42.10.5.1.3.9.2** All pipe casings, ducts, and chases shall be drained. [**407:**7.1.3.9.2]

N **42.10.5.1.3.10** Piping shall be anchored and shall be protected against physical damage for a height of at least 2.4 m (8 ft) above the ground. [**407:**7.1.3.10]

N **42.10.5.1.3.11** An isolation valve shall be installed on the suction and discharge piping of each pump. [**407:**7.1.3.11]

N **42.10.5.1.3.12** A check valve shall be installed at the base of each fuel piping riser to automatically prevent the reverse flow of the fuel into the pump room in the event of pump seal failure, pipe failure, or other malfunction. [**407:**7.1.3.12]

N **42.10.5.1.3.13** Piping within buildings shall comply with 42.10.3.1.3.3. [**407:**7.1.3.13]

N **42.10.5.1.4 Hose and Nozzles. (Reserved)**

N **42.10.5.1.5 Electrostatic Bonding. (Reserved)**

N **42.10.5.1.6 Electrical Systems. (Reserved)**

N **42.10.5.1.7 Control of Fuel Flow. (Reserved)**

N **42.10.5.1.8 Filters and Ancillary Equipment. (Reserved)**

N **42.10.5.1.9 Emergency Fuel Shutoff Systems.**

N **42.10.5.1.9.1** At least two emergency fuel shutoff stations located on opposite sides of the heliport at exitways or at similar locations shall be provided. [**407:**7.1.9.1]

N **42.10.5.1.9.2** An additional emergency fuel shutoff station shall be located at ground level and shall be located at least 3 m (10 ft) from the pump but no further than 6 m (20 ft). [**407:**7.1.9.2]

N **42.10.5.1.10 Fire Protection.** Fire protection shall conform to the requirements of NFPA 418. [**407:**7.1.10]

N **42.10.5.1.11 Marking and Labeling. (Reserved)**

N **42.10.5.2 Operations.**

N **42.10.5.2.1 Security. (Reserved)**

N **42.10.5.2.2 Personnel.** All heliport personnel shall be trained in the use of the available fire extinguishers and fixed extinguishing systems. [**407:**7.2.2]

N **42.10.5.2.3 Prevention and Control of Spills. (Reserved)**

N **42.10.5.2.4 Emergency Fuel Shutoff.** All heliport personnel shall be trained in the operation of emergency fuel shutoff controls. [**407:**7.2.4]

N **42.10.5.2.5 Bonding. (Reserved)**

N **42.10.5.2.6 Monitoring of Fuel Flow. (Reserved)**

N **42.10.5.2.7 Fire Protection. (Reserved)**

N **42.10.5.2.8 Maintenance. (Reserved)**

N **42.10.5.2.9 Aircraft Fueling Hose. (Reserved)**

N **42.10.6 Self-Service Aircraft Fueling.**

This section, along with 42.10.2 (General Requirements) and 42.10.3 (Aviation Fueling Facilities), applies to fixed fueling facilities used for self-service aircraft fueling. These facilities require special considerations due to the risk of accident or misuse by untrained persons. Exhibit 42.25 shows a fixed fueling facility used for self-service aircraft fueling.

N **42.10.6.1 Design and Construction.**

N **42.10.6.1.1 General Requirements.**

N **42.10.6.1.1.1 System Design and Approval.** Self-service fueling shall be permitted, subject to the approval of the authority having jurisdiction. [**407:**8.1.1.1]

N **42.10.6.1.1.2** Dispensing devices shall be located on an island to protect against collision damage or shall be protected with pipe bollards or other approved protection. [**407:**8.1.1.2]

Exhibit 42.25

Self-service aircraft fueling.

N **42.10.6.1.2 Fuel Storage Tanks.** In addition to the special requirements of this chapter, the fuel storage system shall comply with the requirements of NFPA 30. [**407:**8.1.2]

N **42.10.6.1.3 Pumps and Piping Systems.**

N **42.10.6.1.3.1** In addition to the special requirements of this chapter, the piping and dispensing system shall comply with the requirements of NFPA 30. [**407:**8.1.3.1]

N **42.10.6.1.3.2** Listed or approved dispensing devices shall be used. [**407:**8.1.3.2]

N **42.10.6.1.4 Hose and Nozzles. (Reserved)**

N **42.10.6.1.5 Electrostatic Bonding. (Reserved)**

N **42.10.6.1.6 Electrical Systems. (Reserved)**

N **42.10.6.1.7 Control of Fuel Flow. (Reserved)**

N **42.10.6.1.8 Filters and Ancillary Equipment. (Reserved)**

N **42.10.6.1.9 Emergency Fuel Shutoff Systems.**

N **42.10.6.1.9.1** The controls shall be designed to allow only authorized personnel to reset the system after an emergency fuel shutoff. [**407:**8.1.9.1]

N **42.10.6.1.9.2** The emergency fuel shutoff controls shall be installed in a location acceptable to the authority having jurisdiction and shall be more than 6 m (20 ft) but less than 30 m (100 ft) from the dispensers. [**407:**8.1.9.2]

Prior to the 2017 edition of NFPA 407, the emergency fuel shutoff controls (EFSO) were required to be "near" the fuel pump. This was revised to specify both a minimum and a maximum distance from the fuel dispensers to ensure that the EFSO is located away from the potential spill location but within a maximum travel distance.

See the commentary that follows 42.10.1 regarding retroactivity of requirements.

N **42.10.6.1.9.3** A clearly identified means to notify the fire department shall be provided and shall be located in the immediate vicinity of each emergency fuel shutoff control. [**407:**8.1.9.3.]

N **42.10.6.1.9.4** Dispensing devices shall have a listed or approved emergency shutoff valve, incorporating a fusible link or other thermally actuated device designed to close automatically in case of fire. [**407:**8.1.9.4]

N **42.10.6.1.9.5** The emergency shutoff valve also shall incorporate a shear section that automatically shuts off the flow of fuel due to severe impact. [**407:**8.1.9.5]

N **42.10.6.1.9.6** The emergency shutoff valve shall be rigidly mounted at the base of the dispenser in accordance with the manufacturer's instructions. [**407:**8.1.9.6]

N **42.10.6.1.10 Fire Protection.**

N **42.10.6.1.10.1** Each facility shall have a minimum of one fire extinguisher with a rating of at least 80-B:C located at the dispenser. [**407:**8.1.10.1]

N **42.10.6.1.10.2** At least one fire extinguisher with a rating of at least 80-B:C shall be provided at each emergency fuel shutoff control. [**407:**8.1.10.2]

N **42.10.6.1.11 Marking and Labeling.**

N **42.10.6.1.11.1** Emergency instructions shall be conspicuously posted in the dispensing area and at the emergency fuel shutoff control. [**407:**8.1.11.1]

N **42.10.6.1.11.2** Emergency instructions shall incorporate the following or equivalent wording:

**EMERGENCY INSTRUCTIONS
IN CASE OF FIRE OR SPILL**

(1) Use emergency fuel shutoff.

(2) Report accident by calling (specify local fire emergency reporting number) on phone.

(3) Report address of site (list address of site here).

[**407:**8.1.11.2]

N **42.10.6.1.11.3 Operating Instructions.** Operating instructions shall be posted. [**407:**8.1.11.3]

N **42.10.6.1.11.4** The operating instructions shall include the following:

(1) Proper operation and use of all equipment
(2) Correct bonding procedures
(3) Procedures to be employed to dispense fuel safely
(4) Location and use of the emergency fuel shutoff controls
(5) Procedures to be used in the event of an emergency

[**407:**8.1.11.4]

N **42.10.6.2 Operations.**

N **42.10.6.2.1 Security.** Access to dispensing equipment shall be controlled by means of mechanical or electronic devices designed to resist tampering and to prevent access or use by unauthorized persons. [**407:**8.2.1]

N **42.10.6.2.2 Training. (Reserved)**

N **42.10.6.2.3 Prevention and Control of Spills. (Reserved)**

N **42.10.6.2.4 Emergency Fuel Shutoff. (Reserved)**

N **42.10.6.2.5 Bonding. (Reserved)**

N **42.10.6.2.6 Monitoring of Fuel Flow. (Reserved)**

N **42.10.6.2.7 Fire Protection. (Reserved)**

N **42.10.6.2.8 Maintenance. (Reserved)**

N **42.10.6.2.9 Occupancy.** The aircraft shall not be occupied during self-service fueling. [**407:**8.2.9]

42.11 Alternate Fuels

Section 42.11 contains provisions for refueling with alternate fuels derived from NFPA 52 and NFPA 58.

42.11.1 Compressed Natural Gas (CNG) Vehicular Fuel Systems. The design and installation of CNG engine fuel systems on vehicles of all types shall comply with NFPA 52, *Vehicular Gaseous Fuel Systems Code*, and Section 42.11.

Subsection 42.11.1 contains a reference to NFPA 52 and Section 42.11 for provisions for fueling vehicles with alternate fuels at motor fuel dispensing facilities that also dispense traditional motor fuels (Class I or Class II liquids).

Unless otherwise noted within NFPA 52, the provisions of NFPA 52 are not intended to be applied to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the document, except in those cases where the AHJ determines that the existing situation involves a distinct hazard to life or adjacent property.

42.11.1.1* Scope.

Δ **A.42.11.1.1** Natural gas is a flammable gas. It is colorless, tasteless, and nontoxic. It is a light gas, weighing about two-thirds as much as air. As used in the systems covered by this standard, it tends to rise and diffuses rapidly in air when it escapes from the system.

Natural gas burns in air with a luminous flame. At atmospheric pressure, the ignition temperature of natural gas–air mixtures has been reported to be as low as 900°F (482°C). The flammable limits of natural gas–air mixtures at atmospheric pressure are about 5 percent to 15 percent by volume natural gas. [**52:**A.1.1]

Natural gas is nontoxic but can cause anoxia (asphyxiation) when it displaces the normal 21 percent oxygen in air in a confined area without adequate ventilation. [**52:**A.1.1]

The concentrations at which flammable or explosive mixtures form are much lower than the concentration at which asphyxiation risk is significant. [**52:**A.1.1]

NFPA 704 rating is as follows:

(1) Health — 0
(2) Flammability — 4
(3) Reactivity — 0

NFPA 52 applies to the design and installation of CNG engine fuel systems on vehicles of all types, including those listed in 42.11.1.1.1(1) through (3).

(4) Special — None

[**52:**A.1.1]

Cryogenic fluids are gases that have been liquefied by having their temperature brought below –130°F (–90°C). They are typically stored at low pressures in vacuum jacketed containers. Some of the potential hazards of cryogenic fluids are the following:

(1) Extreme cold that freezes or damages human skin on contact and can embrittle metals
(2) Extreme pressure resulting from rapid vaporization of the fluid during a leak or release of the cryogenic fluid
(3) Asphyxiation resulting from a release of the cryogenic fluid that vaporizes and displaces air

[**52:**A.1.1]

Personnel handling cryogenic fluids should use the protective clothing prescribed on the material safety data sheet (MSDS). This clothing typically includes heavy leather gloves, aprons, and eye protection. [**52:**A.1.1]

Δ **42.11.1.1.1** Section 42.11 shall apply to the design, installation, operation, and maintenance of compressed natural gas (CNG) and liquefied natural gas (LNG) engine fuel systems on vehicles of all types and for fueling vehicle (dispensing) systems and associated storage, including the following:

(1) Original equipment manufacturers (OEMs)
(2) Final-stage vehicle integrator/manufacturer (FSVIM)
(3) Vehicle fueling (dispensing) systems

[**52:**1.1.1]

42.11.1.1.2 Section 42.11 shall apply to the design, installation, operation, and maintenance of liquefied natural gas (LNG) engine fuel systems on vehicles of all types, to their associated fueling (dispensing) facilities, and to LNG to CNG facilities with LNG storage in ASME containers of 70,000 gal (265 m³) or less. [**52:**1.1.2]

42.11.1.1.3* Vehicles and fuel supply containers complying with federal motor vehicle safety standards (FMVSSs) covering the installation of CNG fuel systems on vehicles and certified by the respective manufacturer as meeting these standards shall not be required to comply with Sections 4.4, 4.8, 4.9, and 4.10, and Chapter 6 of NFPA 52 (except Sections 6.9, 6.11, 6.12, 6.13, and 6.14 of NFPA 52). [**52:**1.1.3]

A.42.11.1.1.3 Current DOT and TC specifications, exemptions, and specified permits do not address the use of cylinders that are approved for the transportation of natural gas to be used in CNG service. [**52:**A.5.4.4]

The following Compressed Gas Association publications are relevant cylinder inspection standards:

(1) CGA C-6, *Standards for Visual Inspection of Steel Compressed Gas Cylinders*
(2) CGA C-6.1, *Standards for Visual Inspection of High Pressure Aluminum Compressed Gas Cylinders*
(3) CGA C-6.2, *Guidelines for Visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders*
(4) CGA C-10, *Recommended Procedures for Changes of Gas Service for Compressed Gas Cylinders*

The following Compressed Gas Association publication is specified in ANSI/ISA NGV2, *Compressed Natural Gas Vehicle (NGV) Fuel Containers*, as appropriate for CNG container inspection:

CGA C-6.4, *Methods of External Visual Inspection of Natural Gas Vehicle (NGV) Fuel Containers and Their Installations*

[**52:**A.5.4.4]

42.11.1.1.4 Section 42.11 shall include marine, highway, rail, off-road, and industrial vehicles. [**52:**1.1.4]

42.11.1.1.5 Vehicles that are required to comply with applicable federal motor vehicle safety standards covering the installation of LNG fuel systems on vehicles and that are certified by the manufacturer as meeting these standards shall not be required to comply with Chapter 9 of NFPA 52, except 9.12.8 of NFPA 52. [**52:**1.1.5]

42.11.2 Liquefied Petroleum Gas (LP-Gas).

Δ **42.11.2.1** Fuel dispensing facilities for vehicles using LP-Gas shall comply with NFPA 58 and 42.11.2.

Subsection 42.11.2 contains requirements for fuel dispensing facilities for vehicles using liquefied petroleum gases (LP-Gas). For additional requirements on the storage, use, and handling of LP-Gas, see Chapter 60 and Chapter 69 of this *Code* and NFPA 58.

42.11.2.2 Scope.

42.11.2.2.1* Chapter 11 of NFPA 58 applies to engine fuel systems installed on mobile and nonstationary engines and off-road vehicles using LP-Gas in internal combustion engines, including containers, container appurtenances, carburetion equipment, piping, hose and fittings, and their installation. Refer to Chapter 12 for on-road LP-Gas vehicle installations. [**58:**11.1.1]

Chapter 11 of NFPA 58 applies to all engine systems that use propane as a fuel for internal combustion engines, including the engine that powers the vehicle and engines that are mounted on vehicles for reasons other than propulsion. A new provision covering containers for stationary engines was added in the 2011 edition of NFPA 58 (11.15.2). Although not included in the scope, parts of Chapter 11 of NFPA 58 may also apply to fuel cells on vehicles powered by propane.

General-purpose vehicles and industrial trucks are the two categories of vehicles that use propane engines for their propulsion. General-purpose vehicles include most non-industrial trucks using internal combustion engines. Most general-purpose vehicles are used in fleet operations serviced from central sources of supply that are not available to the public. Propane is not readily available in large enough quantities to accommodate masses of individual private vehicle owners. All over-the-road general-purpose vehicles powered by LP-Gas must be labeled by a diamond-shaped marking. (See Figure A.11.12.2.2 of NFPA 58.)

Note that NFPA 58 covers only vehicles operating on land. NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, addresses vessels that use propane. Propane has not been known to be used as an engine fuel for vessels. Propane is also not currently used as an aviation fuel, except for hot-air balloons. In the United States, the Federal Aviation Administration (FAA), an agency of the U.S. Department of Transportation (DOT), regulates the use of propane in hot-air balloons.

A.42.11.2.2.1 Chapter 11 of NFPA 58 covers engine fuel systems for engines installed on vehicles for any purpose, as well as fuel systems for stationary and portable engines. [**58:**A.11.1.1]

42.11.2.2.2* Chapter 11 of NFPA 58 applies to the installation of fuel systems supplying engines used to propel motorized vehicles as defined in 42.11.2.2.1. [**58:**11.1.2]

A.42.11.2.2.2 Containers for engine fuel systems can be of the permanently installed or exchange type. [**58:**A.11.1.2]

42.11.2.2.3 Chapter 11 of NFPA 58 applies to garaging of vehicles where such systems are installed. [**58:**11.1.3]

42.11.2.2.4 Permits. Permits, where required, shall comply with Section 1.12.

42.11.2.3 Training. Each person engaged in installing, repairing, filling, or otherwise servicing an LP-Gas engine fuel system shall be trained. [**58:**11.2]

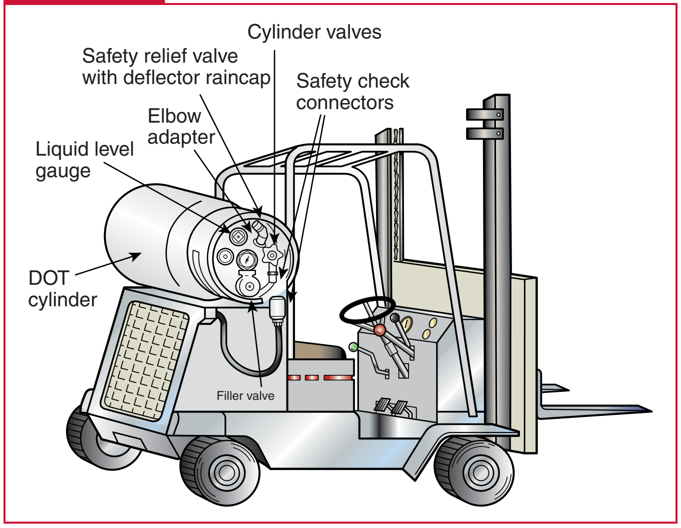
• **42.11.2.4 Industrial (and Forklift) Trucks Powered by LP-Gas.**

42.11.2.4.1 Scope. Paragraph 42.11.2.4 applies to LP-Gas installation on industrial trucks (including forklift trucks), both to propel them and to provide the energy for their materials-handling attachments. [**58:**11.13.1]

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, and NFPA 58 contain requirements for LP-Gas–fueled industrial trucks. While NFPA 58 sets forth installation provisions and certain conditions for their use, NFPA 505 sets forth type designations, areas containing flammables in which the truck can be used, dual-fuel trucks, truck maintenance, and fuel handling and storage. Exhibit 42.26 shows a typical LP-Gas–powered industrial truck.

The basic provisions for engine fuel systems on general-purpose vehicles also apply to those for industrial truck engines, except for some differences that are based on the extensive use of such engines inside buildings.

Exhibit 42.26



Typical LP-Gas–powered industrial truck (forklift truck). (Courtesy of RegO® Products)

Exhibit 42.27

Floor maintenance machine. (Courtesy of Amano Pioneer Eclipse Corp.)

42.11.2.4.2 Operations. The operation of industrial trucks (including forklift trucks) powered by LP-Gas engine fuel systems shall comply with 42.11.2.4.2.1 through 42.11.2.4.2.3. [**58:**11.13.4]

42.11.2.4.2.1 Industrial trucks shall be refueled outdoors. [**58:** 11.13.4.1]

42.11.2.4.2.2 Where cylinders are exchanged indoors, the fuel piping system shall be equipped to minimize the release of fuel when cylinders are exchanged, in accordance with either of the following:

(1) Using an approved quick-closing coupling in the fuel line
(2) Closing the shutoff valve at the fuel cylinder and allowing the engine to run until the fuel in the line is exhausted [**58:**11.13.4.2]

42.11.2.4.2.3 Where LP-Gas–fueled industrial trucks are used in buildings or structures, the following shall apply:

(1) The number of fuel cylinders on such a truck shall not exceed two.
(2) The use of industrial trucks in buildings frequented by the public, including those times when such buildings are occupied by the public, shall require the approval of the AHJ.
(3) The total water capacity of the fuel cylinders on an individual truck shall not exceed 105 lb (48 kg) [nominal 45 lb (20 kg) propane capacity].
(4) Trucks shall not be parked and left unattended in areas occupied by or frequented by the public without the approval of the AHJ. If left unattended with approval, the cylinder shutoff valve shall be closed.
(5) In no case shall trucks be parked and left unattended in areas of excessive heat or near sources of ignition. [**58:**11.13.4.3]

42.11.2.5 General Provisions for Vehicles Having Engines Mounted on Them (Including Floor Maintenance Machines).

42.11.2.5.1 Scope.

Section 11.14 of NFPA 58 includes coverage of floor maintenance machines, such as the one shown in Exhibit 42.27. Use of these propane-powered floor buffers has grown since their introduction into NFPA 58 in 1989. Their widespread use has resulted in specific coverage in NFPA 58 for the benefit of users of this equipment and enforcers of that code.

42.11.2.5.1.1 Paragraph 42.11.2.5 applies to the installation of equipment on vehicles that supply LP-Gas as a fuel for engines installed on these vehicles. [**58:**11.14.1.1]

42.11.2.5.1.2 Vehicles include floor maintenance and any other portable mobile unit, whether the engine is used to propel the vehicle or is mounted on it for other purposes. [**58:**11.14.1.2]

42.11.2.5.2 General Requirements.

42.11.2.5.2.1 Industrial trucks (including forklift trucks) and other engines on vehicles operating in buildings other than those used exclusively to house engines shall have an approved automatic shutoff valve installed in the fuel system. [**58:**11.14.2.1]

Although approved automatic shutoff valves are required by 42.11.2.5.2.1, the use of atmospheric-type regulators (zero governors) recognized for this purpose, with portable engines of 12 horsepower or less and having magneto ignition used exclusively outdoors, is acceptable.

An atmospheric-type regulator, as its name implies, depends on the atmospheric pressure for its control. The regulator is not an approved vacuum lock-off, which is considered an approved automatic shutoff valve. The regulator operates on the principle that, when the carburetor venturi is without vacuum, the regulator shuts off the flow of fuel. Atmospheric-type regulators have been used for many years on outdoor engine applications.

42.11.2.5.2.2 The source of air for combustion shall be isolated from the driver and passenger compartment, ventilating system, or air-conditioning system on the vehicle. [**58:**11.14.2.2]

42.11.2.5.2.3 Non–self-propelled floor maintenance machinery (floor polishers, scrubbers, buffers) and other similar portable equipment shall be listed. [**58:**11.14.2.3]

42.11.2.5.2.3.1 A label shall be affixed to the machinery or equipment, with the label facing the operator, with the text denoting that the cylinder or portion of the machinery or equipment containing the cylinder shall be stored in accordance with Chapter 8 of NFPA 58. [**58:**11.14.2.3(A)]

42.11.2.5.2.3.2 The use of floor maintenance machines in buildings frequented by the public, including the times when such buildings are occupied by the public, shall require the approval of the AHJ. [**58:**11.14.2.3(B)]

Great concern exists that a propane-powered floor buffer, with its 20 lb (9 kg) LP-Gas cylinder, will be stored inside buildings in concealed areas, such as closets. The technical committee, consistent with its long prohibition (with certain exceptions) of LP-Gas cylinders larger than 1 lb (0.5 kg) in buildings, reinforced its intent that cylinders be stored properly in accordance with Chapter 8 of NFPA 58. The technical committee was especially concerned that the introduction of engine fuel cylinders would lead to improper storage and therefore require specific labeling.

Propane-powered floor buffers and forklift trucks are both categorized as industrial trucks. It is highly improbable, however, that a forklift truck will be left in a closet. If a floor buffer and its 20 lb (9 kg) LP-Gas cylinder were stored in a closet and a fire occurred, the propane in the cylinder could be a threat to fire fighters due to the storage of a fuel that can accelerate a fire. Recognition of this threat to fire fighters is especially important when one considers that the nature of the floor buffer requires that it be used in buildings such as offices, malls, schools, and other nonindustrial areas where the storage of propane cylinders is not anticipated.

Propane-powered floor buffers have been found in storage closets and backrooms of a variety of stores, such as clothing stores and big box stores. They have also been found in the areas under the seating in large arenas, such as college basketball venues. In many cases the label required in 42.11.2.5.2.3.1 has come off, been removed, or been ignored. In a few instances, these machines have been found with improperly installed cylinders, so the relief valve would not be communicating with the vapor space if the cylinder were more than half full. Sometimes this is due to a broken locating pin on the machine, thus not "requiring" the cylinder to be properly installed.

Another issue is the apparent lack of awareness of the requirements of 42.11.2.5.2.3.2. Floor maintenance machines may be brought into a building by cleaning contractors and stored in the building, or they may be purchased by building owners for staff use. Both of these groups of people may be unaware of building and fire codes. Building inspectors who inadvertently find these machines in closets or storage rooms also may not be aware of these rules.

42.11.2.6 Garaging of Vehicles. Where vehicles with LP-Gas engine fuel systems mounted on them, and general-purpose vehicles propelled by LP-Gas engines, are stored or serviced inside garages, the following conditions shall apply:

(1) The fuel system shall be leak-free.
(2) The container shall not be filled beyond the limits specified in Chapter 7 of NFPA 58.
(3) The container shutoff valve shall be closed when the vehicle or the engine is being repaired, except when the engine is required to operate. Containers equipped with an automatic shutoff valve as specified in 11.4.1.8 of NFPA 58 satisfy this requirement.
(4) The vehicle shall not be parked near sources of heat, open flames, or similar sources of ignition or near inadequately ventilated pits. [**58:**11.16]

42.11.3* Liquefied Natural Gas (LNG). Fuel dispensing facilities for marine, highway, rail, off-road, and industrial vehicles using LNG and LNG storage in ASME containers of 70,000 gal (265 m^3) or less shall comply with NFPA 52.

• Δ **A.42.11.3** For information on on-site storage of LNG in ASME tanks larger than 70,000 gal (265 m^3) and in tanks built to API or other standards, see NFPA 59A.

Prior to the time NFPA 52 was developed, the use of LNG as an aviation fuel, fueling site liquefaction facilities, and the use of residential LNG fueling facilities were not being considered actively. The NFPA 52 committee intends to provide coverage for these applications at the appropriate time.

NFPA 57, *Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code*, was incorporated into the 2006 edition of NFPA 52. Additionally, the scope of the Technical Committee on Vehicular Alternative Fuel Systems has been expanded to include hydrogen, and new chapters have been added that address general gaseous hydrogen requirements and equipment qualifications; service and maintenance of gaseous hydrogen engine fuel systems; gaseous hydrogen compression systems; gas processing, storage, and dispensing systems; and liquefied hydrogen fueling facilities.

42.11.3.1 Permits. Permits, where required, shall comply with Section 1.12.

Table 1.12.8(a) requires a permit to display, compete, or demonstrate liquid- or gas-fueled vehicles or equipment in assembly buildings.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 2, *Hydrogen Technologies Code*, 2016 edition.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2018 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2016 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2018 edition.

NFPA 52, *Vehicular Natural Gas Fuel Systems Code*, 2018 edition.

NFPA 57, *Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code*, 2002 edition, incorporated into NFPA 52, 2006 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2017 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2013 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2014 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft,* 2015 edition.

NFPA 329, *Recommended Practice for Handling Releases of Flammable and Combustible Liquids and Gases,* 2015 edition.

NFPA 407, *Standard for Aircraft Fuel Servicing*, 2017 edition.

NFPA 409, *Standard on Aircraft Hangars*, 2016 edition.

NFPA 410, *Standard on Aircraft Maintenance,* 2015 edition.

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Spraying, Dipping, and Coating Using Flammable or Combustible Materials

43

Chapter 43 addresses spraying, dipping, and coating using flammable or combustible materials, including automated powder and liquid application; solvent distillation equipment; drying, curing, or fusion processes; and miscellaneous spray operations. Chapter 43 is based on the 2016 edition of NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, and the 2015 edition of NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*. NFPA 33 and NFPA 34 are the primary NFPA standards governing the regulation of spraying, dipping, and coating operations using flammable and combustible materials, and they are extracted into Chapter 43 of this *Code*. The commentary in this chapter has been edited and revised to reflect substantive amendments incorporated in the source documents since the previous edition of this Handbook.

43.1 Application

Δ **43.1.1*** Operations involving the spray application of flammable and combustible materials shall comply with NFPA 33 and Section 43.1.

A.43.1.1 The risk to life and property because of the fire and explosion hazards of spray application of flammable and combustible materials varies depending on the arrangement and operation of the particular process and on the nature of the material being sprayed. The principal hazards addressed in this *Code* are those of the materials being sprayed: flammable and combustible liquids and combustible powders, as well as their vapors, mists, and dusts, and the highly combustible deposits and residues that result from their use. Properly designed, constructed, and ventilated spray areas are able to confine and control combustible residues, dusts, or deposits and to remove vapors and mists from the spray area and discharge them to a safe location, thus reducing the likelihood of fire or explosion. Likewise, accumulations of overspray residues, some of which are not only highly combustible but also subject to spontaneous ignition, can be controlled. [**33:**A.1.1]

The control of sources of ignition in spray areas and in areas where flammable and combustible liquids or powders are handled, together with constant supervision and maintenance, is essential to safe spray application operations. The human element requires careful consideration of the location of spray application operations and the installation of fire extinguishing systems so that the potential for spread of fire to other property and damage to property by extinguishing agent discharge is reduced. [**33:**A.1.1]

NFPA 33 applies to the spray application of flammable or combustible materials (either continuously or intermittently) by any of the following methods:

1. Compressed air atomization
2. Airless or hydraulic atomization
3. Electrostatic application methods
4. Other means of atomized application

It also applies to the application of flammable or combustible materials (either continuously or intermittently) by any of the following methods:

1. Fluidized bed application methods
2. Electrostatic fluidized bed application methods
3. Other means of fluidized application

NFPA 33 also applies to spray application of water-borne, water-based, and water-reducible materials that contain flammable or combustible liquids or that produce combustible deposits or residues.

Finally, NFPA 33 contains provisions for organic peroxide–catalyzed coatings, other coatings using plural component chemistry, and manufacture of glass fiber–reinforced composites using styrene/unsaturated polyester resins.

NFPA 33 provides requirements for fire safety for spray application of flammable or combustible materials. It anticipates conditions of average use. Where unusual industrial processes are involved, the authority having jurisdiction (AHJ) is permitted to require additional safeguards or modifications to the requirements of NFPA 33, provided equivalent safety is achieved. Only the fire and explosion hazards of spray application processes and operations are addressed. NFPA 33 does not address toxicity or industrial health and hygiene. From the standpoint of personnel safety, it should be recognized that the materials used in these processes could be present in concentrations that present a health hazard, even if the concentrations do not present a fire or explosion hazard.

Some paints, varnishes, lacquers, and other coating materials contain volatile flammable solvents. In addition, such solvents are often added as "thinners." When exposed to the atmosphere, these solvents give off vapors that mix with the surrounding air, and, if the concentration reaches as much as approximately 1 percent solvent in air, the vapor-air mixtures can be ignited and an explosion might occur. Spray applications using only liquids that have relatively high flash points, although less likely to produce ignitible atmospheres than those using low flash point liquids, can nevertheless result in mists that are capable of propagating a flame in a manner similar to combustible particulate solids in dust explosions.

The provisions of this chapter also apply to cleaning or removal of overspray (sprayed material that does not reach the workpiece but accumulates on adjacent surfaces), cleaning of tools and equipment used, and safely storing flammable or combustible liquids used in the spraying process.

Δ **43.1.1.1*** Section 43.1 shall apply to the spray application of flammable or combustible materials, as herein defined, either continuously or intermittently by any of the following methods:

(1) Compressed air atomization
(2) Airless or hydraulic atomization
(3) Electrostatic application methods
(4) Other means of atomized application

[**33:**1.1.1]

Note that "other means of atomized application" includes fluidized bed processes, as noted in the commentary to A.43.1.1.

A.43.1.1.1 Refer to Figure A.43.1.1.1 for assistance in determining whether Chapter 43 applies to a particular spray application process. [**33:**A.1.1.1]

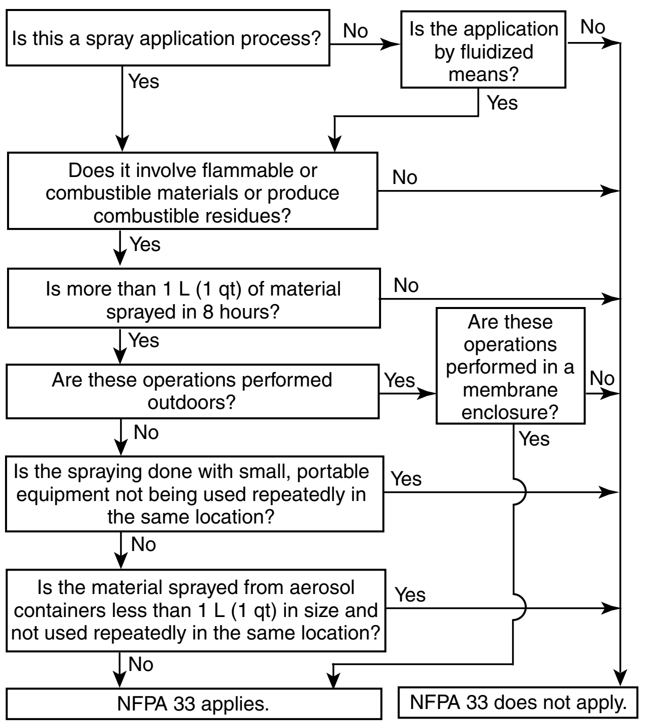
Figure A.43.1.1.1 has been amended to incorporate a decision point for spray processes in membrane enclosure, as covered in Chapter 18 of NFPA 33.

43.1.1.2 Section 43.1 shall also apply to spray application of water-borne, water-based, and water-reducible materials that contain flammable or combustible liquids or that produce combustible deposits or residues. [**33:**1.1.3]

Although these materials comprise a substantial portion of water, they are still of an organic nature, and the dried overspray or residue might present a fire hazard. A fire hazard assessment is warranted.

43.1.1.3 Section 43.1 shall not apply to the following:

(1)* Spray operations that use less than 1 L (33.8 fl oz) of flammable or combustible liquid in any 8-hour period [**33:**1.1.4]



Δ ***FIGURE A.43.1.1.1*** *Decision Tree — Does Chapter 43 Apply? [**33:**Figure A.1.1.1]*

A.43.1.1.3(1) There are many industrial applications that involve routine use of small quantities of flammable or combustible liquids (e.g., coatings, lubricants, adhesives) on a regular or periodic basis. An example would be touch-up of manufactured articles using aerosol containers or small, portable spray application equipment. The intent of this provision is to allow such use without having to comply with the requirements of Chapter 43. [**33:**A.1.1.4]

(2)* Spray application processes or operations that are conducted outdoors [**33:**1.1.6]

A.43.1.1.3(2) Chapter 43 does not cover spray application operations that are conducted outdoors on buildings, bridges, tanks, or similar structures. These situations occur only occasionally for any given structure and overspray deposits are not likely to present a hazardous condition. Also, the space where there might be an ignitible vapor–air or dust–air mixture is very limited due to atmospheric dilution. [**33:**A.1.1.6]

(3)* Portable spraying equipment that is not used repeatedly in the same location [**33:**1.1.7]

Δ **A.43.1.1.3(3)** The occasional use of portable spray equipment or aerosol spray containers is not likely to result in hazardous accumulations of overspray. Therefore, such operations are not within the scope of this *Code*. The following safeguards, however, should be observed:

(1) Adequate ventilation should be provided at all times, particularly where spray application is conducted in relatively small rooms or enclosures.

(2) Spray application should not be conducted in the vicinity of open flames or other sources of ignition. Either the spray operation should be relocated or the source of ignition should be removed or turned off.
(3) Containers of coating materials, thinners, or other hazardous materials should be kept tightly closed when not actually being used.
(4) Oily or coating-laden rags or waste should be disposed of promptly and in a safe manner at the end of each day's operations, due to the potential for spontaneous ignition
(5) The same fundamental rules for area cleanliness and housekeeping that are required for industrial spray application operations should be observed.

[**33:**A.1.1.7]

(4) Use of aerosol products in containers up to and including 1 L (33.8 oz) capacity that are not used repeatedly in the same location [**33:**1.1.8]
(5) Spray application of noncombustible materials [**33:**1.1.9]
(6) The hazards of toxicity or to industrial health and hygiene [**33:**1.1.10]

[**33:**1.1]

43.1.1.4 Permits. Permits, where required, shall comply with Section 1.12.

Table 1.12.8(a) requires that a permit be obtained to store, use, or handle Class I, Class II, or Class IIIA flammable or combustible liquids. A permit is also required for conducting a spraying or dipping operation that uses flammable or combustible liquids or combustible powders, as well as for the installation or modification of any spray room, spray booth, or preparation workstation.

43.1.2 Location of Spray Application Operations.

Δ **43.1.2.1* General.** Spray application operations and processes shall be located in industrial occupancies as defined by *NFPA 5000* and shall be confined to spray booths, spray rooms, spray areas, or in temporary membrane enclosures as defined in this *Code*. [**33:**4.1]

Prior to the 2018 edition of NFPA 1, spray application was not limited to industrial occupancies, simply by omission. Indeed, there was no mention of any particular occupancy. Paragraph 43.1.2.2 did address spray application operations in "other occupancies" but specifically cited only assembly, educational, institutional, and residential occupancies and ignored all others. The 2016 edition of NFPA 33 rectified this oversight by limiting general use of spray application processes to industrial occupancies and expanding application of the special provisions given in 43.1.2.2 to all other occupancy classes.

Temporary membrane enclosures were first addressed in (new) Chapter 18 of the 2016 edition of NFPA 33. They are used for spraying workpieces that are too large or too cumbersome to be enclosed in traditional spray booths or spray rooms. The primary example of such use is spray painting of the hull and superstructure of large luxury marine yachts and similar marine vessels. See Exhibit 43.1.

Exhibit 43.1

Temporary membrane enclosures surrounding motor yachts. (Courtesy of Global Finishing Solutions)

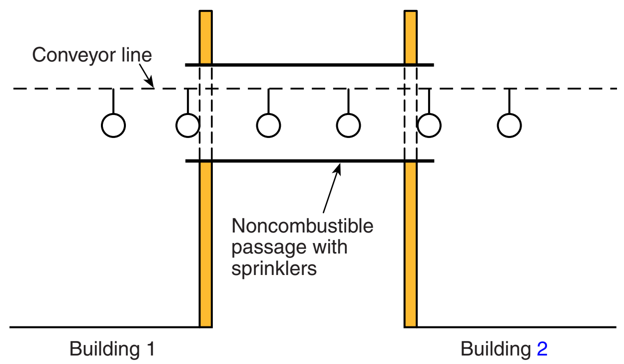
See Section 4.3 of NFPA 33 and its annex material for provisions and a discussion of spray processes located in basement areas.

A.43.1.2.1 Fires involving spray application operations and processes can be expected to develop rapidly and to generate copious quantities of heat and smoke. In sprinklered buildings, such fires can also result in the operation of a greater-than-normal number of sprinklers. Operations and equipment should be arranged and located so that there is adequate egress for personnel and adequate access for fire-fighting operations. Where spray application operations are extensive, they should be located in a separate building or in an area that is separated by fire-rated construction from all other operations or storage. [**33:**A.4.1]

Spray application operations that incorporate assembly lines or conveyor systems present special problems. If the conveyor systems extend between separate buildings, a noncombustible or limited-combustible sprinkler-protected enclosure or sprinkler-protected passageway, as illustrated in Exhibit 43.2, is recommended.

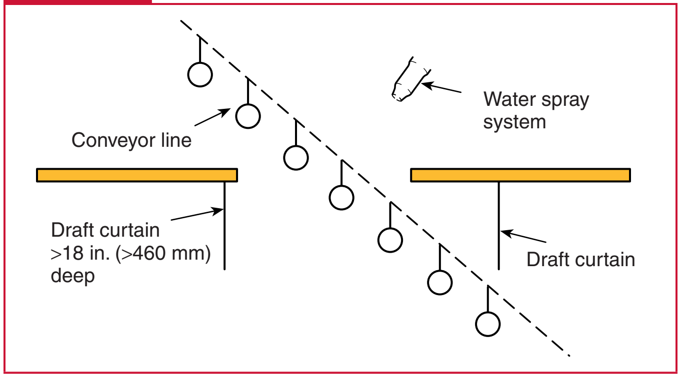
If the conveyor systems pass through floors, the openings should be surrounded by deep draft curtains [greater than 18 in. (460 mm)] on the underside of the floor deck, as illustrated in Exhibit 43.3. Draft curtains extending down from the ceiling

Exhibit 43.2



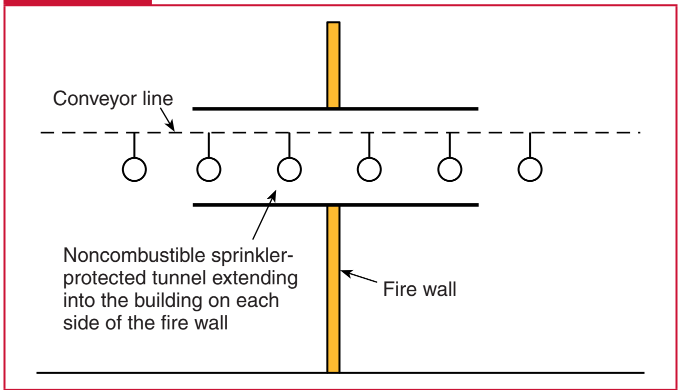
Conveyor line passing between separate buildings.

Exhibit 43.3



Draft curtains surrounding a conveyor line passing through a floor.

Exhibit 43.4



Conveyor line passing through a common building wall.

around spraying operations, along with smoke and heat vents, will slow the "mushrooming" of hot combustion gases along the ceiling and, thus, limit the number of sprinklers that will activate. The use of heat and smoke vents also aids fire control. Another safety precaution is the use of automatic high-velocity spray nozzles arranged to create a counterdraft.

If conveyor systems pass through fire walls or fire partitions, it is difficult to reliably protect the openings with automatic-closing fire doors. One alternative to an automatic fire door system is a noncombustible or limited-combustible, sprinkler-protected tunnel on both sides of the opening, as illustrated in Exhibit 43.4.

43.1.2.2* Locations in Other Occupancies. Spray application operations and processes shall not be conducted in any building that is classified as an assembly, educational, day care, health care, ambulatory health care, detention/correctional, residential, mercantile, business, or storage occupancy, unless the following requirements are met:

(1) The spraying is located in a room that is separated both vertically and horizontally from all surrounding areas by construction having a fire resistance rating of not less than 2 hours.
(2) The room is protected by an approved automatic sprinkler system designed and installed in accordance with Section 13.313.3.

[**33:**4.1.1]

See commentary to 43.1.2.1.

N **A.43.1.2.2** Spray application operations that incorporate assembly lines or conveyor systems present special problems. If conveyor systems extend between separate buildings, sprinklered, noncombustible, connecting passageway is advisable. If conveyor systems pass through floors, the openings should be surrounded by deep [greater than 18 in. (460 mm)] draft curtains on the underside of the floor deck and should be provided with automatic high-velocity spray nozzles arranged to create a counterdraft. If conveyor systems pass through fire walls or fire barrier walls, it is most desirable to provide a short gap in the conveyor to allow automatic fire doors to close. Interlocks might be necessary to stop conveyors moving toward the fire walls and clear the conveyors moving away from the fire walls in order to prevent fire doors from dropping on conveyed materials and thereby preventing complete closure. Another option is to provide a noncombustible or limited-combustible, sprinkler-protected tunnel on both sides of the opening. [**33:**A.4.2]

Rooms that house spray application operations should be separated from other occupancies or operations by construction that meets the requirements of 43.1.3. [**33:**A.4.2]

In sprinklered buildings where spray application operations occupy one portion of an open area, the spray application operations should be surrounded by noncombustible or limited-combustible draft curtains extending downward at least 18 in. (460 mm) from the ceiling, but deeper if practical. The draft curtains aid in preventing the activation of sprinklers outside the area enclosed by the curtains and tend to confine the discharge of water to the immediate area of the fire. Additional consideration might be given to the use of heat and smoke vents to aid in fire control. [**33:**A.4.2]

Sprinkler discharge should be drained to the outside of the building, to an internal drain system, or to some other suitable location. Properly designed and installed floor drains and scuppers of sufficient number and size to handle expected sprinkler discharge should be provided. Where spray application operations are located on an upper floor, they should not be located directly above goods or equipment that are subject to water damage. In addition, the floor should be made watertight and means should be provided to drain sprinkler discharge directly from the area. [**33:**A.4.2]

43.1.3 Construction and Design of Spray Areas, Spray Rooms, and Spray Booths.

43.1.3.1* Walls and Ceilings. Walls, doors, and ceilings that intersect or enclose a spray area shall be constructed of noncombustible or limited-combustible materials or assemblies and shall be securely and rigidly mounted or fastened. The interior surfaces of the spray area shall be smooth, designed and installed to prevent pockets that can trap residues, and designed to facilitate ventilation and cleaning. [**33:**5.1]

A.43.1.3.1 Spray booths can be of a wide variety of shapes and sizes to accommodate the various industrial applications of spray application. Without the use of a spray booth, the spray area, as defined in 3.3.14.12, can constitute a considerable area, with all the requirements for a spray area then becoming applicable. It is important that only equipment suitable for specific purposes be utilized in connection with the handling and application of flammable or combustible liquids or powders. [**33:**A.5.1]

If spray operations are *not* confined to a spray booth, spray room, or limited finishing workstation, the definition of the term *spray area* given in 3.3.14.12 is used and all requirements of Chapter 6 of NFPA 33 apply in the spray area, as well as the electrical area classification shown in Figure 43.1.4.4.1. Also, if an enclosure that does not meet the requirements specified in Chapter 43 for a spray booth or spray room is used for spray application, then that enclosure is treated as an unconfined spray area. Special consideration is given to "limited finishing workstations" in 43.5.3, because they are limited to the use of not more than 1 gal (3.8L) of material per 8-hour shift. Any enclosure that does not comply with 43.5.3 is referred to as a "preparation workstation" and is not considered a suitable enclosure for spray operations. Instead, 43.5.2 treats them as unenclosed spray areas. Preparation workstations ("prep stations") were originally conceived for use by auto body shops as an enclosure for "prepping" vehicles for painting, that is, cleaning and sanding, and should be limited to such use.

Only equipment suitable for the handling and application of flammable or combustible liquids or powders should be used in spray areas.

43.1.3.1.1 Air intake filters that are a part of a wall or ceiling assembly shall be listed as Class 1 or Class 2, in accordance with ANSI/UL 900, *Standard for Air Filter Units*. [**33:**5.1.1]

After the publication of the 2016 edition of NFPA 33, ANSI/UL 900, *Standard for Air Filter Units*, was revised to only require the criteria for Class 2 air filters and the class designations became moot.

43.1.3.1.2 The floor of the spray area shall be constructed of noncombustible material, limited-combustible material, or combustible material that is completely covered by noncombustible material. [**33:**5.1.2]

43.1.3.1.3 Aluminum shall not be used for structural support members or the walls or ceiling of a spray booth or spray room enclosure. Aluminum also shall not be used for ventilation ductwork associated with a spray booth or spray room. Aluminum shall be permitted to be used for interior components, such as platforms, spray apparatus components, and other ancillary devices. [**33:**5.1.3]

Aluminum loses about half its structural strength at temperatures of 400 to 480°F (200 to 250°C). Its melting point ranges from about 1100 to 1200°F (600 to 650°C), depending on the alloy.

43.1.3.1.4 If walls or ceiling assemblies are constructed of sheet metal, single-skin assemblies shall be no thinner than 0.0478 in. (1.2 mm), and each sheet of double-skin assemblies shall be no thinner than 0.0359 in. (0.9 mm). [**33:**5.1.4]

These thicknesses are considered the minimum allowable in order for the booth to maintain structural stability during a fire event.

43.1.3.1.5 Structural sections of spray booths shall be permitted to be sealed with a caulk or sealant to minimize air leakage. [**33:**5.1.5]

The amounts of caulk or sealant used present as negligible fire load.

43.1.3.1.6 Spray rooms shall be constructed of and separated from surrounding areas of the building by construction assemblies that have a fire resistance rating of 1 hour. [**33:**5.1.6]

Managing the spread of a fire from the room of origin or between floors in a building is an important consideration. Managing the spread of fire using construction barriers designed to limit the transfer of heat, smoke, and, in some cases, both, is achieved by compartmentation. Requiring a 1-hour-rated enclosure of spray rooms recognizes a unique fire hazard that is present in those spaces and helps ensure that a fire that starts in a spray room will be confined to the spray room or will at least slow the spread of fire from the compartment of origin.

43.1.3.1.7 Enclosed spray booths and spray rooms shall be provided with means of egress that meet the applicable requirements of Chapter 40 of NFPA *101*. [**33:**5.1.7]

43.1.3.1.8 Spray booths that are used exclusively for powder coating shall meet the requirements of Chapter 15 of NFPA 33. They shall be permitted to be constructed of fire-retardant combustible materials where approved by the AHJ. [**33:**5.1.8]

N **43.1.3.1.8.1** Listed spray booth assemblies that are constructed of other materials shall be permitted. [**33:**5.1.8.1]

43.1.3.2 Conveyor Openings. Conveyor openings that are necessary for transporting or moving work into and out of the spray area shall be as small as practical. [**33:**5.2]

43.1.3.3* Separation from Other Occupancies. Spray booths shall be separated from other operations by a minimum distance of 3 ft (915 mm) or by a partition, wall, or floor/ceiling assembly having a minimum fire resistance rating of 1 hour. Multiple connected spray booths shall not be considered as "other operations" except as provided for in Section 13.3 of NFPA 33. [**33:**5.3]

A.43.1.3.3 The "other" operations referred to in 43.1.3.3 are those that do not involve spray application processes. [**33:**A.5.3]

43.1.3.3.1 Spray booths shall be installed so that all parts of the booth are readily accessible for cleaning. [**33:**5.3.1]

43.1.3.3.2 A clear space of not less than 3 ft (915 mm) shall be maintained on all sides and above the spray booth. This clear space shall be kept free of any storage or combustible construction.

N **43.1.3.3.2.1** This requirement shall not prohibit locating a spray booth closer than 3 ft (915 mm) to or directly against an interior partition, wall, or floor/ceiling assembly that has a fire resistance rating of not less than 1 hour, provided the spray booth can be maintained and cleaned. [**33:**5.3.2.1]

N **43.1.3.3.2.2** This requirement shall not prohibit locating a spray booth closer than 3 ft (915 mm) to an exterior wall or a roof assembly, provided the wall or roof is constructed of noncombustible material and provided the spray booth can be maintained and cleaned. [**33:**5.3.2.2]

43.1.3.4 Movement of Powered Vehicles. Powered vehicles shall not be moved into or out of a spray area or operated in a spray area unless the spray application operation or process is stopped and the ventilation system is maintained in operation.

*Exception: This requirement shall not apply to vehicles that are listed for the specific hazards of the spray area. [**33:**5.4]*

43.1.3.5 Vision and Observation Panels.

43.1.3.5.1 Panels for luminaires or observation shall be of heat-treated glass, laminated glass, wired glass, or hammered-wired glass and shall be sealed to confine vapors, mists, residues, dusts, and deposits to the spray area. [**33:**5.4.1]

N **43.1.3.5.1.1** Listed spray booth assemblies that have *observation* panels constructed of other materials shall be permitted. [**33:**5.4.1.1]

43.1.3.5.2 Panels for luminaires shall be separated from the fixture to prevent the surface temperature of the panel from exceeding 200°F (93°C). [**33:**5.4.2]

The intent here is to prevent autoignition of any overspray deposited on the panels.

43.1.3.5.3 The panel frame and method of attachment shall be designed to not fail under fire exposure before the observation panel fails. [**33:**5.4.3]

43.1.3.5.4 Observation panels for spray booths that are used exclusively for powder coating processes shall be permitted to be constructed of fire-resistant combustible materials. [**33:**5.4.4]

43.1.3.6 Ventilation. Spray areas that are equipped with ventilation distribution or baffle plates or with dry overspray collection filters shall meet the requirements of 43.1.3.6.1 through 43.1.3.6.5. [**33:**5.5]

43.1.3.6.1 Distribution plates or baffles shall be constructed of noncombustible materials and shall be readily removable or accessible for cleaning on both sides. [**33:**5.5.1]

43.1.3.6.2 Filters shall not be used when applying materials known to be highly susceptible to spontaneous heating or spontaneous ignition. [**33:**5.5.2]

43.1.3.6.3 Supports and holders for filters shall be constructed of noncombustible materials. [**33:**5.5.3]

43.1.3.6.4 Overspray collection filters shall be readily removable or accessible for cleaning or replacement. [**33:**5.5.4]

43.1.3.6.5 Filters shall not be alternately used for different types of coating materials if the combination of the materials might result in spontaneous heating or ignition. *(See also Section 10.9 of NFPA 33.)* [**33:**5.5.5]

43.1.4 Electrical and Other Sources of Ignition.

43.1.4.1* General.

A.43.1.4.1 Because of the requirements for special safeguards, electrostatic apparatus; drying, curing, and fusing apparatus; and vehicle undercoating and body lining operations are covered in other chapters of NFPA 33. [**33:**A.6.2]

43.1.4.1.1 Electrical wiring and utilization equipment shall meet all applicable requirements of Articles 500, 501, 502, 505, and 516 of *NFPA 70* and all applicable requirements of this chapter.

Exception No. 1: Powered vehicles shall meet the requirements of 43.1.3.4.

*Exception No. 2: Resin application operations shall meet the requirements of Chapter 17 of NFPA 33. [**33:**6.2.1]*

Articles 500 through 503 of the 2017 edition of *NFPA 70*®, *National Electrical Code*®, cover the requirements for electrical and electronic equipment and wiring for all voltages in Class I, Divisions 1 and 2 locations; Class II, Divisions 1 and 2 locations; and Class III, Divisions 1 and 2 locations where fire or explosion hazards might exist due to flammable gases, flammable liquid–produced vapors, combustible dusts, or ignitible fibers or flyings. Article 505 of *NFPA 70* covers the requirements for the zone classification system, as an alternative to the division classification system covered in Article 501, for electrical and electronic equipment and wiring for all voltages in Zone 0, Zone 1, and Zone 2 hazardous (classified) locations where fire or explosion hazards might exist due to flammable gases, vapors, or liquids. Similarly, Article 506 covers the requirements for the zone classification system, as an alternative to the division classification system covered in Article 502, for electrical and electronic equipment and wiring for all voltages in Zone 20, Zone 21, and Zone 22 hazardous (classified) locations where fire or explosion hazards might exist due to combustible dusts, or ignitible fibers or flyings.

Article 516 covers the regular or frequent application of flammable liquids, combustible liquids, and combustible powders by spray operations and the application of flammable liquids or combustible liquids at temperatures above their flash point by dipping, coating, or other means.

43.1.4.1.2* For the purposes of this *Code*, the Zone system of electrical area classification shall be applied as follows:

(1) The inside of open or closed containers or vessels shall be considered a Class I, Zone 0 location.
(2) A Class I, Division 1 location shall be permitted to be alternatively classified as a Class I, Zone 1 location.
(3) A Class I, Division 2 location shall be permitted to be alternatively classified as a Class I, Zone 2 location.
(4) A Class II, Division 1 location shall be permitted to be alternatively classified as a Zone 21 location.
(5) A Class II, Division 2 location shall be permitted to be alternatively classified as a Zone 22 location. [**33:**6.2.2]

A.43.1.4.1.2 In the Division system, areas are classified as either Division 1 or Division 2, depending on whether ignitible gases or vapors are always present or likely to be present (Division 1) or whether ignitible gases or vapors are not normally present (Division 2). The Zone system identifies hazardous locations as Zone 0, Zone 1, or Zone 2, depending on whether the ignitible atmosphere will always be present (Zone 0), is likely to be present (Zone 1), or is not normally present (Zone 2). The Zone system is based on

International Electrotechnical Commission (IEC) standards and was incorporated into *NFPA 70* in 1996. [**33:**A.6.2.2]

43.1.4.1.3 For the purposes of electrical area classification, the Division system and the Zone system shall not be intermixed for any given source of release. [**33:**6.2.3]

43.1.4.1.4 In instances of areas within the same facility classified separately, Class I, Zone 2 locations shall be permitted to abut, but not overlap, Class I, Division 2 locations. Class I, Zone 0 or Zone 1 locations shall not abut Class I, Division 1 or Division 2 locations. [**33:**6.2.4]

43.1.4.1.5* Open flames, spark-producing equipment or processes, and equipment whose exposed surfaces exceed the autoignition temperature of the material being sprayed shall not be located in a spray area or in any surrounding area that is classified as Division 2, Zone 2, or Zone 22.

A.43.1.4.1.5 There should be no open flames, hot surfaces, or spark-producing equipment in the spray area or in any area where they might be exposed to combustible residues. Open flames or spark-producing equipment should not be located where they can be exposed to deposits of combustible residues. Some residues can be ignited at low temperatures, such as those produced by steam pipes, incandescent luminaires, and power tools. In powder coating applications, the temperature of the object or material being coated should be maintained at least 50°F (28°C) below the autoignation temperature of the powder. [**33:**A.6.2.5]

The potential ignition sources identified in 43.1.4.1.5 should be kept outside any hazardous (classified) areas designated in Chapter 6 of NFPA 33.

The provision for limited temperature of the workpiece in powder coating processes is to prevent carbonization of the powder, which could alter the characteristics of the powder.

N **43.1.4.1.5.1** This requirement shall not apply to drying, curing, or fusing apparatus covered by Section 43.4. [**33:**6.2.5.1]

43.1.4.1.6* Any utilization equipment or apparatus that is capable of producing sparks or particles of hot metal and that is located above or adjacent to either the spray area or the surrounding Division 2, Zone 2, or Zone 22 areas shall be of the totally enclosed type or shall be constructed to prevent the escape of sparks or particles of hot metal. [**33:**6.2.6]

A.43.1.4.1.6 Areas that are above or adjacent to spray areas and where materials are located, stored, mixed, or processed should be ventilated. Equipment that is known to produce flame, sparks, or particles of hot metal, including luminaires, that are adjacent to areas that are safe under normal operating conditions but which can become dangerous due to accident or careless operation should not be installed in such areas unless the equipment is totally enclosed or is separated from the area by partitions that will prevent the sparks or particles from entering the area. [**33:**A.6.2.6]

Any electrical equipment in the spray area must be listed for use in either a Class I, Division 1 location or a Class II, Division 1 location, as applicable. If the equipment is subject to deposits of combustible residue, it also must be listed for that exposure. The equipment should be listed for all the exposures to which it is subjected.

43.1.4.2 Electrical Area Classification.

43.1.4.2.1* Class I Locations. A Class I location shall be any location where a flammable gas or vapor is present or might be present in the air in quantities sufficient to produce an explosive or ignitible mixture. [**33:**6.3.1]

A.43.1.4.2.1 See NFPA 70. [**33:**A.6.3.1]

43.1.4.2.1.1* Class I, Division 1 Locations. As defined in 500.5(B)(1) of *NFPA 70*, a Class I, Division 1 location shall be any location where one of the following conditions exists:

(1) An ignitible concentration of flammable gas or vapor can exist under normal operating conditions.
(2) An ignitible concentration of flammable gas or vapor can exist frequently because of repair or maintenance operations or because of leakage.
(3) Breakdown or faulty operation of equipment or processes might release an ignitible concentration of flammable gas or vapor and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition. [**33:**6.3.1.1]

A.43.1.4.2.1.1 This classification usually includes the following locations:

(1) Where volatile flammable liquids or liquefied flammable gases are transferred from one container to another
(2) Interiors of spray booths and areas in the vicinity of spraying and painting operations where volatile flammable solvents are used
(3) Locations containing open tanks or vats of volatile flammable liquids
(4) Drying rooms or compartments for the evaporation of flammable solvents
(5) All other locations where ignitible concentrations of flammable vapors or gases are likely to occur in the course of normal operations

[**33:**A.6.3.1.1]

In some Division 1 locations, ignitible concentrations of flammable gases or vapors may be present continuously or for long periods of time. Examples include the following:

(1) The inside of inadequately vented enclosures containing instruments normally venting flammable gases or vapors to the interior of the enclosure
(2) Inadequately ventilated areas within spraying or coating operations using volatile flammable fluids
(3) The interior of an exhaust duct that is used to vent ignitible concentrations of vapors

[**33:**A.6.3.1.1]

43.1.4.2.1.2* Class I, Division 2 Locations. As defined in 500.5(B)(2) of *NFPA 70*, a Class I, Division 2 location shall be any location where one of the following conditions exists:

(1) A flammable gas or a volatile flammable liquid is handled, processed, or used, but any flammable gas, vapor, or liquid is confined within a closed container or a closed system from which it can escape only in case of accidental rupture or breakdown of the container or system or in case of abnormal operation of the equipment.
(2) An ignitible concentration of flammable gas or vapor is normally prevented by positive mechanical ventilation but might exist because of failure or abnormal operation of the ventilating equipment.
(3) An ignitible concentration of flammable gas or vapor might occasionally be transmitted from an adjacent Class I, Division 1 location, unless such transmission is prevented by positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided. [**33:**6.3.1.2]

A.43.1.4.2.1.2 This classification usually includes locations where volatile flammable liquids or ignitible vapors are used but that, in the judgment of the AHJ, would become hazardous only in case of an accident or of some unusual operating condition. The quantity of flammable material that might escape in case of accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires are all factors that merit consideration in determining the classification and extent of each location. [**33:**A.6.3.1.2]

Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for flammable liquids. Depending on factors such as the quantity and size of the containers and ventilation, locations used for the storage of flammable liquids in sealed containers may be considered either hazardous (classified) or unclassified locations. See NFPA 30. [**33:**A.6.3.1.2]

43.1.4.2.1.3* Class I, Zone 0 Locations. As defined in 505.5(B)(1) of *NFPA 70*, a Class I, Zone 0 location shall be any location where an ignitible concentration of flammable gas or vapor is present either continuously or for long periods of time. [**33:**6.3.1.3]

A.43.1.4.2.1.3 This classification includes locations inside vented tanks or vessels that contain volatile flammable liquids; inside inadequately vented spraying or coating enclosures, where volatile flammable solvents are used; inside open vessels, tanks and pits containing volatile flammable liquids; and the interior of an exhaust duct that is used to vent ignitible concentrations of vapors. [**33:**A.6.3.1.3]

It is not good practice to install electrical equipment in Zone 0 locations except when the equipment is essential to the process or when other locations are not feasible. [*See NFPA 70, 505.5(A) Informational Note No. 2.*] If it is necessary to install electrical systems in a Zone 0 location, it is good practice to install intrinsically safe systems as described by *NFPA 70*, Article 504. [**33:**A.6.3.1.3]

43.1.4.2.1.4* Class I, Zone 1 Locations. As defined in 505.5(B)(2) of *NFPA 70*, a Class I, Zone 1 location shall be any location where one of the following conditions exists:

(1) An ignitible concentration of flammable gas or vapor is likely to exist under normal operating conditions.
(2) An ignitible concentration of flammable gas or vapor might exist frequently because of repair or maintenance operations or because of leakage.
(3) Breakdown or faulty operation of equipment or processes might release an ignitible concentration of flammable gas or vapor and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition.
(4) An ignitible concentration of flammable gas or vapor might occasionally be transmitted from an adjacent Class I, Zone 0 location, unless such transmission is prevented by positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided. [**33:**6.3.1.4]

A.43.1.4.2.1.4 Normal operation is considered the situation when plant equipment is operating within its design parameters. Minor releases of flammable material may be part of normal operations. Minor releases include the releases from mechanical packings on pumps. Failures that involve repair or shutdown (such as the breakdown of pump seals and flange gaskets, and spillage caused by accidents) are not considered normal operation. [**33:**A.6.3.1.4]

This classification usually includes locations where volatile flammable liquids are transferred from one container to another; areas in the vicinity of spraying and painting operations where flammable solvents are used; adequately ventilated drying rooms or compartments for evaporation of flammable solvents; inadequately ventilated pump rooms for volatile flammable liquids; . . . and other locations where ignitible concentrations of flammable vapors or gases are likely to occur in the course of normal operation but not classified Zone 0. [**33:**A.6.3.1.4]

43.1.4.2.1.5 Class I, Zone 2 Locations. As defined in 505.5(B)(3) of *NFPA 70*, a Class I, Zone 2 location shall be any location where one of the following conditions exists:

(1) An ignitible concentration of a flammable gas or vapor is not likely to exist under normal operating conditions, and if an ignitible concentration does exist, will exist only for a short period of time.
(2) A flammable gas or a volatile flammable liquid is handled, processed, or used, but any flammable gas, vapor, or liquid is confined within a closed container or a closed system from which it can escape only in case of accidental rupture or breakdown of the container or system or in case of abnormal operation of the equipment.
(3) An ignitible concentration of flammable gas or vapor is normally prevented by positive mechanical ventilation but might exist because of failure or abnormal operation of the ventilating equipment.

(4) An ignitible concentration of flammable gas or vapor might occasionally be transmitted from an adjacent Class I, Zone 1 location, unless such transmission is prevented by positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided. *(See also A.43.1.4.2.1.2.)* [**33:**6.3.1.5]

43.1.4.2.2 Class II Locations. A Class II location shall be any location that might be hazardous because of the presence of a combustible dust. [**33:**6.3.2]

43.1.4.2.2.1* Class II, Division 1 Locations. As defined in 500.5(C)(1) of *NFPA 70*, a Class II, Division 1 location shall be any location where one of the following conditions exists:

(1) Combustible dust is in the air in quantities sufficient to produce explosive or ignitible mixtures under normal operating conditions.
(2) Mechanical failure or abnormal operation of machinery or equipment might cause an explosive or ignitible mixture of combustible dust in air and might also provide a source of ignition through simultaneous failure of electrical equipment, operation of protection devices, or from other causes.
(3) Group E combustible dusts might be present in quantities sufficient to be hazardous. [**33:**6.3.2.1]

A.43.1.4.2.2.1 Dusts containing magnesium or aluminum are particularly hazardous, and the use of extreme precaution is necessary to avoid ignition and explosion. [**33:**A.6.3.2.1]

43.1.4.2.2.2* Class II, Division 2 Locations. As defined in 500.5(C)(2) of *NFPA 70*, a Class II, Division 2 location shall be any location where one of the following conditions exists:

(1) Combustible dust due to abnormal operations might be present in the air in quantities sufficient to produce explosive or ignitible mixtures.
(2) Combustible dust accumulations are present but are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but could as a result of infrequent malfunctioning of handling or processing equipment become suspended in the air.
(3) Combustible dust accumulations on, in, or in the vicinity of the electrical equipment could be sufficient to interfere with the safe dissipation of heat from electrical equipment, or could be ignitible by abnormal operation or failure of electrical equipment. [**33:**6.3.2.2]

A.43.1.4.2.2.2 The quantity of combustible dust that may be present and the adequacy of dust removal systems are factors that merit consideration in determining the classification and may result in an unclassified area. [**33:**A.6.3.2.2]

Where products are handled in a manner that produces low quantities of dust, the amount of dust deposited may not warrant classification. [**33:**A.6.3.2.2]

43.1.4.2.2.3* Zone 20. As defined in 506.5(B)(1) of *NFPA 70*, a Zone 20 location shall be any location where one of the following conditions exists:

(1) An ignitible concentration of combustible dust is present continuously.
(2) An ignitible concentration of combustible dust is present for long periods of time. [**33:**6.3.2.3]

A.43.1.4.2.2.3 As a guide to classification of Zone 20, 21, and 22 locations, refer to ANSI/ISA-61241 (12.10.05), *Electrical Apparatus for Use in Zone 20, Zone 21 and Zone 22 Hazardous (Classified) Locations — Classification of Zone 20, Zone 21, and Zone 22 Hazardous (Classified) Locations*. [**33:**A.6.3.2.3]

Zone 20 classification includes locations inside dust containment systems; inside hoppers, silos, cyclones and filter houses, dust transport systems, except some parts of belt and chain conveyors, and so on; inside blenders, mills, dryers, bagging equipment, and so on. [**33:**A.6.3.2.3]

43.1.4.2.2.4* Zone 21. As defined in 506.5(B)(2) of *NFPA 70*, a Zone 21 location shall be any location where one of the following conditions exists:

(1) An ignitible concentration of combustible dust is likely to exist occasionally under normal operating conditions.
(2) An ignitible concentration of combustible dust might exist frequently because of repair or maintenance operations or because of leakage.
(3) Equipment is operated or processes are carried on of such a nature that equipment breakdown or faulty operations could result in the release of an ignitible concentration of combustible dust and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition.
(4) An ignitible concentration of combustible dust could be communicated from an adjacent Zone 20 location, unless communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided. [**33:**6.3.2.4]

A.43.1.4.2.2.4 This classification usually includes locations outside dust containment and in the immediate vicinity of access doors subject to frequent removal or opening for operation purposes when internal combustible mixtures are present; locations outside dust containment in the proximity of filling and emptying points, feed belts, sampling points, truck dump stations, belt dump over points, etc. where no measures are employed to prevent the formation of combustible mixtures; locations outside dust containment where dust accumulates and where due to process operations the dust layer is likely to be disturbed and form combustible mixtures; locations inside dust containment where explosive dust clouds are likely to occur (but neither continuously, nor for long periods, nor frequently) as, for example, silos (if filled and/or emptied only occasionally) and the dirty side of filters if large self-cleaning intervals are occurring. *(See also A.43.1.4.2.2.3.)* [**33:**A.6.3.2.4]

43.1.4.2.2.5* Zone 22. As defined in 506.5(B)(3) of *NFPA 70*, a Zone 22 location shall be any location where one of the following conditions exists:

(1) An ignitible concentration of combustible dust is not likely to occur in normal operation, and if it does occur, will only persist for a short period.
(2) A combustible dust is handled, processed, or used, but the dust is normally confined within closed containers or closed systems from which it can escape only as a result of the abnormal operation of the equipment with which the dust is handled, processed, or used.
(3) An ignitible concentration of combustible dust could be communicated from an adjacent Zone 21 location, unless communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided. [**33:**6.3.2.5]

A.43.1.4.2.2.5 Zone 22 locations usually include outlets from bag filter vents, because in the event of a malfunction there can be emission of combustible mixtures; locations near equipment that has to be opened at infrequent intervals or equipment that from experience can easily form leaks where, due to pressure above atmospheric, dust will blow out; pneumatic equipment, flexible connections that can become damaged, etc.; storage locations for bags containing dusty product, since failure of bags can occur during handling, causing dust leakage; and locations where controllable dust layers are formed that are likely to be raised into explosive dust/air mixtures. Only if the layer is removed by cleaning before hazardous dust–air mixtures can be formed is the area designated non-hazardous. [**33:**A.6.3.2.5]

Locations that normally are classified as Zone 21 can fall into Zone 22 when measures are employed to prevent the formation of explosive dust–air mixtures. Such measures include exhaust ventilation. The measures should be used in the vicinity of (bag) filling and emptying points, feed belts, sampling points, truck dump stations, belt dump over points, etc. *(See also A.43.1.4.2.2.3.)* [**33:**A.6.3.2.5]

43.1.4.3 Electrical Devices in Spray Areas.

43.1.4.3.1 The spray area as defined in NFPA 33 shall be Class I, Division 1; Class I, Zone 1; Class II, Division 1; or Zone 21, whichever is applicable. [**33:**6.4.1]

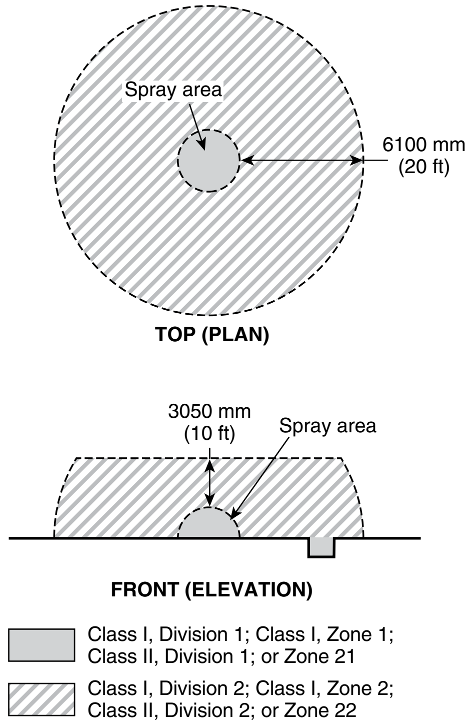
43.1.4.3.2 Electrical wiring and utilization equipment that is located in the spray area and is not subject to deposits of combustible residues shall be suitable for Class I, Division 1; Class I, Zone 1; Class II, Division 1; or Zone 21 locations, whichever is applicable. [**33:**6.4.2]

43.1.4.3.3* Electrical wiring and utilization equipment that is located in the spray area and is subject to deposits of combustible residues shall be listed for such exposure and shall be suitable for Class I, Division 1; Class I, Zone 1; Class II, Division 1; or Zone 21 locations, whichever is applicable. [**33:**6.4.3]

A.43.1.4.3.3 Equipment that is listed for both Class I, Division 1; Class I, Zone 1; Class II, Division 1; and Zone 21 locations and is also listed for accumulation of deposits of combustible residues can be installed in the spray area. *(See NFPA 70.)* [**33:**A.6.4.3]

43.1.4.4 Electrical Devices in Areas Adjacent to or Connected to Spray Areas. Electrical wiring and utilization equipment located in areas adjacent to or connected to the spray area, including but not limited to vestibules and tunnels, shall be classified in accordance with 43.1.4.4.1 through 43.1.4.4.5. [**33:**6.5]

43.1.4.4.1 Electrical wiring and utilization equipment located outside, but within 20 ft (6100 mm) horizontally and 10 ft (3050 mm) vertically, of an unenclosed spray area and not separated from the spray area by partitions extending to the boundaries of the area designated as Division 2, Zone 2; or Zone 22 in Figure 43.1.4.4.1 shall be suitable for Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable. [**33:**6.5.1]



Δ *FIGURE 43.1.4.4.1 Electrical Area Classification for Unenclosed Spray Areas. [33:Figure 6.5.1]*

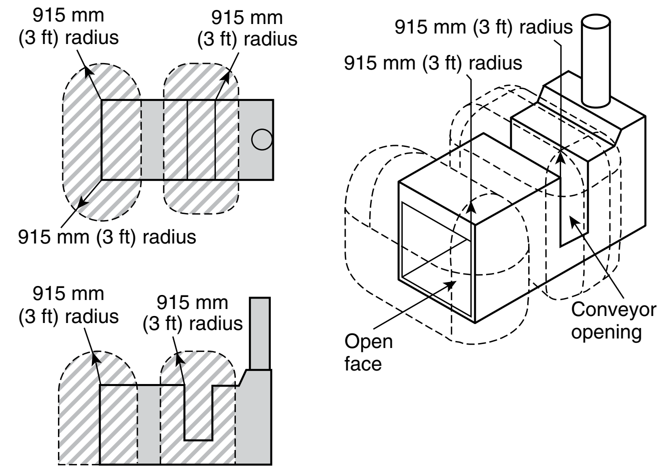
In applying Figure 43.1.4.4.1, envision the spray area as the volume occupied by the workpiece plus the surrounding volume through which the spray apparatus is moved. As an example, assume a railroad boxcar 55 ft (16.8 m) long, 11 ft (3.4 m) wide, and 11 ft (3.4 m) high that is supported 3 ft (0.9 m) above the shop floor. Assume also that the operator holds the spray gun 1.5 ft (0.5 m) from the surface being sprayed. Then the dimensions of the spray area would be as follows:

$$\begin{aligned} 55\text{ ft} + 1.5\text{ ft} + 1.5\text{ ft} &= 58\text{ ft } (16.8\text{ m} + 0.5\text{ m} + 0.5\text{ m} \\ &= 17.8\text{ m) long} \\ 11\text{ ft} + 1.5\text{ ft} + 1.5\text{ ft} &= 14\text{ ft } (3.4\text{ m} + 0.5\text{ m} + 0.5\text{ m} \\ &= 4.4\text{ m) wide} \\ 3\text{ ft} + 11\text{ ft} + 1.5\text{ ft} &= 15.5\text{ ft } (0.9\text{ m} + 3.4\text{ m} + 0.5\text{ m} \\ &= 4.8\text{ m) high} \end{aligned}$$

These are the dimensions of the spray area that must be classified as Class I, Division 1, Class I, Zone 1, Class II, Division 1, or Zone 21, whichever is applicable.

Note that Figure 43.1.4.4.1 has been redrawn for purposes of clarity and now includes a below-grade trench that is classified as Division 1/Zone 1/Zone 21.

43.1.4.4.2 If spray application operations are conducted within a closed-top, open-face or open-front booth or room, as shown in Figure 43.1.4.4.2, any electrical wiring or utilization equipment located outside the booth or room but within 3 ft (915 mm) of any opening shall be suitable for Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable. [**33:**6.5.2(a)]



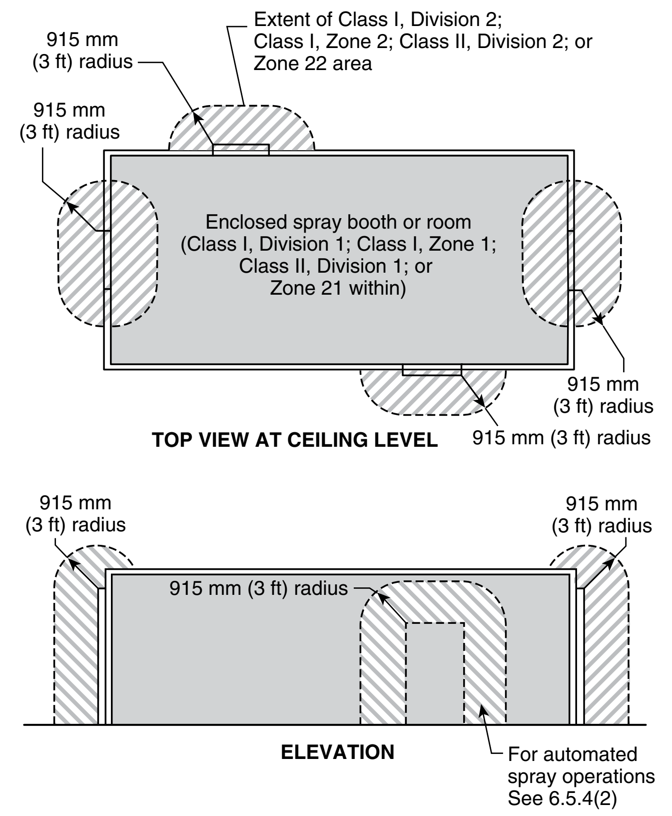
Δ *FIGURE 43.1.4.4.2 Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 Locations Adjacent to an Open-Face or Open-Front Spray Booth or Spray Room. [**33:**Figure 6.5.2]*

43.1.4.4.3 If spray application operations are conducted within an open-top booth, any electrical wiring or utilization equipment located within the space 3 ft (915 mm) vertically from the top of the booth shall be suitable for Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable. In addition, any electrical wiring or utilization equipment located within 3 ft (915 mm) in all directions of openings other than the open top also shall be suitable for Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable. [**33:**6.5.3]

43.1.4.4.4 If spray application operations are confined to an enclosed spray booth or room, electrical area classification shall be as follows:

(1) The area within 3 ft (915 mm) of any opening shall be classified as Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable, as shown in Figure 43.1.4.4.4.

(2)* Where automated spray application equipment is used, the area outside the access doors shall be unclassified provided the door interlock prevents the spray application operations when the door is open.



Δ *FIGURE 43.1.4.4.4 Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 Locations Adjacent to an Enclosed Spray Booth or Spray Room. [**33:**Figure 6.5.4]*

N **A.43.1.4.4.4(2)** Access doors into a spray area that must be closed to allow normal automated spray application operations to occur should not be considered an opening. The door should be considered a maintenance access and never open while a hazardous condition exists in the booth. Therefore, the area outside the door/maintenance access should be considered unclassified. [**33:**A.6.5.4(2)]

(3) Where exhaust air is recirculated and all requirements of 43.1.5.5 are met, both of the following shall apply:
  (a) The interior of any recirculation path downstream of the recirculation particulate filter up to and including the air supply plenum shall be classified as Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable.
  (b) The interior of fresh air supply ducts shall be unclassified.

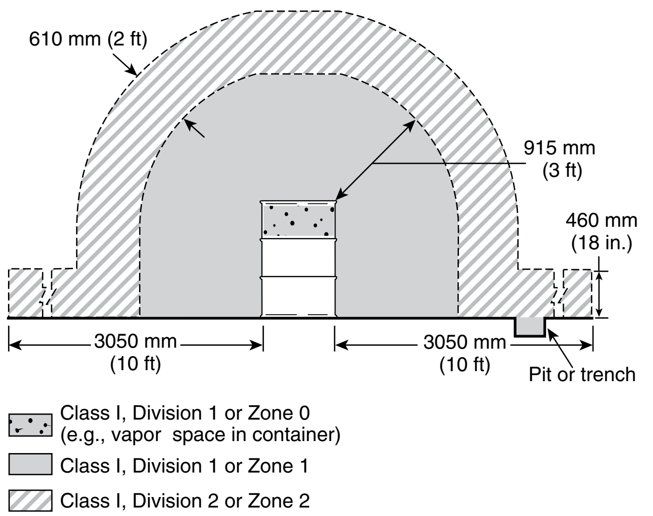
(4) Where exhaust air is not recirculated, the interior of fresh air supply ducts and fresh air supply plenums shall be unclassified. [**33:**6.5.4]

43.1.4.4.5 Open containers, supply containers, waste containers, spray gun cleaners, and solvent distillation units that contain Class I liquids shall be located in areas ventilated in accordance with applicable requirements of 43.1.5. [**33:**6.5.5]

43.1.4.4.5.1 Electrical area classification shall be as follows:

(1) The area within 3 ft (915 mm) in all directions from any such container or equipment and extending to the floor or grade level shall be classified as Class I, Division 1 or Class I, Zone 1, whichever is applicable.
(2) The area extending 2 ft (610 mm) beyond the Division 1 or Zone 1 location shall be classified as Class I, Division 2 or Class I, Zone 2, whichever is applicable.
(3) The area extending 5 ft (1525 mm) horizontally beyond the area described in 43.1.4.4.5.1(2) up to a height of 18 in. (460 mm) above the floor or grade level shall be classified as Class I, Division 2 or Class I, Zone 2, whichever is applicable.
(4) The area inside any tank or container shall be classified as Class I, Division 1 or Class I, Zone 0, whichever is applicable. [**33:**6.5.5.1]

43.1.4.4.5.2 Electrical wiring and utilization equipment installed in these areas shall be suitable for the location, as shown in Figure 43.1.4.4.5.2. [**33:**6.5.5.2]

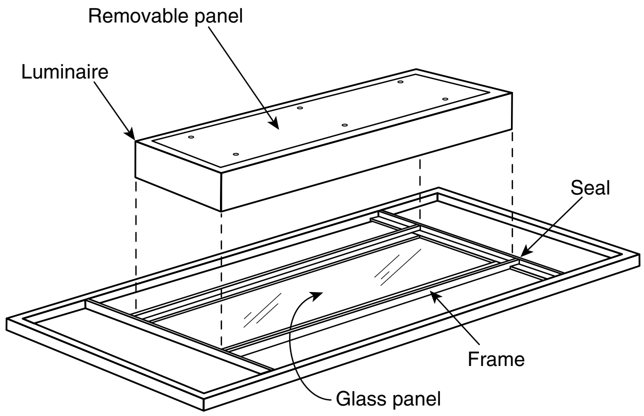


Δ *FIGURE 43.1.4.4.5.2 Electrical Area Classification for Class I Liquid Operations Around Open Containers, Supply Containers, Waste Containers, Spray Gun Cleaners, and Solvent Distillation Units. [**33:**Figure 6.5.5.2]*

43.1.4.5 Illumination.

43.1.4.5.1 Luminaires, like that shown in Figure 43.1.4.5.1, that are attached to the walls or ceiling of a spray area but that are outside any classified area and are separated from the spray area by glass panels that meet the requirements of 43.1.3.5 shall be suitable for use in unclassified locations. Such fixtures shall be serviced from outside the spray area. [**33:**6.6.1]

43.1.4.5.2 Luminaires, like that shown in Figure 43.1.4.5.1, that are attached to the walls or ceiling of a spray area; that are separated from the spray area by glass panels that meet the requirements of



Δ *FIGURE 43.1.4.5.1 Example of a Luminaire Mounted Outside of the Spray Area and Serviced from Outside the Spray Area. [**33:**Figure 6.6.1]*

43.1.3.5; and that are located within a Class I, Division 2, a Class I, Zone 2, a Class II, Division 2; or a Zone 22 location shall be suitable for such location. Such fixtures shall be serviced from outside the spray area. [**33:**6.6.2]

43.1.4.5.3 Luminaires, like that shown in Figure 43.1.4.5.3, that are an integral part of the walls or ceiling of a spray area shall be permitted to be separated from the spray area by glass panels that are an integral part of the fixture. Such fixtures shall be listed for use in Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable, and also shall be listed for accumulations of deposits of combustible residues. Such fixtures shall be permitted to be serviced from inside the spray area. [**33:**6.6.3]

43.1.4.5.4 Luminaires that are located inside the spray area shall meet the requirements of 43.1.4.3 and 43.1.4.6. [**33:**6.6.4]

43.1.4.6* Static Electricity. All electrically conductive objects in the spray area, except those objects required by the process to be at high voltage, shall be electrically connected to ground with a resistance of not more than 1 megohm (10^6 ohms). This requirement shall apply to containers of coating material, wash cans, guards, hose connectors, brackets, and any other electrically conductive objects or devices in the area. This requirement shall also apply to any personnel who enter the spray area. [**33:**6.7]

The 1 megohm limit cited here is an absolute maximum. Generally speaking, a good ground path, that is, the path from the object to earth, would not exceed 10,000 ohms. Resistance greater than that, while still considered safe, is indicative of a deteriorating ground path. Causes might be corroded or loose ground connections. NFPA 77, *Recommended Practice on Static Electricity*, includes useful information on the subject of proper bonding and grounding.

A.43.1.4.6 During operation of any electrostatic equipment, electrically conductive isolated objects within the process area are influenced

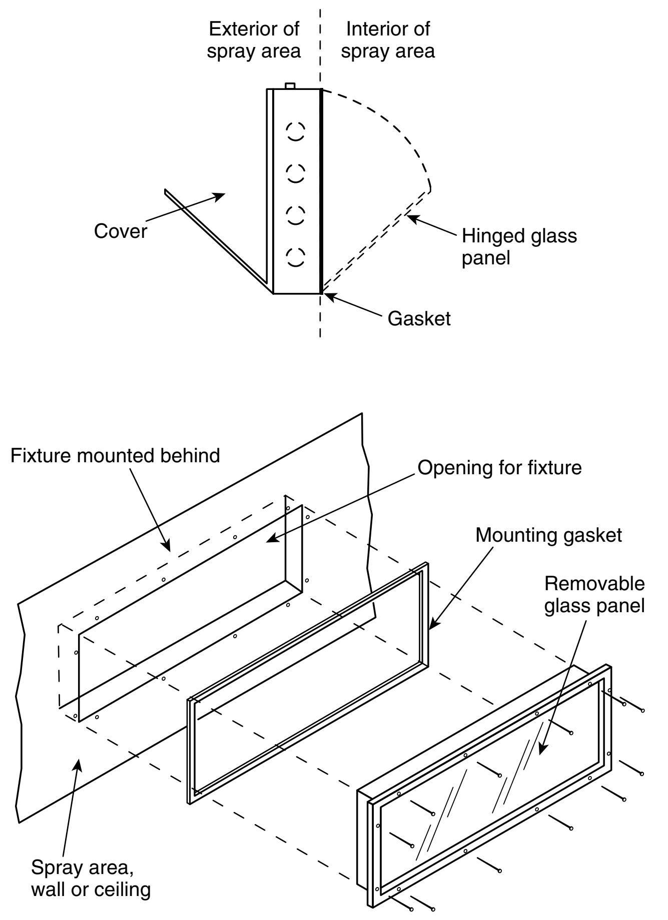


*FIGURE 43.1.4.5.3 Examples of Luminaires That Are Integral Parts of the Spray Area and That Are Serviced from Inside the Spray Area. [**33:**Figure 6.6.3]*

by the process and can become charged to voltages that result in spark discharges capable of igniting flammable or combustible substances. Objects commonly involved in such incidents include workpieces on conveyor racks that have fouled contact points; solvent containers or tools placed on nonconducting paint residues, cardboard, or wooden rests; spray booth components such as loose floor grates; and human beings insulated from ground by rubber footwear, paint residue accumulations on floors, and gloves. [**33:**A.6.7]

Even in spray painting environments where there is no electrostatic equipment in operation but where sticky, electrically nonconductive paint residues have accumulated on the floor, a significant hazard is associated with static electrification of human bodies that results from walking across such a floor. As few as two or three steps can produce sufficient voltage on the body of a worker to create an incendive spark when he or she approaches a grounded object. If this spark occurs in a flammable vapor such as is found surrounding a solvent container or a freshly painted object, a fire results. See NFPA 77 for additional information. [**33:**A.6.7]

Workers must be grounded if they work in an area where spray painting is conducted, or if they work directly with electrostatic equipment in the presence of flammable or combustible substances. Grounding can be accomplished by having the operator grip a grounded spray gun, grounded wire, or grounded metal rod with a bare hand. If the floor is grounded and clean, workers can also be grounded by wearing shoes with electrically conductive soles. To the extent possible, the number of ungrounded (isolated) conductive objects in the spray area should be kept to a minimum.

43.1.4.7 Flexible Power Cords. For automated equipment and robotic equipment, flexible power cords shall be permitted to be used in hazardous (classified) locations and shall be permitted to be connected to the fixed part of the electrical circuit, provided they meet all of the following conditions:

(1) They are approved for extra-hard usage.
(2) They are equipped with a grounding conductor that meets the requirements of Section 400.2 of *NFPA 70*.
(3) They are connected to terminals or conductors in an approved manner.
(4) They are supported by a positive mechanical clamp in such a manner that permits the cord to be readily replaced and prevents strain at the cord connections within the terminal enclosure.
(5) They are provided with explosionproof seals for liquid applications or dusttight seals for powder applications where the cord enters junction boxes, fittings, or enclosures.
(6) They are listed for deposits of combustible residues. [**33:**6.8]

43.1.4.8 Portable Electric Lights. Portable electric luminaires shall not be used in any spray area while spray application operations are being conducted.

*Exception: Where portable electric luminaires are required for use in spaces that are not illuminated by fixed luminaires within the spray area, they shall meet the requirements of 43.1.4.3.3. [**33:**6.9]*

43.1.5 Ventilation.

43.1.5.1 General. Ventilating and exhaust systems shall be designed and installed in accordance with the applicable requirements of NFPA 91 except as amended by the requirements of 43.1.5. [**33:**7.1]

43.1.5.2 Performance Requirements. Each spray area shall be provided with mechanical ventilation that is capable of confining and removing vapors and mists to a safe location and is capable of confining and controlling combustible residues, dusts, and deposits. The concentration of the vapors and mists in the exhaust stream of the ventilation system shall not exceed 25 percent of the lower flammable limit. *(See Annex B of NFPA 33 for additional guidance on determining the lower flammable limit.)* [**33:**7.2]

*Exception: In confined spaces, where ventilation might not be capable of providing the necessary ventilation, a properly applied inerting procedure shall be permitted to be used. Such procedures shall meet the applicable requirements of NFPA 69 and shall be acceptable to the AHJ. [**33:**7.2]*

The atmosphere in the direct path of the spray exceeds the lower flammable limit (LFL) of the solvent. Because the vapors from most solvents are heavier than air, even small quantities of vapor can form an ignitible mixture in low or unventilated spaces.

Instruments are not always required to determine whether the ventilation system is operating properly. A strong odor of solvent vapor evident within 3 ft (1 m) from any opening is an indication that the exhaust ventilation system is not confining vapors and mists. The presence of overspray residues on the floor outside the open front of a booth or outside a conveyor opening is an indication that the exhaust ventilation system is not confining residues, dusts, and deposits. In totally enclosed booths, such as those used in automotive body shops, visual observation can determine whether residues, dusts, and deposits are being removed from the booth.

In large spray rooms, however, such as those used for refinishing aircraft, deposits on the floor are to be expected. Air velocities of 100 ft/min (30 m/min) or greater cannot keep the overspray airborne, although solvent vapors are removed.

43.1.5.2.1* Spray areas equipped with overspray collection filters shall have an effective means to ensure that the performance requirements of 43.1.5.2 are met. [**33:**7.2.1]

A.43.1.5.2.1 Acceptable means to comply with 43.1.5.2.1 include, but are not limited to, visible gauges, audible alarms, approved interlocks, or an effective inspection program. [**33:**A.7.2.1]

43.1.5.2.2 Powder Coating Systems. Powder coating systems also shall meet the requirements of Section 15.8 of NFPA 33. [**33:**7.2.2]

43.1.5.2.3 Mechanical ventilation shall be kept in operation at all times while spray operations are being conducted and for a sufficient time thereafter to allow the vapors from drying coated objects or material and residues to be exhausted. Where spray operations are conducted automatically without an attendant constantly on duty, the operating controls of the spray apparatus shall be arranged so that the spray apparatus cannot function unless the exhaust fans are operating. [**33:**7.2.3]

Δ **43.1.5.2.4** In confined spaces, where ventilation is not capable of meeting the requirements of 43.1.5.2, an inerting procedure shall be permitted to be used. Such procedures shall meet the applicable requirements of NFPA 69 and shall be acceptable to the AHJ. [**33:**7.2.4]

43.1.5.3* Make-Up Air. Clean make-up air shall be provided to compensate for the air exhausted from spray operations. The intake for this make-up air shall be located so that the air exhausted from spray operations is not recirculated. [**33:**7.3]

A.43.1.5.3 All spray areas require make-up air, and since the air exhausted from spray application operations is normally contaminated and can be recirculated only under rigidly controlled conditions, the source of the make-up air should be given careful consideration. When the capacity of the ventilating fan is low and the area where the exhaust system is located is large, sufficient make-up air often can be provided by natural infiltration of air through building walls, windows, doors, and so forth. In general, if the volume of the room or building where the exhaust system is located is not equal to at least 20 times the volumetric capacity of the fans (three air changes per hour), then additional make-up air should be provided. Outside air should be tempered and might have to be dehumidified or chilled for proper operation of the spray application apparatus. Automatic controls, including a high temperature limit switch, fan interlocks, and safety shutoff valves, should be provided for safe operation. [**33:**A.7.3]

The method of distributing the make-up air requires careful consideration. If the velocities and distribution of air through baffles, filters, and registers have not been carefully designed, the spray application operation can be inefficient. The velocity of the air through filters, and so forth, should not exceed 200 ft/min (60 m/min). Higher velocities can disrupt spray application operations due to turbulent airflow in the vicinity of the spray apparatus. This turbulence can also cause a properly designed exhaust system to fail to confine and remove vapors or to fail to confine and control residues, dusts, and deposits. [**33:**A.7.3]

In some heating arrangements, forced make-up or replacement air directly compensating for the contaminated air exhausted from spray application operations is used in place of or to augment general area heating and ventilation. [**33:**A.7.3]

With the many variables that can be encountered in heating and ventilating systems, it generally is advisable to engage the services of a qualified ventilating engineer to obtain a safe and efficient installation. [**33:**A.7.3]

The features that should be considered include the following:

(1) Location of sources of heat to comply with 43.1.4
(2) Locating air intakes to prevent recalculation of contaminated air, and equipping air intakes with appropriate screens or filters
(3) Automatic temperature and proportioning controls, including an independent excess temperature limit control
(4) A safety system interlocked with the heater to automatically provide for its safe ignition and to minimize the hazards that might result from failure of its proper operating cycle, proper pressure of fuel supply, ventilation, and electrical power
(5) An interlock between the spray booth exhaust system and the make-up air system to ensure that both systems are operable and provide a proper balance of supply and replacement air
(6) In the case of direct-fired units, operating controls that ensure that concentrations of unburned fuel or products of combustion, if inhaled, are kept to levels that are safe for operating personnel

[**33:**A.7.3]

Δ **43.1.5.4 Routing of Exhaust Ducts.** Air exhausted from liquid spray operations shall be conducted by ducts directly to the outside of the building. Exhaust ducts shall follow the shortest route to the point of discharge and shall meet the following conditions:

(1) Exhaust ducts shall not penetrate a fire wall.
(2) Exhaust discharge shall be directed away from any fresh air intakes.
(3) Exhaust discharge point shall be at least 6 ft (1830 mm) from any exterior wall or roof.

(4) Exhaust discharge point shall be at least 10 ft (3048 mm) from openings into the building.
(5) Exhaust discharge point shall be at least 10 ft (3048 mm) above adjoining grade.
(6) Exhaust duct shall not discharge in the direction of any combustible construction that is within 25 ft (7625 mm) of the exhaust duct discharge point.
(7) Exhaust duct shall not discharge in the direction of any unprotected opening in any noncombustible or limited-combustible construction that is within 25 ft (7625 mm) of the exhaust duct discharge point.
(8) Exhaust duct shall not discharge in the direction of any exit discharge or public way that is within 25 ft (7625 mm) of the exhaust duct discharge point.

[**33:**7.4]

If a fire occurs in a spray booth or spray room, standard practice is to not shut down the exhaust system. This prevents backdraft of flame into the area where the spray booth or room is located. However, flames, heat, and products of combustion will be ejected out the exhaust stack. The provisions of 43.1.5.4 are intended to minimize damage that might result by ensuring the exhaust stack terminates far enough away from any exposures.

43.1.5.5 Recirculation of Exhaust.

43.1.5.5.1* Air exhausted from spray areas shall not be recirculated unless all of the following requirements are met:

(1) Recirculation particulate filters as defined in this *Code* shall be used to remove particulates from the recirculated air.
(2) The concentration of vapors in the exhaust airstream shall not exceed 25 percent of the lower flammable limit.
(3) Listed equipment shall be used to monitor the concentration of vapors in all exhaust airstreams.
(4) The equipment specified in 43.1.5.5.1(3) shall initiate a local alarm and shall automatically shut down the spray operation if the concentration of any vapor in the exhaust airstream exceeds 25 percent of the lower flammable limit.
(5) All equipment installed to process and remove contaminants from the air exhausted from spray operations shall be approved by the AHJ.
(6)* For occupied spray areas where a portion of the exhaust air is recirculated within the spray area, toxicity and worker exposures shall be addressed.

[**33:**7.5.1]

A.43.1.5.5.1 If air exhausted from the spray area is permitted to be recirculated, as provided for in 43.1.5.5.1, it is critical for effective monitoring that sensors be protected from obstruction and contamination. See *NFPA 72* for recommended maintenance and calibration procedures. [**33:**A.7.5.1]

N **A.43.1.5.5.1(6)** If recirculated air is used for make-up air for occupied spaces, including spray areas, spray booths, spray rooms, and other process areas, the requirements for decontamination and maximum allowable concentrations of solvents are far more stringent than those required by this standard for fire and explosion prevention. Refer to appropriate occupational safety and health and industrial hygiene standards for permissible exposure limits. One such standard is ANSI/AIHA Z9.7, *Recirculation of Air from Industrial Process Exhaust Systems*. [**33:**A.7.5(6)]

43.1.5.5.2* The provisions of 43.1.5.5.1 shall not disallow recirculation of air to occupied spaces. However, other requirements addressing the toxicity and permissible exposure limits shall also apply. *(See ANSI/AIHA Z9.7, Recirculation of Air from Industrial Process Exhaust Systems.)* [**33:**7.5.2]

A.43.1.5.5.2 If recirculated air is used for make-up air for occupied spaces, including spray areas, spray booths, spray rooms, and other process areas, the requirements for decontamination and maximum allowable concentrations of solvents are far more stringent than those required by this *Code* for fire and explosion prevention. Refer to appropriate occupational safety and health and industrial hygiene standards for permissible exposure limits. One such standard is ANSI/AIHA Z9.7, *Recirculation of Air from Industrial Process Exhaust Systems*. [**33:**A.7.5.2]

43.1.5.6* Manifolding of Exhaust Ducts. Individual spray booths shall be separately ducted to the building exterior.

Exception No. 1: Multiple cabinet spray booths whose combined frontal area does not exceed 18 ft² (1.7 m²) shall be permitted to be manifolded if the sprayed materials used will not react and cause ignition of the residue in the ducts.

Exception No. 2: Where treatment of exhaust is necessary for air pollution control or for energy conservation, ducts shall be permitted to be manifolded if all of the following conditions are met:

(1) The sprayed materials used will not react and cause ignition of the residue in the ducts.
(2) No finishing materials containing nitrocellose are used.
(3) An air-cleaning system is provided to reduce the amount of overspray carried into the duct manifold.
(4) Automatic sprinkler protection is provided at the junction of each booth exhaust with the manifold, in addition to the protection required by 43.1.7.
*(5) The installation is approved by the AHJ. [**33:**7.6]*

A.43.1.5.6 Exhaust systems should be individually ducted to the outside of the building. Where treatment of the exhaust airstream is necessary to satisfy environmental regulations or where energy conservation measures are used, this might not be practical, and manifolding of the exhaust ducts might be necessary. It should be understood that manifolding of exhaust ducts increases the fire hazard. A fire starting in one booth can spread through the exhaust system and involve other spray areas. Heat exchangers, which are sometimes used to preheat exhaust air before it enters an incinerator, are subject to fires from the spontaneous ignition of residue that collects on heat exchanger surfaces. [**33:**A.7.6]

It is critical that the provisions of 43.1.5.6, Exception No. 2, be met in order to prevent a fire in a spray booth or spray room from spreading through the exhaust ventilation system and involving other spray areas.

Where heat exchangers are used, the surfaces of the heat exchangers must be cleaned at intervals that are frequent enough to prevent a buildup of residue.

43.1.5.7* Materials of Construction. Exhaust plenums and exhaust ducts and fasteners shall be constructed of steel, except as allowed in 43.1.5.7.1, 43.1.5.7.2, and 43.1.5.7.3. [**33:**7.7]

Δ **A.43.1.5.7** For ducts for powder coating systems, the strength of the materials of construction should be considered, since the duct might have to contain the pressure of a deflagration. *(See NFPA 68.)* [**33:**A.7.7]

43.1.5.7.1 For spray booths used exclusively for powder coating, ducts shall be permitted to be constructed of fire-retardant combustible materials. [**33:**7.7.1]

43.1.5.7.2 Concrete shall be permitted to be used. The interior surfaces of the concrete exhaust plenum or exhaust duct shall be smooth and sealed to facilitate cleaning. [**33:**7.7.2]

43.1.5.7.3 Other materials of construction shall be permitted to be used in cases where the conveyed materials are not compatible with steel. [**33:**7.7.3]

43.1.5.8* Support of Exhaust Ducts. Exhaust ducts shall be supported to prevent collapse under fire conditions. [**33:**7.8]

A.43.1.5.8 The designer of the exhaust ducts and fasteners should refer to appropriate design guides, such as the SMACNA *Round Industrial Duct Construction Standards* and the SMACNA *Rectangular Industrial Duct Construction Standards*, published by the Sheet Metal and Air Conditioning Contractors National Association. [**33:**A.7.8]

43.1.5.8.1 Duct supports shall be designed to carry the weight of the duct system itself, plus the anticipated weight of any residues. If sprinkler protection is provided inside the duct system, then the duct supports also shall be designed to carry the anticipated weight of any accumulation of sprinkler discharge. [**33:**7.8.1]

Δ **43.1.5.8.2** Hangers and supports shall be fastened to the building or to the structure to minimize vibration and stress on the duct system. [**33:**7.8.2]

This provision was revised to eliminate vague and unenforceable language. The words "securely" and "avoid" were deleted. The performance expected is that hangers and supports are fastened strongly enough to minimize vibration, recognizing that it is not possible to completely eliminate it.

43.1.5.8.3 Hangers and supports shall be designed to allow for expansion and contraction. [**33:**7.8.3]

43.1.5.8.4 Exhaust ducts shall not use building walls, floors, ceilings, or roofs as component parts. [**33:**7.8.4]

43.1.5.8.5 The provisions of 43.1.5.8.4 shall not disallow the use of concrete exhaust plenums or exhaust ducts where some or all of the plenum or duct is part of the concrete floor. [**33:**7.8.5]

43.1.5.9 Exhaust Duct Access Openings. Exhaust ducts shall be provided with doors, panels, or other means to facilitate inspection, maintenance, cleaning, and access to fire protection devices. [**33:**7.9]

43.1.5.10 Exhaust Fans and Drives.

43.1.5.10.1 The rotating element of the exhaust fan shall be nonferrous, or the fan shall be constructed so that a shift of the impeller or shaft will not permit two ferrous parts of the fan to rub or strike. Necessary allowances shall be made for ordinary expansion and loading and to prevent contact between moving parts and the duct or fan housing. Fan blades shall be mounted on a shaft that is sufficiently heavy to maintain alignment even when the blades of the fan are heavily loaded. All bearings shall be of the self-lubricating type or shall be provided with accessible lubricating ports. [**33:**7.10.1]

This provision was revised to eliminate vague and unenforceable language. The second sentence was revised to remove text that was redundant to the performance requirement of the first sentence. The provision regarding lubrication points was also revised to remove unenforceable text.

43.1.5.10.2 Electric motors that drive exhaust fans shall not be placed inside any spray area unless they meet the provisions of 43.1.4.3.3. [**33:**7.10.2]

The exhaust duct is considered part of the spray area. Therefore, any electrical devices in the exhaust air stream must be suitable for a hazardous (classified) area.

43.1.5.10.3 Belts shall not enter any spray area unless the belt and pulley within the spray area are completely enclosed. [**33:**7.10.3]

Drive belts are subject to frictional heating that could lead to ignition of the belt. They must be isolated from the exhaust air stream to prevent ignition of any vapors therein or of any residues on the inside of the duct.

43.1.5.11* Drying Areas. Freshly sprayed workpieces shall be dried only in spaces that are ventilated to prevent the concentration of vapors from exceeding 25 percent of the lower flammable limit. *(See also Section 43.4.)* [**33:**7.11]

A.43.1.5.11 If there are other operations that give off ignitible vapors in the vicinity of a spray application operation, they should be provided with independent mechanical ventilation. [**33:**A.7.11]

43.1.6 Storage, Handling, and Distribution of Flammable and Combustible Liquids.

43.1.6.1* General. Storage, handling, and mixing of flammable and combustible liquids shall meet all the applicable requirements of NFPA 30 and 43.1.6. [**33:**8.1]

A.43.1.6.1 For large spray operations, coatings, thinners, and solvents can be stored in one of the following locations:

(1) Underground storage tanks
(2) Aboveground storage tanks
(3) Separate buildings
(4) Separate dedicated rooms within the facility

[**33:**A.8.1]

In some cases, liquids are pumped to a mixing room or paint kitchen, where they are mixed and then pumped to the spray area. For smaller operations, separate storage and mixing areas might not be justified. However, it is desirable to minimize the fire loading in or near the spray area by one or a combination of the following methods:

(1) Flammable liquid storage cabinets
(2) A protected enclosed metal structure
(3) Use of metal containers with limitations on the quantity of liquid located near the spray area

[**33:**A.8.1]

43.1.6.2 Storage in Process Areas.

43.1.6.2.1 The volume of Class I, Class II, and Class IIIA liquids stored in a storage cabinet shall not exceed 120 gal (454 L). [**33:**8.2.1]

Δ **43.1.6.2.1.1** The total aggregate volume of Class I, Class II, and Class IIIA liquids in a group of storage cabinets shall not exceed the maximum allowable quantity of flammable and combustible liquids per control area based on the occupancy where the cabinets are located, as set forth in Section 9.6 of NFPA 30. [**33:**8.2.1.1]

Δ **43.1.6.2.1.2** For industrial occupancies, the total aggregate volume of Class I, Class II, and Class IIIA liquids in a group of storage cabinets in a single area shall not exceed the maximum allowable quantity (MAQ) of flammable and combustible liquids per control area for industrial occupancies as set forth in Table 43.1.6.2.1.2. [**33:**8.2.1.2]

Δ ***TABLE 43.1.6.2.1.2** Maximum Allowable Quantity of Flammable and Combustible Liquids per Control Area*

	Liquid Classes	Quantity		Notes
		L	gal	
Flammable liquids	IA	115	30	1, 2
	IB & IC	460	120	1, 2
	IA, IB, IC combined	460	120	1, 2, 3
Combustible liquids	II	460	120	1, 2
	IIIA	1,265	330	1, 2

Source: Table 34.1.3.1 of *NFPA 5000, Building Construction and Safety Code*, 2009 edition.

Notes:

(1) Quantities are permitted to be increased 100 percent where all liquids are stored in approved flammable liquids storage cabinets or in safety cans. Where Note 2 also applies, the increase for both notes is permitted to be applied accumulatively.

(2) Quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13. Where Note 1 also applies, the increase for both notes is permitted to be applied accumulatively.

(3) Containing not more than the maximum allowable quantity per control area of Class IA, Class IB, or Class IC flammable liquids, individually.

[**33:** Table 8.2.1.2]

43.1.6.2.2 The quantity of liquid located in the vicinity of spraying operations but outside of identified storage areas, such as storage cabinets, an inside liquid storage area, or a warehouse or outside of other specific process areas that are cut off by at least a 2-hour fire separation from the spraying operations shall not exceed the quantity given in either of the following, whichever is greater:

(1)* The amount required to supply spraying operations for one continuous 24-hour period

A.43.1.6.2.2(1) The intent of this requirement is to allow the quantities of flammable and combustible liquids needed to safely and efficiently operate for the actual operating hours in any 24-hour period. As an example, if the facility operates only 8 hours out of 24 (i.e., a single shift) and uses 50 gal (190 L) of liquid during that time, then 50 gal (190 L) is the allowable quantity for the continuous 24-hour period. If the facility increases operations to two shifts, then the allowable quantity doubles to 100 gal (380 L). [**33:**A.8.2.2(1)]

(2) The aggregate sum of the following:
   (a) 25 gal (95 L) of Class IA liquids in containers
   (b) 120 gal (454 L) of Class IB, Class IC, Class II, or Class III liquids in containers
   (c) 1585 gal (6000 L) of either of the following:
      1. Class IB, IC, II, or IIIA liquids in metal portable tanks or metal intermediate bulk containers, each not exceeding 793 gal (3000 L)
      2. Class II or Class IIIA liquids in nonmetallic intermediate bulk containers, each not exceeding 793 gal (3000 L)
   (d) Twenty portable tanks or intermediate bulk containers, each not exceeding 793 gal (3000 L) of Class IIIB liquids [**33:**8.2.2]

It should be noted that the "aggregate sum" of 43.1.6.2.2(2)(a) through (d) is extracted from 8.2.2 of NFPA 33, which, in turn, extracts the text from the 2015 edition of NFPA 30, *Flammable and Combustible Liquids Code*. The 2018 edition of NFPA 30 does not include this text but bases all quantities on the "maximum allowable quantity." Basically, NFPA 30 allows the aggregate sum of the quantities allowed for each class of liquid, as set forth in Table 43.1.6.2.1.2 (i.e., Table 18.5.4 in NFPA 30, 2018 edition) *or* the amount required for a single continuous 24-hour period.

43.1.6.2.3 The quantity of flammable and combustible liquids located in a spray area or in a mixing room adjacent to a spray area shall meet the requirements of 43.1.6.3. [**33:**8.2.3]

43.1.6.3 Mixing.

43.1.6.3.1 Dispensing or transfer of liquids from containers and filling of containers, including portable mixing tanks and "pressure pots," shall be done only in a spray area with the ventilation in operation or in a mixing room. [**33:**8.3.1]

Pressure pots are special pressure tanks designed and outfitted specifically to feed paint or similar coatings to a manual spray gun. See Exhibit 43.5.

Exhibit 43.5

Typical paint pressure pot. (Courtesy of Carlisle Fluid Technologies)

Δ **43.1.6.3.2** Mixing rooms shall meet all of the following requirements:

(1) Mixing rooms shall meet the construction requirements of 43.1.3.
(2) The area of a mixing room shall not exceed 150 ft^2 (14 m^2).
(3) If more than one mix room is installed, the total quantity of liquids shall not exceed the limits in 43.1.6.3.4 or 43.1.6.3.5.
(4) Mixing rooms shall be designed to contain a spill of the contents in the room.
(5) Mixing rooms used for mixing and dispensing operations shall be provided with continuous mechanical ventilation capable of providing air movement of not less than 1 ft^3/min per square foot of floor area (0.3 $m^3/min/m^2$) or 150 ft^3/min (4 m^3/min), whichever is greater. The ventilation system shall be in operation at all times.

This level of exhaust ventilation provides six air changes per hour for the ventilated space, assuming a 10 foot (3 m) ceiling height. Six air changes per hour historically has been considered sufficient to prevent accumulation of fugitive vapors from normal industrial activities.

(6) The mixing room air make-up system and exhaust system shall remain functioning during any fire alarm condition in accordance with Section 9.3 of NFPA 33.

See commentary to 43.1.5.4 and to 43.1.7.3.

(7) Mixing rooms shall be classified, for purposes of electrical area classification, the same as enclosed spray booths, in accordance with 43.1.4.4.4.
(8) Mixing rooms shall be provided with an approved automatic fire protection system that meets all applicable requirements of Chapter 9 of NFPA 33.
(9) Mixing rooms shall be provided with portable fire extinguishers located in accordance with NFPA 10.

[**33:**8.3.3]

43.1.6.3.3 The amount of liquid permitted in a single spray area shall not exceed 60 gal (227 L). [**33:**8.3.4]

43.1.6.3.4 Where a separate mixing room is provided and the mixing room is located adjacent to or within 6 ft (1830 mm) of an adjacent spray area or areas, as shown in Figure 43.1.6.3.4(a) and Figure 43.1.6.3.4(b), the combined quantities of liquids located in the spray areas and the mixing room shall not exceed 120 gal (454 L). [**33:**8.3.5]

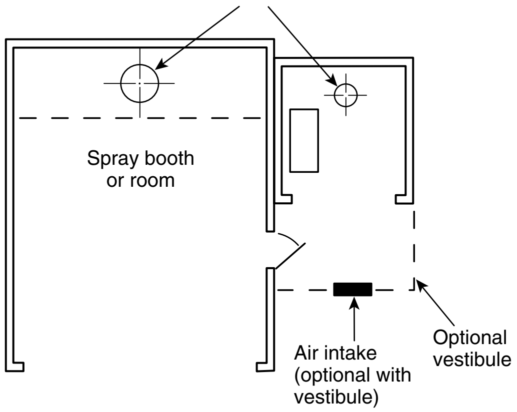


***FIGURE 43.1.6.3.4(a)** Mixing Room Within 6 ft (1830 mm) of Spray Area, Including Maximum Volume of Liquid Allowed. [**33:**Figure 8.3.5.(a)]*

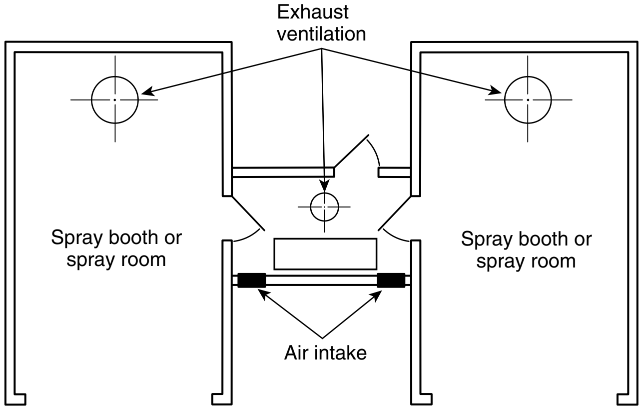


***FIGURE 43.1.6.3.4(b)** Mixing Room Within 6 ft (1830 mm) of Spray Area and with Direct Entry to Spray Area, Including Maximum Volume of Liquid Allowed. [**33:**Figure 8.3.5(b)]*

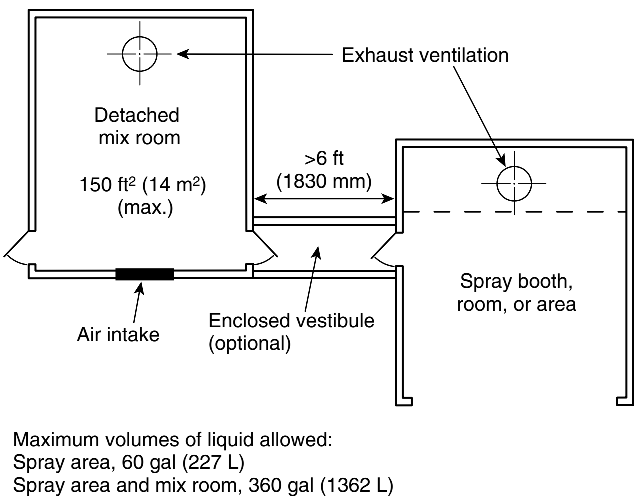


***FIGURE 43.1.6.3.5** Mixing Room More Than 6 ft (1830 mm) from Spray Area, Including Maximum Volume of Liquid Allowed. [**33:**Figure 8.3.6]*

43.1.6.3.5 Where a separate mixing room is provided and the mixing room is located more than 6 ft (1830 mm) from an adjacent spray area or areas, the quantity of liquid permitted in the mixing room shall not exceed 2 gal/ft^2 (80 L/m^2), up to a maximum of 300 gal (1135 L), as shown in Figure 43.1.6.3.5. The amount of liquid in the spray area shall not exceed 60 gal (227 L). [**33:**8.3.6]

43.1.6.4 Distribution Systems — Piping.

43.1.6.4.1* Piping systems that convey flammable or combustible liquids between storage tanks, mixing rooms (paint kitchens), and spray areas shall be of steel or other material having comparable properties of resistance to heat and physical damage. Piping systems shall be properly bonded and grounded. [**33:**8.4.1]

A.43.1.6.4.1 NFPA 77 provides information on bonding and grounding. [**33:**A.8.4.1]

43.1.6.4.2* Piping systems within the spray area shall be of steel or material having comparable heat and physical resistance where possible. Where tubing or hose is used, a shutoff valve shall be provided on the steel pipe at the connection. [**33:**8.4.2]

A.43.1.6.4.2 Valves should be kept shut when spray application operations are not being conducted, to minimize the release of coating material in the event of fire. [**33:**A.8.4.2]

43.1.6.4.3* Tubing or hose shall be inspected and replaced as necessary. Replacement tubing or hose shall be that recommended by the equipment manufacturer. [**33:**8.4.3]

A.43.1.6.4.3 If plastic tubing leaks within shielded areas, such as within color changers, the resulting spray fire will destroy all tubing, releasing large quantities of coating material in an area that cannot be reached by the booth protection system. Automatic protection systems should be provided for these areas. [**33:**A.8.4.3]

A major cause of fire in automatic electrostatic spray booths has been the replacement of original equipment plastic tubing with other types of tubing. Such replacement tubing, particularly if conductive coatings are used, is susceptible to the development of pinhole leaks. [**33:**A.8.4.3]

43.1.6.4.4 Where a pump is used to supply the liquid used in the spray application process, piping, tubing, hose, and other accessories shall be designed to withstand the maximum working pressure of the pump, or means shall be provided to limit the discharge pressure of the pump. [**33:**8.4.4]

43.1.6.4.5* Where a pump is used to supply the liquid used in the spray application process, an automatic means shall be provided to shut off the supply of liquid in event of fire. When pressurized tanks larger than 5 gal (19 L) are used to supply the liquid used in the spray application process, an automatic means shall be provided to shut off liquid flow at the tank outlet in the event of fire. [**33:**8.4.5]

A.43.1.6.4.5 The severity and extent of the many fires in spray application operations has been substantially increased when rubber or plastic supply hose were burned off, resulting in the entire contents of the supply system being added to the fire. By limiting the amount of fuel available, the magnitude of the fire can be held to more manageable limits. The shutoff should be accomplished by means of an interlock with a fire detection system or the automatic fire extinguishing system for the spray area. This shutoff is normally accomplished by shutting the distribution pumps. In some cases, it is also advisable to limit the flow from the solvent piping system. This can be accomplished with properly specified check valves in the pipe “drops.” [**33:**A.8.4.5]

43.1.6.4.6 All pressure tubing, hose, and couplings shall be inspected at regular intervals. With the hose extended, the hose and couplings shall be tested using the in-service maximum operating pressure. Any hose showing material deteriorations, signs of leakage, or weakness in its carcass or at the couplings shall be replaced. [**33:**8.4.6]

43.1.6.5 Distribution Systems — General.

43.1.6.5.1 Liquids shall be transported by means of closed containers, approved safety cans, or approved portable tanks or shall be transferred by means of a piping system. Open containers shall not be used for moving or storing liquids. [**33:**8.5.1]

43.1.6.5.2* Wherever liquids are transferred from one container to another, both containers shall be effectively bonded and grounded to dissipate static electricity. [**33:**8.5.2]

A.43.1.6.5.2 NFPA 77 provides information on static protection. [**33:**A.8.5.2]

43.1.6.5.3 Containers that supply spray nozzles shall be of the closed type or shall be provided with metal covers that are kept closed. Containers that do not rest on the floor shall have supports or shall be suspended by wire cables. Containers that supply spray nozzles by gravity flow shall not exceed 10 gal (38 L) capacity. [**33:**8.5.3]

43.1.6.5.4 Original shipping containers shall not be subjected to air pressure for supplying spray nozzles. [**33:**8.5.4]

43.1.6.5.5 Containers that are pressurized to supply spray nozzles, air storage tanks, and coolers shall comply with all applicable requirements of the ASME *Boiler and Pressure Vessel Code*, Section VIII, for construction, tests, and maintenance. [**33:**8.5.5]

N **43.1.6.5.5.1** Containers that meet the following requirements need not meet the requirements of the ASME *Boiler and Pressure Vessel Code*, Section VIII, for construction, tests, and maintenance:

(1) Pressure containers less than 6 in. (150 mm) in diameter
(2) Pressure containers that operate at less than a gauge pressure of 15 psi (1.03 kPa)
(3) Siphon-type spray cups

[**33:**8.5.5.1]

Δ **43.1.6.5.6** If a heater is used to heat the liquid being sprayed, it shall be low-pressure steam, low-pressure hot water, or electric. [**33:**8.5.6]

N **43.1.6.5.6.1** If electric heaters are used to heat the liquid being sprayed, the electric heater shall be approved and listed for the specific location in which it is used. *(See Chapter 6 of NFPA 33.)* [**33:**8.5.6.1]

N **43.1.6.5.6.2** Heaters shall not be located in spray booths or other locations subject to the accumulation of deposits of combustible residue. [**33:**8.5.6.2]

N **43.1.6.5.7** Agitators, if used, shall be driven by compressed air, water, low-pressure steam, or electricity. [**33:**8.5.7]

N **43.1.6.5.7.1** If the agitators are powered by an electric motor, the motor shall meet the requirements of Chapter 6 of NFPA 33. [**33:**8.5.7.1]

43.1.6.5.8 Methods for cleaning paint circulation systems shall meet the requirements of Chapter 18 of NFPA 30. [**33:**8.5.8]

Δ **43.1.6.5.9** Compressed air shall be permitted to be used for cleaning paint delivery hoses for individual applicators in a spray booth, provided both of the following requirements are met:

(1) The booth ventilation is operating.
(2) The maximum air pressure does not exceed the maximum working pressure of any component of the piping or hose system.

[**33:**8.5.9]

43.1.7 Protection.

Δ **43.1.7.1* General.** Spray areas, as defined in this *Code*, and mixing rooms, shall be protected with an approved automatic fire protection system. This shall apply to both manual and automated spray application processes. [**33:**9.1]

The second sentence was added to emphasize that manual and automated spray application systems are subject to the provisions of Chapter 9 of NFPA 33. Historically, there has been some misconception that only automated systems needed to be protected.

Note that 43.1.7.1 requires an automatic fire *protection* system. This does not imply that an *automatic sprinkler* system is mandated or even preferred. The type of system chosen should be based on the type of spray application system used, the characteristics of the coating(s) used, economics, and, in the case of automatic sprinklers, sufficient water flow to supply the system. See also the commentary after the last paragraph of A.43.1.7.1.

Also note that NFPA 33 incorporated new provisions for the protection of dry particulate scrubbers (Section 9.9), electrostatic precipitator scrubbers (Section 9.10), and high-capacity dry paint arrestors (Section 9.11). Those sections address new technology applications that have not been extracted into this edition of the *Code*. Therefore, the reader will have to refer to the 2016 (or later) edition of NFPA 33 for these protection requirements.

A.43.1.7.1 As indicated in 43.1.6, it is not advisable to keep large quantities of flammable or combustible liquids in areas that expose personnel or important property to injury or loss. The primary reason is that fires in flammable liquids are difficult to extinguish by the usual methods, and if large quantities are involved, they can spread the fire by flowing over large areas. For fires in small amounts of flammable or combustible liquids, hand extinguishers or large extinguishers on wheels especially designed for such fires are effective. If large quantities of liquids are to be protected, suitable automatic equipment should be provided and special attention should be given to proper dikes, curbs, and drains to prevent the flow to other property. [**33:**A.9.1]

For the extinguishment of fire in spray residues, handheld fire extinguishers suitable for fire in ordinary combustibles or hose streams are effective. [**33:**A.9.1]

Regardless of the level of filtration, residues will accumulate in the exhaust ductwork. Because the ductwork is part of the spray area, it must be protected in accordance with 43.1.7. This includes the ductwork from a water-wash booth. [**33:**A.9.1]

Water-wash spray booths use a recirculating curtain of water at the entrance to the exhaust plenum to remove overspray particles from the exhaust air stream. They are typically used where large quantities of coating are used and are very efficient at cleaning the exhaust air stream. As efficient as they are, some coating particles will still pass through the water curtain and will settle on the interior of ductwork. See Exhibit 43.6.

Because the particulate filters will accumulate paint residue, they must be protected. The solvent concentrator units, by their design, contain high concentrations of solvent, so they also must be protected. Also, the most commonly used solvent concentrators use activated carbon as the adsorption medium. This medium is highly combustible, especially with high levels of solvents absorbed. Ketone solvents pose an even greater risk. [**33:**A.9.1]

Because suppression media other than water might damage the carbon bed, water-based suppression systems (wet pipe sprinklers, preaction sprinklers, dry pipe sprinklers, and open-head deluge systems) are recommended for this application. [**33:**A.9.1]

The recirculated air supply unit must be protected because of the filter media it contains. Also, many large air supply units have gas-fired heaters to heat outside make-up air. [**33:**A.9.1]

Exhibit 43.6

Typical water-wash spray booth. (Courtesy of Global Finishing Solutions)

Air supply ducts from the particulate filter to the air supply unit and from the air supply unit to the spray booth are not normally protected, since all particulates have been filtered. [**33:**A.9.1]

The choice of the automatic fire protection system should always be based on good engineering practice. Generally, for most spray areas, automatic sprinklers are considered most appropriate *(see A.43.1.7.4)*. However, consideration must be given to how much water is likely to flow and to how much water is to be contained. [**33:**A.9.1]

Dry chemical extinguishing systems are most appropriate for small spray application operations (e.g., automotive refinishing, furniture refinishing, and similar processes) that utilize dry filters to capture overspray. These systems provide economical adequate protection. They are a viable alternative for any facility without sufficient water supply to support an automatic sprinkler system. [**33:**A.9.1]

Carbon dioxide or clean agent extinguishing systems should be used for open area protection only after careful consideration. Holding the required concentration of agent for the period of time needed for extinguishment in a spray booth environment can be difficult. In addition, total flooding with carbon dioxide in normally or potentially occupied areas presents serious health concerns. The time delay required prior to discharge can allow a fire time to grow and spread. Carbon dioxide and clean agent systems, however, are an appropriate choice for protecting electrostatic equipment enclosures inside or immediately outside the spray area. [**33:**A.9.1]

Handheld fire extinguishers or specially designed large extinguishers on wheels are effective only for fires involving small quantities of flammable or combustible liquids.

Handheld fire extinguishers suitable for fires in ordinary combustibles or hose streams are generally effective for extinguishing fires in spray residue. See Section 13.6 for issues relating to fire extinguisher selection and placement.

Δ **43.1.7.1.1** The automatic fire protection system shall be permitted to be, and shall be installed in accordance with, any of the following:

(1) An automatic water sprinkler system that meets all applicable requirements of NFPA 13
(2) An automatic foam water sprinkler system that meets all applicable requirements of NFPA 16
(3) A carbon dioxide extinguishing system that meets all applicable requirements of NFPA 12
(4) A dry chemical extinguishing system that meets all applicable requirements of NFPA 17
(5) A gaseous agent extinguishing system that meets all applicable requirements of NFPA 2001
(6) A water mist fire protection system that meets the applicable requirements of NFPA 750

[**33:**9.1.1]

43.1.7.1.2 The automatic fire protection system also shall meet all applicable requirements of 43.1.7.2 and 43.1.7.3. [**33:**9.1.2]

43.1.7.1.3 The fire alarm and fire protection system shall be supervised in accordance with *NFPA 72*. [**33:**9.1.3]

43.1.7.2 Continuous Spray Application Operations.

43.1.7.2.1 For continuous spray application operations, activation of the automatic fire protection system shall automatically accomplish all of the following:

(1) Activate a local alarm in the vicinity of the spraying operation
(2) Transmit an alarm signal to the facility's fire alarm system, if such a system is provided
(3) Shut down the coating material delivery system
(4) Shut down all spray application operations
(5) Stop any conveyors into and out of the spray area [**33:**9.2.1]

43.1.7.2.1.1 For continuous spray application operations, the additional requirements of 43.1.7.7, for automated powder application equipment, or 43.1.7.8, for automated liquid electrostatic spray application equipment, whichever is applicable, shall also apply. [**33:**9.2.1.1]

43.1.7.2.2 Emergency Shutdown. For continuous spray application operations, one or more manual emergency system shutdown stations shall be installed to serve each spray area. When activated, the stations shall accomplish at least the functions listed in 43.1.7.2.1(1) and 43.1.7.2.1(3) through 43.1.7.2.1(5). At least one such station shall be within ready access of operating personnel. If access to this station is likely to involve exposure to danger, an additional station shall be located adjacent to an exit from the area. [**33:**9.2.2]

43.1.7.3 Ventilation Systems. Air make-up systems and spray area exhaust systems shall remain functioning during any fire alarm condition. [**33:**9.3]

As explained in the commentary to 43.1.5.4, standard practice is to not shut down the exhaust system if there is a fire in the spray area, to prevent backdraft into the surrounding area. This provision disallows any interlock between the exhaust system controls and the fire alarm system that would initiate a shutdown. This is fine for spray areas protected with an automatic sprinkler system, but it might be detrimental to a gaseous or dry chemical extinguishing system. Recognizing this, 43.1.7.3.1 serves as an exception to this rule.

N **43.1.7.3.1** Where the type of automatic fire protection system requires that ventilation be discontinued, air make-up systems and spray area exhaust systems shall be permitted to be shut down and dampers shall be permitted to close. [**33:**9.3.1]

43.1.7.4* Automatic Sprinkler Systems.

A.43.1.7.4 Spray application operations should be located only in buildings that are completely protected by an approved system of automatic sprinklers. If the operations are located in unsprinklered buildings, sprinklers should be installed to protect spray application processes where practical. Because of the rapidity and intensity of fires that involve spray operations, the available water should be ample to simultaneously supply all sprinklers likely to open in one fire without depleting the available water for use by hose streams. Noncombustible draft curtains can be used to limit the number of sprinklers that will open. [**33:**A.9.4]

Even when areas adjacent to coating operations are considered under reasonably positive fire control by adequate automatic sprinkler protection, damage is possible if operations are conducted on floors above those containing contents that are highly susceptible to water damage. Waterproofing and drainage of spray room floors can assist in reducing water damage on floors below. Proper drainage of the large volume of water frequently necessary to extinguish spray finishing room fires often presents considerable difficulty. [**33:**A.9.4]

Automatic sprinklers in spray areas, including the interior of spray booths and exhaust ducts, should be wet pipe, preaction, or deluge system so that water can be placed on the fire in the shortest possible time. Automatic sprinklers in spray booths and exhaust ducts should be of the lowest practical temperature rating. The delay in application of water with ordinary dry pipe sprinklers can permit a fire to spread so rapidly that final extinguishment is difficult without extensive resulting damage. [**33:**A.9.4]

The location of the sprinklers inside spray booths should be selected with care to avoid heads being placed in the direct path of spray and yet afford protection for the entire booth interior. When sprinklers are in the direct path of spray, even one day's operation can result in deposits on the sprinklers that insulate the fusible link or choke open head orifices to the extent that sprinklers cannot operate efficiently. [**33:**A.9.4]

Automatic sprinklers should also be located so that areas subject to substantial accumulations of overspray residue are protected. Generally, sprinklers are located no more than 4 ft (1220 mm) from side walls of booths and rooms and from dry overspray collectors (where applicable). Sprinklers in booths or rooms should be on Extra Hazard occupancy spacing of 100 ft^2 (9.3 m^2). [**33:**A.9.4]

All sprinkler systems in spray areas should be controlled by an accessible indicating control valve. [**33:**A.9.4]

Use of water as the extinguishing agent for solvent and coating material fires might, in some cases, cause problems with splashing and "floating" of flaming liquids and residues. This possibility should be included with the other factors that are normally considered in the selection of an extinguishing agent. In addition, water from sprinkler or deluge systems, after coming into contact with coating materials, residues, or solvents, might have to be collected and treated as hazardous waste. [**33:**A.9.4]

Where spray application operations are located in unsprinklered buildings, sprinklers can be fed from the domestic water system, if sufficient flow and pressure are available. See NFPA 13, *Standard for the Installation of Sprinkler Systems,* for sprinkler system installation requirements from the domestic water system. This statement does not mean that an unsprinklered building must be retrofitted with automatic sprinklers only because of the presence of a spray application process. Other types of fixed fire protection systems are allowed, as required by the AHJ, to meet the protection requirements for spray operations using flammable or combustible materials.

The alternative agents permitted by 43.1.7.5 have limitations. These limitations include the size of the area or the size of the hazard that can be protected, the need for additional confinement of the area, and personnel safety issues. Also, the supply of extinguishing agent is typically limited to the amount needed to meet the anticipated demand, plus a second back-up (compared to a sprinkler system, which can be considered to have an unlimited capacity.) The AHJ should be involved in reviewing the use of alternative fire protection systems to ensure that they can provide the necessary level of protection. For the installation of these systems, see Section 13.8.

43.1.7.4.1* The automatic sprinkler system shall be a wet pipe system, a dry pipe system, a preaction system, or an open-head deluge system, whichever is most appropriate for the portion of the spray operation being protected. [**33:**9.4.1]

A.43.1.7.4.1 Paragraph 43.1.7.4.1 lists four types of automatic sprinkler systems and requires that the one "most appropriate for the portion of the spray area being protected" be used. Generally, an open-head deluge system provides the highest level of protection, given that all sprinklers in the protected area flow simultaneously. This type of system is most appropriate for large, down-draft, water-wash spray booths when protecting automatic electrostatic spray application zones. [**33:**A.9.4.1]

Wet pipe automatic sprinkler systems are appropriate for protecting spray booths that utilize nonelectrostatic application processes or operations using listed electrostatic application processes. Wet pipe systems are also generally used to protect exhaust plenums (eliminator or scrubber sections), exhaust ducts, and air recirculation filter houses. [**33:**A.9.4.1]

Dry pipe systems have been included because some exhaust duct designs include sections that are subject to freezing. [**33:**A.9.4.1]

Preaction systems have been included because some spray application processes and equipment can be damaged by unwanted water discharge. This damage can be disruptive and costly. Powder spray booths and solvent concentrator (air pollution abatement) systems are examples of systems where it is appropriate to use a preaction system. [**33:**A.9.4.1]

43.1.7.4.2 The automatic sprinkler system shall be designed as follows: for Extra Hazard (Group 2) occupancies, as defined in NFPA 13.

(1) For spray application of styrene cross-link thermoset resin application areas, sprinklers shall be designed for Ordinary Hazard (Group 2) as defined in NFPA 13.
(2) For powder coating operations, sprinklers shall be designed for Ordinary Hazard (Group 2) as defined in NFPA 13.
(3) For all other spray areas, sprinklers shall be designed for Extra Hazard (Group 2) as defined in NFPA 13.

[**33:**9.4.2]

N **43.1.7.4.2.1** The sprinkler design area shall not be required to exceed the area of the booth or room in which spraying or resin application is conducted. [**33:**9.4.2.1]

This provision recognizes that the area around the spray booth or spray room is subject to its own sprinkler design parameters, based on the occupancy of the building. Also, in cases where a spray booth or spray room is in an unprotected building and it is desirable to protect the booth or room from the domestic water system, as is allowed by 43.1.7.4.4, limiting the sprinkler design area to the area of the booth or room does not needlessly penalize the design by imposing a water demand for floor area that will not be protected.

43.1.7.4.3 The water supply shall be sufficient to supply all sprinklers likely to open in any one fire incident without depleting the available water for use in hose streams. [**33:**9.4.3]

Refer to A.9.4.3 of NFPA 33 for a thorough discussion of the protocol for calculating the anticipated water demand for a sprinkler system that protects a spray area. Included in that discussion are sample water demand calculation sheets for simple and complex situations.

43.1.7.4.4 Where sprinklers are installed to protect spray areas and mixing rooms only, water shall be permitted to be supplied from domestic water systems, provided the domestic supply can meet the demand for the design criteria of 43.1.7.4.2. [**33:**9.4.4]

43.1.7.4.5 The sprinkler system shall be controlled by a separate, listed indicating valve(s), operable from floor level. [**33:**9.4.5]

The intent of this provision is to allow shutdown of the part of the sprinkler system that protects the spray booth or room without having to impair the domestic supply or the building's automatic sprinkler system, whichever supplies the former.

43.1.7.4.6* Sprinkler systems protecting stacks or ducts shall meet all of the following requirements:

(1) One sprinkler shall be located at the top of each vertical riser and at the midpoint of each offset. Additional heads shall be spaced on 24 ft (7.3 m) centers if the rise is greater than 24 ft (7.3 m).

The first sentence of this provision was added to the 2016 edition of NFPA 33 and is based on the determination that sprinklers located as stipulated are the most effective in dealing with a duct fire. The requirement for additional heads spaced as stated was retained to deal with large duct systems.

(2) Horizontal exhaust ducts shall have sprinklers located on 12 ft (3.7 m) centers beginning no more than 6 ft (1.7 m) from the duct entrance.
(3) Where exhaust ducts are manifolded, a sprinkler shall be located in the manifold at the junction of each exhaust duct with the manifold.

The intent of this provision is to prevent a fire in one spray area from leap-frogging to an adjacent spray area.

(4) Sprinklers shall provide a minimum flow of 30 gpm (114 L/min) per head at a minimum of 15 psi (1 bar) pressure.
(5) Sprinklers shall be ordinary temperature rated, unless required to be higher due to operating temperatures measured in the ducts, in which case the operating temperature shall be at least 50°F (28°C) above the inside temperature of the duct. [**33:**9.4.6]

A.43.1.7.4.6 Water supply requirements for most industrial paint spray operations should be adequate to supply all automatic sprinklers in the spray area. Loss experience has shown that fires starting in the exhaust duct can spread to the spray booth and that fires starting in the booth can spread to the exhaust duct. [**33:**A.9.4.6]

Sprinklers or sprinkler systems protecting stacks or ducts should be of a type not subject to freezing. Automatic systems are preferred, but manual systems are also acceptable. Nonfreeze or dry-type sprinkler systems can be used in ducts subject to freezing. For some industries, such as the automotive industry, manually operated open-head systems have proved to be effective protection for ducts and stacks. [**33:**A.9.4.6]

43.1.7.4.6.1 Stacks and exhaust ducts shall be provided with access openings for inspection and cleaning of sprinklers. [**33:**9.4.6.1]

43.1.7.4.6.2 Sprinkler systems protecting stacks and ducts that are subject to freezing shall be of a nonfreezing type or be a manually controlled open-head system. [**33:**9.4.6.2]

43.1.7.4.7 Sprinklers shall be protected against overspray residue, either by location or covering, so that they will operate quickly in event of fire. [**33:**9.4.7]

43.1.7.4.7.1 Sprinklers shall be permitted to be covered only by cellophane bags having a thickness of 0.003 in. (0.08 mm) or less or by thin paper bags. These coverings shall be replaced frequently so that heavy deposits of residue do not accumulate. [**33:**9.4.7.1]

Use of other types of plastic film is not allowed. It has been found that plastic film other than cellophane has a tendency to "shrink wrap" the sprinkler when subjected to the heat from a fire, thus preventing the sprinkler from functioning.

43.1.7.4.7.2 Sprinklers that have been painted or coated by overspray or residues shall be replaced with new sprinklers. [**33:**9.4.7.2]

There is no easy way to effectively clean sprinkler heads that have been coated with overspray and be confident of reliable future functioning.

43.1.7.5* Automatic Carbon Dioxide, Dry Chemical, and Clean Agent Systems. The fire protection system shall be capable of discharging its contents into the entire protected area simultaneously, including the exhaust plenum and exhaust ductwork. [**33:**9.5]

A.43.1.7.5 This discharge is typically accomplished by means of a piping network from the fire protection system into all parts of the spray area. To avoid potential flashback of an unextinguished fire, modular fire protection units should not be used to protect areas with ducts or plenums, or areas that exceed the listing of the system. They might, however, be suited for smaller open spray areas that fall within the limits of the listing. [**33:**A.9.5]

43.1.7.6 Portable Fire Extinguishers. Portable fire extinguishers shall be provided and located in accordance with Section 13.6. [**33:**9.6]

Section 13.6 of this *Code* mandates the selection, installation, distribution, inspection, maintenance, and testing of portable fire extinguishers. In addition to being in compliance with this section, fire extinguishers must be in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

43.1.7.7* Protection for Automated Powder Application Equipment.

A.43.1.7.7 During the first few seconds in the development of a fire in a dry powder spray booth, the following observations can be made:

(1) *Conventional structure equipment (spray booth connected to enclosed collector by ductwork)*
    (a) Airborne powder in the spray plumes of the gun(s) burns vigorously as long as the gun feeder(s) continues to supply powder. Flames from about 2 ft to 6 ft (600 mm to 1800 mm) in length might extend from the guns but do not intrude into the interior of the guns. These flames do not extend into the exhaust ductwork if adequate airflow has been provided to maintain maximum powder concentration in the exhaust stream below the minimum explosive concentration (MEC). The flames are extinguished almost instantly if their supply of airborne fuel is interrupted by shutting down the gun feeders.
    (b) Deposits of powder that have accumulated on the interior surfaces of the spray enclosure are not readily ignited, even by direct exposure to flames for a few seconds.
    (c) If a fire in a powder spray booth has been sustained for an appreciable period of time (10- to 60-second delays have been observed), propagation proceeds as follows:
        i. Heat exposure effects of the fire, acting on the deposits of overspray powder that have accumulated on the interior surfaces of the spray enclosure, will modify a layer on the surface of the deposits to form an extremely fragile, tissue-thin structure of powder grains that have been softened only enough to adhere to adjacent grains but not enough to flow together and form a film. This is called a *sintered structure*. In response to the effects of vibration and rapidly fluctuating temperature (flickering of flames, etc.), this structure will break into a "mud-cracked" pattern, and individual platelets in some regions will curl up, presenting their edges to the fire-involved atmosphere. Exposure to this environment's heat and turbulence will char and dislodge platelets to form airborne glowing embers comparable to those formed by burning piles of autumn leaves. These embers, if drawn through exhaust ductwork to the powder collector, could ignite the collector, resulting in an explosion.
        ii. If this sequence is interrupted within the first few seconds of a fire's history, then ember formation and propagation by this mechanism can be stopped. The requirements of 43.1.7.7 are directed toward this result.

(2) *Integrated spray booth/"open" collector*
    (a) Fire in the spray plumes of the guns is identical to that found in A.43.1.7.7(1). Because there is no exhaust ductwork and no enclosed collector, however, the conditions necessary for generation of an explosion do not exist and the risk is confined only to conventional fire considerations. If powder feed to the spray guns is sustained after ignition and if the exhaust fan is kept in operation, enough heat can be delivered to the region of the cartridge filters to result in ignition of the filters and collected residues, which will then be sustained as a "deep-seated" fire producing large quantities of smoke but limited heat.
    (b) Attempts to extinguish "deep-seated" fires with carbon dioxide and dry chemical extinguishers have yielded disappointing results. Although flame is promptly knocked down, continued production of smoke and ultimate reflash should be expected. The most satisfactory results have been yielded by thoroughly soaking the filter cartridges and residues with water.

[**33:**A.9.7]

43.1.7.7.1 Automated powder application equipment, both listed and unlisted, shall be further protected by listed optical flame detection, installed and supervised in accordance with *NFPA 72*. The optical flame detection shall, in event of ignition, react to the presence of flame within one-half (0.5) second and shall accomplish all of the following:

(1) Stop any conveyors into and out of the spray area
(2) Shut off ventilation

(3) Shut off application, transfer, and powder collection equipment
(4) Close segregation dampers in associated ductwork to interrupt airflows from application equipment to powder collectors
(5) Disconnect power to the high-voltage elements in the spray area and de-energize the system [**33:**9.7.1]

43.1.7.7.2 Automated powder application equipment that is unlisted shall be further protected by the following:

(1) In addition to meeting the requirements in 43.1.7.2.1 and 43.1.7.7.1, the optical flame detection system shall also activate the automatic fire protection system, if provided.
(2) Automatic electrostatic equipment enclosures inside the booth shall be protected with an approved automatic fire protection system. Activation of this system shall automatically accomplish the requirements of 43.1.7.2.1 and 43.1.7.7.1.
(3) Manual activation stations shall be installed. At least one such station shall be within ready access of operating personnel. If access to this station is likely to involve exposure to danger, an additional station shall be located adjacent to an exit from the area. These devices shall activate the fire protection system as specified in 43.1.7.1.1 for the affected automated zone, if applicable, and accomplish the requirements in 43.1.7.7.1.

[**33:**9.7.2]

N **43.1.7.7.2.1** This requirement shall not apply to a closed-head wet pipe automatic sprinkler system. [**33:**9.7.2.1]

43.1.7.8* Protection for Automated Liquid Electrostatic Spray Application Equipment.

A.43.1.7.8 Unlike powder application systems, the make-up air and exhaust systems for a liquid application system have to continue to function, unless there is a compelling reason to shut them down. [**33:**A.9.8]

43.1.7.8.1 Automated liquid electrostatic spray application equipment, both listed and unlisted, shall be further protected by listed optical flame detection, installed and supervised in accordance with *NFPA 72*. The optical flame detection shall, in event of ignition, react to the presence of flame within one-half (0.5) second and shall accomplish all of the following:

(1) Meet all of the requirements of 43.1.7.2.1
(2) Disconnect power to the high-voltage elements in the spray area and de-energize the system [**33:**9.8.1]

Δ **43.1.7.8.2** Automated liquid electrostatic spray application equipment that is unlisted shall be protected further by the following:

(1) In addition to meeting the requirements in 43.1.7.8.1, the optical flame detection system shall also activate one of the following over each zone in which fire has been detected:
  (a) An open head deluge system designed to discharge a minimum density of 0.6 gpm/ft^2 (24.4 mm/min)
  (b) A carbon dioxide extinguishing system
  (c) A dry chemical extinguishing system
  (d) A gaseous agent extinguishing system
  (e) A water mist fire protection system
(2) Manual activation stations shall be installed. At least one such station shall be within ready access of operating personnel. If access to this station is likely to involve exposure to danger, an additional station shall be located adjacent to an exit from the area. These devices shall activate the fire protection system as specified in 43.1.7.8.2(1) and accomplish the requirements of 43.1.7.2.1 and 43.1.7.8.2(2).
(3) A wet pipe sprinkler system shall also be provided throughout the spray booth. This system shall meet all the applicable requirements of NFPA 13 for Extra Hazard (Group 2) occupancies.
(4) Automatic electrostatic equipment enclosures inside the booth systems shall be protected with an approved automatic fire protection system. Activation of this system shall automatically accomplish the requirements of 43.1.7.2.1 and 43.1.7.8.1(2). [**33:**9.8.2]

43.1.8 Operations and Maintenance.

43.1.8.1* General. Maintenance procedures shall be established to ensure that all spray application apparatus and processes are operated and maintained in accordance with the manufacturers' specifications and the requirements of this *Code*. Maintenance shall be the responsibility of the users of the apparatus and processes. [**33:**10.1]

A.43.1.8.1 The materials used in spray application processes can create serious fire hazards. For example, the vapors and mists created by the atomization of flammable and combustible liquids can form explosive mixtures in air. In addition, deposits of residues can ignite spontaneously or be easily ignited. Finally, fires involving flammable and combustible liquids or combustible residues can spread rapidly and can produce intense heat and smoke. Properly designed equipment can do much to lessen these hazards but cannot eliminate them. These inherent characteristics should make it obvious that supervision of operations, maintenance of equipment, and daily cleaning are essential to a safe operation. [**33:**A.10.1]

It is important that some type of periodic inspection be conducted and recorded as part of the maintenance procedures. It is also important that any inspections of spray application equipment be conducted by competent and reliable personnel who have knowledge of the equipment and the inherent characteristics of the materials used. [**33:**A.10.1]

The frequency of the inspections depends on the individual components of the spray application process. For example, it might be acceptable to check sprinkler control valves or other control mechanisms for approved fire protection systems on a weekly or even monthly basis. However, this frequency would not be acceptable for ensuring adequate airflow through collector filters of a spray booth. At a minimum, that should be done at the beginning of each operating shift. Similarly, the buildup of residues would also need to be checked on a per-shift basis. Individual plant operations might dictate that either of these items (airflow and residue buildup) be checked every few hours. [**33:**A.10.1]

43.1.8.1.1* Spray application operations shall not be conducted outside predetermined spray areas. [**33:**10.1.1]

A.43.1.8.1.1 The use of the term *predetermined* is intended to convey the idea that one cannot arbitrarily locate or conduct spray application operations without thought to the hazards and special requirements that such operations demand. Requirements regarding electrical equipment and ventilation are of primary concern. This *Code* also specifies requirements that can vary based on the type of equipment used, the type of material being spray applied, and even the type of operation. Any spray application operation should also consider the storage, handling, and distribution of the coating materials used in the process. Certainly there are other factors, but these examples should adequately explain the need for predetermining the spray area and why operations should be confined to those areas. [**33:**A.10.1.1]

43.1.8.1.2 Inspection of extinguishing systems shall be conducted to ensure that the performance of the extinguishing system components will not be affected by overspray and residues. [**33:**10.1.2]

43.1.8.2* Combustible Deposits.

A.43.1.8.2 In the spray finishing of any workpiece, there is frequently a portion of the spray that does not deposit directly on the object or material being coated but does deposit on adjacent surfaces as residue material. This is referred to as *overspray*. Many of these residues are highly combustible, igniting at very low temperatures or spontaneously, resulting in fast-spreading fires. To limit the duration and intensity of fires, the accumulation of deposits has to be minimized and controlled as much as practical. The accumulation of residues represents one of the most significant challenges to fire control. [**33:**A.10.2]

Cleaning. The interior of spray booths, exhaust fan blades, and exhaust ducts should be cleaned regularly to avoid the accumulation of residues. Either spray operators should be allowed ample time for this cleaning, or a special maintenance crew should be provided for cleaning at the close of each day's operation. If equipment is so designed that during cleanup hose streams or fixed water nozzles can be used in ducts and spray booths without water damage to building and contents, cleaning operations are greatly facilitated. Many plants have found that by coating the interior of spray booths with a suitable soap-like or water-soluble material immediately after cleaning, adhesive spray deposits can be removed on the following day with the use of water streams. Other materials, such as plastics that can be readily peeled off the interior of the spray booth, can also be used to facilitate cleaning of the overspray residue. [**33:**A.10.2]

Properly maintained water-wash booths offer lower fire loading than dry booths. To maintain this advantage, it is necessary to perform regular and scheduled maintenance. This maintenance schedule should be recorded and the records filed. When the nozzles, jets or orifices, eliminator packs, and strainer screens become fouled with accumulated sludge or overspray, combustible residues will be deposited on the interior of the exhaust duct and fan blades. The nozzles, jets, orifices, and eliminator packs should be inspected each work shift. Strainer screens should be removed and cleaned each work shift. [**33:**A.10.2]

The booth interior, exhaust stack, and fan blades should be checked periodically, and accumulations of overspray and dirt should be removed as required. Exhaust ducts or stacks should not be entered for cleaning or repairs unless they are free from flammable vapors and have been thoroughly wet down. [**33:**A.10.2]

Many fires are caused by poor maintenance and the accumulation of combustible residues. This is particularly true in spray areas, where residue accumulates in the exhaust ductwork and in the plenums behind the overspray filters. Excessive residues that are present between the overspray filters and the fan or within the ductwork must be removed. If residue has accumulated to the extent that it can be scraped off if rubbed by hand, dangerous or excessive quantities are present and the spray application must be discontinued until the accumulations have been removed.

For more information, refer to the list of NFPA codes and standards in Chapter 40 identifying the fire and explosion hazards of combustible particulate solids for more information.

43.1.8.2.1 All spray areas shall be kept free of excessive accumulation of deposits of combustible residues. [**33:**10.2.1]

43.1.8.2.2 Combustible coverings (thin paper, plastic) and strippable coatings shall be permitted to be used to facilitate cleaning operations in spray areas. [**33:**10.2.2]

43.1.8.2.2.1 Where plastic covering is used, it shall be of a static dissipative nature or shall have a maximum breakdown voltage of 4 kV to prevent accumulation of a hazardous static electric charge. [**33:**10.2.2.1]

43.1.8.2.3 If residue accumulates to excess in booths, duct or duct discharge points, or other spray areas, all spraying operations shall be discontinued until conditions have been corrected. [**33:**10.2.3]

43.1.8.3 High-Pressure Hose Lines. High-pressure hose lines that convey flammable or combustible coating material in "airless" spray application operations shall be inspected daily and shall be repaired or replaced as necessary. Hose lines and equipment shall be located so that, in the event of a leak or rupture, coating material will not be discharged into any space having a source of ignition. [**33:**10.3]

43.1.8.4 Maintenance Procedures.

Δ **43.1.8.4.1** Overspray collectors shall be inspected daily and clogged filters shall be discarded and replaced. Maintenance procedures shall be established to ensure that overspray collector filters are replaced before restriction to airflow is reduced below the minimum established by Section 7.2 of NFPA 33. [**33:**10.4.1]

43.1.8.4.2 At the close of the day's operation, all discarded overspray collector filters, residue scrapings, and debris contaminated with residue shall be removed immediately to a designated storage location, placed in a noncombustible container with a tight-fitting lid, or placed in a water-filled metal container. [**33:**10.4.2]

If overspray collector filters are bundled and compacted for disposal, fires can result from spontaneous ignition. Placing loaded filters in water-filled containers might require disposal of the water as hazardous waste. The best solution is to remove the discarded filters to a safe, well-separated location until they are removed from the facility by an appropriate hazardous waste hauler.

43.1.8.5* Waste Containers.

A.43.1.8.5 Many fires have originated from the spontaneous ignition of fabric and waste impregnated with coating materials. When sprayed articles are rubbed with rags or waste, all unclean rags and waste should be immediately placed in approved waste cans and removed from the premises at least daily at the close of each shift. When employees change clothes on plant premises, soiled clothing should be kept in metal lockers provided in a segregated dressing room. [**33:**A.10.5]

43.1.8.5.1 Approved waste containers shall be provided wherever rags or waste are impregnated with sprayed material, and all such rags or waste shall be deposited therein immediately after use. The contents of waste containers shall be placed in a designated storage location. [**33:**10.5.1]

43.1.8.5.2 Waste containers containing flammable liquids shall be located in ventilated areas that meet the requirements of 43.1.5. Such areas shall also meet the electrical area classification requirements of 43.1.4.4.5. [**33:**10.5.2]

43.1.8.5.3* Waste containers for flammable liquids shall be constructed of conductive materials and shall be bonded and grounded. [**33:**10.5.3]

A.43.1.8.5.3 See NFPA 77 for information on bonding and grounding. [**33:**A.10.5.3]

43.1.8.5.4 Waste containers for flammable liquids shall be handled and stored in accordance with 43.1.6. [**33:**10.5.4]

43.1.8.6 Clothing. Employees' clothing contaminated with sprayed material shall not be left on the premises overnight unless kept in metal lockers. [**33:**10.6]

43.1.8.7 Cleaning Operations.

43.1.8.7.1 Scope. Paragraph 43.1.8.7 shall apply to the use of flammable or combustible liquids for the flushing and cleaning of equipment. [**33:**10.7.1]

43.1.8.7.2 Liquids. Class I and Class II liquids used in cleaning operations shall be in original shipping containers or in listed safety containers. [**33:**10.7.2]

43.1.8.7.3 Location. Cleaning operations using flammable or combustible liquids shall be conducted inside a spray area with ventilating equipment operating or in ventilated areas that meet the requirements of 43.1.5. Such areas shall also meet the electrical area classification requirements of 43.1.4.4.5. [**33:**10.7.3]

Spray gun cleaning devices that are not enclosed should be used only in ventilated areas. Enclosing spray gun devices gives better control of the vapors, fumes, and excess coatings resulting from the application.

43.1.8.7.4* Equipment. Equipment using flammable or combustible liquids shall meet the requirements of 43.1.4.4.5 and shall be bonded and grounded. [**33:**10.7.4]

A.43.1.8.7.4 See NFPA 77 for information on bonding and grounding. [**33:**A.10.7.4]

43.1.8.7.5 Manual Cleaning. Individual manual cleaning operations shall be limited to not more than 1 gal (4 L) of flammable or combustible liquid for each cleaning operator. [**33:**10.7.5]

43.1.8.7.6 Liquid Storage. Flammable and combustible liquids shall be handled and stored in accordance with 43.1.6. Containers used for handling, storage, or recovery of Class I liquids shall be constructed of conductive materials and shall be bonded and grounded. [**33:**10.7.6]

43.1.8.8 Solvent Distillation Units (Solvent Recyclers).

43.1.8.8.1 Scope.

43.1.8.8.1.1 Paragraph 43.1.8.8 shall apply to solvent distillation units having distillation chambers or still pots that do not exceed 60 gal (230 L) capacity and are used to recycle Class I, Class II, and Class IIIA liquids. [**30:**19.6.1.1]

43.1.8.8.1.2 Paragraph 43.1.8.8 shall not apply to research, testing, or experimental processes; to distillation processes carried out in petroleum refineries, chemical plants, or distilleries; or to distillation equipment used in dry cleaning operations. [**30:**19.6.1.2]

43.1.8.8.2 Equipment. Solvent distillation units shall be approved or shall be listed in accordance with ANSI/UL 2208, *Standard for Solvent Distillation Units*. [**30:**19.6.2]

43.1.8.8.3 Solvents. Solvent distillation units shall only be used to distill liquids for which they have been investigated and that are listed on the unit's marking or contained within the manufacturer's literature. [**30:**19.6.3]

43.1.8.8.3.1 Unstable or reactive liquids or materials shall not be processed unless they have been specifically listed on the system's markings or contained within the manufacturer's literature. [**30:**19.6.3.1]

43.1.8.8.4 Location.

43.1.8.8.4.1 Solvent distillation units shall be located and operated in locations in accordance with their approval or listing. [**30:**19.6.4.1]

43.1.8.8.4.2 Solvent distillation units shall not be used in basements. [**30:**19.6.4.2]

43.1.8.8.4.3 Solvent distillation units shall be located away from potential sources of ignition, as indicated on the unit's marking. [**30:**19.6.4.3]

43.1.8.8.5 Liquid Storage. Distilled liquids and liquids awaiting distillation shall be stored in accordance with NFPA 30. [**33:**10.8.5]

43.1.8.9* Spontaneous Ignition Hazards. The same spray booth shall not be alternately used for different types of coating materials if the combination of the materials is conducive to spontaneous ignition, unless all deposits of the first-used coating material are removed from the booth and exhaust ducts prior to spraying with the second coating material. [**33:**10.9]

A.43.1.8.9 Bleaching compounds, such as hydrogen peroxide, hypochlorites, perchlorates, or other oxidizing compounds, can cause fires when in contact with organic finishing materials. Hence, if bleaching compounds are to be used in spray booths, the booths should be thoroughly cleaned and used only for that purpose. The alternate use of spray booths for bleaching compounds and other finishing materials or the alternate use of finishing materials containing nitrocellulose and other types of finishing materials containing drying oils, such as varnishes, oil-based stains, air-drying enamels, primers, and so forth, without first thoroughly removing all traces of deposits can result in a spontaneous ignition fire. [**33:**A.10.9]

43.1.8.10* Chlorinated Solvents. Coating materials containing chlorinated solvents shall not be used with spray application apparatus or fluid-handling equipment if the chlorinated solvent will come into contact with aluminum within a piping system, pump, enclosed container, or any enclosure that is capable of being pressurized by the potential reaction. This shall apply even if the container or system has been constructed with pressure relief devices. [**33:**10.10]

A.43.1.8.10 Stricter environmental regulation has given rise to the increased use of chlorinated solvents, such as 1,1,1-trichloroethane and methylene chloride. These solvents are not photochemically reactive and, therefore, can be useful in helping to meet standards regarding volatile organic compound emissions. However, these solvents have a well-documented characteristic of being chemically reactive with aluminum. The reaction that occurs is unpredictable both in terms of when it will occur and to what degree it will proceed. In most situations there is no apparent reaction. Other situations have noted effects ranging from simple corrosion to catastrophic explosion-like failure accompanied by considerable shrapnel and a fireball. Understanding and controlling the subsequent hazard is hindered by this unpredictability. Although there is some understanding of the actual reaction, the following factors acting as independent variables have been found to have an effect on the initiation and rate of reaction:

(1) Heat
(2) Pressure
(3) Ratio of aluminum surface area to volume of solvent, presence of moisture (condensation), aluminum alloy content, metal content of the coating, and the introduction of other solvents or materials

[**33:**A.10.10]

Therefore, the only assuredly safe condition is to keep these materials separate. [**33:**A.10.10]

It is important to realize that aluminum has been used as a primary material for spray equipment construction over many years. Incorporating these solvents into existing spray systems cannot be done safely without first determining the construction material of the equipment and then replacing those components where contact with aluminum and chlorinated solvent will occur within a pressurizable device (e.g., pumps, heaters, piping, fluid valves, and spray gun cups). [**33:**A.10.10]

43.1.8.11 Smoking. Signs stating NO SMOKING OR OPEN FLAMES in large letters on contrasting color background shall be conspicuously posted at all spray areas and paint storage rooms. [**33:**10.11]

See the smoking provisions in Section 10.9 for additional guidance. An example of a sign complying with this paragraph can be found in Exhibit 43.7.

Exhibit 43.7

Example of a warning sign in compliance with 43.1.8.11.

43.1.8.12* Hot Work. Welding, cutting, and other spark-producing operations shall not be permitted in or adjacent to spray areas until a written permit authorizing such work has been issued. The permit shall be issued by a person in authority following his or her inspection of the area to ensure that precautions have been taken and will be followed until the job is completed. [**33:**10.12]

A.43.1.8.12 If repairs or changes are to be made to equipment, care should be taken to see that all residue deposits are removed and the area wet down with water beforehand in order to avoid a fire. During such repairs, no spraying should be conducted, all flammable and combustible liquids and portable combustible material should be removed from the vicinity, and suitable fire extinguishers should be kept readily available. [**33:**A.10.12]

The use of welding or cutting torches should be prohibited except under the supervision of a competent person familiar with the fire hazards involved. *(See NFPA 51B.)* [**33:**A.10.12]

See Chapter 41 for additional guidance on precautions for the use of welding or cutting torches and other hot work activities.

43.2 Automated Electrostatic Spray Equipment

For information on the installation and use of automated electrostatic spray application apparatus, see Chapter 11 of NFPA 33.

43.3 Handheld Electrostatic Spray Equipment

For information on the installation and use of handheld electrostatic spray application apparatus, see Chapter 12 of NFPA 33.

43.4 Drying, Curing, or Fusion Processes

For information on drying, curing, or fusion apparatus used in connection with spray application of flammable and combustible materials, see Chapter 13 of NFPA 33.

43.5 Miscellaneous Spray Operations

43.5.1 Vehicle Undercoating and Body Lining.

43.5.1.1 Spray undercoating or spray body lining of vehicles that is conducted in an area that has adequate natural or mechanical ventilation shall be exempt from the provisions of this *Code*, if all of the requirements of 43.5.1.1.1 through 43.5.1.1.4 are met. [**33:**14.1.1]

43.5.1.1.1 There shall be no open flames or spark-producing equipment within 20 ft (6100 mm) of the spray operation while the spray operation is being conducted. [**33:**14.1.1.1]

Essentially, this requirement establishes a "safe zone" similar to a Class I, Division 2 hazardous (classified) location around an unenclosed spray area, as depicted in Figure 43.1.4.4.1.

43.5.1.1.2 There shall be no drying, curing, or fusion apparatus in use within 20 ft (6100 mm) of the spray operation while the spray operation is being conducted. [**33:**14.1.1.2]

43.5.1.1.3 Any solvent used for cleaning procedures shall have a flash point not less than 100°F (37.8°C). [**33:**14.1.1.3]

43.5.1.1.4 The coating or lining materials used shall meet one of the following criteria:

(1) Be no more hazardous than UL Class 30-40, when tested in accordance with ANSI/UL 340, *Test for Comparative Flammability of Liquids*
(2) Not contain any solvent or component that has a flash point below 100°F (37.8°C)
(3) Consist only of Class IIIB liquids and not include any organic peroxide catalyst [**33:**14.1.1.4]

43.5.1.2 Noncomplying Undercoating Operations. Spray undercoating operations that do not meet the requirements of 43.5.1 shall meet all applicable requirements of this *Code* pertaining to spray finishing operations. [**33:**14.1.2]

43.5.2 Preparation Workstations. If spray finishing operations are performed at or in a preparation workstation, the preparation workstation shall be considered an unenclosed spray area and shall meet all requirements of an unenclosed spray area. [**33:**14.2]

Although sometimes used for minor spray application, such as touch-up jobs, preparation workstations (prep stations) were originally not conceived of or designed for spray application processes.

N **43.5.2.1** A preparation workstation that is designed and operated in accordance with 43.5.3 shall be considered a limited finishing workstation and not an unenclosed spray area. [**33:**14.2.1]

43.5.3 Limited Finishing Workstations. A limited finishing workstation shall be designed and operated in accordance with the requirements of 43.5.3.1 through 43.5.3.9. [**33:**14.3]

An example of a limited finishing workstation is shown in Exhibit 43.8.

Exhibit 43.8

Typical limited finishing workstation. (Courtesy of Global Finishing Solutions)

43.5.3.1 A limited finishing workstation shall be designed and constructed to have all of the following:

(1) A dedicated make-up air supply and air supply plenum
(2) Curtains or partitions that are noncombustible or limited-combustible, as defined in 3.3.165 and 3.3.175.11 or that can successfully pass Test Method 2 of in Chapter 12 NFPA 701
(3) A dedicated mechanical exhaust and filtration system
(4)* An approved automatic extinguishing system that meets the requirements of 43.1.7 [**33:**14.3.1]

A.43.5.3.1(4) For dry chemical fire protection systems, it might be prudent to double the quantity of agent and its flowrate, compared to a similar size fully enclosed spray booth to achieve the desired degree of protection. This is due to the relatively unenclosed nature of a limited finishing workstation compared to a traditional spray booth. [**33:**A.14.3.1(4)]

This recommendation is based on a white paper provided by the Fire Equipment Manufacturers' Association titled "Recommendations for Protection of Curtained Limited Finishing Workstations." [**33:**A.14.3.1(4)]

43.5.3.2 The amount of material sprayed in a limited finishing workstation shall not exceed 1 gal (3.8 L) in any 8-hour period. [**33:**14.3.2]

43.5.3.3 The limited finishing workstation shall meet all applicable requirements of 43.1.2 through 43.1.8 and Section 43.10. [**33:**14.3.3]

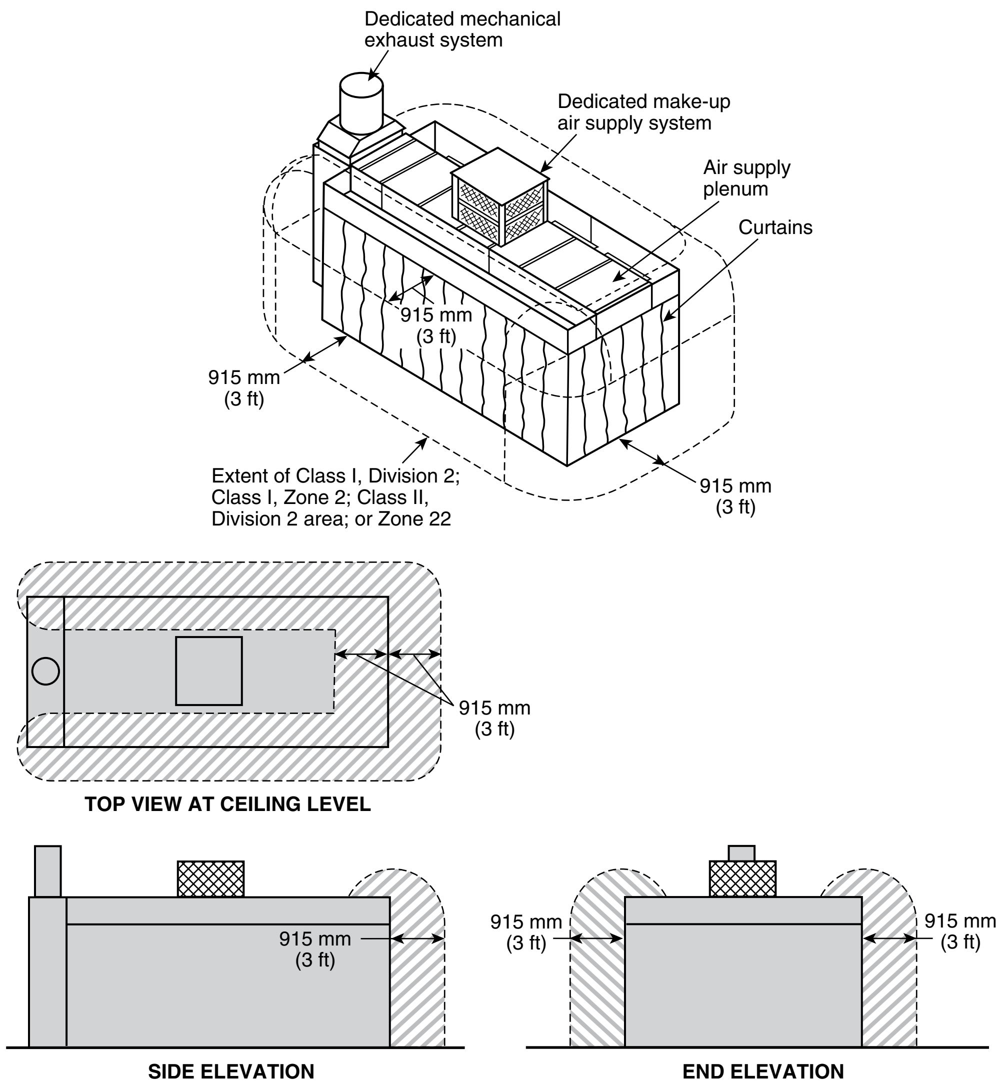
43.5.3.4 Curtains or partitions shall be fully closed during any spray application operations. [**33:**14.3.4]

43.5.3.5 The area inside the curtains or partitions shall be considered a Class I, Division 1; Class I, Zone 1; Class II, Division 1; or Zone 21 hazardous (classified) location, as defined by Article 500 of *NFPA 70*. [**33:**14.3.5]

43.5.3.5.1 A Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 hazardous (classified) location, as applicable, shall extend 3 ft (915 mm) both horizontally and vertically beyond the volume enclosed by the outside surface of the curtains or partitions as shown in Figure 43.5.3.5.1. [**33:**14.3.5.1]

43.5.3.5.2 For the purposes of this subsection, *interlocked* shall mean that the spray application equipment cannot be operated unless the exhaust ventilation system is operating and functioning properly and spray application is automatically stopped if the exhaust ventilation system fails. [**33:**14.3.5.2]

43.5.3.6 Any limited finishing workstation used for spray application operations shall not be used for any operation that is capable of producing sparks or particles of hot metal or for operations that



Δ ***FIGURE 43.5.3.5.1*** *Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 Locations Adjacent to a Limited Finishing Workstation. [**33:**Figure 14.3.5.1]* involve open flames or electrical utilization equipment capable of producing sparks or particles of hot metal. [**33:**14.3.6]

43.5.3.7 Drying, curing, or fusion apparatus shall be permitted to be used in a limited finishing workstation if they meet the requirements of Section 43.4 and the requirements of 43.5.3.7.1 through 43.5.3.7.3. [**33:**14.3.7]

43.5.3.7.1 When industrial air heaters are used to elevate the air temperature for drying, curing, or fusing operations, a high limit switch shall be provided to automatically shut off the drying apparatus if the air temperature in the limited finishing workstation exceeds the maximum discharge-air temperature allowed by the standard that the heater is listed to or 200°F (93°C), whichever is less. [**33:**14.3.7.1]

43.5.3.7.2* A means shall be provided to show that the limited finishing workstation is in the drying or curing mode of operation and that the limited finishing work station is to be unoccupied. [**33:**14.3.7.2]

A.43.5.3.7.2 A means of showing that the limited finishing workstation is in the drying or curing mode of operation can be, but is not limited to, having the lighting of the workstation go out, use of a flashing light or strobe, or use of an audible device. [**33:**A.14.3.7.2]

43.5.3.7.3 Any containers of flammable or combustible liquids shall be removed from the limited finishing workstation before the drying apparatus is energized. [**33:**14.3.7.3]

43.5.3.8 Portable spot-drying, curing, or fusion apparatus shall be permitted to be used in a limited finishing workstation, provided that it is not located within the hazardous (classified) location defined in 43.5.3.5 when spray application operations are being conducted. [**33:**14.3.8]

43.5.3.9 Recirculation of exhaust air shall be permitted only if all provisions of 43.1.5.5 are met. [**33:**14.3.9]

43.6 Powder Coating

For information on the installation and use of powder coating application apparatus, see Chapter 15 of NFPA 33.

43.7 Organic Peroxides and Plural Component Coatings

43.7.1* Scope. Section 43.7 shall apply to the spray application operations that involve the use of organic peroxide formulations and other plural component coatings.

*Exception: As covered in Section 43.8. [**33:**16.1]*

A.43.7.1 Organic peroxides are a group of chemicals that are used as catalysts (chain reaction initiators) in the polymerization of plastics monomers and resins. Commercially, they are available as numerous formulations that differ not only in chemical species but also in concentration, type, and amount of diluent. [**33:**A.16.1]

The rapidly expanding reinforced styrene–polyester composites industry is one of the larger users of organic peroxide formulations. The formulations are used to catalyze (harden) the styrene–polyester resin. Frequently, the resin mixture and the catalyst are spray-applied to the reinforcing matrix using an automatic proportioning spray applicator. The most widely used catalyst systems are formulations of methyl ethyl ketone peroxide (MEKP), in varying concentration with different diluents, usually dibutyl phthalate. For transportation purposes, the U.S. Department of Transportation classifies these formulations as "organic peroxides" or "flammable liquids." [**33:**A.16.1]

For purposes of storage and warehousing, NFPA 400 classifies these materials using a five-tiered system, depending on their relative hazard as packaged for shipment. Thus, NFPA 400 recognizes that the different formulations available differ widely in fire hazard. In many cases, the "active oxygen," a measure of the material's catalytic activity and one measure of its reactivity hazard, has been reduced, thus reducing any explosion hazard. [**33:**A.16.1]

The following precautions are recommended:

(1) Organic peroxide formulations should be stored in a cool, dry location that is separated from the work area. The formulations should not be stored with materials with which they might not be compatible. Storage quantity limitations and fire protection requirements are contained in NFPA 400.
(2) The amount of organic peroxide formulation kept in the work area should be limited to that needed for a single day's use. Any formulation remaining at the end of a workday should be returned to the storage area.
(3) All necessary precautions, as recommended by the supplier, should be taken when organic peroxide formulations are used. Good housekeeping should be strictly observed, and spills should be immediately cleaned. Spilled material or material (such as resin) that has been contaminated with organic peroxide formulations has to be properly disposed of immediately. Trained personnel and safe operating procedures are essential for safe operation. The user should refer to the material safety data sheet (MSDS) or its equivalent for safety and handling information for the specific formulation being used.

[**33:**A.16.1]

See Annex B for tabular information on typical organic peroxide formulations.

43.7.2 General. Spray application operations that involve the use of organic peroxide formulations and other plural component coatings shall be conducted in spray areas that are protected by approved automatic sprinkler systems that meet the requirements of 43.1.7. [**33:**16.2]

43.7.3 Prevention of Contamination. Measures shall be taken to prevent the contamination of organic peroxide formulations with any foreign substance. Only spray guns and related handling equipment that are specifically manufactured for use with organic peroxide formulations shall be used. Separate fluid-handling equipment shall be used for the resin and for the catalyst, and they shall not be interchanged. [**33:**16.3]

43.7.3.1 The wetted portions of equipment and apparatus that handle organic peroxide formulations shall be constructed of stainless steel (300 series), polyethylene, Teflon®, or other materials that are specifically recommended for the application. [**33:**16.3.1]

43.7.3.2* Measures shall be taken to prevent contamination of organic peroxide formulations with dusts or overspray residues resulting from the sanding or spray application of finishing materials. [**33:**16.3.2]

A.43.7.3.2 Such mixing can result in a spontaneous fire or explosion. [**33:**A.16.3.2]

43.7.3.3 Spills of organic peroxide formulations shall be promptly removed so there are no residues. Spilled material shall be permitted to be absorbed by use of a noncombustible absorbent, which is then disposed of promptly in accordance with the manufacturer's recommendations. [**33:**16.3.3]

43.7.4 Storage of Organic Peroxides. Organic peroxide formulations shall be stored in accordance with the requirements of Chapter 70 and with the manufacturers' recommendations. [**33:**16.4]

43.7.5 Handling of Organic Peroxides. Measures shall be taken to prevent handling of organic peroxide formulations to avoid shock and friction, which can cause decomposition and violent reaction. [**33:**16.5]

43.7.6* Mixing of Organic Peroxides with Promoters. Organic peroxide formulations shall not be mixed directly with any cobalt compounds or other promoters or accelerators, due to the possibility of violent decomposition or explosion. To minimize the possibility of such accidental mixing, these materials shall not be stored adjacent to each other. [**33:**16.6]

A.43.7.6 The chemical and thermal stability of organic peroxide formulations is markedly reduced by contact or contamination with strong acids or bases, sulfur compounds, amines, and reducing agents of any type. Decomposition gases or vapors produced by some organic peroxide formulations can present a fire or explosion hazard. For example, the decomposition of benzoyl peroxide produces highly flammable vapors. [**33:**A.16.6]

Heat, including heat from fire exposure, is an important factor in the decomposition of organic peroxide formulations. Some formulations decompose quietly when exposed to a slow, gradual increase in temperature. However, these same formulations can decompose violently or even explode when subjected to a rapid, excessive increase in temperature, such as from fire exposure. [**33:**A.16.6]

In general, an organic peroxide that is formulated with a diluent into a dilute solution or paste burns more slowly than the concentrated or pure material and is less sensitive to shock or impact. [**33:**A.16.6]

43.7.7 Smoking. Smoking shall be prohibited, NO SMOKING signs shall be prominently displayed, and only nonsparking tools shall be used in any area where organic peroxide formulations are stored, mixed, or applied. [**33:**16.7]

43.7.8 Trained Personnel. Only designated personnel trained to use and handle organic peroxide formulations shall be permitted to use these materials. [**33:**16.8]

43.7.9 Material Safety Data Sheets. Where organic peroxide formulations are used, the material safety data sheet (MSDS) or its equivalent shall be consulted. [**33:**16.9]

With the introduction in the United States of the United Nations *Globally Harmonized System of Classification and Labeling of Chemicals* (*GHS*), material safety data sheets are now known simply as safety data sheets (SDS). See 29, CFR, 1910.1200, "Hazard Communication."

43.8 Styrene Cross-Linked Composites Manufacturing (Glass Fiber–Reinforced Plastics)

43.8.1* Scope. Section 43.8 shall apply to manufacturing processes involving spray application of styrene cross-linked thermoset resins (commonly known as glass fiber–reinforced plastics) for hand lay-up or spray fabrication methods, that is, resin application areas, and where the processes do not produce vapors that exceed 25 percent of the lower flammable limit. [**33:**17.1]

A.43.8.1 The reinforced styrene–polyester composites industry uses a variety of fabrication techniques to manufacture a wide range of useful products. Most of these products are fabricated with polyester- or vinyl ester–based resins and a fiber reinforcement, most commonly glass fiber. The resins contain a monomer, usually styrene, and are mixed with a catalyst to initiate curing. Other volatile organic chemicals used include the organic peroxide formulations, such as methyl ethyl ketone peroxide (MEKP), used to cure the resin, and various dyes and admixtures. [**33:**A.17.1]

Open molding is the predominant molding method, with mold sizes ranging from less than 1 ft^2 (0.1 m^2) to very large structures, such as boat hulls over 100 ft (30 m) in length. The two most widely used application methods are hand lay-up and spray-up. In the hand lay-up fabrication method, a glass fiber mat is saturated with the resin by direct spray application or by manual application of the liquid resin. The spray-up fabrication method employs a "chopper gun" that simultaneously applies catalyzed resin and chopped glass fiber to a mold. In addition, many operations use a spray-applied polyester resin gelcoat, as for in-mold coating. Products produced by this industry include boats, bathtubs and shower enclosures, sinks and lavatories, underground storage tanks, auto and truck bodies, recreational vehicles, pollution control equipment, piping, and other specialized parts. [**33:**A.17.1]

43.8.2 Resin Application Equipment. The equipment and apparatus for spray application of the resin shall be installed and used in accordance with the requirements of Sections 43.7 and 43.8. [**33:**17.2]

Δ **43.8.3* Fire Protection.** Resin application areas shall be protected in accordance with 43.1.7. [**33:**17.3]

A.43.8.3 The determination by the Technical Committee on Finishing Processes that Ordinary Hazard (Group 2) sprinkler design density is sufficient for protecting spray application of styrene cross-linked thermoset resins (commonly known as glass fiber–reinforced plastics) is based on the following factors:

(1) Although the styrene monomer that is a component in unsaturated polyester resin is a Class I flammable liquid by definition, actual burn tests reveal that the resin does not readily ignite and burns slowly when it does ignite.
(2) Tests of resin application areas have shown that the processes do not produce vapors that exceed 25 percent of the lower flammable limit (LFL). Resin application tests have also indicated that the maximum levels of vapor concentrations are about 690 parts per million (ppm) for spray application. The tests were conducted in an enclosed area with no ventilation. The LFL concentration for styrene is 11,000 ppm. Twenty-five percent of the LFL is 2,750 ppm. [**33:**A.17.3]

43.8.4 Resin Storage. The quantity of flammable and combustible liquids located in the vicinity of resin application areas outside an inside storage room or storage cabinet in any one process area shall not exceed the greater of any of the following:

(1) A supply for one day
(2) The sum of 25 gal (95 L) of Class IA liquids in containers and 120 gal (454 L) of Class IB, IC, II, or III liquids in containers
(3) One approved portable tank not exceeding 660 gal (2500 L) of Class IB, IC, II, or III liquids [**33:**17.4]

43.8.5 Electrical and Other Hazards.

43.8.5.1 Electrical wiring and utilization equipment located in resin application areas that is not subject to deposits of combustible residues shall be installed in accordance with the requirements of *NFPA 70* for Ordinary Hazard locations. [**33:**17.5.1]

43.8.5.2 Electrical wiring and utilization equipment located in resin application areas that is subject to deposits of combustible residues shall be listed for such exposure and shall be suitable for Class I, Division 2 or Class I, Zone 2 locations if applicable as defined in 43.1.4.2.1.2. [**33:**17.5.2]

43.8.5.3* All metal parts of resin application areas, exhaust ducts, ventilation fans, spray application equipment, workpieces or containers that receive the spray stream, and piping that conveys flammable or combustible liquids shall be electrically grounded. [**33:**17.5.3]

A.43.8.5.3 NFPA 77 contains information on static electricity. [**33:**A.17.5.3]

43.8.5.4 Space heating appliances or other hot surfaces in resin application areas shall not be located where deposits or residues accumulate. [**33:**17.5.4]

43.8.6 Ventilation.

43.8.6.1 Mechanical ventilation shall be designed and installed throughout the resin application area in accordance with the requirements of 43.1.5.

Exception: Buildings that are not enclosed for at least three-quarters of their perimeter shall not be required to meet this requirement. [33:17.6.1]

43.8.6.2 Local ventilation shall be provided where personnel are under or inside of the workpiece being fabricated. [**33:**17.6.2]

43.8.7 Use and Handling.

43.8.7.1 The storage and use of organic peroxide formulations shall meet the requirements of Section 43.7. [**33:**17.7.1]

43.8.7.2 Excess catalyzed resin, while still in the liquid state, shall be drained into an open-top, noncombustible container. Enough water shall be added to the container to cover the contained resin by at least 2 in. (50 mm). [**33:**17.7.2]

43.8.7.3 In areas where chopper guns are used, paper, polyethylene film, or similar material shall be provided to cover the exposed surfaces of the walls and floor to allow the buildup of overchop to be removed. When the accumulated overchop has reached an average thickness of 2 in. (50 mm), it shall be disposed of after a minimum curing time of 4 hours.

Exception: A single day's accumulation of more than an average of 2 in. (50 mm) shall be permitted, provided that it is properly cured and disposed of before operations are resumed. [33:17.7.3]

43.8.7.3.1 Used paper, polyethylene film, or similar material shall be placed in a noncombustible container and disposed of when removed from the facility. [**33:**17.7.3.1]

43.9 Dipping, Coating, and Printing Processes

43.9.1 Dipping, roll coating, flow coating, curtain coating, printing, cleaning, and similar processes, hereinafter referred to as "coating processes" or "processes," in which articles or materials are passed through tanks, vats, or containers, or passed over rollers, drums, or other process equipment that contain flammable or combustible liquids shall comply with NFPA 34 and Section 43.9. [**34:**1.1.1]

Section 43.9 is based on NFPA 34, which is the primary NFPA standard governing dipping and coating operations that use flammable and combustible materials and which is extracted, in part, in this section. The commentary in this section reflects substantive amendments incorporated into the 2015 edition of NFPA 34.

NFPA 34 applies to processes in which articles or materials are passed through tanks, vats, containers, or process equipment that contain flammable or combustible liquids. Application can be direct, as in dipping the workpiece into a tank that holds the liquid (Exhibit 43.9), or indirect, as in impregnating fabric with liquid that is applied by passing the fabric through rollers that pick up the liquid from a trough. A printing press is an example of the latter application (Exhibit 43.10).

NFPA 34 addresses the fire and explosion hazards of dipping and coating processes and operations that use flammable and combustible liquids. It does not address toxicity or industrial health and hygiene. From the standpoint of personnel safety, it must be recognized that the materials used in these processes

Exhibit 43.9

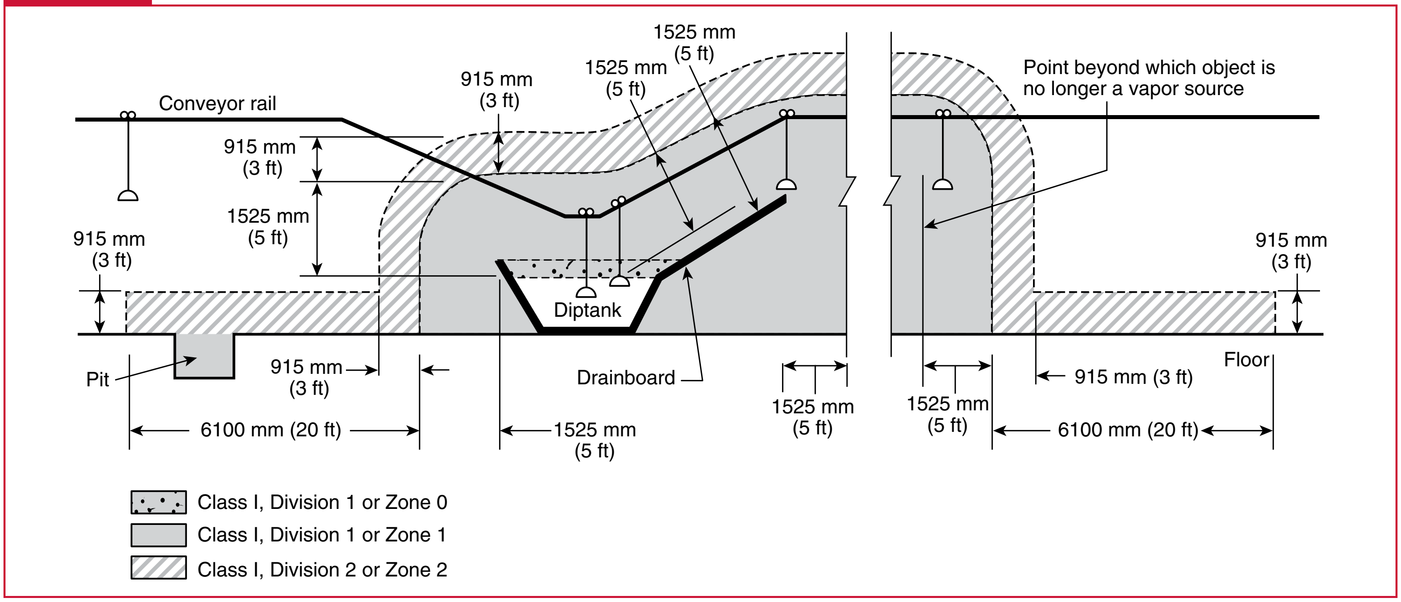


Diagram showing the hazardous (classified) areas surrounding an open dipping process. [Figure 6.4(a) from NFPA 34-2018.]

Exhibit 43.10

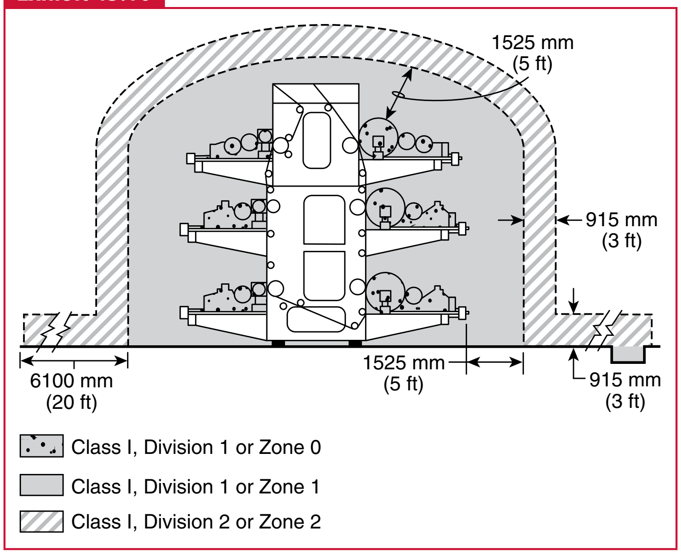


Diagram showing the hazardous (classified) areas surrounding a printing press. [Figure 6.4(d) from NFPA 34-2018.]

and operations could be present in concentrations that present a health hazard, even if the concentrations do not present a fire or explosion hazard. The requirements of NFPA 34 are intended to minimize the risk of fire and explosion; they are not intended to — and might not be adequate to — protect personnel from the toxic or negative effects from exposure to the materials used. The risk to life and property from fire or explosion as a result of dipping or coating processes varies, depending on the arrangement and operation of a particular installation. The principal hazards of such processes are fire and explosion hazards from large quantities of exposed flammable liquids. A fire, if not quickly controlled, can open sprinklers over a large area and might seriously damage building structural members. Enclosed processes, if not properly ventilated, present an explosion hazard that can result in release of coating material and could cause structural damage.

The fire hazard can be reduced by any one of several protection systems, which generally fall into the following two categories:

1. Protection system designed specifically for the process, such as a dry chemical system with an automatic-closing cover
2. Area protection system, such as an automatic sprinkler system for the room where the process is located

In some cases, a combination of the systems might be required. Protection should be chosen based on the design of the process and the properties of the coating used.

The elimination of all sources of ignition in areas where flammable or combustible liquids or combustible residues are present is essential to safe operation. Spread of fire to other property, exposure of personnel, and possibility of damage to goods in process or equipment should be considered in locating processes and installing protection systems. This consideration should be made regardless of the size of the process.

Unless otherwise noted, the provisions of NFPA 34 are not intended to be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of the standard, except in those cases where the AHJ determines that the existing situation involves a distinct hazard to life or adjacent property.

For the benefit of the user and because much of the text of NFPA 34 is not part of NFPA 1, the following is a summary of the major changes incorporated into the 2015 edition of NFPA 34:

1. Requirements were added to cover processes located in basements to ensure safe egress of personnel and safe access by emergency responders.
2. Provisions were added to address recirculation particulate filters.
3. Requirements for routing of exhaust ducts were modified to be consistent with those in NFPA 33.
4. Storage quantities for flammable and combustible liquids were modified to be consistent with both NFPA 30 and NFPA 33.
5. Water mist fire protection systems meeting the requirements of NFPA 750, *Standard on Water Mist Fire Protection Systems*, are now recognized as an acceptable means of protection.

43.9.1.1 Section 43.9 shall also apply to cleaning processes that utilize a solvent vapor, such as vapor degreasing processes. [**34:**1.1.2]

43.9.1.2 Section 43.9 shall also apply to processes that use waterborne, water-based, and water-reducible materials that contain flammable or combustible liquids or that produce combustible deposits or residues. [**34:**1.1.3]

43.9.1.3 Section 43.9 shall not apply to processes that use only noncombustible liquids for processing and cleaning. Section 43.9 shall also not apply to processes that use only Class IIIB liquids for processing or cleaning, provided the liquids or mixtures thereof maintain their Class IIIB classification at their point of use. [**34:**1.1.4]

43.9.1.4 Section 43.9 shall not apply to processes that use a liquid that does not have a fire point when tested in accordance with ASTM D92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup*, up to the boiling point of the liquid or up to a temperature at which the sample being tested shows an obvious physical change. [**34:**1.1.5]

Δ **43.9.1.5** Section 43.9 shall not apply to fluidized bed powder application. *(See Chapter 15 of NFPA 33.)* [**34:**1.1.6]

43.9.1.6* Section 43.9 shall not apply to quench tanks that are addressed in Chapter 51 of this *Code*.

Δ **A.43.9.1.6** See NFPA 86.

See also Chapter 51 for more information on quench tanks.

43.9.2* Where unusual industrial processes are involved, the AHJ shall be permitted to require additional safeguards or modifications to the requirements of NFPA 34, provided equivalent safety is achieved.

A.43.9.2 Section 43.9 anticipates conditions of average use.

43.10 Training

Δ **43.10.1* General.** All personnel involved in the spray application processes covered by this *Code* shall be instructed in the following:

(1) Potential safety and health hazards
(2) Operational, maintenance, and emergency procedures required
(3) Importance of constant operator awareness

[**33:**19.1]

A.43.10.1 The safety of a spray application process depends on the employees who operate it and the knowledge and understanding they have of the process and equipment involved. Therefore, it is important to maintain an effective and ongoing training program for all employees involved in such work. New employees should be effectively trained before being assigned to a job. After the initial training, employees should receive periodic retraining to ensure their knowledge and understanding of normal process procedures as well as with emergency procedures or changes in procedures. Safe work habits are developed; they do not occur naturally. [**33:**A.19.1]

All training should be provided by qualified personnel knowledgeable in the processes and operations involved. Appropriate training should be provided for all employees involved in or affected by spray application processes. This includes, but is not limited to, operating, supervisory, housekeeping, and maintenance personnel. [**33:**A.19.1]

43.10.1.1 Personnel required to handle or use flammable or combustible materials shall be instructed in the safe handling, storage, and use of the materials, as well as emergency procedures. [**33:**19.1.1]

43.10.1.2* All personnel required to enter or to work within confined or enclosed spaces shall be instructed as to the nature of the hazard involved, the necessary precautions to be taken, and the use of protective and emergency equipment required. [**33:**19.1.2]

A.43.10.1.2 Any work requiring entry of employees into confined spaces should be conducted in accordance with a written procedure that is rigidly followed. This procedure should include, but not be limited to, the following:

(1) Analysis of confined space atmosphere for flammable, combustible, toxic, or oxygen-deficient conditions
(2) Rescue, fire, and emergency procedures
(3) Locking and tagging procedures for all power and process hazard sources
(4) Ventilation
(5) Personal protective equipment
(6) Proper tools and electrical equipment
(7) Written entry authorization by a qualified responsible individual

[**33:**A.19.1.2]

All confined spaces should be considered hazardous areas due to their potential for containing atmospheric hazards such as oxygen deficiency and the presence of flammable and toxic vapors.

In addition, confined spaces can also present physical hazards (e.g., slips, trips, and falls) due to the structure and configuration of the space, particularly if lockout/tagout techniques are not employed. Consequently, confined space regulations and safety practices should be followed for any work that requires personnel to enter confined spaces. Safe practices could involve testing the atmosphere in the confined space before entry and while work is being performed in the space.

Personnel assigned to work in confined spaces, as well as others who are to respond to such areas in the event of an emergency, should receive training on the safe practices to be followed. The training program should address the anticipated hazards for the area and how to eliminate or reduce their effects. For additional information and regulatory requirements, consult 29 CFR 1910.146, "Permit-Required Confined Spaces."

43.10.1.3 All personnel shall be instructed in the proper use, maintenance, and storage of all emergency, safety, or personal protective equipment that they might be required to use in their normal work performance. [**33:**19.1.3]

The safety of spray application processes and dipping and coating processes depends on the personnel who perform the work and their knowledge and understanding of the process and the equipment involved. Therefore, maintaining an effective and ongoing training program for all personnel involved in such work is important. New employees should be effectively trained before being assigned to a job. After their initial training, employees should receive periodic retraining to reinforce their knowledge and understanding of normal process procedures, as well as to ensure their knowledge of emergency procedures and changes in procedures. Maintenance personnel must be trained to use the proper tools when performing routine maintenance and to inspect enclosed areas, such as plenums and ductwork, before using torches or cutting tools on outside surfaces. Safe work habits must be developed.

All training should be provided by qualified personnel who are knowledgeable in the processes and operations involved. Appropriate training should be provided for all personnel involved in, or affected by, spray application processes. Such personnel include, but are not limited to, operating, supervisory, housekeeping, and maintenance personnel.

43.10.1.4 Documentation shall be employed to record the type and date of training provided to each individual involved in these processes. [**33:**19.1.4]

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2018 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2015 and 2018 editions.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2016 edition.

NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*, 2015 edition.

NFPA 70®, *National Electrical Code®*, 2017 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2014 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2015 edition.

ANSI/UL 900, *Standard for Air Filter Units*, Underwriters Laboratories, Northbrook, IL, 2015.

United Nations, *Globally Harmonized System of Classification and Labeling of Chemicals* (*GHS*), 7th revised edition, 2017, available online at www.unece.org.

U.S. Government Publishing Office, Washington, DC.

Title 29, Code of Federal Regulations, Part 1910.146, "Permit-Required Confined Spaces."

Title 29, Code of Federal Regulations, Part 1910.1200, "Hazard Communication."

Solvent Extraction

44

Chapter 44 contains requirements for solvent extraction plants. There are some fundamental differences between the operation of solvent extraction plants and the processing of solvents in other facilities. Many extraction plants are relatively small units in isolated locations that are operated without the benefit of the overall fire protection measures customary in large solvent processing installations.

The operator of an extraction plant must establish and maintain a fire safety philosophy among a small number of employees, because they cannot rely on established fire safety programs as can be done in large-scale operations.

Certain inherent hazards that result from the combining and separating of solids and solvents are unique to this industry. Compounding the problem is the potential dust explosion hazard in some areas of a typical solvent extraction plant. Therefore, due consideration has been given to established industry practices that would apply to either potential dust-laden or flammable vapor atmospheres.

Δ 44.1 General

Solvent extraction plants shall comply with NFPA 36 and Chapter 44.

NFPA 36, *Standard for Solvent Extraction Plants*, contains requirements for the commercial-scale extraction processing of animal and vegetable oils and fats by the use of Class I flammable hydrocarbon liquids, referred to as solvents. NFPA 36 applies to the unloading, storage, and handling of solvents and applies to the means by which the material to be extracted is conveyed from the preparation process to the extraction process. In addition, it applies to the means by which extracted desolventized solids and oils are conveyed from the extraction process. NFPA 36 includes any preparation or meal-finishing processes that are connected to the solvent extraction process by a conveyor, establishing a boundary between those operations governed by NFPA 36 and those that might be governed by NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*.

NFPA 36 contains provisions that address the following conditions:

1. Requirements for the design, construction, and operation of extraction processes that use Class I flammable hydrocarbon liquids
2. Requirements for the prevention of fire and explosions in extraction processes and in associated preparation and meal-finishing areas
3. Means by which plant fire protection and supervisory personnel can evaluate the processes and operations under their control
4. Guidance to regulatory and inspection officials in determining whether a given facility is being operated in accordance with good practice
5. A workable set of standards for the use of design engineers, architects, and others in the planning and designing of new installations

The provisions of NFPA 36 apply to all extraction plants. Existing plants that comply with the edition of NFPA 36 in effect at the time of construction are considered to be in compliance with the *Code*, provided that they do not constitute a recognized hazard to life or adjacent property, as determined by the authority having jurisdiction (AHJ).

The effective date for the edition of NFPA 36 referenced in this *Code* is December 1, 2016. However, the provisions of NFPA 36 might not be enforceable retroactively to its effective date if it has not been adopted by a separate action in the jurisdiction. The date that NFPA 1, *Fire Code*, was adopted in the jurisdiction establishes the effective date for the enforcement of not only NFPA 1 but also the other codes and standards incorporated into the *Code*.

44.2 Application

44.2.1 Chapter 44 shall apply to the following:

(1) The commercial scale extraction processing of animal and vegetable oils and fats by the use of Class I flammable hydrocarbon liquids, hereinafter referred to as “solvents” [**36:**1.1.1]
(2) Any equipment and buildings that are located within 100 ft (30 m) of the extraction process [**36:**1.1.2]

(3) The unloading, storage, and handling of solvents, regardless of distance from the extraction process [**36:**1.1.3]
(4) The means by which material to be extracted is conveyed from the preparation process to the extraction process [**36:**1.1.4]
(5) The means by which extracted desolventized solids and oil oils are conveyed from the extraction process [**36:**1.1.5]
(6) Preparation and meal finishing processes that are connected by conveyor to the extraction process, regardless of intervening distance [**36:**1.1.6]

44.2.2 Chapter 44 shall not apply to the following:

(1) The storage of raw materials or finished products [**36:**1.1.7]
(2) Extraction processes that use liquids that are miscible with water [**36:**1.1.8]
(3) Extraction processes that use flammable gases, liquefied petroleum gases, or nonflammable gases [**36:**1.1.9]

44.3 Permits

Permits, where required, shall comply with Section 1.12.

Permit requirements are listed in Table 1.12.8(a). Permits are required for the storage, use, and handling of solvents associated with a solvent extraction process.

44.4 Special Requirements

The use of processes that employ oxygen-active compounds that are heat or shock sensitive, such as certain organic peroxides, shall be prohibited within the area defined in 44.2.1(2). [**36:**1.1.10]

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 36, *Standard for Solvent Extraction Plants*, 2017 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, 2017 edition.

45 Combustible Fibers

45.1 General

45.1.1 The storage, use, and handling of combustible fibers shall comply with the requirements of Chapter 45.

Fibers are the basic components of all textiles; they can be either natural or man-made. Natural fiber sources include cellulosic materials, proteins, and minerals. Cellulosic fibers come from a variety of plants, the most common of which is cotton, while protein fibers come from a variety of animal hairs. Mineral fibers include mineral wool and fiberglass. Man-made fibers are produced by chemical processes. All fibers come in a variety of lengths. Although natural fiber length can be slightly manipulated genetically, man-made fiber can be produced in any length.

The term *combustible fiber* is defined in 3.3.59 as "any material in a fibrous or shredded form that readily ignites when heat sources are present." Combustible fibers include cotton, sisal, henequen, ixtle, jute, hemp, tow, cocoa fiber, oakum, baled waste, baled wastepaper, kapok, hay, straw, excelsior, Spanish moss, or other similar materials.

Commentary Table 45.1 provides the fire hazard properties of common textile fibers. Many fibers are spun into yarns and then woven or knitted into a variety of fabrics. Examples include plain or patterned fabrics or pile, such as flannels, terry cloth towels, artificial furs, and carpets. Fibers also can be processed directly into useful materials, such as nonwoven fabrics or battings. Fabrics are usually scoured, bleached, dyed, or finished (or undergo a combination of these processes) with chemicals that provide them with a stiffer or softer feel, with permanent-press characteristics, with luster, or with resistance to flame or weather. See Commentary Table 45.2 for more information on identification of textiles by their burning characteristics. The *NFPA Fire Protection Handbook®* contains additional information on combustible fibers.

45.1.2* Chapter 45 shall not apply to buildings completely protected by an approved automatic fire-extinguishing system; however, this exclusion does not preclude the need for good housekeeping.

A.45.1.2 The use of automatic sprinkler protection in accordance with NFPA 13 is recommended for all storage of combustible fibers.

N **45.1.3** Chapter 45 shall not apply to biomass feedstock regulated by Chapter 31.

45.1.4 Permits. Permits, where required, shall comply with Section 1.12.

Subsection 1.12.8 requires a permit for the storage or handling of combustible fibers greater than 100 ft^3 (2.8 m^3); see Table 1.12.8(a).

45.2 Electrical Wiring

45.2.1 Electrical wiring and equipment in any combustible fiber storage room or building shall be installed in accordance with the requirements of *NFPA 70* for Class III hazardous locations.

45.2.2 The AHJ shall be responsible for designating the areas requiring hazardous location electrical classifications and shall classify the area in accordance with the classification system set forth in *NFPA 70*.

45.3 No Smoking

45.3.1 No smoking or open flame shall be permitted in any area where combustible fibers are handled or stored, nor within 50 ft (15 m) of any uncovered pile of such fibers.

45.3.2 NO SMOKING signs shall be posted.

See Section 10.9 for further information on smoking restrictions.

Δ 45.4 Vehicles and Material Handling Equipment

Trucks or automobiles, other than mechanical handling equipment and approved industrial trucks complying with NFPA 505, shall not enter any fiber storage room or building but shall be permitted to be used at loading platforms.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, applies to fork trucks, tractors, platform lift trucks, motorized hand trucks, and other specialized industrial trucks powered by electric motors or internal combustion engines.

COMMENTARY TABLE 45.1 *Fire Hazard Properties of Common Textile Fibers*

Fiber Designation	Decomp. Temp. °F (°C)	Melting Temp. °F (°C)	Ignition Temp. °F (°C)	Burning Temp. °F (°C)	Burning Behavior	End Uses
A. Natural Fibers						
Cellulosic: cotton, hemp, jute, linen, sisal, etc.	580–610 (305–320)	— —	490–750 (255–400)	1560 (850)	Chars, burns, sometimes afterglow	Apparel, furnishings, towels, cordage
Protein: wool, mohair, cashmere, camel hair, etc.	450 (230)	— —	1060–1110 (570–600)	1720 (940)	Chars, intumesces, burns less readily than cellulosics	Apparel, blankets, carpets, furniture covers
B. Manufactured Fibers						
Acetate	570 (300)	500 (260)	842 (450)	1720 (940)	Shrinks, melts, and burns	Apparel, lingerie, furnishings
Acrylic	540–590 (280–310)	420–490 (215–255)	860–1050 (460–565)	1560 (850)	Chars, intumesces, burns, and drips	Apparel, furnishings, carpets, blankets, pile fabrics
Nylon	600–790 (315–420)	420–490 (215–255)	840–1060 (450–570)	1600 (870)	Melts, ablates, burns	Apparel, lingerie, furnishings, carpets, cordage, industrial uses
Anidex	NA	NA	NA	NA	NA	Elastic fiber used in apparel, home furnishings, and laces
Aramid	660 (370–400)	3700 (2040)	800–1040 (427–560)		Does not melt	
Lyocell	350 (175)	450–500 (230–260)	860 (460)			Dresses, slacks, coats, jeans
Modacrylic	500 (287)		1025 (550)			Children's sleepwear, carpets, blankets, draperies
Novoloid		Nonmelting				Protective equipment
Rubber	200 (93)					
Triacetate	>572 (>300)	550 (288)	>842 (>450)	1560 (850)	Shrinks, melts, and burns	
Vinal	Similar to nylon					Good chemical resistance
Vinyon						Good chemical resistance
Olefin (polypropylene)	750 (400)	330 (165)	930–1060 (500–570)	1540 (840)	Melts, ablates, burns	Knitted sportswear, carpets, cordage, furniture covers, industrial uses
Polyester	680–750 (360–400)	480–570 (250–300)	840–1040 (450–560)	1290–1330 (700–720)	Melts, ablates, burns	Apparel, lingerie, furnishings, carpets, blankets, fiberfill, cordage, industrial uses
Rayon (viscose)	550 (290)	—	790 (420)	1560 (850)	Chars, burns	Apparel, lingerie, furnishings
Spandex	581–671 (305–355)	446–482 (230–250)	780 (415)	NA	Melts, burns	In apparel and lingerie where stretch is desired

NA: Not available.

Source: Table 6.5.7 of the *NFPA Fire Protection Handbook*.

COMMENTARY TABLE 45.2 *Textile Identification by Burning Characteristics*

Fiber	Burn Characteristics	Residue
Acetate	Shrinks, melts, and burns	Dark, hard, solid bead; acrid odor (hot vinegar)
Acrylic	Shrinks, melts, and burns	Hard, irregularly shaped bead; black smoke; acrid odor
Aramid	Shrinks, melts, and burns	Hard, black bead; self-extinguishing
Cotton	Burns	Fine, feathery gray ash; odor similar to burning paper
Flax, hemp, jute, ramie	Burns	Fine, feathery gray ash, odor similar to burning paper
Glass	Shrinks slowly, melts at very high temperature	Flame-resistant fiber, heat from lighter will not cause fiber to melt
Modacrylic	Shrinks, melts, and burns	Hard, black, irregular bead; self-extinguishing; acrid chemical odor
Novoloid	Shrinks, burns at high temperature	Retains shape but turns black; heat from lighter will not cause fiber to burn
Nylon	Shrinks, melts, and burns	Hard, cream-colored bead; if fibers are overheated, bead will become dark; flaming usually caused by finish present; drops of melted fiber may fall from heated portion of sample; celery odor
Olefin	Shrinks, melts, and burns	Hard, tan bead; black smoke; chemical odor
Polyester	Shrinks, melts, and burns	Hard, cream-colored bead; if fibers are overheated, bead will become dark; drops of melted fiber may fall from heated portion of sample; black smoke; chemical odor
Rayon	Burns	Fine, feathery gray ash
Rubber	Shrinks, melts, and burns rapidly	Tacky, soft black residue
Saran	Shrinks, melts, and burns	Hard, black, irregular bead; self-extinguishing; chemical odor
Silk	Shrinks and burns	Black, hollow, irregular bead that crushes easily to a gritty black powder
Spandex	Burns and melts	Soft, black ash
Triacetate	Shrinks, melts, and burns	Dark, hard, solid bead; chemical odor
Vinal	Shrinks, melts, and burns	Hard, tan bead; chemical odor
Vinyon	Shrinks, melts, and burns	Hard, black, irregular bead; acrid odor
Wool, mohair, cashmere, alpaca	Shrinks and burns	Black, hollow, irregular bead that crushes easily to a gritty black powder

Source: Table 6.5.7 of the *NFPA Fire Protection Handbook.*

45.5 Loose Storage of Combustible Fibers

45.5.1 Loose combustible fibers (not in bales or packages), whether housed or in the open, shall not be stored within 100 ft (30 m) of any building, except as hereinafter specified.

45.5.2 Quantities of loose combustible fibers up to 100 ft^3 (2.8 m^3) shall not be kept in any building unless stored in a metal or metal-lined bin that is equipped with a self-closing cover.

A summary of the loose storage of combustible fibers in rooms or buildings is provided in Commentary Table 45.3.

COMMENTARY TABLE 45.3 *Requirements for Loose Storage of Combustible Fibers*

Quantity	Storage
$\leq$100 ft^3 (2.8 m^3)	Metal or metal-lined bin with self-closing cover
$>$100 ft^3 (2.8 m^3) and $\leq$500 ft^3 (14.2 m^3)	Rooms or compartments with floors, walls, and ceilings having not less than ¾-hour fire-resistance rating; self-closing fire door
$>$500 ft^3 (2.8 m^3) and $\leq$1000 ft^3 (28.3 m^3)	Storage vaults enclosed with floors, walls, and ceilings with 2-hour fire-resistance-rated fire barriers*
$>$1000 ft^3 (28.3 m^3)	Storage vaults enclosed with floors, walls, and ceilings with 2-hour fire-resistance-rated fire barriers and protected by an approved automatic sprinkler system*

*Additional requirements may apply depending on if the storage vault is located inside or outside the building.

45.5.3 Rooms or Compartments for Quantities of Loose Combustible Fibers Ranging Between 100 ft^3 (2.8 m^3) and 500 ft^3 (14.2 m^3).

45.5.3.1 Quantities exceeding 100 ft^3 (2.8 m^3) of loose combustible fibers, but not exceeding 500 ft^3 (14.2 m^3), shall be permitted to be stored in rooms or compartments in which the floors, walls, and ceilings have a fire-resistance rating of not less than ¾ hour.

45.5.3.2 Each opening into such rooms or compartments from other parts of the building shall be equipped with an approved self-closing fire door.

45.5.4 Storage Vaults for Quantities of Loose Combustible Fibers Ranging Between 500 ft³ (14.2 m³) and 1000 ft³ (28.3 m³).

45.5.4.1 Quantities exceeding 500 ft^3 (14.2 m^3) of loose combustible fibers, but not exceeding 1000 ft^3 (28.3 m^3), shall be permitted to be stored in storage vaults enclosed with floors, walls, and ceilings that are 2-hour fire-resistance-rated fire barriers.

45.5.4.2 Such storage vaults shall be located outside of buildings or, if located inside, shall be protected with approved safety vents to the outside.

45.5.4.3 If such storage vaults are located inside a building, each opening into the storage vault from other parts of the building shall be protected on each side of the wall by an approved opening protective assembly having a fire resistance rating of 1½ hours.

45.5.4.4 If such storage vaults are located outside of buildings but have openings that expose other buildings (not sufficiently detached to be considered cutoff), each such opening shall be protected on each side of the wall by an approved opening protective assembly having a fire resistance rating of 1½ hours.

45.5.4.5 Roofs of outside vaults shall be of noncombustible material, but shall be permitted to be constructed so as to readily give way in case of an internal explosion.

45.5.5 Storage Vaults for Quantities of Loose Combustible Fibers Exceeding 1000 ft³ (28.3 m³).

45.5.5.1 Quantities exceeding 1000 ft^3 (28.3 m^3) of loose combustible fibers shall be permitted to be stored in storage vaults as indicated in 45.5.4.

45.5.5.2 The storage vault shall also be protected by an approved automatic sprinkler system designed and installed in accordance with Section 13.3.

45.5.6 Loose House.

45.5.6.1 Not more than 2500 ft^3 (71 m^3) of loose fibers shall be permitted to be stored in a detached loose house, with openings properly protected against the entrance of sparks.

45.5.6.2 The loose house shall be used for no other purpose.

45.6 Baled Storage

The main hazard of baled cotton and other fibers of vegetable origin is the multitude of exposed, minute fibers on the surfaces of the bales. Fire quickly flashes over the vertical surfaces, the loose particles on the floor, and the lint on overhead piping and structural members. Fire on one side of an automatic-closing fire door can progress through the open doorway on loose floor scraps before the door can close automatically. Therefore, proper housekeeping is especially important in areas where such fibers are present.

Fire also tends to penetrate between and into bales, requiring their removal from the building for extinguishment. Considerable smoke emission complicates fire fighting. Certain fibers, such as jute, swell when wet; therefore, the bales should be piled with careful attention to their stability during a fire and with proper clearance from walls. See NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, for more information on fire protection requirements that affect the fibers industry.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, and FM Global Property Loss Prevention Data Sheet 8-7, "Baled Fiber Storage," provide guidance for the protection of fibers.

45.6.1 Blocks or Piles.

45.6.1.1 No single block or pile shall contain more than 25,000 ft^3 (708 m^3) of combustible fibers, exclusive of aisles or clearances.

45.6.1.2 Blocks or piles of baled fiber shall be separated from adjacent storage by aisles not less than 5 ft (1.5 m) wide or by flash fire barriers consisting of continuous sheets of noncombustible material extending from the floor to a height of at least 1 ft (0.3 m) beyond the top of the piles and projecting not less than 1 ft (0.3 m) beyond the sides of the piles.

45.6.1.3 Baled cotton storage and combustibles shall be kept at least 4 ft (1.2 m) from fire door openings.

45.6.2 Sisal and Other Fibers.

45.6.2.1 Sisal and other fibers in bales bound with combustible tie ropes or jute and other fibers that are liable to swell when wet shall be stored in a manner that allows for expansion in any direction without endangering building walls, ceilings, or columns.

45.6.2.2 Not less than 3 ft (0.9 m) of clearance shall be left between walls and sides of piles, except that in storage compartments not more than 30 ft (9 m) in width, 1 ft (0.3 m) clearance at side walls shall be sufficient, provided that a center aisle not less than 5 ft (1.5 m) wide is maintained.

The application of water, either from a sprinkler system or from fire-fighting hose lines, causes certain fibers to swell. If baled fibers are located adjacent to the walls or the structural components of a building, the swelling can be sufficient to deform the building components, pushing out walls or displacing columns.

Waterlogged fiber bales impinging on building components can lead to structural instability. Limiting the width of piles allows the focus to remain on fire-fighting operations, but it also limits the amount of expansion due to swelling and reduces the chances for pile instability. The potential movement of unstable piles is also a hazard to fire fighters.

45.7 Storage of Hay, Straw, and Other Similar Agricultural Products

45.7.1 Hay, straw, and other similar agricultural products shall not be stored adjacent to buildings or combustible material unless a cleared horizontal distance equal to the height of pile is maintained between such storage and combustible material and buildings.

45.7.2 Storage shall be limited to stacks of 100 tons (90,720 kg) each.

Δ **45.7.3** Either an approved 1-hour fire wall installed in accordance with NFPA 221 or a clear space of 20 ft (6.1 m) shall be maintained between such stacks.

45.7.4 Unlimited quantities of hay, straw, and other agricultural products shall be permitted to be stored in or near farm buildings located outside of closely built areas.

45.8 Hazardous Materials

Combustible fibers shall not be stored in rooms or buildings with hazardous gases, flammable liquids, dangerous chemicals, or other similar materials.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, 2013 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2017 edition.

NFPA Fire Protection Handbook®, 20th edition.

FM Global Property Loss Prevention Data Sheet 8-7, "Baled Fiber Storage," FM Global, Johnston, RI, 1974, Revised 2000.

46–49
Reserved

In the 2018 edition of NFPA 1, *Fire Code,* the following chapters have been reserved for future use:

- Chapter 46
- Chapter 47
- Chapter 48
- Chapter 49

Commercial Cooking

50

Fires in commercial cooking establishments are a serious concern. Many commercial cooking operations are part of assembly, educational, and health care occupancies where a fire could create a significant risk to life safety. Based on a report published by NFPA's Fire Analysis and Research Division, "Structure Fires in Eating and Drinking Establishments," between 2010 and 2014 U.S. fire departments responded to an estimated average of 7410 structure fires at eating and drinking establishments per year. Those fires caused average annual losses of three civilian deaths, 110 civilian injuries, and $165 million in direct property damage each year. Three out of five (61 percent) of the fires involved cooking equipment. The vast majority of the fires in this category were in restaurants. Of the 7410 fires, 59 percent (4380 fires) began in the kitchen or cooking area and caused 35 percent ($58 million) of the direct property damage. Leading factors contributing to the ignition of fires in restaurants were reported as failure to clean the equipment, electrical and/or mechanical failures, abandoned or discarded material or product, heat source too close to combustibles, or unattended equipment. The proper design, installation, and maintenance of a commercial cooking system are essential to the proper function of a building and the safety of its occupants.

The case studies included in the commentary in this chapter are published incidents in eating and drinking establishments where the presence of commercial cooking equipment played an important role in the fire scenario. These incidents show the importance of the proper installation, inspection, testing, and maintenance of such equipment in case of a fire event. These case studies are based on short articles from the "Firewatch" column in the *NFPA Journal* and incidents from either the large-loss fires report or the catastrophic fires report. It is important to remember that this is anecdotal information.

Case Study

Suppression Systems Control Restaurant Grease Fire, Pennsylvania

A kitchen extinguishing system and a sprinkler that activated during a fire in an Asian restaurant limited fire damage. The single-story restaurant building, which was 20 feet (6 meters) wide and 40 feet (12 meters) long, was protected by a wet-pipe sprinkler system and a kitchen hood suppression system, both of which were connected to a monitored fire alarm system. Investigators determined that the fire started in grease deposits that had formed in the bottom of smoke box cooking equipment and spread to a deep-fat fryer, causing the hood extinguishing system to activate. Additional heat fused a nearby sprinkler, which held the fire in check until the fire department arrived to extinguish the blaze. The kitchen's hood system extinguished the fire in the deep fryer.

— "Firewatch," *NFPA Journal*, May/June 2012, pp. 38–39

Suppression System Controls Kitchen Hood Fire, Utah

A fire suppression system controlled a fire that started in the hood duct of a restaurant kitchen, but the fire fed off the grease that had built up in the duct and continued to burn until firefighters extinguished it. The building was occupied when the fire broke out, but everyone had evacuated safely by the time firefighters arrived. Someone called 911 to report the blaze at 4:20 p.m., and firefighters arrived four minutes later to find smoke coming from the roof. The restaurant owner told the incident commander that the hood had caught fire after they started the grill. It looked as though the hood suppression system had put the fire out, but firefighters on the roof reported that they could still see the fire burning in the ductwork some 8 feet (2 meters) below them. When they were unable to get water on the flames from their position, they recommended an interior attack.

Interior crews advanced a hose line into the kitchen and opened the ceiling around the ductwork. Once the duct was exposed, they saw that the grease and creosote that had built up on the sides of it were still burning. Fortunately, the duct maintained its integrity, preventing the fire and heat from escaping into hidden areas before it was extinguished. Investigators noted that the hood suppression system heads did not discharge properly.

Damage to the property and its contents was estimated at $5,000. There were no injuries.

— "Firewatch," *NFPA Journal*, May/June 2012, p. 39

Kitchen Fire Damages Restaurant, Ohio

A restaurant suffered significant structural damage when a pressurized deep-fat fryer malfunctioned and ignited cooking oil, starting a fire that caused more than a million dollars in property damage. The single-story, wood-frame building covered an area of 16,625 square feet (1,545 square meters) and had a wood-frame roof covered in asphalt shingles. Smoke and heat detectors throughout the building were connected to a monitored fire alarm panel. A kitchen hood fire suppression system was installed in the kitchen, but it did not operate. There were no sprinklers.

Employees detected the fire and tried unsuccessfully to control it using portable fire extinguishers before the restaurant manager called the fire department at 9:17 a.m. The monitoring company did not report the alarm to the fire department until 20 minutes into the incident.

Firefighters arrived within four minutes of the manager's 911 call to find heavy smoke pouring from the back of the building and flames coming out the roof. First-in crews found flames from floor to ceiling at the end of the cooking line and abandoned their initial efforts to control the fire from inside, undertaking a defensive fire attack instead.

The building, valued at $2.1 million, and its contents, valued at $500,000, sustained damage estimated at $1.25 million and $250,000, respectively. There were no injuries.

— "Firewatch," *NFPA Journal*, September/October 2011, p. 14

Grease Fire Destroys Restaurant, Maryland

Employees of a take-out restaurant had begun preparing to open for the day when they discovered a fire in the ductwork over two rotisserie ovens and a deep fat fryer. They tried to put out the flames with fire extinguishers, but the fire spread through the ductwork to concealed spaces above. The single-story, wood-frame restaurant, which measured 100 by 30 feet (30 by 9 meters), was separated from adjacent stores by gypsum board walls. The restaurant had no smoke or fire detection equipment, and its kitchen hood system was not operational as heads were missing.

Approximately 30 minutes after a worker cleaned the overhead duct filters and ignited charcoal in the ovens, he noticed the fire and used several fire extinguishers in an unsuccessful effort to control the flames. After a delay of about eight minutes, a restaurant employee called 911 at 8:40 a.m.

Investigators determined that the fire began when heat from the ovens ignited a buildup of grease in the ductwork. A hole in the ductwork allowed the fire to spread into the concealed ceiling space, where it charred the combustible construction and ignited the roof assembly. The owner told investigators that the ductwork had been poorly cleaned two weeks earlier and that he had contacted another firm about future cleaning.

The structure, valued at $2 million, and its contents, valued at $500,000, were destroyed. There were no injuries.

— "Firewatch," *NFPA Journal*, May/June 2009, pp. 43–44

50.1 Application

Δ **50.1.1*** The design, installation, operation, inspection, and maintenance of all public and private commercial cooking equipment and mobile and temporary cooking operations shall comply with this chapter and NFPA 96.

A.50.1.1 These requirements include, but are not limited to, all manner of cooking equipment, exhaust hoods, grease removal devices, exhaust ductwork, exhaust fans, dampers, fire-extinguishing equipment, and all other auxiliary or ancillary components or systems that are involved in the capture, containment, and control of grease-laden cooking effluent. [**96:**A.1.1.1]

The effective date for the edition of NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, referenced in this *Code* is December 1, 2016. However, the provisions of NFPA 96 might not be enforceable retroactively to its effective date if it has not been adopted by a separate action in the jurisdiction. The date that NFPA 1, *Fire Code*, was adopted in the jurisdiction establishes the effective date for enforcement of not only NFPA 1 but also other codes and standards incorporated into this *Code*.

The 2017 edition of NFPA 96 added a new normative annex on mobile and temporary cooking operations. Section 50.7 includes provisions on mobile and temporary cooking operations that are consistent with the new guidelines in NFPA 96. See Section 50.7 for additional commentary and information on these new provisions.

50.1.2 This chapter shall apply to residential cooking equipment used for commercial cooking operations. [**96:**1.1.2]

50.1.3 This chapter shall not apply to cooking equipment located in a single dwelling unit. [**96:**1.1.3]

Δ **50.1.4*** This chapter shall not apply to facilities where all of the following are met:

(1) Only residential equipment is being used.
(2) Fire extinguishers are located in all kitchen areas in accordance with Section 13.6.

(3) The facility is not an assembly occupancy.
(4) The AHJ has approved the installation.
[**96:**1.1.4]

Δ **A.50.1.4** This judgment should take into account the type of cooking being performed, the items being cooked, and the frequency of cooking operations. Examples of operations that might not require compliance with Chapter 50 include the following:

(1) Day care centers warming bottles and lunches
(2) Therapy cooking facilities in health care occupancies
(3) Churches and meeting operations that are not cooking meals that produce grease-laden vapors
(4) Employee break rooms where food is warmed

In non-assembly occupancies where residential equipment is utilized, the AHJ may consider requiring protection of the cooking surface with a listed residential range top extinguishing unit as an alternative to no protection or requiring full protection in accordance with this standard.

[**96:**A.1.1.4]

In the past, NFPA 96 was used for commercial cooking operations, public or private. However, other operations, particularly those involving residential cooking equipment, were a source of considerable debate. NFPA 96 now clearly states that residential equipment used in commercial cooking operations is within its scope. The current text in NFPA 96 and in this *Code* establishes the following four criteria that all must be met for a facility to be considered exempt from the requirements of NFPA 96:

1. Only residential equipment is being used.
2. Fire extinguishers must be located in all kitchen areas in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.
3. The facility must not be an assembly occupancy (see 6.1.2).
4. The authority having jurisdiction (AHJ) has approved the installation.

In the past, a frequently asked question was how to apply NFPA 96 to specific pieces of equipment, such as standard pizza ovens, conveyor pizza ovens, smokers, steamers, mesquite grills, and other equipment. Much of the debate centered on the production of grease-laden vapors and on the amount of grease-laden vapor that can be produced by a given piece of equipment, because previous editions of the standard contained scope language regarding equipment that "produces grease-laden vapors." Recent editions have removed that language from the scope and, as a result, have clearly established that NFPA 96 is intended to apply to any and all commercial cooking appliances.

50.2 General Requirements

50.2.1 General.

50.2.1.1 Cooking equipment used in processes producing smoke or grease-laden vapors shall be equipped with an exhaust system that complies with all the equipment and performance requirements of this chapter. [**96:**4.1.1]

Most commercial cooking equipment produces smoke and grease-laden vapors with very few exceptions. Equipment that is being considered for qualification as an exception must be carefully evaluated before any of the requirements for ventilation and protection are modified.

The operation and protection of commercial cooking equipment have general requirements. Special attention must be given to the arrangement and protection of ventilation systems that serve multiple hoods in multiple tenancies, such as food courts in malls. Those tenancies house various arrangements that affect ventilation and fire protection system operation, as well as system maintenance. All these factors need to be considered in the design and maintenance plan to ensure that fire protection systems operate properly.

Given the requirement of 50.2.1.1, it is therefore possible to have a piece of equipment and a location that fall under the applicability of NFPA 96 but are not required to be provided with an exhaust system as the standard specifies. This will be a rare occurrence, since the vast majority of cooking operations will produce smoke or grease-laden vapors. The possibility still exists, for example, for a piece of equipment to be installed without the exhaust system, provided a policy is set that limits its use to only operations that do not produce smoke or grease-laden vapors. That is a policy that would be difficult to ensure and the final approval would need to come from the AHJ.

50.2.1.1.1* Cooking equipment that has been listed in accordance with ANSI/UL 197, *Standard for Commercial Electric Cooking Appliances*, or an equivalent standard for reduced emissions shall not be required to be provided with an exhaust system. [**96:**4.1.1.1]

ANSI/UL 197, *Standard for Commercial Electric Cooking Appliances,* addresses commercial electric cooking appliances rated 600 volts or less, intended for indoor use, and intended for use in accordance with *NFPA 70®, National Electrical Code®*. It also covers coffee makers, conductive cookers, food warmers, fryers, griddles, steam kettles, steam cookers, nut warmers, popcorn machines, ranges, utensil warmers, and other appliances found in commercial kitchens, restaurants, or other business establishments where food is dispensed.

For valid conclusions, it is imperative to conduct the evaluation while the equipment is being operated at an airflow of 500 cfm (0.236 m^3/s), since lower and higher airflow rates would likely produce unreliable results. This airflow rate was determined after a comprehensive research project conducted by ASHRAE in the early 2000s generated a report titled "Effects of Air Velocity on Grease Deposition in Exhaust Ductwork."

A.50.2.1.1.1 As referenced in ANSI/UL 197, some products evaluated using the emission test procedure EPA 202, as described in ANSI/UL 710B, are listed in the UL directory under the category KNLZ, Commercial, with Integral Systems for Limiting the Emission of Grease-laden Air. [**96:**A.4.1.1.1]

50.2.1.1.2 The listing evaluation of cooking equipment covered by 50.2.1.1.1 shall demonstrate that the grease discharge at the exhaust duct of a test hood placed over the appliance shall not exceed 0.00018 oz/ft^3 (5 mg/m^3) when operated with a total airflow of 500 cfm (0.236 m^3/s). [**96:**4.1.1.2]

50.2.1.2 All such equipment and its performance shall be maintained in accordance with the requirements of this chapter during all periods of operation of the cooking equipment. [**96:**4.1.2]

Δ **50.2.1.3** The following equipment shall be kept in working condition:

(1) Cooking equipment
(2) Hoods
(3) Ducts (if applicable)
(4) Fans
(5) Fire-extinguishing equipment
(6) Special effluent or energy control equipment

[**96:**4.1.3]

50.2.1.3.1 Maintenance and repairs shall be performed on all components at intervals necessary to maintain good working condition. [**96:**4.1.3.1]

Maintenance is performed predominantly to create an acceptable level of confidence in the performance of the equipment being maintained. Maintenance schedules often include inspection of components, which provides an opportunity to discover components needing repair. Routine maintenance and repairs keep the equipment operable in a safe and efficient manner.

50.2.1.4 All airflows shall be maintained. [**96:**4.1.4]

Airflow is important for two reasons. First, airflow is a critical component in the process of effectively filtering grease from the exhaust during cooking operations. Second, airflow provides an important cooling feature when it continues after an extinguishing agent is discharged, because it removes residual heat from the appliances and from the protected surfaces.

Most fire officials do not feel that air movement caused by the continued running of an exhaust system fan significantly affects fire behavior. The slight additional risk is far outweighed by the benefit of the additional cooling that is achieved when the exhaust fan continues to run. With modern extinguishing systems relying on no "reflash" on the cooking surfaces, shutting off fuel and removing residual heat are important evolutions.

50.2.1.5 The responsibility for inspection, testing, maintenance, and cleanliness of the ventilation control and fire protection of the commercial cooking operations, including cooking appliances, shall ultimately be that of the owner of the system, provided that this responsibility has not been transferred in written form to a management company, tenant, or other party. [**96:**4.1.5]

This requirement states that the responsibility for the systems is that of the system owner. This responsibility can only be transferred in written form to other parties, including a tenant or a management company. It is important for building owners and tenants to understand who will have this responsibility where a space with an existing kitchen exhaust system is leased.

The phrase "including cooking appliances" was added to the 2017 edition of NFPA 96 to emphasize that, in addition to the owner taking responsibility for the inspection, testing, maintenance, and cleanliness of exhaust systems and fire protection systems, the owner is responsible for maintaining the cooking appliances to comply with the standard.

50.2.1.6* All solid fuel cooking equipment are required to comply with the requirements of Chapter 14 of NFPA 96. [**96:**4.1.6]

A.50.2.1.6 When solid fuel is burned in cooking operations, increased quantities of carbon, creosote, and grease-laden vapors are produced that rapidly contaminate surfaces, produce airborne sparks and embers, and are subject to significant flare-ups. Also, solid fuel cooking requires fuel storage and handling and produces ash that requires disposal. For these reasons, solid fuel cooking operations are required to comply with Chapter 14 of NFPA 96. [**96:**A.4.1.6]

Solid fuel cooking equipment has the added consequence of creating by-products beyond grease and smoke, which might in themselves be hazards. In the case of wood fuel, an added by-product is creosote. Other solid fuels might contain other by-products, such as paraffin and tar, which might need to be addressed.

50.2.1.7 Multi-tenant applications shall require the concerted cooperation of design, installation, operation, and maintenance responsibilities by tenants and by the building owner. [**96:**4.1.7]

50.2.1.8 All interior surfaces of the exhaust system shall be accessible for cleaning and inspection purposes. [**96:**4.1.8]

Since the continued safe operation of commercial cooking depends on inspection and routine cleaning, access needs to be provided to the interior areas that require inspection and cleaning.

Δ **50.2.1.9*** Cooking equipment used in fixed, mobile, or temporary concessions, such as trucks, buses, trailers, pavilions, tents, or any form of roofed enclosure, shall comply with NFPA 96. [**96:**4.1.9]

A.50.2.1.9 The AHJ can exempt temporary facilities, such as a tent, upon evaluation for compliance to the applicable portions of NFPA 96 or this *Code*.

Although it might not be practical to enforce all requirements of NFPA 96 in temporary facilities, the AHJ should determine that all necessary provisions that affect the personal safety of the occupants are considered. [**96:**A.4.1.9]

Enforcement of the requirements for temporary installations, such as those found in pavilions, outdoor carnivals, and temporary concessions, is important. The *Code* recognizes that the criterion established has been done with much forethought and deliberation. The requirement is believed to be the most all-encompassing yet prudent means of mitigating the known hazards inherent in tents and temporary installations. Enforcing these rules in some operations but not enforcing them in others, or adopting the regulations and then not implementing them, at least in part, merely because of the untraditional arrangement and nature of temporary installations, such as those found in buses, tents, and food trucks, would not be logical.

Many AHJs have developed specific guidelines to address temporary arrangements within their jurisdictions, such as temporary venues, including carnivals and mobile street vendors. The provisions provide the AHJ with some latitude as to which provisions they require to be enforced and to what degree, based on the circumstances in each individual instance or as jurisdictional policy for all temporary cooking arrangements. See Section 50.7 for more information on mobile and temporary cooking operations.

50.2.2* Clearance.

A.50.2.2 See Figure A.50.2.2(a) through Figure A.50.2.2(h) for clarification of the appropriate clearances required in 50.2.2. [**96:**A.4.2]

The exhaust system for commercial cooking equipment is primarily composed of a hood, ductwork, and a fan; it can also include special control equipment, such as grease extraction devices and odor control devices, through which the exhaust air flows. All this equipment is subject to the requirements of 50.2.2, unless a specific listing alters the clearances.

The issue of clearance from cooking equipment to combustible material is particularly important to prevent fires from spreading. Fires that burn in ducts can reach very high temperatures. Extremely hot temperatures in a duct can create a large amount of radiant heat on the outside of the duct even where the duct is not compromised. The radiant heat has the potential to ignite combustible materials and start fires in the combustible concealed spaces of a building. Maintaining a clearance from the duct to combustible and limited-combustible materials is intended to reduce this risk. Exhibit 50.1 shows an example of a hood with near zero clearance to noncombustible construction.

Exhibit 50.1

Example of near zero clearance to noncombustible construction.

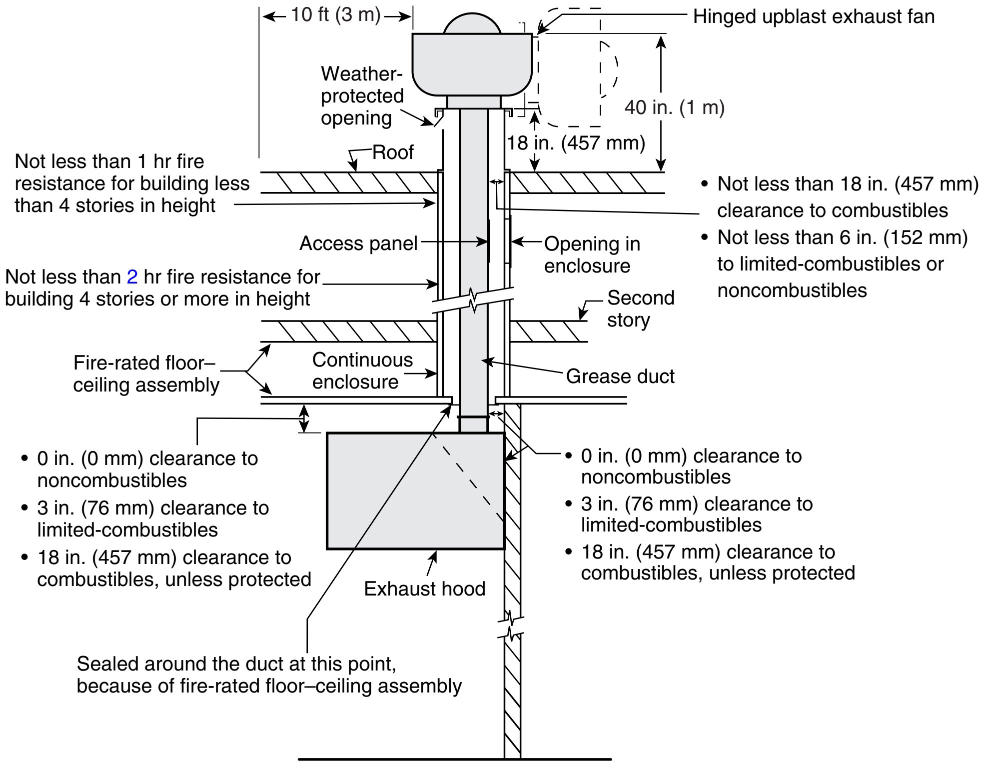


FIGURE A.50.2.2(a) *Typical Section View for Building with Two Stories or More with Fire-Rated Floor–Ceiling Assembly. [**96:**Figure A.4.2(a)]*

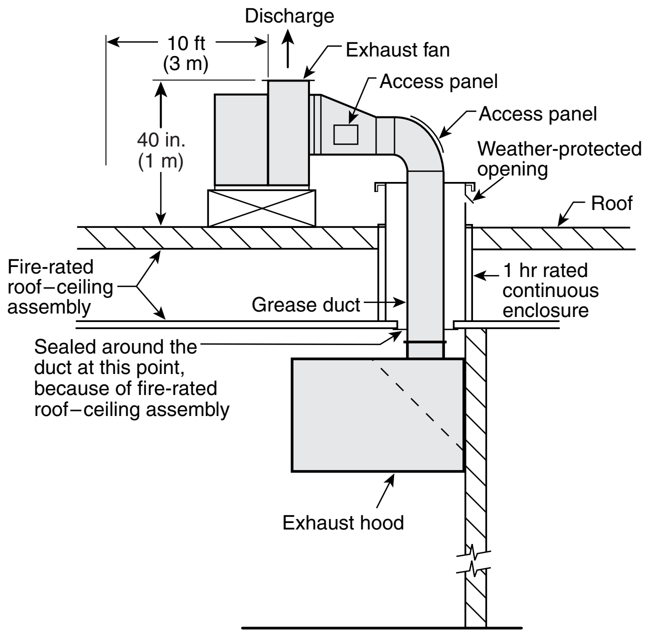


*FIGURE A.50.2.2(b) Typical Section View for One-Story Building with Fire-Rated Roof–Ceiling Assembly. [Clearances given in Figure A.50.2.2(a) apply also to this drawing.] [**96:**Figure A.4.2(b)]*

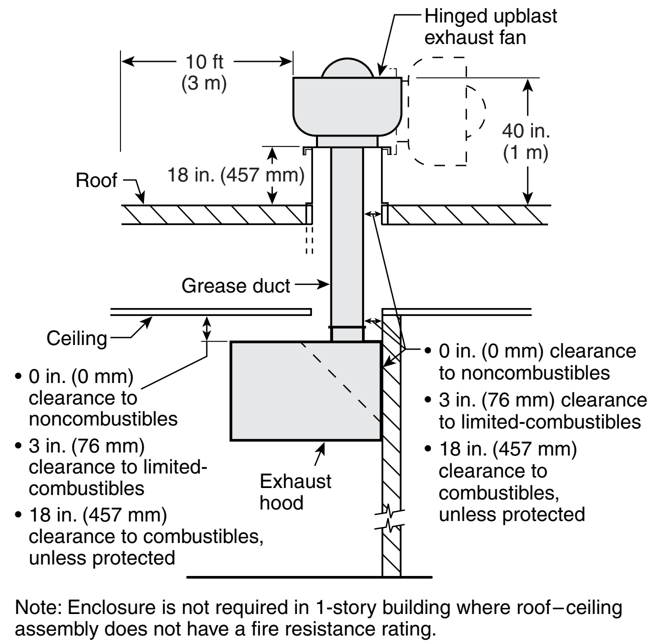


*FIGURE A.50.2.2(d) Typical Section View for One-Story Building Without Fire-Rated Roof–Ceiling Assembly. [**96:**Figure A.4.2(d)]*

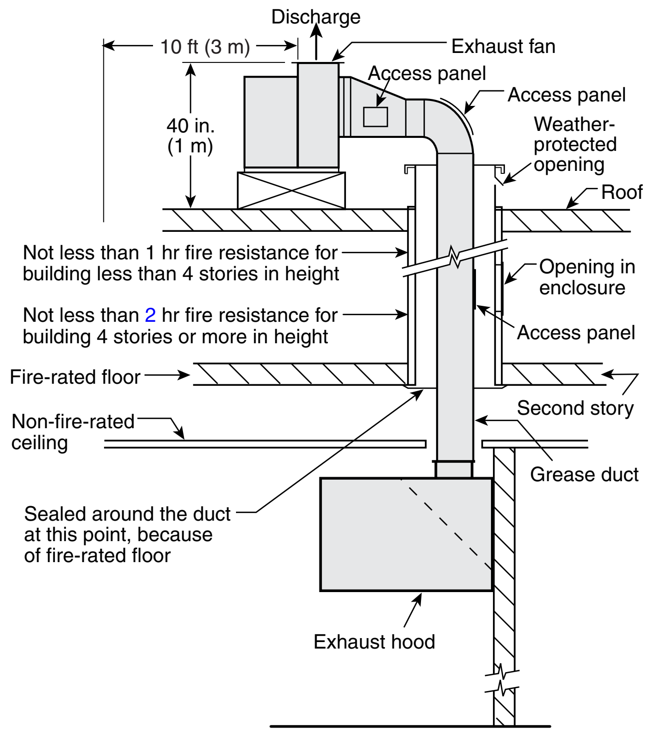


*FIGURE A.50.2.2(c) Typical Section View for Building with Two Stories or More with Non-Fire-Rated Ceiling and Fire-Rated Floor. [Clearances given in Figure A.50.2.2(a) apply also to this drawing.] [**96:**Figure A.4.2(c)]*

While the clearances specified in Section 4.2 of NFPA 96 are directly related to construction requirements, the clearances should still be observed in the ongoing operational life of the system. Placing combustible boxes on top of a hood or directly against the side of it, for instance, can present the very same hazards discussed in the preceding paragraph.

50.2.2.1* Where enclosures are not required, hoods, grease removal devices, exhaust fans, and ducts shall have a clearance of at least 18 in. (457 mm) to combustible material, 3 in. (76 mm) to limited-combustible material, and 0 in. (0 mm) to noncombustible material. [**96:**4.2.1]

N **A.50.2.2.1 Measurement of Clearance.** The measurement of clearance to combustible or limited-combustible material is intended to be measured from the closest point of the exhaust system component to that material. Example: The clearance where ceramic tile is installed over gypsum board that extends behind the hood should be measured from the hood to the gypsum board. Placing a noncombustible material over a combustible or limited-combustible material does not permit a zero clearance installation. [**96:**A.4.2.1]

For the 2017 edition of NFPA 96, new annex material was added to clarify how to measure the distances given in 50.2.2.1. In addition, it is important to recognize that the distance specified in this requirement is intended to apply in every direction from the hoods, grease removal devices, exhaust fans, and ducts to the combustible, limited-combustible, and noncombustible materials.

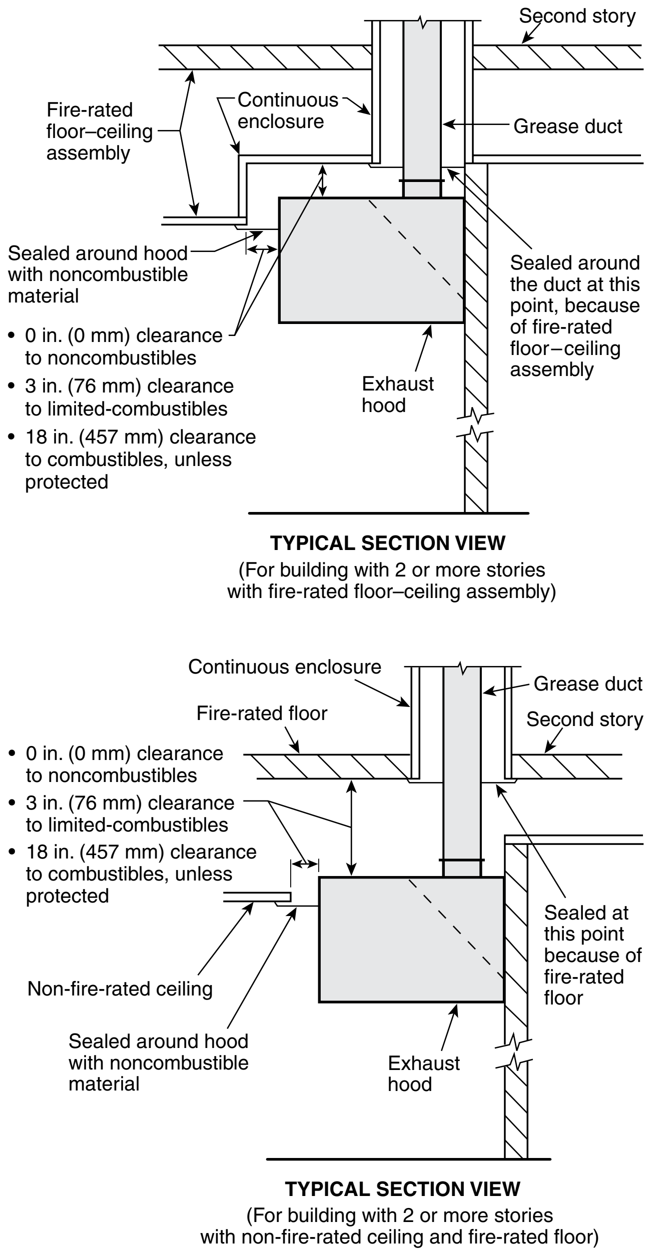
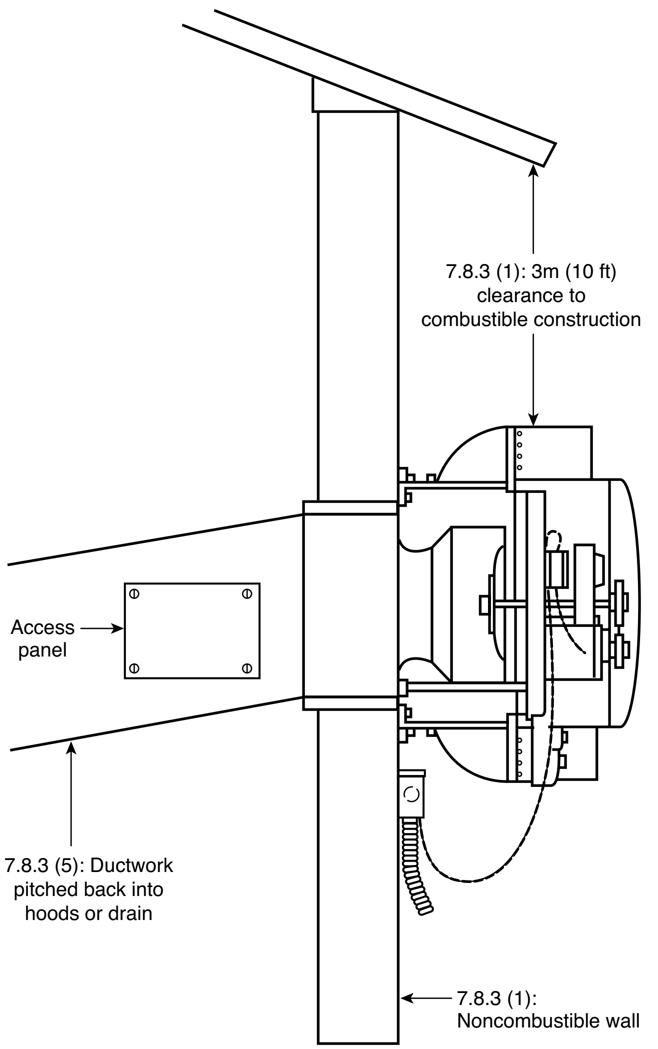


***FIGURE A.50.2.2(e)** Detail Drawings Showing Hoods Penetrating Ceilings. [**96:**Figure A.4.2(e)]*



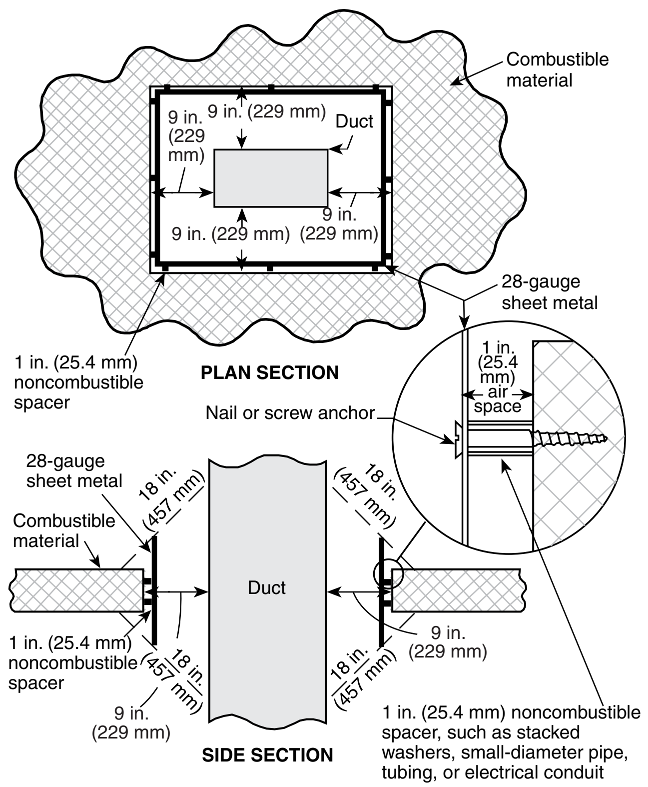
N ***FIGURE A.50.2.2(f)** Wall Mounted Fan. [**96:**Figure A.4.2(f)]*

50.2.2.2 Where a hood, duct, or grease removal device is listed for clearances less than those required in 50.2.2.1, the listing requirements shall be permitted. [**96:**4.2.2]

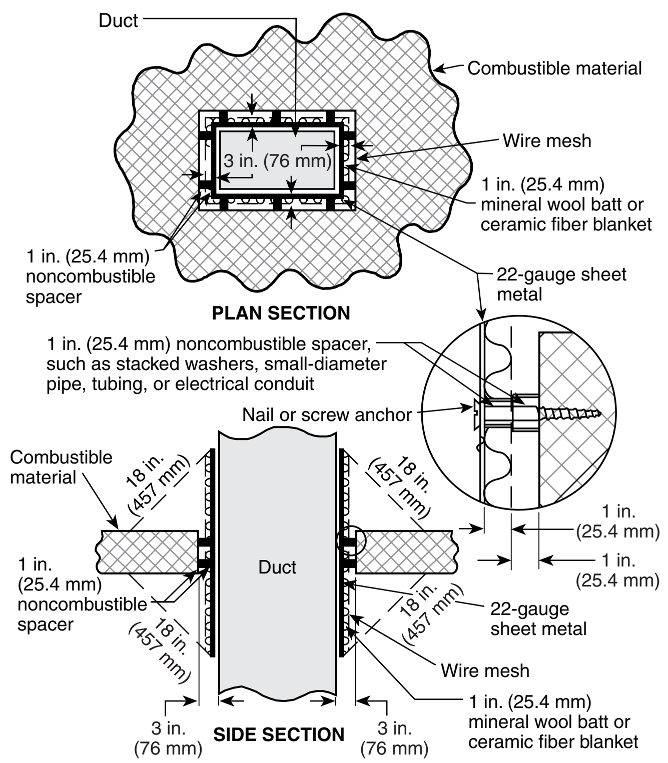
50.2.2.3 Clearance Reduction.

If the hood, duct, or grease removal equipment is not listed for a reduction of the clearances established, the clearances could still be reduced by the installation of a clearance reduction system as detailed in 50.2.2.3.

In practical terms, normally an insulating blanket is built into the back wall of the hood in a special cavity that permits the hood to be directly mounted to a combustible wall while holding the active back wall of the hood at the specified 3 in. (76 mm) clearance from the wall. Similar insulated panels are usually installed on the wall above the hood to provide the same clearance from the exhaust duct to the wall. A three-sided panel is installed around the duct and connected to the ends of the insulated wall panel to provide a decorative chase to hide the duct. Within an attic space, where a chase is not required, all combustible structural materials (joists, trusses, or rafters) within 18 in. (457 mm) of the ductwork must be protected by one of the methods for reducing clearances to combustibles. Some restaurants build kitchen walls and ceiling and roof structures with noncombustible materials, making it unnecessary to provide minimum clearances from the duct to such structures.



△ *FIGURE A.50.2.2(g) Example of Clearance Reduction System: 9 in. (229 mm) Clearance to Combustible Material. [**96:**Figure A.4.2(g)]*



△ *FIGURE A.50.2.2(h) Example of Clearance Reduction System: 3 in. (76 mm) Clearance to Combustible Material. [**96:**Figure A.4.2(h)]*

Where exposed ducts are run through an attic space (whether or not the construction is combustible) and there is any likelihood that the attic space will be used for storage, a good practice is to put a strong metal guard around all ductwork at a distance of at least 18 in. (457 mm). This guard keeps stored combustibles safely away from the ductwork while still allowing visual inspection of the ductwork.

50.2.2.3.1 Where a clearance reduction system consisting of 0.013 in. (0.33 mm) (28 gauge) sheet metal spaced out 1 in. (25 mm) on noncombustible spacers is provided, there shall be a minimum of 9 in. (229 mm) clearance to combustible material. [**96:**4.2.3.1]

50.2.2.3.2 Where a clearance reduction system consisting of 0.027 in. (0.69 mm) (22 gauge) sheet metal on 1 in. (25 mm) mineral wool batts or ceramic fiber blanket reinforced with wire mesh or equivalent spaced 1 in. (25 mm) on noncombustible spacers is provided, there shall be a minimum of 3 in. (76 mm) clearance to combustible material. [**96:**4.2.3.2]

50.2.2.3.3 Where a clearance reduction system consisting of a *listed* and *labeled* field-applied grease duct enclosure material, system, product, or method of construction specifically evaluated for such purpose in accordance with ASTM E2336, the required clearance shall be in accordance with the listing. [**96:**4.2.3.3]

Paragraph 50.2.2.3.3 clarifies that listed and labeled systems (permitted by Section 4.3 of NFPA 96), which are also tested and approved for their clearance to combustibles, can be installed in accordance with their listings.

Manufacturers of field-applied grease duct enclosure systems have, as part of their listings for each system, an allowable clearance from the outside of the enclosure system to adjacent combustibles. They achieve this clearance based on the type, quantity, and method of installation of the protective enclosure materials, and test them in accordance with ASTM E2336, *Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems*. ASTM E2336 is designed to evaluate for zero clearance, and most field-applied grease duct enclosure system manufacturers have listings for zero clearance.

The materials are routinely used as an option for reducing clearances, particularly in cases where a limited amount of space is available for other means of protection. Another typical use is in a one-story restaurant where no rated wall/ceiling is being penetrated, but field-applied protection is installed because of the proximity of the grease duct to adjacent combustible construction.

50.2.2.3.4 Zero clearance to limited-combustible materials shall be permitted where protected by one of the following:

(1) Metal lath and plaster
(2) Ceramic tile
(3) Quarry tile
(4) Other noncombustible materials or assembly of noncombustible materials that are listed for the purpose of reducing clearance
(5) Other materials and products that are listed for the purpose of reducing clearance

[**96:**4.2.3.4]

The requirement in 50.2.2.3.4 permits the materials listed to be laid over the limited-combustible materials to allow for reduced clearance. The clearance reduction systems covered in 50.2.2.3.1 through 50.2.2.3.3 provide clearance reduction to combustible material.

50.2.3 Drawings. A drawing(s) of the exhaust system installation along with copies of operating instructions for subassemblies and components used in the exhaust system, including electrical schematics, shall be kept on the premises. [**96:**4.6]

50.2.4 AHJ Notification. If required by the AHJ, notification in writing shall be given of any alteration, replacement, or relocation of any exhaust or extinguishing system or part thereof or cooking equipment. [**96:**4.7]

50.3 Protection of Coverings and Enclosure Materials

50.3.1 Measures shall be taken to prevent physical damage to any covering or enclosure material. [**96:**7.7.3.1]

The primary objective is to maintain the protection afforded by the covering or enclosure by using whatever safeguards are necessary to minimize damage to enclosure materials. Where daily operations or another occurrence does cause damage to the covering, 50.3.2 requires that it be repaired or restored so as to meet its initial listing and fire resistance rating.

50.3.2 Any damage to the covering or enclosure shall be repaired, and the covering or enclosure shall be restored to meet its intended listing and fire resistance rating and to be acceptable to the AHJ. [**96:**7.7.3.2]

50.3.3 In the event of a fire within a kitchen exhaust system, the duct, the enclosure, and the covering directly applied to the duct shall be inspected by qualified personnel to determine whether the duct, the enclosure, and the covering directly applied to the duct are structurally sound, capable of maintaining their fire protection functions, suitable for continued operation, and acceptable to the AHJ. [**96:**7.7.3.3]

If a fire occurs within the kitchen exhaust system, the entire system — including the duct, its enclosure, and other items associated with the exhaust system — must be inspected by a qualified person before being returned to operation. Before permitting operation of a system that has been involved in a fire, the AHJ should review the report submitted by the qualified person for the structural soundness of the duct and enclosure and should ask questions such as the following:

1. Is the system safe for operation?
2. Has the suppression system been recharged?
3. Is the entire system capable of its original fire protection function and protection?

50.3.4 Listed grease ducts shall be installed in accordance with the terms of the listing and the manufacturer's instructions. [**96:**7.7.3.4]

50.4 Fire-Extinguishing Equipment

50.4.1 Prior to installation of any fire-extinguishing system, construction documents shall be reviewed and approved by the AHJ.

See Section 1.14 for plan review requirements.

50.4.2 Permits. Permits, where required, shall comply with Section 1.12.

See 1.12.8 for information on permits. Permits are required for installation, modification, or removal from service of any automatic fire suppression system.

50.4.3 General Requirements.

50.4.3.1 Fire-extinguishing equipment for the protection of grease removal devices, hood exhaust plenums, and exhaust duct systems shall be provided. [**96:**10.1.1]

Fire-extinguishing equipment includes both automatic fire-extinguishing systems and portable fire extinguishers. Any pre-engineered systems provided for the protection of grease removal devices, hoods, duct systems, and cooking equipment must be listed for such use.

50.4.3.2* Cooking equipment that produces grease-laden vapors and that might be a source of ignition of grease in the hood, grease removal device, or duct shall be protected by fire-extinguishing equipment. [**96:**10.1.2]

A.50.4.3.2 Examples of cooking equipment that produce grease-laden vapors include, but are not limited to, deep fat fryers, ranges, griddles, broilers, woks, tilting skillets, and braising pans. [**96:**A.10.1.2]

While 50.4.3.1 requires the protection of the exhaust system components without any stipulations, 50.4.3.2 requires the protection of cooking equipment that produces grease-laden vapors, which can be a source of ignition for grease in those exhaust system components. If the provisions of NFPA 96 have been applied to this point, based on the application requirements of Section 4.1 of NFPA 96, then the equipment is more than likely going to require protection by a fire-extinguishing system.

N **50.4.3.3** Fume incinerators, thermal recovery units, air pollution control devices, or other devices installed in the exhaust duct, shall be protected by an automatic fire-extinguishing system. [**96:**10.1.3]

50.4.4 Types of Equipment.

50.4.4.1 Fire-extinguishing equipment shall include both automatic fire-extinguishing systems as primary protection and portable fire extinguishers as secondary backup. [**96:**10.2.1]

The type of fire extinguisher selected should be compatible with the fire-extinguishing agent in the extinguishing system. Fire-extinguishing agents form a foam layer over the burning surface that can separate the fuel from the needed oxygen. If a fire extinguisher is discharged over the surface, it can have an adverse effect on the maintenance of that foam layer, causing a breakdown of the foam layer and increasing the possibility of the fuel re-igniting.

It is important to recognize that the fire suppression system built into a kitchen exhaust hood serves as the primary line of defense in the event of a fire. The required portable fire extinguisher serves as a backup to the fixed fire-extinguishing system and is not the preferred method of extinguishment. However, some history shows that the availability of a required portable fire extinguisher has led to the quick extinguishment of small fires on cooking surfaces, other than deep-fat fryers, prior to the activation of the fixed fire-extinguishing system. The following is the typical appropriate sequence of actions upon discovery of a fire in a restaurant that is beyond the incipient stage:

1. Operate the manual actuator for the hood fire suppression system; do NOT wait for automatic operation.
2. Call the fire department.
3. Evacuate the building.
4. Until the fire department arrives, a person(s) properly trained in the use and limitations of portable extinguishers should stand by with the proper portable extinguisher in the event of a reflash.

Upon activation of the fire-extinguishing system, all sources of fuel and electrical power that produce heat to all equipment requiring protection by that system are automatically shut off. If these heat-producing appliances were not shut down, they would contribute to the fire problem, possibly allowing ignition or re-ignition. Since portable fire extinguishers do not shut off these heat sources, they should be used only after the system has activated.

50.4.4.2* A placard shall be conspicuously placed near each Class K extinguisher that states that the fire protection system shall be activated prior to using the fire extinguisher. [**96:**10.2.2]

A.50.4.4.2 NFPA 10, Annex A, provides recommendations for placards. [**96:**A.10.2.2]

In an effort to coordinate with NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*, "Class K" was added to this requirement in the 2017 edition of NFPA 96 to clearly identify which

Exhibit 50.2

Required placard located directly above the fire extinguisher.

extinguishers need a placard. Exhibit 50.2 shows an example of a placard located directly above an extinguisher.

50.4.4.2.1 The language and wording for the placard shall be approved by the AHJ. [**96:**10.2.2.1]

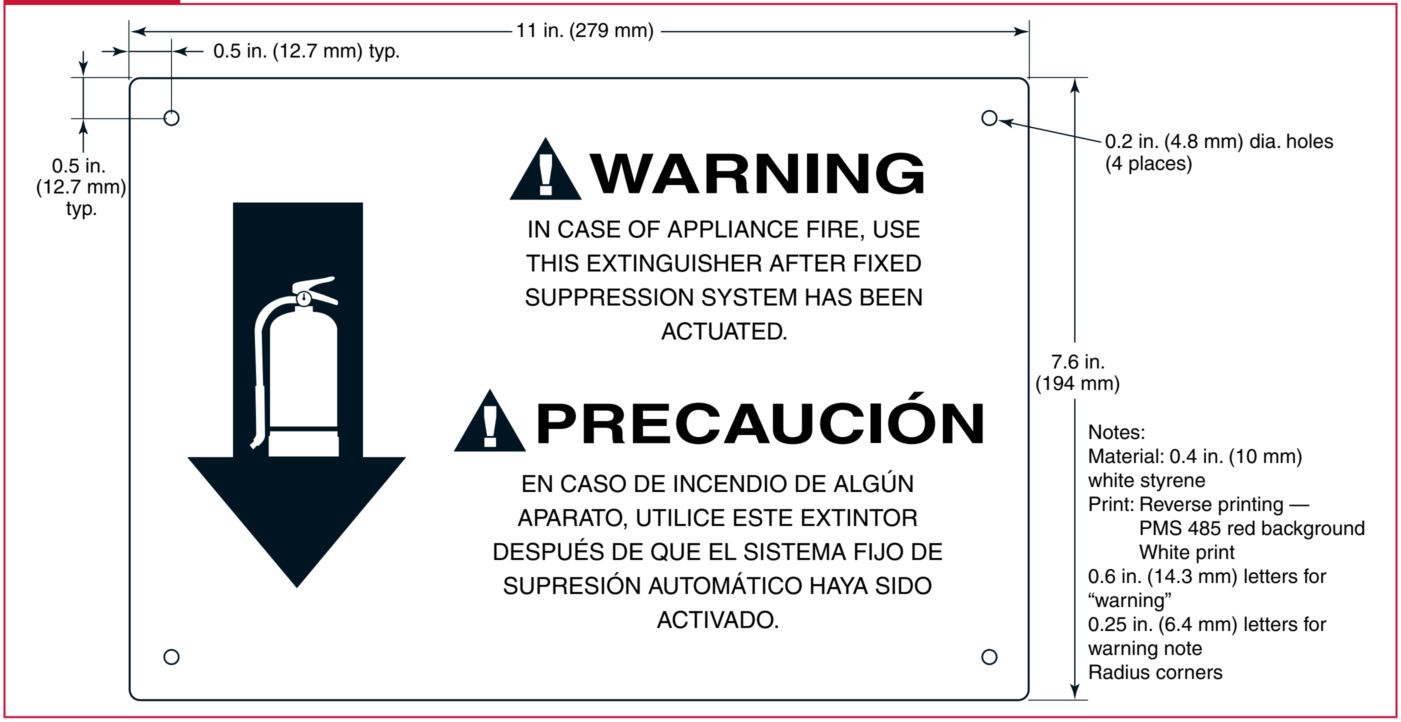
Exhibit 50.3(a) and Exhibit 50.3(b) show the recommended wording for the Class K placard. This is the language suggested in NFPA 10, *Standard for Portable Fire Extinguishers*. The recommended size for the placard is 11 in. × 7 ⅝ in. (279 mm × 194 mm).

50.4.4.3* Automatic fire-extinguishing systems shall comply with ANSI/UL 300, *Standard for Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas*, or other equivalent standards and shall be installed in accordance with the requirements of the listing. [**96:**10.2.3]

A.50.4.4.3 ANSI/UL 300 primarily addresses the method of fire testing for self-contained chemical extinguishing systems commonly referred to as pre-engineered systems. ANSI/UL 300 has been identified as a baseline for testing fire-extinguishing systems intended for the protection of commercial cooking–related hazards. Additional equivalent testing standards can and have been written for other types of fire-extinguishing systems not considered pre-engineered that demonstrate equivalent fire testing severity to the ANSI/UL 300 test standard. Current examples include, but are not limited to, ANSI/UL 199, UL Subject 199B, UL Subject 199E, and ANSI/UL 710B. [**96:**A.10.2.3]

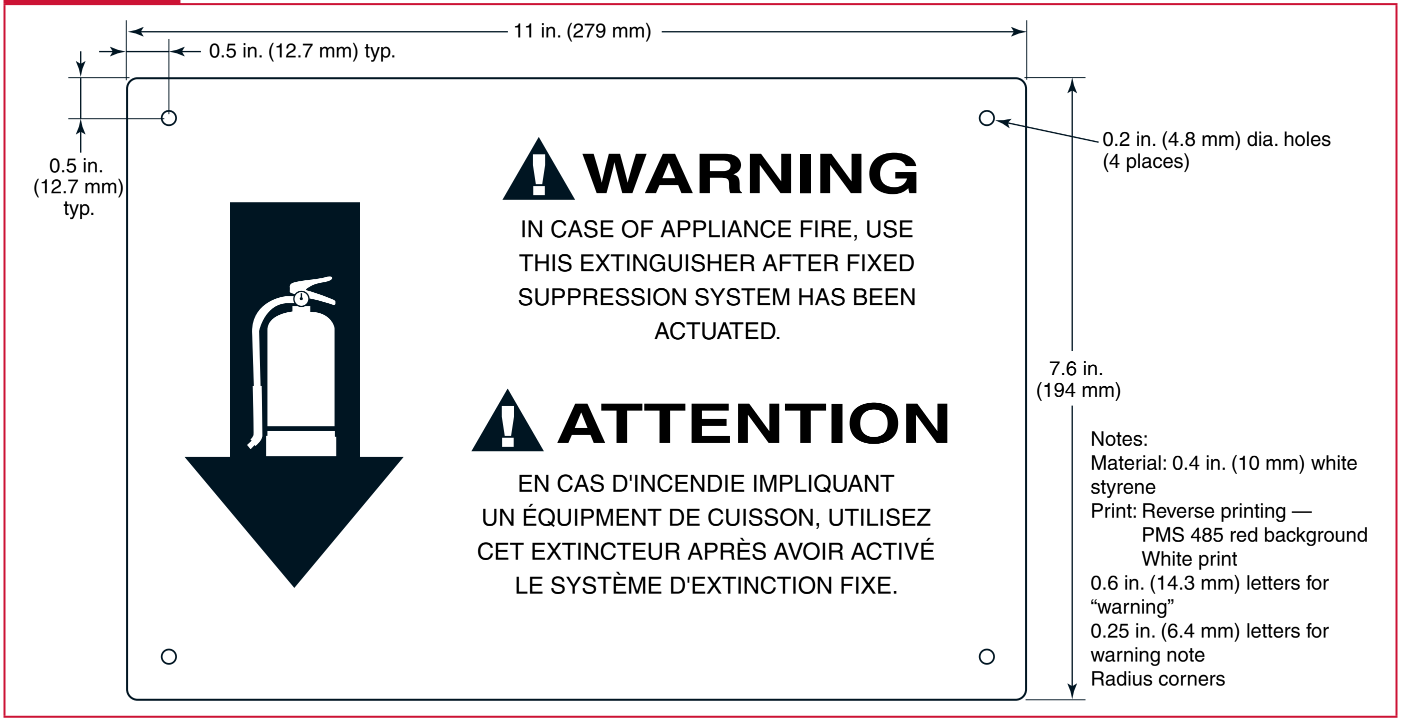
Dry and wet chemical fire-extinguishing systems provide an agent that develops a blanket of soapy foam in reaction to the grease (a process called saponification) to keep the combustible surface separated from the oxygen. The change in the type of cooking media from animal fats to vegetable oils and the advent of more energy-efficient cooking equipment have had a dramatic effect on the ability of dry chemical extinguishing

Exhibit 50.3(a)



Typical Class K placard in English and Spanish. [Source: NFPA 10, 2016 edition, Figure A.5.5.5.3(a).]

Exhibit 50.3(b)



Typical Class K placard in English and French. [Source: NFPA 10, 2016 edition, Figure A.5.5.5.3(b).]

agents to develop and maintain a layer of extinguishing agent over the cooking oil. This change in fire hazard contributed to the development of ANSI/UL 300, *Standard for Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment,* which contains provisions that only wet chemical extinguishing systems have been able to meet.

ANSI/UL 300 is a fire test protocol for the listing of pre-engineered extinguishing systems. In addition to establishing fire test methods, ANSI/UL 300 includes fire tests for evaluating the capability of pre-engineered systems for the protection of cooking appliances, as well as the ability to protect hoods, plenums, and ducts. The test standard takes into consideration all the special characteristics of pre-engineered systems, including the limited supply of extinguishing agent. Since there is a limited quantity of agent in pre-engineered systems that is discharged over a short period of time, these systems are designed to quickly extinguish the test fires. The severity of the test fires is intended to far exceed anything that is likely to be encountered in the field. An example of one such system is provided in Exhibit 50.4.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, is commonly accepted as an equivalent standard to ANSI/UL 300. Automatic sprinkler systems installed in accordance with NFPA 13 for the protection of commercial cooking appliances are designed to discharge large quantities of water over long periods of time, thereby controlling the fire by cooling it and wetting the surrounding combustible materials. Additionally, NFPA 13 requires that sprinklers or automatic spray nozzles be specifically listed for the protection of fryers.

Other systems, referred to as engineered systems, must be custom engineered for each application. These systems have been designed primarily for other industrial and commercial food preparation applications involving materials with similar hazards, such as potato chip manufacturing and bulk bakery ovens, and have been applied to a limited degree to some restaurant cooking operations with varied success and acceptance. They can be used successfully in restaurant applications if their design criteria and performance limits are clearly understood and applied. The applicable NFPA extinguishing system standard for each system should be read in detail before it is applied. Some of the more common concerns about system usage are addressed in subsequent commentary sections.

Exhibit 50.4

Hood suppression system. (Courtesy of Tyco Fire Protection Products)

50.4.4.3.1* In existing dry or wet chemical systems not in compliance with ANSI/UL 300, the fire-extinguishing system shall be made to comply with 50.4.4.3 when any of the following occurs:

(1) The cooking medium is changed from animal oils and fats to vegetable oils.
(2) The positioning of the cooking equipment is changed.
(3) Cooking equipment is replaced.
(4) The equipment is no longer supported by the manufacturer.

[**96:**10.2.3.1]

The AHJ needs to evaluate the impact a change has on the overall operation. Insignificant changes in the position of some equipment and replacement of equipment with equipment of identical characteristics do not necessarily cause a code-compliant arrangement to become concurrently nonconforming.

One common question is: Are existing, unmodified extinguishing systems, installed prior to the development of ANSI/UL 300, required to be replaced with an extinguishing system that is compliant with ANSI/UL 300?

There have been safety concerns in the field that there was a potential for the language of 50.4.4.3.1 in previous editions to be misunderstood and misapplied. Past text implied that previously listed dry chemical systems could be used only with animal oils and fats, but it was not clearly stated in the requirement. Paragraph 50.4.4.3.1 was revised to provide a clear requirement that can be enforced without question. The new text makes it clear that where the cooking media is vegetable oil the system must comply with ANSI/UL 300.

Commercial cooking operations historically have been protected with pre-engineered extinguishing systems that use an extinguishing agent that chemically reacts with cooking oil to create a thick blanket of foam to suffocate the fire and prevent the escape of combustible vapors, thereby preventing reignition (saponification). The earlier versions of ANSI/UL 300 for listing pre-engineered systems were not rigorous enough to reflect typical modern day appliances and the cooking oils used in them. The fire test standard was updated to require using actual appliances with vegetable oil. Dry chemical systems that passed the old test are not able to pass the new test protocol. Only wet chemical systems are able to pass the new fire tests and can be listed for this application.

Unfortunately, only part of the problem was solved. Although dry chemical systems can no longer be listed for the protection of cooking appliances and associated hood and duct systems, the listing standard did not impact existing installations. Similar to other listing standards, it affects only the listing of products.

Dry chemical fire-extinguishing systems are now deemed to be inadequate for the protection of cooking appliances as well as the ability to protect hoods, plenums, and ducts; therefore, these systems need to be removed and replaced with appropriate systems. Only systems that meet the currently accepted level of safety established by ANSI/UL 300 or an equivalent standard are permitted to remain in place.

As written today, all automatic fire-extinguishing systems are required to comply with ANSI/UL 300 or other equivalent standards and to be installed in accordance with the requirements of the listing. Existing systems must be brought up to compliance with ANSI/UL 300 effective as of January 1, 2014.

A.50.4.4.3.1 A change from rendered animal fat to cooking oil likely will increase auto-ignition temperatures, and a change to insulated energy-efficient cooking equipment that does not allow ease of cooling likely will result in difficulties sustaining extinguishment with systems not complying with UL 300 or equivalent standards. [**96:**A.10.2.3.1]

50.4.4.3.2 All existing fire-extinguishing systems shall meet the requirements of 50.4.4.3. [**96:**10.2.3.2]

Since the effective date of January 1, 2014, specified in the 2014 edition of ANSI/UL 300, has passed, there is no need to identify a date. As of January 1, 2014, all systems (existing and new) are required to comply with ANSI/UL 300 or an equivalent standard.

50.4.4.4 Grease removal devices, hood exhaust plenums, exhaust ducts, and cooking equipment that are not addressed in ANSI/UL 300 or other equivalent test standards shall be protected with an automatic fire-extinguishing system(s) in accordance with the applicable NFPA standard(s), all local building and fire codes, and the fire extinguishing system's manufacturer's recommendations and shall be approved by the AHJ. [**96:**10.2.4]

ANSI/UL 300 contains testing criteria for a wide variety of cooking equipment and media found in restaurants. However, it does not cover all cooking equipment. Therefore, the basic requirement is that a fire-extinguishing system that has been tested to ANSI/UL 300 be used to protect cooking equipment and its associated cooking media. If the cooking equipment and its cooking media in question (such as non-restaurant-type equipment) are not addressed in ANSI/UL 300, other types of fire-extinguishing systems might be considered.

50.4.4.5 Automatic fire-extinguishing equipment provided as part of listed recirculating systems shall comply with ANSI/UL 710B, *Outline of Investigation for Recirculating Exhaust System*. [**96:**10.2.5]

Δ **50.4.4.6** Automatic fire-extinguishing systems shall be installed in accordance with the terms of their listing, the manufacturer's instructions, and the following standards where applicable:

(1) NFPA 12

Carbon dioxide extinguishing systems, as covered by NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, require a concentration of carbon dioxide on top of the cooking oil in order to successfully protect against fire reflash. Achieving this concentration usually requires that all exhaust fans be shut off (even at adjacent hoods) and that the air-conditioning and ventilation also be shut off. Even under these conditions, a concentration adequate to prevent reflash is difficult to maintain. These systems are seldom used in typical commercial cooking operations.

(2) NFPA 13

Water systems are still fairly common in certain restaurant cooking operations, but many of these systems are spray systems rather than sprinkler systems covered by NFPA 13, *Standard for the Installation of Sprinkler Systems*. Spray systems are used mostly for hood protection, where their primary application is for wash-down of the hood or for grease extraction. However, spray systems are beginning to be used with standard sprinklers for duct and appliance protection. Because spray systems are small systems, they are usually supplied by a kitchen water line rather than a true sprinkler line.

NFPA 13 requires that sprinkler systems provide a sprinkler every 10 ft (3 m) for exhaust duct protection and includes provisions for the duct system as it changes directions. Installation is typically more complex than for conventional commercial cooking fire protection equipment. Also, with sprinklers, possible freezing conditions have to be addressed where such weather can occur.

(3) NFPA 17

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, addresses both pre-engineered systems and engineered systems. While no dry chemical systems are currently listed to ANSI/UL 300, NFPA 17 is included on this list to permit the installation of an engineered dry chemical system or the possibility of a dry chemical pre-engineered system listed to ANSI/UL 300. Currently, no pre-engineered dry chemical systems are listed to ANSI/UL 300-2014. However, engineered systems have been applied in some customized cooking product lines and are more often applied in large industrial cooking operations. Paragraph 50.4.4.3.1 prohibits systems that are not listed to ANSI/UL 300-2005 to remain in place.

(4) NFPA 17A

NFPA 17A poses strict requirements regarding the pre-engineered wet chemical systems that are applied in restaurant operations. Both dry and wet chemical systems have had success where they have been applied, since they both provide the saponifying effect on top of the shortening that separates the chemical from the air. However, a wet chemical also has an extra feature that is significant. It has the cooling (heat absorption) effect that can add to extinguishing capability and reflash prevention capability.

(5) NFPA 750
[**96:**10.2.6]

NFPA 750, *Standard on Water Mist Fire Protection Systems*, provides requirements to standardize the design, installation, maintenance, and testing requirements for a water-based suppression system using spray (mist) to absorb heat, displace oxygen, or block radiant heat to control, suppress, or extinguish fires as required by the application.

50.4.4.7 Modifications to Existing Hood Systems.

The requirements in 50.4.4.7 apply directly to systems that are already in use. The provisions located here ensure that changes to the cooking appliances or cooking media or modifications on the hood or duct system do not reduce the level of safety from the point when the system was first designed.

50.4.4.7.1 Any abandoned pipe or conduit from a previous installation shall be removed from within the hood, plenum, and exhaust duct. [**96:**10.2.7.1]

Abandoned pipe or conduit creates surfaces for the accumulation of grease, which increases the fire load.

50.4.4.7.2 Penetrations and holes resulting from the removal of conduit or piping shall be sealed with listed or equivalent liquidtight sealing devices. [**96:**10.2.7.2]

The term *liquidtight* is defined as being constructed and performing in such a manner as to not permit the passage of any liquid through at any temperature. An example of a listed patch seal for patching unwanted holes without welding is shown in Exhibit 50.5.

Exhibit 50.5

Example of listed penetration device. (Courtesy of Brooks Equipment Company, Inc.)

50.4.4.7.3 The addition of obstructions to spray patterns from the cooking appliance nozzle(s) such as baffle plates, shelves, or any modification shall not be permitted. [**96:**10.2.7.3]

The distribution pattern for appliance nozzles is tested and listed only under specific conditions and does not include testing with objects that will obstruct the application of the extinguishing agent onto the cooking appliance.

50.4.4.7.4 Changes or modifications to the hazard after installation of the fire-extinguishing systems shall result in re-evaluation of the system design by a properly trained, qualified, and certified person(s). [**96:**10.2.7.4]

50.4.4.8 Hoods with Water Wash.

This heading was revised in the 2017 edition of NFPA 96 to include terminology that clarifies the difference between a basic water-wash system and one that is listed as a fire-extinguishing system. A *water-wash fire-extinguishing system* is a water-wash system that is listed as a fire-extinguishing system. These types of systems provide water spray for the exhaust plenum in addition to the hood's automatic fire suppression system. A *water-wash system* provides a pressurized spray of hot water and detergent to clean the hood in a timed cycle. Some water-wash systems have a fire mode option that provides water spray for the exhaust plenum when the system is in fire mode that is in addition to the hood's automatic fire suppression system.

Δ **50.4.4.8.1** Areas requiring protection in accordance with 50.4.3.1 shall be permitted to be protected by a water-wash system that is listed as a fire-extinguishing system in compliance with ANSI/UL 300 or other equivalent standards and installed in accordance with the requirements of its listing. [**96:**10.2.8.1]

50.4.4.8.2 Each such area not provided with a listed water-wash fire-extinguishing system shall be provided with a fire-extinguishing system listed for the purpose. [**96:**10.2.8.2]

50.4.4.8.3 The water supply for water-wash fire-extinguishing systems shall be permitted to be supplied from the domestic water supply when the minimum water pressure and flow are provided in accordance with the terms of the listing. [**96:**10.2.8.3]

50.4.4.8.4 The water supply for water-wash fire-extinguishing systems shall be controlled by a listed indicating valve. [**96:**10.2.8.4]

50.4.4.8.5 Where a separate fire-extinguishing system is used for protection of cooking equipment only, a water-wash fire-extinguishing system listed for protection of the grease removal device(s), hood exhaust plenum(s), exhaust duct(s), or combination thereof shall be provided with instructions and appropriate means for electrical interface for simultaneous activation. [**96:**10.2.8.5]

50.4.4.8.6 A water-wash system approved to be used for protection of the grease removal device(s), hood exhaust plenum(s), exhaust duct(s), or combination thereof shall include instructions and appropriate electrical interface for simultaneous activation of the water-wash system from an automatic fire-extinguishing system, where the automatic fire-extinguishing system is used for cooking equipment protection only. [**96:**10.2.8.6]

50.4.4.8.7 Where the automatic fire extinguishing system in accordance with NFPA 17A provides protection for the hood and duct in a fixed baffle hood containing a water-wash system, the water-wash system shall be made inoperable or delayed for a minimum of 60 seconds upon operation of the automatic fire-extinguishing system. [**96:**10.2.8.7]

The delay of at least 60 seconds is necessary to allow the extinguishing agent to chemically react with cooking oil to create a thick blanket of foam to suffocate the fire and prevent the escape of combustible vapors, thereby preventing reignition.

Δ **50.4.4.8.8** Grease removal devices, hood exhaust plenums, and exhaust ducts on hoods with water wash shall be permitted to be protected by a sprinkler system with an individual control valve if the design of the hood prevents the water from reaching the cooking appliances. [**96:**10.2.8.8]

Paragraph 50.4.4.8.8 was added to the *Code* as a means of providing coverage for many water-wash systems that currently lack protection for these areas. The text provides a solution to the challenge of existing fixed baffle hoods with water wash; previously, the omission of this coverage was allowed.

50.4.4.9 Water-Based Fire-Extinguishing System.

50.4.4.9.1 The water required for listed automatic fire-extinguishing systems shall be permitted to be supplied from the domestic water supply where the minimum water pressure and flow are provided in accordance with the terms of the listing. The water supply shall be controlled by a supervised water supply control valve. [**96:**10.2.9.1]

50.4.4.9.2 Where the water supply is from a dedicated fire protection water supply in a building with one or more fire sprinkler systems, separate indicating control valves and drains shall be provided and arranged so that the hood system and sprinkler systems can be controlled individually. [**96:**10.2.9.2]

Δ **50.4.4.10 Water Valve Supervision.** Valves controlling the water supply to listed water-wash fire-extinguishing systems, automatic fire-extinguishing systems, or both shall be listed indicating type of valve and shall be supervised open by one of the following methods:

(1) Central station, proprietary, or remote station alarm service
(2) Local alarm service that will cause the sounding of an audible signal at a constantly attended point
(3) Locking valves open
(4)* Sealing of valves and approved weekly recorded inspection

[**96:**10.2.10]

A.50.4.4.10(4) An approved weekly recorded inspection could consist of a log of entries that would display the date and time of each inspection and the initials of the person(s) conducting the visual inspection. Attaching the log to a clipboard and mounting it near the valve in question serves as a convenient reminder of the need to conduct the inspection. [**96:**A.10.2.10(4)]

50.4.5 Simultaneous Operation.

50.4.5.1 Fixed pipe extinguishing systems in a single hazard area *(see 3.3.44 of NFPA 96 for the definition of single hazard area)* shall be arranged for simultaneous automatic operation upon actuation of any one of the systems. [**96:**10.3.1]

The term *single hazard area* is defined in NFPA 96 as "where two or more hazards can be simultaneously involved in fire by reason of their proximity, as determined by the authority having jurisdiction." In general, a single hazard area is considered to be two or more adjacent hazards so close together that one could directly ignite the other; or two or more separate hazards connected by common ductwork through which a fire could pass to ignite the other hazard(s).

50.4.5.1.1 Hoods installed end to end, back to back, or both, or sharing a common ductwork, not exceeding 22.9 m (75 ft) in distance from the farthest hood, and having a grease-producing appliance(s) located under one or more of the hoods shall be considered a single hazard area requiring simultaneous automatic fire protection in all hoods and ducts. [**96:**10.3.1.1]

While the definition of *single hazard area* identifies it as an area determined by the AHJ, this section identifies a specific type of arrangement that must be protected as a single hazard area. Paragraph 50.4.5.1.1.1 identifies arrangement(s) that do not need to be treated as such.

N **50.4.5.1.1.1** In hoods that are installed end to end, back to back, or both, and that share a common ductwork, the ductwork beyond 22.9 m (75 ft) from the farthest hood shall be protected by an independent fire-extinguishing system with its own detection system or by a fire-extinguishing system that activates simultaneously with the fire-extinguishing system(s) protecting the hoods. [**96:**10.3.1.1.1]

Δ **50.4.5.1.2** Hoods installed end to end, back to back, or both that do not share a common exhaust duct and are separated by a wall(s) or other means to ensure that grease-laden vapors exhausted under one hood cannot propagate to the other hoods, the hoods' fire-extinguishing system(s) shall be independent and shall not be required to simultaneously discharge. [**96:**10.3.1.2]

N **50.4.5.1.3** Fume incinerators, thermal recovery units, air pollution control devices, or other devices installed in the exhaust duct shall not be required to comply with 50.4.5.1.1. [**96:**10.3.1.3]

50.4.5.2 Simultaneous operation shall not be required where the one fixed pipe extinguishing system is an automatic sprinkler system. [**96:**10.3.2]

Each of the sprinklers typically will have its own fusible link that will activate when the temperature of that link reaches a certain point. To require simultaneous operation would require complex arrangements, and that is not the intent of NFPA 96.

50.4.5.2.1 Where an automatic sprinkler system is used in conjunction with a water-based fire-extinguishing system served by the same water supply, hydraulic calculations shall consider both systems operating simultaneously. [**96:**10.3.2.1]

The introduction of water-based fire-extinguishing systems within commercial cooking hoods, potentially using the same water supply as the building's fire sprinkler system, requires consideration of simultaneous operation.

50.4.5.3 Simultaneous operation shall be required where a dry or wet chemical system is used to protect common exhaust ductwork by one of the methods specified in NFPA 17 or NFPA 17A. [**96:**10.3.3]

Simultaneous operation provides for common actuation of all fire suppression systems protecting the hazards in the single hazard area. The goal of this requirement is to cover all the components of the cooking operation to suppress a fire.

Arguments have been made against the simultaneous operation approach, especially with respect to chemical systems, which provide a limited supply of extinguishing agent. Some believe it is safer to discharge the chemical only in the areas where the fire is burning. If the fire then spreads to other areas, some remaining chemical is still available. When chemical is prematurely discharged, dry chemical tends to be carried out of the system by fan action, while wet chemical tends to drain out of the system; therefore, if a fire subsequently spreads, no agent remains to extinguish the spreading fire.

The concern regarding premature discharge of extinguishing agent led to the sequential or separate component fire suppression approach as an alternative to simultaneous discharge. This approach is especially effective and practical in the case of a manifold exhaust system in a large restaurant or when manifolding multiple types of restaurant exhaust systems in a food court of a shopping mall. In either case, simultaneous actuation of all systems is messy and expensive, especially in the case of a food court, where a real or an accidental discharge in one restaurant can result in multiple lawsuits from the affected restaurants due to premature actuation of adjacent fire protection systems.

NFPA 17 contains requirements for fixed pipe extinguishing systems using dry chemical agents for protection of restaurant hood, duct, and cooking appliance systems. Additionally, NFPA 17A contains requirements for fixed pipe extinguishing systems using wet chemical agents for protection of cooking equipment.

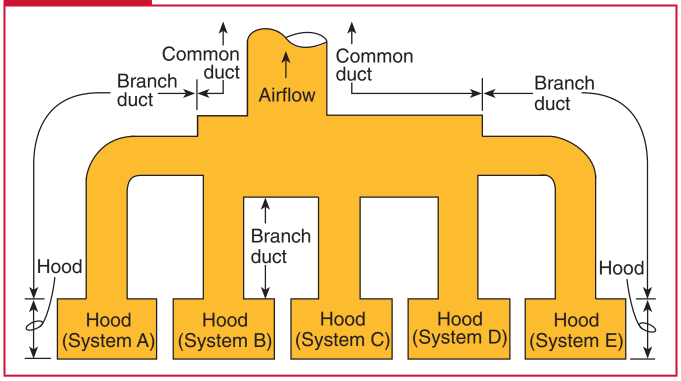
Alternative designs to simultaneous discharge are found in the annexes of NFPA 17 and NFPA 17A. These alternative systems segment the total manifold exhaust in different ways, all of which provide some backup protection in the common duct areas that permits some of the hoods or restaurants to continue operating while shutting down those that have experienced fire or those without a backup system in their common duct. These systems are a necessity for common design solutions for food courts with manifold exhaust systems and can be economical in large restaurants with multiple hoods on manifold exhaust systems. Exhibit 50.6 through Exhibit 50.9 illustrate various system configurations.

Example 1

A fire is detected by System A; its hood and branch duct are operated. Simultaneously, Systems B, C, D, and E are also actuated. All fuel or power to all protected appliances served by the common exhaust duct is shut off.

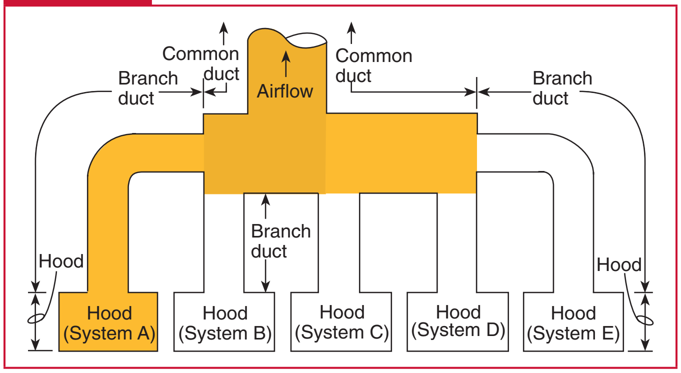
Upon operation of the common exhaust duct systems, the fuel or power to all protected appliances served by the common exhaust duct is shut off. The cooking appliance, hood, and branch duct systems provide protection in accordance with NFPA 17 and NFPA 17A. (See Exhibit 50.6.)

Exhibit 50.6



Simultaneous operation of all systems.

Exhibit 50.7



Simultaneous operation of a single cooking appliance, hood, or branch duct system and the system protecting the common duct.

Example 2

System 1, protecting the entire common exhaust duct, is separate from Systems A, B, C, D, and E. A fire is detected in System A. System A and System 1 operate simultaneously. Shutdown of all appliances protected by Systems A, B, C, D, and E is in accordance with NFPA 17. (See Exhibit 50.7.)

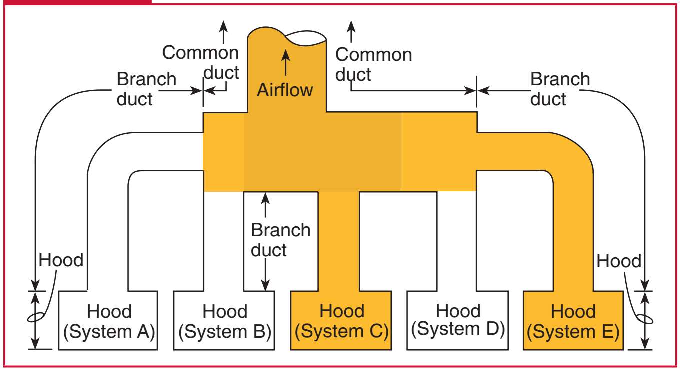
Example 3

System E also provides protection for the entire common exhaust duct. A fire is detected in System C. System C and System E operate simultaneously. Shutdown of all appliances protected by Systems A, B, C, D, and E is in accordance with NFPA 17. (See Exhibit 50.8.)

Example 4

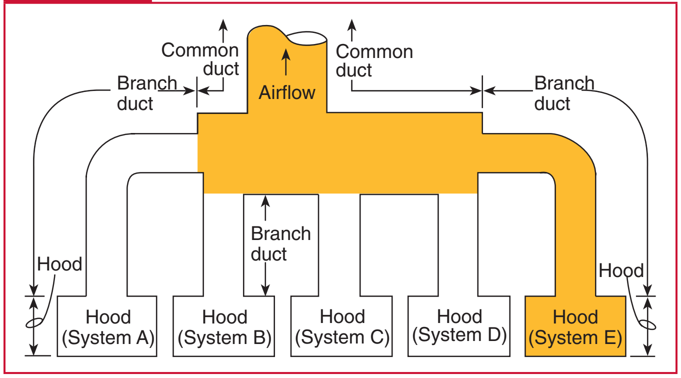
System E also provides protection for the entire common exhaust duct. A fire detected in System E will result in the actuation of System E only. Shutdown of all appliances protected by Systems A, B, C, D, and E is in accordance with NFPA 17. (See Exhibit 50.9.)

Exhibit 50.8



Simultaneous operation of two systems in which one also provides common duct protection.

Exhibit 50.9



Independent operation of a system that protects a hood and the common duct.

50.4.6 Fuel and Electric Power Shutoff.

50.4.6.1 Upon activation of any fire-extinguishing system for a cooking operation, all sources of fuel and electric power that produce heat to all equipment requiring protection by that system shall automatically shut off. [**96:**10.4.1]

If heat-producing appliances are not shut down, they will likely contribute to the fire, possibly allowing re-ignition.

When a fire-extinguishing system discharges, any possible source of re-ignition should be discontinued. This is typically accomplished through the use of a solenoid such as the one shown in Exhibit 50.10. This shutdown includes only heat-producing appliances that require protection (an appliance that requires protection typically has a nozzle directed at it). Therefore, this provision requires that only fuel or electrical power to appliances requiring protection be automatically shut off. Those appliances that do not require protection and are not gas appliances under the same hood as protected appliances are not to be shut off.

Questions have arisen regarding liquid extinguishing agents, such as wet chemical, flowing into electrical outlets and causing a shock hazard. As with sprinkler systems, no scientific evidence or experimental data have ever substantiated this as a valid safety concern.

Exhibit 50.10

Solenoid for providing fuel shutoff.

50.4.6.2 Steam supplied from an external source shall not be required to automatically shut off. [**96:**10.4.2]

Steam-heated appliances typically are not a fire protection concern since they do not have the capability of allowing the appliances to overheat and spontaneously ignite the cooking oil. Gas-fired and electrically heated appliances are the concern.

50.4.6.3 Any gas appliance not requiring protection but located under ventilating equipment where protected appliances are located shall be automatically shut off upon activation of the extinguishing system. [**96:**10.4.3]

50.4.6.4 Shutoff devices shall require manual reset. [**96:**10.4.4]

In a cooking fire, the two sources of heat are the burning grease and the normal source of heat used for cooking, which can be provided by any number of fuels, including electricity. This normal source of heat can pose a significant challenge to the effectiveness of the extinguishing agent, because effective extinguishment depends on lowering the fuel temperature to below its autoignition temperature. If the normal heat source continues to operate and heat the grease, such cooling might never occur. It is important to shut off all sources of fuel to the cooking equipment when the fire-extinguishing system has operated to allow the proper cooling to occur.

For gas appliances, a shutoff valve is typically directly connected to the operating controls for the fire-extinguishing system. Often cooking equipment, such as an oven, might be located under a hood that does not require a fire-extinguishing system. The gas supply to these appliances must also be shut down, because, if a fire occurs in the hood, heat produced by these appliances can inhibit the effectiveness of the fire-extinguishing system.

Exhibit 50.11

Manual reset for fuel and electric power.

Exhibit 50.12

Example of a properly located manual pull station.

A fire-extinguishing system has an interlock that automatically shuts off all sources of fuel and electrical power that produce heat to all equipment requiring protection. A manual reset, such as the one shown in Exhibit 50.11, allows time to analyze the cause of the fire before the shutoff is reset. If an automatic reset were permitted, the problem causing the fire might not be fixed before the reset operates.

Electrical power used as a source of heat for appliances must also be shut down. This includes outlets that are located under the hood that could be a potential source of heat to cooking appliances, regardless of whether they are currently connected to appliances. Power to the hood lights is not required to shut off.

N **50.4.6.5** Solid fuel cooking operations shall not be required to be shut down. [**96:**10.4.5]

50.4.7 Manual Activation.

To improve correlation between NFPA 17A and NFPA 96, the requirements in this subsection were revised for the 2017 edition of NFPA 96 and are applicable to all types of extinguishing systems.

50.4.7.1 All systems shall have both automatic and manual methods of actuation. [**96:**10.5.1]

50.4.7.1.1 At least one manual actuation device shall be located in means of egress or at a location acceptable to the AHJ. [**96:**10.5.1.1]

Manual pull stations should be strategically located, and employees should be trained how to use them. Exhibit 50.12 shows a manual pull station located next to a door in a path of egress. Access to the manual pull station needs to be maintained during the day-to-day operations of the system. While the pull stations can be designed for an appropriate location, placing movable tables or stacking boxes in front of a pull station defeats the purpose of 50.4.7.1.1, which is to allow for employees to easily activate the extinguishing system as they exit the area.

50.4.7.1.2 The manual actuation device shall clearly identify the hazard protected. [**96:**10.5.1.2]

50.4.7.2 An automatic sprinkler system shall not require a method of manual actuation. [**96:**10.5.2]

• Δ **50.4.7.3** Instruction regarding the proper use of portable fire extinguishers and the manual activation of fire-extinguishing equipment shall be documented and shall be provided by the management to new employees on hiring and to all employees annually. [**96:**10.5.3]

Experience has demonstrated that many employees of commercial cooking operations have not received initial instruction in the proper use of portable fire extinguishers and activation of fire-extinguishing equipment. Of those who have, many forget the lessons from their initial training, resulting in inappropriate responses to fire. The new language in 50.4.7.3 requiring training for new employees upon being hired and for all employees annually is consistent with the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) requirements. Employees are required to be trained to manually discharge the fire-extinguishing system on noticing a fire in or around a cooking appliance. Class K extinguishers are the only extinguishers that should be used for cooking oil fires in appliances. Class K extinguishers should be used only after the system has been discharged because the system has an interlock to automatically shut down the heat source to the appliance.

Employees should be trained to use various types of portable fire extinguishers as a first line of defense for fires other than Class K fires. The importance of personal safety should be stressed, and persons should use extinguishers only if the fire is small and only if the person using the extinguisher understands how to use it and is comfortable with the fire situation.

50.4.8 System Annunciation.

50.4.8.1 Upon activation of an automatic fire-extinguishing system, an audible alarm or visual indicator shall be provided to show that the system has activated. [**96:**10.6.1]

Exhibit 50.13

Two examples of visual indicators.

The fire-extinguishing system must be equipped to indicate, visibly or audibly, that it has operated. If no fire alarm system is in the building, the extinguishing system needs only to provide a local indicator. This local indicator can be in the form of a light or even a sign-type indicator identifying that the system has operated and needs to be restored. Exhibit 50.13 illustrates examples of visual indicators that show when a system has activated.

50.4.8.2 Where a fire alarm signaling system is serving the occupancy where the extinguishing system is located, the activation of the automatic fire-extinguishing system shall activate the fire alarm signaling system. [**96:**10.6.2]

If the building is equipped with a fire alarm system, operation of the commercial cooking extinguishing system is required to cause an alarm signal in the protected building. Paragraph 50.4.8.2 does not mean that all buildings that have commercial cooking extinguishing systems must be provided with a fire alarm system.

50.4.9 Special Design and Application.

50.4.9.1 Hoods containing automatic fire-extinguishing systems are protected areas; therefore, these hoods shall not be considered obstructions to overhead sprinkler systems and shall not require additional sprinkler coverage underneath. [**96:**10.7.1]

Unlike other shadow areas that are shielded from the spray pattern of the automatic sprinkler system discharge and have no extinguishing agent reaching the shadow area, the area under the hood is protected with extinguishing agent from the discharge devices of the fire protection system in the hood. Therefore, commercial cooking hoods that have total fire protection installed are not considered obstructions to ceiling-installed sprinklers.

50.4.9.2 A single detection device, listed with the extinguishing system, shall be permitted for more than one appliance where installed in accordance with the terms of the listing. [**96:**10.7.2]

50.4.10 Review and Certification.

50.4.10.1 Where required, complete drawings of the system installation, including the hood(s), exhaust duct(s), and appliances, along with the interface of the fire-extinguishing system detectors, piping, nozzles, fuel and electric power shutoff devices, agent storage container(s), and manual actuation device(s), shall be submitted to the AHJ. [**96:**10.8.1]

In order to review plans of cooking operations and equipment for compliance, a printed guideline or checklist could promote consistency and completeness. Exhibit 50.14 is an example of such a guideline.

50.4.10.2* Installation Requirements.

A.50.4.10.2 Although training and qualification might be available elsewhere, the manufacturer of the equipment being installed should be considered an appropriate source of training and qualification. [**96:**A.10.9.2]

50.4.10.2.1 Installation of systems shall be performed only by persons properly trained and qualified to install the specific system being provided. [**96:**10.8.2.1]

A pre-engineered kitchen fire suppression system installation and maintenance technician typically completes a classroom or online course and is required to pass an examination offered by a pre-engineered system manufacturer, an agent of a pre-engineered system manufacturer, or an organization that is approved by the AHJ.

50.4.10.2.2 The installer shall provide certification to the AHJ that the installation is in agreement with the terms of the listing and the manufacturer's instructions and/or approved design. [**96:**10.8.2.2]

50.4.11 Portable Fire Extinguishers.

50.4.11.1* Portable fire extinguishers shall be selected and installed in kitchen cooking areas in accordance with Section 13.6 and shall be specifically listed for such use. [**96:**10.9.1]

Exhibit 50.14

OFFICE OF THE FIRE MARSHAL

(City, State, Zip Code)

In order to successfully review and approve a commercial cooking equipment submission, all the components required in the *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations* (NFPA 96) need to be shown on the drawing or in the plans. Mentioned below are some of the more common omissions that are resulting in plans not being approved:

The drawings/plans are to indicate the MSG gauge of the ductwork and the hood and whether steel or stainless.

The drawings/plans are to indicate that all welds on the exhaust duct are liquid tight and external to the duct.

In the case of listed hoods or duct systems, cut sheets of the listed component(s) need to be submitted in order to verify that the component is listed and that restrictions and conditions of the listing are not being violated.

Only filters listed by Underwriters Laboratories for use in cooking ventilation system are permitted in the hood.

For horizontal runs of exhaust duct, the drawings/plans are to indicate that at least one 20 in. x 20 in. (508 mm x 508 mm) opening is provided for personnel entry. Where this size opening is not possible, openings shall be provided at 12-foot (3.6 m) intervals.

If the supply air plenum is integral with the exhaust ventilation system, the drawings/plans are to indicate that fire actuated dampers are provided where the supply air duct penetrates the shell of the assembly.

The drawings/plans are to indicate the fan rating in CFM and the dimensions (width and depth or cross-sectional area) of the duct system in order to verify that a velocity of 500 ft/min (150 m/min) is being produced.

The drawings/plans are to indicate that the make-up (supply) air ventilation rate does not exceed the exhaust ventilation rate.

The drawings/plans are to show that a 10-foot (3.05 m) clearance exists between the discharge of an upblast fan and property lines, adjacent buildings, and all other air intakes, including between the discharge of the upblast fan and return air intake.

A distance of at least 16 inches (406 mm) is required between deep fat fryers and all other fired appliances. In lieu of this, a noncombustible baffle of at least 8 inches (203 mm) in height can be accepted provided it is indicated on the drawings/plans.

Deep fat fryers are to be equipped with a separate high limit control in addition to the operating control. It is to shut off fuel or energy when the fat temperature at 1 inch (25 mm) below the surface reaches 475°F (246°C).

On the resubmittal, make sure that all the components required in the *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations* (NFPA 96) are shown on the drawing or in the plans.

Plan review guidelines for cooking operations and equipment.

Most fires start small and can be extinguished with portable fire extinguishers. Notifying the fire department as soon as a fire is discovered is essential. This notification should not be delayed by awaiting results of using portable fire extinguishers.

A.50.4.11.1 The system used to rate extinguishers for Class B fires (flammable liquids in depth) does not take into consideration the special nature of heated grease fires. Cooking-grease fires are a special hazard requiring agents that saponify (make a soap foam layer to seal the top surface of the grease) for this application. [**96:**A.10.10.1]

Many restaurant fires have failed to be extinguished because an inappropriate portable fire extinguisher was used. Cooking oil fires that occur in deep vessels, such as in deep-fat fryers, require a fire-extinguishing agent that reacts with the cooking oil and forms a soapy foam layer (a process called saponification). This layer should keep the surface of the hot oil separated from the air until the oil is cooled to below its autoignition temperature, usually around 650°F (343°C).

If the fire-extinguishing agent does not support saponification, the fire can reignite when the agent discharge is stopped. No multipurpose dry chemical (known as type A:B:C), halon, or carbon dioxide fire-extinguishing agents are capable of saponification. Only carbonate-based agents saponify with cooking oil. Additionally, the high temperature of cooking oil can slowly break down the soapy foam layer before the oil drops below its autoignition temperature, and the fire can reignite. A properly trained individual should stand by with the proper portable fire extinguisher until the fire department arrives in case an extinguished cooking oil fire reignites.

While, in the past, some portable fire extinguishers have used bicarbonate-based dry chemical, wet chemical fire extinguishers, designated by a K rating, are available and are listed for use on actual fryer-type cooking oils.

50.4.11.2 Class K fire extinguishers shall be provided for cooking appliance hazards that involve combustible cooking media (vegetable oils and animal oils and fats). [**96:**10.9.2]

In the kitchen area, the essential hazard involves combustible cooking oils, and a Class K fire extinguisher is a match for the hazard. Class K combustible cooking media fires typically involve kitchen appliances containing quantities of cooking greases or oils that present special extinguishment and reflash concerns. The development of high-efficiency cooking equipment with high-energy input rates and the widespread use of vegetable oils with high autoignition temperatures have highlighted the need for Class K fire extinguishers.

The wet chemical extinguisher is the only extinguisher to qualify to the Class K listing requirements. In addition to offering rapid fire extinguishment, a thick foam blanket is formed to prevent reignition while cooling both the appliance and the hot cooking oil.

Fire extinguishers classified for use on Class K hazards do not have a number preceding the classification letter. According to NFPA 10, the maximum travel distance to a Class K extinguisher is not permitted to exceed 30 ft (9.1 m) from the hazard to the extinguisher.

50.4.11.3 Portable fire extinguishers shall be provided for other hazards in kitchen areas and shall be selected and installed in accordance with Section 13.6. [**96:**10.9.3]

NFPA 10 uses the following classifications for fires in determining appropriate extinguishers:

- Class A: Ordinary
- Class B: Flammable liquids
- Class C: Energized electrical equipment
- Class D: Combustible metals
- Class K: Cooking appliances that involve combustible cooking media

All buildings have Class A fire hazards. Where ordinary combustibles are present, there could be the need for fire extinguishers suitable for use on Class B and Class C fires (e.g., in the dining areas of a restaurant, the principal combustibles present are wood, paper, and fabrics, which are Class A materials).

According to NFPA 10, all solid fuel cooking appliances (whether or not under a hood) with fire boxes of 5 ft^3 (0.14 m^3) volume or less are required to have at least a listed 2-A rated water-type fire extinguisher or a 1.6 gal (6 L) wet chemical fire extinguisher that is listed for Class K fires.

N **50.4.11.4** Carbon dioxide–type extinguishers shall not be permitted. [**96:**10.9.4]

50.4.11.5 Portable fire extinguishers shall be maintained in accordance with Section 13.6. [**96:**10.9.5]

50.5 Procedures for the Use, Inspection, Testing, and Maintenance of Equipment

50.5.1 Operating Procedures.

50.5.1.1 Exhaust systems shall be operated whenever cooking equipment is turned on. [**96:**11.1.1]

When the cooking equipment is turned on, heat is being produced at all times. Even when no food is being cooked, residual grease is being heated and vaporized. Additionally, both the exhaust system and the extinguishing system are designed to function most effectively when excessive temperatures are exhausted and not lingering across the cooking surfaces and under the hood. An interlock is required in 8.2.3.3 of NFPA 96 so that the exhaust fan is activated when any appliance under the hood is turned on. This requirement can be accomplished with the installation of a separate heat detector that turns the fan on when a preset temperature is reached.

50.5.1.2 Filter-equipped exhaust systems shall not be operated with filters removed. [**96:**11.1.2]

In the normal mode, filter-equipped exhaust systems are designed to run when filters are in place. Filter spacers are often used to fill voids when standard size filters are used. These are solid blocks that fill in any gaps left after standard size filters are put in place at a point where they do not cover the entire hood but do not leave enough room for another filter. The spacers should be used only where the space being filled is not critical to airflow, typically on the very ends. Detection devices for the extinguishing system should not be installed directly above a spacer due to limited airflow that will pass through the solid filter.

Where any of the required filters are missing, exhaust volumes will be captured from a path of lesser resistance (where the filter is missing), resulting in unfiltered smoke and vapors being introduced into the exhaust system; thus, uncaptured grease and deposits accumulate on the plenum and duct surfaces.

During maintenance, a missing filter serves as a visual indicator that service is being conducted. Operating the exhaust system during maintenance could pose a hazard to service personnel and cause damage to mechanical parts of the equipment.

50.5.1.3 Openings provided for replacing air exhausted through ventilating equipment shall not be restricted by covers, dampers, or any other means that would reduce the operating efficiency of the exhaust system. [**96:**11.1.3]

Openings are commonly provided to afford sufficient airflow for the exhaust system to work properly to remove grease-laden vapors from the cooking area. Because covering the openings restricts airflow, covers, dampers, or other means are prohibited from being installed while the exhaust system is in operation.

50.5.1.4* Instructions shall be provided to new employees on hiring and to all employees semiannually on the use of portable fire extinguishers and the manual actuation of the fire-extinguishing system. [**96:**11.1.4]

N **A.50.5.1.4** It is important that all kitchen employees be instructed that the fire-extinguishing system is the primary protection and how to respond appropriately to a fire. If the fire cannot be extinguished by shutting off the fuel source to a pan of burning grease and covering the pan, then employees should perform the following:

(1) Operate the manual actuation device for the fire-extinguishing system to suppress the fire and automatically shut off fuel to the appliances.
(2) Call the fire department and report the fire.
(3) Evacuate personnel and guests, as needed.
(4) Stand by with a Class K fire extinguisher to be used if the fire is not fully extinguished by the fire-extinguishing system.

[**96:**A.11.1.4]

N **50.5.1.4.1** Responsibility for compliance with 11.1.4 shall be that of management of the commercial cooking operation. [**96:**11.1.4.1]

N **50.5.1.4.2** Records of compliance with 11.1.4 shall be maintained and shall be available to the authority having jurisdiction. [**96:**11.1.4.2]

N **50.5.1.4.3** Instructions for manually operating the fire-extinguishing system shall be posted conspicuously in the kitchen and shall be reviewed with employees by the management. [**96:**11.1.4.3]

The most common means for compliance with this requirement is to post a placard near each manual activation device for the fire-extinguishing system. The signage should be in a language commonly used by employees. Alternatively, pictographs (picture symbols) or a combination of pictographs and words can be used.

50.5.1.5 Listed exhaust hoods shall be operated in accordance with the terms of their listings and the manufacturer's instructions. [**96:**11.1.5]

50.5.1.6 Cooking equipment shall not be operated while its fire-extinguishing system or exhaust system is nonoperational or impaired. [**96:**11.1.6]

By its very nature, commercial cooking has been recognized as a hazard that requires appropriate protection. If the fire protection system is nonoperational, the hazard must be eliminated by discontinuing the cooking operation. Similarly, if cooking equipment were allowed to operate without the exhaust system operating, grease-laden vapors would not be removed and excessive heat would accumulate in the cooking area.

50.5.1.6.1 Where the fire-extinguishing system or exhaust system is nonoperational or impaired, the systems shall be tagged as noncompliant, and the system owner or owner's representative shall be notified in writing of the impairment, and where required, the AHJ shall be notified. [**96:**11.1.6.1]

In addition to providing written notification, it is important that the owner is made aware as soon as possible that the protective systems are not operative. Not all AHJs require notification, as they might have other procedures in place to address the inoperative equipment.

50.5.1.7 Secondary filtration and pollution control equipment shall be operated in accordance with the terms of its listing and the manufacturer's recommendations. [**96:**11.1.7]

The manufacturer's published operating guidelines regarding reducing the hazard through proper operation should be closely followed. The turnover of personnel in the food service industry makes it necessary for this information to be available for training of new personnel so as to continue the safe practices of equipment operation.

50.5.1.8 Inspection and maintenance of "other equipment" allowed in 9.3.1 of NFPA 96 shall be conducted by properly trained and qualified persons at a frequency determined by the manufacturer's instructions or equipment listing. [**96:**11.1.8]

The AHJ determines who is and who is not "properly trained and qualified."

50.5.2 Inspection, Testing, and Maintenance of Fire-Extinguishing Systems.

50.5.2.1* Maintenance of the fire-extinguishing systems and listed exhaust hoods containing a constant or fire-activated water system that is listed to extinguish a fire in the grease removal devices, hood exhaust plenums, and exhaust ducts shall be made by properly trained, qualified, and certified person(s) acceptable to the AHJ at least every 6 months. [**96:**11.2.1]

Most automatic fire-extinguishing systems installed for the protection of commercial cooking operations are wet chemical extinguishing systems listed to ANSI/UL 300. Certification of maintenance technicians for wet chemical fire-extinguishing systems is addressed in 7.3.1 and 7.3.1.1 of NFPA 17A. Service technicians performing maintenance on wet chemical extinguishing systems are required to be trained and to pass a written or online test that is acceptable to the AHJ and to possess a certification document confirming an acceptable score on the test. The certification document must be issued by a system manufacturer, an agent of a system manufacturer, or a testing organization that is acceptable to the AHJ.

It is important that the 6-month and annual inspections are performed on schedule. These inspections not only provide for the replacement of necessary components on schedule, they test the actual performance of the components to ensure they are all operating normally and are not compromised by grease buildup or by other mechanical seizures that would prevent the system from performing as designed. Without these inspections being properly performed, the system can easily slip into a condition of decay that eventually seizes up a cable or an operator or results in a grease buildup that thickly coats and insulates a detector link, so that the system is unable to respond when it is needed.

A.50.5.2.1 It is recommended that such training and qualification be performed by the manufacturer of the equipment being inspected and serviced. The various electrical, mechanical, and filtration components of the systems should be inspected and tested

Case Study

On Wednesday, August 29, 2007, a fire tore through a Cantonese restaurant in West Roxbury, Massachusetts, resulting in the deaths of two city fire fighters and injuries to several other fire fighters. A total of four employees were working in the restaurant on the night of the fire. One of the employees discovered the fire, evacuated coworkers, and called 911. Minutes after the fire was discovered, the restaurant erupted into a ball of flames, fully engulfing it and other properties nearby.

The fire appeared to have been caused by an accumulation of grease and fumes from the kitchen that ignited after smoldering in the restaurant's ceiling. When the fire fighters entered the building, they were responding to a standard kitchen fire, but it quickly took a turn for the worse. It was later discovered that the fire had been smoldering in the ceiling throughout the evening as patrons ate in the dining room below.

The kitchen was located in the right rear of the restaurant. Cooking equipment was fueled by natural gas and included five woks, two deep fryers, and an upright oven/broiler. (The deep fryers were located directly next to the oven/broiler, without the required clearance between them.) Kitchen exhaust hoods were located above the cooking equipment and ran along a partition wall ending at the building's cellar stairs. A tag from a local company was recovered during the fire investigation, which indicated that the hoods and ducts had been cleaned three months earlier.

A probable contributor to the deaths of the two fire fighters was the collapse of the roof, which occurred when a heating, ventilation, and air-conditioning (HVAC) unit fell through the roof and crashed down into the burning restaurant below. The HVAC system was an old-type roof model providing both heat and air-conditioning to the restaurant, powered by natural gas and electrically cooled. The unit, which had a 3 ton (2.7 metric ton) capacity and weighed approximately 400 lb (181 kg), was on the roof approximately 40 ft (12.2 m) from the front exterior wall of the restaurant

The cooking equipment was protected by a fire suppression system. The fire suppression system in the kitchen hoods did not operate until well after the fire started. It was documented that a few of the heads did not activate as designed because the caps were grease-bound.

The hood, kitchen exhaust duct, and roof curbing were of nonconforming construction and were contaminated by grease that had been building up unnoticed due to lack of maintenance cleaning, allowing the grease to escape to adjoining combustible areas, which allowed fire and the products of combustion to escape from the containment area. As reported by the local fire department, due to the substandard materials being used, the duct above the hood degraded, and a section of the duct became open. Flame and products of combustion, including heat, carbon monoxide, and other fire gases, escaped from the duct. Combustible building materials had become coated with grease. The fire in the ductwork above the hood escaped from containment and ignited combustible wall materials. The flame quickly spread vertically to the ceiling and the roof. The fire, smoke, and toxic gases expanded and also traveled horizontally, filling both the top and bottom ceiling voids in the dining room, as well as the ceiling void in the kitchen, allowing the fire to go undetected for an unknown length of time. By the time the fire did fall from the ceiling into the kitchen below, it was too late; it had grown to an unmanageable and tragic inferno.

Source: Boston Fire Department, *Board of Inquiry report on fatal fire of August 29th, 2007*

as required to ensure that they continue to function according to original design. [**96:**A.11.2.1]

50.5.2.2* All actuation and control components, including remote manual pull stations, mechanical or electrical devices, detectors, and actuators, shall be tested for proper operation during the inspection in accordance with the manufacturer's procedures. [**96:**11.2.2]

A.50.5.2.2 It is not intended that actual discharge of agent occur to test all components, but where pressure from the discharging agent or from compressed gas actuators is needed to activate control components, an alternate means for testing those components should be provided and used. [**96:**A.11.2.2]

All mechanical and electrical components need to be physically tested periodically to ensure that they remain operational. Generally, all such components will be tested during the semiannual inspection, although the last component that physically releases the extinguishing agent need not be tested, except during the inspection of the agent and tank as required by the applicable equipment standard. Where control components, such as gas or electric fuel shutoff devices, depend on release of the extinguishing agent or compressed gas for pressurizing a switch or similar component, alternative means for testing those components must be provided and followed.

The gas or electric shutoff is often critical for successful fire extinguishment and should be tested periodically.

50.5.2.3 The specific inspection and maintenance requirements of the extinguishing system standards as well as the applicable installation and maintenance manuals for the listed system and service bulletins shall be followed. [**96:**11.2.3]

Δ **50.5.2.4*** Fusible links of the metal alloy type and automatic sprinklers of the metal alloy type shall be replaced at least semiannually. [**96:**11.2.4]

A.50.5.2.4 The date of manufacture marked on fusible metal alloy sensing elements does not limit when they can be used. These devices have unlimited shelf life. The intent of 50.5.2.4 is to require semiannual replacement of fusible metal alloy sensing elements that have been installed in environments that subject them to

Exhibit 50.15

Fusible link requiring replacement.

contaminant loading, such as grease in restaurant hoods and ducts, that could adversely affect their proper operation. [**96:**A.11.2.4]

Fusible links, such as the one shown in Exhibit 50.15, act as the automatic activation component for most fire-extinguishing systems in hoods. The effectiveness of the extinguishing system is dependent on the fusible link activating the system in a timely manner before the fire becomes too large. The buildup of grease on the fusible link has the potential to affect its thermal characteristics and, therefore, possibly diminish the effectiveness of the extinguishing system. That is why the links are required to be replaced on a semiannual basis. (The year of manufacture indicated on the fusible link is not necessarily the date the link was installed. Links should be replaced every 6 months, regardless of the date that appears on the fusible link.)

50.5.2.5 The year of manufacture and the date of installation of the fusible links shall be marked on the system inspection tag. [**96:**11.2.5]

It should be noted that the year of manufacture indicated on the fusible link is not necessarily the date the link was installed. Link replacement should be every 6 months, regardless of the date that appears on the fusible link.

50.5.2.5.1 The tag shall be signed or initialed by the installer. [**96:**11.2.5.1]

50.5.2.5.2 The fusible links shall be destroyed when removed. [**96:**11.2.5.2]

Destroying links is a safety measure that prevents the removed links from ever being installed again in a fire-extinguishing system.

50.5.2.6 Detection devices that are bulb-type automatic sprinklers and fusible links other than the metal alloy type shall be examined and cleaned or replaced annually. [**96:**11.2.6]

Cleaning bulb-type automatic sprinklers and fusible links is essential for them to operate as designed. When they cannot be thoroughly cleaned, they must be replaced. It is also acceptable to replace them every 12 months if cleaning is undesirable or cost prohibitive, as allowed in 50.5.2.7.

50.5.2.7 Fixed temperature-sensing elements other than the fusible metal alloy type shall be permitted to remain continuously in service, provided they are inspected and cleaned or replaced if necessary in accordance with the manufacturer's instructions, every 12 months or more frequently to ensure proper operation of the system. [**96:**11.2.7]

50.5.2.8 Where required, certificates of inspection and maintenance shall be forwarded to the AHJ. [**96:**11.2.8]

N **50.5.2.8.1** Records, including certificates of inspection and maintenance, shall be permitted to be forwarded to or shared with the authority having jurisdiction either by hard copy or electronically. [**96:**11.2.8.1]

Recognizing that fire-extinguishing equipment might not operate as designed if not periodically inspected and maintained, some AHJs might require documentation of the inspections. Other AHJs might have different policies in place to address inspection and maintenance of equipment.

Permission to store and access inspection and maintenance documentation electronically is provided in NFPA 10; NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*; *NFPA 72®, National Fire Alarm and Signaling Code®*; NFPA 80, *Standard for Fire Doors and Other Opening Protectives*; and NFPA 731, *Standard for the Installation of Electronic Premises Security Systems.* This new requirement for the 2017 edition brings NFPA 96 in line with other documents, while still allowing for documentation in hard copy format.

50.5.3 Inspection of Fire Dampers.

Fire dampers can be vital to the overall performance of the fire-extinguishing system and the integrity of the ventilation system under fire conditions. These devices are typically activated by fusible links that must be inspected and replaced at regular intervals to allow for proper operation when needed.

50.5.3.1 Actuation components for fire dampers shall be inspected for proper operation in accordance with the manufacturer's listed procedures. [**96:**11.3.1]

50.5.3.2 Replacement of Fusible Links.

50.5.3.2.1 Fusible links on fire damper assemblies shall be replaced at least semiannually or more frequently as necessary. [**96:**11.3.2.1]

50.5.3.2.2 Replacement shall be made by a certified person acceptable to the AHJ. [**96:**11.3.2.2]

50.5.3.3* Documentation Tag.

A.50.5.3.3 See A.50.5.2.4. [**96:**A.11.3.3]

50.5.3.3.1 The year of manufacture and the date of installation of the fusible links shall be documented. [**96:**11.3.3.1]

Δ ***TABLE 50.5.4*** *Schedule of Inspection for Grease Buildup*

Type or Volume of Cooking	Inspection Frequency
Systems serving solid fuel cooking operations	Monthly
*Systems serving high-volume cooking operations	Quarterly
Systems serving moderate-volume cooking operations	Semiannually
†Systems serving low-volume cooking operations	Annually

*High-volume cooking operations include 24-hour cooking, charbroiling, and wok cooking.

†Low-volume cooking operations include churches, day camps, seasonal businesses, and senior centers.

[**96:** Table 11.4]

50.5.3.3.2 The tag shall be signed or initialed by the installer. [**96:**11.3.3.2]

Δ **50.5.4* Inspection for Grease Buildup.** The entire exhaust system shall be inspected for grease buildup by a properly trained, qualified, and certified person(s) acceptable to the AHJ and in accordance with Table 50.5.4. [**96:**11.4]

A.50.5.4 The primary focus of an inspection for cleanliness is to establish whether the volume of grease buildup within the exhaust system warrants cleaning and to determine whether adequate access is available throughout the exhaust system to remove the grease buildup. [**96:**A.11.4]

Excessive grease buildup increases the fire hazard and has been documented as the cause of many fires involving commercial cooking equipment. Cleaning of the exhaust hoods should be based on the amount of grease buildup observed during inspections. The intervals between inspections and cleanings can vary, depending on the types and volumes of cooking that take place, the condition of the equipment, and the efficiency of the hood filtration system. A reduced frequency of inspection might be justified for systems that are used on a part-time or seasonal basis only. Inspections for grease buildup should be conducted only by a person with adequate training, certifications, and qualifications acceptable to the AHJ.

50.5.5 Inspection, Testing, and Maintenance of Listed Hoods Containing Mechanical, Water Spray, or Ultraviolet Devices. Listed hoods containing mechanical or fire-actuated dampers, internal washing components, or other mechanically operated devices shall be inspected and tested by properly trained, qualified, and certified persons every 6 months or at frequencies recommended by the manufacturer in accordance with their listings. [**96:**11.5]

50.5.6 Cleaning of Exhaust Systems.

50.5.6.1* If upon inspection, the exhaust system is found to be contaminated with deposits from grease-laden vapors, the contaminated portions of the exhaust system shall be cleaned by a properly trained qualified, and certified person(s) acceptable to the AHJ. [**96:**11.6.1]

If an exhaust system is found to be contaminated with deposits from grease-laden vapors during an inspection, the contaminated portions of the system must be cleaned by a trained, qualified, and certified person(s) who is acceptable to the AHJ. By definition, a qualified person is a competent and capable person who has met the requirements and training for a given field acceptable to the AHJ. A certified person possesses a certification, which is a formally stated recognition and approval of an acceptable level of competency, acceptable to the AHJ. Certification can be provided by the manufacturer of the listed equipment being serviced or by an independent third party. A trained person is someone who has become proficient in performing a skill reliably and safely through instruction and practice/field experience acceptable to the AHJ. Formal or technical training can be administered by the employer or by a recognized training program.

A.50.5.6.1 ANSI/IKECA Standard C-10 provides guidance for cleaning the exhaust system.

A good operating practice is for cleaning personnel of commercial kitchen exhaust systems to have personal protective equipment (PPE) and height access equipment. The following items should be considered as a minimum:

(1) Eye protection
(2) Hand protection
(3) Head protection
(4) Foot protection
(5) Respiratory protection
(6) Fall protection
(7) Ladders
(8) Lock-out/tag-out kit

[**96:**A.11.6.1]

Preparation. The fan should be turned off, locked out, and tagged out. Open flames should be extinguished, and switches/breakers serving the appliance and cooking area outlets should be locked out. If the switches/breakers are not capable of being locked out and tagged out, any solid-fuel cooking appliances should be extinguished and the solid fuel removed. [**96:**A.11.6.1]

Removal or Covering of Equipment. Food products, cookware, and cooking support equipment that can be removed should be removed from the cleaning area. Equipment that cannot be removed should be covered. [**96:**A.11.6.1]

Cleaning Methods. The following methods for cleaning surfaces covered with grease and contaminants been proved to be effective:

(1) Manual cleaning by scraping, grinding, or scrubbing
(2) Chemical cleaning with agents and water
(3) Pressure washing with pressurized water or pressurized water and agents
(4) Steam cleaning with pressurized steam

[**96:**A.11.6.1]

Waste Water and Solid Waste. Water and agents used in the cleaning process and solid waste should be collected for disposal. [**96:**A.11.6.1]

N **50.5.6.1.1** A measurement system of deposition shall be established to trigger a need to clean when the exhaust system is inspected at the frequencies in Table 50.5.4. [**96:**11.6.1.1]

N **50.5.6.1.1.1** Hoods, grease removal devices, fans, ducts, and other appurtenances shall be cleaned to remove combustible contaminants to a minimum of 50 μm (0.002 in.). [**96:**11.6.1.1.1]

N **50.5.6.1.1.2** A grease depth gauge comb, as shown in Figure 50.5.6.1.1.2, shall be placed upon the surface to measure grease depth. [**96:**11.6.1.1.2]

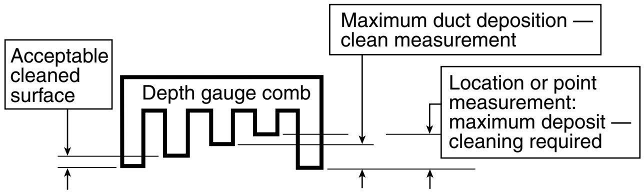


FIGURE 50.5.6.1.1.2 *Depth Gauge Comb.*

N **50.5.6.1.1.3** Where a measured depth of 2000 μm (0.078 in.) is observed, the surfaces shall be cleaned in accordance with 50.5.6.1. [**96:**11.6.1.1.3]

N **50.5.6.1.1.4** Where a measured depth of 3175 μm (0.125 in.) is observed in a fan housing, the surfaces shall be cleaned in accordance with 50.5.6.1. [**96:**11.6.1.1.4]

50.5.6.2 Hoods, grease removal devices, fans, ducts, and other appurtenances shall be cleaned to remove combustible contaminants prior to surfaces becoming heavily contaminated with grease or oily sludge. [**96:**11.6.2]

50.5.6.3 At the start of the cleaning process, electrical switches that could be activated accidentally shall be locked out. [**96:**11.6.3]

Switches that might start an exhaust fan, a heating element, an electrostatic precipitator, or a spray or wash system must be locked out (locked in the "off" position) to ensure safety during the cleaning process. These switches could be hazardous to those who are cleaning the exhaust system if not locked out. The agency responsible for the lockout is responsible for turning the switches back on at the end of the cleaning process, so the systems they control can resume their intended services.

50.5.6.4 Components of the fire suppression system shall not be rendered inoperable during the cleaning process. [**96:**11.6.4]

50.5.6.5 Fire-extinguishing systems shall be permitted to be rendered inoperable during the cleaning process where serviced by properly trained and qualified persons. [**96:**11.6.5]

Interfering with the normal operation of a fire suppression system can create a serious hazard. An untrained person who attempts to disarm the suppression system during cleaning of the exhaust system could discharge the suppression system accidentally. A person who successfully disarms the system but forgets to rearm it or rearms it incorrectly creates a serious problem if a subsequent fire in the exhaust system occurs. If the suppression system is allowed to be disarmed only by a qualified person, the responsibility for rearming the system remains with the qualified person.

50.5.6.6 Flammable solvents or other flammable cleaning aids shall not be used. [**96:**11.6.6]

These chemicals are not permitted because the fumes from flammable solvents or other flammable cleaning aids are heavier than air and invisible and can travel to an ignition source and cause a fire.

50.5.6.7 Cleaning chemicals shall not be applied on fusible links or other detection devices of the automatic extinguishing system. [**96:**11.6.7]

Some cleaning materials can cause corrosion of the detector links and the cables. Such corrosion could adversely affect the system, causing premature or delayed activation.

50.5.6.8 After the exhaust system is cleaned, it shall not be coated with powder or other substance. [**96:**11.6.8]

Some cleaning vendors find that applying special agents to the exhaust system interior prior to cleaning can assist in the cleaning. However, coating the inside of the duct with powder or other substance after the system is cleaned can cause grease buildup. The safest approach is to leave the metal duct surfaces as clean as possible.

50.5.6.9 When cleaning procedures are completed, all access panels (doors) and cover plates shall be restored to their normal operational condition. [**96:**11.6.9]

Access panels (doors) and cover plates must be replaced with the original hardware (gasketing and fasteners). An improperly placed access panel could allow grease to leak out of the duct and into concealed areas during the cooking operation. A subsequent duct fire could ignite this renegade grease. In addition, where there is a fire-rated chase, there are also panels or cover plates in the chase to allow access to the panels in the duct itself. If the fire chase panel is not replaced, the fire rating of the chase is voided. It is possible that, without the chase protection, some combustible materials in the vicinity of the chase could be subjected to radiated heat from a fire inside the duct. The total restoration of all duct and chase panels with a proper gasketing seal is critical.

50.5.6.10 When an access panel is removed, a service company label or tag preprinted with the name of the company and giving the date of inspection or cleaning shall be affixed near the affected access panels. [**96:**11.6.10]

50.5.6.11 Dampers and diffusers shall be positioned for proper airflow. [**96:**11.6.11]

Diffusers are not normally found in the exhaust system, but they can be found in the supply air system that is provided in some operations. Fire dampers (not balancing dampers) can be found in some exhaust and supply systems. Typically, these dampers do not have to be moved during the cleaning process of the exhaust system, but if moving is necessary, they must be returned to their original positions. This step ensures that the original airflows are maintained. If dampers are not returned to their original positions, it is possible that the hood will fail to capture all the effluent from the cooking process.

50.5.6.12 When cleaning procedures are completed, all electrical switches and system components shall be returned to an operable state. [**96:**11.6.12]

50.5.6.13 When an exhaust system is inspected or cleaned, a certificate showing the name of the servicing company, the name of the person performing the work, and the date of inspection or cleaning shall be maintained on the premises. [**96:**11.6.13]

Exhibit 50.16 is an example of such a certificate affixed to the exterior of the hood, showing all the required information.

Exhibit 50.16

Certificate on the exterior of a hood.

50.5.6.14 After cleaning or inspection is completed, the exhaust cleaning company and the person performing the work at the location shall provide the owner of the system with a written report that also specifies areas that were inaccessible or not cleaned. [**96:**11.6.14]

An area that is not cleaned should be noted so that it can, if necessary, be identified as a continuing hazard that needs to be corrected. Usually, an area is not cleaned because it is not easily accessible. In some instances, an area is not cleaned because multiple restaurants are feeding into a common duct, and no agreement designates who is responsible for maintaining the common duct. In rare instances, an area might not be cleaned because the operator does not want to spend the money necessary for the cleaning. In all cases, the cleaning agency must identify and keep records of the areas not cleaned and explain why they have not been cleaned. This information will be taken into consideration by the local AHJ when the cleaning records are reviewed.

50.5.6.15 Where required, certificates of inspection and cleaning and reports of areas not cleaned shall be submitted to the AHJ. [**96:**11.6.15]

N **50.5.6.16** Metal containers used to collect grease drippings shall be inspected or emptied at least weekly. [**96:**11.6.16]

New for the 2017 edition of NFPA 96, 50.5.6.16 addresses the subject of metal grease drip collectors within hoods that can become involved in a fire before the fire-extinguishing system operates. Typically, no agent is discharged into these devices, and a fire on an appliance and within the hood that is successfully extinguished can subsequently spread from a fire that is fueled from the grease collector into the exhaust system.

50.5.7 Cooking Equipment Maintenance.

50.5.7.1 Inspection and servicing of the cooking equipment shall be made at least annually by properly trained and qualified persons. [**96:**11.7.1]

50.5.7.2 Cooking equipment that collects grease below the surface, behind the equipment, or in cooking equipment flue gas exhaust, such as griddles or charbroilers, shall be inspected and, if found with grease accumulation, cleaned by a properly trained, qualified, and certified person acceptable to the AHJ. [**96:**11.7.2]

In most cases, maintenance and cleaning can be effectively conducted without moving the cooking appliances. For cooking appliances that are moved, 50.6.1.2.3.1 requires that an approved method be provided to ensure that the appliances are returned to their approved designated locations. In some cases where the cooking appliance must be moved, it might be possible to do so without disconnecting any of the fire-extinguishing system nozzles.

50.6 Minimum Safety Requirements for Cooking Equipment

50.6.1 Cooking Equipment.

Δ **50.6.1.1*** Cooking equipment shall be approved based on one of the following criteria:

(1) Listings by a testing laboratory
(2) Test data acceptable to the AHJ

[**96:**12.1.1]

The allowance for listed appliances is predicated on the assumption that the appliances will be used in the manner and for the use outlined in the listing. Where not listed, 50.6.1.1(2) will normally be accomplished with the manufacturer's cut sheets for the appliance, or the manufacturer might use a testing lab with which they have contracted (for quality assurance purposes). Although it might not be a traditional testing lab, if it produces data, it might be acceptable to an AHJ.

A.50.6.1.1 Cooking appliances that are designed for permanent installation, including, but not limited to, ranges, ovens, stoves, broilers, grills, fryers, griddles, and barbecues, should be installed in accordance with the manufacturer's installation instructions.

(1) Commercial electric cooking appliances should be listed and labeled in accordance with ANSI/UL 197.
(2) Microwave cooking appliances should be listed and labeled in accordance with ANSI/UL 923.
(3) Oil-burning stoves should be listed and labeled in accordance with ANSI/UL 896.
(4) Wood-fired cooking appliances should be listed and labeled in accordance with ANSI/UL 737, UL Subject 2162, or UL Subject 2728, depending on exact appliance type.
(5) Gas-fired cooking appliances should be listed and labeled in accordance with ANSI Z83.11.
(6) Gas-wood-fired cooking appliances should be listed and labeled in accordance with ANSI Z83.11, ANSI/UL 737, and/or UL Subject 2162, depending on exact appliance type.

[**96:** A.12.1.1]

50.6.1.2 Installation.

50.6.1.2.1* All listed appliances shall be installed in accordance with the terms of their listings and the manufacturer's instructions. [**96:**12.1.2.1]

A.50.6.1.2.1 Gas-fueled appliances should be installed to the requirements of NFPA 54 or NFPA 58. [**96:**A.12.1.2.1]

50.6.1.2.1.1 Solid fuel used for flavoring within a gas-operated appliance shall be in a solid fuel holder (smoker box) that is listed with the equipment. [**96:**12.1.2.1.1]

50.6.1.2.2* Cooking appliances requiring protection shall not be moved, modified, or rearranged without prior re-evaluation of the fire-extinguishing system by the system installer or servicing agent, unless otherwise allowed by the design of the fire-extinguishing system. [**96:**12.1.2.2]

A.50.6.1.2.2 The effectiveness of an automatic extinguishing system is affected by the placement of the nozzles. For this reason, it is essential that cooking appliances be situated in the area in which they were when the extinguishing equipment was designed and installed. If an appliance is moved from under the equipment for cleaning or any other reason, it should be returned to its original position prior to initiation of a cooking operation. [**96:**A.12.1.2.2]

When appliances are on wheels or casters for ease of cleaning, it is important that the appliance be placed in its design position to ensure that the fire-extinguishing system will be effective. An approved method should ensure that the appliance is returned to its appropriate position before cooking takes place. Channels, markings, or other approved methods assist in ensuring proper placement. [**96:**A.12.1.2.2]

50.6.1.2.2.1 A solid fuel holder shall not be added to an existing appliance until the fire-extinguishing system has been evaluated by the fire-extinguishing system service provider. [**96:**12.1.2.2.1]

Solid fuel used for flavoring can be used only in solid fuel holders within gas-operated appliances where the solid fuel holder is listed with the appliance. Where solid fuel holders are added to existing appliances, the existing fire-extinguishing system should be evaluated to determine if an upgrade is needed.

50.6.1.2.3 The fire-extinguishing system shall not require re-evaluation where the cooking appliances are moved for the purposes of maintenance and cleaning, provided the appliances are returned to approved design location prior to cooking operations, and any disconnected fire-extinguishing system nozzles attached to the appliances are reconnected in accordance with the manufacturer's listed design manual. [**96:**12.1.2.3]

In most cases, maintenance and cleaning can be effectively conducted without moving the cooking appliances. In some cases, where the cooking appliance does need to be moved, doing so without disconnecting any of the fire-extinguishing system nozzles might be possible.

50.6.1.2.3.1 An approved method shall be provided that will ensure that the appliance is returned to an approved design location. [**96:**12.1.2.3.1]

50.6.1.2.4 All deep-fat fryers shall be installed with at least a 16 in. (406 mm) space between the fryer and surface flames from adjacent cooking equipment. [**96:**12.1.2.4]

It is important to note that a deep-fat fryer located within 16 in. (406 mm) of another cooking appliance is not necessarily in violation of the requirement of 50.6.1.2.4. The requirement specifically addresses the distance between a deep-fat fryer and the surface flames of adjacent cooking appliances. Additionally, an electric cooking appliance typically does not have a flame.

Exhibit 50.17 shows a situation in which the fryer is located within 16 in. (406 mm) of the other cooking equipment. However, because the other cooking equipment is electric and does not produce a flame, this separation requirement does not apply.

50.6.1.2.5 Where a steel or tempered glass baffle plate is installed at a minimum 8 in. (203 mm) in height between the fryer and surface flames of the adjacent appliance, the requirement for a 16 in. (406 mm) space shall not apply. [**96:**12.1.2.5]

An 8 in. (203 mm) vertical barrier in effect creates 16 in. (406 mm) of travel [8 in. (203 mm) up, 8 in. (203 mm) down] between the deep-fat fryer and the flames of the adjacent appliance. Exhibit 50.18 shows a baffle plate that meets the separation requirement of 50.6.1.2.5.

Exhibit 50.17

Example of a situation in which separation is not required.

Exhibit 50.18

Example of a baffle plate providing separation between a fryer and an adjacent appliance that produces surface flames.

50.6.1.2.5.1 If the fryer and the surface flames are at different horizontal planes, the minimum height of 8 in. (203 mm) shall be measured from the higher of the two. [**96:**12.1.2.5.1]

If the vertical barrier were to be placed 8 in. (203 mm) above the lower of the two appliances, a situation in which a path of less than 16 in. (406 mm) between the deep-fat fryer and the flames of the adjacent appliance could exist. Therefore, where a vertical barrier method is utilized, it should be arranged to be at least 8 in. (203 mm) above the higher of the two appliances.

50.6.2 Operating Controls. Deep-fat fryers shall be equipped with a separate high-limit control in addition to the adjustable operating control (thermostat) to shut off fuel or energy when the fat temperature reaches 475°F (246°C) at 1 in. (25.4 mm) below the surface. [**96:**12.2]

A separate high-limit control has been required on all gas and electric fryers for many years. The requirement of 50.6.2 states that the separate high-limit control must operate a gas valve or electrical contactor that is separate from that operated by the normal operating thermostat. This arrangement ensures that, if the thermostat or its valve or contactor fails, the high-limit control will close the second valve or open the second contactor to shut off the fuel. Although it would be beneficial, this high-limit control is not required to have a manual reset.

50.6.3 Commercial Kitchen Cooking Oil Storage Tank Systems. Commercial kitchen cooking oil storage tank systems shall comply with 66.19.7.

Cooking oil storage tank systems fall under the jurisdiction of NFPA 30, *Flammable and Combustible Liquids Code*. Additional commentary regarding these types of systems can be found after 66.19.7.

N 50.7 Mobile and Temporary Cooking Operations

Recent incidents involving mobile and temporary cooking operations have created an awareness of the lack of minimum fire safety requirements for the growing number of these operations in jurisdictions throughout the world:

New York, NY

On April 11, 2011, a food truck collided with another vehicle on a highway in NYC. The accident caused the truck to burst into flames, and one of the propane tanks exploded. It was later found that the driver was carrying twice the maximum limit of propane (limit of 2 tanks, driver had 4) when he crashed into another car. The accident caused injuries to two workers aboard the food truck.

Toronto, Ontario

On August 24, 2012, at around 4 a.m., an explosion destroyed a food truck at the Canadian National Exhibition grounds. The explosion caused debris to be scattered throughout the parking lot where it was located. Fortunately, the explosion happened at a time of day when no one was in the area, and no injuries occurred. It is expected that the cause of the explosion, which was felt by police officers over a mile away, was a propane leak.

Philadelphia, PA

On July 1, 2014, an explosion involving a food truck resulted in 13 injuries, including the deaths of the mother and daughter operating the food truck. The truck was equipped with two 100-pound propane tanks. Investigators believe the cause of the problem was a rupture of the entire tank. The age of the tank could have contributed to this failure. The tragedy captured the world's attention, because the explosion was captured on video by a nearby surveillance camera, revealing how dangerous propane systems can be if not properly inspected and maintained.

Denver, CO

Two food trucks were damaged by a small propane explosion on September 12, 2014. An employee was switching out a propane tank when a leak that occurred during the refilling was ignited and caused a small explosion. One employee suffered facial burns, but no other injuries were reported.

Indianapolis, IN

On June 20, 2015, four people were injured when a fire destroyed a food truck in a parking lot. Two of those injured were employees of the food truck, who sustained serious burns. An investigation determined that the fire occurred when employees were trying to refuel the generator. Fumes from the gas hit a nearby open flame from a propane grill that was being used while the generator was being refueled.

Washington D.C

On November 16, 2016, a fire occurred on a food truck located on the George Washington University campus. Three employees were taken to the hospital with burns. The fire caused severe damage inside the food truck, which turned out to be a converted school bus. It was later determined that the cause of the fire was an employee refueling a gas generator while the truck engine was on and while food was being served. The fire started outside the truck and spread to the inside.

Portland, OR

On October 19, 2017, a fire and explosion occurred at a food cart pod in downtown Portland. As a result of the fire, two carts were destroyed and many cars in the parking lot nearby were damaged. A food cart employee was refueling a hot generator that was being used for power. Some of the fuel spilled and fumes were blown into an ignition source. Two additional propane tanks exploded in the fire. No injuries were reported.

It is important to note that there have been several other incidents involving food truck fires and explosions that have not been reported as such because these incidents are coded either as "Restaurant Fires" or "Vehicle Fires" in the National Fire Incident Reporting System (NFIRS).

It was the incident in Philadelphia that caused the International Fire Marshals Association (IFMA) to assemble a task group to develop minimum fire safety requirements for inclusion in NFPA 1 and NFPA 96. Section 50.7 is new to the 2017 edition of this *Code* and is based on the revisions recommended by IFMA as well as other contributions from the Fire Code Technical Committee made throughout the revision cycle.

Exhibit 50.19

Food truck. (Thinkstock)

To support the provisions of Section 50.7, a definition of *mobile or temporary cooking* was added to Chapter 3. It is defined in 3.3.187 as "any cooking apparatus or equipment operated on a one-time basis, interim basis, or for less than 90 days in the same location, other than at a fixed location, building, or structure that has been inspected and permitted under another section of this *Code*, regulation, or statute." Mobile or temporary cooking can include self-propelled trucks and vehicles; trailered units; push carts; equipment located under cover of awnings, canopies, or pop-up tents; or other structures for which a building permit has not been issued. The provisions of Section 50.7 are applicable not only to food trucks (mobile cooking operations) but also to stationary cooking operations that are temporary. Exhibit 50.19 shows an example of a food truck.

The information shown in Exhibit 50.20 is provided to help advance the safety of mobile and temporary cooking operations and is not intended to be a comprehensive list of requirements. Exhibit 50.20 and its accompanying text are included here as a useful starting point and quick reference tool when applying the provisions for mobile cooking requirements to food trucks. This information should not replace a full fire safety analysis. Users should check with their local jurisdiction for specific requirements. For more information, go to nfpa.org/foodtrucksafety.

N **50.7.1 General.**

N **50.7.1.1** Mobile and temporary cooking operations shall comply with 50.7.1 and the applicable section for the type of cooking performed.

N **50.7.1.2** Where required by the AHJ, permits shall be required for the location, design, construction, and operation of mobile and temporary cooking operations.

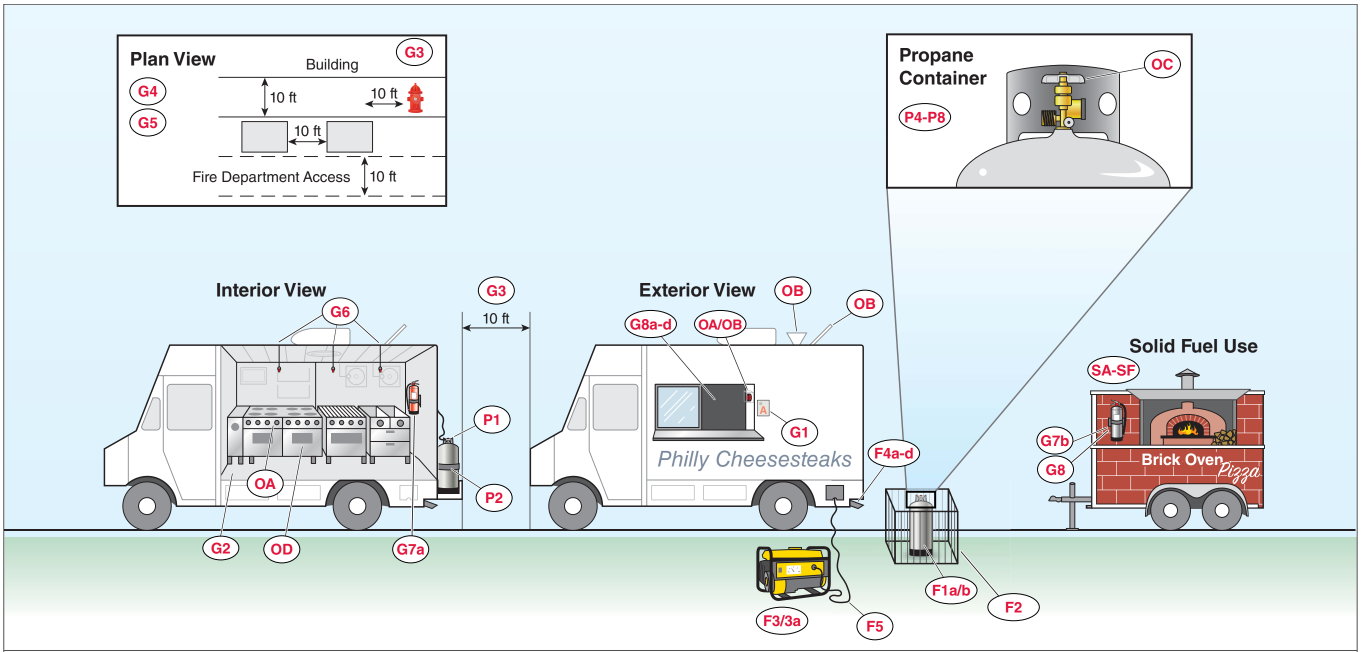
See 1.12.8 and Table 1.12.8(a) for permit requirements. Permits are required to conduct mobile cooking operations.

N **50.7.1.3** Wheel chocks shall be used to prevent mobile and temporary cooking units from moving.

N **50.7.1.4 Portable Fire Extinguishers.**

N **50.7.1.4.1** Portable fire extinguishers shall be provided per NFPA 96 for cooking operations.

Exhibit 50.20



NFPA code references are provided at the end of each item. The red keys correspond to the NFPA food truck safety diagram. For more detailed information, see Annex B in NFPA 96.

General Safety Checklist

- ❑ Obtain license or permits from the local authorities. [**1:**1.12.8(a)] **G1**
- ❑ Ensure there is no public seating within the mobile food truck. **G2**
- ❑ Check that there is a clearance of at least 10 ft away from buildings, structures, vehicles, and any combustible materials. [**96:**7.8.2; **96:**7.8.3 for carnivals only] **G3**
- ❑ Verify fire department vehicular access is provided for fire lanes and access roads. [**1:**18.2.4] **G4**
- ❑ Ensure clearance is provided for the fire department to access fire hydrants and access fire department connections. [**1:**13.1.3; **1:**13.1.4; **1:**13.1.5] **G5**
- ❑ Check that appliances using combustible media are protected by an approved fire extinguishing system. [**96:**10.1.2] **G6**
- ❑ Verify portable fire extinguishers have been selected and installed in kitchen cooking areas in accordance with NFPA 10. [**96:**10.9.3] **G7a**
- ❑ Where solid fuel cooking appliance produce grease-laden vapors, make sure the appliances are protected by listed fire-extinguishing equipment. [**96:**14.7.1] **G7b**
- ❑ Ensure that workers are trained in the following: [**96:**B.15.1]: **G8**
  - ❑ Proper use of portable fire extinguishers and extinguishing systems [**10:**1.2] **G8a**
  - ❑ Proper method of shutting off fuel sources [**96:**10.4.1] **G8b**
  - ❑ Proper procedure for notifying the local fire department [**1:**10.14.9 for carnivals only] **G8c**
  - ❑ Proper procedure for how to perform simple leak test on gas connections [**58:**6.16, **58:**6.17] **G8d**

Fuel & Power Sources Checklist

- ❑ Verify that fuel tanks are filled to the capacity needed for uninterrupted operation during normal operating hours. [**1:**10.14.10.1 for carnivals only] **F1a**
- ❑ Ensure that refueling is conducted only during non-operating hours. [**96:**B.18.3] **F1b**
- ❑ Check that any engine-driven source of power is separated from the public by barriers, such as physical guards, fencing, or enclosures. [**96:**B.16.2.2] **F2**
- ❑ Ensure that any engine-driven source of power is shut down prior to refueling from a portable container. [**1:**11.7.2.1.2] **F3**
- ❑ Check that surfaces of engine-driven source of power are cool to the touch prior to refueling from a portable container. **F3a**
- ❑ Make sure that exhaust from engine-driven source of power complies with the following: **F4**
  - ❑ At least 10 ft in all directions from openings and air intakes [**96:**B.13] **F4a**
  - ❑ At least 10 ft from every means of egress [**96:**B.13] **F4b**
  - ❑ Directed away from all buildings [**1:**11.7.2.2] **F4c**
  - ❑ Directed away from all other cooking vehicles and operations [**1:**11.7.2.2] **F4d**
- ❑ Ensure that all electrical appliances, fixtures, equipment, and wiring complies with the NFPA 70®. [**96:**B.18] **F5**

NOTE: This information is provided to help advance safety of mobile and temporary cooking operations. It is not intended to be a comprehensive list of requirements for mobile and temporary cooking operations. Check with the local jurisdiction for specific requirements. This safety sheet does not represent the official position of the NFPA or its Technical Committees. The NFPA disclaims liability for any personal injury, property, or other damages of any nature whatsoever resulting from the use of this information. For more information, go to nfpa.org/foodtrucksafety.

Propane System Integrity Checklist

- ❑ Check that the main shutoff valve on all gas containers is readily accessible. [**58:**6.26.4.1(3)] **P1**
- ❑ Ensure that portable gas containers are in the upright position and secured to prevent tipping over. [**58:**6.26.3.4] **P2**
- ❑ Inspect gas systems prior to each use. [**96:**B.19.2.3] **P3**
- ❑ Perform leak testing on all new gas connections of the gas system. [**58:**6.16; **58:**6.17] **P4**
- ❑ Perform leak testing on all gas connections affected by replacement of an exchangeable container. [**58:**6.16; **58:**6.17] **P5**
- ❑ Document leak testing and make documentation available for review by the authorized official. [**58:**6.26.5.1(M)] **P6**
- ❑ Ensure that on gas system piping, a flexible connector is installed between the regulator outlet and the fixed piping system. [**58:**6.26.5.1(B)] **P7**
- ❑ Where a gas detection system is installed, ensure that it has been tested in accordance with the manufacturer's instructions. [**96:**B.19.2.1] **P8**

Operational Safety Checklist

- ❑ Do not leave cooking equipment unattended while it is still hot. (This is the leading cause of home structure fires and home fire injuries.) **OA**
- ❑ Operate cooking equipment only when all windows, service hatches, and ventilation sources are fully opened. [**96:**14.2.2; **96:**14.2.3] **OB**
- ❑ Close gas supply piping valves and gas container valves when equipment is not in use. [**58:**6.26.8.3] **OC**
- ❑ Keep cooking equipment, including the cooking ventilation system, clean by regularly removing grease. [**96:**11.4] **OD**

Solid Fuel Safety Checklist (Where Wood, Charcoal, or Other Solid Fuel Is Used)

- ❑ Fuel is not stored above any heat-producing appliance or vent. [**96:**14.9.2.2] **SA**
- ❑ Fuel is not stored closer than 3 ft to any cooking appliance. [**96:**14.9.2.2] **SB**
- ❑ Fuel is not stored near any combustible flammable liquids, ignition sources, chemicals, and food supplies and packaged goods. [**96:**14.9.2.7] **SC**
- ❑ Fuel is not stored in the path of the ash removal or near removed ashes. [**96:**14.9.2.4] **SD**
- ❑ Ash, cinders, and other fire debris should be removed from the firebox at regular intervals and at least once a day. [**96:**14.9.3.6.1] **SE**
- ❑ Removed ashes, cinders, and other removed fire debris should be placed in a closed, metal container located at least 3 ft from any cooking appliance. [**96:**14.9.3.8] **SF**

NFPA Resources

NFPA 1, *Fire Code*, 2015 Edition
NFPA 1 Fire Code Handbook, 2015 Edition
NFPA 58, *Liquefied Petroleum Gas Code*, 2017 Edition
LP-Gas Code Handbook, 2017 Edition
NFPA 70®, *National Electrical Code*®, 2017 Edition
National Electrical Code® Handbook, 2017 Edition
NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2017 Edition
NFPA 96: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations Handbook, 2017 Edition

Food truck safety requirements.

N **50.7.1.4.2** A minimum of one 2A:10BC portable fire extinguisher shall be provided when a generator or other fuel fired appliance is used.

N **50.7.1.4.3** When wood or charcoal is used, a minimum of one 2A portable fire extinguisher or an approved hose line shall be provided.

N **50.7.1.5 Separation.** Mobile or temporary cooking operations shall be separated from buildings or structures, combustible materials, vehicles, and other cooking operations by a minimum of 10 ft (3 m).

This paragraph requires food trucks and other mobile or temporary cooking operations to be separated not only from buildings or structures but also from other vehicles by a minimum of 10 ft (3 m). Events such as food truck "rodeos" or festivals often have 20 or more food trucks present. The AHJ would need to verify the arrangement of the food trucks to ensure that the 10 ft (3 m) separation is provided at all times. The separation reduces the likelihood that a fire event in one truck will impact other surrounding trucks. Where a fire does occur, the separation can slow the spread of the fire to adjacent trucks or cooking operations. Exhibit 50.21 shows food trucks that do not meet the 10 ft (3 m) separation requirement.

Exhibit 50.21

Food trucks without the minimum 10 ft (3 m) separation. (Thinkstock)

N **50.7.1.6 Tents.**

N **50.7.1.6.1** Mobile or temporary cooking shall not take place within tents occupied by the public.

N **50.7.1.6.2** Tents shall comply with Chapter 25.

N **50.7.1.6.3** Seating for the public shall not be located within any mobile or temporary cooking vehicle.

NFPA staff have been asked about food truck–type buses that have both cooking operations and seating in the same vehicle. These vehicles often are double decker buses with cooking on the first level and seating on the second level or a similar arrangement. However, such vehicles would not be in compliance with the provisions of 50.7.1.6.3, which does not permit a seating area within the vehicle (bus).

N **50.7.1.7 Fire Department Access.** Mobile or temporary cooking operations shall not block fire department access roads, fire lanes, fire hydrants, or other fire protection devices and equipment.

N **50.7.1.8 Communications.**

N **50.7.1.8.1** An approved method of communication to emergency personnel shall be accessible to all employees.

N **50.7.1.8.2** The address of the current operational location shall be posted and accessible to all employees.

Food trucks do not have a permanent address. Because they are mobile cooking operations, they are often moving around to a different location, perhaps multiple locations, each day. The provision of 50.7.1.8.2 ensures that a mobile food truck's current location is posted and available should an employee need to report the location to emergency personnel. Posting the location allows staff to identify quickly the truck's exact location so that the dispatch or response of the fire department is not delayed in the event of an emergency.

N **50.7.1.9 Training.**

N **50.7.1.9.1*** Prior to performing mobile or temporary cooking operations, workers shall be trained in emergency response procedures, including the following:

(1) Proper use of portable fire extinguishers and extinguishing systems
(2) Proper method of shutting off fuel sources
(3) Proper procedure for notifying the local fire department
(4) Proper refueling
(5) How to perform leak detection
(6) Fuel properties

N **A.50.7.1.9.1** An approved method of leak detection would include pressurizing the LP-Gas system with LP-Gas and utilizing a gas meter to detect the presence of LP-Gas around the tank, piping, and appliances.

Many of the incidents described in the commentary following Section 50.7 were related to refueling, fuel sources and ignition sources (fuel leaks), and improper use of equipment. The items listed in 50.7.1.9.1(1) through (6) ensure that workers are trained and understand the proper use and handling of equipment and fire protection systems. Proper training should alleviate some of the mistakes and accidents that have already been cited as causing serious injuries or fatalities.

N **50.7.1.9.2** Refresher training shall be provided every year.

N **50.7.1.9.3** Initial and refresher training shall be documented and made available to the AHJ on request.

N **50.7.1.10 Internal Combustion Power Sources.**

N **50.7.1.10.1** Electric generator and internal combustion power sources used for mobile or temporary cooking shall comply with 11.7.2.

N **50.7.1.10.2** Portable generators shall be positioned so that the exhaust is at least 5 ft (1.5 m) in any direction away from any openings, air intakes, means of egress, or from any building, structure, or vehicle.

N **50.7.1.10.3** Electrical appliances, fixtures, equipment, or wiring other than low-voltage and automotive vehicle circuits or extensions thereof, installed within or on vehicles, shall comply with *NFPA 70*.

N **50.7.1.11 Charcoal and Wood Burning.**

N **50.7.1.11.1** Mobile or temporary cooking operations that use wood or charcoal shall comply with Section 14.9 of NFPA 96.

Section 14.9 of NFPA 96 addresses the minimum safety requirements for fuel storage, handling, and ash removal for solid fuel cooking.

N **50.7.1.11.2** An approved carbon monoxide detector shall be installed where mobile cooking operations are performed in an enclosed area.

N **50.7.1.12** Flammable liquids shall not be stored inside mobile cooking vehicles or in temporary cooking areas unless stored in accordance with NFPA 30.

N **50.7.2 Mobile Cooking.**

N **50.7.2.1 General.** Mobile cooking operations and equipment shall comply with 50.7.1, 50.7.2, and NFPA 96.

N **50.7.2.2 LP-Gas Systems.**

N **50.7.2.2.1** Cylinders shall be secured in an upright position to prevent tipping over.

Cylinders that are not secure, especially during transit, are at risk for tipping over.

N **50.7.2.2.2** Gas systems on mobile cooking vehicles shall comply with NFPA 58 and this section.

N **50.7.2.2.3** Where a shutoff valve is provided, it shall be readily accessible and identified with a sign permanently affixed to the vehicle in reflective decal material with letters a minimum of 2 in. (50 mm) high.

N **50.7.2.3* Leak Detection.**

N **A.50.7.2.3** The certification documentation might consist of the following:

(1) The name of the certification company
(2) The license number, certificate of fitness number or other applicable identifying number that demonstrates the certification company is approved to install, inspect, and maintain LP-Gas systems
(3) The corporate name of the mobile food service business
(4) The identifying name on the side of the mobile food vehicle
(5) Date of inspection
(6) Vehicle tag number and VIN 7
(7) A signed statement by the agent for the certification company that reads: The LP-Gas system has been inspected for compliance with the current edition of NFPA 58 and found to be in compliance with the provisions of the code. In addition, leak detection has been conducted on the LP-Gas system piping and the piping has been found to maintain integrity.

N **50.7.2.3.1** Gas systems shall be inspected prior to each use by a worker trained in accordance with 50.7.1.8.

N **50.7.2.3.2** Leak detection testing shall be documented and made available to the AHJ on request in accordance with 50.7.2.3.4.

N **50.7.2.3.3** Where a gas detection system has been installed, it shall be tested every month.

N **50.7.2.3.4*** LP-Gas systems on mobile food service vehicles shall be certified for compliance with NFPA 58 by an approved company with expertise in the installation, inspection, and maintenance of LP-Gas systems.

N **A.50.7.2.3.4** The certification documentation might consist of the following:

(1) The name of the certification company
(2) The license number, certificate of fitness number or other applicable identifying number that demonstrates the certification company is approved to install, inspect, and maintain LP-Gas systems
(3) The corporate name of the mobile food service business
(4) The identifying name on the side of the mobile food vehicle
(5) Date of inspection
(6) Vehicle tag number and VIN
(7) A signed statement by the agent for the certification company that reads: The LP-Gas system has been inspected for compliance with the current edition of NFPA 58 and found to be in compliance with the provisions of the code. In addition, leak detection has been conducted on the LP-Gas system piping and the piping has been found to maintain integrity.

N **50.7.2.3.4.1** The certification shall be good for one year.

N **50.7.2.3.4.2** Recertification shall occur every time an appliance is replaced or added and if a piping connection is modified in anyway.

N **50.7.2.3.4.2.1** A change in cylinder shall not be considered a piping connection modification.

N **50.7.2.3.4.3** Mobile food service vehicles equipped with an LP-Gas system, but without a current approved LP-Gas certification, shall not be permitted to be operated for mobile food service.

N **50.7.2.4 LP-Gas Systems on Vehicles (Other than Engine Fuel Systems).**

Paragraph 50.7.2.4 and its subparagraphs cover all LP-Gas systems mounted on vehicles, other than engine fuel systems, with the following exceptions:

- Manufactured housing (mobile homes)
- Recreational vehicles (RVs) (The provisions of NFPA 58, *Liquefied Petroleum Gas Code*, are used extensively for standards on LP-Gas systems in NFPA 1192, *Standard on Recreational Vehicles*.)
- Cargo tank vehicles (covered in Chapter 9 of NFPA 58)
- Engine fuel systems (covered in Chapter 11 of NFPA 58)

N **50.7.2.4.1* Application.** Section 50.7.2.4 shall apply to the following:

(1) Nonengine fuel systems on all vehicles
(2) Installations served by exchangeable (removable) cylinder systems and by permanently mounted containers.

[**58:**6.26.1]

N **A.50.7.2.4.1** Typical nonengine fuel systems include those on commercial, industrial, construction, and public service vehicles such as trucks, semitrailers, trailers, portable tar kettles, road surface heating equipment, mobile laboratories, clinics, and mobile cooking units (such as catering and canteen vehicles). [**58:**A.6.26.1]

A variety of LP-Gas systems are installed on vehicles where the gas is not used as a vehicle engine fuel. Examples include the following:

- Vehicles (usually trailers) with mounted tar kettles used in the construction industry for heating tar for roofing
- Food-warming delivery vehicles, such as pretzel or hot dog carts and larger hot dog or lunch wagons
- Service vehicles that need a source of heated water, such as those used by carpet cleaning services
- Food trucks that use the propane to prepare food

N **50.7.2.4.2 Nonapplication.** Section 50.7.2.4 shall not apply to the following:

(1) Systems installed on mobile homes
(2) Systems installed on recreational vehicles
(3) Cargo tank vehicles, including trailers and semitrailers, and similar units used to transport LP-Gas as cargo, which are covered by Chapter 9 of NFPA 58.
(4) LP-Gas engine fuel systems on the vehicles, which are covered by Chapter 11 of NFPA 58.

[**58:**6.26.2]

N **50.7.2.4.3 Container Installation Requirements.**

N **50.7.2.4.3.1** Containers shall comply with 50.7.2.4.3.1.1 through 50.7.2.4.3.1.5.

N **50.7.2.4.3.1.1** ASME mobile containers shall be in accordance with one of the following:

(1) A MAWP of 312 psig (2.2 MPag) or higher where installed in enclosed spaces of vehicles
(2) A MAWP of 312 psig (2.2 MPag) or higher where installed on passenger vehicles
(3) A MAWP of 250 psig (1.7 MPag) or higher for containers where installed on the exterior of nonpassenger vehicles

N **50.7.2.4.3.1.2** LP-Gas fuel containers used on passenger-carrying vehicles shall not exceed 200 gal (0.8 m^3) aggregate water capacity.

N **50.7.2.4.3.1.3** The capacity of individual LP-Gas containers on highway nonpassenger vehicles shall 1000 gal (3.8 m^3) or in accordance with U.S. Department of Transportation regulations.

N **50.7.2.4.3.1.4** The capacity of cargo tank motor vehicles shall not be limited by NFPA 58.

N **50.7.2.4.3.1.5** Containers designed for stationary service only and not in compliance with the container appurtenance protection requirements of 5.2.6 of NFPA 58 shall not be used. [**58:**6.26.3]

N **50.7.2.4.3.2** ASME containers and cylinders used for the purposes covered by 50.7.2.4 shall not be installed, transported, or stored (even temporarily) inside any vehicle covered by 50.7.2.4, except for ASME containers installed in accordance with 50.7.2.4.3.4.9, Chapter 9, or DOT regulations. [**58:**6.26.3.2]

N **50.7.2.4.3.3** The LP-Gas supply system, including the containers, shall be installed either on the outside of the vehicle or in a recess or cabinet vaportight to the inside of the vehicle but accessible from and vented to the outside, with the vents located near the top and bottom of the enclosure and 3 ft (1 m) horizontally away from any opening into the vehicle below the level of the vents. [**58:**6.26.3.3]

N **50.7.2.4.3.4** Containers shall be mounted securely on the vehicle or within the enclosing recess or cabinet. [**58:**6.26.3.4]

N **50.7.2.4.3.4.1** Containers shall be installed with road clearance in accordance with 11.8.3 of NFPA 58. [**58:**6.26.3.4(A)]

N **50.7.2.4.3.4.2** Fuel containers shall be mounted to prevent jarring loose and slipping or rotating, and the fastenings shall be designed and constructed to withstand, without permanent visible deformation, static loading in any direction equal to four times the weight of the container filled with fuel. [**58:**6.26.3.4(B)]

N **50.7.2.4.3.4.3** Where containers are mounted within a vehicle housing, the securing of the housing to the vehicle shall comply with this provision. Any removable portions of the housing or cabinet shall be secured while in transit. [**58:**6.26.3.4(C)]

N **50.7.2.4.3.4.4** Field welding on containers shall be limited to attachments to nonpressure parts such as saddle plates, wear plates, or brackets applied by the container manufacturer. [**58:**6.26.3.4(D)]

N **50.7.2.4.3.4.5** All container valves, appurtenances, and connections shall be protected to prevent damage from accidental contact with stationary objects; from loose objects, stones, mud, or ice thrown up from the ground or floor; and from damage due to overturn or similar vehicular accident. [**58:**6.26.3.4(E)]

As with vehicle propulsion engine fuel containers, exterior containers and appurtenances must be protected against material thrown up from the road, as set forth in 50.7.2.4.3.4.5. Slush and other hazards thrown up from the road must not block the regulator vent, and splashguards or the practice of locating the regulator in a compartment can protect from these hazards. A blocked vent can lead to higher than normal pressures in the utilization system and can lead to pilot failure and improper appliance operation. Appurtenances on a container, particularly those mounted below the vehicle, should be installed so that they are accessible for maintenance and readily accessible if needed for normal operations such as operation of the fixed maximum liquid level gauge during filling.

N **50.7.2.4.3.4.6** Permanently mounted ASME containers shall be located on the vehicle to provide the protection specified in 50.7.2.4.3.4.5. [**58:**6.26.3.4(F)]

N **50.7.2.4.3.4.7** Cylinders shall have permanent protection for cylinder valves and connections. [**58:**6.26.3.4(G)]

N **50.7.2.4.3.4.8** Where cylinders are located on the outside of a vehicle, weather protection shall be provided. [**58:**6.26.3.4(H)]

N **50.7.2.4.3.4.9** Containers mounted on the interior of passenger-carrying vehicles shall be installed in compliance with Section 11.9 of NFPA 58. Pressure relief valve installations for such containers shall comply with 11.8.5 of NFPA 58. [**58:**6.26.3.4(I)]

The container mounting arrangement must be strong enough to remain intact and to protect the container and its appurtenances and connections from damage caused by collisions, road debris, and weather. These provisions do not apply to engine fuel containers, as stated by the reference to Chapter 11 of NFPA 58.

N **50.7.2.4.4 Installation of Container Appurtenances.**

N **50.7.2.4.4.1** Container appurtenances shall be installed in accordance with the following:

(1) Pressure relief valve installation on ASME containers installed in the interior of vehicles complying with Section 11.9 of NFPA 58 shall comply with 11.8.5 of NFPA 58.
(2) Pressure relief valve installations on ASME containers installed on the outside of vehicles shall comply with 11.8.5 of NFPA 58 and 50.7.2.4.3.3.
(3) Main shutoff valves on containers for liquid and vapor shall be readily accessible.
(4) Cylinders shall be designed to be filled in either the vertical or horizontal position, or if they are the universal type, they are permitted to be filled in either position.
(5) All container inlets, outlets, or valves installed in container inlets or outlets, except pressure relief devices and gauging devices, shall be labeled to designate whether they communicate with the vapor or liquid space.
(6) Containers from which only vapor is to be withdrawn shall be installed and equipped with connections to minimize the possibility of the accidental withdrawal of liquid.

[**58:**6.26.4.1]

N **50.7.2.4.4.2** Regulators shall be installed in accordance with 6.10.2 of NFPA 58 and 50.7.2.4.4.2.1 through 50.7.2.4.4.2.5. [**58:**6.26.4.2]

N **50.7.2.4.4.2.1** Regulators shall be installed with the pressure relief vent opening pointing vertically downward to allow for drainage of moisture collected on the diaphragm of the regulator. [**58:**6.26.4.2(A)]

N **50.7.2.4.4.2.2** Regulators not installed in compartments shall be equipped with a durable cover designed to protect the regulator vent opening from sleet, snow, freezing rain, ice, mud, and wheel spray. [**58:**6.26.4.2(B)]

N **50.7.2.4.4.2.3** If vehicle-mounted regulators are installed at or below the floor level, they shall be installed in a compartment that provides protection against the weather and wheel spray. [**58:**6.26.4.2(C)]

N **50.7.2.4.4.2.4** Regulator compartments shall comply with the following:

(1) The compartment shall be of sufficient size to allow tool operation for connection to and replacement of the regulator(s).
(2) The compartment shall be vaportight to the interior of the vehicle.
(3) The compartment shall have a 1 in.^{2} (650 mm^2) minimum vent opening to the exterior located within 1 in. (25 mm) of the bottom of the compartment.
(4) The compartment shall not contain flame or spark-producing equipment.

[**58:**6.26.4.2(D)]

N **50.7.2.4.4.2.5** A regulator vent outlet shall be at least 2 in. (51 mm) above the compartment vent opening. [**58:**6.26.4.2(E)]

Two-stage pressure regulation must be used in all systems covered in Section 6.26 of NFPA 58. Multiple regulators provide several safety features. Regulators (and cylinders) used on vehicles are usually installed in a compartment for security and to comply with the requirement for protection of regulators from sleet, snow, freezing rain, and so forth. The enclosure cannot contain electrical devices that are a source of ignition and must be ventilated to allow any released propane to disperse. Louvers in the compartment or its door are typically used to provide this required ventilation. Louvers must communicate with the outdoors and not to the interior of the vehicle.

N **50.7.2.4.5 Piping.**

N **50.7.2.4.5.1** Piping shall be installed in accordance with 6.11.3 of NFPA 58 and 50.7.2.4.5.1.1 through 50.7.2.4.5.1.13. [**58:**6.26.5.1]

The main lines and branch connections must be kept outside the vehicle so that, if leakage occurs, gas will not accumulate in the vehicle. In order to avoid compounding problems in the event of collisions, overturns, and disconnection of vehicles, fuel lines cannot be connected between two vehicular units. These types of risks are regarded as greater than the corresponding risks in a system located completely on one vehicle.

N **50.7.2.4.5.1.1** Steel tubing shall have a minimum wall thickness of 0.049 in. (1.2 mm). [**58:**6.26.5.1(A)]

Steel tubing in vehicular installations has been specified as having a minimum 0.049 in. (1.2 mm) wall thickness to provide strength against vibration and also to provide an additional tolerance for corrosion.

N **50.7.2.4.5.1.2** A flexible connector shall be installed between the regulator outlet and the fixed piping system to protect against expansion, contraction, jarring, and vibration strains. [**58:**6.26.5.1(B)]

N **50.7.2.4.5.1.3** Flexibility shall be provided in the piping between a cylinder and the gas piping system or regulator. [**58:**6.26.5.1(C)]

N **50.7.2.4.5.1.4** Flexible connectors shall be installed in accordance with 6.11.6 of NFPA 58. [**58:**6.26.5.1(D)]

N **50.7.2.4.5.1.5** Flexible connectors longer than the length allowed in NFPA 58, or fuel lines that incorporate hose, shall be used only where approved. [**58:**6.26.5.1(E)]

N **50.7.2.4.5.1.6** The fixed piping system shall be designed, installed, supported, and secured to minimize the possibility of damage due to vibration, strains, or wear and to preclude any loosening while in transit. [**58:**6.26.5.1(F)]

N **50.7.2.4.5.1.7** Piping shall be installed in a protected location. [**58:**6.26.5.1(F)]

N **50.7.2.4.5.1.8** Where piping is installed outside the vehicle, it shall be installed as follows:

(1) Piping shall be under the vehicle and below any insulation or false bottom.
(2) Fastening or other protection shall be installed to prevent damage due to vibration or abrasion.
(3) At each point where piping passes through sheet metal or a structural member, a rubber grommet or equivalent protection shall be installed to prevent chafing.

[**58:**6.26.5.1(H)]

N **50.7.2.4.5.1.9** Gas piping shall be installed to enter the vehicle through the floor directly beneath or adjacent to the appliance served. [**58:**6.26.5.1(I)]

N **50.7.2.4.5.1.10** If a branch line is installed, the tee connection shall be located in the main gas line under the floor and outside the vehicle. [**58:**6.26.5.1(J)]

N **50.7.2.4.5.1.11** Exposed parts of the fixed piping system either shall be of corrosion-resistant material or shall be coated or protected to minimize exterior corrosion. [**58:**6.26.5.1(K)]

N **50.7.2.4.5.1.12** Hydrostatic relief valves shall be installed in isolated sections of liquid piping as provided in Section 6.15 of NFPA 58. [**58:**6.26.5.1(L)]

N **50.7.2.4.5.1.13** Piping systems, including hose, shall be pressure tested and proven free of leaks in accordance with Section 6.16 of NFPA 58. [**58:**6.26.5.1(M)]

N **50.7.2.4.5.2** There shall be no fuel connection between a tractor and trailer or other vehicle units. [**58:**6.26.5.2]

N **50.7.2.4.6 Equipment Installation.** Equipment shall be installed in accordance with Section 6.20 of NFPA 58, 50.7.2.4.6.1, and 50.7.2.4.6.2. [**58:**6.26.6]

N **50.7.2.4.6.1** Installation shall be made in accordance with the manufacturer's recommendations and, in the case of approved equipment, as provided in the approval. [**58:**6.26.6.1]

N **50.7.2.4.6.2** Equipment installed on vehicles shall be protected against vehicular damage as provided for container appurtenances and connections in 50.7.2.4.3.4.5. [**58:**6.26.6.2]

N **50.7.2.4.7 Appliance Installation on Vehicles.**

N **50.7.2.4.7.1** Subsection 50.7.2.4.7 shall apply to the installation of all appliances on vehicles. It shall not apply to engines. [**58:**6.26.7.1]

N **50.7.2.4.7.2** All appliances covered by 50.7.2.4.7 installed on vehicles shall be approved. [**58:**6.26.7.2]

N **50.7.2.4.7.3** Where the device or appliance, such as a cargo heater or cooler, is designed to be in operation while the vehicle is in transit, means, such as an excess-flow valve, to stop the flow of gas in the event of a line break shall be installed. [**58:**6.26.7.3]

Appliances used in vehicles and the vibration that occurs while vehicles are in transit can result in fittings loosening or becoming disconnected. The requirement in 50.7.2.4.7.3 recognizes that possibility and requires a positive means of stopping the flow if fittings are disconnected. Excess-flow valves are given as an example of protection, but other types of protection can be used. Excess-flow valves will close only when the design flow is reached, and they might not operate in the event of a partial separation of a fitting. If the vehicle comes under U.S. Department of Transportation (DOT) regulations, reference should be made to the DOT requirements that may apply.

N **50.7.2.4.7.4** Gas-fired heating appliances shall be equipped with shutoffs in accordance with 5.23.7(A) of NFPA 58, except for portable heaters used with cylinders having a maximum water capacity of 2.7 lb (1.2 kg), portable torches, melting pots, and tar kettles. [**58:**6.26.7.4]

N **50.7.2.4.7.5** Gas-fired heating appliances, other than ranges and illuminating appliances installed on vehicles intended for human occupancy, shall be designed or installed to provide for a complete separation of the combustion system from the atmosphere inside the vehicle. [**58:**6.26.7.5]

The concept of isolating the combustion system of appliances, except ranges in vehicle interiors where passengers might be, is consistent with all other vehicle standards on this subject, including the standards for RVs. No portable or conventional room heaters should be used inside such vehicles. Isolation can be accomplished through the use of direct vent–type heaters and water heaters or through separation by installing the appliance in a compartment with provisions for outside air. The range is an attended appliance and need not be isolated, but it should never be used for comfort heating.

Although extensive requirements for the installation of appliances fueled by LP-Gas are included in NFPA 54, *National Fuel Gas Code*, that code is limited to appliances that are connected to a fixed building piping system. The appliances covered under NFPA 58 are those not normally connected to a fixed building system.

N **50.7.2.4.7.6*** Where unvented-type heaters that are designed to protect cargo are used on vehicles not intended for human occupancy, provisions shall be made to provide air from the outside for combustion and dispose of the products of combustion to the outside. [**58:**6.26.7.6]

N **A.50.7.2.4.7.6** Requirements for the design of containers are located in Section 5.2 [of NFPA 58]. Requirements for container appurtenances are located in Section 5.3 [of NFPA 58]. [**58:**A.6.26.7.6]

N **50.7.2.4.7.7** Appliances installed in the cargo space of a vehicle shall be readily accessible whether the vehicle is loaded or empty. [**58:**6.26.7.7]

N **50.7.2.4.7.8** Appliances shall be constructed or otherwise protected to minimize possible damage or impaired operation due to cargo shifting or handling. [**58:**6.26.7.8]

N **50.7.2.4.7.9** Appliances shall be located so that a fire at any appliance will not block egress of persons from the vehicle. [**58:**6.26.7.9]

N **50.7.2.4.7.10** A permanent caution plate shall be affixed to either the appliance or the vehicle outside of any enclosure, shall be adjacent to the container(s), and shall include the following instructions:

(1) Be sure all appliance valves are closed before opening container valve.
(2) Connections at the appliances, regulators, and containers shall be checked periodically for leaks with soapy water or its equivalent.
(3) Never use a match or flame to check for leaks.
(4) Container valves shall be closed when equipment is not in use.

[**58:**6.26.7.10]

N **50.7.2.4.7.11** Gas-fired heating appliances and water heaters shall be equipped with automatic devices designed to shut off the flow of gas to the main burner and the pilot in the event the pilot flame is extinguished. [**58:**6.26.7.11]

N **50.7.2.4.8 General Precautions.**

N **50.7.2.4.8.1** All fat fryers shall have a lid over the oil vat that can be secured to prevent the spillage of cooking oil during transit. This lid shall be secured at all times when the vehicle is in motion.

N **50.7.2.4.9 Parking, Servicing, and Repair.**

N **50.7.2.4.9.1** Where vehicles with LP-Gas fuel systems used for purposes other than propulsion are parked, serviced, or repaired inside buildings, the requirements of 50.7.2.4.9.2 through 50.7.2.4.9.4 shall apply. [**58:**6.26.8.1]

N **50.7.2.4.9.2** The fuel system shall be leak-free, and the container(s) shall not be filled beyond the limits specified in Chapter 7 of NFPA 58. [**58:**6.26.8.2]

N **50.7.2.4.9.3** The container shutoff valve shall be closed, except that the container shutoff valve shall not be required to be closed when fuel is required for test or repair. [**58:**6.26.8.3]

N **50.7.2.4.9.4** The vehicle shall not be parked near sources of heat, open flames, or similar sources of ignition, or near unventilated pits. [**58:**6.26.8.4]

N **50.7.2.4.9.5** Vehicles having containers with water capacities larger than 300 gal (1.1 m3) shall comply with the requirements of Section 9.7 of NFPA 58. [**58:**6.26.8.5]

N **50.7.2.4.10*** Containers shall be designed, fabricated, tested, and marked (or stamped) in accordance with the regulations of the U.S. Department of Transportation (DOT); Section VIII of the ASME code, "Rules for the Construction of Unfired Pressure Vessels"; or the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*, except for UG-125 through UG-136. [**58:**5.2.1.1]

The DOT has approved the use of composite cylinders only when fabricated under a DOT special permit. They have a 15-year service life and must be requalified every 5 years. These cylinders can be used for all applications not prohibited by NFPA 58, such as outdoor gas grills, industrial trucks, and other applications not located in buildings.

A.50.7.2.4.10 Prior to April 1, 1967, regulations of the U.S. Department of Transportation were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply and are available from the Canadian Transport Commission, Union Station, Ottawa, Canada. [**58:**A.5.2.1.1]

Construction of containers to the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases* has not been authorized after July 1, 1961. [**58:**A.5.2.1.1]

N **50.7.2.4.10.1** Used containers constructed to specifications of the Association of American Railroads shall not be installed. [**58:**5.2.1.1(A)]

N **50.7.2.4.10.2** Adherence to applicable ASME code case interpretations and addenda that have been adopted and published by ASME 180 calendar days prior to the effective date of NFPA 58 shall be considered as compliant with the ASME code. [**58:**5.2.1.1(B)]

N **50.7.2.4.10.3** Where containers fabricated to earlier editions of regulations, rules, or codes listed in 5.2.1.1 of NFPA 58, and of the Interstate Commerce Commission (ICC) *Rules for Construction of Unfired Pressure Vessels*, prior to April 1, 1967, are used, the requirements of Section 1.4 of NFPA 58 shall apply. [**58:**5.2.1.1(C)]

The intent and application of 50.7.2.4.10.3 is often misinterpreted with regard to containers that were built to the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases* (specifications U-200 and U-201) and pre-1949 editions of the ASME *Boiler and Pressure Vessel Code* (specifications U-68 and U-69). Because these ASME containers have a very long service life when properly maintained, many remain in use and are sometimes relocated and reinstalled. However, not all containers built to these older editions of the ASME Code can remain in use or relocated and reinstalled, regardless of their condition. The reinstallation of containers built to older editions of the code must be reviewed by the AHJ to determine if any current requirements meet a threshold for retroactivity.

N **50.7.2.4.10.4** DOT 4E specification (aluminum) cylinders and composite cylinders involved in a fire shall be removed from service. [**58:**5.2.1.1(D)]

N **50.7.2.4.11** After installation or modification, piping systems (including hose) shall be proven free of leaks by performing a pressure test at not less than the normal operating pressure. [**58:**6.16.1.1]

N **50.7.2.4.12 General Location of Cylinders.**

N **50.7.2.4.12.1** Cylinders in storage shall be located to minimize exposure to excessive temperature rises, physical damage, or tampering. [**58:**8.2.1.1]

Because of the smaller size of the cylinders covered in Chapter 8 of NFPA 58, the temperature of their contents tends to fluctuate more directly with ambient air temperatures or solar radiation than does the temperature of larger containers. These cylinders should not relieve LP-Gas through their pressure relief devices until the temperature of their contents exceeds 130°F (54°C), at which point the cylinder may become liquid full. These high temperatures could be reached in some extremely hot climates or in poorly located, poorly constructed, or unventilated storage locations.

In addition to temperature control, physical damage protection may be needed in storage locations. Certain facilities have considerable vehicular traffic — for example, forklift trucks — and require these precautions. Finally, tampering is a valid consideration. Although small portable cylinders, such as those used with grills, will not flow gas even if the valve is opened by hand, it is still important to provide protection from tampering, which could affect the safety devices.

N **50.7.2.4.12.2** Cylinders in storage having individual water capacity greater than 2.7 lb (1.1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] shall be positioned so that the pressure relief valve is in direct communication with the vapor space of the cylinder. [**58:**8.2.1.2]

The requirement that cylinders, other than very small cylinders, be stored so that the pressure relief valve is in the vapor space of the cylinder is an important safety concept that is repeated in several locations throughout NFPA 58. The requirement is important because the capacity of pressure relief valves is based on gas flow, not liquid flow. If the pressure in a cylinder were sufficiently high to cause the pressure relief valve to operate, and the pressure relief valve were in communication with the liquid space of the cylinder, the following might occur:

- It might take more time to reduce the pressure in the container, since liquid is more dense than gas and would therefore require a larger flow of liquid before resetting the valve.
- Liquid discharged from the cylinder will vaporize almost instantly, resulting in approximately 270 times as much vapor by volume as a gaseous release. If fire is the cause of the pressure relief valve operation, a liquid release will provide more fuel to the fire than a gaseous release.
- Liquid discharge will reduce the volume of liquid inside the container that would have contributed to the autorefrigeration reaction. Autorefrigeration occurs when the vapor pressure in the container decreases and causes the liquid to change phases. The liquid utilizes heat from the container as it changes phases, and the decrease in temperature of the container reduces the overall pressure in the container.

Cylinders less than 2.7 lb (1.1 kg) water capacity [about 1 lb (0.45 kg) of propane] are excluded from this requirement. Examples of such cylinders are those used for handheld soldering torches, portable stoves, camping equipment, refillable portable appliances such as cigarette lighters, and so forth. These small cylinders are normally stored in cardboard shipping containers, and the proper storage orientation should be indicated on the shipping container.

N **50.7.2.4.12.3** Cylinders stored in buildings in accordance with Section 8.3 of NFPA 58 shall not be located near exits, near stairways, or in areas normally used, or intended to be used, for the safe egress of occupants. [**58:**8.2.1.3]

N **50.7.2.4.12.4** If empty cylinders that have been in LP-Gas service are stored indoors, they shall be considered as full cylinders for the purposes of determining the maximum quantities of LP-Gas permitted by 8.3.1, 8.3.2.1, and 8.3.3.1 of NFPA 58. [**58:**8.2.1.4]

Once filled, an LP-Gas cylinder seldom becomes completely empty. At the very least, the cylinder will usually be full of vapor and may contain some liquid or a residue that could contain the flammable odorant. If empty cylinders were not counted as full cylinders, it would be impossible for an enforcing authority to determine whether the storage limits were being exceeded without weighing all the cylinders.

N **50.7.2.4.12.5** Cylinders shall not be stored on roofs. [**58:**8.2.1.5]

N **50.7.2.4.13 Protection of Valves on Cylinders in Storage.**

N **50.7.2.4.13.1** Cylinder valves shall be protected as required by 5.2.6.1 and 7.2.2.5 of NFPA 58. [**58:**8.2.2.1]

N **50.7.2.4.13.2** Screw-on-type caps or collars shall be in place on all cylinders stored, regardless of whether they are full, partially full, or empty, and cylinder outlet valves shall be closed. [**58:**8.2.2.2]

Protection for all cylinder valves is required by the DOT requirements for containers of hazardous materials. Smaller portable cylinders typically use a metal protective collar around the cylinder valve, while larger cylinders typically found in stationary service may have a screw-on cap or a dome cover.

N **50.7.2.4.13.3** Valve outlets on cylinders less than 108 lb (49 kg) water capacity [nominal 45 lb (20 kg) propane capacity] shall be plugged, capped, or sealed in accordance with 7.2.2.5 of NFPA 58. [**58:**8.2.2.3]

N **50.7.2.4.14 Transportation of Cylinders.**

N **50.7.2.4.14.1** Cylinders having an individual water capacity not exceeding 1000 lb (454 kg) [nominal 420 lb (191 kg) propane capacity], when filled with LP-Gas, shall be transported in accordance with the requirements of Section 9.3 of NFPA 58. [**58:**9.3.2.1]

The maximum size of an individual cylinder permitted under DOT regulations is 1000 lb (454 kg) water capacity [nominal 420 lb (191 kg) of propane]. Portable ASME containers, which generally serve the same purpose as DOT cylinders, may be encountered and are also limited to this size for transportation.

N **50.7.2.4.14.2** Cylinders shall be constructed as provided in Section 5.2 of NFPA 58 and equipped in accordance with Section 5.7 of NFPA 58 for transportation as cylinders. [**58:**9.3.2.2]

N **50.7.2.4.14.3** The quantity of LP-Gas in cylinders shall be in accordance with Chapter 7 of NFPA 58. [**58:**9.3.2.3]

N **50.7.2.4.14.4** Cylinder valves shall comply with the following:

(1) Valves of cylinders shall be protected in accordance with 5.2.6.1 of NFPA 58.
(2) Screw-on-type protecting caps or collars shall be secured in place.
(3) The provisions of 7.2.2.5 of NFPA 58 shall apply.
[**58:**9.3.2.4]

Refer to the commentary following 69.4.2.2.5 for the requirements referenced on cylinder valve plugs. The importance of providing protection for cylinder valves from damage cannot be overstated. A damaged or separated cylinder valve could result in an uncontrolled release of LP-Gas and perhaps even the propulsion of the cylinder itself.

N **50.7.2.4.14.5** The cargo space of the vehicle shall be isolated from the driver's compartment, the engine, and the engine's exhaust system. [**58:**9.3.2.5]

N **50.7.2.4.14.5.1** Open-bodied vehicles shall be considered to be in compliance with this provision. [**58:**9.3.2.5(A)]

N **50.7.2.4.14.5.2** Closed-bodied vehicles having separate cargo, driver, and engine compartments shall be considered to be in compliance with this provision. [**58:**9.3.2.5(B)]

N **50.7.2.4.14.5.3** Closed-bodied vehicles, such as passenger cars, vans, and station wagons, shall not be used for transporting more than 215 lb (98 kg) water capacity [nominal 90 lb (41 kg) propane capacity], but not more than 108 lb (49 kg) water capacity [nominal 45 lb (20 kg) propane capacity] per cylinder, unless the driver and engine compartments are separated from the cargo space by a vaportight partition that contains no means of access to the cargo space. [**58:**9.3.2.5(C)]

The transportation of privately owned cylinders in passenger automobiles is a safety concern that is addressed based on the vehicle type. The transportation of LP-Gas by private parties, where the transportation is not considered to be "in commerce" as defined by the DOT, is not regulated by the DOT, and therefore only the provisions of NFPA 58 apply. The provisions of Section 9.3 of NFPA 58 are applied in the following situations:

1. **Cylinder transported in an open-bodied vehicle (such as a pickup truck) or in a closed-bodied vehicle with a vaportight partition between the cargo space and the driver and engine compartments.** In both cases, up to 1000 lb (454 kg) of LP-Gas (total weight, including the weight of the LP-Gas and the cylinders) can be transported in the vehicle as stated in 50.7.2.4.14.1. Where the LP-Gas exceeds 1000 lb (454 kg), the requirements of 50.7.2.4.14.10 and the DOT would apply to the vehicle.
2. **Cylinder transported in a closed-body vehicle.** A maximum of 90 lb (41 kg) of propane can be transported in the passenger or cargo space of the vehicle. This requirement allows up to four typical grill cylinders [20 lb (9.1 kg) propane capacity each], up to three 30 lb (13.6 kg) cylinders, or up to two 40 lb (18 kg) cylinders to be transported.

Note that the 90 lb (41 kg) limit in closed-body vehicles effectively prohibits the transportation of a 100 lb (45 kg) LP-Gas cylinder in passenger cars, vans, sport utility vehicles, and station wagons. Also, see 50.7.2.4.14.9 for requirements on cylinder orientation during transport.

These rules apply to all transportation of cylinders, whether by propane company employees delivering cylinders to residences, by exchange cabinets, or by forklift operators or private citizens taking grill cylinders in for filling or exchange. These rules apply in much the same way as building codes apply to the modification a citizen makes to a house. In the case of building codes (and this varies with location), the citizen is responsible for obtaining a building permit, for having construction done to meet the applicable code(s), and for getting an inspection by a building code official during construction and/or after the work is complete.

NFPA 58's requirements are less well known to consumers than building codes are, which is why some jurisdictions consider it the responsibility of propane company employees to ensure that cylinders transported by customers are properly placed and secured in their vehicles before they leave the dispensing site.

N **50.7.2.4.14.6** Cylinders and their appurtenances shall be determined to be leak-free before being loaded into vehicles. [**58:**9.3.2.6]

N **50.7.2.4.14.7** Cylinders shall be loaded into vehicles with flat floors or equipped with racks for holding cylinders. [**58:**9.3.2.7]

N **50.7.2.4.14.8** Cylinders shall be fastened in position to minimize the possibility of movement, tipping, and physical damage. [**58:**9.3.2.8]

N **50.7.2.4.14.9** Cylinders being transported by vehicles shall be positioned in accordance with Table 50.7.2.4.14.9. [**58:**9.3.2.9]

***TABLE 50.7.2.4.14.9** Orientation of Cylinders on Vehicles*

Propane Capacity of Cylinder lb	kg	Open Vehicles	Enclosed Spaces of Vehicles
≤45	≤20	Any position	
>45	>20	Relief valve in communication with the vapor space	
≤4.2	≤1.9		Any position
>4.2	>1.9		Relief valve in communication with the vapor space

[**58:**Table 9.3.2.9]

Racks that hold cylinders in a horizontal position are commonly used for the delivery of industrial truck cylinders in open-body vehicles. The safety experience with this type of transportation has been good and is the reason that LP-Gas cylinders with a maximum propane capacity of 45 lb (20 kg) can be transported with the relief valve in contact with the liquid space of the container. That size is the maximum portable cylinder generally used in industrial trucks. Larger containers must be transported in a position such that the pressure relief valve is in communication with the vapor space of the container.

In closed-body vehicles, the requirements are much more stringent. Only cylinders less than or equal to 4.2 lb (1.9 kg) propane capacity can be transported in any position, thereby resulting in the relief valve being in communication with liquid. As a result of this provision, nominal 20 lb (9.1 kg) cylinders (gas grill cylinders) cannot be transported on their sides inside a vehicle.

N **50.7.2.4.14.10** Vehicles transporting cylinders where the total weight is more than 1000 lb (454 kg), including the weight of the LP-Gas and the cylinders, shall be placarded as required by DOT regulations or state law. [**58:**9.3.2.10]

Placard is a term used in the DOT regulations. Placards are used to warn others of hazardous materials present on the vehicle, placed on the outside of the vehicle or its cargo tank to identify the hazard class of the cargo. For LP-Gas, "1075" is the identification number, the "2" in the lower part is the hazard class ("gas," in this case), and the hazard class division is "flammable," as shown by the flame. A placard must convey this information to emergency responders. A typical flammable gas placard such as the one described above is shown in Exhibit 50.22. DOT rules require the placard to be identical to the one shown, with a red background color.

Exhibit 50.22

Placard for propane truck. (Courtesy of U.S. Department of Transportation)

N **50.7.3 Temporary Cooking.**

N **50.7.3.1** Temporary cooking operations and equipment shall comply with NFPA 96, Section 50.7.1 and Section 50.7.3.

N **50.7.3.2** Temporary cooking equipment and installations shall comply with NFPA 58.

N **50.7.3.3** Deep fat fryers, fry-o-lators, or other appliances having combustible liquids heated by LP Gas, solid fuels, or electricity shall be protected by an approved hood fire suppression system or other approved means of extinguishment in the event of fire.

References Cited in Commentary

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NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.
NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2017 edition.
NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*, 2017 edition.
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NFPA 30, *Flammable and Combustible Liquids Code,* 2018 edition.
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NFPA 58, *Liquefied Petroleum Gas Code*, 2017 edition.
NFPA 70®, National Electrical Code®, 2017 edition.
NFPA 72®, National Fire Alarm Code®, 2016 edition.
NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2016 edition.
NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2017 edition.
NFPA 731, *Standard for the Installation of Electronic Premises Security Systems*, 2017 edition.
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ANSI/UL 197, *Standard for Commercial Electric Cooking Appliances,* 2014.

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U.S. Publishing Office, Washington, DC

Title 49, Code of Federal Regulations, Part 172.504, "General Placarding Requirements."

Title 49, Code of Federal Regulations, Part 172.532, "FLAMMABLE GAS Placard."

51

Industrial Ovens and Furnaces

Explosions and fires in fuel-fired and electric heat utilization equipment constitute a potential loss to life, property, and production. Other regulations and conditions should be reviewed for the design and operation of furnaces not covered by this chapter or by NFPA 86, *Standard for Ovens and Furnaces*. Subjects covered in other regulations include, but are not limited to, toxic vapors; hazardous materials; noise levels; heat stress; and local, state, and federal regulations, such as those by the U.S. Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA).

51.1 General

Δ **51.1.1 Application.** Industrial ovens and furnaces shall comply with this chapter and the applicable provisions of NFPA 86.

The effective date for the edition of NFPA 86 referenced in this *Code* is May 19, 2014. However, the provisions of NFPA 86 might not be enforceable retroactively to its effective date if the standard has not been adopted by a separate action in the jurisdiction. The date that NFPA 1, *Fire Code*, was adopted in the jurisdiction establishes the effective date for enforcement of not only NFPA 1 but also other codes and standards incorporated into this *Code*.

Ovens and furnaces are used in many industrial processes to dry, cure, or alter the physical characteristics of materials. Common examples would be a bakery or a kiln. The fire and explosion hazards presented by ovens and furnaces are related to their operation at elevated temperatures in conjunction with their use of flammable and combustible fuels, flammable and combustible materials in process, and flammable special processing atmospheres. Examples of industrial processes that use ovens and furnaces include the following:

1. Melting metals
2. Drying cloth
3. Baking painted metal parts
4. Curing rubber conveyor belts
5. Annealing steel under a hydrogen atmosphere
6. Treating metal parts in molten salts
7. Heating materials under vacuum

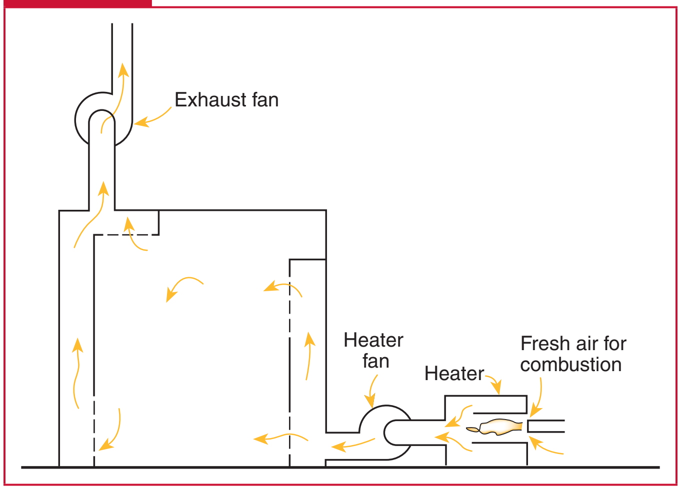
In industry, the terms *oven* and *furnace* are used interchangeably. Ovens and furnaces can be batch or continuous units. In a batch furnace, materials are loaded, the furnace is operated, the furnace is shut down, then the materials are unloaded. In a continuous furnace, materials enter one end of the furnace, are processed as they move through the furnace, then exit the furnace at the other end. In a continuous furnace, the furnace is continuously operated as new materials are constantly introduced.

Exhibit 51.1, Exhibit 51.2, and Exhibit 51.3 illustrate three examples of batch units. Exhibit 51.4 shows an example of a continuous unit.

All ovens and furnaces share similar hazards associated with their heating systems. In addition to these hazards, ovens and furnaces are classified as Class A, Class B, Class C, or Class D to address additional process hazards. Descriptions of those classifications follow.

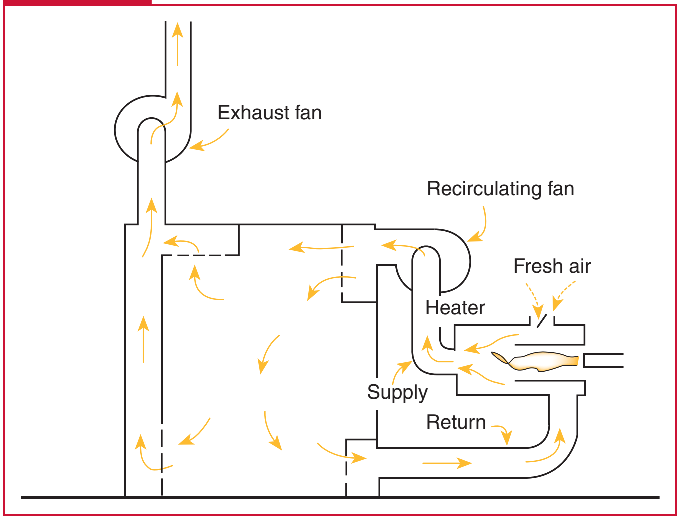
Class A. Class A ovens or furnaces have heat utilization equipment where there is a potential explosion or fire hazard that could be accompanied by the presence of flammable volatiles or combustible materials processed or heated in the furnace.

Exhibit 51.1



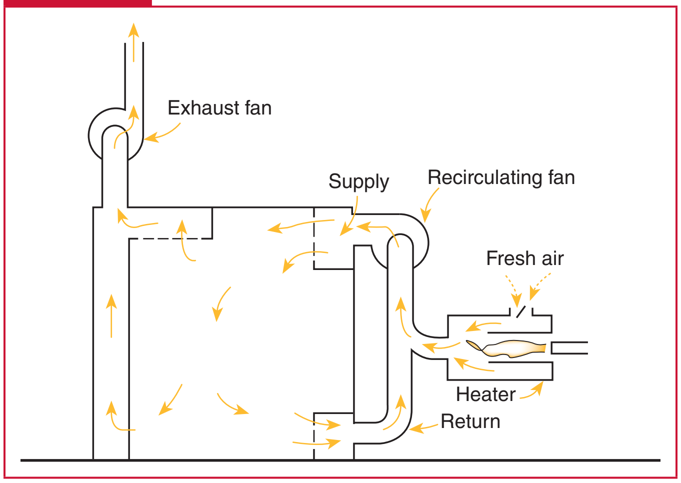
Direct-fired, external, nonrecirculating heater.

Exhibit 51.2



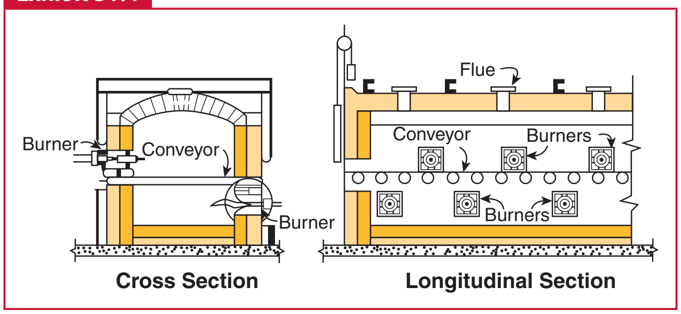
Direct-fired, external, recirculating-through heater.

Exhibit 51.3



Direct-fired, external, recirculating-not-through heater.

Exhibit 51.4



Direct-fired continuous furnace with multiple internal burners.

Flammable volatiles or combustible materials can include, but are not limited to, any of the following:

1. Paints, powders, inks, and adhesives from finishing processes, such as dipping, coating, or spraying, and impregnated materials
2. Substrate material
3. Wood, paper, and plastic pallets, spacers, or packaging materials
4. Polymerization or other molecular rearrangements

In addition, potentially flammable materials, such as quench oil, waterborne finishes, cooling oil, or cooking fats, that present a hazard should be ventilated according to Class A standards.

Class B. Class B ovens or furnaces have heat utilization equipment where there are no flammable volatiles or combustible materials being heated. It is important to note that the loads processed in Class B furnaces typically do not contain any flammable volatiles or combustible materials. However, when small amounts of flammable volatiles or combustible materials are present, it can be appropriate not to add safety ventilation, as would be required for a Class A furnace, when doing so would be detrimental to the process and would not increase the level of safety.

Class C. Class C ovens or furnaces have a potential hazard due to a flammable or other special atmosphere being used for the treatment of material in process. This type of furnace uses any type of heating system and includes a special atmosphere supply system(s). Included in this classification are integral quench furnaces and molten bath furnaces.

Class D. Class D ovens or furnaces, referred to as *vacuum furnaces,* have a pressure vessel that operates under vacuum for all or part of the process cycle. Such furnaces can process any product or material. These furnaces can use special atmospheres introduced when the furnace is above or below atmospheric pressure. During inert quenching, Class D furnaces operate at pressures from below atmospheric to over gauge pressure of 100 psi (690 kPa).

NFPA 86 provides information on the protection of Class A, Class B, Class C, and Class D ovens and furnaces against the hazards of fire and explosion. It is a compilation of guidelines, rules, and methods applicable to the safe operation of this type of equipment. Specifically, requirements on furnace location, arrangement, installation, control, and use are detailed in NFPA 86.

NFPA 86 requires that personnel who operate, maintain, or supervise the furnace be thoroughly instructed and trained in their respective job functions under the direction of a qualified person(s). When training, they must demonstrate an understanding of the equipment, its operation, and the practice of safe operating procedures in their respective job functions. A typical training program could include the following items:

1. Review of operating and maintenance information
2. Periodic formal instruction
3. Use of simulators

4. Field training
5. Other procedures
6. Comprehension testing

The following topics may be included as part of the training when it is being developed:

1. Process and equipment inspection testing
2. Combustion of fuel-air mixtures
3. Explosion hazards, including improper purge timing and purge flow and safety ventilation
4. Sources of ignition, including autoignition (e.g., by incandescent surfaces)
5. Functions of controls, safety devices, and maintenance of proper set points
6. Handling of special atmospheres
7. Handling of low-oxygen atmospheres
8. Handling and processing of hazardous materials
9. Confined space entry procedures
10. Operating instructions
11. Lockout/tagout procedures
12. Hazardous conditions resulting from interaction with surrounding processes
13. Fire protection systems
14. Molten material
15. Quench systems

In addition, personnel are required to receive regularly scheduled refresher training and must demonstrate understanding of the equipment, its operation, and the practice of safe operating procedures in their respective job functions.

Personnel must have access to written operating instructions at all times. Instructions include normal startup, normal shutdown, and emergency shutdown. Where necessary, separate instructions should be provided for cold startup and for warm startup. A warm startup might occur after a weekend when a furnace is not in use; rather than shutting down and allowing the furnace to cool off, the furnace can be brought back to an idling temperature.

Operator error has been identified as a significant cause or contributing factor in upsets and explosions involving heat utilization equipment. These unwanted events usually result from operators taking actions that deviate from written operating instructions. Operators must be thoroughly instructed and trained in the written operating instructions. When abnormal or unusual conditions are detected, written emergency shutdown procedures should be implemented. Deviation from normal or emergency written operating instructions should not be permitted at the operator level.

The cold startup of heat utilization equipment should occur under the supervision of a trained operator. When heat utilization equipment experiences an automatic safety shutdown or a manual emergency shutdown by the operator, restart of the equipment is not permitted without maintenance personnel first identifying and correcting the cause of the off-normal shutdown.

Heat utilization equipment is equipped with numerous control and safety devices intended to maintain the equipment within safe operating boundaries or cause a safety shutdown. If these controls and safety devices are to be reliable, they must be periodically inspected and tested. Maintenance must then be provided as needed.

NFPA 86 places the responsibility for establishing an inspection, testing, and maintenance program, as well as the frequency and extent of the inspection and corrective action to be taken, with the equipment user. The program should identify the features to be inspected, tested, and maintained. Frequencies for each action are based on specific installation needs.

Leak testing of fuel gas safety shutoff valves is an essential program that users often overlook. A leak test program offers a control over one of the primary causes of explosions in heat utilization equipment, that is, fuel leakage into idle equipment. NFPA 86 requires an annual leak test of each fuel gas safety shutoff valve. Written leak test procedures describing how the test is to be conducted should be provided. The typical leak test is the bubble test. In this test, one end of a flexible hose is connected to an outlet located between the safety shutoff valve to be tested and a downstream blocking valve. The other end of the flexible hose is submerged into a water bath for several minutes. The number of fuel gas bubbles per minute is measured.

The written procedure should define a pass/fail leak standard in terms of bubbles per minute. No valve is perfect; therefore, a minimum acceptable leakage rate is established. Because the head of water above the end of the hose could create sufficient pressure to hold back any leaking gas, the test operator should avoid submerging the hose too deeply into the water bath during the test.

A test procedure is to be established for verifying the performance of each safety control. Off-normal conditions should be corrected promptly. Where the control has a design set point, the following actions should be taken:

1. ***Inspect.*** Verify that the device is at the correct setting.
2. ***Test.*** Verify that the device operates at the correct set point.
3. ***Maintain.*** Recalibrate or replace the device if the displayed setting deviates from the actual setting beyond an acceptable limit.

The inspection of safety devices should include an evaluation of their physical condition. Missing cover plates should be promptly replaced. Corroded devices or devices with obvious physical damage should be repaired or replaced. Tampering with devices must not be allowed. Evidence of tampering could include wire jumpers inserted across contacts, foreign material inserted between contacts, and adjustment of devices to improper settings. Where adjustable safety devices are found adjusted to extreme high or low settings, the device is not at its proper setting.

For Class A ovens that pose a solvent hazard — for example, ovens that remove a flammable solvent from painted metal parts — a safety design form is used that describes the solvent hazard the oven is designed to handle. The form should identify the solvent that the furnace is designed for and the solvent introduction rates. Inspections should verify that no unauthorized solvents are being used and that design solvent input rates are not being violated. Deviations should receive prompt attention.

Class A ovens and their associated ductwork might be equipped with fixed fire protection systems, such as automatic sprinklers or carbon dioxide systems. Where installed, fire protection systems must be inspected, tested, and maintained in accordance with the appropriate NFPA standard for the type of system involved. See Chapter 13 for additional guidance.

Combustible materials, such as stock and other storage, should not be allowed close to heat utilization equipment. Suitable clearance should be maintained at all times. NFPA 86 specifies a minimum required separation distance of 2½ ft (0.76 m).

51.1.2 Permits.

51.1.2.1 Permits, where required, shall comply with Section 1.12.

Subsection 1.12.8 requires a permit for the operation of an industrial oven or furnace [(see Table 1.12.8(a)]. Depending on the fuel used with the furnace, additional permits might be required for the storage and use of the particular fuel.

51.1.2.2 Applications for a permit shall be accompanied by plans for safe operation showing all essential details and calculations.

Compliance with this *Code* does not eliminate the need for an engineer or for competent engineering judgment. The intent of this *Code* is that a designer who is capable of applying more complete and rigorous analysis to special or unusual problems should be given latitude in the development of an oven or furnace design. In such cases, the designer is required to be responsible for demonstrating and documenting the safety and validity of the design.

NFPA 86 requires plans that show all essential details with respect to location, construction, ventilation, piping, and electrical safety equipment. A list of all combustion, control, and safety equipment that includes the name of the manufacturer and the type number is also required. Wiring diagrams and instructions for sequence of operations for all safety controls must also be provided. Ladder-type schematic diagrams are recommended.

As part of the approval process, the authority having jurisdiction (AHJ) should consider using the two-page application form entitled Furnace or Oven Manufacturer's Application for Acceptance, shown in Exhibit 51.5.

Exhibit 51.5

MANUFACTURER'S JOB OR CONTRACT NO.	DATE

PART A — PLANS

	NAME & ADDRESS OF CUSTOMER (OWNER) · NAME & ADDRESS OF MANUFACTURER
	DRAWINGS SUBMITTED, NOS. · NO OF SETS
INSTALLATION	ERECTION & ADJUSTMENTS (SEE PART B) BY: ☐ MANUFACTURER ☐ CUSTOMER · IF OTHER, DESCRIBE
	SAFETY VENTILATION AIRFLOW TESTS (SEE PART B) TO BE MADE AFTER ERECTION BY: ☐ MANUFACTURER ☐ CUSTOMER · IF OTHER, DESCRIBE
	TYPE ☐ BATCH ☐ CONTINUOUS · TYPE NO OR OTHER INFORMATION
CON-STRUCTION	☐ SHEET STEEL ON STEEL FRAME NONCOMBUSTIBLE INSULATION · IF OTHER, DESCRIBE
RATED HEAT INPUT	☐ GAS BTU/HR · ☐ FUEL OIL NO. GAL/HR · ☐ ELECTRIC KW · ☐ STEAM PRESS, psig
SIZE	LENGTH (External) FT · WIDTH (External) FT · HEIGHT (External) FT · VOLUME (Internal) FT³ · OPERATING TEMP. ∞F
LOCATION OF EQUIPMENT	BLDG. NO OR NAME · BUILDING FLOOR CONSTRUCTION AND NO OF FLOOR OR STORY
	AIR SPACE BETWEEN OVEN & WOOD FLOOR IN. · IF OTHER, DESCRIBE
	AIR SPACE BETWEEN STACKS, DUCTS, & WOOD BLDG. CONST. IN. · IF OTHER, DESCRIBE
	EXHAUST STACKS · DIAM OR SIZE IN. · METAL GAUGE (USS) · ☐ INSULATED · NO OF CLEAN-OUT (ACCESS) DOORS
EXPLOSION VENTING AREA	OPEN ENDS FT² · LOOSE ROOF PANELS FT² · ACCESS DOORS WITH EXPLOSION LATCHES FT²
	MANUFACTURER AND TYPE LATCH · TOTAL AREA FT² · VENT RATIO $\frac{\text{VENT AREA}}{\text{INTERNAL VOLUME}}$ =
FUEL SHUTOFF	ACCESSIBLE IN EVENT OF FIRE? ☐ YES ☐ NO
FIRE PROTECTION IN OVEN	☐ NONE ☐ AUTOMATIC SPRINKLERS ☐ OPEN SPRINKLERS ☐ CO_2 ☐ STEAM · DRAWINGS SUBMITTED? ☐ YES ☐ NO
	☐ OTHER (DESCRIBE) · ☐ SEPARATE EXCESS TEMPERATURE LIMIT SWITCH WITH MANUAL RESET · SET FOR ∞F
FIRE PROTECTION FOR DIP TANK & DRAINBOARD	DRAWINGS SUBMITTED? ☐ YES ☐ NO · FIXED AUTO CO_2? ☐ YES ☐ NO · ☐ OTHER (DESCRIBE)
	OVERFLOW VALVES? ☐ YES ☐ NO · DUMP VALVES? ☐ YES ☐ NO · SALVAGE TANK? ☐ YES ☐ NO · IS HEAT SHUT OFF AUTOMATICALLY ON FAILURE OF CONVEYOR? ☐ YES ☐ NO
TYPE OF WORK	IMPREGNATED-COATED ABSORBENT MATERIAL ☐ PAPER ☐ CLOTH · ☐ LITHOGRAPH COATING · ☐ VARNISH ELECT. COILS · ☐ GRAVURE PRESS · ☐ FOOD BAKING · ☐ CORES OR MOLDS
	METAL ☐ DIPPED ☐ FLOW-COATED ☐ SPRAYED · ☐ OTHER (DESCRIBE)
SOLVENTS ENTERING OVEN	NAME OF SOLVENT USED · LENGTH OF BAKE MIN. · MAX. SOLVENT FOR WHICH OVEN DESIGNED CONTINUOUS GAL/HR BATCH GAL/BATCH
DESIGNED SAFETY VENTILATION	ARRANGEMENT ☐ SEPARATE CENTRIFUGAL EXHAUSTER ☐ RECIRCULATING FAN WITH SPILL ☐ NATURAL DRAFT STACK ☐ OPENINGS INTO ROOM · FILTERS ON FRESH AIR INTAKE? ☐ YES ☐ NO
	FRESH AIR ADMITTED INTO OVEN CFM REFERRED TO 70∞F · OPENING WITH DAMPER CLOSED FRESH AIR INLET ____% EXHAUST OUTLET____% · DOES CONVEYOR STOP AUTOMATICALLY ON FAILURE OF SAFETY EXHAUST FANS? ☐ YES ☐ NO
	FAN MFR., SIZE, TYPE · WHEEL DESIGN (BLADE TIP) ☐ RADIAL TIP ☐ BACKWARD INCLINED ☐ FORWARD CURVED · DIAM. IN. · TIP SPEED FT/MIN

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HEATING ARRANGEMENT	☐ INTERNAL DIRECT-FIRED NONRECIRCULATING ☐ INTERNAL DIRECT-FIRED RECIRCULATING ☐ EXTERNAL DIRECT-FIRED RECIRCULATING ☐ EXTERNAL INDIRECT-FIRED
	☐ OTHER (DESCRIBE)
	TYPE OF ELECTRIC HEATING ELEMENTS AND LOCATION
	NO OF MAIN BURNERS · NO OF PILOT BURNERS · CAN DRIPPINGS OFF WORK FALL ON HEATING ELEMENTS? ☐ YES ☐ NO
METHOD OF LIGHT-OFF	☐ PORTABLE TORCH ☐ FIXED ☐ PILOT ☐ OIL ☐ GAS ☐ SPARK IGNITER
METHOD OF FIRING	☐ HI–LOW ☐ ON–OFF ☐ MODULATING ☐ CONTINUOUS ☐ AUTOMATIC-LIGHTED ☐ MANUAL-LIGHTED ☐ SEMI-AUTOMATIC-LIGHTED
	TYPE OF PILOT ☐ CONTINUOUS ☐ INTERRUPTED ☐ INTERMITTENT ☐ OTHER (DESCRIBE)
MIXER TYPE	☐ GAS · NO MAIN BURNER INSPIRATORS · ☐ ZERO-GOVERNOR TYPE ☐ ATMOSPHERIC INSPIRATOR ☐ HIGH PRESSURE ☐ LOW PRESSURE
	NO PILOT INSPIRATORS · ☐ ZERO-GOVERNOR TYPE ☐ ATMOSPHERIC INSPIRATOR ☐ HIGH PRESSURE ☐ LOW PRESSURE
	☐ OIL · ☐ AIR (16–32 OZ) ATOMIZING
	☐ OTHER · OTHER TYPE MIXERS OR OIL BURNERS INCLUDING PILOTS (MFR. & TYPE)
PROTECTION AGAINST FUEL EXPLOSION — LIGHTING OFF	NO FUEL AND IGNITION UNTIL: ☐ TIMED PREVENTILATION BY EXHAUST AND RECIRC FANS · TIMER SETTING MIN. · ☐ DOORS WIDE OPEN · ☐ BURNER (F.M.) COCKS CLOSED · ☐ MEANS PROVIDED FOR CHECK OF MAIN SAFETY SHUTOFF VALVE TIGHTNESS
	PILOT-FLAME-ESTABLISHING PERIOD AUTOMATICALLY LIMITED? ☐ YES ☐ NO SEC. · TRIAL-FOR-IGNITION PERIOD AUTOMATICALLY LIMITED? ☐ YES ☐ NO SEC. · OIL TEMP INTERLOCK? ☐ YES ☐ NO SET FOR ∞F · PROVED LOW-FIRE INTERLOCK? ☐ YES ☐ NO
	MFR. AND TYPE NO OF F.M. COCKS & TIMER · ☐ COMBUSTION AIR BLOWER CANNOT BE STARTED UNTIL END OF PREVENT. (IF TIMER USED) · ☐ COMBUSTION SAFEGUARD PROVES PILOT BEFORE MAIN SAFETY SHUTOFF VALVE OPENS
FIRING	HEAT CUTOFF AUTOMATICALLY, REQUIRING MANUAL OPERATION TO RESTORE, ON FAILURE OF ☐ COMBUSTION AIR ☐ RECIRCULATING FAN ☐ SAFETY EXHAUST FAN ☐ HIGH AND LOW GAS PRESSURE ☐ LOW OIL PRESSURE ☐ FLAME (Combustion Safeguard)
	☐ ROD OR SCANNER LOCATION ENSURES PILOT IGNITES MAIN FLAME · MANDATORY PURGE AFTER FLAME FAILURE? ☐ YES ☐ NO
MANUFACTURER & TYPE NO.	MAIN SAFETY SHUTOFF VALVE IPS. IN. · PILOT SAFETY SHUTOFF VALVE IPS. IN.
	COMBUSTION SAFEGUARD · PRESSURE SWITCHES · AIRFLOW SWITCHES
PART A ACCEPTED	☐ AS SUBMITTED ☐ SUBJECT TO ANY CHANGES INDICATED · BY · DATE

PART B — MANUFACTURER'S INSPECTION & TEST

SAFETY VENTILATION	CFM REF. TO 70∞ F · MEASURED BY ☐ PITOT ☐ OTHER (SPECIFY) · MEASURED WITH FRESH AIR INLET & EXHAUST OUTLET DAMPERS IN MAXIMUM CLOSED POSITION ☐ YES ☐ NO
BURNERS	☐ LIGHTED ☐ MIXERS ADJUSTED ☐ TEMP. CONTROL SET ☐ ADJUSTED FOR STABLE LOW FLAME
SAFETY CONTROLS	☐ ADJUSTED ☐ TESTED FOR PROPER RESPONSE
INSTRUCTIONS	☐ CUSTOMER'S OPERATOR INSTRUCTED ☐ PRINTED OPERATING INSTRUCTIONS LEFT ☐ APPLICATION FOR ACCEPTANCE POSTED ON CONTROL PANEL
SIGNATURES	MFR'S FIELD REP. · TEST WITNESSED BY FOR CUSTOMER · DATE
PART B ACCEPTED	☐ AS SUBMITTED ☐ SUBJECT TO ANY CHANGES INDICATED · BY · DATE

PART C — FIELD EXAMINATION OF COMPLETED INSTALLATION

☐ PART A CHECKED ☐ PART B CHECKED ☐ SAFETY CONTROLS TESTED ☐ ROD OR SCANNER LOCATION ENSURES PILOT IGNITES MAIN FLAME	
ENGINEER'S SIGNATURE	DATE

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Furnace or oven manufacturer's application for acceptance.

51.2 Location

Special consideration shall be given to the location of equipment using flammable liquids or when using gas fuels with a vapor density greater than air.

Ovens and furnaces are usually associated with a production process. As such, they typically are found located within a production area separated only by some physical distance from other process equipment. The decision as to where to locate an oven or furnace should take into account the following factors:

1. Where possible, the oven or furnace should be located in a separate cutoff area.
2. Where a separate cutoff area is not feasible, there should be adequate separation from paint spray booths, dipping or coating operations, external quench tanks, and combustible storage.
3. Where furnaces use or process flammable gases or combustible liquids with a vapor density greater than air, low points where vapors might collect if accidentally released should be evaluated. Adequate ventilation should be provided, and ignition sources controlled to eliminate serious fire or explosion potentials.
4. Where molten materials are involved (e.g., molten metal, molten glass), the effects of a release or spill of the molten material should be considered. Containment systems should be provided to limit the spread of spills, and combustible building construction, exposed steel building columns, or exposed steel furnace supports protected from thermal damage.
5. Where furnaces have integral quench tanks that use combustible oils, spill containment and supplemental fixed fire protection (e.g., a carbon dioxide extinguishing system) should be provided for pits, oil filter stations, and the area immediately outside the furnace vestibule door and within any hood and associated exhaust ductwork over the furnace vestibule door.

Where ovens are equipped with explosion relief features, it is essential that those features be free and unobstructed, so that they are operable if an explosion occurs. Work waiting to be processed must not be placed in front of doors that are designed to open in the event of an explosion. Beams, columns, piping, ductwork, stock, or other obstructions must not impair the functioning of explosion relief panels in the oven's walls or roof.

Oven ductwork exposed to combustible dusts or condensed flammable or combustible liquids requires periodic internal inspections and periodic cleaning. Suitable access to ductwork is required. The inspector should review NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, for additional requirements. Frequencies for duct inspection and cleaning must be determined on a case-by-case basis.

51.3 Safety Controls

Safety controls, as specified in NFPA 86, shall be sufficient in number and substantially constructed and arranged to maintain the required conditions of safety and prevent the development of fire and explosion hazards.

In general, the interior volume of any fuel-fired oven or furnace is purged with air before ignition of the burners. The objective of the purging is to remove accumulated fuel vapors or other flammable vapors that might have leaked into the equipment during the preceding idle period. For ovens and furnaces, four volume changes are needed to accomplish the purge.

A complete pre-ignition purge interval must occur before any attempt is made to ignite burners. Even when nuisance safety shutdowns occur, the restart must include another purge interval. Because the purge interval, especially repeated purge intervals, will encroach on valuable production time, operators or maintenance personnel might be tempted to reduce or eliminate the purge interval. Because tampering with the purge interval is a dangerous practice that has led to explosions, inspectors should be on the lookout for signs of such tampering.

For heat utilization equipment with a single burner, the purge interval can be regulated by the flame safeguard. With this arrangement, the purge interval is fixed and can be altered only by modifying the flame safeguard (i.e., replacing a plug-in purge time module). This arrangement greatly reduces the potential for purge interval tampering.

With more complex heat utilization equipment, such as multiple burner systems, a purge timer is typically provided that is physically external to the flame safeguard. Listed purge timers are adjustable devices (e.g., 0 minutes to 30 minutes), and the adjustable feature introduces the opportunity for tampering. Finding purge timers adjusted to zero is not uncommon. Such a situation is serious and should be addressed promptly.

Oven and furnace fans are referred to as combustion air, exhaust air, and recirculation air fans. All fans needed for safe operation must be functioning during the purge interval and during operation. The manufacturer of the heat utilization equipment should establish which fans are needed for purge and which are needed for operation.

The functional operation of fans are accomplished with devices such as the following:

1. ***Pressure switch.*** A pressure switch senses air pressure after a fan is actuated when the airflow from the fan is adequate.
2. ***Suction switch.*** A suction switch senses negative pressure before a fan is activated when airflow into the fan is adequate.
3. ***Differential pressure switch.*** A differential pressure switch senses the pressure on each side of a fan or other feature, such as an orifice plate. The differential pressure switch is activated when the airflow through the fan or other feature is adequate.
4. ***Airflow switch.*** An airflow switch has a paddle or sail that is inserted into the airstream. The switch is activated when the airflow past the paddle or sail is adequate.

Many pressure switches, suction switches, and differential pressure switches are adjustable devices. Equipment records should clearly indicate the appropriate setting for each device. If, during an inspection, a switch is found to have been adjusted to an extreme upscale or downscale setting, an investigation should be made. The switch might never have been adjusted at the time of installation, or the switch might simply have been adjusted to the extreme to resolve a nuisance trip problem.

The pipe, fittings, and devices that make up the fuel piping of a piece of heat utilization equipment are referred to as the fuel train. For main and pilot fuel gas trains, double safety shutoff valves are always needed.

Fuel gas pressure regulators, fuel gas pressure relief valves, and fuel gas pressure switches contain rubber diaphragms. Fuel gas pressure acts on the bottom side of the diaphragm. A spring or microswitch, along with atmospheric pressure, acts on the top side. To maintain atmospheric pressure on the top side, a vent is provided in the device housing. This vent needs to be managed so that an excessive amount of fuel gas is not released into the building if the rubber diaphragm breaks.

Typically, vents are piped to a safe outdoor location; however, some vents might be equipped with a listed vent limiter that limits the release of fuel gas to acceptable levels. General guidelines and principles on the use of vented devices incorporating vent limiters from A.6.2.6.4 of NFPA 86 include the following:

1. The listing requirements for vent limiters are covered in ANSI Z21.18/CSA 6.3, *Standard for Gas Appliance Pressure Regulators*, for regulators, and UL 353, *Standard for Limit Controls*, for pressure switches and limit controls. ANSI Z21.18/CSA 6.3 requires maximum allowable leakage rates of 2.5 ft^3/hr (0.071 m^3/hr) for natural gas and 1.0 ft^3/hr (0.028 m^3/hr) for LP-Gas at the device's maximum rated pressure. UL 353 allows 1.0 ft^3/hr (0.028 m^3/hr) for natural gas and 1.53 ft^3/hr (0.043 m^3/hr) for LP-Gas at the device's maximum rated pressure. Since a vent limiter may be rated less than the device itself and may be a field-installable device, a combination listed device–vent limiter should be used.
2. Where a vent limiter is used, there should be adequate airflow through the room or enclosure in which the equipment is installed. In reality, conditions may be less ideal, and care should be exercised for the following reasons:
   - **(a)** The relative density of the gas influences its ability to disperse in air. The higher the relative density, the more difficult it is for the gas to disperse (propane, for instance, will disperse more slowly than natural gas).
   - **(b)** Airflow patterns through a room or enclosure, especially in the vicinity of the gas leak, affect the ability of the air to dilute the gas. The greater the local air movement, the greater the ease with which the gas is able to disperse.
   - **(c)** The vent limiter may not prevent the formation of a localized flammable air–gas concentration for the reasons given in items (a) and (b).

NFPA 86 requires that vents be terminated to an approved location. The official NFPA definition for the term *approved* is "acceptable to the authority having jurisdiction." Therefore, the AHJ can determine the acceptable termination point for a vent. Paragraph A.6.2.6.3 in NFPA 86 offers guidance to the AHJ regarding suitable locations for terminating vents. NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, should be reviewed for additional considerations regarding deflagration (explosion) venting. Paragraph A.6.2.6.3 in NFPA 86 reads as follows:

> Paragraph 6.2.6.3 [of NFPA 86] covers venting of flammable and oxidizing gases only. Gases that are asphyxiants, toxic, or corrosive are outside of the scope of this standard. In this regard, other standards should be consulted for appropriate venting. Flammable gases and oxidizers should be vented to a safe location to prevent fire or explosion hazards. When gases are vented, the vent pipe should be located in accordance with the following:
>
> (1) Gas should not impinge on equipment, support, building, windows, or materials because the gas could ignite and create a fire hazard.
> (2) Gas should not impinge on personnel at work in the area or in the vicinity of the exit of the vent pipe because the gas could ignite and create a fire hazard.
> (3) Gas should not be vented in the vicinity of air intakes, compressor inlets, or other devices that utilize ambient air.
>
> The vent exit should be designed in accordance with the following:
>
> (1) The pipe exit should not be subject to physical damage or foreign matter that could block the exit.
> (2) The vent pipe should be sized to minimize the pressure drop associated with length, fitting, and elbows at the maximum vent flow rate.
> (3) The vent piping should not have any shutoff valves in the line.
>
> If the gas is to be vented inside the building, the following additional guidance is offered:
>
> (1) If the gas is flammable and lighter than air, the flammable gases should be vented to a location where the gas is diluted below its lower flammable limit (LFL) before coming in contact with sources of ignition and the gas cannot re-enter the work area without extreme dilution.
> (2) If the gas is oxygen or air enriched with oxygen, the vent gas should be vented to a location where the gas will blend with atmospheric air to a point

between 19 percent and 23 percent oxygen before coming in contact with combustibles or personnel.

(3) See also Chapter 4 of NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems*, which provides information about the development and implementation of written procedures for the discharge of flammable gases.

Heat utilization equipment that is equipped with only a single burner needs simple burner management. In particular, the equipment needs a supervised flame monitored by a flame detector and combustion safeguard. It is not unusual, however, for equipment to have numerous burners. Numerous burners require numerous flame safeguards and increased safety control complexity. Where a supervised flame is required for a burner, each pilot and main burner is required to be equipped with flame supervision in one of three ways: (1) main and pilot flames supervised with independent flame sensors; (2) main and interrupted pilot flames supervised with a single flame sensor; or (3) self-piloted burner supervised with a single flame sensor.

Currently, four types of flame-sensing devices are listed for proving the presence of flame at a burner, as shown in Commentary Table 51.1.

Although ultraviolet (UV) scanners are popular and very common flame-sensing devices, they can fail. In some failure modes, the UV scanner might report the presence of flame, regardless of whether flame is present. This concern is addressed by the following two means:

First, self-checking flame safeguards are available. These devices include a shutter assembly that tests the scanner by periodically closing the shutter while the scanner is in normal use. If the flame signal does not disappear when the shutter is closed, a safety shutdown occurs.

Second, most flame safeguards offer a "safe-start check" diagnostic. During each burner start sequence, the safe-start check diagnostic verifies that the UV scanner does not see flame. If the UV scanner is reporting flame, the start sequence is not allowed to proceed. A safe-start check is required to be performed during each burner startup sequence.

For ovens and furnaces, the use of a self-checking UV scanner where burners operate for more than 24 hours at a time is good practice; however, this feature is not required. In all cases, a safe-start check feature is required.

COMMENTARY TABLE 51.1 *Flame-Sensing Devices*

Type Scanner	*Application*	*Potential Problems*
Ultraviolet (UV)	Fuel gas or oil	Can read spark as flame scanner
Flame rod	Fuel gas only	Oil will cause carbon buildup
Infrared (IR)	Fuel gas or oil	Can read refractory glow scanner as flame
Photoelectric cell	Oil only	Fuel gas is invisible

NFPA 86 requires that safety devices be listed for their intended purpose; however, if a listed device is not available, an approved device must be used. As discussed previously, NFPA defines the term *approved* as "acceptable to the authority having jurisdiction." Therefore, instances might occur where the AHJ is asked to determine if a nonlisted safety device is acceptable when a listed device is not available.

As an example, no fuel gas safety shutoff valves over the size of 8 in. (200 mm) are listed. For valves 10 in. (250 mm) and larger, a nonlisted valve must be selected. The AHJ might be asked to approve the selected valve. In the course of making the decision, the AHJ might apply the following thought process:

Step 1. A listed valve of the needed size is not commercially available.

Step 2. The proposed valve is made by a manufacturer that also produces smaller valves that are listed as fuel gas safety shutoff valves.

Step 3. The larger nonlisted valve is built to the same standards as the smaller listed valves. According to the manufacturer, it is rated for the proposed operating pressure, and it is rated for the proposed fuel gas.

Step 4. The larger valve is approved.

Where an oven handles a combustible product, a fixed fire-extinguishing system is needed within the oven to protect the unit. Chapter 9 of NFPA 86 addresses fire protection in general.

Where a sprinkler system is selected for the protection of ovens, furnaces, or related equipment, the use of closed-head sprinkler systems is prohibited, and only deluge sprinkler systems can be used where both the temperatures in the equipment can exceed 625°F (329°C) and flash conditions can occur. If the oven operating temperature is above the boiling point of water [212°F (100°C)], a dry pipe system is needed. If a wet pipe system were used, the water would attempt to boil within the pipes. This attempt to boil would be countered by the confining strength of the sprinkler system pipe and fittings. Excessive pressures would eventually lead to a failure at some point in the system.

Rubber-gasketed sprinkler fittings might not be appropriate. Such fittings must not be used at temperatures beyond their listing. Their maximum operating temperature is typically 150°F (66°C), unless specifically listed otherwise.

Some AHJs require dry pipe systems to be made of galvanized pipe. The use of galvanized pipe, however, should be avoided in sprinkler or water spray systems in ovens, furnaces, or related equipment. Experience has shown that the galvanizing can flake off when exposed to oven temperatures. This flaking within the pipes could lead to obstructions or plugging.

Class C furnaces and some Class D furnaces use special processing atmospheres to protect the work in process from oxidation and to cause desired metallurgical changes to the surface of the work in process. Because products of combustion are usually detrimental to such furnaces, these furnaces are usually indirect fired, that is, the products of combustion do not come into contact with the work in process.

Special atmospheres include those listed in Commentary Table 51.2. These special atmospheres can be used alone or in different combinations. Concern develops where flammable atmospheres are used.

Hydrogen, nitrogen, and argon are atmosphere gases that normally are supplied to the furnace from storage tanks, although hydrogen and nitrogen generators are available for use at industrial facilities with large atmosphere gas demands. For requirements on the storage of hydrogen, the AHJ should consult Chapter 10 or Chapter 11 of NFPA 55, *Compressed Gases and Cryogenic Fluids Code*. Also, see Chapter 63 of this *Code*.

Dissociated ammonia, exothermic gas, and endothermic gas are atmosphere gases that are produced in heated generators. An ammonia dissociator heats ammonia (NH_3) to crack or dissociate its molecules into its constituent parts (25 percent nitrogen and 75 percent hydrogen). An exothermic gas generator partially burns natural gas with air in a controlled ratio to form the desired atmosphere. An endothermic gas generator requires heat to complete the reaction of the gas and air generating the desired atmosphere. Requirements on the protection of these atmosphere generators can be found in Chapter 13 of NFPA 86.

Methanol and anhydrous ammonia are liquids that will vaporize and dissociate to form the desired atmosphere when they are injected into a hot furnace.

Flammable special processing atmosphere gases are introduced to and removed from furnaces in either the burn-in/burn-out method or the purge-in/purge-out method. With the burn-in/burn-out method, the furnace must be above 1400°F (760°C), so that all flammables will be reliably ignited and consumed as they are introduced. A burning flame front gradually moves from the atmosphere inlet to the open furnace ends (in a continuous furnace) or to the effluent vent stack (in a batch furnace). Proven pilots provide reliable means for maintaining combustion of the flammable atmosphere gas as it exits the furnace. A positive flow of atmosphere gas is needed to continually replenish the gas consumed at the exits or the stacks.

COMMENTARY TABLE 51.2 *Special Atmospheres*

Stored Atmospheres	Generated Atmospheres	Liquids for Atmospheres
Hydrogen	Dissociated ammonia	Methanol
Nitrogen*	Exothermic gas	Anhydrous ammonia
Argon*	Endothermic gas	—

*Nonflammable gas.

With the purge-in/purge-out method, nitrogen is used to purge the furnace before the flammable atmosphere is introduced. With the purge-in method, the nitrogen purge must provide five oven volume changes. Once this step is accomplished, atmosphere sampling is conducted. When two consecutive manual samples confirm that less than 1 percent oxygen is in the furnace atmosphere, the flammable atmosphere gas can be introduced. During furnace commissioning, the time needed to reach less than 1 percent oxygen can be measured. Thereafter, a purge timer can be used in conjunction with a nitrogen pressure switch to confirm the purge-in without manually sampling the atmosphere.

Regardless of which introduction and removal method is used, the operator must follow written instructions for normal atmosphere introduction, normal atmosphere removal, and emergency action. The emergency action typically involves the initiation of a nitrogen purge of the furnace.

When a special processing atmosphere furnace is operating under a flammable atmosphere, only the addition of air or oxygen is needed to cause an explosion. Keeping the furnace under positive pressure controls air infiltration. Some conditions that can lead to air infiltration follow.

Furnace safety shutdown. When a safety shutdown occurs, the sudden interruption of heat causes the furnace temperature to drop. This temperature drop causes the furnace atmosphere to contract or shrink. Because the special atmosphere flow might not be able to maintain positive furnace pressure under this condition, an emergency nitrogen purge should be initiated when safety shutdown of the furnace heat source occurs.

Cold work load. The introduction of a cold work load into a furnace causes the atmosphere to cool and shrink, which is normally accommodated by furnace design.

Liquids injection. Where liquids are injected into a furnace to produce the desired atmosphere, any condition that causes the furnace temperature to fall below that needed to vaporize the liquid quickly causes a loss of internal furnace pressure. Minimum operating temperatures for liquid-injected special atmospheres must be maintained at all times.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2016 edition.

NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems,* 2017 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2018 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 2015 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, 2015 edition.

ANSI Z21.18/CSA 6.3, *Standard for Gas Appliance Pressure Regulators*, Canadian Standards Association, Cleveland, OH, 2007.

UL 353, *Standard for Limit Controls*, Underwriters Laboratories Inc., Northbrook, IL, 1994, revised 2001.

Energy Storage Systems

52

Chapter 52 addresses the specific use of energy storage systems and the inherent hazard these systems and operations present. In the past, this chapter applied only to batteries using lead-acid technology. Due to changes over the past few editions of the *Code*, other types of energy storage technology have been introduced. The basis for the chapter title and the scope changes is to include additional energy storage technologies. The types of energy storage systems now include lead-acid, nickel-cadmium, valve-regulated lead–acid (VRLA), lithium-ion of various chemistries, sodium, flow, and other new technologies and capacitors.

The use of energy storage systems to provide uninterruptible power has steadily increased over the years. This increase originally occurred within the telecommunications industry using lead-acid energy storage systems, which has decentralized into additional, smaller telephone switching operations and call sites. Computer-dependent companies and operations have also increased their use of energy storage systems to provide backup power in the event of an emergency. The need for uninterruptible power provided by energy storage systems will continue to increase as new industries and processes demand additional reliability and increased power from energy storage systems. As telecommunications and computer use continue to grow worldwide, faster, more efficient, long-lasting power sources are needed to meet the increased demand. Many communities worldwide are increasing their use of alternative energy sources, such as wind and solar power, and the need to store the extra energy for their own use and to provide personal and public energy flowing into the grid also has increased tremendously. That need will continue to increase as alternative power sources grow in profitability, popularity, and efficiency.

A number of safety concerns must be considered in the response to emergencies involving energy storage systems. The most expected risk is electric shock, fire, or explosion due to a short in the electrical connection system or a malfunction of the thermal chemical electrical process. Fire involving energy storage systems can create numerous hazards, including dense acidic smoke, flammable gas, heavy flame generation, toxic gas, and potential explosion.

N 52.1 General

Chapter 52 is divided into three sections: Section 52.1 covers general issues regarding energy storage systems; Section 52.2 applies to larger lead-acid stationary battery systems; and Section 52.3 applies to all other energy storage systems. The intent was to keep the current lead-acid systems unaffected by *Code* changes and to address the newest technologies. This chapter does not apply to small batteries found in connection with backup power for small one-cell systems. A larger system poses an increased risk to responding personnel due to the amount of corrosive liquid found in some systems and due to the potential for escaping gas to produce fire or explosion when subjected to a source of ignition, such as a *dead short* or a *thermal runaway*, which are defined as follows:

1. *Dead short* refers to a system failure that produces a line-to-ground current where the system is not provided with protection of equipment from damaging line-to-ground fault currents.
2. *Thermal runaway* refers to the reaction of certain battery types, such as VRLA or nickel-cadmium batteries, that can experience thermal failure when overcharged or damaged by physical mechanical means.

Section 52.2 provides requirements for flooded lead-acid, nickel-cadmium, and VRLA battery systems containing electrolyte solution in excess of 100 gal (378.5 L) in buildings provided with a sprinkler system and in excess of 50 gal (189.3 L) in unsprinklered buildings. Doubling the amount of electrolyte for buildings provided with automatic sprinkler protection is consistent with other hazardous materials amounts where special protection features are provided. The sprinkler protection is provided to address the potential for fire directly involved with the battery system and to prevent an unrelated fire from spreading to the system. See NFPA's *Fire Protection Guide to Hazardous Materials* for more information on battery electrolytes.

Section 52.3 provides requirements for additional energy storage types like lithium-ion, sodium, and flow batteries that do not contain energy capacities in excess of 20 KWh (18.0 Mega joules) in buildings, whether provided with a sprinkler system or not. Additionally capacitors are being introduced as an energy storage system that does not contain energy capacities in excess of 70 KWh (25.2 Mega joules).

Where energy storage exceeds these amounts and where approved by the AHJ, areas containing stationary storage battery systems that exceed the amounts in Table 52.3.2.2.1 shall be permitted to be treated as an ordinary-hazard and not a high-hazard classification based on a hazardous mitigation analysis in accordance with 52.3.2.4 and large-scale fire and fault condition testing conducted or witnessed and reported by an approved testing laboratory.

With the addition of today's energy storage systems, it is imperative that battery management systems be used to protect the integrity of the system and prevent system failures that can result in loss of power, shock, and fire. Energy storage systems are being addressed in a new standard, NFPA 855, *Standard for the Installation of Energy Storage Systems*, currently being developed and going through the NFPA standards development process. More information about NFPA 855 can be found at http://www.nfpa.org/855.

Exhibit 52.1 shows an example of a stationary storage battery system.

N **52.1.1** Energy storage systems shall comply with Chapter 52.

N **52.1.2 Permits.**

N **52.1.2.1** Permits, where required, shall comply with Section 1.12.

N **52.1.2.2** Prior to installation, plans shall be submitted and approved by the AHJ.

Exhibit 52.1

Stationary storage battery system. (Courtesy of Applied Power Services, LLC)

N 52.2* Lead-Acid and Nickel-Cadmium Batteries

A.52.2 The requirements in Section 52.2 supersede all the hazardous material designations, permits, and requirements in Chapter 60.

Permit requirements are listed in Section 1.12.

Δ **52.2.1 General.** Stationary storage battery systems having an electrolyte capacity of more than 100 gal (378.5 L) in sprinklered buildings or 50 gal (189.3 L) in unsprinklered buildings for flooded lead-acid, nickel-cadmium, and valve-regulated lead–acid (VRLA) batteries used for facility standby power, emergency power, or uninterrupted power supplies shall be in accordance with Section 52.2 and Table 52.2.1.

•

Table 52.2.1 is a quick guide to what safety provisions are required for these types of systems. The authority having jurisdiction (AHJ) needs to pay particular attention to the requirements and ensure that they are included in the permitting and approval process.

Δ ***TABLE 52.2.1*** *Battery Requirements*

	Nonrecombinant Batteries		Recombinant Batteries
Requirement	**Flooded Lead-Acid**	**Flooded Nickel-Cadmium (Ni-Cd)**	**Valve-Regulated Lead–Acid (VRLA)**
Safety caps	Venting caps	Venting caps	Self-resealing flame-arresting caps
Thermal runaway management	Not required	Not required	Required
Spill control	Required	Required	Not required
Neutralization	Required	Required	Required
Ventilation	Required	Required	Required
Signage	Required	Required	Required
Seismic control	Required	Required	Required
Fire detection	Required	Required	Required

52.2.2 Safety Features.

Δ **52.2.2.1 Safety Venting.** Batteries shall be provided with safety venting caps per 52.2.2.1.1 and 52.2.2.1.2.

Δ **52.2.2.1.1 Nonrecombinant Batteries.** Vented lead-acid and nickel-cadmium shall be provided with safety venting caps.

Δ **52.2.2.1.2 Recombinant Batteries.** VRLA shall be equipped with self-resealing flame-arresting safety vents.

Δ **52.2.2.2 Thermal Runaway.** VRLA systems shall be provided with a listed device or other approved method to preclude, detect, and control thermal runaway.

Battery management systems are used to control the amount of charge and output of battery systems and are meant to shut down or control the battery before thermal runaway can occur. Battery management systems are computer motherboard-like devices that are co-located with the battery system. Depowering the battery management system can occur if the battery system is shut down. Residual heat in the batteries can lead to thermal runaway because the cooling system and battery management system is no longer operational to control the system. Caution should be exercised in deciding if shutting down the battery system is the right thing to do based on the observed operational problems of the system.

Select care must be taken in approving the location of energy storage systems. In the event of overheating or thermal runaway, there are often large amounts of smoke and possibly overpressurization of the enclosure. The amount of radiant heat from open flaming of the systems are considerable, and most often the cells cannot be reached with adequate water to cool them. The cells are so tightly wrapped that water keeps only the exterior of the cells cool while the interior of the cell continues to promote thermal energy. Abundant water supplies are usually required for lengthy periods of time to actually cool the cells. It is probably best to consider tactically active control rather than extinguishment if responding to this type of energy storage system.

52.2.2.3 Location and Occupancy Separation.

52.2.2.3.1 Battery systems shall be permitted in the same room as the equipment that they support.

52.2.2.3.2 Battery systems shall be housed in a noncombustible, locked cabinet or other enclosure to prevent access by unauthorized personnel unless located in a separate equipment room accessible only to authorized personnel.

Δ **52.2.2.3.3** In other than assembly, educational, detention, and correction facilities; health care, ambulatory health care, and day care centers; and residential board and care and residential occupancies, battery systems shall be located in a room separated from other portions of the building by a minimum of a 1-hour fire barrier.

Δ **52.2.2.3.4** In assembly, educational, detention and correction facilities; health care, ambulatory health care, and day care centers; and, residential board and care and residential occupancies, battery systems shall be located in a room separated from other portions of the building by a minimum of a 2-hour fire barrier.

52.2.2.4 Spill Control.

52.2.2.4.1 Rooms, buildings, or areas containing free-flowing liquid electrolyte in individual vessels having a capacity of more than 55 gal (208 L) or multiple vessels having an aggregate capacity exceeding 1000 gal (3785 L) shall be provided with spill control to prevent the flow of liquids to adjoining areas.

Paragraph 52.2.2.4.1 identifies the need to restrict any possibility of corrosive liquid that is released from spreading outside the immediate battery storage and use area. The term *free-flowing* is used to indicate that released electrolyte has the potential to flow unrestricted throughout the battery area. The *Code* also provides for different techniques for storing electrolyte within the battery, such as saturating pads and other materials with electrolyte or gel. In these non-free-flowing types of containers, cracks or breaks in the case might create slow drips or spills, but large amounts of free-flowing electrolyte will not be released and expose adjacent equipment or responding personnel.

Free-flowing electrolyte causes damage to metal objects adjacent to the battery system if a spill occurs and, if undetected, could cause structural damage to racks or supports of other batteries. Emergency responders should be aware that spilled electrolyte might be contained under or near the battery system.

Personnel responding to an incident might expect to find damaged battery systems and equipment in the storage area. Emergency responders should use appropriate personal protective equipment (PPE), given the potential for chemical burns upon contact with electrolyte and the fact that exposure to smoke and fumes can be toxic. NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response,* covers identification of hazardous areas to assist emergency responders in identifying the appropriate response and protection.

NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents,* should be reviewed for applicable requirements for personal protection of emergency responders, while NFPA 600, *Standard on Facility Fire Brigades,* should be reviewed for applicable requirements for personal protection of facility fire brigade members.

52.2.2.4.2* An approved method and materials for the control of a spill of electrolyte shall be provided that will be capable of controlling a spill from the single largest vessel.

A.52.2.2.4.2 Methods of achieving this protection can include, but are not limited to, the following:

(1) Liquidtight sloped or recessed floors in indoor locations or similar areas in outdoor locations
(2) Liquidtight floors in indoor locations or similar areas in outdoor locations provided with liquidtight raised or recessed sills or dikes
(3) Sumps and collection systems
(4) Spill containment systems such as that described in A.52.2.2.5.1

A range of methods for controlling spilled electrolyte liquid is outlined in A.52.3.4.2. These methods include, but are not limited to, fixed dike or sump systems designed to hold the spill of the largest container. The *Code* assumes that the largest spill in the majority of incidents would be from one container, and this amount is based on the largest single container. Additional spill protection might include the storage of absorbent pads or blankets within the containment area that are designed to hold the liquid in place. These control systems must be designed to contain the spill without human intervention and to operate automatically. The intent of 52.3.4.2 does not require someone to apply absorbent material to the spill. If the corrosive liquid spreads beyond the immediate storage area, intervention by emergency responders will be necessary.

Δ **52.2.2.4.3** VRLA batteries with immobilized electrolyte shall not require spill control.

Paragraph 52.2.2.4.3 requires that neutralizing material be available to handle an on-site spill from the battery system, including absorbent material, neutralizing chemicals, or a containment and removal system. Neutralizing the corrosive liquid hazard is an important consideration, and a response plan and neutralizing material must be available on-site. In addition, eyewash or safety showers are needed adjacent to battery storage areas where the potential exists for exposure of personnel to acid spill or spray.

52.2.2.5 Neutralization.

52.2.2.5.1* An approved method to neutralize spilled electrolyte shall be provided.

A.52.2.2.5.1 One method to determine compliance with the neutralization requirements of this subsection is found in Underwriters Laboratories Subject 2436, *Outline of Investigation for Spill Containment for Stationary Lead Acid Battery Systems*. Subject 2436 investigates the liquid tightness, level of electrolyte absorption, pH neutralization capability, and flame spread resistance of spill containment systems.

Δ **52.2.2.5.2** For VRLA batteries, the method shall be capable of neutralizing a spill from the largest battery to a pH between 7.0 and 9.0.

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Lowering the pH of the corrosive liquid to between 7.0 and 9.0 should eliminate the potential for additional damage to equipment and hazard to personnel. Personnel responsible for responding to the spill must have adequate personal protection and proper quantities of neutralizing material available to handle the spill. The method of neutralization used to counteract the spill must be consistent with the nature and size of the spill.

52.2.2.6* Ventilation. For flooded lead-acid, flooded nickel-cadmium, and VRLA batteries, ventilation shall be provided for rooms and cabinets in accordance with the mechanical code and one of the following:

(1) The ventilation system shall be designed to limit the maximum concentration of hydrogen to 1.0 percent of the total volume of the room during the worst-case event of simultaneous "boost" charging of all the batteries, in accordance with nationally recognized standards.

(2) Continuous ventilation shall be provided at a rate of not less than 1 $ft^3/min/ft^2$ (5.1 $L/sec/m^2$) of floor area of the room or cabinet.

The direction provided within this *Code* is to identify the minimum requirements for protection from flammable gas buildup. A major concern with battery systems is the creation of flammable hydrogen gas during the charging period. To reduce this potential danger, a ventilation system must be designed to remove any concentration of hydrogen gas, which is lighter than air, from the area or the cabinet used to enclose the battery system. The installation and design of the battery area ventilation system must meet the mechanical code requirements adopted by the jurisdiction.

Paragraph 52.2.2.6 provides two ways to reduce the hazard: (1) limiting the percentage of hydrogen gas to 1.0 percent of the total volume of the room or (2) providing a storage cabinet to isolate the remaining space from reaching the explosive level.

The ventilation system must be reviewed by the AHJ to ensure that the design manages the peak period of greatest hydrogen gas production, with the understanding that all batteries are assumed to be charging at the same time under the rapid charge, or "boost," cycle. The ventilation system must also provide continuous ventilation for the room or cabinet based on the floor area. Hydrogen gas is lighter than air; therefore, ventilation must be provided to bring in fresh air at the floor level and exhaust the gas at the ceiling or roof level. The continuous ventilation rate of 1 ft^3/min of air for every square foot of floor area (5.1 L/sec of air for every square meter of floor area) has demonstrated a reduced risk of an explosion and that accumulations of hydrogen gas will not reach an explosive level. This approach is used in many different types of operations where flammable gases are produced or might be present. See NFPA 69, *Standard on Explosion Prevention Systems,* for more information about techniques for reducing concentrations of flammable gases.

A.52.2.2.6 Information on battery room ventilation can be found in IEEE 1635/ASHRAE 21, *Guide to Battery Room Ventilation and Thermal Management*.

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52.2.2.7 Environment. The battery environment shall be controlled or analyzed to maintain temperature in a safe operating range for the specific battery technology used.

52.2.2.8 Signs.

The use of identification signs is important to inform responding personnel of potential hazards in areas where battery systems are stored or operated. Paragraphs 52.2.2.8.1 through 52.2.2.8.5 require that clear signage expressing the potential for exposure to corrosive liquids and flammable gases be posted at the doors or other access into battery storage buildings, rooms containing stationary storage battery systems, or other areas containing stationary storage battery systems. This hazard identification is important during times of power failures, earthquakes, or similar events, as well as during fire-related events.

52.2.2.8.1 Doors or accesses into the following shall be provided with approved signs:

(1) Battery storage buildings
(2) Rooms containing stationary storage battery systems
(3) Other areas containing stationary storage battery systems

52.2.2.8.2 For rooms that contain VRLA batteries, the signs required by 52.2.2.8.1 shall state the following:

This room contains:

(1) Stationary storage battery systems
(2) Energized electrical circuits

Δ **52.2.2.8.3** For rooms that contain flooded lead-acid or flooded Ni-Cd batteries, the signs required by 52.2.2.8.1 shall state the following:

This room contains:

(1) Stationary storage battery systems
(2) Energized electrical circuits
(3) Corrosive battery electrolyte

52.2.2.8.4 Battery cabinets shall be provided with exterior labels that identify the manufacturer and model number of the system and electrical rating (i.e., voltage and current) of the contained battery system.

52.2.2.8.5 Signs shall be provided within battery cabinets to indicate the relevant electrical, chemical, and fire hazard.

52.2.2.9 Seismic Protection. Battery systems shall be seismically braced in accordance with the building code.

Within known seismic areas, the battery system must be designed and protected from movement in accordance with the building code adopted by the jurisdiction. Braces for the racks and cases must be compatible with the proposed protection features and the storage space, including the spill control and detection systems.

52.2.2.10 Smoke Detection. An approved automatic smoke detection system shall be installed in rooms containing stationary battery storage systems in accordance with *NFPA 72*.

Area smoke detection provides early warning that a problem is occurring at or near the battery system. This type of detection is specific to smoke, because the smoke produced from a fire involving these systems is very hazardous and, if not detected early, might delay and increase the danger to evacuation and impact first responders. See *NFPA 72®, National Fire Alarm and Signaling Code®*, for more information on the design and installation of smoke detection systems.

N **52.2.2.10.1** The required automatic smoke detection system shall be supervised by an approved central, proprietary, or remote station service or a local alarm that will give an audible signal at a constantly attended location.

N **52.2.2.10.2** Normally unoccupied, stand-alone telecommunications structures with a gross floor area of less than 1,500 ft^2 (140 m^2) shall not be required to have the detection as indicated in 52.2.2.10.

N 52.3* Additional Battery Technologies

N **A.52.3** The requirements in Section 52.3 supersede all the hazardous material designations, permits, and requirements in Chapter 60.

N **52.3.1 General.** Energy storage systems having a capacity greater than the quantities listed in Table 52.3.1 shall be in accordance with Section 52.3 and where used as a legally required emergency or standby power system, shall also comply with 11.7.3.

TABLE 52.3.1 *Energy Storage System Threshold Quantities*

Type	Capacity[a]
Lithium batteries, all types	20 KWh (18.0 Mega joules)
Sodium batteries, all types	20 KWh (18.0 Mega joules)[c]
Flow batteries[b]	20 KWh (18.0 Mega joules)
Other battery technologies	10 KWh (10.8 Mega joules)
Capacitors	70 KWh (25.2 Mega joules)

Notes:

[a]For batteries and capacitors rated in Amp-Hours, KWh should equal rated voltage times amp-hour rating divided by 1000.

[b]Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[c]Or 70 KWh (25.2 Mega joules) for sodium-ion technologies.

Due to the increase in types of energy storage systems, the protection features for venting the battery case must be designed to match the potential hazard. Some battery types do not require venting due to the solid nature of the storage material within lithium-ion and lithium metal polymer batteries. Section 52.3 details the same safety features as found in Table 52.2.1.

The battery type defined as VRLA is required to have self-resealing flame-arresting caps. This type of venting protection is designed to release pressure and provide a seal.

The concern regarding the use of flooded lead-acid and flooded nickel-cadmium batteries with any sealed vessel is their potential to rupture due to overpressurization in the case of vented lead-acid or nickel-cadmium batteries. With sealed batteries containing electrolyte, this possibility is very real. History has shown that battery cases bulge and crack due to outside heat sources or interior heat buildup. Charging can produce pressure within the battery. Overcharging without appropriate safety venting can cause overpressurization and battery case failure. Safety vent caps are designed to release pressure from within the sealed battery case above the liquid level into the room. When batteries are charging, safety vent caps must be kept in place to avoid release of electrolyte spray. Safety vent caps must be inspected to ensure their proper performance. If a major problem occurs within the case, or the case is exposed to an outside heat source, the safety vent caps are not designed to eliminate the potential for the case to fail.

N **52.3.2* Stationary Storage Battery Systems.**

Thermal runaway is a decomposition chemical reaction that is self-accelerating due to the heat that evolves from the chemical decomposing or degrading. The reaction continues until the chemical experiencing the phenomenon is used up.

Battery management systems designed to prevent or detect a thermal runaway of the battery must be listed or approved by the AHJ as part of the installation and permit process for the battery system. Thermal runaway can produce excessive amounts of heat and can cause damage to the battery, which could result in a fire or loss of the battery case.

Battery management systems are used to control the amount of charge and output of battery systems and are meant to shut down or control the battery before thermal runaway can occur. Battery management systems are computer motherboard–like devices that are co-located with the battery system. Depowering the battery management system can occur if the battery system is shut down. Residual heat in the batteries can lead to thermal runaway because the cooling system and battery management system is no longer operational to control the system. Caution should be exercised in deciding if shutting down the battery system is the right thing to do based on the observed operational problems of the system.

N **A.52.3.2** This section covers stationary battery systems that are typically used for facility standby power, emergency power, uninterrupted power supplies, or load shedding/load balancing applications.

Stationary storage battery systems that exceed the amounts specified in Table 52.3.1 pose potential hazards that are significant enough to require compliance with the requirements in Chapter 52. It is not the intent of Chapter 52 to regulate equipment with integral standby power systems below the amounts in Table 52.3.1, such as emergency lighting units, fire alarm control units, and other appliances and equipment.

N **52.3.2.1 Location and Occupancy Separation.** Stationary storage battery systems shall be located and constructed in accordance with this section.

N **52.3.2.1.1** Stationary storage battery systems shall be housed in a noncombustible, locked cabinet or other enclosure to prevent access by unauthorized personnel unless located in a separate equipment room accessible only to authorized personnel.

N **52.3.2.1.2 Location.**

N **52.3.2.1.2.1** Stationary storage battery systems shall not be located in areas where the floor is located more than 75 ft (22,860 mm) above the lowest level of fire department vehicle access, or where the floor level is more than 30 ft (9144 mm) below the finished floor of the lowest level of exit discharge, unless otherwise permitted by 52.3.2.1.2.

N **52.3.2.1.2.2** Installations on noncombustible rooftops of buildings exceeding 75 ft (22,860 mm) in height that do not obstruct fire department rooftop operations shall be permitted when approved by the AHJ.

N **52.3.2.1.3 Separation.** Rooms containing stationary storage battery systems shall be located in high-hazard occupancies, or shall be separated from other areas of the building as stated in 52.3.2.1.3.1 and 52.3.2.1.3.2. Stationary storage battery systems shall be allowed to be in the same room with the equipment they support.

N **52.3.2.1.3.1** In other than assembly, educational, detention, and correction facilities; health care, ambulatory health care, and day care centers; and residential board and care and residential occupancies, stationary storage battery systems shall be located in a room separated from other portions of the building by a minimum of a 1-hour fire barrier.

Paragraph 52.3.3.3 requires that rooms used for battery systems in the specified occupancies be separated from the remaining portion of the building with a 1-hour fire barrier. This rated separation reduces the potential of a fire within the battery system to reach the adjacent spaces. It also prevents a fire outside the space from reaching the battery system.

N **52.3.2.1.3.2** In assembly, educational, detention, and correction facilities; health care, ambulatory health care, and day care centers; and residential board and care and residential occupancies, stationary storage battery systems shall be located in a room separated from other portions of the building by a minimum of a 2-hour fire barrier.

Paragraph 52.3.3.4 requires separation from the remaining portion of the buildings with a 2-hour fire barrier for occupancies that have large numbers of persons who are unfamiliar with the hazards of battery systems or who might be delayed in evacuating the area used for battery systems. The increased fire separation helps provide the extra time occupants need to evacuate the occupancy or building prior to being exposed to a fire within the battery system room.

N **52.3.2.1.4 Outdoor Installations.** Stationary storage battery systems located outdoors shall comply with this paragraph, in addition to all applicable requirements of Section 52.3.

Select care must be taken in approving the location of energy storage systems. In the event of overheating or thermal runaway there are often large amounts of smoke and possibly overpressurization of the enclosure. The amount of radiant heat from open flaming of these systems are considerable, and most often the lithium cells cannot be reached with adequate water to cool them. These cells are so tightly wrapped that water keeps only the exterior of the cells cool while the interior of the cell continues to promote thermal energy. Abundant water supplies are usually required for lengthy periods of time to actually cool the cells. It is probably best to consider tactically active control rather than extinguishment if responding to this type of energy storage system.

N **52.3.2.1.4.1** Installations in outdoor enclosures or containers that are occupied for servicing, testing, maintenance, and other functions shall be treated as stationary storage battery system rooms.

N **52.3.2.1.4.2** Battery arrays in noncombustible containers shall not be required to be spaced 3 ft (914 mm) from the container walls.

N **52.3.2.1.4.3** Stationary storage battery systems located outdoors shall be separated by a minimum 5 ft (1524 mm) from the following:

(1) Lot lines
(2) Public ways
(3) Buildings
(4) Stored combustible materials
(5) Hazardous materials
(6) High-piled stock
(7) Other exposure hazards

N **52.3.2.1.4.4** The AHJ shall be permitted to authorize smaller separation distances if large-scale fire and fault condition testing conducted or witnessed and reported by an approved testing laboratory is provided showing that a fire involving the system will not adversely impact occupant egress from adjacent buildings, or adversely impact adjacent stored materials or structures.

As more manufacturers bring their systems to market, it will be necessary for them to have those systems listed and labeled. Where they are not, the AHJ has to depend on the systems being tested so the hazards can be understood and planned for. Most fire test data for these systems are not publicly available. However the AHJ can require the testing so the fire performance can be evaluated and appropriate requirements put in place to protect the public from hazards.

N **52.3.2.1.4.5 Means of Egress.**

N **52.3.2.1.4.5.1** Stationary storage battery systems located outdoors shall be separated from any means of egress as required by the AHJ to ensure safe egress under fire conditions, but in no case less than 10 ft (3048 mm).

N **52.3.2.1.4.5.2** The AHJ shall be permitted to authorize smaller separation distances if large-scale fire and fault condition testing conducted or witnessed and reported by an approved testing laboratory is provided showing that a fire involving the system will not adversely impact occupant egress.

N **52.3.2.1.4.6 Security of Areas.** Outdoor areas in which stationary storage battery systems are located shall be secured against unauthorized entry in an approved manner.

N **52.3.2.2 Maximum Allowable Quantities.**

N **52.3.2.2.1** Fire areas within buildings containing stationary storage battery systems exceeding the maximum allowable quantities in Table 52.3.2.2.1 shall comply with all applicable ordinary-hazard and high-hazard requirements as identified in 6.2.2 of NFPA *101* and the building code.

TABLE 52.3.2.2.1

Type	Maximum Allowable Quantities[a]	Hazard Classification
Lithium batteries, all types	600 KWh	High hazard[c]
Sodium batteries, all types	600 KWh	High hazard[c]
Flow batteries[b]	600 KWh	High hazard[c]
Other battery technologies	200 KWh	High hazard[c]

Notes:

[a]For batteries rated in amp-hours, KWh should equal rated voltage times amp-hour rating divided by 1000.

[b]Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[c]Can be permitted to be ordinary hazard classification if approved by the AHJ based on (1) a hazard mitigation analysis conducted in accordance with 52.3.2.4 and (2) large-scale fire and fault condition testing conducted or witnessed and reported by an approved testing laboratory that shows that a fire involving the stationary storage battery system is contained within the room for a duration equal to the fire resistance rating of the room separation required in 52.3.2.1.3.1 or 52.3.2.1.3.2, as applicable.

N **52.3.2.2.2** Where approved by the AHJ, areas containing stationary storage battery systems that exceed the amounts in Table 52.3.2.2.1 shall be permitted to be treated as a ordinary-hazard and not a high-hazard classification based on a hazardous mitigation analysis in accordance with 52.3.2.4 and large-scale fire and fault condition testing conducted or witnessed and reported by an approved testing laboratory.

N **52.3.2.2.3** Where areas within buildings contain a combination of energy system technologies, the total aggregate quantities shall be determined based on the sum of percentages of each type divided by the maximum allowable quantity of each type. If the sum of the percentages exceeds 100 percent, the area shall be treated as a high-hazard classification in accordance with Table 52.3.2.2.1.

Where multiple independent battery storage systems are located in the same room or on the same floor, it is important to understand how they can interact in a fire situation. Knowing the amount of energy that responders may be exposed to and its impact on the room, the floor, or the facility in which they are housed is necessary to plan response procedures. Knowing if the location is ordinary or high hazard is important to the facility and to first responders.

N **52.3.2.3* Battery Arrays.**

N **A.52.3.2.3** A stationary battery array is an arrangement of individual stationary storage batteries in close proximity to each other, mounted on storage racks or in modules, battery cabinets, or other enclosures.

N **52.3.2.3.1** Battery arrays shall comply with 52.3.2.3.2 and 52.3.2.3.3 unless otherwise permitted by 52.3.2.3.4 or 52.3.2.3.5.

N **52.3.2.3.2** Storage batteries, prepackaged stationary storage battery systems, and pre-engineered stationary storage battery systems shall be segregated into arrays not exceeding 50 KWh (180 Mega joules) each.

N **52.3.2.3.3** Each array shall be spaced a minimum 3 ft (914 mm) from other arrays and from walls in the storage room or area. The storage arrangements shall comply with the egress provisions in NFPA *101*.

N **52.3.2.3.4** Listed pre-engineered stationary storage battery systems and prepackaged stationary storage battery systems shall not exceed 250 KWh (900 Mega joules) each.

N **52.3.2.3.5** The AHJ shall be permitted to approve listed pre-engineered and prepackaged battery arrays with larger capacities or smaller battery array spacing if large-scale fire and fault condition testing conducted or witnessed and reported by an approved testing laboratory is provided showing that a fire involving one array will not propagate to an adjacent array, and be contained within the room for a duration equal to the fire resistance rating of the room separation required by 52.3.2.1.3.

N **52.3.2.4 Hazard Mitigation Analysis.** A failure mode and effects analysis (FMEA) or other approved hazard mitigation analysis shall be provided to the AHJ when any of the following conditions are present:

(1) Battery technologies not specifically identified in Table 52.3.1 are provided.
(2) More than one stationary storage battery technology is provided in a room or indoor area where there is a potential for adverse interaction between technologies.
(3) When allowed as a basis for increasing maximum allowable quantities as specified in Table 52.3.2.2.1.

N **52.3.2.4.1** The analysis shall evaluate the consequences of the following failure modes, and others deemed necessary by the AHJ. Only single failure modes shall be considered for each mode:

(1) Thermal runaway condition in a single module or array
(2) Failure of a battery management system
(3) Failure of a required ventilation system
(4) Voltage surges on the primary electric supply
(5) Short circuits on the load side of the stationary battery storage system
(6) Failure of the smoke detection, fire suppression, or gas detection system

N **52.3.2.4.2** The AHJ shall be permitted to approve the hazardous mitigation analysis provided the consequences of the FMEA demonstrate the following:

(1) Fires or explosions will be contained within unoccupied stationary storage battery system rooms for the minimum duration of the fire resistance rated specified in 52.3.2.1.3.1 or 52.3.2.1.3.2, as applicable
(2) Fires and explosions in stationary storage battery system cabinets in occupied work centers allow occupants to safely evacuate
(3) Toxic and highly toxic gases released during charging, discharging, and normal operation shall not exceed the permissible exposure limit (PEL)
(4) Toxic and highly toxic gases released during fires and other fault conditions shall not reach concentrations in access of IDLH level in the building or adjacent means of egress routes during the time deemed necessary to evacuate from that area
(5) Flammable gases released from batteries during charging, discharging, and normal operation shall not exceed 25 percent of the lower flammable limit (LFL)

N **52.3.2.4.3** Construction, equipment, and systems that are required for the stationary storage battery system to comply with the hazardous mitigation analysis shall be installed, maintained, and tested in accordance with nationally recognized standards and specified design parameters.

N **52.3.2.5 Listings.** Storage batteries shall be listed in accordance with UL 1973, *Standard for Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications*. Prepackaged and pre-engineered stationary storage battery systems shall be listed in accordance with UL 9540, *Outline of Investigation for Energy Storage Systems and Equipment*.

N **52.3.2.5.1* Prepackaged and Pre-engineered Systems.** Prepackaged and pre-engineered stationary storage battery systems shall be installed in accordance with their listing and the manufacturer's instructions.

N **A.52.3.2.5.1** A prepackaged stationary storage battery system is designed and investigated as a single unit, assembled in a factory, and shipped to the site. A pre-engineered stationary storage battery system is designed and investigated as a single unit, but is shipped in modular form for assembly at the site.

N **52.3.2.5.2 Environment.** The storage battery environment shall be controlled to maintain temperatures and conditions within the battery manufacturer's specifications.

N **52.3.2.6 Installation.**

N **52.3.2.6.1 Battery Management System.** An approved battery management system shall be provided for battery technologies for monitoring and balancing cell voltages, currents, and temperatures within the manufacturer's specifications. The system shall transmit an alarm signal to an approved location if potentially hazardous temperatures or other conditions including short circuits, overvoltage (i.e., overcharge) or under voltage (i.e., over discharge) are detected.

A battery management system is the controlling function and hazard protection tool for any battery storage system. It regulates the amount of charge, the output, and the condition of the system. It is essentially the brains of the system. It should be recognized that removing the power for the battery management system during an emergency will remove its ability to control the system and shut it down in the event of an incident.

N **52.3.2.6.2 Battery Chargers.** Battery chargers shall be compatible with the battery manufacturer's electrical ratings and charging specifications. Battery chargers shall be listed in accordance with the UL 1564, *Standard for Industrial Battery Chargers*, or provided as part of a listed pre-engineered or prepackaged stationary storage battery system.

N **52.3.2.6.3 Vehicle Impact Protection.** Vehicle impact protection shall be provided where stationary storage battery systems are subject to impact by motor vehicles.

N **52.3.2.6.4 Combustible Storage.**

N **52.3.2.6.4.1** Combustible materials not related to the stationary storage battery system shall not be stored in battery rooms, cabinets, or enclosures.

N **52.3.2.6.4.2** Combustible materials in occupied work centers shall comply with Section 10.18 and shall not be stored within 3 ft (915 mm) of battery cabinets.

N **52.3.2.6.5 Signage.**

N **52.3.2.6.5.1** Approved signage shall be provided on doors or in approved locations near entrances to stationary battery storage system rooms.

N **52.3.2.6.5.2** New signage installations shall require the following items:

(1) Hazard identification markings in accordance with NFPA 704.
(2) "This room contains energized battery systems," or the equivalent.
(3) Identification of the type(s) of batteries present
(4) AUTHORIZED PERSONNEL ONLY
(5) Technology-specific markings, if required in 52.3.2.11

N **52.3.2.6.5.3** Where the battery storage system disconnecting means is not within sight of the main service disconnect, placards or directories shall be installed at the locations of the main service disconnect to indicate the location of all battery storage disconnecting means in accordance with *NFPA 70*.

It always should be assumed that there are multiple electronic feeds into any one system. It is important to have technical support from the system operator to fully know when a system is truly disconnected.

N **52.3.2.6.5.4** Existing stationary storage battery systems shall be permitted to include the signage required at the time it was installed.

N **52.3.2.6.5.5** Battery cabinets shall be provided with exterior labels that identify the manufacturer and model number of the system and electrical rating (i.e., voltage and current) of the contained battery system.

N **52.3.2.6.5.6** Signs shall be provided within battery cabinets to indicate the relevant electrical, chemical, and fire hazard.

N **52.3.2.6.5.7** Fire command centers in buildings containing stationary storage battery systems shall include signage or readily available documentation that describes the location of stationary storage battery systems, the types of batteries present, operating voltages, and location of electrical disconnects.

N **52.3.2.6.6 Seismic Protection.** Battery systems shall be seismically braced in accordance with the building code.

N **52.3.2.6.7 Safety Caps.** Vented batteries shall be provided with flame-arresting safety caps.

N **52.3.2.6.8* Mixed Battery Systems.** Different types of batteries shall not be installed in the same room or cabinet if there is a potential for unsafe interaction between them, as determined by the AHJ.

N **A.52.3.2.6.8** This section is intended to address unique situations where the installation of different types of batteries in the same room or cabinet could create a situation where there is unacceptable chemical, thermal, or other interaction between them, or where the surrounding environment is not within the battery manufacturers' specifications. The AHJ has the option to require a hazard mitigation analysis, conducted in accordance with 52.3.2.4, to identify hazards and potential solutions that will mitigate the hazards.

N **52.3.2.7 Suppression and Detection.**

N **52.3.2.7.1 Fire suppression.** Rooms containing stationary storage battery systems shall be protected by an automatic sprinkler system installed in accordance with Section 13.3.

N **52.3.2.7.1.1** Commodity classifications for specific technologies of storage batteries shall be in accordance with Chapter 5 of NFPA 13.

N **52.3.2.7.1.2** If the storage battery types are not specifically addressed in Chapter 5 of NFPA 13, the AHJ shall be permitted to approve the fire suppression system based on full-scale fire and fault condition testing conducted or witnessed and reported by an approved laboratory.

N **52.3.2.7.2 Smoke Detection.** An approved automatic smoke detection system shall be installed in rooms containing stationary battery storage systems in accordance with *NFPA 72* and the required automatic smoke detection system shall be supervised by an approved central, proprietary, or remote station service or a local alarm that will give an audible signal at a constantly attended location.

N **52.3.2.8* Ventilation.** Where required by 52.3.2.11, ventilation shall be provided for rooms and cabinets in accordance with the mechanical code and one of the following:

(1) The ventilation system shall be designed to limit the maximum concentration of flammable gas to 25 percent of the lower flammable limit (LFL) of the total volume of the room during the worst-case event of simultaneous "boost" charging of all the batteries, in accordance with nationally recognized standards.
(2) Mechanical ventilation shall be provided at a rate of not less than 1 $ft^3/min/ft^2$ (5.1 $L/sec/m^2$) of floor area of the room or cabinet. The ventilation can be either continuous, or activated by a gas detection system in accordance with 52.3.2.8.2.

N **A.52.3.2.8** Information on battery room ventilation can be found in IEEE 1635/ASHRAE 21, *Guide to Battery Room Ventilation and Thermal Management.*

N **52.3.2.8.1** Required mechanical ventilation systems for rooms and cabinets containing storage batteries shall be supervised by an approved central, proprietary, or remote station service or shall initiate an audible and visual signal at an approved constantly attended on-site location.

N **52.3.2.8.2** Where required by 52.3.2.8(2), rooms containing stationary storage battery systems shall be protected by an approved continuous gas detection system.

N **52.3.2.8.2.1** The gas detection system shall be designed to activate when the level of flammable gas exceeds 25 percent of the lower flammable limit (LFL)

N **52.3.2.8.2.2** Activation of the gas detection system shall result in activation of the mechanical ventilation system, which shall remain on until the flammable gas detected is less than 25 percent of the LFL.

N **52.3.2.8.2.3** The gas detection system shall include a minimum two hours of standby power.

N **52.3.2.8.2.4** Failure of the gas detection system shall annunciate a trouble signal at an approved central, proprietary, or remote station service, or when approved at a constantly attended onsite location.

N **52.3.2.9* Spill Control and Neutralization.** Where required by 52.3.2.11, approved methods and materials shall be provided for the control and neutralization of spills of electrolyte or other hazardous materials in rooms containing stationary storage batteries as follows:

(1) For batteries with free-flowing electrolyte, the method and materials shall be capable of neutralizing a spill of the total capacity from the largest cell or block to a pH between 5.0 and 9.0.
(2) For batteries with immobilized electrolyte, the method and materials shall be capable of neutralizing a spill of 3.0 percent of the capacity of the largest cell or block in the room to a pH between 5.0 and 9.0.

N **A.52.3.2.9** Methods of achieving this protection can include, but are not limited to, the following:

(1) Liquidtight sloped or recessed floors in indoor locations or similar areas in outdoor locations
(2) Liquidtight floors in indoor locations or similar areas in outdoor locations provided with liquidtight raised or recessed sills or dikes
(3) Sumps and collection systems

N **52.3.2.10 Thermal Runaway.** Where required by 52.3.2.11, a listed device or other approved method shall be provided to preclude, detect, and control thermal runaway.

N **52.3.2.11 Battery-Specific Protection.** Stationary storage battery systems shall comply with 52.3.2 through 52.3.2.10 and this section, as applicable.

N **52.3.2.11.1 Lithium Batteries.** Stationary storage battery systems utilizing lithium batteries shall be provided with thermal runaway protection in accordance with 52.3.2.10.

N **52.3.2.11.2 Sodium Batteries.** Stationary storage battery systems utilizing sodium batteries shall comply with the following:

(1) Ventilation shall be provided in accordance with 52.3.2.8.
(2) Spill control and neutralization shall be in accordance with 52.3.2.9.
(3) Thermal runaway protection shall be provided for in accordance with 52.3.2.10.
(4) A hazard mitigation analysis shall be provided for systems that utilize sodium sulfur batteries, or other sulfur-type battery systems that operate above ambient temperatures.
(5) The signage required in 52.3.2.6.5 shall include, where applicable, "Water Reactive Hazard — Apply No Water."

N **52.3.2.11.3 Flow Batteries.** Stationary storage battery systems utilizing flow batteries shall comply with the following:

(1) Ventilation shall be provided in accordance with 52.3.2.8.
(2) Spill control and neutralization shall be in accordance with 52.3.2.9.

N **52.3.2.11.4 Other Battery Types.** Stationary storage battery systems utilizing battery technologies other than those described in 52.3.2.11.1 through 52.3.2.11.1 shall comply with the following:

(1) Ventilation shall be provided in accordance with 52.3.2.8 where flammable, toxic or highly toxic gases could be present during charging, discharging, and normal system use.
(2) Spill control and neutralization shall be in accordance with 52.3.2.9 where the batteries contain electrolytes that could be released from the batteries.
(3) Thermal runaway protection shall be provided in accordance with 52.3.2.10.
(4) The signage required in 52.3.2.6.5 shall also identify any potential hazards associated with the batteries.

N **52.3.2.12 Testing, Maintenance, and Repairs.**

N **52.3.2.12.1** Stationary storage batteries and associated equipment and systems shall be tested and maintained in accordance with the manufacturer's instructions.

N **52.3.2.12.2** Any storage batteries or system components used to replace existing units shall be compatible with the battery charger, battery management systems, other storage batteries, and other safety systems.

N **52.3.3 Capacitor Energy Storage Systems.**

N **52.3.3.1 Capacity.** Stationary capacitor energy storage systems having capacities greater than those described in Table 52.3.1 shall comply with 52.3.3.

Battery systems historically have been kept in a separate location that is typically considered an equipment area. Some AHJs have interpreted this action to mean that a separation is required between the battery system and the equipment served. Separation between the two areas is not the intent of 52.3.3.1 and

52.3.3.2; therefore, if the designer determines that the battery and the equipment are to be located in one space, no separation is needed.

N **52.3.3.2 Location and Occupancy Separation.** Stationary capacitor energy storage systems shall be located and constructed as required for stationary storage battery system in accordance with 52.3.2.1 through 52.3.2.1.4.3.

The security of a battery system is one of the safety features designed to limit battery system problems. Misuse or vandalism of a battery system or unintended damage can cause a system to fail or start a fire. Any contact of the system with metal objects, liquid spills, or physical impact could start a series of events that would override built-in safety features. Battery racks, trays, and cabinets must be made of substantial construction and protected to withstand corrosion from trace amounts of acid released during charging, particularly from open systems. Persons within the room or having access to the room or cabinet must be trained to understand the hazards associated with this type of equipment.

N **52.3.3.3 Maximum Allowable Quantities.** Fire areas within buildings containing capacitor energy storage systems exceeding 600 KWh (2160 mJ) shall comply with all applicable ordinary-hazard and high-hazard requirements as identified in 6.2.2 of NFPA *101* and the building code.

N **52.3.3.4 Capacitor Arrays.**

N **52.3.3.4.1** Capacitors, prepackaged stationary capacitor energy storage systems, and pre-engineered capacitor energy storage systems shall be segregated into arrays not exceeding 50 KWh (180 Mega joules) each.

N **52.3.3.4.2** Each array shall be spaced a minimum 3 ft (914 mm) from other arrays and from walls in the storage room or area. The storage arrangements shall comply with the egress provisions in NFPA *101*.

N **52.3.3.5 Listings.** Capacitors shall be listed in accordance with UL 1973, *Standard for Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications*. Prepackaged and pre-engineered capacitor energy systems shall be listed in accordance with UL 9540, *Outline of Investigation for Energy Storage Systems and Equipment*.

N **52.3.3.5.1* Prepackaged and Pre-engineered Systems.** Prepackaged and pre-engineered capacitor energy storage systems shall be installed in accordance with their listing and the manufacturer's instructions.

N **A.52.3.3.5.1** A prepackaged capacitor energy system is designed and investigated as a single unit, assembled in a factory, and shipped to the site. A pre-engineered capacitor energy system is designed and investigated as a single unit, but is shipped in modular form for assembly at the site.

N **52.3.3.5.2 Environment.** The environment surrounding the capacitors shall be controlled to maintain temperatures and conditions within the manufacturer's specifications.

N **52.3.3.6 Chargers.** Capacitor chargers shall be compatible with the capacitor manufacturer's electrical ratings and charging specifications, and shall be listed in accordance with the UL 1564, *Standard for Industrial Battery Chargers*, or provided as part of a listed pre-engineered or prepackaged capacitor energy storage system.

N **52.3.3.7 Vehicle Impact Protection.** Vehicle impact protection shall be provided where capacitor energy storage systems are subject to impact by motor vehicles.

N **52.3.3.8 Combustible Storage.**

N **52.3.3.8.1** Combustible materials not related to the capacitor energy storage system shall not be stored in capacitor rooms, cabinets, or enclosures.

N **52.3.3.8.2** Combustible materials in occupied work centers shall comply with Section 10.18 and shall not be stored within 3 ft (915 mm) of capacitor cabinets.

N **52.3.3.9 Signage.** Approved signage shall be provided on doors or in approved locations near entrances to capacitor energy storage systems, and shall include the following:

(1) Hazard identification markings in accordance with NFPA 704.
(2) "This room contains energized capacitor systems," or the equivalent
(3) Identification of the type(s) of capacitors present
(4) AUTHORIZED PERSONNEL ONLY

N **52.3.3.9.1** Where the capacitor energy storage system disconnecting means is not within sight of the main service disconnect, placards or directories shall be installed at the locations of the main service disconnect to indicate the location of all capacitor energy storage system disconnecting means in accordance with *NFPA 70*.

N **52.3.3.9.2** Capacitor cabinets shall be provided with exterior labels that identify the manufacturer and model number of the system and electrical rating (i.e., voltage and current) of the contained battery system.

N **52.3.3.9.3** Signs shall be provided within capacitor cabinets to indicate the relevant electrical, chemical, and fire hazard.

N **52.3.3.9.4** Fire command centers in buildings containing capacitor energy storage systems shall include signage or readily available documentation that describes the location of the systems, the types of capacitors present, operating voltages, and location of electrical disconnects.

N **52.3.3.10 Seismic Protection.** Capacitor energy storage systems shall be seismically braced in accordance with the building code.

N **52.3.3.11 Testing, Maintenance, and Repairs.**

N **52.3.3.11.1** Capacitor energy storage systems and associated equipment and systems shall be tested and maintained in accordance with the manufacturer's instructions.

N **52.3.3.11.2** Capacitors or system components used to replace existing units shall be compatible with the capacitor charger, other capacitors, and other safety systems.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 69, *Standard on Explosion Prevention Systems,* 2014 edition.
NFPA 72®, National Fire Alarm and Signaling Code®, 2016 edition.
NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents,* 2018 edition.
NFPA 600, *Standard on Facility Fire Brigades,* 2015 edition.
NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response,* 2017 edition.
NFPA 855, *Standard for the Installation of Energy Storage Systems*, in development.

Fire Protection Guide to Hazardous Materials, Colonna, G. R., ed., 2010 edition.

53 Mechanical Refrigeration

Chapter 53 covers mechanical refrigeration systems, which are usually designed to provide a means for cooling specific locations or processes to temperatures below ambient. Although the types of mechanical refrigeration systems are many, all involve heat exchangers, differing only in size, mechanical and thermal design, and use of different fluids as refrigerants.

53.1* General

A.53.1 See the mechanical code for refrigerant group descriptions.

For the most part, the design of mechanical refrigeration systems is overseen by regulations listed in the mechanical code adopted by the jurisdiction. For mechanical refrigeration systems, the intent of this *Code* is to identify appropriate safety features for the system. Depending on the type of refrigerant gas used, different levels of safety are necessary. Traditional refrigerant gases, such as chlorofluorocarbons (CFCs), have been eliminated from all new systems because of scientific evidence that they have the capability of destroying the ozone layer surrounding the earth. CFCs have been replaced by CFC substitutes, natural refrigerants, which have a lower global warming potential (GWP). One type of natural refrigerant are hydrocarbons, such as propane, which are classified as A3 refrigerants. Most common CFC substitute refrigerant gases are relatively harmless. However, one longtime refrigerant gas still in use is ammonia.

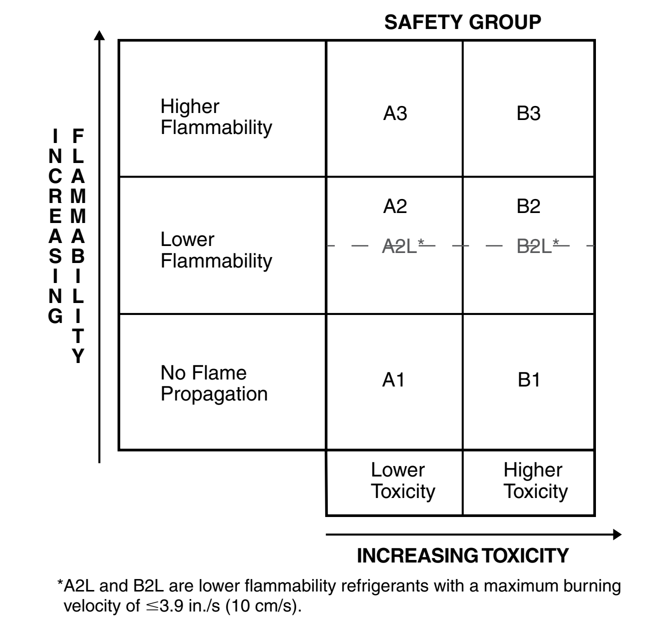
The material safety data sheet (MSDS) on a refrigerant gas is a good way to become familiar with the properties of the refrigeration agent. To effectively use Chapter 53, the user should know whether the refrigerant gas is toxic, highly toxic, or flammable and whether it has other hazard characteristics or no characteristics. The user also should know whether the gas is lighter or heavier than air in order to implement the proper protection features.

A refrigerant can be a liquid, a gas, or a combination of both. In order to measure the amount of refrigerant, the refrigeration industry measures the refrigerant by its weight, referring to pounds (or kilograms) of refrigerant. Section 53.1 explains the conditions under which the refrigeration equipment and system must comply with the stated provisions, which are based on the type of refrigerant and the number of pounds (kilograms) of refrigerant in the system.

If the refrigeration equipment contains refrigerant gases that are classified as hazardous (toxic, highly toxic, or flammable — including ammonia, which deflagrates), the refrigeration system and its components might be required to meet additional protection levels, including stronger seismic restraint, as required by the building code adopted by the jurisdiction.

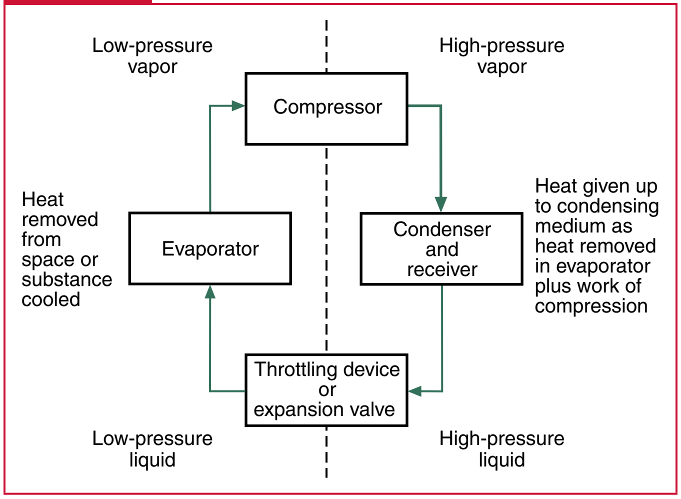
Safety group classification of refrigerants can be found in Exhibit 53.1. Exhibit 53.2 is a schematic of a refrigeration system, consisting of a circulating refrigerant, a condenser and receiver, a control device, an evaporator, and a compression device.

Exhibit 53.1



Refrigerant safety group classification. (Courtesy of ASHRAE; from ANSI/ASHRAE 34, Designation and Safety Classification of Refrigerants, 2016)

Exhibit 53.2



Schematic of basic mechanical refrigeration system. (© FM Global; reprinted with permission)

53.1.1 Applicability.

53.1.1.1* Refrigeration unit and system installations having a refrigerant circuit containing more than 220 lb (100 kg) of Group A1 or 30 lb (13.6 kg) of any other group refrigerant shall be in accordance with Chapter 53 and the mechanical code.

Refrigerant groups are found in the IAPMO *Uniform Mechanical Code*™. Most refrigerants made from CFCs are classified as Group A1. These refrigerants generally have a very low toxicity level, usually an immediately dangerous to life and health (IDLH) rating of 50,000 ppm, and are nonflammable, as listed in the *Uniform Mechanical Code*.

Other refrigerant gases have been developed that might be identified in other refrigerant classifications. An important practice is always to ask for the refrigerant name and an MSDS on the refrigerant. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) helps maintain the accuracy of Table 1102.3, Refrigerant Groups Properties and Allowable Quantities, found in the *Uniform Mechanical Code*. The table can be a valuable resource in helping to properly classify refrigerant gases.

Chapter 53 regulates refrigeration systems having a refrigerant circuit containing more than 220 lb (100 kg) of Group A1 or 30 lb (13.6 kg) of any other group refrigerant.

A.53.1.1.1 Refrigerant safety groups are established by ANSI/ASHRAE 34, *Designation and Safety Classification of Refrigerants*. Safety groups are based on the relative safety with respect to toxicity and flammability. The classification groups include a letter designation that indicates the toxicity (A is "lower toxicity" and B is "higher toxicity") and a number that indicates flammability (1 indicates no flame propagation in air when tested by prescribed methods at specified conditions, 2 is "lower flammability," and 3 is "higher flammability").

53.1.1.2 Temporary and portable installations shall be exempt from the requirements of this chapter when approved.

53.1.2 Permits and Plans.

53.1.2.1 Permits, where required, shall comply with Section 1.12.

A permit might be required for a variety of reasons, including for construction or installation of the refrigeration system once it has been proven to comply with the provisions of Chapter 53. The authority having jurisdiction (AHJ) should inspect the refrigeration system annually to ensure that compliance with Chapter 53 is maintained throughout the life of the refrigeration system. A permit also provides the advantage of spotting a potential hazard within a jurisdiction.

A useful reference for the permit application process is the Hazardous Materials Management Plan (HMMP) Instructions shown in Figure D.3.1 of this *Code*. The HMMP provides the name of the facility, the names of responsible individuals at the location, a chemical inventory statement (for amounts of refrigerant gases on site), and a sketch of the building that includes locations of emergency controls. This provision references the standard permit requirement found in Table 1.12.8(a).

53.1.2.2 Plans and specifications for devices and systems required by this chapter shall be submitted to the AHJ for review and approval prior to installation.

The AHJ usually does not require permits to maintain a refrigeration system. Where a system is being maintained, it is assumed that it is being run in a safe operating condition, just as it was at the time of installation. An exception to this rule is when a refrigerant is replaced with a different type of gas. (See 53.3.1.4.)

53.1.3 Reference Codes and Standards. Refrigeration systems shall be in accordance with ASHRAE 15 and the mechanical code. Refrigeration systems using ammonia as a refrigerant shall also comply with ANSI/IIAR 2, *Standard for Equipment, Design and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems*.

Subsection 53.1.3 was updated for the 2015 edition of the *Code* to reference not only ANSI/ASHRAE 15, *Safety Standard for Refrigeration Systems,* but also ANSI/IIAR 2, *Standard for Equipment, Design and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems,* for ammonia refrigerants, which is a common CFC replacement gas. For ammonia refrigeration systems, IIAR 2 is an ANSI-accredited document that supplements ASHRAE 15 and provides important additional safeguards regarding the equipment, design, and installation of closed-circuit ammonia mechanical refrigerating systems. ANSI/IIAR 2 is also referenced by other recognized mechanical codes.

53.2 Safety Features

53.2.1 Emergency Pressure Control System. Refrigeration systems containing more than 6.6 lb (3 kg) of flammable, toxic, or highly toxic refrigerant or ammonia shall be provided with an emergency pressure control system in accordance with 53.2.1.1 and 53.2.1.2.

Earlier editions of this *Code* required manually operated emergency control boxes for certain refrigeration systems. Subsection 53.2.1 now requires an automatic emergency pressure control system to be installed. The International Institute of Ammonia Refrigeration (IIAR) has developed a detailed design guide for emergency pressure control systems, which can be found in Appendix K of ANSI/IIAR 2.

Enhancements in refrigeration system control equipment associated with new technologies now make it possible to provide an automatic emergency control system to replace key functions of the traditional emergency control box. The proposed automatic controls provide a means of mitigating an overpressure condition prior to operation of emergency pressure relief vents and, most likely, prior to the arrival of emergency responders. The automatic valves also eliminate the need for emergency responders to decipher the condition of a system in an attempt to determine whether operation of manual crossover valves in an emergency control box would be of benefit in mitigating a system malfunction.

This requirement ensures that lower pressure zones will be capable of handling the additional pressure added by a crossover condition without overpressurizing or operating the emergency relief vents on the lower zone. Earlier editions of the *Code* did not address this concern on the assumption that someone operating a manual bypass valve in the emergency control box would be knowledgeable with regard to system limitations. Nevertheless, this *Code* has never required the low pressure side of the system to handle the high pressure side, and, therefore, some systems with emergency control boxes could present the potential for an emergency responder to overpressurize a system zone by fully opening a manual crossover valve too quickly. The resulting overpressure condition could cause a relief vent to operate or even cause a failure in the piping system.

Overall, the requirement for a fully redundant safety control system in lieu of a manual system has rarely, if ever, been utilized by the fire service. Such a requirement would resolve long-standing concerns regarding the potential for harm caused by an untrained person operating valves in an emergency control box. There is no condition under which removal of refrigerant from a refrigeration system by the fire service is considered advisable. In contrast, automatic transfer of excess pressure to another zone of the system in conjunction with stopping the pressure source (compressors) can safely mitigate an overpressure condition.

The unlikely event in which a fire causes an overpressure condition that allows system zones to automatically interconnect creates a much larger heat sink to limit pressure buildup while safely containing refrigerant. If the exposure fire continues to grow, emergency relief vents can protect the refrigeration system, and automatic-reseating valves can automatically limit the release of refrigerant to the amount necessary to maintain the system within design limits. In contrast, an emergency responder normally would not know how to properly cycle a manual valve in an emergency control box to limit the release of refrigerant to the minimum amount necessary for safety.

The 6.6 lb (3 kg) threshold parallels existing provisions found in other model codes.

53.2.1.1 High and Intermediate Pressure Zones. Each high and intermediate pressure zone in a refrigeration system shall be provided with a single automatic valve providing a crossover connection to a lower pressure zone. Automatic crossover valves shall comply with 53.2.1.1.1 through 53.2.1.1.4.

53.2.1.1.1 Overpressure Limit Set Point for Crossover Valves. Automatic crossover valves shall be provided to automatically relieve excess system pressure to a lower pressure zone if the pressure in a high or intermediate pressure zone rises to within 90 percent of the set point for emergency pressure relief devices.

Prior to the 2009 edition of the *Code*, this requirement used 15 psi (103.3 kPa) as the trigger for application of this paragraph. Beginning with the 2009 edition, however, this section instead uses the trigger of 90 percent of the set point differential between operation of the crossover valve and the emergency relief vent. The intent has not changed, and there continues to be a minimum to permit the overpressure condition to be mitigated prior to operation of the emergency relief vent. A larger pressure differential is preferred where possible, because emergency relief vents will often begin to open at a pressure below the indicated operating pressure. Larger differentials provide an increased factor of safety and can prevent unnecessary operation of a relief vent. This additional safety system is likely to lead to a dramatic reduction in fugitive discharges from refrigeration systems during both day-to-day operations and emergency conditions.

53.2.1.1.2 Manual Operation. Where required by the AHJ, automatic crossover valves shall be capable of manual operation.

Paragraph 53.2.1.1.2 permits the AHJ to require manual control capabilities for the crossover valve. Although this requirement is not regarded as necessary, it recognizes the option for manual controls. Some fire departments are reluctant to give up manual controls, which the AHJ can mandate if necessary.

53.2.1.1.3 System Design Pressure. Refrigeration system zones that are connected to a higher pressure zone by an automatic crossover valve shall be designed to safely contain the maximum pressure that can be achieved by interconnection of the two zones.

53.2.1.1.4 Automatic Emergency Stop. Operation of an automatic crossover valve shall cause all compressors on the affected system to immediately stop in accordance with the following:

(1) Dedicated pressure-sensing devices located immediately adjacent to crossover valves shall be permitted as a means for determining operation of a valve.
(2) To ensure that the automatic crossover valve system provides a redundant means of stopping compressors in an overpressure

condition, high pressure cutout sensors associated with compressors shall not be used as a basis for determining operation of a crossover valve.

The intent of this provision is for the automatic crossover system to have a fully redundant means of stopping compressors. Compressors are ordinarily provided with automatic high pressure cutout controls, but 53.2.1.1.4 requires that these controls not be used to satisfy the *Code* requirement. An additional set of controls is required to serve as a backup means of preventing a severe overpressure condition that could cause operation of an emergency relief vent.

53.2.1.2 Low Pressure Zone.

The lowest pressure zone of a system cannot be arranged to bleed pressure to another system zone, since crossing the lowest pressure zone to a higher pressure zone would most likely result in reverse flow. However, by providing a redundant emergency stop control, which would disengage the compressor, an overpressure condition should be automatically mitigated.

Overpressure on a low pressure zone would most likely result from a defrost line from the high pressure side that is stuck in the open position, and stopping the compressor will disengage the pressure source for the defrost system. Note that compressors will cut out only if an overpressure condition occurs. If the emergency condition involves a leak on the low pressure side, compressors will continue to operate, which is beneficial in pumping down the low pressure side for this type of event.

53.2.1.2.1 Overpressure Limit Set Point for Emergency Stop. The lowest pressure zone in a refrigeration system shall be provided with a dedicated means of determining a rise in system pressure to within 90 percent of the set point for emergency pressure relief devices.

53.2.1.2.2 Automatic Emergency Stop. Activation of the overpressure sensing device shall cause all compressors on the affected system to immediately stop.

53.2.2 Treatment, Flaring, and Diffusion Systems for Refrigerant Discharge.

53.2.2.1 Required Systems. Unless the AHJ determines, upon review of an engineering analysis prepared at the expense of the owner, that a significant fire, health, or environmental hazard would not result from an atmospheric release, refrigeration systems that are designed to discharge refrigerant vapor to the atmosphere shall be provided with an approved treatment, flaring, or diffusion system where required by 53.2.2.1.1 through 53.2.2.1.3.

Paragraph 53.2.2.1 requires a treatment system for the discharge of the refrigerant. In some cases, this paragraph allows for review of the protection needs and allows the AHJ to permit other types of protection based on the review. An example of the application of this provision might include a cold storage (refrigerated) warehouse that could be located so far from populations, including rural housing, that a release of refrigerant would not impact public health or the environment. The refrigeration system installer needs to show, by a calculation or dispersion model that, by the time it disperses over a populated area, the refrigerant gas will be diluted in air to the point that it is not a health hazard to the public. The AHJ should check with other jurisdictional authorities to see whether future planned development includes a densely populated area located within the calculated impact area of the dispersion model.

53.2.2.1.1 Toxic and Highly Toxic Refrigerants. Systems containing toxic or highly toxic refrigerants shall discharge vapor to the atmosphere only through an approved treatment system in accordance with Chapter 63 or flaring system in accordance with 53.2.2.2.

Currently, the only amounts of toxic or highly toxic refrigerant gas that would trigger the need for a treatment system are those specified in 53.1.1.1. The definitions of the terms *toxic material* and *highly toxic material,* also found in 3.3.180.14 and 3.3.180.7, respectively, and extracted from NFPA 400, *Hazardous Materials* Code, are as follows:

> **Toxic Material.** A material that produces a lethal dose or a lethal concentration within any of the following categories: (1) a chemical or substance that has a median lethal dose (LD_{50}) of more than 50 mg/kg but not more than 500 mg/kg of body weight when administered orally to albino rats weighing between 200 g and 300 g each; (2) a chemical or substance that has a median lethal dose (LD_{50}) of more than 200 mg/kg but not more than 1000 mg/kg of body weight when administered by continuous contact for 24 hours, or less if death occurs within 24 hours, with the bare skin of albino rabbits weighing between 2 kg and 3 kg each; (3) a chemical or substance that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2000 parts per million by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L, of mist, fume, or dust when administered by continuous inhalation for 1 hour, or less if death occurs within 1 hour, to albino rats weighing between 200 g and 300 g each. [**400,** 2016]

> **Highly Toxic Material.** A material that produces a lethal dose or lethal concentration that falls within any of following categories: (1) a chemical that has a median lethal dose (LD_{50}) of 50 mg/kg or less of body weight when administered orally to albino rats weighing between 200 g and 300 g each; (2) a chemical that has a median lethal dose (LD_{50}) of 200 mg/kg or less of body weight when administered by continuous contact for 24 hours, or less if death occurs within 24 hours, with the bare skin of albino rabbits weighing between 2 kg and 3 kg each or albino rats weighing 200 g to 300 g each; (3) a chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by

volume or less of gas or vapor, or 2 mg/L or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour, or less if death occurs within 1 hour, to albino rats weighing between 200 g and 300 g each. [**400,** 2016]

Discharges from any treatment system for toxic or highly toxic gases must not be closer than 75 ft (23 m) from any building opening (e.g., windows, doors, mechanical air intake) or property line.

53.2.2.1.2 Flammable Refrigerants. Systems containing flammable refrigerants shall discharge vapor to the atmosphere in accordance with the following:

(1) For refrigerants having a density equal to or greater than the density of air, discharge shall be through an approved treatment system in accordance with or flaring system in accordance with 53.2.2.2.
(2) For refrigerants having a density less than the density of air, discharge to the atmosphere shall be permitted, provided that the point of discharge is located outside of the structure at not less than 15 ft (4.6 m) above the adjoining grade level and not less than 20 ft (6.1 m) from any window, ventilation opening, or exit.

53.2.2.1.3 Ammonia Refrigerant. Systems containing ammonia refrigerant shall discharge vapor to the atmosphere through a treatment system in accordance with 53.2.2.1, through a flaring system in accordance with 53.2.2.2, through an approved ammonia diffusion system in accordance with 53.2.2.3, or by other approved means except as follows:

(1) Discharge through a treatment, flaring, or diffusion system shall not be required for ammonia–water absorption unit systems installed outdoors serving a dwelling unit, provided that the discharge is shielded and dispersed.
(2) Discharge through a treatment, flaring, or diffusion system shall not be required for ammonia–water absorption unit systems containing less than 22 lb (10 kg) of ammonia and for which the ammonia circuit is located entirely outdoors.

53.2.2.2 Design of Flaring Systems.

53.2.2.2.1 Flaring systems for incineration of flammable, toxic, or highly toxic refrigerants or ammonia shall be designed to incinerate the entire discharge.

53.2.2.2.2 The products of refrigerant incineration shall not pose health or environmental hazards.

The MSDS helps determine which products of combustion will be released into the atmosphere after the incineration process and whether the particles of combustion pose harm to populations downwind of a flaring system.

53.2.2.2.3 Incineration shall be automatic upon initiation of discharge, shall be designed to prevent blowback, and shall not expose structures or materials to threat of fire.

53.2.2.2.4 Standby fuel, such as LP-Gas, and standby power shall have the capacity to operate for one and one half the required time for complete incineration of refrigerant in the system.

See Chapters 60, 66, and 69 of this *Code* for proper amounts, storage, and separation of standby fuel system requirements.

53.2.2.3 Design of Ammonia Diffusion Systems.

53.2.2.3.1 Ammonia diffusion systems shall include a tank containing 1 gal of water for each pound of ammonia (4 L of water for each kg of ammonia) that will be released in 1 hour from the largest relief device connected to the discharge pipe.

53.2.2.3.2 The water used shall be prevented from freezing without the use of salt or chemicals by burial of the discharge pipe below frost depth or other approved means.

53.2.2.3.3 The discharge pipe from the pressure relief device shall distribute ammonia in the bottom of the tank, but no lower than 33 ft (10 m) below the maximum liquid level.

53.2.2.3.4 The tank shall contain the volume of water and ammonia, described in 53.2.2.3.1, without overflowing.

53.2.2.3.5 The tank shall be substantially constructed of not less than ⅛ in. (2.51 mm) (10 gauge) steel.

53.2.2.3.6 The horizontal dimensions of the tank shall be equal to or less than one half of the height.

53.2.2.3.7 The tank shall have a hinged cover or, if of the enclosed type, shall have a vent hole at the top.

53.2.2.3.8 Pipe connections shall be through the top of the tank.

53.2.3 Refrigeration Machinery Rooms. Where required by the mechanical code, refrigeration systems shall be provided with a refrigeration machinery room, which shall comply with 53.2.3.1 through 53.2.3.4.

Refrigeration machinery rooms are rooms that contain stop valves for all the refrigerant gas–entrained portions of the system, except some evaporators, cooling towers, and other piping allowed to be omitted by the mechanical code. The *Uniform Mechanical Code* states that the refrigeration mechanical room must be not less than 6 ft 8 in. (2 m) high, with an unobstructed space of not less the 36 in. (915 mm), to gain access.

53.2.3.1 Refrigerant Vapor Detection, Monitoring, Alarm, and Electrical Systems. Refrigeration machinery rooms shall have an approved refrigerant vapor detection, monitoring, and alarm system in accordance with 53.2.3.1.1 through 53.2.3.1.7 and the mechanical code.

53.2.3.1.1 Alarm Threshold. The refrigerant vapor detector shall activate approved visual and audible alarm signaling devices at one of the following refrigerant thresholds:

(1) At a value not greater than the corresponding TLV-TWA (or toxicity measure consistent therewith); not to exceed 25 percent of the lower flammable limit (LFL)
(2) For ammonia, at a concentration not exceeding 25 parts per million

Depending on the type of refrigerant, vapor detectors need to be placed either at floor level for refrigerants heavier than air or at the highest point of the ceiling for refrigerants lighter than air. The AHJ should witness the detector's ability to function and record the vapor concentration at which the detector is activated. Detectors must activate at a point not greater than 50 percent of the IDLH, at the gas's permissible exposure limit (PEL), measured in ppm, or at 25 percent of the lower flammability limit (LFL). When the system detects the refrigerant's PEL, it is not unusual to have a gas detection system cause a warning alarm and then activate an emergency alarm capable of "dumping" the system of refrigerant when a given gas reaches 50 percent of the IDLH or 25 percent of the LFL.

Information on flammability limits for flammable gases and vapors can be found in NFPA 69, *Standard on Explosion Prevention Systems,* and NFPA's *Fire Protection Guide to Hazardous Materials*.

53.2.3.1.2 Location of Signaling Devices. Audible and visual alarm signaling devices shall be located inside the refrigeration machinery room and outside the room at each entrance into the room.

53.2.3.1.3 Audibility. Audible alarm signaling devices shall provide a sound level of at least 15 dB above the operating ambient noise sound pressure level of the space in which they are installed and shall provide approved, distinctive audible and visual alarms.

The alarms identified in 53.2.3.1.3 are not permitted to be fire alarms. The system must activate a distinctive audible alarm system that differs from the sound and visual color of a fire alarm. The refrigerant gas detection devices need to be located either near floor level for refrigerant gases that are heavier than air or at the highest ceiling point for refrigerant gases lighter than air.

Refrigerant vapor detection alarm systems are usually not required if the system can be sufficiently exhausted by natural ventilation or if the system contains a refrigerant amount not regulated by Chapter 53.

53.2.3.1.4* Emergency Shutoff Interface. Where the quantity of a Group A2, B2, A3, or B3 refrigerant, other than ammonia, in an independent circuit would exceed 25 percent of the LFL if released to the surrounding room, either of the following shall apply:

(1) Electrical equipment shall comply with the requirements of *NFPA 70* for Class I, Division 2.
(2) The refrigerant vapor detection system required by 53.2.3.1 shall automatically de-energize all electrical power within the space at vapor concentrations at or above 25 percent of the LFL.

A.53.2.3.1.4 See A.53.1.1.1.

53.2.3.1.5 Power and Supervision. Refrigerant vapor detection and alarm systems shall be powered and supervised as required for fire alarm systems in accordance with *NFPA 72*.

53.2.3.1.6 Monitoring and Annunciation. Refrigerant vapor detection and alarm systems shall transmit a signal to an approved location.

53.2.3.1.7 Installation and Maintenance. Detection and alarm systems shall be installed and maintained in accordance with the equipment manufacturers' specifications. *(Also see 53.3.2.1.)*

53.2.3.2* Prohibited Sources of Ignition. Open flames or devices having an exposed surface temperature exceeding 800°F (427°C) shall be prohibited in refrigeration machinery rooms except as follows:

(1) Momentary temperature excursions such as electrical contacts in Group A1 and B1 systems shall be permitted.
(2) Open flames or devices having an exposed surface temperature exceeding 800°F (427°C) shall be permitted in refrigeration machinery rooms used exclusively for direct-fired absorption equipment.
(3) Existing nonconforming installations shall be permitted where approved by the AHJ, where the combustion system is interlocked with the refrigerant detection system to shut off at the permissible exposure limit (PEL).
(4) Direct-vented combustion equipment shall be permitted in accordance with the mechanical code.

A.53.2.3.2 See A.53.1.1.1.

53.2.3.3 Ventilation Systems.

53.2.3.3.1 Fans providing emergency purge ventilation for refrigerant escape from a refrigeration room shall have a clearly identified switch of the break-glass type providing on-only control immediately adjacent to, and outside of, each refrigerant machinery room means of egress.

53.2.3.3.2 An emergency purge control shall be provided with a manual reset only.

53.2.3.3.3 For systems using a refrigerant other than ammonia, purge fans shall also respond automatically to the refrigerant concentration detection system set to activate the ventilation system at the threshold levels set forth in 53.2.3.1.1. For systems using ammonia, purge fans shall also respond automatically to the refrigerant concentration detection system set to activate the ventilation system at an ammonia concentration not exceeding 150 parts per million.

New for the 2018 edition of the *Code*, 53.2.3.3.3 was updated to differentiate the detection threshold for activation of ventilation systems from refrigeration rooms for systems using a refrigerant other than ammonia and also for those using ammonia. This change correlates with the provisions of ANSI/IIAR-2, *Standard for the Safe Design of Closed-Circuit Ammonia Refrigeration Systems.*

53.2.3.3.4 Mechanical ventilation systems serving refrigeration rooms shall have switches to control the power to each fan.

53.2.3.3.5 The switches shall be key-operated or within a locked glass-covered or tamper-resistant enclosure at an approved location adjacent to and outside of the principal entrance to the refrigeration machinery room.

53.2.3.3.6 Keys necessary for operation of ventilation systems shall be located in a single approved location.

An example of "a single approved location" required by 53.2.3.3.6 is the access box for the building, as described in 18.2.2.1, which addresses access to structures or areas.

53.2.3.3.7 Switches controlling fans providing continuous ventilation shall be of the two-position, on/off type.

53.2.3.3.8 Switches controlling fans providing intermittent or emergency ventilation shall be of the three-position, automatic on/off type.

53.2.3.3.9 Switches shall be labeled identifying both the function and the specific fan being controlled.

53.2.3.3.10 Two colored and labeled indicator lamps responding to the differential pressure created by airflow shall be provided for each switch.

53.2.3.3.11 One lamp shall indicate flow, and the other shall indicate no flow.

53.2.3.3.12 Exhaust from mechanical ventilation systems in refrigeration rooms shall be discharged 20 ft (6.1 m) or more from a property line or openings into buildings.

53.2.3.3.13 Discharges capable of exceeding 25 percent of the LFL or 50 percent of the immediately dangerous to life and health (IDLH) value shall be equipped with approved treatment systems to reduce the discharge concentrations to these values or lower, except as provided in 53.2.3.3.13.1 and 53.2.3.3.13.2. *(Also see 53.2.2.1.)*

53.2.3.3.13.1 A treatment system shall not be required when an approved engineering analysis of plume dispersion demonstrates that the limiting value will not be exceeded at the property line.

53.2.3.3.13.2 A treatment system shall not be required for ventilation provided for an ammonia refrigeration system.

See NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, for requirements on mechanical ventilation systems used to exhaust refrigerants. See NFPA 69 for requirements to keep exhaust discharges from introducing explosion hazards into buildings and surrounding areas.

53.2.3.4 Electrical.

53.2.3.4.1 The refrigeration machinery room shall not be required to be classified as a hazardous location for electrical equipment except as provided in the mechanical code or *NFPA 70*.

53.2.3.4.2 Refrigeration machinery rooms used exclusively for direct-fired absorption equipment shall be permitted not to be classified as a hazardous location for electrical equipment in accordance with *NFPA 70*.

53.2.3.4.3 Electrical equipment and electrical installations in refrigeration machinery rooms shall comply with Section 11.1.

53.2.3.4.4 Where treatment, detection, or alarm systems are required, such systems shall be connected to a secondary source of power to automatically supply electrical power in the event of loss of power from the primary source.

53.2.3.4.5 A clearly identified switch of the break-glass type or with an approved tamper-resistant cover shall provide off-only control of refrigerant compressors, refrigerant pumps, and normally closed, automatic refrigerant valves located in the machinery room. In addition, this equipment shall be automatically shut off whenever the refrigerant vapor concentration in the machinery room exceeds the vapor detector's upper detection limit or 25 percent of the LFL, whichever is lower.

53.2.3.4.5.1 In machinery rooms where only nonflammable refrigerants are used, only compressors shall be required to be stopped by vapor detection or the cut-off switch. *(Also see 53.2.3.1.4.)*

53.2.4 Signs and Labels.

Δ **53.2.4.1 General.** Refrigeration units or systems shall be provided with approved hazard identification signs in accordance with NFPA 704, emergency operational signs, charts, and labels in accordance with the mechanical code, and the following:

(1) Name and address of the manufacturer or installer
(2) Type and total number of pounds of refrigerant contained in the system
(3) Field test pressure applied

53.2.4.2 Systems with More Than 110 lb (50 kg) of Refrigerant. Systems containing more than 110 lb (50 kg) of refrigerant shall be provided with signs having letters not less than ½ in. (12.7 mm) high, designating the following:

(1) Main shutoff valves to each vessel
(2) Mainstream or electrical controls
(3) Remote control switch
(4) Pressure-limiting device

53.3 Operations, Maintenance, Testing, and Decommissioning

53.3.1 Operations and Maintenance.

53.3.1.1 General. Refrigeration systems shall be operated and maintained in a safe and operable condition, free from accumulations of oil, dirt, waste, excessive corrosion, other debris, or leaks, and in accordance with ASHRAE 15, *Safety Standard for Refrigeration Systems,* and the mechanical code. Ammonia refrigerator systems shall be operated and maintained in accordance with ANSI/IIAR 7, *Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems*.

ANSI/IIAR 7, *Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems,* defines the minimum requirements for developing operating procedures for closed-circuit ammonia mechanical refrigerating systems. The operating procedures were developed to be easy to understand; to be safe, effective, and reliable; and to meet applicable regulatory requirements. ANSI/IIAR 7 is intended for those who develop, define, and/or review operating procedures for ammonia refrigeration systems. The reference to ANSI/IIAR 7 in this paragraph provides important safety information on the maintenance, inspection, and operation of ammonia refrigeration systems not currently covered elsewhere in the *Code* and is suitable for adoption and enforcement.

53.3.1.2 Access to System. Refrigeration systems shall be maintained accessible to the fire department as required by the AHJ.

Fire department emergency access to refrigeration systems, including passageways and access to control panels, usually requires an accessway of not less than 36 in. (915 mm) in width.

53.3.1.3 Storage in Machinery Rooms.

53.3.1.3.1 Flammable and combustible materials shall not be stored in refrigeration machinery rooms except for incidental materials necessary for the safe and proper operation and maintenance of the system.

53.3.1.3.2 Storage of materials in a refrigeration machinery room, including reserve supplies of refrigerants or refrigerant oils, shall be in accordance with other applicable chapters of this *Code*.

53.3.1.4 Changing of Refrigerant Type. Refrigerant types shall not be changed without prior notification and approval of the AHJ.

When refrigerant types are to be changed, the AHJ should verify that the previous refrigerant is chemically compatible with the new refrigerant and that components of the system are compatible with the new refrigerant material. The AHJ needs to verify that new vapor detectors are included in the changeover and that they will provide the same level of detection and protection required by Chapter 53.

53.3.1.5 Records of Refrigerant Quantities. The person in charge of the premises on which a refrigeration unit or system subject to these regulations is installed or maintained shall keep a written record of refrigerant quantities brought onto and removed from the premises, which shall be made available to the AHJ upon request.

53.3.1.6 Permissible Refrigerant Discharges. Refrigerant shall be only permitted to be released to atmosphere in the following circumstances:

(1) Refrigeration systems operating at pressures below atmospheric and incorporating automatic purge cycles
(2) Incidental operation of automatic pressure relief valves resulting in minor release of the refrigerant charge
(3) Incidental minor releases associated with service operations after system pumpdown has been accomplished
(4) In an emergency

For information regarding acceptable conditions for discharge of refrigerant gases, see ASHRAE safety pamphlets, which can be obtained from the ASHRAE website at www.ASHRAE.org.

Δ **53.3.1.7 Notification of Fugitive Releases.** Where required by the fire department, the fire department shall be notified upon discharges of refrigerant that are not in accordance with 53.3.1.6(1), (2), or (3).

53.3.2 Testing of Equipment.

53.3.2.1 Acceptance Testing. The following emergency devices or systems shall be tested to demonstrate their safety and effectiveness upon completion of the installation or alteration:

(1) Treatment and flaring systems
(2) Ammonia diffusion systems
(3) Fans and associated equipment intended to operate emergency purge ventilation systems
(4) Refrigerant vapor detection and alarm systems

Acceptance testing can be accomplished with a test gas connected by tubing directly to the gas detector. The gas detector must then activate the devices identified in 53.3.2.1, as required, to verify function and operation. The AHJ must witness the testing. Written verification from the manufacturer or the installer of the emergency gas detection system should not be the only condition of acceptance.

53.3.2.2 Periodic Testing. The following emergency devices or systems shall be tested in accordance with the manufacturers' specifications at intervals not exceeding one year:

(1) Treatment and flaring systems
(2) Fans and associated equipment intended to operate emergency purge ventilation systems
(3) Refrigerant vapor detection and alarm systems

53.3.2.3 Records of Required Testing. A written record of required testing shall be maintained on the premises.

53.3.2.4 Testing Personnel Qualifications. Tests of emergency devices or systems required by Chapter 53 shall be conducted by persons trained in such testing.

N **53.3.3 Decommissioning of Ammonia Refrigeration Systems.** Decommissioning of closed-circuit ammonia refrigeration systems shall comply with ANSI/IIAR 8, *Decommissioning of Closed-Circuit Ammonia Mechanical Refrigerating Systems*.

Subsection 53.3.3 is new to the 2018 edition of the *Code*. ANSI/IIAR 8, *Decommissioning of Closed-Circuit Ammonia Refrigeration Systems*, specifies the minimum criteria for removing the ammonia charge in conjunction with the decommissioning of closed-circuit ammonia refrigeration systems.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 69, *Standard on Explosion Prevention Systems*, 2014 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids*, 2015 edition.

NFPA 400, *Hazardous Materials Code*, 2016 edition.

Fire Protection Guide to Hazardous Materials, Colonna, G. R., ed., 2010 edition.

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA

ANSI/ASHRAE 15, *Safety Standard for Refrigeration Systems,* 2013.

ANSI/ASHRAE 34, *Designation and Safety Classification of Refrigerants*, 2016.

International Institute of Ammonia Refrigeration, Alexandria, VA

ANSI/IIAR 2, *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems,* 2014.

ANSI/IIAR 7, *Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems,* 2013.

ANSI/IIAR 8, *Decommissioning of Closed-Circuit Ammonia Refrigeration Systems*, 2015.

Uniform Mechanical Code™, International Association of Plumbing and Mechanical Officials (IAPMO), Ontario, CA, 2018.

Ozone Gas–Generating Equipment

54

54.1 Scope

54.1.1 Equipment having a maximum ozone-generating capacity of not less than ½ lb (0.23 kg) over a 24-hour period shall comply with Chapter 54 unless otherwise permitted by 54.1.2.

54.1.2 Chapter 54 shall not apply to ozone-generating equipment used in one- and two-family dwellings or lodging or rooming house occupancies.

Chapter 54 also deals with water treatment facilities. Section 54.1 allows for small ozone generators, which would be used for swimming pools or spas in residential occupancies. Ozone is not widely used as a disinfectant for water treatment.

For requirements and an explanation of the water treatment process, refer to NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities.*

54.2 Location

54.2.1 General.

54.2.1.1 Ozone generators shall be located in approved cabinets or ozone generator rooms in accordance with Section 54.2 unless otherwise permitted by 54.2.1.2.

54.2.1.2 Ozone generators within approved pressure vessels located outside of buildings shall not be required to be located in a cabinet or ozone generator room.

For approval criteria of cabinets used for ozone generators, see NEMA 250, *Enclosures for Electrical Equipment,* which describes construction details and compatible materials.

54.2.2 Cabinets.

54.2.2.1 Ozone cabinets shall be constructed of approved materials compatible with ozone in accordance with nationally recognized standards.

54.2.2.2* Cabinets shall display an approved sign stating: OZONE GAS GENERATOR — HIGHLY TOXIC — OXIDIZER.

A.54.2.2.2 NEMA 250, *Enclosures for Electrical Equipment*, is intended for use as a guide in the design, fabrication, testing, and use of equipment regulated by Chapter 54.

54.2.2.3 Cabinets shall be braced for seismic activity in accordance with the building code.

54.2.2.4 Cabinets shall be mechanically ventilated in accordance with all of the following:

(1) Not less than six air changes per hour shall be provided.
(2) Exhausted air shall be directed to a treatment system designed to reduce the discharge concentration of the gas to one-half of the immediately dangerous to life and health (IDLH) value at the point of discharge to the atmosphere.
(3) The average velocity of ventilation at makeup air openings with cabinet doors closed shall not be less than 200 ft/min (1.02 m/s).

54.2.3 Ozone Generator Rooms. Ozone generator rooms shall comply with all of the following:

(1) Not less than six air changes per hour shall be provided.
(2) Exhausted air shall be directed to a treatment system designed to reduce the discharge concentration of the gas to one-half of the IDLH value at the point of discharge to the atmosphere, or the ozone generator room shall be equipped with a continuous gas detection system that will shut off the ozone generator and sound a local alarm when concentrations above the permissible exposure limit occur.
(3) Ozone generator rooms shall not normally be occupied, and such rooms shall be kept free of combustible and hazardous material storage.
(4) Room access doors shall display an approved sign stating: OZONE GAS GENERATOR — HIGHLY TOXIC — OXIDIZER.

Subsection 54.2.3 requires the monitoring of ambient concentrations of ozone at indoor installations. The off-gas from the ozone contactors generally exceeds the immediately dangerous to life and health (IDLH) level; therefore, the remaining ozone gas has to be recycled or destroyed. The off-gas is first passed through a demister, which traps small water droplets on stainless steel mesh. Then the ozone gas is heated and passed through a destruct unit, which contains a catalyst to speed up the process.

Ozone is a strong oxidant that reacts with human tissues, most notably the lungs, and leads to breathing difficulties. The eyes and nose are also affected; thus, there are requirements for treating the discharge concentration of the ozone.

Unlike cabinet requirements, the ozone generator room is allowed to use an interlocked shutdown system in place of the treatment system. The interlocked shutdown system shuts down the ozone treatment process when the ozone concentrations exceed 50 percent of the IDLH for ozone.

54.3 Piping, Valves, and Fittings

54.3.1 General. Piping, valves, fittings, and related components used to convey ozone shall be in accordance with Section 54.3.

54.3.2 Secondary Containment.

54.3.2.1 Secondary containment, such as double-walled piping or exhausted enclosures, shall be provided for piping, valves, fittings, and related components, unless otherwise permitted by 54.3.2.3.

54.3.2.2 Secondary containment shall be capable of directing a sudden release to an approved treatment system.

54.3.2.3 Secondary containment shall not be required for welded stainless steel piping and tubing.

54.3.3 Materials. Materials shall be compatible with ozone and shall be rated for the design operating pressures.

For compatibility information, refer to the listing for the product to be used in an ozone-exposed environment.

54.3.4 Identification. Piping shall be identified: OZONE GAS — HIGHLY TOXIC — OXIDIZER.

54.4 Automatic Shutdown

Ozone generators shall be designed to automatically shut down when any one of the following occurs:

(1) The dissolved ozone concentration in the water being treated is above saturation when measured at the point where the water is exposed to the atmosphere.
(2) The process using generated ozone is shut down.
(3) The ventilation system for the cabinet or ozone generator room fails.
(4) The gas detection system fails.

54.5 Manual Shutdown

Manual shutdown controls shall be provided at the ozone generator and, if in a room, within 10 ft (3 m) of the main exit or exit access door.

Manual shutdown is a fail-safe effort to allow an operator to shut down the operation before the automatic shutdown procedure takes place or in the event of interlock failure. The controls for manual shutdown must be placed near the point of egress for the operator's safety.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*, 2016 edition.

NEMA 250, *Enclosures for Electrical Equipment,* National Electrical Manufacturers Association, Rosslyn, VA, 2014.

Cleaning and Purging of Flammable Gas Piping Systems

55

55.1 Application

Cleaning and purging activities for new and existing flammable gas piping found in electric generating plants and in industrial, institutional, and commercial applications shall comply with NFPA 56.

NFPA 56*, Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems,* provides minimum safety requirements for the cleaning and purging procedures of flammable gas piping systems, including cleaning new or existing piping systems, purging piping systems into service, and purging piping systems out of service. The 2017 edition of NFPA 56 is referenced in this edition of the *Code*. The first edition of NFPA 56 was issued as a provisional standard in 2011 with a 2012 edition date. The development and issuance of the document as a provisional standard ensured prompt dissemination of new safety criteria related to the safe conduct of cleaning and purging procedures of flammable and combustible gas piping systems. Within 45 days of its issuance as a provisional standard, the document entered into a complete revision cycle process. The 2014 and 2017 editions then followed.

NFPA 56 was developed in response to an explosion on February 7, 2010, at Kleen Energy, a natural gas–fueled power plant under construction. The explosion was caused by a "gas blow," a commonly used cleaning procedure in natural gas–fueled power plants, where flammable gas is blown through piping at high pressure to remove debris and foreign materials. The gas was being vented into an area where it was unable to dissipate fully and found an ignition source, triggering the explosion. The provisions of NFPA 56 now address the safe procedures that must be followed during cleaning and purging activities for new and existing flammable gas piping in electric generating plants and in industrial, institutional, and commercial applications.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems,* 2017 edition.

56–59

Reserved

In the 2018 edition of NFPA 1, *Fire Code,* the following chapters have been reserved for future use:

- Chapter 56
- Chapter 57
- Chapter 58
- Chapter 59

60 Hazardous Materials

Chapter 60 provides general requirements for the storage, use, and handling of hazardous materials and is the first in a series of chapters in this *Code* that address provisions specifically related to the protection of areas containing hazardous materials.

Chapter 60 references certain provisions of the 2018 edition of NFPA 5000®, *Building Construction and Safety Code*®, and the 2016 edition of NFPA 400, *Hazardous Materials Code*. The purpose of NFPA 400 is to provide fundamental safeguards for storing, using, and handling certain hazardous materials. The 2010 edition of NFPA 400 was the first edition of this code and marked the combination of several NFPA hazardous materials documents into a single document: NFPA 430, *Code for the Storage of Liquid and Solid Oxidizers;* NFPA 432, *Code for the Storage of Organic Peroxide Formulations;* NFPA 434, *Code for the Storage of Pesticides;* and NFPA 490, *Code for the Storage of Ammonium Nitrate*. Those four codes were then withdrawn as separate documents.

In addition to the subjects covered by the incorporated documents, NFPA 400 covers other hazardous material categories specified in building and fire codes, such as corrosives, flammable solids, pyrophoric substances, toxic and highly toxic materials, unstable materials, and water-reactive materials. Chapter 21 of NFPA 400 also covers compressed gases and cryogenic fluids by including material extracted from NFPA 55, *Compressed Gases and Cryogenic Fluids Code*.

Chapter 60 is organized as follows:

Section 60.1	General requirements
Section 60.2	Special definitions
Section 60.3	Provisions for the classification of hazardous materials and hazardous wastes and for the classification of hazard level
Section 60.4	Permissible storage quantities; permissible locations of use; requirements for control areas
Section 60.5	Basic requirements for control, mitigation, and cleanup of unauthorized releases; emergency response planning and training; hazard communication and signage; control of potential sources of ignition; handling and processing systems, including process equipment, piping systems, and storage vessels; identification of hazardous materials; separation of incompatible materials; general storage and storage cabinets (in other words, any requirements that are not quantity specific and are broadly applicable)
Section 60.6	Requirements for emergency action planning fire control, and handling of chemical hazards for certain materials when in excess of the maximum allowable quantity (MAQ)
Section 60.7	Provisions for use of a performance alternative to the prescriptive controls contained in this chapter

The home and garden warehouse described in the following case study contained chlorinated pool chemicals and pool treatment products. Based on their fire and reactivity characteristics, these materials were classified by NFPA 430 as oxidizers. (The 2000 edition of NFPA 430 was cited in the investigation report referenced in the case study. As noted above, NFPA 430 has since been withdrawn and incorporated into the new NFPA 400.) By their nature, oxidizers increase the burning rate (intensity) of combustible materials. Some oxidizers can also cause spontaneous combustion in such materials.

The storage of oxidizers poses unique hazards for emergency responders. These compounds will react exothermically to varying degrees when contaminated, depending on the specific oxidizer and the nature of the contaminant. Fires involving oxidizers can produce heat, smoke, and harmful products of combustion in greater quantities than would be expected of an equivalent size fire involving only normal combustibles. Gross contamination can cause some oxidizers to undergo an explosive reaction, particularly if they are subjected to confinement and heating. It is imperative that emergency responders be able to recognize the presence of hazardous materials, preferably by advance knowledge consequent to preplanning or by means of visual cues, such as warning placards, hazard identification signs as described by NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, and so forth. The responders can then take the appropriate action, which in some cases is to take no action at all and protect exposures (human and structural) and allow the reaction to proceed to its end.

Storage and protection of hazardous materials in accordance with applicable NFPA codes and standards are critical to the protection of life and property and can assist in minimizing the hazards posed by the storage, use, and handling of bulk quantities of hazardous materials. Chapter 60, supplemented by Chapter 61 through Chapter 75, provides the necessary requirements to ensure adequate protection where hazardous materials are present.

This case study provides but one example of the severity of a fire involving hazardous materials and just one class of hazardous material at that. Conditions could have been much worse if other classes of commodities had been involved.

Case Study

In August 2000, the National Fire Protection Association (NFPA) investigated a Phoenix, Arizona, warehouse fire that involved hazardous materials. A summary of the report, as well as key findings related to the presence of hazardous materials, follows. The complete report, "Storage Warehouse, Phoenix, AZ, August 2, 2000," can be downloaded at https://www.nfpa.org/News-and-Research/Resources/Fire-investigations/Non-residential-properties.

On August 2, 2000, a fire was discovered in a multi-tenant 85,000 ft^2 warehouse in Phoenix, Arizona, at 4:58 p.m. By the time the fire was extinguished the next day, it had completely destroyed the facility. The damage to property and the commodities stored inside was estimated at over $100 million.

The warehouse consisted of a single-story main structure, with a two-story office wing on the east side and was fully sprinklered. Two tenants occupied the warehouse: a home and garden supply company and a pharmaceutical distribution operation. The former operation housed merchandise typically found in home improvement retail outlets. Materials were stored in several configurations, including solid and open shelf rack storage and palletized, solid-pile storage. Commodities stored in that part of the building included calcium hypochlorite, referred to in the trade as "calhypo," and other pool sanitizers based on "trichlor," or trichloro-S-triazinetrione.

Storage of merchandise in the pharmaceutical section of the warehouse consisted of open and solid shelf rack storage, in single- and double-row arrangements, as well as palletized solid-pile storage and shelf storage.

The fire began in the home and garden part of the building on the afternoon of August 2, less than an hour after workers had left for the day. A large plume of smoke was spotted coming from the south portion of the warehouse by a Tempe, Arizona, battalion chief traveling on the freeway adjacent to the warehouse. Simultaneously, occupants in the pharmaceutical warehouse reported hearing banging noises from the home and garden supply portion of the building. Some employees, thinking it was a passing thunderstorm, went outside to look and saw a column of smoke rising from the building. (The banging noises were later theorized to be aerosol cans rocketing in the warehouse and striking the concrete wall between the two warehouses or containers rupturing.)

By 12:14 a.m., the fires in the north section of the building were reportedly extinguished. By morning, on August 3, the entire building and all its contents were destroyed. Department of Environmental Quality (DEQ) and Department of Human Services (DHS) representatives were on the scene from the early moments of the incident and throughout the day after the fire, monitoring air and water samples for contaminants.

Investigation into the cause of the fire was continuing as of the publication date of the NFPA report. Fire investigators had tentatively determined the area of origin was in the center of the bulk storage area of the home and garden supply warehouse, where the calhypo and trichlor materials were stored. The source of ignition had not then been determined.

The fire caused the complete destruction of the building. Most tilt-panel concrete walls had collapsed inward or outward by the time the fire was extinguished. Portions of the north wall were deliberately pushed inward with heavy equipment for safety reasons. Portions of the east wall were later demolished for safety reasons. Virtually all the contents of the home and garden warehouse were destroyed in the fire. The majority of the materials stored in the pharmaceutical warehouse were also destroyed. Those materials not destroyed by fire were contaminated by smoke.

60.1 General Requirements

60.1.1 Applicability. Occupancies containing high hazard contents shall comply with this chapter in addition to other applicable requirements of this *Code.* [**5000:**34.1.1.1]

Chapter 60 is the basis for all the requirements regarding hazardous materials and the starting point for the regulation of all hazardous materials. Depending on the materials and their amount, certain sections or all of Chapter 60 might apply. Chapter 60 adapts established regulatory provisions and experience gained from codes and standards application to expand effective protection features. The authorities having jurisdiction (AHJs) have the opportunity to regulate the amount of hazardous material at a location at a level consistent with the perceived risk to public safety presented by the hazardous material, as addressed by the applicable code or standard.

NFPA 1, *Fire Code,* uses an occupancy approach for regulating hazardous materials by allowing quantities of hazardous materials in excess of a regulated amount without a change in the occupancy classification. The occupancy approach is achieved by relying on added passive and active protection features to protect the occupancy from hazards presented by the use of the hazardous material, without posing a risk to the public located outside the occupancy. When faced with hazardous materials within a building or in large-scale industrial facilities, this *Code* refers to applicable NFPA codes and standards for the majority of requirements available to regulate the particular hazardous material(s) involved. Many of the codes and standards are written for application in industrial settings or in storage facilities, where larger quantities of hazardous materials are present because of the operations and processes involved. It is to be expected that the quantities of hazardous materials at those facilities will be greater than would be found in nonmanufacturing facilities. Recognizing that fact, the AHJ reviews or inspects facilities that normally involve the use of hazardous materials on a regular basis, for example, flammable liquids at service stations, which are regulated by NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*.

Chapter 60 includes a number of occupancy-based tables (Table 60.4.2.1.2 through Table 60.4.2.1.10.1) that were originally added in the 2006 edition. Each table provides an MAQ for each hazardous material allowed to be handled, stored, or used within a control area of that particular occupancy *without* having to resort to increased protection measures. This concept provides the designer and the AHJ with a direct understanding of the amount of each hazardous material that is permitted in any one control area without increased regulatory oversight. In conjunction with the occupancy-based tables, a section on the requirements for mercantile and industrial occupancies and storage facilities is also available. The indoor control area limits remain the key factor in the determination of the protection features required for each level of hazard. The MAQs for hazardous materials handled, stored, or used in an outdoor control area are included in Table 60.4.4.1.2.

The MAQ tables are used as a basis for determining when protection is required. Hazardous materials stored or used in amounts below the MAQs require no additional protection other than that required for the occupancy in which the material is located. But, once the MAQ limits are exceeded, the level of protection increases based on the hazardous material. As shown in the tables, some hazardous materials are not permitted within an occupancy even if additional protection is provided.

Outdoor storage, handling, and use have their own set of requirements. Protection of materials or hazards located outside a building is not usually addressed, since the perception is that little hazard exists. The intent of provisions for outdoor storage of hazardous materials is to protect those persons in the vicinity of the material and responding emergency personnel.

60.1.2 Subjects Not Regulated. Buildings, and portions thereof, containing high hazard contents limited to any of the following shall not be required to comply with this chapter:

(1) Flammable and combustible liquids associated with application of flammable finishes and complying with Chapter 43.
(2) Flammable and combustible liquids associated with wholesale and retail sales and storage in mercantile occupancies and complying with Chapter 66
(3) Class IIIA and Class IIIB combustible liquid solvents in closed systems employing listed cleaning equipment complying with Chapter 24
(4) Refrigerants and refrigerant oil contained within closed-cycle refrigeration systems complying with Chapter 53 and the building code
(5) Flammable and combustible liquid beverages in liquor stores and distributors without bulk storage
(6) High hazard contents stored or used in farm buildings or similar occupancies for on-premises agricultural use
(7) Corrosive materials in stationary batteries utilized for facility emergency power, uninterrupted power supply, or similar purposes, provided that the batteries are provided with safety venting caps and ventilation is provided in accordance with Chapter 52
(8) Corrosive materials displayed in original packaging in mercantile occupancies and intended for personal or household use or as building materials
(9) Aerosol products in storage or mercantile occupancies and complying with Chapter 61
(10) Flammable and combustible liquids storage tank buildings meeting the requirements of Chapter 24 of NFPA 30
(11) Flammable and combustible liquids storage tank vaults meeting the requirements of Chapter 25 of NFPA 30
(12) Flammable and combustible liquids process buildings meeting the requirements of Chapter 17 of NFPA 30
(13) Installation of fuel gas distribution systems and associated equipment in accordance with Section 11.4 and Chapter 69

[**5000:**34.1.1.2]

Subsection 60.1.2 identifies high hazard contents or operations that do not require compliance with Chapter 60. Many of the entries refer the user to another chapter of this *Code* or to a specific NFPA document for the purpose of locating the specific requirements and protection features for the identified hazard. Most of the hazardous materials and high hazard uses have been validated by testing and include protection features referenced in other chapters of this *Code*, using extracted provisions from NFPA codes and standards or other sources. In addition, most of the uses have been exempt from the hazardous materials regulation sections of previous editions of NFPA 1 for many years and were not identified as being a specific fire or life safety problem. However, because NFPA 1 has a concern for emergency responder safety and health, the *Code* now addresses additional classes of hazardous materials.

For the benefit of the user, following is a list of hazardous materials and situations that are exempt from the provisions of NFPA 400:

1. Personal storage and use in one- and two-family dwellings
2. Storage and use of explosives and blasting agents (see NFPA 495, *Explosive Materials Code*)
3. Storage and use of fireworks (see NFPA 1124, *Code for the Manufacture, Transportation, and Storage of Fireworks and Pyrotechnic Articles*)
4. Refrigerants and refrigerant oils in closed cycle refrigeration systems that otherwise comply with the local fire and mechanical codes
5. Storage and use of hazardous materials in farm buildings or similar occupancies and in remote locations for on-premises agricultural use
6. Corrosive materials in stationary batteries used for an emergency power supply, an uninterrupted power supply, or a similar purpose, in accordance with this *Code*
7. Storage and use of aerosol products (see NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*)
8. Corrosive materials in original packaging in mercantile occupancies and intended for personal or household use or for use as a building material
9. Flammable and combustible liquids having no other physical or health hazard covered by NFPA 400 (See NFPA 30)
10. Certain organic peroxide formulations that are capable of detonation, as manufactured, or when unpackaged, or in their authorized shipping containers, under conditions of fire exposure, when stored, manufactured, or used in accordance with NFPA 495, *Explosive Materials Code*
11. Combustible metals, as defined in NFPA 484, *Standard for Combustible Metals*
12. LP-gas storage or utilization systems, in compliance with NFPA 58, *Liquefied Petroleum Gas Code*, or NFPA 59, *Utility LP-Gas Plant Code*
13. Where approved, materials that have been satisfactorily demonstrated not to present a potential danger to public health, safety, or welfare, based upon the quantity or condition of storage
14. Off-site transportation where in accordance with U.S. Department of Transportation (DOT) regulations
15. Cellulose nitrate film stored in compliance with NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*

In item (1), the use of the word *personal* is deliberate and meaningful. The exemption is only for materials that are for the use of the occupants on a day-to-day basis. Storage of any materials that are related to an occupant's business interests would not be included in the context of *personal*.

The systems in items (4), (6), and (12) would be considered building utilities.

The wording is deliberate in item (13). It is expected that the AHJ will review each specific situation and determine whether an exemption is to be granted.

In item (14), the DOT has broad authority to preempt any local or state rule or regulation that encroaches on federal rules for transporting hazardous materials.

60.1.3 Applicability of Sections.

60.1.3.1 Quantities Not Exceeding the Maximum Allowable Quantities per Control Area. Storage, use, and handling of hazardous materials in quantities not exceeding maximum allowable quantities permitted in control areas set forth in Section 60.1.3.1 shall be in accordance with Section 60.1 through Section 60.5.

Paragraph 60.1.3.1 requires the user to follow the requirements for general protection, such as reporting quantities of hazardous materials to local and state jurisdictions and using appropriate signage, even where less than the MAQ is present. This ensures that AHJs are aware of the presence of any hazardous materials on-site and that a special review might be needed to determine the level of risk for the occupancy.

60.1.3.2 Quantities Exceeding the Maximum Allowable Quantities per Control Area. Storage, use, and handling of hazardous materials in quantities in excess of the maximum allowable quantities permitted in control areas set forth in 60.1.3.2 shall comply with Section 60.2 through Section 60.6.

Paragraph 60.1.3.2 implements the protection strategies within Chapter 60. If an amount of hazardous material exceeds the MAQ for storage, use, and handling, the user must follow all the applicable sections of the chapter. This does not include notification, signage, and reporting requirements, but it does include specific protection, construction, and property setback requirements.

60.1.3.3 Limited Applicability of this Chapter for Specific Material Classes. Chapter 60 shall apply in its entirety to all hazardous materials except where Chapters 61 through 73 of this *Code* specify that only certain sections of this chapter shall apply to a specific material classification category.

Paragraph 60.1.3.3 might appear to be in conflict with earlier sections of this chapter, but, in addition to the rest of Chapter 60, it provides guidance to the user to ensure that other chapters of the *Code* are reviewed and followed. Paragraph 60.1.3.3 allows the use of specific protection features and provides direction and limits found in other chapters for use when applicable.

An example of this application involves the use of flammable liquids. Chapter 66 contains specific requirements for the use of storage cabinets for flammable liquids. The user must apply the specific requirements found in Chapter 66 and not follow the general cabinet requirements in Chapter 60. Also, if a specific chapter other than Chapter 60 does not provide direction or protection features for a specific hazardous material use or storage arrangement, then Chapter 60 must be used to regulate that material.

60.1.4 Facility Closure.

60.1.4.1 Where required by the AHJ, no facility storing hazardous materials listed in 1.1.1 of NFPA 400 shall close or abandon an entire storage facility without notifying the AHJ at least 30 days prior to the scheduled closing. [**400:**1.9.1]

This requirement provides a means for local officials to mandate advance notice of the impending closure of a facility, so that they can work with the management of the facility to ensure proper shutdown, safe removal of any hazardous materials remaining on site, proper disposal of any hazardous waste materials, and a final risk assessment. This requirement also provides for an assessment of whether protective measures need to be kept in place. Going one step further, it can serve as notification to emergency responders that there likely will be no on-site assistance from facility personnel should an emergency occur.

60.1.4.2 The AHJ shall be permitted to reduce the 30-day period specified in 60.1.4.1 when there are special circumstances requiring such reduction. [**400:**1.9.2]

60.1.4.3 Facilities Out of Service.

60.1.4.3.1 Facilities Temporarily Out of Service. Facilities that are temporarily out of service shall continue to maintain a permit and be monitored and inspected. [**400:**1.9.3.1]

60.1.4.3.2 Facilities Permanently Out of Service. Facilities for which a permit is not kept current or that are not monitored and inspected on a regular basis shall be deemed to be permanently out of service and shall be closed in accordance with 60.1.4.4.1 through 60.1.4.4.2. [**400:**1.9.3.2]

60.1.4.4 Closure Plan.

60.1.4.4.1 Where required by the AHJ, the permit holder or applicant shall submit a closure plan to the fire department to terminate storage, dispensing, handling, or use of hazardous materials at least 30 days prior to facility closure. [**400:**1.9.4.1]

This paragraph gives the AHJ and the facility owner time to determine whether compliance for closure is regulated and whether the agreements for the protection features are appropriate for the hazard of the materials on-site. The time frame also allows the AHJ or the facility owner to obtain outside assistance if a third-party review is needed. If both parties agree that a shorter notice is workable, this requirement allows for the approved plan to be accepted in less time.

60.1.4.4.2 The plan shall demonstrate that hazardous materials that were stored, dispensed, handled, or used in the facility have been transported, disposed of, or reused in a manner that eliminates the need for further maintenance and any threat to public health and safety. [**400:**1.9.4.2]

60.1.5 Emergency Planning.

60.1.5.1 Emergency Action Plan. An emergency action plan, consistent with the available equipment and personnel, shall be established to respond to fire and other emergencies in accordance with requirements set forth in this Code. [**400:**1.10.1]

60.1.5.2 Activation. The facility responsible for an unauthorized release shall activate the emergency action element of the Hazardous Materials Management Plan. [**400:**1.10.2]

60.1.6 Hazardous Materials Management Plan (HMMP).

60.1.6.1* When required by the AHJ, new or existing facilities that store, use, or handle hazardous materials covered by this *Code* in amounts above the MAQ specified in 60.4.2.1.2 through 60.4.2.1.13 and 5.4.1.2 of NFPA 400 shall submit a hazardous materials management plan (HMMP) to the AHJ. [**400:**1.11.1]

A.60.1.6.1 See Annex D for a model Hazardous Materials Management Plan (HMMP).

A hazardous materials management plan (HMMP) is an optional requirement that can be imposed by the AHJ. A facility or business using a hazardous material should contact the AHJ to determine whether an HMMP is needed and, if so, when it must be submitted. Paragraph 60.1.6.1 and its subparagraphs provide requirements for the management of hazardous materials used at facilities — all key components of a typical HMMP. Additional information and a number of sample HMMP forms can be found in Annex D.

The intent of an HMMP is to provide specific information on the quantities of each hazardous material and its specific use in the process, as well as locations where and how each hazardous material is stored and used. The HMMP should also provide information on spill control and secondary containment features, as well as details of the facility's emergency response plan. Where an HMMP is provided, it must be reviewed by and include input from all parties that might respond to an incident, so that emergency responders know their respective roles. Training drills and site tours should be conducted. The HMMP should be reviewed and updated as facility modifications occur and as key participants change. The commentary following 60.1.6.2(3) is relevant here.

Δ **60.1.6.2** The HMMP shall be reviewed and updated as follows:

(1) Annually
(2) When the facility is modified
(3) When hazardous materials representing a new hazard category not previously addressed are stored, used, or handled in the facility

[**400:**1.11.2]

The situation in 60.1.6.2(3) is known as "management of change" and is deemed critical to safe operations. Management of change strives to ensure that any substantive change in operating conditions, equipment, or materials used is documented and made known to all personnel who might be involved. The HMMP can be thought of as an extension of management of change to local officials and emergency responders.

60.1.6.3 The HMMP shall comply with the requirements of Section 60.5. [**400:**1.11.3]

60.1.7* Hazardous Materials Inventory Statement (HMIS).

A.60.1.7 See Annex D for a model Hazardous Materials Inventory Statement (HMIS).

A hazardous materials inventory statement (HMIS) must be prepared and submitted when required by the AHJ. Sample guidelines and information can be found in Annex D. The form for the HMIS can be modified as necessary by the AHJ to accommodate local and site-specific concerns.

60.1.7.1 When required by the AHJ, a hazardous materials inventory statement (HMIS) shall be completed and submitted to the AHJ. [**400:**1.12.1]

60.2 Special Definitions

60.2.1 Chemical Name. See 3.3.43.

60.2.2 Closed System Use. See 3.3.271.1.

60.2.3 Control Area. See 3.3.14.2.

60.2.4 Dispensing. See 3.3.87.

60.2.5 Flammable Solid. See 3.3.240.2.

60.2.6 Hazardous Material. See 3.3.175.4.

60.2.7 Health Hazard Material. See 3.3.175.6.

60.2.8 Highly Toxic Material. See 3.3.175.7.

60.2.9 Incompatible Material. See 3.3.175.9.

60.2.10 Liquid. See 3.3.166.

60.2.11 Open System Use. See 3.3.271.2.

60.2.12 Organic Peroxide. See 3.3.191.

60.2.12.1 Organic Peroxide Formulation. See 3.3.191.1.

60.2.12.1.1 Class I. See 3.3.191.1.1.

60.2.12.1.2 Class II. See 3.3.191.1.2.

60.2.12.1.3 Class III. See 3.3.191.1.3.

60.2.12.1.4 Class IV. See 3.3.191.1.4.

60.2.12.1.5 Class V. See 3.3.191.1.5.

60.2.13 Oxidizer. See 3.3.194.

60.2.13.1 Class 1. See 3.3.194.1.

60.2.13.2 Class 2. See 3.3.194.2.

60.2.13.3 Class 3. See 3.3.194.3.

60.2.13.4 Class 4. See 3.3.194.4.

60.2.14 Physical Hazard Material. See 3.3.175.12.

60.2.15 Pyrophoric Material. See 3.3.175.13.

60.2.16 Solid Material. See 3.3.241.

60.2.17 Toxic Material. See 3.3.175.14.

60.2.18 Unstable (Reactive) Material. See 3.3.175.15.

60.2.19 Use. See 3.3.271.

60.2.20 Water-Reactive Material. See 3.3.175.16.

60.3 Classification of Materials, Wastes, and Hazard of Contents

Δ **60.3.1* Hazardous Material Classification.** Materials shall be classified into one or more of the following categories of hazardous materials, based on the definitions found in Chapter 3:

(1) Corrosive solids, liquids, or gases
(2) Flammable solids
(3) Flammable gases
(4) Flammable cryogenic fluids
(5) Inert cryogenic fluids
(6) Inert gases
(7) Organic peroxide formulations
(8) Oxidizer solids or liquids
(9) Oxidizing gases
(10) Oxidizing cryogenic fluids
(11) Pyrophoric solids, liquids, or gases
(12) Toxic or highly toxic solids, liquids, or gases
(13) Unstable (reactive) solids, liquids, or gases
(14) Water-reactive solids or liquids

[**400:**4.1]

A.60.3.1 The categorization and classification of hazardous materials enables the code user to determine the applicability of requirements based on hazard category and class related to the physical and health hazards of materials. The current definitions found in Chapter 3 have been developed using a compilation of criteria found in NFPA codes and standards, requirements of the U.S. DOT, and in some cases definitions established by OSHA in 29 CFR. [**400:**A.4.1]

A system known as the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) has been developed based on standards for classification published by the United Nations (UN) Subcommittee of Experts on the GHS. The U.S. continues its efforts to incorporate the GHS in its federal regulatory scheme. OSHA published its revised Hazard Communication Standard (29 CFR 1910.1200) to align with the GHS in March 2012. The revised standard became effective in May 2012. [**400:**A.4.1]

It is anticipated by the Committee that over time, the GHS will be reviewed for applicability and possible integration into the regulatory scheme developed in NFPA 400 for hazardous materials storage, use, and handling. The evolution of this system of classification will be facilitated by the changes associated with classification, labeling, and safety data sheets. It is not anticipated that the GHS will be fully implemented immediately within NFPA 400, recognizing the historical basis that exists for some of the classifications of materials, such as flammable and combustible liquids. [**400:**A.4.1]

An example of the difficulty in fully integrating the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) into NFPA's regulatory scheme lies in the manner in which GHS treats flammable liquids and combustible liquids, as opposed to their treatment in NFPA 30. NFPA broadly defines *flammable liquid* [flash point below 100°F (38°C)] and *combustible liquid* [flash point 100°F (38°C) and above]. NFPA 30 then classifies flammable liquids as Class IA, Class IB, and Class IC, depending on flash point and boiling point, and flammable liquids as Class II, Class IIIA, and Class IIIB, using flash point only. GHS uses only the word *flammable* and establishes only four categories.

Ignoring the boiling point criterion, NFPA 30 Classes IA and IB correspond to GHS Flammable Categories 1 and 2. NFPA 30 Class IIIA corresponds to GHS Flammable Category 4. NFPA 30 Class IIIB liquids, flash points 200°F (93°C) and higher, have no equivalent in GHS and, therefore, are not regulated under GHS.

Of greater concern is the fact that GHS Flammable Category 3 corresponds to *two* NFPA 30 classes: Class IC flammable [flash point 73°F to 100°F (23°C to 38°C)] and Class II combustible [flash point 100°F to 140°F (38°C to 60°C)]. GHS treats these two groups essentially the same, while NFPA 30 imposes stricter requirements on Class IC.

60.3.2 Classification of High-Hazard Contents.

60.3.2.1 General.

60.3.2.1.1 High hazard contents shall include materials defined as hazardous material in Chapter 3, whether stored, used, or handled. [**400:**4.2.1.1]

60.3.2.1.2 High hazard contents shall include those materials defined as hazardous material solids, liquids, or gases limited to the hazard categories specified in 1.1.1 of NFPA 400 and classified in accordance with 60.3.2.1.2.1 through 60.3.2.1.2.4 whether stored, used, or handled. [**400:**4.2.1.2]

Δ **60.3.2.1.2.1 High Hazard Level 1 Contents.** High hazard Level 1 contents shall include materials that present a detonation hazard, including, but not limited to, the following hazard categories:

(1) Class 4 oxidizers
(2) Detonable pyrophoric solids or liquids
(3) Class 3 detonable and Class 4 unstable (reactive) solids, liquids, or gases
(4) Detonable organic peroxides

[**400:**4.2.1.2.1]

Δ **60.3.2.1.2.2 High-Hazard Level 2 Contents.** High-hazard Level 2 contents shall include materials that present a deflagration hazard or a hazard from accelerated burning limited to the following hazard categories:

(1) Combustible dusts stored, used, or generated in a manner creating a severe fire or explosion hazard
(2) Class I organic peroxides
(3) Class 3 solid or liquid oxidizers that are used or stored in normally open containers or systems or in closed containers or systems at gauge pressures of more than 15 psi (103.4 kPa)
(4) Flammable gases
(5) Flammable cryogenic fluids
(6) Nondetonable pyrophoric solids, liquids, or gases
(7) Class 3 nondetonable unstable (reactive) solids, liquids, or gases
(8) Class 3 water-reactive solids and liquids

[**400:**4.2.1.2.2]

Δ **60.3.2.1.2.3 High-Hazard Level 3 Contents.** High-hazard Level 3 contents shall include materials that readily support combustion or present a physical hazard limited to the following hazard categories:

(1) Flammable solids, other than dusts classified as high-hazard Level 2, stored, used, or generated in a manner creating a high fire hazard
(2) Class II and Class III organic peroxides
(3) Class 2 solid or liquid oxidizers
(4) Class 3 solid or liquid oxidizers that are used or stored in normally closed containers or systems at gauge pressures of less than 15 psi (103.4 kPa)
(5) Class 2 unstable (reactive) materials
(6) Class 2 water-reactive solids, liquids, or gases
(7) Oxidizing gases
(8) Oxidizing cryogenic fluids

[**400:**4.2.1.2.3]

Δ **60.3.2.1.2.4 High-Hazard Level 4 Contents.** High-hazard Level 4 contents shall include materials that are acute health hazards limited to the following hazard categories:

(1) Corrosive solids, liquids, or gases
(2) Highly toxic solids, liquids, or gases
(3) Toxic solids, liquids, or gases

[**400:**4.2.1.2.4]

60.3.3 Mixtures. Mixtures shall be classified in accordance with the hazards of the mixture as a whole by an approved, qualified organization, individual, or testing laboratory. [**400:**4.3]

60.3.4* Multiple Hazards. Hazardous materials that have multiple hazards shall conform to the code requirements for each applicable hazard category. [**400:**4.4]

A.60.3.4 Where a conflict exists between applicable requirements, an analysis should be made and the proper applicable requirement should be implemented or conformed to subject to the approval of the AHJ. [**400:**A.4.4]

A material characterized by multiple hazards must be reviewed with extra care. If a hazardous material is classified in one category, the user is required to review the material based on that category and identify the appropriate protection features. If the material falls under two or more categories, the material must be reviewed for each category. Each protection feature identified must be outlined and provided. For example, if a hazardous material is an oxidizer, a suppression system is required but a ventilation system is not; therefore, the user must review the hazardous material to see whether it meets other hazard classifications addressed in this *Code*. If the same hazardous material is also toxic and, due to the classification, a ventilation system is required, both the suppression system and the ventilation system must be provided for this hazardous material.

60.3.5* Classification of Waste. Waste comprised of or containing hazardous materials shall be classified in accordance with 60.3.1 through 60.3.4 as applicable. [**400:**4.5]

Δ **A.60.3.5** The safe handling, collection, and disposal of hazardous waste can be accomplished only if the physical, chemical, and hazardous properties of its components are known and that information is properly applied. The categorization of a material as waste is normally under the purview of the user. In some cases the waste might be contaminated or "off spec" material, or material where the concentration of the hazardous components has been diluted. In other cases the waste might consist of cleaning materials that have become contaminated with a hazardous material. [**400:**A.4.5]

The classifiers of waste are cautioned that the classification of hazardous waste under the requirements of the Environmental Protection Agency (EPA) or Department of Transportation (DOT) for labeling required for shipping purposes might not correspond to the system of classification incorporated into 60.3.1. In addition, some judgment is needed to apply the *Code* in circumstances where the waste material is not in a form that is normally encountered when the hazardous material employed is in its virgin state. For example, a material that might not have been hazardous in its pure form might become hazardous when it becomes contaminated as use occurs. A tank of water used for rinsing parts on a plating line will eventually become contaminated by the materials that are being rinsed from parts as they travel through the line. If the concentration of the material being rinsed from parts becomes high enough, the content of hazardous materials in the rinse tank might be present in a concentration sufficient enough to cause the waste rinse water to be classified as hazardous. See Section B.5 of NFPA 400 for examples on the classification of dilute solutions of common corrosive materials. [**400:**A.4.5]

In many cases the waste material could be a mixture of materials that must be classified in accordance with the requirements of 60.3.3. [**400:**A.4.5]

60.4 Permissible Storage and Use Locations

60.4.1* General.

A.60.4.1 Section 60.4 introduces the concepts of control areas and MAQ. The purpose is to permit limited amounts of hazardous contents in occupancies having minimum controls without triggering the more restrictive Protection Level 1 through Protection Level 4 building requirements. The MAQ in Table 60.4.2.1.1.3, Table 60.4.2.1.2 through Table 60.4.2.1.8, and Table 60.4.2.1.10.1 is based on demonstrated need and historical safe storage and use of hazardous contents. Subsection 60.4.3, however, establishes additional controls for occupancies exceeding the hazardous contents limits prescribed for control areas. [**400:**A.5.1]

All of the hazardous materials within the scope of 1.1.1 of NFPA 400 are high-hazard contents; see 60.3.2.1.1. However, not all of the hazardous materials categories are placed into High-Hazard Levels 1–4 requiring Protection Levels 1–4 are considered to be high-hazard contents, and some of these materials have been recognized as being of low or ordinary hazards, depending on their nature in a fire. In some cases, Class 1 unstable (reactive) materials, Class 1 water-reactive materials, and Class IV and Class V organic peroxides, do not have a MAQ and, therefore, are not required to comply with the requirements for Protection Level 1 through Protection Level 4. Figure A.60.4.1 helps to illustrate the conditions under which the protection level requirements are applicable. [**400:**A.5.1]

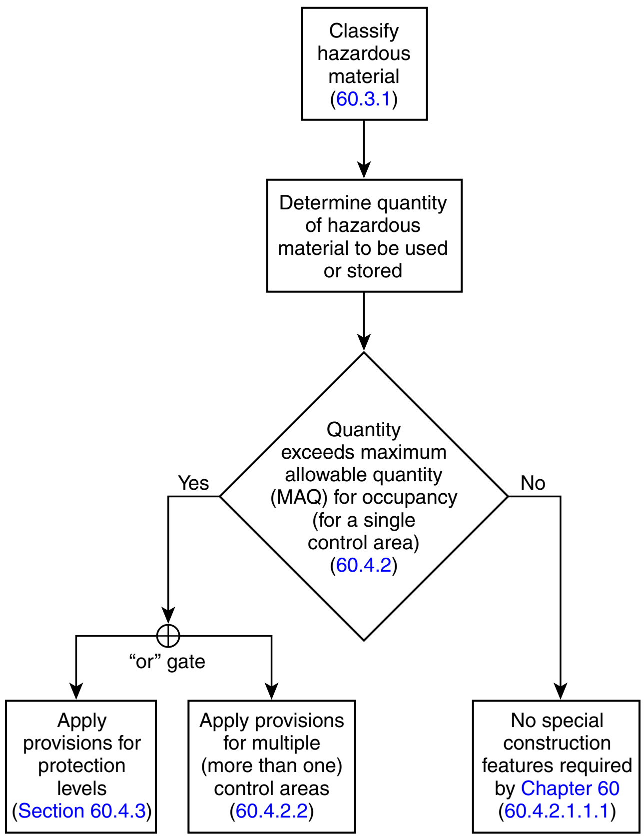


FIGURE A.60.4.1 *Application of Chapter 60 Requirements for Hazardous Materials. [**400:**Figure A.5.1]*

60.4.1.1 Control Areas or Special Protection Required. Hazardous materials shall be stored and used in any of the following:

(1) In control areas complying with 60.4.2
(2) In occupancies complying with requirements for Protection Level 1, Protection Level 2, Protection Level 3, or Protection Level 4 in accordance with 60.4.3
(3) In outdoor areas complying with 60.4.4

[**400:**5.1.1]

60.4.1.2 Weather Protection Structures. Weather protection, when provided, shall comply with 6.2.7.2 of NFPA 400. [**400:**5.1.2]

60.4.1.3 High Hazard Contents. Occupancies in which high hazard contents are stored, used, or handled shall also comply with Chapter 6 of NFPA 400. [**400:**5.1.3]

60.4.2 Control Areas.

60.4.2.1 Hazardous materials shall be permitted to be stored and used in control areas in accordance with 60.4.2.1 and 60.4.2.2. [**400:**5.2.1]

Control area is defined in 3.3.14.2. To paraphrase, it is a building, a part of a building, or an outside area in which one is allowed to store, handle, or use hazardous materials, with the assumption that the quantities involved do not exceed the MAQ specified in this *Code* for each hazardous material present. The concept is that a freestanding building does not require additional protection measures beyond what would normally be required for that occupancy when not more than a given amount of hazardous material (the MAQ) is present. The assumption is that the presence of the MAQ amount does not increase the fire risk. To take this a step further, an area within a building containing the same amount of hazardous material should not require additional protection features if it is isolated from adjacent areas with fire-rated construction.

This approach works well if the separation is durable enough to prevent one incident from impacting adjacent control areas. This approach also works well for additional control areas within the building. At some point, the number of control areas allowed must be limited based on the building's size and associated response time. For example, where material is located on an upper level of a building, direct access might be limited and there will be a delay in response by emergency services.

If hazardous materials are present in amounts greater than the MAQ, the following are true:

1. The quantity is deemed to present a greater hazard than that of a comparable nonhazardous occupancy.
2. Where the material is divided into quantities that are less than the MAQs and moved to separate areas of the building, the risk is the same as for a nonhazardous occupancy due to the fire-rated separation of the hazardous material.

See the also the commentary following A.60.3.4.

60.4.2.1.1 General.

60.4.2.1.1.1 All occupancies shall be permitted to have one or more control areas in accordance with 60.4.2. [**400:**5.2.1.1.1]

60.4.2.1.1.2 The quantity of hazardous materials in an individual control area shall not exceed the maximum allowable quantity (MAQ) for the applicable occupancy set forth in 60.4.2.1.2 through 60.4.2.1.13, except as modified by Table 60.4.2.1.1.3. [**400:**5.2.1.1.2]

Δ **60.4.2.1.1.3** For all occupancies not covered by 60.4.2.1.2 through 60.4.2.1.13, the MAQ of hazardous materials per control area shall be as specified in Table 60.4.2.1.1.3. Ammonium nitrate shall also comply with Chapter 11 of NFPA 400. [**400:**5.2.1.1.3]

Table 60.4.2.1.1.3 presents what can be termed the "general" MAQs. These are maximum quantities of hazardous materials that are considered to be appropriate for industrial, mercantile, or storage occupancies without the need for special protective measures. Table 60.4.2.1.1.3 is used to determine the MAQ for any given material, unless the MAQ for the specific occupancy, as specified in Table 60.4.2.1.2 through Table 60.4.2.1.10.1, is different. In that case, the MAQ in the occupancy-specific table applies. The user should go to the occupancy-specific MAQ table first for information on the relevant occupancy requirements.

It is important to understand a few facts regarding the identified hazardous materials. The following steps should be followed when using Table 60.4.2.1.1.3:

1. The category of the hazardous material should be determined, based on the classification of the material and the definitions within the *Code*. Without this basic information, the limits and protection features cannot be identified. All physical and health hazards associated with the hazardous material must be identified and classified so that each risk can be determined and the protection features or limits can be specified.

2. The use of the hazardous material in a building must be understood so that appropriate limits can be established. These uses are generally categorized as storage, use-closed, and use-open. The storage category is designed for a hazardous material that is intended to enter a building in a container, cylinder, or tank and is not removed from the original container, cylinder, or tank in the storage room or control area. If the hazardous material is shipped to the site, stored, then shipped off-site, only the storage column of the table is used.

3. If the material is used in a process, the process system must be reviewed to determine whether it is classified as use-closed or use-open. Where the process is determined to be closed use, Table 60.4.2.1.1.3 requires that, under normal conditions, the hazardous material not be open to the atmosphere and be kept within a container, a pipe, or equipment that does not allow vapors to escape into the air. These systems include closed piping systems, where a large container of material is transferred through closed piping to smaller containers and sealed for shipping. This condition of use also includes pouring inert material into a vessel, sealing the vessel, and introducing a hazardous material to mix with it, which is then removed under

Δ ***TABLE 60.4.2.1.1.3*** *Maximum Allowable Quantity (MAQ) of Hazardous Materials per Control Area*[a]

Material	Class	High Hazard Protection Level	Storage			Use — Closed Systems			Use — Open Systems	
			Solid Pounds	Liquid Gallons (lb)	Gas[b] scf (lb)	Solid Pounds	Liquid Gallons (lb)	Gas[b] scf (lb)	Solid Pounds	Liquid Gallons (lb)
Physical Hazard Materials		See note	See note	See note	See note					
Combustible liquid	See note	See note	See note	See note	See note	See note	See note	See note	See note	See note
Combustible metals	See note	See note	See note	See note	See note	See note	See note	See note	See note	See note
Cryogenic fluid [**55:**Table 6.3.1.1]	Flammable	2	N/A	45[j,k]	N/A	N/A	45[j,k]	N/A	N/A	45[j,k]
	Oxidizing	3	N/A	45[c,d]	N/A	N/A	45[c,d]	N/A	N/A	45[c,d]
	Inert	N/A	N/A	NL	N/A	N/A	NL	N/A	N/A	NL
Explosives	See note	See note	See note	See note	See note	See note	See note	See note	See note	See note
Flammable gas[l] [**55:**Table 6.3.1.1]	Gaseous	2	N/A	N/A	1000[c,d]	N/A	N/A	1000[c,d]	N/A	N/A
	Liquefied	2	N/A	N/A	(150)[c,d]	N/A	N/A	(150)[c,d]	N/A	N/A
	Liquefied Petroleum (LP)	See note	See note	See note	See note	See note	See note	See note	See note	See note
Flammable liquid	IA IB and IC Combination (IA, IB, IC)	See note	See note	See note	See note	See note	See note	See note	See note	See note
Flammable solid	N/A	3	125[c,d]	N/A	N/A	125[c,d]	N/A	N/A	25[c,d]	N/A
Inert gas	Gaseous	N/A	N/A	N/A	NL	N/A	N/A	NL	N/A	N/A
	Liquefied	N/A	N/A	N/A	NL	N/A	N/A	NL	N/A	N/A
Organic peroxide	UD	1	1[c,il]	(1)[c,I]	N/A	¼[i]	(¼)[i]	N/A	¼[i]	(¼)[i]
	I	1	5[c,d]	(5)[c,d]	N/A	1[c,d]	(1)[c,d]	N/A	1[c,d]	(1)[c,d]
	II	2	50[c,d]	(50)[c,d]	N/A	50[d]	(50)[d]	N/A	10[c,d]	(10)[c,d]
	III	3	125[c,d]	(125)[c,d]	N/A	125[d]	(125)[d]	N/A	25[c,d]	(25)[c,d]
	IV	N/A	NL	NL	N/A	NL	NL	N/A	NL	NL
	V	N/A	NL	NL	N/A	NL	NL	N/A	NL	NL
Oxidizer	4	1	1[g,l]	(1)[g,l]	N/A	¼[l]	(¼)[I]	N/A	¼[l]	(¼)[l]
	3[j]	2 or 3	10[g,h]	(10)[g,h]	N/A	2[h]	(2)[h]	N/A	2[h]	(2)[h]
	2	3	250[g,h]	(250)[g,h]	N/A	250[h]	(250)[h]	N/A	50[h]	(50)[h]
	1	N/A	4,000[g,I]	(4,000)[g,I]	NA	4,000[g]	(4,000)[g]	N/A	1,000[g]	(1,000)[g]
Oxidizing gas [**55:**Table 6.3.1.1]	Gaseous	3	N/A	N/A	1,500[g, h]	N/A	N/A	1,500[g,h]	N/A	N/A
	Liquefied	3	N/A		(150)[g,h]	N/A		(150)[g,h]	N/A	N/A
Pyrophoric		2	4[g,l]	(4)[g,l]	NA	11	(1)[l]	NA	0	0
Pyrophoric Gas [**55:**Table 6.3.1.1]	Gaseous	2	N/A	N/A	50[g,l]	N/A	N/A	50[g,l]	N/A	N/A
	Liquefied	2	N/A	N/A	(4)[g,l]	N/A	N/A	(4)[g,l]	N/A	N/A
Unstable Reactive	4	1	1[g,l]	(1)[g,l]	NA	¼[l]	(¼)[l]	NA	¼[l]	(¼)[h]
	3	1 or 2	5[g,h]	(5)[g,h]	N/A	1[h]	(1)[h]	N/A	1[h]	(1)[h]
	2	2	50[g,h]	(50)[g,h]	N/A	50[h]	(50)[h]	N/A	10[d]	(10)[d]
	1	N/A	NL	NL	N/A	NL	NL	N/A	NL	NL
Unstable (reactive) Gas [**55:**Table 6.3.1.1]	Gaseous									
	4 or 3 detonable	1	N/A	N/A	10[c,i]	N/A	N/A	10[c,i]	N/A	N/A
	3 non-detonable	2	N/A	N/A	50[c,d]	N/A	N/A	50[c,d]	N/A	N/A
	2	3	N/A	N/A	750[c,d]	N/A	N/A	750[c,d]	N/A	N/A
	1	N/A	N/A	N/A	NL	N/A	N/A	NL	N/A	N/A
Unstable (reactive) Gas [**55:**Table 6.3.1.1]	Liquefied									
	4 or 3 detonable	1	N/A	N/A	(1)[g,l]	N/A	N/A	(1)[g,l]	N/A	N/A
	3 non-detonable	2	N/A	N/A	(2)[g,h]	N/A	N/A	(2)[g,h]	N/A	N/A
	2	3	N/A	N/A	[30][g,h]	N/A	N/A	[30][g,h]	N/A	N/A
	1	N/A	N/A	N/A	NL	N/A	N/A	NL	N/A	N/A
Water (reactive)	3	2	5[g,h]	(5)[g,h]	N/A	5[h]	(5)[h]	N/A	1[h]	(1)[h]
	2	3	50[g,h]	(50)[g,h]	N/A	50[h]	(50)[h]	N/A	10[h]	(10)[h]
	1	N/A	NL	NL	N/A	NL	NL	N/A	NL	NL

Material	Class	High Hazard Protection Level	Storage			Use — Closed Systems			Use — Open Systems	
			Solid Pounds	Liquid Gallons (lb)	Gas[b] scf (lb)	Solid Pounds	Liquid Gallons (lb)	Gas[b] scf (lb)	Solid Pounds	Liquid Gallons (lb)
Corrosive	N/A	4	5,000[g,h]	500[g,h]	N/A	5,000[h]	500	N/A	1,000[h]	100[h]
Corrosive gas	Gaseous	4	N/A	N/A	810[g,h]	N/A	N/A	810[g,h]	N/A	N/A
[**55:**Table 6.3.1.1]	Liquefied		N/A	N/A	(150)[g,h]	N/A	N/A	(150)[g,h]	N/A	N/A
Highly toxic	N/A	4	10[g,h]	(10)[g,h]	N/A	10[h]	(10)[h]	N/A	3[h]	(3)[h]
Highly toxic gas	Gaseous	4	N/A	N/A	20[h,s]	N/A	N/A	20[h,s]	N/A	N/A
[**55:**Table 6.3.1.1]	Liquefied		N/A	N/A	(4)[h,s]	N/A	N/A	(4)[d,g]	N/A	N/A
Toxic	N/A	4	500[g,h]	(500)[g,h]	N/A	500[h]	(500)[h]	N/A	125[h]	(125)[h]
Toxic gas	Gaseous	4	N/A	N/A	810[g,h]	N/A	N/A	810[g,h]	N/A	N/A
	Liquefied		N/A	N/A	(150)[g,h]	N/A	N/A	(150)[g,h]	N/A	N/A

N/A: Not applicable. NL: Not limited. NP: Not permitted. UD: Unclassified detonable.

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 scf = 0.0283 Nm^3.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by Chapter 60 or NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2 of NFPA 400, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

[a]Table values in parentheses correspond to the unit name in parentheses at the top of the column. The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage.

[b]Measured at NTP or 70°F (21°C) and absolute pressure of 14.7 psi (101.3 kPa).

[c]Quantities are permitted to be increased 100 percent where stored or used in approved cabinets, gas cabinets, exhausted enclosures, gas rooms explosives magazines, or safety cans, as appropriate for the material stored, in accordance with this code. Where footnote d also applies, the increase for both footnote c and footnote d is permitted to be applied accumulatively.

[d]Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where footnote c also applies, the increase for both footnote c and footnote d is permitted to be applied accumulatively.

[e]The permitted quantities are not limited in a building equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

[f]A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

[g]Allowed only where stored or used in gas rooms or approved cabinets, exhausted gas cabinets or exhausted enclosures, as specified in this *Code*. [**5000:** Table 34.1.3.1]

[h]Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

[i]Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

[j]None allowed in unsprinklered buildings unless stored or used in gas rooms or in approved gas cabinets or exhausted enclosures, as specified in this *Code*.

[k]With pressure-relief devices for stationary or portable containers vented directly outdoors or to an exhaust hood. [**55:** Table 6.3.1.1]

[l]Flammable gases in the fuel tanks of mobile equipment or vehicles are permitted to exceed the MAQ where the equipment is stored and operated in accordance with this *Code*. [**400:**Table 5.2.1.1.3]

[m]The permitted quantities are not limited in a building equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13 and designed in accordance with the protection criteria contained in Chapter 16 of NFPA 30.

[n]Containing not more than the maximum allowable quantity per control area of Class I-A, Class I-B, or Class I-C flammable liquids, individually.

[o]Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1.3-gallon capacity. [**30:**9.1.4(4)]

[p]Additional storage locations are required to be separated by a minimum of 300 ft (92 m).

[q]In mercantile occupancies, storage of LP-gas is limited to a maximum of 200 lb (91 kg) in nominal 1 lb (0.45 kg) LP-gas containers.

[r]See NFPA 58 for liquefied petroleum gas (LP-gas) requirements. LP-gas is not within the scope of NFPA 400.

a sealed system. This condition of use also applies where mixed finished material is no longer classified as hazardous. Closed use and storage have very similar risks and are treated the same with respect to MAQ.

If a process involves pouring or dispensing into an open vessel, open mixing, transferring, or processing of a hazardous material that is exposed to the atmosphere, the process is classified as open use. This type of activity is considered the most hazardous and, therefore, is most restricted with respect to an MAQ from Table 60.4.2.1.1.3.

4. Apply the appropriate footnotes.

Footnote a contains an important limit and a major component in the proper use of the table. It states that the combination of quantity under use and storage must not exceed the total amount allowed for storage alone. This limit restricts the amount of hazardous material on-site from increasing by simply stating that it is "in use."

Footnote c applies to quantities of most hazardous materials. It allows an increase of 100 percent, or doubling, of the quantity of hazardous materials, where they are stored in an approved cabinet, an exhausted enclosure, an explosive magazine, a safety can, or a gas room. The protection feature used must match the hazard the material presents — for example, putting explosives into a safety cabinet cannot qualify as appropriate protection. As an example, Footnote c allows a flammable solid, which is limited to 125 lb (56.7 kg) in storage, to be increased to 250 lb (115 kg) if it is protected within an approved cabinet. The second sentence of footnote c allows for the increase of some hazardous materials where both footnotes c and d appear with the MAQ value for the particular hazardous material.

Footnote d applies to quantities of hazardous materials that are permitted to increased by 100 percent where the building is completely protected with an automatic sprinkler system. The risk of a problem occurring within the building and spreading to the area where the hazardous material is stored or used is the justification for the increase specified by footnote d. Sprinkler protection that is provided in accordance with footnote d is why materials such as corrosive liquids that are not flammable or combustible are allowed such an increase. Again, footnotes c and d, where indicated, are designed to be added together where both protection measures are present.

EXAMPLE

A warehouse is storing a solid Class III organic peroxide formulation. The material is stored in approved storage cabinets, and the building is fully protected throughout by an automatic sprinkler system designed and installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*. What is the maximum allowable quantity of this commodity that can be stored within the control area without additional protection features?

Based on Table 60.4.2.1.1.3, the base MAQ is 125 lb (56.7 kg). Footnote c would permit a 100 percent increase of the amount, to 250 lb (115 kg), based on the protection afforded by the storage cabinets. Because the building is also protected with an automatic sprinkler system installed in accordance with NFPA 13, footnote d allows an additional 100 percent increase to be applied accumulatively, resulting in a maximum allowable quantity of 500 lb (227 kg) of the Class III organic peroxide per control area.

It should be noted that, if this commodity was found to also have an additional classification, such as being toxic or highly toxic (which would depend on the specific material; see Annex B through Annex H of NFPA 400 for additional information), then the material would also have to conform to the requirements for the applicable additional hazard category.

Footnote e allows a hazardous material to be stored in unlimited quantity if the building is completely protected by an NFPA 13–compliant automatic sprinkler system. At present, Footnote e applies only to one category of hazardous materials addressed by NFPA 400 and NFPA 1: Class 1 oxidizers. NFPA 30 contains a similar provision for Class IIIB liquids: unlimited quantities are allowed if the building is protected throughout with an NFPA 13–compliant sprinkler system that also complies with the provisions of Chapter 16 of NFPA 30.

Footnote f applies specifically to Class 3 oxidizers and limits this class of hazardous material to use for maintenance purposes, operation, or sanitation of equipment.

Footnote i applies to several categories that have been identified as higher risk hazardous materials and are permitted only in buildings protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.

EXAMPLE

Further illustrating the influence of the footnotes to Table 60.4.2.1.1.3 might be helpful to the user.

If a solid material has a classification of oxidizer Class 2, the MAQ is 250 lb (115 kg) for storage per control area. In a one-story building, a designer can designate up to four separate control areas, each with 100 percent of the MAQ, per Table 60.4.2.2.1 This assumes that the control areas are completely separated vertically and horizontally from other control areas with 1-hour fire-resistance-rated fire barriers. This increases the aggregate amount in the building to 1000 lb (454 kg). It must be remembered, however, that footnote a states that the amount of hazardous material in use and storage combined cannot exceed the MAQ for storage.

Footnote c doubles the MAQ per control area if the hazardous material is stored in an approved cabinet, which allows 500 lb (227 kg) per control area, for a total of 2000 lb (907 kg) aggregate in the building (assuming the maximum of four separated control areas as described in the preceding paragraph). The only other footnote that might apply is footnote d, which, again, doubles the MAQ per control area based on the presence of a sprinkler system for the building. With no approved storage cabinet, the sprinkler protection would result, again, in an increase to 500 lb (227 kg) per control area, or 2000 lb (907 kg) for the building. As noted in footnotes c and d, if both are used, the maximum amount is applied cumulatively, which results in 1000 lb (454 kg) per control area, or 4000 lb (1814 kg) for the entire building.

The limits in 60.4.2.1.1.3 as well as in 60.4.2.1.2 through 60.4.2.1.13 must be reviewed to ensure that the special occupancy restrictions are not exceeded.

A review of the MAQs in 60.4.2.1.2 through 60.4.2.1.13 shows that they are, in many cases, less than the corresponding base MAQs in Table 60.4.2.1.1.3 or are designated as NP, i.e., "not permitted." This is deliberate and is based on a determination that the hazards posed by even the base MAQs of certain hazardous materials in certain occupancies is too great without additional protective measures. For example, in health care occupancies, some of the occupants, namely, patients, are not ambulatory and cannot evacuate themselves. For that reason, the user is cautioned that the specific occupancy limits given in Table 60.4.2.1.2 through Table 60.4.2.1.10.1 must be compared against the MAQs specified in Table 60.4.2.1.1.3 to ensure that special occupancy quantity limitations are not exceeded.

Δ **60.4.2.1.2 Assembly Occupancies.** The MAQ of hazardous materials per control area in assembly occupancies shall be as specified in Table 60.4.2.1.2. [**400:**5.2.1.2]

Δ **60.4.2.1.3 Educational Occupancies.** The MAQ of hazardous materials per control area in educational occupancies shall be as specified in Table 60.4.2.1.3. [**400:**5.2.1.3]

Δ **60.4.2.1.4 Day-Care Occupancies.** The MAQ of hazardous materials per control area in day-care occupancies shall be as specified in Table 60.4.2.1.4. [**400:**5.2.1.4]

Δ **60.4.2.1.5 Health Care Occupancies.** The MAQ of hazardous materials per control area in health care occupancies shall be as specified in Table 60.4.2.1.5. [**400:**5.2.1.5]

Δ **60.4.2.1.6 Ambulatory Health Care Occupancies.** The MAQ of hazardous materials per control area in ambulatory health care occupancies shall be as specified in Table 60.4.2.1.6. [**400:**5.2.1.6]

Δ **60.4.2.1.7 Detention and Correctional Occupancies.** The MAQ of hazardous materials per control area in detention and correctional occupancies shall be as specified in Table 60.4.2.1.7. [**400:**5.2.1.7]

Δ **60.4.2.1.8 Residential Occupancies.** The MAQ of hazardous materials per control area in residential occupancies, including lodging and rooming houses, hotels, dormitories, apartments, and residential board and care facilities, shall be as specified in Table 60.4.2.1.8. [**400:**5.2.1.8]

60.4.2.1.9 Mercantile Occupancies. The MAQ of hazardous materials per control area in mercantile occupancies shall be as specified in Table 60.4.2.1.1.3, with increased quantities permitted where storage or display areas comply with 60.4.2.1.13. [**400:**5.2.1.9]

60.4.2.1.10 Business Occupancies.

Δ **60.4.2.1.10.1** The MAQ of hazardous materials per control area in business occupancies, other than laboratories, shall be as specified in Table 60.4.2.1.10.1. [**400:**5.2.1.10.1]

Table 60.4.2.1.2 through Table 60.4.2.1.10.1 provide special quantity limitations for hazardous materials in specific occupancies without the imposition of additional protection features on a new building. In addition, the tables provide guidance for MAQs in existing buildings when new hazardous materials are introduced. The tables also address special conditions, risks, or situations that impact one type of occupancy and not others. For instance, they allow for small amounts of hazardous materials that can be protected by special protection features without putting the total occupancy at risk.

For example, per Table 60.4.2.1.5, the MAQ for Class 2 water-reactive solids in a health care occupancy is 10 lb (4.5 kg) per control area. This is less than the MAQ allowed per Table 60.4.2.1.1.3 [50 lb, (23 kg)]; thus, the more restrictive quantity must be used. Additional explanation is given in the last paragraph of the commentary to 60.4.2.1.1.3.

60.4.2.1.10.2 The MAQ of hazardous materials per control area in laboratories classified as business occupancies shall be as specified in Table 60.4.2.1.1.3. [**400:**5.2.1.10.2]

60.4.2.1.11 Industrial Occupancies. The MAQ of hazardous materials per control area in industrial occupancies shall be as specified in Table 60.4.2.1.1.3, with increased quantities permitted where storage areas comply with 60.4.2.1.13. [**400:**5.2.1.11]

60.4.2.1.12 Storage Occupancies. The MAQ of hazardous materials per control area in storage occupancies shall be as specified in Table 60.4.2.1.1.3, with increased quantities permitted where storage areas comply with 60.4.2.1.13. [**400:**5.2.1.12]

60.4.2.1.13 Special Quantity Limits for Mercantile, Industrial, and Storage Occupancies.

60.4.2.1.13.1 General. Where storage in mercantile, industrial, and storage occupancies is in compliance with all of the special controls set forth in 60.4.2.1.13.2, the MAQ of selected hazardous materials shall be permitted to be increased in accordance with 60.4.2.1.13.3. [**400:**5.2.1.13.1]

Δ **60.4.2.1.13.2 Special Controls Required for Increased Quantities.** Where quantities of hazardous materials are increased in

△ *TABLE 60.4.2.1.2 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Assembly Occupancies*

Material	Class	Solid	Liquid[k]	Gas[a] (at NTP)
Flammable and combustible liquid[b,c,]	See note	See note	See note	See note
Cryogenic fluid	Flammable	NA	10 gal	NA
	Oxidizing	NA	10 gal	NA
Explosives[d,e,f,g]	See note	See note	See note	See note
Flammable gas[c,h]	Gaseous	NP	NP	NP
	Liquefied	NP	20 lb	NA
Flammable solid	NA	5 lb	N/A	N/A
Oxidizers	4	NP	NP	NA
	3	10 lb[i]	1 gal[i]	NA
	2	250 lb	25 gal	NA
	1	4,000 lb	400 gal	NA
Oxidizing gas[h]	Gaseous	NA	NA	NP
	Liquefied	NA	NP	NA
Organic peroxides	I	NP	NP	NA
	II	NP	NP	NA
	III	1,500 lb	1,500 lb	NA
	IV	100,000 lb	100,000 lb	NA
	V	NL	NL	NA
Pyrophoric materials	NA	1 lb	1 lb	NP
Unstable reactives	4	¼ lb	(¼)	NP
	3	1 lb	(1)	NP
	2	10 lb	(10)	NP[h]
	1	NL	NL	NP
Water-reactive	3	1 lb	1 lb	NA
	2	10 lb	10 lb	NA
	1	NL	NL	NA
Corrosives	NA	1,000 lb	100 gal	NP
Highly toxic	NA	3 lb	3 lb	NP[j]
Toxic	NA	125 lb	125 lb	NP[j]

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 ft^3 = 0.0283 m^3.

NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by Chapter 60 or NFPA 400 but are provided here for informational purposes. See Chapter 2 of NFPA 400 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2 of NFPA 400, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

[a]Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

[b]Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

[c]Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this *Code*.

[d]The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

[e]The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

[f]The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

[g]The storage and use of small arms ammunition, and components thereof, are permitted where in accordance with NFPA 495.

[h]Containers, cylinders, or tanks not exceeding 250 scf (7.1 m^3) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

[i]A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

[j]Gas cylinders not exceeding 20 scf (0.57 m^3) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods. [**5000:** Table 34.1.3.2(a)]

[k]Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

[l]Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that so not exceed a 1.3-gallon capacity. [**30:**9.1.4(4)]

[**400:** Table 5.2.1.2]

Δ *TABLE 60.4.2.1.3 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Educational Occupancies*

Material	Class	Solid	Liquid[m]	Gas[a] (at NTP)
Flammable and combustible liquid[b,c]	See note	See note	See note	See note
Cryogenic fluid	Flammable	N/A	10	N/A
	Oxidizing	N/A	10	N/A
Explosives[d,e,f,g]	See note	See note	See note	See note
Flammable gas[c,h]	Gaseous	NP	NP	NP
	Liquefied	NP	20	N/A
Flammable solid	NA	5 lb	N/A	N/A
Oxidizers	4	NP	NP	N/A
	3	10 lb[i]	1 gal[i]	N/A
	2	250 lb	25 gal	N/A
	1	4,000 lb	400 gal	NA
Oxidizing gas[h]	Gaseous	N/A	N/A	NP
	Liquefied	N/A	NP	N/A
Organic peroxides	I	NP	NP	N/A
	II	NP	NP	N/A
	III	1,500 lb	1,500 lb	N/A
	IV	100,000 lb	100,000 lb	N/A
	V	NL	NL	N/A
Pyrophoric materials	N/A	1 lb	1 lb	NP
Unstable reactives	4	¼ lb	(¼)	NP
	3	1 lb	(1)	NP
	2	10 lb	(10)	NP[h]
	1	NL	NL	NP
Water-reactive	3	1 lb	1 lb	N/A
	2	10 lb	10 lb	N/A
	1	NL	NL	N/A
Corrosives	N/A	1,000 lb	100 gal	NP
Highly toxic	N/A	3 lb	3 lb	NP[j]
Toxic	N/A	125 lb	125 lb	NP[j]

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 ft^3 = 0.0283 m^3.

NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by Chapter 60 or NFPA 400 but are provided here for informational purposes. See Chapter 2 of NFPA 400 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2 of NFPA 400, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

[a]Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

[b]Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

[c]Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this *Code*.

[d]The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

[e]The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

[f]The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

[g]The storage and use of small arms ammunition, and components thereof, are permitted where in accordance with NFPA 495.

[h]Containers, cylinders or tanks not exceeding 250 scf (7.1 m^3) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

[i]A maximum quantity of 220 lb (99 kg) or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

[j]The permitted quantities are not limited in a building protected throughout by automatic sprinkler systems in accordance with NFPA 13.

[k]Storage in laboratories only; additional 20 lb (9 kg) units are permitted where minimum 20 ft (6.1 m) separation is provided.

[l]Gas cylinders not exceeding 20scf (0.57 m^3) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

[m]Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

[n]Storage shall be permitted to be increased 100% if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.

[o]Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed 1.3-gallon capacity. [**30:**9.1.4(4)]
[**400:** Table 5.2.1.3]

Δ **TABLE 60.4.2.1.4** *Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Day-Care Occupancies*

Material	Class	Solid	Liquid[k]	Gas[a] (at NTP)
Flammable and combustible liquid[b,c,l]	See note	See note	See note	See note
Cryogenic fluid	Flammable	N/A	10 gal	N/A
	Oxidizing	N/A	10 gal	N/A
Explosives[d,e,f,g]	See note	See note	See note	See note
Flammable gas[c,h]	Gaseous	NP	NP	NP
	Liquefied	NP	20 lb	(20)
Flammable solid	N/A	5 lb	N/A	N/A
Oxidizers	4	NP	NP	N/A
	3	10 lb[i]	1 gal[i]	N/A
	2	250	25	N/A
	1	4,000	400	N/A
Oxidizing gas[h]	Gaseous	N/A	N/A	NP
	Liquefied	N/A	NP	N/A
Organic peroxides	I	NP	NP	N/A
	II	NP	NP	N/A
	III	1,500	1,500	N/A
	IV	100,000 lb	100,000 lb	N/A
	V	NL	NL	N/A
Pyrophoric materials	N/A	1 lb	1 lb	NP
Unstable reactives	4	¼ lb	¼ lb	NP
	3	1 lb	1 lb	NP
	2	10 lb	10 lb	NP[h]
	1	NL	NL	NP
Water-reactive	3	1 lb	1 lb	N/A
	2	10 lb	10 lb	N/A
	1	NL	NL	N/A
Corrosives	N/A	1,000 lb	100 gal	NP
Highly toxic	N/A	3 lb	3 lb	NP[j]
Toxic	N/A	125 lb	125 lb	NP[j]

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 ft^3 = 0.0283 m^3.

NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 of NFPA 400 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2 of NFPA 400, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

[a]Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

[b]Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

[c]Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this *Code*.

[d]The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

[e]The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

[f]The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

[g]Containers, cylinders, or tanks not exceeding 250 scf (7.1 m^3) content measured at 70°F (21°C) and 14.7 psi (101 kPa and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

[h]The permitted quantities are not limited in a building protected throughout by automatic sprinkler systems in accordance with NFPA 13.

[i]A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

[j]Gas cylinders not exceeding 20 scf (0.57 m^3) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

[k]Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

[l]Storage shall be permitted to be increased 100% if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.

[m]Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do exceed a 1.3-gallon capacity.

[**400:** Table 5.2.1.4]

Δ ***TABLE 60.4.2.1.5*** *Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Health Care Occupancies*

Material	Class	Solid	Liquid[k]	Gas[a] (at NTP)
Flammable and combustible liquid[b,c]	See note	See note	See note	See note
Cryogenic fluid	Flammable	N/A	10	N/A
	Oxidizing	N/A	10	N/A
Explosives[d,e,f]	See note	See note	See note	See note
Flammable gas[c,g]	Gaseous	N/A	N/A	NP
	Liquefied	N/A	20	N/A
Flammable solid	N/A	5 lb	N/A	N/A
Oxidizers	4	NP	NP	N/A
	3	10 lb[h]	1 gal[h]	N/A
	2	250 lb	25 gal	N/A
	1	4,000 lb[i]	400 gal[i]	N/A
Oxidizing gas	Gaseous	N/A	N/A	NP[h]
	Liquefied	N/A	15 gal	N/A
Organic peroxides	I	NP	NP	N/A
	II	NP	NP	N/A
	III	25 lb	(1,500)	N/A
	IV	NL	(100,000)	N/A
	V	NL	NL	N/A
Pyrophoric materials	N/A	NP	NP	NP
Unstable reactives	4	NP	NP	NP
	3	NP	NP	NP
	2	10	(10)	NP[g]
	1	NL	NL	NP
Water-reactive	3	1 lb	(1)	N/A
	2	10 lb	(10)	N/A
	1	NL	NL	N/A
Corrosives	N/A	1,000 lb	100 gal	NP
Highly toxic	N/A	3 lb	(3)	NP[j]
Toxic	N/A	125 lb	(125)	NP[j]

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 ft^3 = 0.0283 m^3.

NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 of NFPA 400 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2 of NFPA 400, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

[a]Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

[b]Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

[c]Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this code.

[d]The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

[e]The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

[f]The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

[g]Containers, cylinders, or tanks not exceeding 250 scf (7.1 m^3) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

[h]A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

[i]The permitted quantities are not limited in a building protected throughout by automatic sprinkler systems in accordance with NFPA 13.

[j]Gas cylinders not exceeding 20 scf (0.57 m^3) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

[k]Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

[l]Storage shall be permitted to be increased 100% if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.

[m]Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1.3-gallon capacity. [**30:**9.1.4(4)]

[**400:** Table 5.2.1.5]

Δ *TABLE 60.4.2.1.6 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Ambulatory Health Care Occupancies[a]*

Material	Class	Solid	Liquid[k]	Gas[a] (at NTP)
Flammable and combustible liquid[b,c]	See note	See note	See note	See note
Cryogenic fluid	Flammable	N/A	10	N/A
	Oxidizing	N/A	10	N/A
Explosives[d,e,f]	See note	See note	See note	See note
Flammable gas[c,g]	Gaseous	N/A	N/A	NP
	Liquefied	N/A	N/A	N/A
	Liquefied Petroleum	N/A	N/A	(20)
Flammable solid	N/A	5	N/A	N/A
Oxidizers	4	NP	NP	NP
	3	10[h]	1[h]	NP
	2	250	25	NP
	1	4,000[i]	400[i]	NP
Oxidizing gas	Gaseous	N/A	N/A	NP[h]
	Liquefied	N/A	N/A	NP[h]
Organic peroxides	I	NP	NP	N/A
	II	NP	NP	N/A
	III	25	(25)	N/A
	IV	NL	NL	N/A
	V	NL	NL	N/A
Pyrophoric materials	N/A	NP	NP	NP
Unstable reactives	4	NP	NP	NP
	3	NP	NP	NP
	2	10	(10)	NP[g]
	1	NL	NL	NP
Water-reactive	3	1	(1)	N/A
	2	10	(10)	N/A
	1	NL	NL	N/A
Corrosives	N/A	1,000	100	NP
Highly toxic	N/A	3	(3)	NP[j]
Toxic	N/A	125	(125)	NP[j]

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 ft^3 = 0.0283 m^3.

NTP: Normal temperature and pressure [70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 of NFPA 400 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2 of NFPA 400, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

[a]Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

[b]Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

[c]Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this *Code*.

[d]The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

[e]The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

[f]The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

[g]Containers, cylinders, or tanks not exceeding 250 scf (7.1 m^3) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

[h]A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

[i]The permitted quantities are not limited in a building protected throughout by automatic sprinkler systems in accordance with NFPA 13.

[j]Gas cylinders not exceeding 20 scf (0.57 m^3) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

[k]Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

[l]Storage shall be permitted to be increased 100% if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.

[m]Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do exceed a 1.3-gallon capacity. [**30:**9.1.4.(4)]

[**400:** Table 5.2.1.6]

△ ***TABLE 60.4.2.1.7** Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Detention and Correctional Occupancies*[a]

Material	Class	Solid	Liquid[k]	Gas[a] (at NTP)
Flammable and combustible liquid[b,c]	See note	See note	See note	See note
Cryogenic fluid	Flammable	N/A	10	N/A
	Oxidizing	N/A	10	N/A
Explosives[d,e,f,g]	See note	See note	See note	See note
Flammable gas[c,h]	Gaseous	N/A	N/A	NP
	Liquefied	N/A	N/A	(20)
	Liquefied Petroleum	N/A	N/A	(20)
Flammable solid	N/A	5	N/A	N/A
Oxidizers	4	NP	NP	N/A
	3	10[i]	1[i]	N/A
	2	250	25	N/A
	1	4000	400	N/A
Oxidizing gas[h]	Gaseous	N/A	N/A	NP
	Liquefied	N/A	N/A	N/A
Organic peroxides	I	NP	NP	N/A
	II	NP	NP	N/A
	III	25	(25)	N/A
	IV	NL	NL	N/A
	V	NL	NL	N/A
Pyrophoric materials	N/A	1	(1)	NP
Unstable reactives	4	¼	(¼)	NP
	3	1	(1)	NP
	2	10	(10)	NP[h]
	1	NL	NL	NP
Water-reactive	3	1	(1)	N/A
	2	10	(10)	N/A
	1	NL	NL	N/A
Corrosives	N/A	1,000	100	NP
Highly toxic	N/A	3	(3)	NP[j]
Toxic	N/A	125	(125)	NP[j]

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 ft^3 = 0.0283 m^3.

NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by Chapter 60 or NFPA 400 but are provided here for informational purposes. See Chapter 2 of NFPA 400 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2 of NFPA 400, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

[a]Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

[b]Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

[c]Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this *Code*.

[d]The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

[e]The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

[f]The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

[g]The storage and use of small arms ammunition, and components thereof, are permitted where in accordance with NFPA 495.

[h]Containers, cylinders, or tanks not exceeding 250 scf (7.1 m^3) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

[i]A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

[j]Gas cylinders not exceeding 20 scf (0.57 m^3) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

[k]Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

[l]Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1.3-gallon capacity. [**30:**9.1.4(4)]

[**400:**Table 5.2.1.7]

Δ *TABLE 60.4.2.1.8 Maximum Allowable Quantities of Hazardous Materials per Control Area in Residential Occupancies Consisting of Lodging and Rooming Houses, Hotels, Dormitories, Apartments, and Residential Board and Care Facilities*

Material	Class	Solid	Liquid[l]	Gas[a] (at NTP)
Flammable and combustible liquid[b,c]	See note	See note	See note	See note
Cryogenic fluid	Flammable	N/A	10	N/A
	Oxidizing	N/A	10	N/A
Explosives[d,e,f,g]	See note	See note	See note	See note
Flammable gas[c,h]	Gaseous	N/A	N/A	NP
	Liquefied[j]	N/A	N/A	(20)
	Liquefied Petroleum	N/A	N/A	(20)
Flammable solid	N/A	5 lb	N/A	N/A
Oxidizers	4	NP	NP	N/A
	3	10[i]	1[i]	N/A
	2	250	25	N/A
	1	4000	400	N/A
Oxidizing gas[h]	Gaseous	N/A	N/A	NP[h]
	Liquefied	N/A	NL	N/A
Organic peroxides	I	NP	NP	N/A
	II	NP	NP	N/A
	III	25	(25)	N/A
	IV	NL	NL	N/A
	V	NL	NL	N/A
Pyrophoric materials	N/A	1	(1)	NP
Unstable reactives	4	¼	(¼)	NP
	3	1	(1)	NP
	2	10	(10)	NP[h]
	1	NL	NL	NP
Water-reactive	3	1	(1)	N/A
	2	10	(10)	N/A
	1	NL	NL	N/A
Corrosives	N/A	1000	100	NP
Highly toxic	N/A	3	(3)	NP[k]
Toxic	N/A	125	(125)	NP[k]

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 ft^3 = 0.0283 m^3.

NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by Chapter 60 or NFPA 400 but are provided here for informational purposes. See Chapter 2 of NFPA 400 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2 of NFPA 400, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

[a]Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

[b]Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids are permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

[c]Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this *Code*.

[d]The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

[e]The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

[f]The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

[g]The storage and use of small arms ammunition, and components thereof, are permitted where in accordance with NFPA 495.

[h]Containers, cylinders, or tanks not exceeding 250 scf (7.1 m^3) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

[i]A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

[j]Storage containers are not permitted to exceed 0.325 ft^3 (0.0092 m^3) capacity.

[k]Gas cylinders not exceeding 20 scf 0.57 m^3) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

[l]Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

[m]Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1.3-gallon capacity. [**30:**9.1.4.(4)]

[**400:** Table 5.2.1.8]

△ *TABLE 60.4.2.1.10.1 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Business Occupancies*

Material	Class	Solid	Liquid[j]	Gas[a,i] (at NTP)
Flammable and combustible liquid[b,c]	See note	See note	See note	See note
Cryogenic fluid	Flammable	N/A	10	N/A
	Oxidizing	N/A	10	N/A
Explosives[d,e,f,g]	See note	See note	See note	See note
Flammable gas[c]	Gaseous	N/A	N/A	1000
	Liquefied	N/A	N/A	(20)
	Liquefied Petroleum	N/A	N/A	(20)
Flammable solid	N/A	5	N/A	N/A
Oxidizers	4	NP	NP	NP
	3	10[h]	1[h]	NP
	2	250	25	NP
	1	4000	400	NP
Oxidizing gas	Gaseous	N/A	N/A	1500
	Liquefied	N/A	15	N/A
Organic peroxides	I	NP	NP	N/A
	II	NP	NP	N/A
	III	1500	(1500)	N/A
	IV	100,000	(100,000)	N/A
	V	NL	NL	N/A
Pyrophoric materials	N/A	1	(1)	10
Unstable reactives	4	¼	(¼)	2
	3	1	(1)	10
	2	10	(10)	750
	1	NL	NL	NL
Water-reactive	3	1	(1)	N/A
	2	10	(10)	N/A
	1	NL	NL	N/A
Corrosives	N/A	1000	100	810
Highly toxic[i]	N/A	3	(3)	20
Toxic[i]	N/A	125	(125)	810

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 ft^3 = 0.0283 m^3.

NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 of NFPA 400 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2 of NFPA 400, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

[a]Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

[b]Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

[c]Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this *Code*.

[d]The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

[e]The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

[f]The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

[g]The storage and use of small arms ammunition, and components thereof, are permitted where in accordance with NFPA 495.

[h]A maximum quantity of 200 lb (91 kg) of solid or 20 gal (76 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

[i]Gas cylinders not exceeding 20 scf (0.57 m^3) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

[j]Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

[k]Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1.3-gallon capacity. [**30:**9.1.4(4)]

[**400:** Table 5.2.1.10.1]

accordance with 60.4.2.1.13.3, such materials shall be stored in accordance with the following limitations:

(1) Storage and display of solids shall not exceed 200 lb/ft^2 (976.4 kg/m^2) of floor area actually occupied by solid merchandise.
(2) Storage and display of liquids shall not exceed 20 gal/ft^2 (76 L/m^2) of floor area actually occupied by liquid merchandise.
(3) Storage and display height shall not exceed 6 ft (1.8 m) above the finished floor.
(4) Individual containers less than 5 gal (19 L) or less than 25 lb (11 kg) shall be stored or displayed on pallets, racks, or shelves.
(5) Racks and shelves used for storage or display shall be in accordance with 60.5.1.13.
(6) Containers shall be listed or approved for the intended use.
(7) Individual containers shall not exceed 100 lb (45.4 kg) capacity for solids or a 10 gal (38 L) capacity for liquids.
(8) Incompatible materials shall be separated in accordance with 60.5.1.12.
(9) Except for surfacing, floors shall be of noncombustible construction.
(10) Aisles 4 ft (1.2 m) in width shall be maintained on three sides of the storage or display area.
(11) Hazard identification signs shall be provided in accordance with 60.5.1.8.

[**400:**5.2.1.13.2]

Δ **60.4.2.1.13.3 Special Maximum Allowable Quantity Increases for Storage in Mercantile, Storage, and Industrial Occupancies.** The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials permitted within a single control area of a mercantile, storage, or industrial occupancy shall be permitted to exceed the MAQ specified in Table 60.4.2.1.1.3, without complying with Protection Level 2, Protection Level 3, or Protection Level 4, provided that the quantities comply with Table 60.4.2.1.13.3(a) and Table 60.4.2.1.13.3(b) and that materials are displayed and stored in accordance with the special limitations in 60.4.2.1.13.2. [**400:**5.2.1.13.3]

Note that, instead of using Table 60.4.2.1.1.3, the user can take advantage of the increased quantity limits in Table 60.4.2.1.13.3(a) and Table 60.4.2.1.13.3(b), at least for certain hazardous materials in certain occupancies, provided the storage requirements of 60.4.2.1.13.2 are met.

If the storage consists of a mixture of hazardous materials, or if the hazardous material has been classified as flammable or combustible, Table 60.4.2.1.13.3(a) and Table 60.4.2.1.13.3(b) cannot be used. Nor can these provisions be used if the hazardous material is in the form of a gas. This does not mean that flammable or combustible liquids or solids or any type of hazardous gas cannot be present, but only that such materials must be protected as required by other sections of this chapter.

Δ ***TABLE 60.4.2.1.13.3(a)** Maximum Allowable Quantity (MAQ) per Indoor and Outdoor Control Area for Selected Hazard Categories in Mercantile, Storage, and Industrial Occupancies*

Hazard Category	Maximum Allowable Quantity[a,b]			
	Solids		Liquids	
	lb	kg	gal	L
Physical Hazard Materials: Nonflammable and Noncombustible Solids and Liquids				
Oxidizers				
Class 3	1,350	616	135	511
Class 2	2,250	1,021	225	852
Class 1	18,000[c]	8,165[c]	1,800[c]	6,814[c]

Note: Maximum quantities for hazard categories not shown are required to be in accordance with Table 60.4.2.1.1.3.

[a]Maximum quantities are permitted to be increased 100 percent in buildings that are sprinklered in accordance with NFPA 13. Where footnote b also applies, the increase for both footnotes is permitted to be applied.

[b]Maximum quantities are permitted to be increased 100 percent where stored in approved storage cabinets in accordance with this *Code*. Where footnote a also applies, the increase for both footnotes is permitted to be applied.

[c]Quantities are not limited in buildings protected by an automatic sprinkler system complying with NFPA 13. [**5000:** Table 34.1.3.3.1(a)] [**400:** Table 5.2.1.13.3(a)]

EXAMPLE

This example of the application of Table 60.4.2.1.13.3(a) should help the user understand the concept. Assume the material is a Class 3 oxidizer in a liquid state (e.g., a calcium hypochlorite solution greater than 50 percent by weight, which is a typical pool chemical), stored in a retail store with one control area. If all the base requirements of 60.4.2.1.13.2 are followed, the retail store can display 135 gal (510 L). Based on footnote a to Table 60.4.2.1.13.3(a), the quantity of this Class 3 oxidizer can be increased by an additional 100 percent if the building is protected with an approved sprinkler system in accordance with NFPA 13. The new amount of stored material permitted would then increase to 270 gal (1022 L).

If footnote b of Table 60.4.2.1.13.3(a) is applied, the quantity of this Class 3 oxidizer can also be increased by 100 percent if the material is stored in an approved storage cabinet. Although materials in a retail setting are unlikely to be displayed in this type of arrangement, this increase would result in an additional allowance of 270 gal (1022 L). Thus, if both footnotes a and b to Table 60.4.2.1.13.3(a) are used, the total amount of Class 3 oxidizer permitted would be 540 gal (2044 L).

TABLE 60.4.2.1.13.3(b) *Maximum Allowable Quantity (MAQ) per Indoor and Outdoor Control Area for Selected Hazard Categories in Mercantile and Storage Occupancies*

Hazard Category	Maximum Allowable Quantity[a,b,c]			
	Solids		Liquids	
	lb	kg	gal	L
Physical Hazard Materials: Nonflammable and Noncombustible Solids and Liquids				
Unstable (reactive)				
Class 3	550	250	55	208
Class 2	1,150	522	115	435
Water-reactive				
Class 3	550	250	55	208
Class 2	1,150	522	115	435
Health Hazard Materials: Nonflammable and Noncombustible Solids and Liquids				
Corrosive	10,000	4,536	1,000	3,785
Highly toxic[d]	20	9	2	8
Toxic[d]	1,000	454	100	378

[a]Maximum quantities for hazard categories not shown are required to be in accordance with Table 60.4.2.1.1.3.

[b]Maximum quantities are permitted to be increased 100 percent in buildings that are sprinklered in accordance with NFPA 13. Where footnote b also applies, the increase for both footnotes can be applied.

[c]Maximum quantities are permitted to be increased 100 percent where stored in approved storage cabinets in accordance with this *Code*. Where footnote a also applies, the increase for both footnotes is permitted to be applied. [**5000:** Table 34.1.3.3.1(b)]

[d]Toxic or highly toxic solids or liquids displayed in original packaging in mercantile or storage occupancies and intended for maintenance, operation of equipment, or sanitation when contained in individual packaging not exceeding 100 lb (45.4 kg) shall be limited to an aggregate of 1200 lb (544.3 kg) or 120 gal (454.2 L). The increases allowed by footnotes a, b, and c shall not apply to highly toxic solids and liquids. [**400:** Table 5.2.1.13.3(b)]

This approach might seem complicated, but, using the special controls for increased quantities of hazardous materials in mercantile occupancies outlined in 60.4.2.1.13.2 for the hazard categories shown in Table 60.4.2.1.13.3(a), the potential risk from increased quantities of Class 3 oxidizer materials is limited.

Many of the retail display arrangements for consumer products have been tested to limit spills or leaks, and the protection features are appropriate for the risk they pose. One of the main reasons this increase is allowed is that the retail industry, with the exception of incidents in bulk retail facilities, has experienced few incidents involving these products in retail settings.

TABLE 60.4.2.2.1 *Design and Number of Control Areas*

Floor Level	Maximum Allowable Quantity per Control Area (%)*	Number of Control Areas per Floor	Fire Resistance Rating for Fire Barriers† (hr)
Above grade			
>9	5.0	1	2
7–9	5.0	2	2
4–6	12.5	2	2
3	50.0	2	1
2	75.0	3	1
1	100.0	4	1
Below grade			
1	75.	3	1
2	50.	2	1
Lower than 2	NP	NP	N/A

NP: Not permitted. N/A: Not applicable.

*Percentages represent the MAQ per control area shown in Table 60.4.2.1.1.3, with all the increases permitted in the footnotes of that table.

†Fire barriers are required to include floors and walls, as necessary, to provide a complete separation from other control areas. [**400:** Table 5.2.2.1]

Historically, spills and leaks have not been a problem, due to the requirement to keep the sales area neat and orderly.

60.4.2.2 Construction Requirements for Control Areas.

60.4.2.2.1 Number of Control Areas. The maximum number of control areas within a building shall be in accordance with Table 60.4.2.2.1. [**400:**5.2.2.1]

Control area is defined in 3.3.14.2 as, essentially, a building, a part of a building, or an outside area in which one is allowed to store, handle, or use hazardous materials, with the assumption that the quantities involved do not exceed a certain specified amount for each hazardous material present. Table 60.4.2.2.1 requires a minimum 1-hour fire barrier around a control area to ensure that an incident in one area does not impact an adjacent area. The table also identifies where the separation needs to be increased to a 2-hour fire barrier, based on the elevation of the control area above grade. This increase in required fire barrier ratings has a direct relationship to the time it would take first responders to set up their equipment and effectively handle the incident. The higher a control area is located within a building, the greater the amount of resources required to handle an incident and the greater the time needed to assemble those resources.

Another feature of Table 60.4.2.2.1 is that, as a control area moves farther above (or below) grade, the MAQ is "derated," that is, the MAQ for any given hazardous material is multiplied by a specified fraction, so only a certain percentage of the base MAQ is allowed. This limit is codified in the asterisk footnote to Table 60.4.2.2.1. The justification for this penalty is the same as for the increase from a 1-hour barrier to a 2-hour barrier: the farther, vertically, from grade, the greater the time required for emergency responders to reach the incident and the greater the difficulty in controlling and resolving it.

The dagger footnote to Table 60.4.2.2.1 clarifies that the fire barrier must completely separate the control area from adjacent spaces. Therefore, rating required for each level applies to walls, floors, and floor/ceiling assemblies, so that an envelope of protection surrounds the control area. If Table 60.4.2.2.1 requires the fire barrier rating to be 1 hour, then that rating also applies to the floor and all walls. If a 2-hour rating is required, as is found on floor level 4 and above, all floor/ceiling assemblies and walls must be 2-hour rated.

Table 60.4.2.2.1 represents a minimum set of construction ratings and cannot be used to reduce construction requirements found in local building codes. For example, if a control area is located on floor level 3 and the local building code requires a 2-hour-rated fire barrier, then Table 60.4.2.2.1 cannot be used to reduce the fire barrier rating to 1 hour; it cannot be used to override any stricter requirements that might apply. As noted under the "below grade" section of the table's "floor level" column, hazardous materials above the MAQ are not allowed to be located on levels more than two levels below grade. The risk to first responders is too great, and the protection features cannot offset the response time needed for an area so far below grade.

The approach for determining the number of control areas and the fire-resistive rating of separation requirements can be demonstrated using the example that follows.

Example

On floor level 1, the user is allowed to have 100 percent of the MAQ in each control area, and up to four control areas are allowed on that floor level. This requirement is the same as in previous editions of the *Code*, in which four was the maximum number of control areas. If flammable solids are stored in the building, this approach allows an MAQ of 125 lb (57 kg) per control area or 500 lb (227 kg) on the first floor level in four control areas, each separated by a 1-hour fire barrier.

The approach of this *Code* is to use the floor level to reduce risk and to increase protection. Protection increases in the following three ways as the building increases in height:

1. The quantity of hazardous material is reduced, because of the percentage factor.
2. The number of control areas per floor is reduced.
3. The fire separation of the control areas is increased.

In this example, on floor level 1 of the building, the user could have 500 lb (227 kg) of flammable solids, but if the same user wanted to have all the flammable solids one level higher or one level lower in the building, the allowable quantity would be reduced. On floor level 2, the amount of material would be reduced to 75 percent of the MAQ, or 94 lb (43 kg), and the number of allowed control areas would be reduced to three. This translates to a reduction in the aggregate amount of material from 500 lb to 282 lb (227 kg to 128 kg).

If the user wanted to use the flammable solids even higher in the building, the allowable quantity would be further limited. For example, applying Table 60.4.2.2.1 to calculate quantities for the same user on floor level 9, the separation of the control areas would increase from a 1-hour to a 2-hour fire barrier, the percentage in the control area would reduce to 5 percent, and only two control areas would be allowed on that floor level. This placement would decrease the allowable amount of flammable solids from 500 lb (227 kg) on floor level 1 to 12.5 lb (5.7 kg) on floor level 9, provided that both control areas contained no more than the maximum amount, or 6.25 lb (2.8 kg), in each control area.

60.4.2.2.2 Where only one control area is present in a building, no special construction provisions shall be required. [**400:**5.2.2.2]

60.4.2.2.3 Where more than one control area is present in a building, control areas shall be separated from each other by fire barriers in accordance with Table 60.4.2.2.1. [**400:**5.2.2.3]

60.4.3 Protection Levels.

Subsection 60.4.3 implements extra protection strategies for quantities of hazardous materials that exceed the MAQ for identified occupancies within Chapter 60. If an amount of hazardous material exceeds the MAQ for storage, the user must follow the applicable sections of Chapter 60, in addition to 60.4.3, and the applicable sections of NFPA 400 for use and handling. If the MAQ is exceeded, additional protection is needed. Specific protection, construction, and property setback requirements are imposed for the higher quantities of hazardous materials that are regulated within this chapter.

Subsection 60.4.3 contains protection requirements that are more restrictive than normal occupancy classification use due to the increased amounts of hazardous materials. If the amount of hazardous material needed for the site cannot be isolated by subdividing the building into separate control areas that contain less hazardous material than allowed by Table 60.4.2.1.1.3, the user must increase the protection features of the building. Table 60.4.2.1.1.3 already includes important provisions that recognize sprinkler protection or approved storage cabinets or special design features; these provisions allow increases in the hazardous materials quantities for the specific occupancy classification beyond the base MAQ. Paragraphs 60.4.3.1 through 60.4.3.7 outline the additional protection features that must be in place to allow even greater quantities of hazardous materials to be stored. If the protection features cannot be provided or are determined not to be an option for the site, then these greater quantities are not allowed, and the MAQs from Table 60.4.2.1.1.3 prevail.

60.4.3.1 Where the quantity of hazardous materials in storage or use exceeds the MAQ for indoor control areas as set forth in 60.4.2, the occupancy shall comply with the requirements for Protection Level 1, Protection Level 2, Protection Level 3, or Protection Level 4, as required for the material in storage or use as defined in 6.2.2 through 6.2.5 of NFPA 400. [**400:**5.3.1]

60.4.3.2 Protection Level 5 shall apply to semiconductor fabrication facilities where required by the building code. [**400:**5.3.2]

60.4.3.3 Protection Level 1.

60.4.3.3.1 Buildings containing quantities of hazardous materials exceeding the MAQ of high hazard Level 1 contents permitted in control areas shall comply with applicable regulations for Protection Level 1, as set forth in the applicable sections of Chapter 6 and Chapters 11 through 21 of NFPA 400, and the building code. [**400:**5.3.3.1]

60.4.3.3.2 High hazard Level 1 contents shall include materials that present a detonation hazard as defined in 60.3.2.1.2.1. [**400:**5.3.3.2]

Protection Level 1 is the highest level of protection and provides the greatest level of protection from the risk provided for by the *Code*. The only way to provide a greater level of protection is to prohibit additional hazardous materials at the site or to move the hazardous materials to a detached building.

High hazard Level 1 contents are unstable materials and can pose a detonation hazard. Many of the facilities using this class of hazardous material would benefit from the option to store it in a detached building or a bunker.

60.4.3.4 Protection Level 2.

60.4.3.4.1 Buildings, and portions thereof, containing quantities of hazardous materials exceeding the MAQ of high-hazard level 2 contents permitted in control areas shall comply with applicable regulations for Protection Level 2, as set forth in the applicable sections of Chapter 6 and Chapters 11 through 21 of NFPA 400, and the building code. [**400:**5.3.4.1]

Protection Level 2 is designed to limit the spread of fire from materials that deflagrate or accelerate burning. Additionally, the protection features are designed to limit the potential for fire to spread from an outside source and affect the hazardous materials in the building.

60.4.3.4.2 High-hazard level 2 contents shall include materials that present a deflagration hazard or a hazard from accelerated burning as defined in 60.3.2.1.2.2. [**400:**5.3.4.2]

60.4.3.5 Protection Level 3.

60.4.3.5.1 Buildings, and portions thereof, containing quantities of hazardous materials exceeding the MAQ of high-hazard level 3 contents permitted in control areas shall comply with applicable regulations for Protection Level 3, as set forth in the applicable sections of Chapter 6 and Chapters 11 through 21 of NFPA 400, and the building code. [**400:**5.3.5.1]

60.4.3.5.2 High-hazard level 3 contents shall include materials that readily support combustion or present a physical hazard as defined in 60.3.2.1.2.3. [**400:**5.3.5.2]

Protection Level 3 is one of the most common protection levels encountered in the general inspection of storage and industrial operations that use hazardous materials. These types of operations and storage facilities normally operate with amounts of hazardous materials greater than the MAQ while conducting business. The protection features should be understood in detail, and the amounts of hazardous materials should be reviewed due to their frequent presence within most jurisdictions. Features for Protection Level 1 through Protection Level 3 are intended primarily to provide protection from physical hazards.

60.4.3.6 Protection Level 4.

60.4.3.6.1 Buildings, and portions thereof, containing quantities of hazardous materials exceeding the MAQ of high-hazard level 4 contents permitted in control areas shall comply with applicable regulations for Protection Level 4, as set forth in the applicable sections of Chapter 6 and Chapters 11 through 21 of NFPA 400, and the building code. [**400:**5.3.6.1]

60.4.3.6.2 High-hazard level 4 contents shall include materials that are acute health hazards as defined in 60.3.2.1.2.4. [**400:**5.3.6.2]

Protection Level 4 is intended to mitigate the acute health hazards resulting from the storage, use, or handling of high hazard Level 4 materials in excess of the predetermined MAQ; these high hazard contents include corrosives, highly toxic materials, and toxic materials. The objective is to protect evacuating occupants and arriving first responders from being injured by these hazardous materials. The MAQ amount is designed to limit the amount to a manageable level without requiring protection features. When the MAQ amount is exceeded, additional protection features must be provided.

Δ **60.4.3.7 Detached Building Required for High-Hazard Level 2 and High Hazard Level 3 Materials.** Buildings required to comply with Protection Level 2 or 3 and containing quantities of high hazard contents exceeding the quantity limits set forth in Table 60.4.3.7 shall be in accordance with 6.2.3.4 or 6.2.4.4 of NFPA 400, as applicable. [**400:**5.3.7]

60.4.4 Outdoor Areas.

An area that is often overlooked is that of protecting hazardous materials stored outdoors. Subsection 60.4.4 addresses the need to limit the amount of material that would be exposed if an incident occurred. Separation between outdoor control areas provides an opportunity for emergency responders to deal with an incident involving a quantity of hazardous material that has been limited to a manageable quantity. It also provides time for the emergency responders to prevent the incident from spreading to adjacent materials, to adjacent buildings, or across property lines to exposed property. See NFPA 400 for additional details.

60.4.4.1 Outdoor Control Areas.

60.4.4.1.1 General.

60.4.4.1.1.1 Hazardous materials shall be permitted to be stored or used in outdoor control areas in accordance with 60.4.4.1.2 and 60.4.4.1.3. [**400:**5.4.1.1.1]

Δ *TABLE 60.4.3.7 Detached Buildings Required Where Quantity of Material Exceeds Amount Shown*

Gas Hazard	Class	Quantity of Material scf	Quantity of Material Nm³*
Individual bulk hydrogen compressed gas systems	N/A	N/A	15,000 (425)
Oxidizers	3	1,200	N/A
	2	2,000	N/A
Organic peroxides	II	25	N/A
	III	50	N/A
Unstable (reactive) materials	3, nondetonable	1	2,000 (57)
	2	25	10,000 (283)
Water-reactive materials	3	1	N/A
	2, deflagrating	25	N/A
Pyrophoric gases		N/A	2,000 (57)

For SI units, 1 ton = 0.9 met ton.
N/A: Not applicable.
*See Table 21.2.5 of NFPA 400. [**400:** Table 5.3.7]

60.4.4.1.1.2 Where storage or use is in an outdoor control area, compliance with the outdoor storage and use requirements in Chapters 11 through 21 of NFPA 400 shall not be required. [**400:**5.4.1.1.2]

Chapters 11 through 21 of NFPA 400 address specific classes of hazardous materials.

60.4.4.1.2 Maximum Allowable Quantity per Outdoor Control Area. Maximum allowable quantities of hazardous materials in an outdoor control area shall be as specified in Table 60.4.2.1.13.3(a) and Table 60.4.2.1.13.3(b) or Table 60.4.4.1.2. [**400:**5.4.1.2]

Table 60.4.4.1.2 presents a list of hazardous materials that are regulated when stored or used outdoors. The amount is not allowed to be increased, because if a release were to occur, it would not be contained within a building and, therefore, might adversely expose occupants trying to egress from an adjacent building.

Outdoor control areas do create exposure problems, but the concept is that 75 percent to 100 percent of the perimeter of the use or storage control area will be open. In addition, no overhead obstruction would be present, except for, perhaps, an approved weather shelter or canopy. Due to this openness of design, outdoor control areas allow for direct access by first responders on multiple sides, with an opportunity for evacuees to exit an adjacent building in other directions. Outdoor control areas also allow gases, vapors, and products of combustion to dissipate, minimizing any adverse exposure to people in the surrounding area. However, this is also a drawback, since these same gases, vapors, and products of combustion might be at harmful levels in the immediate area of the incident.

As residential and commercial development encroaches on industrial sites where hazardous materials are stored and used, and populated areas develop near storage and use areas, approved plans for notification and response will have to be developed and maintained.

60.4.4.1.3 Number of Outdoor Control Areas.

60.4.4.1.3.1 A single outdoor control area shall be permitted on any property. [**400:**5.4.1.3.1]

60.4.4.1.3.2 Where a property exceeds 10,000 ft² (929 m²), a group of two outdoor control areas shall be permitted where approved and where each control area is separated by a minimum distance of 50 ft (15 m). [**400:**5.4.1.3.2]

Paragraph 60.4.4.1.3.2 permits two separate outdoor control areas as an exception to the single control area allowed by 60.4.4.1.3.1. All of the following conditions must be met prior to having two outdoor control areas:

1. The property must be larger than 10,000 ft² (929 m²).
2. The arrangement of hazardous materials and buildings must allow for a 50 ft (15 m) separation between control areas.
3. The "where approved" condition must allow the AHJ the ability to limit the site to one control area if concerns such as limited access, water supply, zoning restriction, or setbacks to adjacent properties are present.

60.4.4.1.3.3 Where a property exceeds 35,000 ft² (3252 m²), additional groups of outdoor control areas shall be permitted where approved, provided that each group is separated by a minimum distance of 300 ft (91 m). [**400:**5.4.1.3.3]

60.4.4.2 Outdoor Storage and Use Areas. Where the quantity of hazardous materials in outdoor storage or use exceeds the MAQ for outdoor control areas as set forth in Table 60.4.4.1.2, the outdoor area shall comply with the applicable outdoor requirements of Chapter 6 and Chapters 11 through 21 of NFPA 400. [**400:**5.4.2]

60.5 Fundamental Requirements

60.5.1 General Requirements.

60.5.1.1 Applicability. Storage, use, and handling of hazardous materials in any quantity shall comply with 60.5.1. [**400:**6.1.1]

Δ **60.5.1.1.1*** Storage of hazardous materials in quantities exceeding the maximum allowable quantity set forth in Section 60.4 and the applicable material specific requirements in Chapters 11 through 21 of NFPA 400. [**400:**6.1.1.1]

A.60.5.1.1.1 Outdoor control areas are not classified with protection levels. [**400:**A.6.1.1.1]

Δ *TABLE 60.4.4.1.2 Maximum Allowable Quantities of Hazardous Materials per Outdoor Control Area*

		Storage			Use — Closed Systems			Use — Open Systems	
Material	**Class**	**Solid Pounds**	**Liquid Gallons (lb)**	**Gas scf (lb)**	**Solid Pounds**	**Liquid Gallons (lb)**	**Gas scf (lb)**	**Solid Pounds**	**Liquid Gallons (lb)**
Physical Hazard Materials									
Flammable gas									
Gaseous		N/A	N/A	3000	N/A	N/A	1500	N/A	N/A
Liquefied		N/A	N/A	(300)	N/A	N/A	(150)	N/A	N/A
Flammable solid		500	N/A	N/A	250	N/A	N/A	50	N/A
Organic peroxide	Detonable	1	(1)	N/A	¼	(¼)	N/A	¼	(¼)
Organic peroxide	I	20	20	N/A	10	(10)	N/A	2	2
	II	200	200	N/A	100	(100)	N/A	20	20
	III	500	500	N/A	250	(250)	N/A	50	50
	IV	NL	NL	N/A	NL	NL	N/A	NL	NL
	V	NL	NL	N/A	NL	NL	N/A	NL	NL
Oxidizer	4	2	(2)	N/A	1	(¼)	N/A	¼	(¼)
	3	40	(40)	N/A	20	(2)	N/A	2	(2)
	2	1000	(1000)	N/A	500	(250)	N/A	50	(50)
	1	NL	NL	N/A	NL	NL	N/A	NL	NL
Oxidizing gas									
Gaseous		N/A	N/A	6000	N/A	N/A	6000	N/A	N/A
Liquefied		N/A	N/A	(600)	N/A	N/A	(300)	N/A	N/A
Pyrophoric		8	(8)	100	4	(4)	10	0	0
Unstable (Reactive)	4	2	(2)	20	1	(1)	2	¼	(¼)
	3	20	(20)	200	10	(10)	10	1	(1)
	2	200	(200)	1000	100	(100)	250	10	(10)
	1	NL	NL	1500	NL	NL	NL	NL	NL
Water-reactive	3	20	(20)	N/A	10	(10)	N/A	1	(1)
	2	200	(200)	N/A	100	(100)	N/A	10	(10)
	1	NL	NL	N/A	NL	NL	N/A	NL	NL
Health Hazard Materials									
Corrosive		20,000	2000	N/A	10,000	1000	N/A	1000	100
Corrosive gas									
Gaseous		N/A	N/A	1620	N/A	N/A	810	N/A	N/A
Liquefied		N/A	N/A	(300)	N/A	N/A	(150)	N/A	N/A
Highly toxic		20	(20)	N/A	10	(10)	N/A	3	(3)
Highly toxic gas									
Gaseous		N/A	N/A	40*	N/A	N/A	20*	N/A	N/A
Liquefied		N/A	N/A	(8)*	N/A	N/A	(4)*	N/A	N/A
Toxic		1000	(1000)	N/A	500	50	N/A	125	(125)
Toxic gas									
Gaseous		N/A	N/A	1620	N/A	N/A	810	N/A	N/A
Liquefied		N/A	N/A	(300)	N/A	N/A	(150)	N/A	N/A

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 scf = 0.0283Nm3.
N/A: Not applicable. NL: Not limited.
Notes:
(1) Table values in parentheses correspond to the unit name in parentheses at the top of the column.
(2) For gallons of liquids, divide the amount in pounds by 10.
(3) The aggregate quantities in storage and use cannot exceed the quantity listed for storage.
(4) The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials allowed in outdoor storage per single property under the same ownership or control used for retail or wholesale sales is permitted to exceed the MAQ where such storage is in accordance with 60.4.2.1.13.3.
*Permitted only where stored or used in approved exhausted gas cabinets, exhausted enclosures, or fume hoods. [**400:** Table 5.4.1.2]

Δ **60.5.1.1.2*** The use, dispensing, and handling of hazardous materials in quantities exceeding the maximum allowable quantity (MAQ) set forth in Section 60.4 shall comply with Section 6.3 of NFPA 400 and the applicable material specific requirements in Chapters 11 through 21 of NFPA 400. [**400:**6.1.1.2]

A.60.5.1.1.2 Outdoor control areas are not classified with protection levels. [**400:**A.6.1.1.2]

60.5.1.2* Safety Data Sheets (SDS). Safety data sheets (SDS) shall be available on the premises for hazardous materials regulated by this code. When approved, SDSs shall be permitted to be retrievable by electronic access. [**400:**6.1.2]

A.60.5.1.2 *Readily available* can mean access to the product manufacturer's or user's paper or electronic copies of SDSs. [**400:**A.6.1.2]

60.5.1.3 Release of Hazardous Materials.

Paragraphs 60.5.1.3.1 through 60.5.1.3.7.2 outline the need to review and prepare for unauthorized or accidental discharges and to provide clear direction identifying that the responsible person, firm, or corporation is financially capable of meeting the cost of the mitigation and cleanup. This process begins with a knowledge of regulations that prohibit releases without permission. The process further requires the user to record the release and to notify all governmental agencies, including the fire department, as required by the regulations. Preparing for an unauthorized or accidental release includes modification to the design of equipment and materials-handling systems and developing procedures for the control and containment of the release.

Δ **60.5.1.3.1 Prohibited Releases.** Hazardous materials shall not be released into a sewer, storm drain, ditch, drainage canal, lake, river, or tidal waterway; upon the ground, a sidewalk, a street, or a highway; or into the atmosphere, unless such release is permitted by the following:

(1) Federal, state, or local governing regulations
(2) Permits of the jurisdictional air quality management board
(3) National Pollutant Discharge Elimination System permit
(4) Waste discharge requirements established by the jurisdictional water quality control board
(5) Sewer pretreatment requirements for publicly or privately owned treatment works

[**400:**6.1.3.1]

60.5.1.3.2 Control and Mitigation of Unauthorized Releases. Provisions shall be made for controlling and mitigating unauthorized releases. [**400:**6.1.3.2]

Provisions might include secondary containment for storage tanks and piping systems; secondary containment in buildings where hazardous materials are used or processed; excess flow valves; appropriately located control valves in piping systems; or alarm systems to warn of a release.

60.5.1.3.3 Records of Unauthorized Releases. Accurate records of the unauthorized release of hazardous materials shall be kept by the permittee. [**400:**6.1.3.3]

60.5.1.3.4* Notification of Unauthorized Releases. The fire department shall be notified immediately or in accordance with approved emergency procedures when an unauthorized release becomes reportable under state, federal, or local regulations. [**400:**6.1.3.4]

A.60.5.1.3.4 There might be additional regulations that must be complied with to notify other agencies. [**400:**A.6.1.3.4]

60.5.1.3.5 Container Failure. When an unauthorized release due to primary container failure is discovered, the involved primary container shall be repaired or removed from service. [**400:**6.1.3.5]

60.5.1.3.6 Overpack Containers. Overpack containers shall be permitted to be used as a means to provide protection for primary containers to be transported for repair or removal from service. [**400:**6.1.3.6]

60.5.1.3.7 Responsibility for Cleanup of Unauthorized Releases.

60.5.1.3.7.1 The person, firm, or corporation responsible for an unauthorized release shall institute and complete all actions necessary to remedy the effects of such unauthorized release, whether sudden or gradual, at no cost to the AHJ. [**400:**6.1.3.7.1]

60.5.1.3.7.2 When deemed necessary by the AHJ, cleanup of an unauthorized release shall be permitted to be initiated by the fire department or by an authorized individual or firm, and costs associated with such cleanup shall be borne by the owner, operator, or other person responsible for the unauthorized release. [**400:**6.1.3.7.2]

60.5.1.4* Personnel Training. Persons in areas where hazardous materials are stored, dispensed, handled, or used shall be trained in the hazards of the materials employed and actions required by the emergency plan. The level of training to be conducted shall be consistent with the responsibilities of the persons to be trained in accordance with 60.5.1.4.1 through 60.5.1.4.5. [**400:**6.1.4]

A.60.5.1.4 The hazard potential of a facility is not dependent on any single factor. Physical size, number of employees, and the quantity and the nature of the hazardous materials are important considerations. The level of training can vary with the complexity of the facility under consideration. [**400:**A.6.1.4]

Paragraph 60.5.1.4 is straightforward, but it addresses an important concept: the basic need and essential requirement to have trained and knowledgeable staff operating in areas where hazardous materials are present. One of the greatest and most cost-effective initial protections against a fire, leak, or spill is a qualified staff. A trained staff provides the needed monitoring and experience to avert or stop an incident before it becomes a major problem. If an incident does occur, the same staff members are an important resource used by the first responders, as outlined in 60.5.1.4.3.

60.5.1.4.1 Awareness. The training provided for persons designated in 60.5.1.4 shall include awareness training in accordance with 60.5.1.4.1.1 through 60.5.1.4.1.3. [**400:**6.1.4.1]

60.5.1.4.1.1 Completion. Initial training shall be completed prior to beginning work in the work area. [**400:**6.1.4.1.1]

60.5.1.4.1.2 Hazard Communications. Training shall be provided prior to beginning work in the work area to enable personnel to recognize and identify hazardous materials stored, dispensed, handled, or used on site and where to find safety information pertaining to the hazards of the materials employed. [**400:**6.1.4.1.2]

60.5.1.4.1.3 Emergency Plan. Training shall be provided prior to beginning work in the work area to enable personnel to implement the emergency plan. [**400:**6.1.4.1.3]

60.5.1.4.2 Operations Personnel. Persons engaged in storing, using, or handling hazardous materials shall be designated as operations personnel and shall be trained in accordance with 60.5.1.4.1 and 60.5.1.4.2.1 through 60.5.1.4.2.6. [**400:**6.1.4.2]

60.5.1.4.2.1 Physical and Health Hazard Properties. Operations personnel shall be trained in the chemical nature of the materials, including their physical hazards and the symptoms of acute or chronic exposure as provided by the safety data sheet (SDS) furnished by the manufacturer or other authoritative sources. [**400:**6.1.4.2.1]

60.5.1.4.2.2 Dispensing, Using, and Processing. Operations personnel shall be trained in the use of specific safeguards applicable to the dispensing, processing, or use of the materials and equipment employed. [**400:**6.1.4.2.2]

60.5.1.4.2.3 Storage. Operations personnel shall be trained in the application of storage arrangements and site-specific limitations on storage for the materials employed. [**400:**6.1.4.2.3]

60.5.1.4.2.4 Transport (Handling). Operations personnel involved in materials handling shall be trained in the requirements for on-site transport of the materials employed. [**400:**6.1.4.2.4]

60.5.1.4.2.5 Actions in an Emergency. Operations personnel shall be trained in the necessary actions to take in the event of an emergency, including the operation and activation of emergency controls prior to evacuation. [**400:**6.1.4.2.5]

Δ **60.5.1.4.2.6 Changes.** Training shall be provided whenever a new hazardous material is introduced into the work area that presents a new physical or health hazard, or when new information is obtained pertaining to physical or health hazards of an existing hazardous material that has not been included in previous training, and when there are changes in any of the following:

(1) Equipment
(2) Operations
(3) Hazardous materials

[**400:**6.1.4.2.6]

This is another element of "management of change," as discussed in the commentary to 60.1.6.2(3).

60.5.1.4.3 Emergency Response Liaison.

60.5.1.4.3.1 Responsible persons shall be designated and trained to be emergency response (ER) liaison personnel. [**400:**6.1.4.3.1]

Δ **60.5.1.4.3.2** Emergency response liaison personnel shall do the following:

(1) Aid emergency responders in pre-planning responses to emergencies
(2) Identify locations where hazardous materials are located
(3) Have access to material safety data sheets
(4) Be knowledgeable in the site emergency response procedures

[**400:**6.1.4.3.2]

60.5.1.4.4* Emergency Responders. Emergency responders shall be trained to be competent in the actions to be taken in an emergency event. [**400:**6.1.4.4]

A.60.5.1.4.4 Emergency responders can include on-site personnel that have been designated and trained to respond to emergencies, persons from the public sector such as fire department personnel, or persons from the private sector that can be contracted or otherwise engaged to perform emergency response duties. *(See Annex I of NFPA 400.)* [**400:**A.6.1.4.4]

60.5.1.4.4.1* Emergency Response Team Leader. Persons acting as ER team leaders shall be trained under the Incident Command System concept or equivalent. [**400:**6.1.4.4.1]

A.60.5.1.4.4.1 OSHA describes an Incident Command System as a standardized on-scene incident management concept designed specifically to allow responders to adopt an integrated organizational structure equal to the complexity and demands of any single incident or multiple incidents without being hindered by jurisdictional boundaries. [**400:**A.6.1.4.4.1]

60.5.1.4.4.2* Response to Incipient Events. Responses to incidental releases of hazardous materials where the material can be absorbed, neutralized, or otherwise controlled at the time of release by employees in the immediate release area, or by maintenance personnel, shall not be considered emergency responses as defined within the scope of this *Code*. [**400:**6.1.4.4.2]

A.60.5.1.4.4.2 Responses to releases of hazardous materials where there is no potential safety or health hazard such as fire, explosion, or chemical exposure are not considered emergency responses as defined within the context of this *Code*. [**400:**A.6.1.4.4.2]

60.5.1.4.4.3* On-Site Emergency Response Team. When an onsite emergency response team is provided, emergency responders shall be trained in accordance with the requirements of the specific site emergency plan or as required by federal, state, or local governmental agencies. [**400:**6.1.4.4.3]

A.60.5.1.4.4.3 Emergency response training will vary depending on the level of emergency response required and by the requirements of the governmental agency. [**400:**A.6.1.4.4.3]

60.5.1.4.5 Training Mandated by Other Agencies. Training required by federal, state, or local regulations that is required based on the quantity or type of hazardous materials stored, dispensed, handled, or used shall be conducted in accordance with the requirements of and under the jurisdiction of the governing agency. [**400:**6.1.4.5]

60.5.1.4.6 Documentation. Training shall be documented and the documentation made available to the AHJ upon written request. [**400:**6.1.4.6]

60.5.1.5 Ignition Source Controls.

Δ **60.5.1.5.1 Smoking.** Smoking shall be prohibited in the following locations:

(1) Within 25 ft (7.6 m) of outdoor storage areas, dispensing areas, or open use areas
(2) In rooms or areas where hazardous materials are stored or dispensed or used in open systems in amounts requiring a permit in accordance with Section 1.8 of NFPA 400

[**400:**6.1.5.1]

Paragraph 60.5.1.5.1 contains a set of minimum requirements that prohibit smoking in areas where hazardous materials are present. If operating conditions are more hazardous due to the hazardous material being used or stored, additional distances could be required to increase the "no smoking" areas. See Section 10.9 for additional guidance on regulating smoking.

60.5.1.5.2 Open Flames and High-Temperature Devices. Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition. [**400:**6.1.5.2]

60.5.1.5.3 Energy-Consuming Equipment. Energy-consuming equipment with the potential to serve as a source of ignition shall be listed or approved for use with the hazardous materials stored or used. [**400:**6.1.5.3]

Δ **60.5.1.5.3.1* Powered Industrial Trucks.** Powered industrial trucks shall be operated and maintained in accordance with NFPA 505. [**400:**6.1.5.3.1]

Δ **A.60.5.1.5.3.1** The approved powered industrial trucks addressed in NFPA 505 are trucks that are listed by a testing laboratory for the use intended and should be tested and labeled in accordance with ANSI/UL 558, *Standard for Safety Industrial Trucks, Internal Combustion Engine-Powered*, or ANSI/UL 583, *Standard for Safety Electric Battery-Powered Industrial Trucks*. [**505:**1.3.3]

60.5.1.6 Systems, Equipment, and Processes. Processes, methods, specifications, equipment testing and maintenance, design standards, performance, installation, equipment design and construction, and other pertinent criteria shall be in accordance with this section. [**400:**6.1.6]

60.5.1.6.1 Design and Construction of Containers and Tanks. Containers, cylinders, and tanks shall be designed and constructed in accordance with approved standards. Containers, cylinders, tanks, and other means used for containment of hazardous materials shall be of an approved type. [**400:**6.1.6.1]

Δ **60.5.1.6.2 Piping, Tubing, Valves, and Fittings.** Piping, tubing, valves, fittings, and related components used for hazardous materials shall be in accordance with the following:

(1) Piping, tubing, valves, fittings, and related components shall be designed and fabricated from materials compatible with the material to be contained and shall be of a strength and durability to withstand the pressure, structural and seismic stress, and exposure to which they are subject.
(2) Piping and tubing shall be identified in accordance with ASME A13.1, *Scheme for the Identification of Piping Systems,* to indicate the material conveyed.
(3) Accessible manual valves, or fail-safe emergency shutoff valves operated by a remotely located manually or automatically activated shutdown control, shall be installed on supply piping and tubing at the following locations:
    (a) Point of use
    (b) Tank or bulk source
(4) Manual emergency shutoff valves and remotely located manually activated shutdown controls for emergency shutoff valves shall be identified, and the location shall be clearly visible, accessible, and indicated by means of a sign.
(5) Backflow prevention or check valves shall be provided when the backflow of hazardous materials could create a hazardous condition or cause the unauthorized discharge of hazardous materials.
(6) Liquids classified in accordance with NFPA 704 shall be carried in pressurized piping above a gauge pressure of 15 psi (103 kPa) having a hazard ranking as follows:
    (a) Health hazard Class 3 or Class 4
    (b) Flammability Class 4
    (c) Instability Class 3 or Class 4
(7) The pressurized piping specified in 60.5.1.6.2(6) shall be provided with an approved means of leak detection and emergency shutoff or excess flow control in accordance with the following:
    (a) Where the piping originates from within a hazardous material storage room or area, the excess flow control shall be located within the storage room or area.
    (b) Where the piping originates from a bulk source, the excess flow control shall be located at the bulk source.
    (c) Piping for inlet connections designed to prevent backflow shall not be required to be equipped with excess flow control.

[**400:**6.1.6.2]

Δ **60.5.1.6.3 Additional Regulations for Supply Piping for Health Hazard Materials.** Supply piping and tubing for liquids or solids having a health hazard ranking of Class 3 or Class 4 in accordance with NFPA 704 shall be in accordance with ASME B31.3, *Process Piping,* and the following:

(1) Piping and tubing utilized for the transmission of highly toxic, toxic, or highly volatile corrosive liquids shall have welded, threaded, or flanged connections throughout, except for connections located within a ventilated enclosure, or an approved method of drainage or containment.
(2) Piping and tubing shall not be located within corridors, within any portion of a means of egress required to be enclosed in fire resistance–rated construction, or in concealed spaces in areas not classified as Protection Level 1 through Protection Level 4 occupancies.

[**400:**6.1.6.3]

60.5.1.6.4 Equipment, Machinery, and Alarms. Equipment, machinery, and required detection and alarm systems associated with the use, storage, or handling of hazardous materials shall be listed or approved. [**400:**6.1.6.4]

60.5.1.7 Empty Containers and Tanks. Empty containers and tanks previously used for the storage of hazardous materials shall be free from residual material and vapor as defined by DOT, the Resource Conservation and Recovery Act (RCRA), or other regulating authority or shall be maintained as specified for the storage of hazardous material. [**400:**6.1.7]

60.5.1.8 Signs.

Signs that identify hazards and materials are an important means of ensuring safety in areas where hazardous materials are present. The signs should be designed to be identifiable by staff, visitors, and first responders. The requirements of 60.5.1.8 cover the minimum standard size, color, and lettering of signs. Additional signs can be added for specific needs.

60.5.1.8.1 General.

60.5.1.8.1.1 Design and Construction. Signs shall be durable, and the size, color, and lettering of signs shall be in accordance with nationally recognized standards. [**400:**6.1.8.1.1]

60.5.1.8.1.2 Language. Signs shall be in English as the primary language or in symbols permitted by this *Code*. [**400:**6.1.8.1.2]

Δ **60.5.1.8.1.3 Maintenance.** Signs shall meet the following criteria:

(1) They shall not be obscured.
(2) They shall be maintained in a legible condition.
(3) They shall not be removed, unless for replacement.

[**400:**6.1.8.1.3]

60.5.1.8.2 Hazard Materials Identification.

Δ **60.5.1.8.2.1 NFPA 704 Placard.** Visible hazard identification signs in accordance with NFPA 704 shall be placed at the following locations, except where the AHJ has received a hazardous materials management plan and a hazardous materials inventory statement in accordance with 60.1.6 and 60.1.7 and has determined that omission of such signs is consistent with safety:

(1) On stationary aboveground tanks
(2) On stationary aboveground containers
(3) At entrances to locations where hazardous materials are stored, dispensed, used, or handled in quantities requiring a permit
(4) At other entrances and locations designated by the AHJ

[**400:**6.1.8.2.1]

60.5.1.8.2.2 Identification of Containers, Cartons, and Packages. Individual containers, cartons, or packages shall be conspicuously marked or labeled in accordance with nationally recognized standards. [**400:**6.1.8.2.2]

Δ **60.5.1.8.3 No Smoking Signs.** Where "no smoking" is not applicable to an entire site or building, signs shall be provided as follows:

(1) In rooms or areas where hazardous materials are stored or dispensed or used in open systems in amounts requiring a permit in accordance with Section 1.8 of NFPA 400
(2) Within 25 ft (7.6 m) of outdoor storage, dispensing, or open-use areas

[**400:**6.1.8.3]

60.5.1.9 Protection from Vehicles.

The requirements of 60.5.1.9 outline the need for protection of containers and piping containing hazardous materials in areas where vehicular traffic is likely. They describe the most commonly used protection strategy — guard posts — although other approved means such as curbs, landscaping berms, or guardrails can be used.

Δ **60.5.1.9.1** Guard posts or other approved means shall be provided to protect the following where subject to vehicular damage:

(1) Storage tanks and connected piping, valves, and fittings
(2) Storage areas containing tanks or portable containers except where the exposing vehicles are powered industrial trucks used for transporting the hazardous materials
(3) Use areas

[**400:**6.1.9.1]

Δ **60.5.1.9.2** Where guard posts are installed, the posts shall meet the following criteria:

(1) They shall be constructed of steel not less than 4 in. (102 mm) in diameter and concrete filled.
(2) They shall be spaced not more than 4 ft (1.2 m) between posts on center.
(3) They shall be set not less than 3 ft (0.9 m) deep in a concrete footing of not less than a 15 in. (381 mm) diameter.
(4) They shall be set with the top of the posts not less than 3 ft (0.9 m) above ground.
(5) They shall be located not less than 3 ft (0.9 m) from the tank.

[**400:**6.1.9.2]

60.5.1.10 Electrical Wiring and Equipment.

Many hazardous materials are particularly susceptible to ignition or to initiation of a hazardous reaction from exposure to thermal energy. A minor spark can produce a major reaction. Where necessary, electrical wiring and utilization equipment should comply with Chapter 5 of *NFPA 70®*, *National Electrical Code*. The potential for the development of dangerous levels of static electricity should be assessed carefully. The requirements of 60.5.1.10 are a reminder to verify that all wiring and equipment are checked for their appropriateness in the storage or use area.

60.5.1.10.1 General. Electrical wiring and equipment shall be installed in accordance with Section 11.1. [**400:**6.1.10.1]

60.5.1.10.2 Static Accumulation. When processes or use conditions exist where flammable gases, dusts, or vapors can be ignited by static electricity, means shall be provided to prevent the accumulation of a static charge and to dissipate the static charge to ground. [**400:**6.1.10.2]

60.5.1.11 Protection from Light. Materials that are sensitive to light shall be stored in containers designed to protect them from such exposure. [**400:**6.1.11]

60.5.1.12 Separation of Incompatible Materials.

A basic approach to reviewing sites where multiple hazardous materials are present is to determine which materials are compatible for storage or use near other materials. The requirements of 60.5.1.12 are minimum requirements. Each site requires a review of the distances and protection features, because the mixing of incompatible materials can create extremely hazardous and life-threatening incidents. Mixing of incompatible materials can occur at many sites, but one of the most common is a hazardous waste recycling facility, where numerous different materials are separated and stored.

60.5.1.12.1 Incompatible materials in storage and storage of materials incompatible with materials in use shall be separated when the stored materials are in containers having a capacity of more than 5 lb (2.268 kg) or ½ gal (1.89 L). [**400:**6.1.12.1]

Δ **60.5.1.12.2** Separation shall be accomplished by one of the following methods:

(1) Segregating incompatible materials storage by a distance of not less than 20 ft (6.1 m)
(2) Isolating incompatible materials storage by a noncombustible partition extending not less than 18 in. (457 mm) above and to the sides of the stored material or by a noncombustible partition that interrupts the line of sight between the incompatible materials
(3) Storing liquid and solid materials in hazardous materials storage cabinets complying with 60.5.1.18
(4) Storing compressed gases in gas cabinets or exhausted enclosures complying with Chapter 21 of NFPA 400

[**400:**6.1.12.2]

60.5.1.12.3 Materials that are incompatible shall not be stored within the same cabinet or enclosure. [**400:**6.1.12.3]

60.5.1.13 General Storage.

60.5.1.13.1 Storage. The storage arrangement of materials shall be in accordance with this chapter and the material specific requirements of Chapters 11 through 21 of NFPA 400 as applicable. [**400:**6.1.13.1]

60.5.1.13.2 Shelf Storage. Shelving shall be constructed to carry the design loads and shall be braced and anchored in accordance with the seismic design requirements of the applicable building code. [**400:**6.1.13.2]

60.5.1.13.2.1 Shelf Construction.

60.5.1.13.2.1.1 Shelving shall be treated, coated, or constructed of materials that are compatible with the hazardous materials stored. [**400:**6.1.13.2.1.1]

Δ **60.5.1.13.2.1.2** Shelves shall be provided with a lip or guard where used for the storage of individual containers, except under either of the following conditions:

(1) Where storage is located in hazardous materials storage cabinets or laboratory furniture specifically designed for such use
(2) Where amounts of hazardous materials in storage do not exceed the quantity threshold for requiring a permit in accordance with Section 1.8 of NFPA 400

[**400:**6.1.13.2.1.2]

60.5.1.13.2.2 Shelf storage of hazardous materials shall be maintained in an orderly manner. [**400:**6.1.13.2.2]

60.5.1.14* Seismic Protection. Machinery and equipment utilizing hazardous materials in areas subject to seismic activity shall be seismically anchored in accordance with the building code. [**400:**6.1.14]

A.60.5.1.14 For seismic requirements and the seismic zone in which the material is located, see the building code. [**400:**A.6.1.14]

60.5.1.14.1 Shock Padding. Materials that are shock sensitive shall be padded, suspended, or otherwise protected against accidental dislodgement and dislodgement during seismic activity. [**400:**6.1.14.1]

Δ **60.5.1.15 Outdoor Storage and Use Areas.** Outdoor storage and use areas for hazardous materials shall comply with the following:

(1) Outdoor storage and use areas shall be kept free of weeds, debris, and common combustible materials not necessary to the storage or use of hazardous materials.
(2) The area surrounding an outdoor storage and use area shall be kept clear of weeds, debris, and common combustible materials not necessary to the storage or use of hazardous materials for a minimum distance of 15 ft (4.5 m).
(3) Outdoor storage and use areas for hazardous materials shall be located not closer than 20 ft (6.1 m) from a property line that can be built upon, a street, an alley, or a public way, except that a 2-hour fire barrier wall, without openings and extending not less than 30 in. (762 mm) above and to the sides of the storage area, shall be permitted in lieu of such distance.

[**400:**6.1.15]

The provision of 60.5.1.15(1) is intended to prevent a fire from spreading to the outside hazardous materials storage area. Combustible material needed for storage or use (e.g., pallets and cribbing) can be located within the hazardous materials area, but combustible materials that are not associated with the hazardous materials and that are not needed for such storage or use cannot be located in that area. See 10.13.10 for additional guidance.

The provision of 60.5.1.15(2) is intended to ensure that a fire does not spread to the storage or use area from outside the hazardous materials area. This includes combustible materials on-site and off-site within a minimum distance of 15 ft (4.5 m). If the material warrants, a greater setback distance can be required within the wording of 60.5.1.15(2). See 10.13.10 for additional guidance.

The provision of 60.5.1.15(3) provides direction to the user that a minimum of 20 ft (6.1 m) is needed from neighboring buildings and general public areas, such as public ways, streets, and similar areas. The use of a 2-hour fire barrier wall is permitted as an alternative to this minimum separation.

60.5.1.16 Maintenance Required.

60.5.1.16.1* Equipment, machinery, and required detection and alarm systems associated with hazardous materials shall be maintained in an operable condition. [**400:**6.1.16.1]

A.60.5.1.16.1 Maintenance procedures are an important part of any mechanical integrity program. They should contain information on which equipment is covered; what tests and inspections are to be performed; how to perform the tests and inspections in accordance with recognized industry standards and manufacturer's recommendations; what constitutes acceptance of the measured parameters; corrective actions to be taken if the equipment does not meet requirements; and the frequency of the testing and inspection. For examples of additional guidance, refer to *Guidelines for Mechanical Integrity Systems* (AIChE/CCPS); *Guidelines for Safe and Reliable Instrumented Protective Systems* (AIChE/CCPS); and *Guidelines for Writing Effective Operating and Maintenance Procedures* (AIChE/CCPS). [**400:**A.6.1.16.1]

60.5.1.16.2 Stationary tanks not used for a period of 90 days shall be safeguarded or removed in an approved manner. [**400:**6.1.16.2]

60.5.1.16.2.1 The tanks specified in 60.5.1.16.2 shall have the fill line, gauge opening, and pump connection secured against tampering. [**400:**6.1.16.2.1]

60.5.1.16.2.2 Vent lines shall be maintained. [**400:**6.1.16.2.2]

60.5.1.16.2.3* Tanks that are to be placed back in service shall be tested in an approved manner. [**400:**6.1.16.2.3]

A.60.5.1.16.2.3 Testing can include visual inspection, x-ray, spark testing, pressure testing, leak testing, or other nondestructive methods. [**400:**A.6.1.16.2.3]

Δ **60.5.1.16.3** The following shall apply to defective containers, cylinders, and tanks:

(1) They shall be removed from service, repaired, or disposed of in an approved manner.
(2) Overpack containers shall be permitted to be used as a means to provide protection for primary containers that are transported for repair or removal from service.

[**400:**6.1.16.3]

60.5.1.16.4 Defective equipment or machinery shall be removed from service and repaired or replaced. [**400:**6.1.16.4]

60.5.1.16.5 Required detection and alarm systems that are defective shall be replaced or repaired. [**400:**6.1.16.5]

60.5.1.17 Testing.

60.5.1.17.1 The equipment, devices, and systems listed in 60.5.1.17.2.1 shall be tested at one of the intervals listed in 60.5.1.17.2.2. Written records of the tests conducted or maintenance performed shall be maintained. [**400:**6.1.17.1]

Δ **60.5.1.17.2** Testing shall not be required under the following conditions:

(1) Where approved written documentation is provided that testing will damage the equipment, device, or system and the equipment, device, or system is maintained as specified by the manufacturer
(2) Where equipment, devices, and systems fail in a fail-safe manner
(3) Where equipment, devices, and systems self-diagnose and report trouble, with records of the self-diagnosis and trouble reporting made available to the AHJ
(4) Where system activation occurs during the required test cycle for the components activated during the test cycle
(5) Where approved maintenance in accordance with 60.5.1.16.1 is performed not less than annually or in accordance with an approved schedule, in which case the testing requirements set forth in 60.5.1.17.2.1 and 60.5.1.17.2.2 are permitted to apply.

[**400:**6.1.17.2]

Δ **60.5.1.17.2.1 Equipment, Devices, and Systems Requiring Testing.** The following equipment, devices, and systems shall be tested in accordance with 60.5.1.17 and 60.5.1.17.2.2:

(1) Limit control systems for liquid level, temperature, and pressure required by 6.2.1.7 of NFPA 400
(2) Monitoring and supervisory systems required by 6.2.1.1 of NFPA 400

[**400:**6.1.17.2.1]

Δ **60.5.1.17.2.2 Testing Frequency.** The equipment, systems, and devices listed in 60.5.1.17.2.1 shall be tested at one of the following frequencies:

(1) Not less than annually
(2) In accordance with the approved manufacturer's requirements
(3) In accordance with approved recognized industry standards
(4) In accordance with an approved schedule

[**400:**6.1.17.2.2]

Δ **60.5.1.18 Hazardous Materials Storage Cabinets.** When storage cabinets are used to increase maximum allowable quantities per control area or to otherwise comply with a specific provision in Section 60.5, such cabinets shall be in accordance with the following:

(1) Cabinets shall be constructed of metal.
(2) The interior of cabinets shall be treated, coated, or constructed of materials that are nonreactive with the hazardous material stored, and such treatment, coating, or construction shall include the entire interior of the cabinet.
(3) Cabinets shall be either listed as suitable for the intended storage or constructed in accordance with the following:
    (a) Cabinets shall be of steel having a thickness of not less than 0.044 in. (1.12 mm) (18 gauge).
    (b) The cabinet, including the door, shall be double-walled with 1½ in. (38.1 mm) airspace between the walls.
    (c) Joints shall be riveted or welded and shall be tightfitting.
    (d) Doors shall be well fitted, self-closing, and equipped with a self-latching device.
    (e) The bottoms of cabinets utilized for the storage of liquids shall be liquidtight to a minimum height of 2 in. (51 mm).
    (f) For requirements regarding electrical equipment and devices within cabinets used for the storage of hazardous liquids, compressed gases, or cryogenic fluids, see *NFPA 70*.
(4) Cabinets shall be marked in conspicuous lettering that reads as follows: HAZARDOUS — KEEP FIRE AWAY

[**400:**6.1.18]

Isolating and locking hazardous materials in a cabinet can prevent incidents. Hazardous materials storage cabinets allow most MAQs to be doubled or regarded as the same level of protection as that provided by a separate control area. As outlined in the cabinet construction requirements in 60.5.1.18(1) and (2), hazardous materials cabinets are designed so that a fire does not immediately affect the hazardous material in the cabinet, but they also keep the effects of an incident or accident within the cabinet from spreading outside of its protected enclosure. Many premanufactured cabinets are designed and tested for protection of specific hazardous materials, such as flammable and combustible liquids, and carry a product performance listing. If a hazardous material has not been tested in a cabinet, or if a specific cabinet design is required and no listed cabinets are available, a minimum of six essential features as outlined in 60.5.1.18(3) will help a designer create a specialized cabinet and still allow the increase in quantities of hazardous material permitted to be stored using the cabinet for protection. In addition, cabinets are required to be marked with lettering that specifically reads "HAZARDOUS — KEEP FIRE AWAY."

60.5.1.19 Installation of Tanks. Installation of tanks shall be in accordance with 60.5.1.19.1 through 60.5.1.19.2. [**400:**6.1.19]

60.5.1.19.1 Underground Tanks.

60.5.1.19.1.1 Underground tanks used for the storage of liquid hazardous materials shall be provided with secondary containment. [**400:**6.1.19.1.1]

Consideration should be given to using secondary containment-type piping as well.

Δ **60.5.1.19.1.2** In lieu of providing secondary containment for an underground tank, an aboveground tank in an underground vault complying with NFPA 30 shall be permitted. [**400:**6.1.19.1.2]

It is important to note that an underground tank cannot be installed inside a vault. An underground tank is designed to be supported by the backfill placed around it; it cannot accommodate the stresses that would be imposed by support on legs or saddles. Also, underground tanks are not designed to be directly exposed to fire. They are not fitted with emergency vents that relieve the overpressure from an exposure fire.

60.5.1.19.2 Aboveground Tanks. Aboveground stationary tanks installed outdoors and used for the storage of hazardous materials shall be located and protected in accordance with the requirements for outdoor storage of the particular material involved and in accordance with the requirements of Chapters 11 through 21 of NFPA 400. [**400:**6.1.19.2]

Δ **60.5.1.19.2.1** Aboveground tanks that are installed in vaults complying with NFPA 30 shall not be required to comply with location and protection requirements for outdoor storage. [**400:**6.1.19.2.1]

The commentary to 60.5.1.19.1.2 applies here as well.

60.5.1.19.2.2 Aboveground tanks that are installed inside buildings and used for the storage of hazardous materials shall be located and protected in accordance with the requirements for indoor storage of the particular material involved. [**400:**6.1.19.2.2]

60.5.1.19.3 Marking. Aboveground stationary tanks shall be marked as required by 60.5.1.8.2.1. [**400:**6.1.19.2.3]

Δ **60.5.1.20** When required, fire alarm systems and smoke detection systems shall be installed in accordance with *NFPA 72*. [**400:**6.1.20]

Δ **60.5.2** Where permitted by Chapters 11 through 43 of NFPA 101 alcohol-based hand-rub dispensers shall be permitted provided they meet all the following criteria:

(1) The maximum individual dispenser fluid capacity shall be as follows:
  (a) 0.32 gal (1.2 L) for dispensers in corridors and areas open to corridors
  (b) 0.53 gal (2.0 L) for dispensers in rooms or suites of rooms separated from corridors
(2) Where aerosol containers are used, the maximum capacity of the aerosol dispenser shall be 18 oz. (0.51 kg) and shall be limited to Level 1 aerosols as defined in NFPA 30B.
(3) Dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(4) Not more than an aggregate 10 gal (37.8 L) of alcohol-based hand-rub solution or 1135 oz (32.2 kg) of Level 1 aerosols, or a combination of liquids and Level 1 aerosols not to exceed, in total, the equivalent of 10 gal (37.8 L) or 1135 oz (32.2 kg,) shall be in use outside of a storage cabinet in a single smoke compartment or fire compartment or story, whichever is less in area. One dispenser complying with 60.5.2(1) per room and located in that room shall not be included in the aggregated quantity.
(5) Storage of quantities greater than 5 gal (18.9 L) in a single smoke compartment or fire compartment or story, whichever is less in area, shall meet the requirements of NFPA 30.
(6) Dispensers shall not be installed in the following locations:
  (a) Above an ignition source for a horizontal distance of 1 in. (25 mm) to each side of the ignition source
  (b) To the side of an ignition source within a 1 in. (25 mm) horizontal distance from the ignition source
  (c) Beneath an ignition source within a 1 in. (25 mm) vertical distance from the ignition source
(7) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered areas of the building.
(8) The alcohol-based hand-rub solution shall not exceed 95 percent alcohol content by volume.
(9) Operation of the dispenser shall comply with the following criteria:
  (a) The dispenser shall not release its contents except when the dispenser is activated, either manually or automatically by touch-free activation.
  (b) Any activation of the dispenser shall only occur when an object is placed within 4 in. (100 mm) of the sensing device.
  (c) An object placed within the activation zone and left in place shall not cause more than one activation.
  (d) The dispenser shall not dispense more solution than the amount required for hand hygiene consistent with label instructions.

(e) The dispenser shall be designed, constructed, and operated in a manner that ensures accidental or malicious activation of the dispensing device is minimized.

(f) The dispenser shall be tested in accordance with the manufacturer's care and use instructions each time a new refill is installed.

[***101:***8.7.3.3]

Subsection 60.5.2 adds guidance on the presence of alcohol-based hand-rub dispensers used in buildings where permitted by the specific occupancy chapter in NFPA *101®, Life Safety Code®*.

Alcohol-based hand-rub dispensers and solutions have been in many buildings for years: office buildings, schools, industrial facilities, hotels, and so on. However, prior to the addition of these requirements in the 2015 edition, NFPA *101* regulated their presence only in health care, ambulatory health care, educational, and day care occupancies. All other occupancies were silent on the issue. Thus, the question arose as to whether or not the *Code* even permitted them in the other occupancies. The addition of 60.5.2 recognizes alcohol-based hand-rub dispensers for any occupancy type, so long as NFPA *101* specifically permits its use in the occupancy.

Subsection 60.5.2 addresses many concerns regarding the presence of alcohol-based hand-rub dispensers, including the maximum capacity per dispenser, aerosol-based hand-rub solutions, location of dispensers, aggregate quantity of solution in use and in storage, and the alcohol content of the solution.

△ 60.6 Emergency Action Planning, Fire Risk Control and Chemical Hazard Requirements for Industrial Processes

Emergency planning, fire risk control, and chemical hazard requirements associated with industrial processes where the quantities of materials in use require compliance with Protection Level 1, Protection Level 2, Protection Level 3, or Protection Level 4 based on materials exceeding the maximum allowable quantities (MAQ) in the following categories shall comply with the requirements of Chapter 7 of NFPA 400:

(1) Unpackaged organic peroxide formulations that are capable of explosive decomposition in their unpackaged state
(2) Oxidizer Class 3 and Class 4: solids and liquids
(3) Pyrophoric solids, liquids, and gases
(4) Unstable reactive Class 3 and Class 4: solids, liquids, and gases
(5) Highly toxic solids, liquids, and gases
(6) Water-reactive liquids, Class 3

△ 60.7 Performance Alternative

In lieu of complying with Chapter 60 in its entirety, occupancies containing high hazard Level 1 to high hazard Level 5 contents shall be permitted to comply with Chapter 10 of NFPA 400.

Section 60.7 offers a performance alternative to Chapter 60 requirements. This section makes reference to Chapter 10 of NFPA 400, which outlines the goals and objectives for a performance-based approach. The performance option of NFPA 400 establishes acceptable levels of risk for facilities (buildings and other structures and the operations associated therewith) as addressed in Section 1.3 of NFPA 400. While the performance option does contain goals, objectives, and performance criteria necessary to provide for an acceptable level of risk, it does not describe how to meet those goals, objectives, and performance criteria. For fire protection designs, the *SFPE Engineering Guide to Performance-Based Fire Protection* provides a framework for such assessments.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.
NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.
NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2018 edition.
NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*, 2015 edition.
NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*, 2016 edition.
NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2016 edition.
NFPA 58, *Liquefied Petroleum Gas Code*, 2017 edition.
NFPA 59, *Utility LP-Gas Plant Code*, 2018 edition.
NFPA 70®, *National Electrical Code®*, 2017 edition.
NFPA *101®*, *Life Safety Code®*, 2018 edition.
NFPA 400, *Hazardous Materials Code*, 2016 edition.
NFPA 430, *Code for the Storage of Liquid and Solid Oxidizers*, 2004 edition (withdrawn, incorporated into NFPA 400).
NFPA 432, *Code for the Storage of Organic Peroxide Formulations*, 2002 edition (withdrawn, incorporated into NFPA 400).
NFPA 434, *Code for the Storage of Pesticides*, 2002 edition (withdrawn, incorporated into NFPA 400).
NFPA 484, *Standard for Combustible Metals*, 2015 edition.
NFPA 490, *Code for the Storage of Ammonium Nitrate*, 2002 edition (withdrawn, incorporated into NFPA 400).
NFPA 495, *Explosive Materials Code*, 2013 edition.
NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2017 edition.
NFPA 1124, *Code for the Manufacture, Transportation, and Storage of Fireworks and Pyrotechnic Articles*, 2017 edition.
NFPA 5000®, *Building Construction and Safety Code®*, 2018 edition.
SFPE Engineering Guide to Performance-Based Fire Protection, 2nd edition.

"Storage Warehouse, Phoenix, AZ, August 2, 2000," Duval, R. F., NFPA Fire Investigations.

Aerosol Products

61

Chapter 61 references NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*. NFPA 30B and Chapter 61 provide minimum requirements for fire prevention and control of fires and explosions in facilities that manufacture, store, or display aerosol products.

61.1 General Provisions

61.1.1 Application.

Δ **61.1.1.1*** The manufacture, storage, use, handling, and display of aerosol products shall comply with the requirements of Chapter 61; NFPA 30B and Sections 60.1 through 60.4 of this *Code*.

Δ **A.61.1.1.1** Chapter 61 provides minimum acceptable requirements for fire prevention and protection in facilities that manufacture and store aerosol products and in mercantile occupancies where aerosol products are displayed and sold. As explained in A.5.1 of NFPA 30B, the hazards presented by each stage of the manufacturing process will vary, depending on the flammability of the base product and on the flammability of the propellant. Considerable judgment will be required of the designer and of the AHJ to provide an adequate level of fire protection. *(See also Annex B of NFPA 30B.)* [**30B:**A.1.2]

Aerosol products in storage or mercantile occupancies complying with this chapter, and covered by 60.1.2(9), are not required to comply with Sections 60.1 through 60.4.

The manufacture and storage of aerosol products present a variety of hazards that need to be addressed through appropriate construction methods, appropriate passive and active fire protection systems, and appropriate fire prevention measures. Aerosol manufacturing facilities include hazards associated with the storage, handling, and dispensing of flammable and combustible liquids and the storage, handling, and use of liquefied flammable gases. Mitigation measures include noncombustible, fire-resistive, and damage-limiting construction. Fire protection systems include automatic sprinkler protection, deflagration suppression systems, and fire alarm and detection systems.

The designer of a manufacturing facility and the authority having jurisdiction (AHJ) must exercise careful judgment to provide for an appropriate level of fire protection for the facility. Information on the properties, safe handling, and storage of liquefied petroleum gases (LP-Gas) is found in Chapter 69 and NFPA 58, *Liquefied Petroleum Gas Code*. Information on the handling and storage of flammable and combustible liquids is found in Chapter 66 and NFPA 30, *Flammable and Combustible Liquids Code*.

The storage of large quantities of aerosol products in a warehouse presents a significant fire challenge that requires the installation of automatic sprinkler systems that are specifically designed to meet the aerosol fire challenge.

61.1.1.2 Where the provisions of Chapter 61 or NFPA 30B conflict with the provisions of Chapter 60, the provisions of Chapter 61 and NFPA 30B shall apply.

61.1.1.3* Chapter 61 shall not apply to the storage and display of containers whose contents are comprised entirely of LP-Gas products. [**30B:**1.1.2]

Δ **A.61.1.1.3** See NFPA 58. [**30B:**A.1.1.2]

61.1.1.4 Chapter 61 shall not apply to post-consumer processing of aerosol containers. [**30B:**1.1.3]

The term *aerosol product* is defined in 3.3.4 as "a combination of a container, a propellant, and a material that is dispensed." Therefore, an aerosol product includes a base product and a propellant. A product whose contents comprise solely of LP-Gas products does not meet this definition. Such products would be regulated as LP-Gas products under the requirements of NFPA 58 and Chapter 69 of this *Code*.

Post-consumer processing of aerosol containers, such as disposal and recycling, is exempt from the requirements of Chapter 61. During post-consumer processing, aerosol containers are assumed to be empty, or nearly so; therefore, the risk of fire or explosion should be minimal.

61.1.1.5* Chapter 61 shall not apply to containers that do not meet the definition of *Aerosol Container* (*see 3.3.2 of NFPA 30B*). [**30B:**1.1.4]

The definition of the term *aerosol container* was revised for the 2011 edition of NFPA 30B to reflect the new requirements from the U.S. Department of Transportation (DOT) allowing the use of plastic aerosol containers up to a maximum size of 1000 ml

(33.8 fl oz). The revised definition prompted changes in several locations of NFPA 30B to accommodate aerosol products in plastic containers. In support of the revised definition of aerosol container, new material that provides several sets of fire test data on the results of testing aerosols in plastic containers was also included in Annex B of NFPA 30B.

The term was further revised for the 2015 edition of NFPA 30B as a pressurized metal or plastic container, up to a maximum size of 1000 ml (33.8 fl oz), or a glass bottle, up to a maximum size of 118 ml (4 fl oz), that is designed and intended to dispense an aerosol.

A.61.1.1.5 Chapter 61 does not apply to products that can be dispensed as aerosolized sprays that are not packaged in aerosol containers as defined in 3.3.2 of NFPA 30B. Chapter 61 is not applicable to other applications such as industrial spray adhesives that are dispensed from large [5–125 gal (18.9 L–475 L)] pressurized gas cylinders. There is no assurance that the protection specified in Chapter 61 will be adequate. [**30B:**A.1.1.4]

61.1.1.5.1 Containers that contain a product that meets the definitions in 3.3.1 and 3.3.3 of NFPA 30B, but are larger than the limits specified in 3.3.2 of NFPA 30B, shall not be classified as aerosol products, and Chapter 61 shall not apply to the manufacture, storage, and display of such products. [**30B:**1.1.4.1]

61.1.2 Permits. Permits, where required, shall comply with Section 1.12.

61.1.3* Classification of Aerosol Products in Metal Containers of Not More Than 33.8 fl oz (1000 ml) and in Plastic or Glass Containers of Not More Than 4 fl oz (118 ml). See Annex E of NFPA 30B. [**30B:**1.7]

A.61.1.3 Tests have shown that aerosol products in plastic containers with a heat of combustion of 10.5 kJ/g have been adequately protected as determined by fire tests. See Annex C of NFPA 30B for a description of the testing of aerosol products in plastic containers. [**30B:**A.1.7]

61.1.3.1 Aerosol products shall be classified by means of the calculation of their chemical or theoretical heats of combustion and shall be designated Level 1, Level 2, or Level 3 in accordance with 61.1.3.2 through 61.1.3.4 and Table 61.1.3.1. [**30B:**1.7.1]

The severity of a fire involving aerosol products depends on the classification of the aerosol products involved. Aerosol products are classified based on a calculation of the chemical or theoretical heats of combustion, taking into account all the constituents of the base product, as well as the propellant. The higher the heat of combustion of the aerosol product, the more severe the fire challenge it poses.

Heat of combustion is expressed in terms of units of heat energy [Btu (kJ)] per units of mass [lb (g)]. Heat of combustion can be determined either theoretically on the basis of the chemical properties of the materials involved or by physical testing in a laboratory.

Annex H of NFPA 30B provides a table of chemical heat of combustion for representative materials. Annex H also provides examples of the chemical heat of combustion calculations required for classifying aerosol products in accordance with 61.1.3 and 61.1.4 of this *Code*.

The protection requirements of NFPA 30B vary depending on an aerosol product's classification. These requirements include automatic sprinkler system design criteria, storage height limitations, and storage arrangements to ensure that sprinkler protection and other protection features provided in the building will adequately control a fire.

The aerosol classification system provided in NFPA 30B is intended to be used only for application of these fire protection requirements. The aerosol level classification system is separate from any consumer product labeling requirements, which are intended as warnings for consumers using the products. Labels on aerosol containers that include such terms as *flammable*, *highly flammable*, or *extremely flammable* are consumer product warning labels, and they are not intended to classify the product for application of NFPA 30B requirements.

TABLE 61.1.3.1 *Aerosol Product Classification*

If the chemical heat of combustion is >	≤	Aerosol Classification Level
0	20 kJ/g (8,600 Btu/lb)	1
20 kJ/g (8,600 Btu/lb)	30 kJ/g (13,000 Btu/lb)	2
30 kJ/g (13,000 Btu/lb)	—	3

[**30B:**Table 1.7.1]

61.1.3.1.1 In lieu of classification by means of the chemical heats of combustion, aerosol products shall be permitted to be classified by means of data obtained from properly conducted full-scale fire tests that utilize a 12-pallet test array. [**30B:**1.7.1.1]

*Exception: This shall not apply to aerosol cooking spray products. (See 61.1.3.5.) [**30B:**1.7.1.1]*

61.1.3.1.2 The fire tests shall be conducted at an approved testing laboratory. *(See Annex C of NFPA 30B for information on the 12-pallet test array.)* [**30B:**1.7.1.2]

61.1.3.2 Level 1 Aerosol Products. Level 1 aerosol products shall be defined as those products with a total chemical heat of combustion that is less than or equal to 20 kJ/g (8600 Btu/lb). [**30B:**1.7.2]

61.1.3.3 Level 2 Aerosol Products. Level 2 aerosol products shall be defined as those products with a total chemical heat of combustion that is greater than 20 kJ/g (8600 Btu/lb), but less than or equal to 30 kJ/g (13,000 Btu/lb). [**30B:**1.7.3]

61.1.3.4 Level 3 Aerosol Products. Level 3 aerosol products shall be defined as those products with a total chemical heat of combustion that is greater than 30 kJ/g (13,000 Btu/lb). [**30B:**1.7.4]

61.1.3.5 Aerosol Cooking Spray Products. Aerosol cooking spray products shall be defined as those aerosol products designed to deliver a vegetable oil or a solid or nonflammable liquid to reduce sticking on cooking and baking surfaces or to be applied to food or both. These products have a chemical heat of combustion that is greater than 20 kJ/g (8600 Btu/lb) and contain not more than 18 percent by weight of flammable propellant. [**30B:**1.7.5]

61.1.3.5.1 If the aerosol cooking spray product has a chemical heat of combustion that does not exceed 20 kJ/g (8600 Btu/lb), it shall be considered a Level 1 aerosol product. [**30B:**1.7.5.1]

61.1.3.5.2 If the aerosol cooking spray product contains more than 18 percent by weight of flammable propellant, it shall be classified in accordance with its chemical heat of combustion, as set forth in Table 61.1.3.1. [**30B:**1.7.5.2]

The classification of aerosol cooking products is new for the 2015 edition of NFPA 30B. Aerosol cooking spray products include those commonly used household products that dispense a vegetable oil or some other nonflammable liquid to reduce sticking of food to cooking or baking surfaces. Aerosol cooking products are characterized by having a chemical heat of combustion greater than 20 kJ/g (8600 Btu/lb) and contain no more than 18 percent of flammable propellant by weight. Where a cooking spray product has a chemical heat of combustion that does not exceed 20 kJ/g (8600 Btu/lb), it should be treated as a Level 1 aerosol product and follow the provisions of NFPA 30B for Level 1 aerosols.

61.1.4 Classification of Aerosol Products in Plastic Containers Greater Than 4 fl oz (118 ml) and Less Than 33.8 oz (1000 ml).

61.1.4.1 Plastic Aerosol 1 Products. Plastic aerosol 1 products shall be defined as those that meet one of the following criteria:

(1) The base product has no fire point when tested in accordance with ASTM D92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*, and the propellant is nonflammable.

(2) The base product does not exhibit sustained combustion when tested in accordance with 49 CFR 173, Appendix H, '"Method of Testing for Sustained Combustibility, or the *UN Recommendations on the Transport of Dangerous Goods*, and the propellant is nonflammable.

(3)* The base product contains not more than 20% by volume (15.8% by weight) of ethanol or propanol or mixtures thereof in an aqueous mix and the propellant is nonflammable.

A.61.1.4.1(3) Fire testing with alcohol and water at this percentage in plastic bottles has been successful. Small-scale burn tests of aerosol products in plastic containers have shown the aerosol with a nonflammable propellant to behave the same as the aerosol with no propellant. [**30B:**A.1.8.1(3)]

(4)* The base product contains not more than 4% by weight of an emulsified liquefied flammable gas propellant within an aqueous base, said propellant to remain emulsified for the life of the product. Where such propellant is not permanently emulsified then the propellant shall be nonflammable.

[**30B:**1.8.1]

A.61.1.4.1(4) A fire test with a formula of this type using liquefied petroleum gas was successful. An emulsion, in an aerosol product, would be a mixture of two or more liquids in which one is present as droplets, of microscopic or ultramicroscopic size, distributed throughout the other. Emulsions are formed from the component liquids either spontaneously or, more often, by mechanical means, such as agitation, provided that the liquids that are mixed have no (or a very limited) mutual solubility. Emulsions are stabilized by agents that form films at the surface of the droplets (e.g., soap molecules) or that impart to them a mechanical stability (e.g., colloidal carbon or bentonite). Colloidal distributions or suspension of one or more liquid(s) with another will have a shelf life that varies with the efficiency of the recipe used. [**30B:**A.1.8.1(4)]

61.1.4.2 Plastic Aerosol X Products. Plastic aerosol X products shall be defined as those that do not meet any of the criteria provided in 61.1.4.1. [**30B:**1.8.2]

Paragraph 61.1.4.1 addresses the classification of aerosol products in plastic containers greater than 4 fl oz (118 ml) and less than 33.8 fl oz (1000 ml). This category of aerosol products takes over where the aerosol products in 61.1.4.3 leave off. Also new to the 2015 edition of NFPA 30B was a classification of aerosol products referred to as "Aerosol X." Where an aerosol product does not meet one of the classifications in 61.1.3.1 or 61.1.4.1, it is considered a plastic "aerosol X" product. Requirements for this classification of aerosol are also found throughout Chapter 61 and NFPA 30B.

Commentary Table 61.1 provides a summary of aerosol classifications.

61.1.5 Marking of Packages of Aerosol Products.

This *Code* requires marking of cartons and packages containing aerosol products with their classification level to allow facility operators and AHJs to readily verify that storage is in accordance with building and suppression system design limitations. This marking ensures, for example, that permitted storage heights and sprinkler system design limitations are not exceeded for the specific product.

The intent is not to require such markings to be readable by emergency responders from a distance during an incident. For additional information on identification of hazardous materials for emergency responders, see Chapter 60 and NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*.

61.1.5.1 Manufacturers of aerosol products shall ensure that all cartons or packages of aerosol products are identified on at least one exterior side with the classification of the aerosol products contained therein, in accordance with 61.1.3 and 61.1.4. [**30B:**1.9.1]

Δ **61.1.5.2** Cartons or packages containing aerosol products in metal containers or glass and plastic containers 4 fl oz (118 ml) or less shall be clearly marked as follows:

Level _____ Aerosols

[**30B:**1.9.2]

COMMENTARY TABLE 61.1 *Classification of Aerosol Products*

Container Type and Size	Aerosol Product	Classification	Section Reference
Metal containers not more than 33.8 fl oz (1000 ml) Plastic or glass containers not more than 4 fl oz (118 ml)	Total chemical heat of combustion ≤20 kJ/g (8,600 Btu/lb)	Level 1	61.1.3.2
	Total chemical heat of combustion >20 kJ/g (8,600 Btu/lb) and ≤30 kJ/g (13,000 Btu/lb)	Level 2	61.1.3.3
	Total chemical heat of combustion >30 kJ/g (13,000 Btu/lb)	Level 3	61.1.3.4
	Cooking spray with chemical heat of combustion >20 kJ/g (8,600 Btu/lb)	Aerosol cooking spray	61.1.3.5
	Cooking spray with chemical heat of combustion ≤20 kJ/g (8,600 Btu/lb)	Level 1	61.1.3.5.1
	Cooking spray with >18% percent flammable propellant by weight	Level 1, 2, or 3 depending on chemical heat of combustion	61.1.3.5.2
Plastic containers larger than 4 fl oz (118 ml) and smaller than 33.8 fl oz (1000 ml)	Meets one of the following: 1. Base product has no fire point when tested to ASTM D92, Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester; nonflammable propellant 2. Base product does not exhibit sustained combustion when tested to 49 CFR 173, Appendix H, "Method of Testing for Sustained Combustibility"; or *UN Recommendations on the Transport of Dangerous Goods*; nonflammable propellant 3. Base product contains not more than 20 percent by volume of ethanol or propanol, or mixtures in an aqueous mix; nonflammable propellant 4. Base product contains not more than 4 percent of emulsified liquefied flammable gas propellant with aqueous base	Plastic aerosol 1	61.1.4.1
	Plastic aerosol product not meeting any of the four criteria listed in 61.1.4.1	Aerosol X	61.1.4.2

N **61.1.5.3** Cartons or packages containing aerosol cooking spray products in metal containers shall be clearly marked as follows:

Aerosol Cooking Spray

[**30B:**1.9.3]

Δ **61.1.5.4** Cartons or packages containing aerosol products in plastic containers greater than 4 fl oz (118 ml) shall be clearly marked on the exterior of the carton as follows:

Plastic Aerosol 1 (or X)

[**30B:**1.9.4]

61.2 Basic Requirements

61.2.1 Site Requirements. Distances between buildings used for the manufacture or storage of aerosol products and adjacent buildings or property lines that are or can be built upon shall be based on sound engineering principles. [**30B:**4.1]

An engineering-based approach to determine the required separation of buildings on the basis of the expected intensity of an exposing fire is described in NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*. For additional provisions on building separation distances, see *NFPA 5000®, Building Construction and Safety Code®*.

61.2.2 Building Construction.

Aerosol product manufacturing facilities are specialized facilities that have specific construction and protection requirements. These facilities include flammable and combustible liquid tank farms, LP-Gas propellant tank farms, flammable and combustible liquid filling lines, and "gas houses" in which the aerosol containers are charged with propellants. All of these different areas of the aerosol manufacturing facility present different hazards, and all require different protection and mitigation strategies.

Chapter 5 of NFPA 30B provides specific requirements for the construction and protection of aerosol manufacturing facilities. These requirements include fire-resistive separations, deflagration venting, automatic sprinkler protection, deflagration suppression systems, gas detection systems, normal and emergency ventilation systems, and equipment interlocks and controls.

61.2.2.1 Openings in fire walls or fire barriers shall be kept to a minimum. [**30B:**4.2.1]

61.2.2.1.1 All openings (i.e., personnel doorways, ductwork, conveyor line, etc.) shall be protected with automatic-closing or self-closing fire doors or dampers. [**30B:**4.2.1.1]

Automatic-closing doors typically are arranged to be held open magnetically and are released automatically upon the detection of smoke by smoke detectors in the vicinity of the door opening. Smoke detectors for door-releasing service must be listed for such use. For details on the placement of smoke detectors for controlling automatic-closing doors, see *NFPA 72®, National Fire Alarm and Signaling Code*, or NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.

Δ **61.2.2.1.2** Fire doors shall be installed in accordance with NFPA 80. [**30B:**4.2.1.2]

Δ **61.2.2.1.3** Fire dampers shall be installed in accordance with manufacturer's instructions and NFPA 90A. [**30B:**4.2.1.3]

61.2.2.2 Means of Egress.

61.2.2.2.1 Means of egress shall comply with applicable provisions of NFPA *101*. [**30B:**4.2.2.1]

61.2.2.2.2 The design and construction of conveyor lines and other physical obstacles, such as in the flammable propellant charging and pump rooms, shall not allow entrapment of personnel and shall provide for direct access to exits. [**30B:**4.2.2.2]

61.2.3 Electrical Installations.

61.2.3.1 All electrical equipment and wiring, including heating equipment, shall be installed in accordance with *NFPA 70*. [**30B:**4.3.1]

61.2.3.1.1 Electrical equipment and wiring in areas where flammable liquids or flammable gases are handled shall meet the additional requirements of Articles 500 and 501 of *NFPA 70*. [**30B:**4.3.1.1]

Articles 500 and 501 of *NFPA 70®, National Electrical Code®*, specify requirements for electrical equipment located in hazardous (classified) locations. Areas in which flammable gases or vapors are, or might be, present in quantities sufficient to produce explosive or ignitible mixtures are considered Class I locations. Electrical equipment in Class I locations must be listed for such use to prevent vapors or gases from coming into contact with potential ignition sources. Numerous protection methods are described in the *National Electrical Code® Handbook*. Also see *Electrical Installations in Hazardous Locations*.

61.2.3.2 Aerosol product storage and display areas shall be considered unclassified for purposes of electrical installation. [**30B:**4.3.2]

61.2.4 Heating Equipment. Heating equipment shall be installed in accordance with the applicable requirements of the following:

(1) NFPA 31, *Standard for the Installation of Oil-Burning Equipment*
(2) NFPA 54, *National Fuel Gas Code*
(3) NFPA 58, *Liquefied Petroleum Gas Code*
(4) NFPA 85, *Boiler and Combustion Systems Hazards Code* [**30B:**4.4]

Δ **61.2.5 Flammable Liquids and Gases.** Areas in which flammable liquids and flammable gases are handled or stored shall meet the applicable requirements of the following:

(1) Chapter 66 and NFPA 30
(2) Chapter 69 and NFPA 58 [**30B:**4.5]

61.2.6 Fire Protection.

Δ **61.2.6.1 Automatic Sprinkler Systems.** Installations of automatic sprinklers, where required by this *Code* and NFPA 30B, shall be installed in accordance with Section 13.3 and NFPA 13 and the provisions of NFPA 30B. [**30B:**4.6.1]

See Section 13.3 for information on automatic sprinkler systems.

Δ **61.2.6.1.1** Where the provisions of Chapter 61 and NFPA 13 differ, the provisions of Chapter 61 shall prevail. [**30B:**4.6.1.1]

Δ **61.2.6.1.2** Where Chapter 61 does not address specific automatic sprinkler protection criteria, the provisions of NFPA 13 shall prevail. [**30B:**4.6.1.2]

N **61.2.6.1.3** Production areas that contain base product fillers, button tippers, valve crimpers, test baths, and aerosol product packaging equipment shall be protected by a wet-pipe automatic sprinkler system installed in accordance with NFPA 13. The sprinkler system shall be designed to protect the highest level of storage or production hazard that is present. [**30B:**5.8.2]

N **61.2.6.1.3.1** Level 2 and Level 3 aerosol products shall be permitted to be stored in production areas, such as staging areas (e.g., awaiting transfer to a warehouse), provided all of the following are met:

(1) They are stacked no more than 5 ft (1.5 m) high.
(2) There is no warehouse storage of aerosol products within 25 ft (7.6 m) of the production line.

[**30B:**5.8.2.1]

N **61.2.6.1.3.1.1** All other storage shall be protected in accordance with Table 6.4.2.7(a) through Table 6.4.2.7(l), of NFPA 30B, as applicable. [**30B:**5.8.2.1.1]

N **61.2.6.1.3.2** Aerosol products in plastic containers of capacity larger than 4 fl oz (118 ml) shall be permitted to be stored in production areas, such as staging areas (e.g., awaiting transfer to a warehouse), up to a maximum quantity of 1000 lb (454 kg), provided all of the following are met:

(1) The aerosol products are not treated as Class III commodities in accordance with Section 6.5 of NFPA 30B.
(2) They are stacked no more than 5 ft (1.5 m) high.
(3) There is no warehouse storage of aerosol products within 25 ft (7.6 m) of the production line.

[**30B:**5.8.2.2]

61.2.6.2 Standpipe and Hose System. Installations of standpipe and hose systems, where required by this *Code* and NFPA 30B, shall be designed and installed in accordance with Section 13.2 and NFPA 14 and with the provisions of NFPA 30B. Only combination or spray hose nozzles shall be used. [**30B:**4.6.2]

61.2.6.3 Portable Fire Extinguishers. Fire extinguishers shall be provided in accordance with Section 13.6. [**30B:**4.6.3]

61.2.6.4 Water Supplies.

Aerosol products can burn with extreme intensity. When exposed to heat, the pressure increase inside a container can cause it to rupture and release its flammable contents, which, under pressure, can cause the container to rocket and ignite combustibles otherwise uninvolved in the fire. Such behavior was observed in a 1982 fire involving aerosol products that destroyed a 1,000,000 ft^2 (92,900 m^2) distribution center in Falls Township, Pennsylvania. Because of this severe fire behavior, fire suppression systems must be provided with a sufficient water supply in terms of flow rates, pressures, and flow duration. Additional fire flow capacity should be provided to allow manual fire-fighting operations to supplement any operating automatic suppression systems. See Section 18.4 for additional guidance on fire flow.

61.2.6.4.1 In addition to the water supply requirements for automatic sprinkler systems, a minimum requirement for hose stream supply for combined inside and outside hose streams shall be provided in accordance with one of the following:

(1) 500 gpm (1900 L/min) for buildings protected with spray and/or control mode specific application (CMSA) sprinkler protection
(2) 250 gpm (950 L/min) for buildings protected with ESFR sprinkler protection
(3) 1000 gpm (3800 L/min) for buildings without automatic sprinkler protection [**30B:**4.6.4.1]

61.2.6.4.1.1 The water supply shall be sufficient to provide the required hose stream demand for a minimum duration of 2 hours, unless otherwise specified in 61.3.4.2. [**30B:**4.6.4.1.1]

Δ **61.2.6.4.1.2** The water supply system shall be designed and installed in accordance with Section 13.5 and NFPA 24. [**30B:**4.6.4.1.2]

61.2.6.4.1.3 The water supply requirements shall be permitted as modified by the provisions of NFPA 30B. [**30B:**4.6.4.1.3]

Δ **61.2.6.4.2** Installations of fire pumps and tanks that are needed to supply the required fire protection water shall be installed in accordance with Section 13.4 and NFPA 20 and NFPA 22. [**30B:**4.6.4.2]

61.2.7 Fire Alarms. Fire alarm systems shall be installed, tested, and maintained in accordance with applicable requirements of Section 13.7 and *NFPA 72*. [**30B:**4.7]

61.2.8 Sources of Ignition.

61.2.8.1 In areas where flammable gases or flammable vapors might be present, precautions shall be taken to prevent ignition by eliminating or controlling sources of ignition. [**30B:**4.8.1]

61.2.8.2 Sources of ignition shall include, but are not limited to, the following:

(1) Open flames
(2) Lightning
(3) Hot surfaces
(4) Radiant heat
(5) Smoking
(6) Cutting and welding
(7) Spontaneous ignition
(8) Frictional heat or sparks
(9) Static electricity
(10) Electrical arcs and sparks
(11) Stray currents
(12) Ovens, furnaces, and other heating equipment
(13) Automotive vehicles
(14) Material-handling equipment [**30B:**4.8.2]

Any designated smoking area should be located well away from an aerosol storage area or filling operation and preferably outside the building. See Section 10.9 for smoking restrictions.

61.3 Storage in Warehouses and Storage Areas

61.3.1 Basic Requirements.

61.3.1.1 The protection criteria in Section 61.3 shall apply to the following:

(1) Level 1 aerosol products in metal containers not more than 33.8 fl oz (1000 ml) capacity, in accordance with 61.3.2
(2) Aerosol cooking spray products in metal containers not more than 33.8 fl oz (1000 ml) capacity, in accordance with 61.3.3
(3) Level 2 and Level 3 aerosol products in metal containers not more than 33.8 fl oz (1000 ml) capacity, in accordance with Section 6.4 of NFPA 30B

(4) Aerosol products in glass and plastic containers not more than 4 fl oz (118 ml) capacity, in accordance with Section 6.4
(5) Aerosol products in plastic containers greater than 4 fl oz (118 ml) capacity and not more than 33.8 fl oz (1000 ml) capacity, in accordance with Section 6.5 of NFPA 30B

[**30B:**6.1.1]

61.3.1.2 All outer packaging of aerosol products, including cartons, trays, shrouds, or other packaging, shall be identified on at least one side with the classification of the aerosol products in accordance with Section 1.9 of NFPA 30B and with one of the following, whichever is appropriate:

(a) Level _____ Aerosols
(b) Aerosol Cooking Spray
(c) Plastic Aerosol 1 (or X)

[**30B:**6.1.2]

61.3.1.3* Fire-retardant cartons shall not be considered an acceptable alternative to the protection requirements of Chapter 6 of NFPA 30B. [**30B:**6.1.3]

A.61.3.1.3 At the present time there have been no fire-retardant packaging systems tested that have demonstrated substantial mitigation of the fire hazards presented by aerosol products. [**30B:**A.6.1.3]

61.3.2* Storage of Level 1 Aerosol Products.

A.61.3.2 Fire tests and fire experience show that Level 1 aerosol products present relatively the same fire hazards as Class III commodities, as these are defined and described in NFPA 13. In some cases, the AHJ or applicable fire or building regulations might require storage of such materials to be protected from fire. If fire protection is by means of automatic sprinklers, then the requirements of NFPA 13 should be used as a design basis. [**30B:**A.6.2]

61.3.2.1 Level 1 aerosol products shall be considered equivalent to Class III commodities, as defined in NFPA 13. [**30B:**6.2.1]

61.3.2.2 In cases where the storage of Level 1 aerosol products is required to be protected, such storage shall be protected in accordance with the requirements for Class III commodities set forth in NFPA 13. [**30B:**6.2.2]

61.3.3 Storage of Aerosol Cooking Spray Products.

61.3.3.1 General.

61.3.3.1.1 Aerosol cooking spray products shall be permitted to be stored in a general-purpose warehouse. [**30B:**6.3.1.1]

61.3.3.1.2 Aerosol cooking spray products shall be permitted to be stored mixed with other higher hazard aerosols as long as the provided isolation, storage height restrictions, and protection are based on the highest hazard aerosol product present. [**30B:**6.3.1.2]

61.3.3.2 Fire Protection.

61.3.3.2.1 Encapsulated storage of cartoned aerosol cooking spray products shall be protected as uncartoned storage. [**30B:**6.3.2.1]

61.3.3.2.2 Stretch-wrapping of cartons of aerosol cooking spray products shall be protected as cartoned storage. [**30B:**6.3.2.2]

61.3.3.2.3 Wet-pipe automatic sprinkler protection shall be provided in accordance with Table 61.3.3.2.3(a) or Table 61.3.3.2.3(b) for cartoned aerosol cooking spray products stored in open frame racks without solid shelves or stored as palletized or solid pile storage. [**30B:**6.3.2.3]

61.3.3.2.4 Rack storage shall be arranged so that a minimum aisle width of 8 ft (2.4 m) is maintained between rows of racks and between racks and adjacent solid pile or palletized storage. [**30B:**6.3.2.4]

61.3.3.2.5 Solid pile and palletized storage shall be arranged so that no storage is more than 25 ft (7.6 m) from an aisle. Aisles shall be not less than 4 ft (1.2 m) wide. [**30B:**6.3.2.5]

61.3.3.2.6 Aerosol cooking spray product that is stored uncartoned shall be protected in accordance with Section 6.4 of NFPA 30B using the criteria for a Level 2 or Level 3 aerosol product, based on the product's chemical heat of combustion. [**30B:**6.3.2.6]

61.3.3.2.7 Protection criteria that are developed based on full-scale fire tests performed at an approved facility shall be considered an acceptable alternative to the protection criteria set forth in Table 61.3.3.2.3(a) or Table 61.3.3.2.3(b). [**30B:**6.3.2.7]

Δ ***TABLE 61.3.3.2.3(a)*** *Rack, Palletized and Solid Pile Storage of Cartoned Aerosol Cooking Spray Products (Metric Units)*

Maximum Ceiling Height (m)	Maximum Storage Height (m)	Ceiling Sprinkler Protection Criteria: Sprinkler Type/Nominal Orifice (L/min/bar$^{0.5}$)	Ceiling Sprinkler Protection Criteria: Response/Nominal Temperature Rating	Ceiling Sprinkler Protection Criteria: Design (# sprinklers @ discharge pressure)	Hose Stream Demand (L/min)	Water Supply Duration (hr)
9.1	7.6	ESFR-pendent K = 200	FR/Ordinary	12 @ 5.2 bar	950	1

[**30B:**Table 6.3.2.3(a)]

△ *TABLE 61.3.3.2.3(b) Rack, Palletized and Solid Pile Storage of Cartoned Aerosol Cooking Spray Products (English Units)*

Maximum Ceiling Height (ft)	Maximum Storage Height (ft)	Ceiling Sprinkler Protection Criteria: Sprinkler Type/Nominal Orifice (gpm/psi$^{0.5}$)	Response/ Nominal Temperature Rating	Design (# sprinklers @ discharge pressure)	Hose Stream Demand (gpm)	Water Supply Duration (hr)
30	25	ESFR-pendent K = 14.0	FR/Ordinary	12 @ 75 psi	250	1

[**30B:**Table 6.3.2.3(b)]

61.3.3.2.8 Storage in occupancies other than warehouses or mercantile occupancies, such as in assembly, business, educational, industrial, and institutional occupancies, shall be permitted up to a maximum of 1000 lb (454 kg) net weight. [**30B:**6.3.2.8]

61.3.3.2.9 Solid pile, palletized, or rack storage of aerosol cooking spray product shall be permitted in a general-purpose warehouse that is either unsprinklered or not protected in accordance with this *Code*, up to a maximum of 2500 lb (1135 kg). [**30B:**6.3.2.9]

Subsection 61.3.3 was new for the 2015 edition of NFPA 30B and provides all the criteria for the storage of aerosol cooking spray products. Aerosol cooking spray was added as a classification of aerosol products in 61.1.3.5.

61.3.4 Storage of Level 2 and Level 3 Aerosol Products.

61.3.4.1 The storage of Level 2 and Level 3 aerosol products shall be in accordance with 61.3.4. [**30B:**6.4.1]

61.3.4.1.1 Level 2 aerosol products in containers whose net weight is less than 1 oz (28 g) shall be considered to be equivalent to cartoned unexpanded Group A plastics, as defined in NFPA 13. [**30B:**6.4.1.1]

61.3.4.1.1.1 In cases where the storage of Level 2 aerosol products in containers whose net weight is less than 1 oz (28 g) is required to be protected, such storage shall be in accordance with the requirements set forth in NFPA 13 for cartoned unexpanded Group A plastics. [**30B:**6.4.1.1.1]

61.3.4.2 Fire Protection — Basic Requirements.

61.3.4.2.1 Storage of Level 2 and Level 3 aerosol products shall not be permitted in basement areas of warehouses. [**30B:**6.4.2.1]

61.3.4.2.1.1 Storage of Level 2 and Level 3 aerosol products shall be permitted as provided for in 6.3.3 of NFPA 30B. [**30B:**6.4.2.1.1]

61.3.4.2.2* Encapsulated storage of cartoned Level 2 and Level 3 aerosol products shall be protected as uncartoned. [**30B:**6.4.2.2]

The term *encapsulated storage* refers to a method of packaging that consists of a plastic sheet that completely encloses the sides and top of a pallet load of combustible commodities. Banding, or stretch wrapping, around only the sides of a pallet load is not considered encapsulation.

A.61.3.4.2.2 Fire testing has not been performed on encapsulated pallets of cartoned aerosol products; however, this type of protection should be appropriate for this condition, based on testing of uncartoned aerosol products. [**30B:**A.6.3.2.2]

61.3.4.2.2.1 Stretch-wrapping of cartons of aerosol products shall be permitted. [**30B:**6.4.2.2.1]

61.3.4.2.2.2 Encapsulated storage of uncartoned Level 2 and Level 3 aerosol products on slip sheets or in trays shall be permitted. [**30B:**6.4.2.2.2]

Aerosol sprinkler test programs that led to the development of the aerosol sprinkler protection criteria did not address uncartoned aerosol products. These same test programs showed the importance of "pre-wetting" of cardboard cartons by sprinkler system discharge in the aerosol storage array. The consensus at that time was that, without the presence of the cardboard carton to provide for this pre-wetting, the sprinkler design criteria provided for cartoned aerosols might not adequately control a fire in a storage array involving uncartoned aerosols.

Encapsulated storage of Level 2 and Level 3 aerosol products on slip sheets or on trays has become popular in some areas, and, therefore, appropriate protection was needed for this aerosol storage method. Additional sprinkler testing was performed on uncartoned aerosol storage arrays. These tests led to new protection criteria for uncartoned aerosol products in earlier editions of NFPA 30B.

61.3.4.2.3 Level 2 and Level 3 aerosol products whose containers are designed to vent at gauge pressures of less than 210 psi (1450 kPa) shall not be stored. [**30B:**6.4.2.3]

61.3.4.2.4 Noncombustible draft curtains shall extend down a minimum of 2 ft (0.61 m) from the ceiling and shall be installed at the interface between ordinary and high-temperature sprinklers. [**30B:**6.4.2.4]

61.3.4.2.5 Storage of mixed commodities within or adjacent to aerosol product storage areas shall meet all applicable requirements of Chapter 6 of NFPA 30B. [**30B:**6.4.2.5]

61.3.4.2.6 Storage of idle or empty pallets shall meet all applicable requirements of NFPA 13. [**30B:**6.4.2.6]

61.3.4.2.7 Where required by Chapter 6 of NFPA 30B, wet-pipe automatic sprinkler protection shall be provided in accordance with Table 6.4.2.7(a) through Table 6.4.2.7(l) of NFPA 30B and Figure 6.4.2.7(a) through Figure 6.4.2.7(e) of NFPA 30B as designated in the corresponding table(s). Protection shall be based on the highest level of aerosol product present. No protection criteria have been established for the protection of palletized and solid piled storage of uncartoned Level 3 aerosol products. The tables are as follows:

(1) Table 6.4.2.7(a) of NFPA 30B Palletized and Solid Pile Storage of Cartoned Level 2 and Level 3 Aerosol Products (Metric Units)
(2) Table 6.4.2.7(b) of NFPA 30B Palletized and Solid Pile Storage of Cartoned Level 2 and Level 3 Aerosol Products (English Units)
(3) Table 6.4.2.7(c) of NFPA 30B Palletized and Solid Pile Storage of Uncartoned Level 2 Aerosol Products (Metric Units)
(4) Table 6.4.2.7(d) of NFPA 30B Palletized and Solid Pile Storage of Uncartoned Level 2 Aerosol Products (English Units)
(5) Table 6.4.2.7(e) of NFPA 30B Rack Storage of Cartoned Level 2 Aerosol Products (Metric Units)
(6) Table 6.4.2.7(f) of NFPA 30B Rack Storage of Cartoned Level 2 Aerosol Products (English Units)
(7) Table 6.4.2.7(g) of NFPA 30B Rack Storage of Cartoned Level 3 Aerosol Products (Metric Units)
(8) Table 6.4.2.7(h) of NFPA 30B Rack Storage of Cartoned Level 3 Aerosol Products (English Units)
(9) Table 6.4.2.7(i) of NFPA 30B Rack Storage of Uncartoned Level 2 Aerosol Products (Metric Units)
(10) Table 6.4.2.7(j) of NFPA 30B Rack Storage of Uncartoned Level 2 Aerosol Products (English Units)
(11) Table 6.4.2.7(k) of NFPA 30B Rack Storage of Uncartoned Level 3 Aerosol Products (Metric Units)
(12) Table 6.4.2.7(l) of NFPA 30B Rack Storage of Uncartoned Level 3 Aerosol Products (English Units)

[**30B:**6.4.2.7]

Annex B of NFPA 30B provides a summary of the aerosol product fire tests that culminated in the development of the sprinkler protection criteria for aerosol products. This testing included more than a dozen full-scale aerosol product fire tests in the late 1970s and early 1980s, which were conducted by a major insurance company, and more than 50 small-, medium-, and large-scale tests sponsored by the aerosol industry during the 1980s. These test programs led to the body of knowledge that was used to develop the first edition of NFPA 30B in 1990. The sprinkler protection criteria provided in NFPA 30B is based on those original tests, as well as ongoing testing of new sprinkler designs, and new storage and display methods. The tables for rack storage of aerosol products were updated for the 2011 edition of NFPA 30B to clarify the permitted sprinkler type and maximum size orifice permitted for certain storage arrangements.

61.3.4.2.7.1 The protection criteria in Tables 6.4.2.7(a) through 6.4.2.7(l) of NFPA 30B shall only be used with ceilings having a pitch of 2 in 12 or less. [**30B:**6.4.2.7.1]

61.3.4.2.7.2 Fire protection requirements for more demanding commodity and clearance situations shall be permitted to be used for less demanding situations. [**30B:**6.4.2.7.2]

61.3.4.2.7.3 The ordinary-temperature design criteria correspond to ordinary-temperature rated sprinklers and shall be used for sprinklers with ordinary- and intermediate-temperature classification. [**30B:**6.4.2.7.3]

61.3.4.2.7.4 The high-temperature design criteria correspond to high-temperature rated sprinklers and shall be used for sprinklers having a high-temperature rating. [**30B:**6.4.2.7.4]

61.3.4.2.8 Protection criteria that are developed based on full-scale fire tests performed at an approved test facility shall be considered an acceptable alternative to the protection criteria set forth in Table 6.4.2.7(a) through Table 6.4.2.7(l) of NFPA 30B. Such alternative protection criteria shall be subject to the approval of the AHJ. [**30B:**6.4.2.8]

As indicated in the commentary to 61.3.4.2.7, the sprinkler protection criteria contained in NFPA 30B has been developed based on full-scale test programs. Performing full-scale fire tests to develop appropriate criteria for new sprinkler designs or storage methods is a valid approach to defining appropriate protection for aerosol product storage.

Δ **61.3.4.2.9** Installation of in-rack sprinklers shall be in accordance with NFPA 13 as modified by Table 6.4.2.7(e) through Table 6.4.2.7(l) of NFPA 30B. [**30B:**6.4.2.9]

61.3.4.2.9.1 The in-rack sprinkler water demand shall be based on the simultaneous operation of the most hydraulically remote sprinklers as follows:

(1) Sprinkler design parameters shall be in accordance with Table 6.4.2.7(a) through Table 6.4.2.7(l) of NFPA 30B, whichever is applicable.
(2) In-rack design flows indicated in Table 6.4.2.7(e) through Table 6.4.2.7(l) of NFPA 30B shall be provided, but in no case shall the end-sprinkler discharge be less than 10 psi (0.69 bar).
(3) Eight (8) sprinklers where only one level of in-rack sprinklers is provided.
(4) Twelve (12) sprinklers [six (6) sprinklers on two levels] where only two levels of in-rack sprinklers are provided.
(5) Eighteen (18) sprinklers [six (6) sprinklers on the top three levels] where more than two levels of in-rack sprinklers are provided.

[**30B:**6.4.2.9.1]

61.3.4.2.9.2 Where in-rack sprinklers are not shielded by horizontal barriers, water shields shall be provided above the sprinklers or listed intermediate level/rack sprinklers shall be used. [**30B:**6.4.2.9.2]

61.3.4.2.9.3 When in-rack sprinklers are necessary to protect a higher hazard commodity that occupies only a portion of the length of a rack, the following shall apply:

(1) In-rack sprinklers shall be extended a minimum of 2.4 m (8 ft) or one bay, whichever is greater, in each direction along the rack on either side of the higher hazard.
(2) The in-rack sprinklers protecting the higher hazard shall not be required to be extended across the aisle.

[**30B:**6.4.2.9.3]

61.3.4.2.9.4 Where a storage rack, due to its length, requires less than the number of in-rack sprinklers specified, only those in-rack sprinklers in a single rack need to be included in the calculation. [**30B:**6.4.2.9.4]

61.3.4.2.9.5* In-rack sprinklers shall be located at an intersection of the transverse and longitudinal flues while not exceeding the maximum spacing rules. [**30B:**6.4.2.9.5]

A.61.3.4.2.9.5 In-rack sprinklers have proven to be the most effective way to fight fires in rack storage. To accomplish this, however, in-rack sprinklers must be located where they will operate early in a fire as well as direct water where it will do the most good. Simply maintaining a minimum horizontal spacing between sprinklers does not achieve this goal, because fires in rack storage develop and grow in transverse and longitudinal flues, and in-rack sprinklers do not operate until flames actually impinge on them. To ensure early operation and effective discharge, in-rack sprinklers in the longitudinal flue of open-frame racks must be located at transverse flue intersections. The commodity loads shown in Figure 6.3.2.7(a) through Figure 6.3.2.7(e) of NFPA 30B are typically 1.2 m (4 ft) cubes. Accounting for flue spaces and vertical clear space between loads, this puts the in-rack sprinklers shown in the figures approximately 1.4 m (4.5 ft) apart horizontally when they are between each load and approximately 2.7 m (9 ft) apart horizontally when they are spaced at every other load. If the length or width of loads exceeds 1.2 m (4 ft), in-rack sprinklers should still be positioned at flue intersections, but additional sprinklers may be necessary between the loads. [**30B:**A.6.3.9.2.5]

61.3.4.2.9.5.1 Where no transverse flues exist, in-rack sprinklers shall not exceed the maximum spacing rules. [**30B:**6.4.2.9.5.1]

61.3.4.2.9.6 A minimum 150 mm (6 in.) vertical clearance shall be maintained between the sprinkler deflectors and the top of the tier of storage. [**30B:**6.4.2.9.6]

61.3.4.2.9.7 Horizontal barriers used in conjunction with in-rack sprinklers to impede vertical fire development shall be constructed of minimum 22 ga sheet metal, 10 mm (⅜ in.) plywood, or similar material and shall extend the full length and depth of the rack. [**30B:**6.4.2.9.7]

61.3.4.2.9.7.1 Barriers shall be fitted within 50 mm (2 in.) horizontally around rack uprights. [**30B:**6.4.2.9.7.1]

61.3.4.2.10 Installations of hose connections shall meet the requirements of NFPA 13. [**30B:**6.4.2.10]

61.3.4.2.10.1 Subject to the approval of the AHJ, hose stations shall not be required to be installed in storage areas. [**30B:**6.4.2.10.1]

61.3.4.2.11 Storage height and building heights shall comply with Table 6.4.2.7(a) through Table 6.4.2.7(l) of NFPA 30B. [**30B:**6.4.2.11]

61.3.4.2.12 Solid shelving shall comply with 61.3.4.2.12.1 through 61.3.4.2.12.3. [**30B:**6.4.2.12]

61.3.4.2.12.1 Solid shelving that is installed in racks that contain Level 2 and Level 3 aerosol products shall be protected in accordance with Table 6.4.2.7(e) through Table 6.4.2.7(l) of NFPA 30B, whichever is applicable. [**30B:**6.4.2.12.1]

61.3.4.2.12.2 In addition to the in-rack sprinklers shown in Figure 6.4.2.7(a) through Figure 6.4.2.7(e) of NFPA 30B, whichever is applicable, a face sprinkler shall be provided directly below the solid shelf or the elevation of the solid shelf if the face sprinkler is located in a transverse flue. [**30B:**6.4.2.12.2]

61.3.4.2.12.3 The face sprinklers below the shelving required by 61.3.4.2.12.2 shall be not greater than 8 ft (2.4 m) apart as far as the solid shelving level extends. [**30B:**6.4.2.12.3]

61.3.4.2.13 Where spray sprinklers are utilized for ceiling protection, sprinkler spacing shall not exceed 100 ft^2 (9.3 m^2) unless otherwise permitted by 61.3.4.2.14. [**30B:**6.4.2.13]

61.3.4.2.14 Ordinary or intermediate temperature rated K = 25.2 extended-coverage spray sprinklers shall be permitted to be used for all density spray sprinkler design criteria in Table 6.4.2.7(a) through Table 6.4.2.7(l) of NFPA 30B when installed in accordance with their listing. [**30B:**6.4.2.14]

61.3.4.2.15 The ceiling heights in Table 6.4.2.7(e) through Table 6.4.2.7(l) of NFPA 30B shall be permitted to be increased by a maximum of 10 percent if an equivalent percent increase in ceiling sprinkler design density is provided. This shall only apply to spray sprinkler protection criteria. [**30B:**6.4.2.15]

61.3.4.2.16 Protection systems that are designed and developed based on full-scale fire tests performed at an approved test facility or on other engineered protection schemes shall be considered an acceptable alternative to the protection criteria set forth in Section 6.3 of NFPA 30B. Such alternative protection systems shall be approved by the AHJ. [**30B:**6.4.2.16]

61.3.4.2.17 Rack storage shall be arranged so that a minimum aisle width of 8 ft (2.4 m) is maintained between rows of racks and between racks and adjacent solid pile or palletized storage. [**30B:**6.4.2.17]

61.3.4.2.18 Where protection is provided by ESFR sprinklers, aisle width shall be not less than 4 ft (1.2 m). [**30B:**6.4.2.18]

61.3.4.2.19 Solid pile and palletized storage shall be arranged so that no storage is more than 25 ft (7.6 m) from an aisle. Aisles shall be not less than 4 ft (1.2 m) wide. [**30B:**6.4.2.19]

N **61.3.4.3 Aerosol Products in Plastic Containers Greater Than 4 fl oz (118 ml) and Not More Than 33.8 fl oz (1000 ml).**

N **61.3.4.3.1 Fire Protection — Plastic Aerosol 1 Products.**

N **61.3.4.3.1.1** Plastic aerosol 1 products shall be permitted to be stored in a general-purpose warehouse without isolation. [**30B:**6.5.1.1]

N **61.3.4.3.1.2*** Plastic aerosol 1 products shall be considered equivalent to Class III commodities, as defined in NFPA 13. [**30B:**6.5.1.2.]

N **A.61.3.4.3.1.2** The maximum quantity of storage of plastic aerosol X products is limited to what is provided in 61.3.4.3.1.2 because no demonstrated protection criteria are available.

N **61.3.4.3.1.3** In cases where the storage of plastic aerosol 1 products is required to be protected, they shall be protected in accordance with the requirements of NFPA 13. [**30B:**6.5.1.3]

N **61.3.4.3.2 Fire Protection — Plastic Aerosol X Products.**

N **61.3.4.3.2.1** Storage of plastic aerosol X products in occupancies other than warehouses or mercantile occupancies, such as in assembly, business, educational, industrial, and institutional occupancies, shall be permitted up to a maximum of 100 lb (45 kg) net weight. [**30B:**6.5.2.1]

N **61.3.4.3.2.2** Solid pile, palletized, or rack storage of plastic aerosol X products shall be permitted in a general-purpose warehouse or an aerosol warehouse regardless of protection level up to a maximum of 250 lb (115 kg). [**30B:**6.5.2.2]

61.4 Mercantile Occupancies

61.4.1 Plastic Aerosol X Products. Plastic aerosol X products shall be permitted to be stored in mercantile occupancies up to a maximum quantity of 100 lb (45 kg) net weight. [**30B:**7.1]

61.4.2 Sales Display Areas — Aerosol Product Storage Not Exceeding 8 ft (2.4 m) High.

61.4.2.1 Level 1 aerosol products and plastic aerosol 1 products in sales display areas shall not be limited. [**30B:**7.2.1]

61.4.2.2 Aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products shall be removed from combustible cartons, or the cartons shall be display-cut, when located in sales display areas. [**30B:**7.2.2]

61.4.2.2.1 Cartoned display of aerosol cooking spray products shall be permitted provided the area is protected in accordance with Table 6.3.2.3(a) or Table 6.3.2.3(b) of NFPA 30B, or the area is protected in accordance with Table 6.4.2.7(a) through Table 6.4.2.7(l) of NFPA 30B, or the maximum quantity of cartoned display complies with 61.4.2.3.1. [**30B:**7.2.2.1]

61.4.2.2.2 Cartoned display of Level 2 aerosol products and Level 3 aerosol products shall be permitted, provided the area is either protected in accordance with Table 6.4.2.7(a) through Table 6.4.2.7(l) of NFPA 30B or the maximum quantity of cartoned display complies with 61.4.2.3.1. [**30B:**7.2.2.1]

61.4.2.3 Aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products in sales display areas shall not exceed the maximum quantities given in 61.4.2.3.1 and 61.4.2.3.2 according to the protection provided. [**30B:**7.2.3]

61.4.2.3.1 In sales display areas that are nonsprinklered or whose sprinkler system does not meet the requirements of 61.4.2.3.2, the total aggregate quantity of aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products shall not exceed 2 lb/ft^2 (9.8 kg/m^2) of total sales display area, up to the quantities specified in Table 61.4.2.3.1. [**30B:**7.2.3.1]

61.4.2.3.1.1 No single 10 ft × 10 ft (3 m × 3 m) section of sales display area shall contain an aggregate quantity of more than 1000 lb (454 kg) net weight aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products. [**30B:**7.2.3.1.1]

61.4.2.3.2 In sales display areas that are sprinklered in accordance with NFPA 13, for at least Ordinary Hazard (Group 2) occupancies, the total aggregate quantity aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products shall not exceed 2 lb/ft^2 (9.8 kg/m^2) of total sales display area. [**30B:**7.2.3.2]

61.4.2.3.2.1 No single 10 ft × 10 ft (3 m × 3 m) section of sales display area shall contain an aggregate quantity of more than 1000 lb (454 kg) net weight of aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products. [**30B:**7.1.3.2.1]

61.4.2.4 Aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products shall be securely stacked to not more than 6 ft (1.8 m) high from base to top of the storage array unless on fixed shelving. [**30B:**7.2.4]

TABLE 61.4.2.3.1 *Maximum Quantity per Floor of Aerosol Cooking Spray Products, Level 2 Aerosol Products, and Level 3 Aerosol Products, and Aerosol Products in Plastic Containers*

	Max. Net Weight per Floor	
Floor	**lb**	**kg**
Basement	Not Permitted	
Ground	2500	1135
Upper	500	227

[**30B:**Table 7.2.3.1]

61.4.2.4.1 Shelving shall be of stable construction and storage shall not exceed 8 ft (2.4 m) in height. [**30B:**7.2.4.1]

61.4.3 Sales Display Areas — Aerosol Products Storage Exceeding 8 ft (2.4 m) High.

The storage and display of aerosol products in bulk retail establishments present additional fire protection challenges beyond those found in separate retail display or storage occupancies. Limitations are provided to allow for the uncartoned display of aerosol products on lower shelving, with palletized, cartoned products displayed above. The sprinkler protection for such facilities is required to comply with the aerosol sprinkler protection criteria provided for warehouses.

61.4.3.1 Storage and display of Level 1 aerosol products and plastic aerosol 1 products in sales display areas shall not be limited. [**30B:**7.3.1]

61.4.3.2 Uncartoned or display-cut (case-cut) aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products that are stored for display no more than 6 ft (1.8 m) above the floor shall be permitted where protection is installed in accordance with 61.4.3.3, based on the highest level of aerosol product in the array and the packaging method of the storage above 6 ft (1.8 m). [**30B:**7.3.2]

61.4.3.3 Protection.

61.4.3.3.1 The storage and display of aerosol cooking spray products in metal containers only shall be protected in accordance with Table 6.3.2.3(a) or Table 6.3.2.3(b) of NFPA 30B, or shall be protected in accordance with Table 6.4.2.7(a) through Table 6.4.2.7(l) of NFPA 30B. The storage and display of Level 2 and Level 3 aerosol products in metal containers only shall be protected in accordance with Table 6.3.2.7(a) through Table 6.3.2.7(l) of NFPA 30B, whichever is applicable. [**30B:**7.3.3.1]

61.4.3.3.1.1 Where in-rack sprinklers are required by Table 6.43.2.7(e) through Table 6.4.2.7(l) of NFPA 30B and where the aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products are stored for display below the 6 ft (1.8 m) level, the first tier of in-rack sprinklers shall be installed above the display, but not more than 6 ft (1.8 m) above the floor level. [**30B:**7.2.3.1.1]

61.4.3.3.2 Noncombustible draft curtains shall extend down a minimum of 2 ft (0.61 m) from the ceiling and shall be installed at the interface between ordinary and high-temperature sprinklers. [**30B:**7.3.3.2]

61.4.3.4 Storage and display of aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products shall not exceed 10,000 lb (4,540 kg) net weight within any 25,000 ft^2 (2,323 m^2) of sales display area. [**30B:**7.2.4]

61.4.3.4.1 Aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol product display areas shall be separated from each other by a minimum of 25 ft (7.6 m). [**30B:**7.2.4.1]

61.4.3.5 The area of the design for the required ceiling sprinkler system shall extend 20 ft (6 m) beyond the area devoted to storage of aerosol cooking spray products or Level 2 aerosol product and Level 3 products. [**30B:**7.3.5]

61.4.3.6 Storage and display of aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products shall be separated from the storage of flammable and combustible liquids by a minimum distance of 25 ft (7.6 m) or by a segregating wall or noncombustible barrier. [**30B:**7.3.6]

The aerosol product sprinkler protection criteria provided in NFPA 30B is based on full-scale testing of aerosol product storage arrays. These tests typically involved a "point" ignition source.

Flammable and combustible liquids stored or displayed in the vicinity of aerosol storage could result in a pool fire exposing the aerosol products. A pool fire exposure is a much more severe ignition scenario than the point ignition source utilized in the aerosol full-scale test programs. Therefore, flammable and combustible liquids need to be physically separated from aerosol product storage, and precautions should be taken to prevent the flow of flammable and combustible liquids underneath the aerosol storage arrays.

61.4.3.6.1 Where aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products are stored within 25 ft (7.6 m) of flammable and combustible liquids, beneath the noncombustible barrier shall be liquidtight at the floor to prevent spilled liquids from flowing beneath the aerosol products. [**30B:**7.3.6.1]

61.4.3.7 The sales display area shall meet the requirements for mercantile occupancies in NFPA *101*. [**30B:**7.3.7]

61.4.4 Back Stock Storage Areas.

61.4.4.1 Where back stock areas are separated from sales display areas by construction having a minimum 1-hour fire resistance rating, storage of aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products shall meet the requirements of Chapter 6 of NFPA 30B. [**30B:**7.4.1]

61.4.4.2 Where back stock areas are not separated from sales display areas by construction having a minimum 1-hour fire resistance rating, the quantity of aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products in back stock areas shall be included in the total allowable quantities specified in 61.4.2.3 or 61.4.3.4. [**30B:**7.4.2]

61.4.4.2.1 Protection shall be provided in accordance with 61.4.3.3. [**30B:**7.3.2.1]

61.4.4.3 An additional quantity of aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products, up to a maximum of 500 lb (227 kg) net weight, shall be permitted in back stock areas where the additional quantities are stored in flammable liquid storage cabinets that meet the requirements of Section 9.5 of NFPA 30. [**30B:**7.4.3]

61.4.4.4 Storage of aerosol cooking spray products, Level 2 aerosol products, and Level 3 aerosol products in separate, inside flammable liquids storage rooms shall meet the requirements of 6.3.7 of NFPA 30B. [**30B:**7.4.4]

61.5 Operations and Maintenance

61.5.1 Means of Egress. Means of egress and exits shall be maintained in accordance with NFPA *101*. [**30B:**8.1]

Means of egress, including doors, stairs, corridors, and aisles, must be maintained clear of obstructions to provide free travel to a safe location outside the building in the event of a fire, without passing through a more hazardous area. Where egress doors are provided with locks or latches, they must be arranged such that they can be opened with not more than one latch- or lock-releasing operation and must not require the use of keys, tools, or special knowledge or effort. For example, egress doors must not be arranged such that an occupant needs to swipe a key card or enter a numerical code to allow the door to open in the direction of egress travel. Special locking arrangements must comply with 14.5.3.

61.5.2 Powered Industrial Trucks.

61.5.2.1 The use and selection of powered industrial trucks shall comply with Section 10.17. [**30B:**8.2.1]

See Section 10.17 for information on powered industrial trucks, which must comply with NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations.*

61.5.2.2 Only trained and authorized operators shall be allowed to operate powered industrial trucks. [**30B:**8.2.2]

61.5.2.3 Operator training shall be equivalent to that specified by ANSI/ASME B56.1, *Safety Standard for Low-Lift and High-Lift Trucks*. [**30B:**8.2.3]

61.5.2.4 Loads.

61.5.2.4.1 If the type of load handled presents a hazard of backward falls, the powered industrial truck shall be equipped with a vertical load backrest extension. [**30B:**8.2.4.1]

61.5.2.4.2 For loads that are elevated above the mast of the truck, the backrest extension shall reach at least halfway into the uppermost pallet load. [**30B:**8.2.4.2]

61.5.3 Control of Ignition Sources.

61.5.3.1 Sources of Ignition.

61.5.3.1.1 In areas where flammable gases or flammable vapors might be present, precautions shall be taken to prevent ignition by eliminating or controlling sources of ignition. Sources of ignition include, but are not limited to, the following:

(1) Open flames
(2) Lightning
(3) Hot surfaces
(4) Radiant heat
(5) Smoking
(6) Cutting and welding
(7) Spontaneous ignition
(8) Frictional heat or sparks
(9) Static electricity
(10) Electrical arcs and sparks
(11) Stray currents
(12) Ovens, furnaces, and other heating equipment
(13) Automotive vehicles
(14) Material-handling equipment [**30B:**8.3.1.1]

61.5.3.2 Smoking shall be strictly prohibited, except in designated smoking areas. [**30B:**8.3.2]

61.5.3.3* Welding, cutting, and similar spark-producing operations shall not be permitted in areas that contain aerosol products, until a written permit authorizing the work has been issued. [**30B:**8.3.3]

A.61.5.3.3 See NFPA 51B for further information. [**30B:**A.8.3.3]

61.5.3.3.1 The permit shall be issued by a person in authority following an inspection of the area to assure that proper precautions have been taken and will be followed until completion of the work. [**30B:**8.3.3.1]

61.5.4 Aisles. Storage in aisles shall be prohibited so as to permit access for fire fighting, salvage, and removal of stored commodities. [**30B:**8.4]

61.5.5 Waste Disposal.

61.5.5.1 Filled or partly filled aerosol containers shall be separated from all other rubbish and trash. [**30B:**8.5.1]

61.5.5.1.1 Filled or partly filled aerosol containers shall be placed in noncombustible waste containers. [**30B:**8.5.1.1]

61.5.5.2 Filled or partly filled aerosol containers shall not be disposed of in compactors, balers, or incinerators that crush the container or heat its contents. [**30B:**8.5.2]

61.5.5.2.1 Equipment and facilities that are specifically designed for the disposal of aerosol containers shall be permitted to dispose of filled or partly filled aerosol containers. [**30B:**8.5.2.1]

61.5.6 Inspection and Maintenance.

61.5.6.1 A written and documented preventive maintenance program shall be developed for equipment, machinery, and processes that are critical to fire-safe operation of the facility. [**30B:**8.6.1]

61.5.6.2 Critical detection systems and their components, emergency trips and interlocks, alarms, and safety shutdown systems shall be inspected on a regularly scheduled basis, and any deficiencies shall be immediately corrected. [**30B:**8.6.2]

61.5.6.2.1 Items in this inspection schedule shall include, but are not limited to, the following:

(1) Gas detection systems
(2) Deflagration suppression systems
(3) Deflagration vent systems
(4) Ventilation and local exhaust systems
(5) Propellant charging room door interlocks
(6) Process safety devices
(7) Fire alarm systems [**30B:**8.6.2.1]

61.5.6.3 Maintenance. [**68:**11.10]

61.5.6.3.1 Vent closure maintenance shall be performed after every act of nature or process upset condition to ensure that the closure has not been physically damaged and there are no obstructions, including but not limited to snow, ice, water, mud, or process material, that could lessen or impair the efficiency of the vent closure. [**68:**11.10.1]

Δ **61.5.6.3.2** An inspection shall be performed in accordance with 11.4.4 of NFPA 68 after every process maintenance turnaround. [**68:**11.10.2]

61.5.6.3.3 If process material has a tendency to adhere to the vent closure, the vent closure shall be cleaned periodically to maintain vent efficiency. [**68:**11.10.3]

61.5.6.3.4 Process interlocks, if provided, shall be verified. [**68:**11.10.4]

61.5.6.3.5 Known potential ignition sources shall be inspected and maintained. [**68:**11.10.5]

61.5.6.3.6 Records shall be kept of any maintenance and repairs performed. [**68:**11.10.6]

61.5.7* Static Electricity. All process equipment and piping involved in the transfer of flammable liquids or gases shall be connected to a static-dissipating earth ground system to prevent accumulations of static charge. [**30B:**8.7]

Δ **A.61.5.7** See NFPA 77. [**30B:**A.8.7]

Where not dissipated to ground, a buildup of static electricity can serve as an ignition source where flammable vapors are present and potentially result in a deflagration. By properly grounding equipment as described in NFPA 77, *Recommended Practice on Static Electricity,* any static charge should be safely dissipated, thus eliminating a potential ignition source.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.
NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*, 2015 edition.
NFPA 58, *Liquefied Petroleum Gas Code*, 2017 edition.
NFPA 70®, *National Electrical Code®*, 2017 edition.
NFPA 72®, *National Fire Alarm and Signaling Code®*, 2016 edition.
NFPA 77, *Recommended Practice on Static Electricity*, 2014 edition.
NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2016 edition.
NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, 2017 edition.
NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, 2013 edition.
NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2017 edition.
NFPA 5000®, *Building Construction and Safety Code®*, 2018 edition.
National Electrical Code® Handbook, Earley, M. W., ed., 2017.

ASTM D92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*, 2012b, ASTM International, West Conshohocken, PA.

Recommendations on the Transport of Dangerous Goods, United Nations, New York, NY, and Geneva, Switzerland, 2011.
Schram, P. J., R. P. Benedetti, and M. W. Earley, *Electrical Installations in Hazardous Locations*, Jones & Bartlett Learning, Burlington, MA, 2009.
Title 49, Code of Federal Regulations, Part 173, Appendix H, "Method of Testing for Sustained Combustibility," U.S. Government Printing Office, Washington, DC.

Reserved

62

In the 2018 edition of NFPA 1, *Fire Code,* Chapter 62 is reserved for future use.

Compressed Gases and Cryogenic Fluids

63

Chapter 63 contains requirements for compressed gases and cryogenic fluids. For the 2018 edition of this *Code*, Chapter 63 includes extracts from the 2016 edition of NFPA 55, *Compressed Gases and Cryogenic Fluids Code*.

The 2016 edition of NFPA 55 has the following significant changes from the 2013 edition:

1. Clarification and organization of the requirements in Chapter 10 for gaseous hydrogen systems into three tiers based on the quantity of hydrogen stored: less than or equal to the maximum allowable quantity (MAQ), greater than the MAQ but less than bulk quantity, and bulk systems
2. Changes to the requirements in Chapter 7 for emergency isolation
3. Complete revision of Chapter 13, Insulated Liquid Carbon Dioxide Systems, with a focus on carbon dioxide beverage systems
4. A new chapter on liquid nitrous oxide systems (Chapter 16)

The term *compressed gas* is defined in 3.3.140.1 of this *Code* as "a material, or mixture of materials, that (1) is a gas at 68°F (20°C) or less at an absolute pressure of 14.7 psi (101.3 kPa) and (2) has a boiling point of 68°F (20°C) or less at an absolute pressure of 14.7 psi (101.3 kPa) and that is liquefied, nonliquefied, or in solution, except those gases that have no other health or physical hazard properties are not considered to be compressed until the pressure in the packaging exceeds an absolute pressure of 40.6 psi (280 kPa) at 68°F (20°C)." The states of a compressed gas are categorized as follows:

1. Nonliquefied compressed gases are gases, other than those in solution, that are in packaging under the charged pressure and are entirely gaseous at a temperature of 68°F (20°C).
2. Liquefied compressed gases are gases that, in packaging under the charged pressure, are partially liquid at a temperature of 68°F (20°C).
3. Compressed gases in solution are nonliquefied gases that are dissolved in a solvent.
4. Compressed gas mixtures consist of a mixture of two or more compressed gases contained in packaging, the hazard properties of which are represented by the properties of the mixture as a whole.

Cryogenic fluids represent a transient state of a gas that is created through the use of refrigeration. Cryogenic fluids cannot exist in liquid form or partial liquid form at temperatures of 68°F (20°C); hence, they are not compressed gases as defined.

Chapter 63 covers cylinder and bulk gases and cryogenic fluids at all facilities, including gas manufacturing facilities, bulk oxygen systems, gaseous hydrogen systems, and liquefied hydrogen systems — all at consumer sites.

63.1 General Provisions

63.1.1 Application.

63.1.1.1* The installation, storage, use, and handling of compressed gases and cryogenic fluids in portable and stationary containers, cylinders, equipment, and tanks in all occupancies shall comply with the requirements of Chapter 63; NFPA 55, and Sections 60.1 through 60.4 of this *Code*.

A.63.1.1.1 See A.1.3.2.

63.1.1.2 Where the provisions of Chapter 63 or NFPA 55 conflict with the provisions of Chapter 60, the provisions of Chapter 63 and NFPA 55 shall apply.

63.1.1.3 The requirements in this chapter shall apply to users, producers, distributors, and others who are involved with the storage, use, or handling of compressed gases or cryogenic fluids. [**55:**1.3]

Δ **63.1.1.4 Specific Applications.** Chapter 63 shall not apply to the following:

(1)* Off-site transportation of materials covered by Chapter 63.

A.63.1.1.4(1) For regulations on the transportation of gases, see 49 CFR 100–185, "Transportation" and *Transportation of Dangerous Goods Regulations*. [**55:**A.1.1.2(1)]

(2) Storage, use, and handling of radioactive gases in accordance with NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*.

(3)* Use and handling of medical compressed gases at health care facilities in accordance with NFPA 99, *Health Care Facilities Code*.

Δ **A.63.1.1.4(3)** Bulk compressed gas and cryogenic fluid system installations are intended to be covered by the requirements of this *Code*. Instrumentation and alarms that are attendant to the system and designed to interface with the application in a health care facility are to be retained within the purview of NFPA 99. [**55:**A.1.1.2(3)]

Refer to Section 63.11 for requirements for liquid oxygen (LOX) in home health care.

(4) Systems consisting of cylinders of oxygen and cylinders of fuel gas used for welding and cutting in accordance with NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes*.

(5)* Flammable gases used as a vehicle fuel when stored on a vehicle.

Δ **A.63.1.1.4(5)** For information, see NFPA 52 or NFPA 58. [**55:**A.1.1.2(5)]

(6)* Storage, use, and handling of liquefied and nonliquefied compressed gases in laboratory work areas in accordance with NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*.

A.63.1.1.4(6) The storage and use of compressed gases and cryogenic fluids outside the boundaries of laboratory work areas are covered by NFPA 55. [**55:**A.1.1.2(6)]

(7) Storage, use, and handling of liquefied petroleum gases in accordance with NFPA 58, *Liquefied Petroleum Gas Code*.

(8) Storage, use, and handling of compressed gases within closed-cycle refrigeration systems complying with the mechanical code.

(9) Liquefied natural gas (LNG) storage at utility plants under NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*.

(10) Compressed natural gas (CNG) and liquefied natural gas (LNG), utilized as a vehicle fuel in accordance with NFPA 52, *Vehicular Gaseous Fuel Systems Code*.

(11)* Compressed hydrogen gas (GH2), or liquefied hydrogen gas (LH2) generated, installed, stored, piped, used, or handled in accordance with NFPA 2, *Hydrogen Technologies Code*, when there are no specific or applicable requirements in NFPA 55.

Δ **A.63.1.1.4(11)** NFPA 55 is used as the source document for the fundamental requirements for compressed hydrogen gas (GH2), or liquefied hydrogen gas (LH2) system installations. Correlation between NFPA 55 and NFPA 2 is the responsibility of the two technical committees involved. The installation requirements for bulk GH2 or LH2 are viewed as fundamental provisions. On the other hand, use-specific requirements for designated applications such as vehicular fueling are not resident in NFPA 55 and are under the purview of the NFPA 2 Technical Committee. Where there are specific provisions or controls included in NFPA 55, the specific controls of NFPA 55 will govern except that modifications made to provisions that have been extracted can be followed when the modifications have been made within NFPA's extract procedure as indicated in the *Manual of Style for NFPA Technical Committee Documents*. [**55:**A.1.1.2(11)]

(12) Nonflammable mixtures of ethylene oxide with other chemicals.

(13) Ethylene oxide in chambers 10 scf (0.283 Nm^3) or less in volume or for containers holding 7.05 oz (200 g) of ethylene oxide or less.

[**55:**1.1.2]

63.1.2 Permits Permits, where required, shall comply with Section 1.12.

For permit requirements for compressed gas facility closures, see 63.1.2.1. A number of permits might be required, depending on the operations using various compressed gases. The principal permit that applies to the hazards covered in Chapter 63, however, is a permit for compressed gases. Also see Section 1.12 for additional provisions regarding permits.

63.1.2.1 The permit applicant shall apply for approval to close storage, use, or handling facilities at least 30 days prior to the termination of the storage, use, or handling of compressed or liquefied gases.

63.1.2.2 Such application shall include any change or alteration of the facility closure plan filed pursuant to 60.1.4.4.

63.1.2.3 This 30-day period shall be permitted to be waived by the AHJ if special circumstances require such waiver.

63.1.2.3.1 Permits shall not be required for routine maintenance.

63.1.2.3.2 For repair work performed on an emergency basis, application for permit shall be made within 2 working days of commencement of work.

63.1.3 General Definitions.

63.1.3.1 Absolute Pressure. See 3.3.1.

63.1.3.2 ASTM. See 3.3.17.

63.1.3.3 Automatic Emergency Shutoff Valve. See 3.3.18.

63.1.3.4 Bulk Hydrogen Compressed Gas System. See 3.3.267.1.

63.1.3.5 Bulk Inert Gas System. See 3.3.267.2.

63.1.3.6 Bulk Liquefied Hydrogen System. See 3.3.267.3.

63.1.3.7 Bulk Oxygen System. See 3.3.267.4.

63.1.3.8 Cathodic Protection. See 3.3.37.

63.1.3.9 Cathodic Protection Tester. See 3.3.38.

63.1.3.10 CGA. See 3.3.41.

63.1.3.11 Compressed Gas Container. See 3.3.70.3.

63.1.3.12 Compressed Gas System. See 3.3.267.6.

63.1.3.13 Continuous Gas Detection System. See 3.3.267.7.

63.1.3.14 Cryogenic Fluid. See 3.3.78.

63.1.3.14.1 Flammable Cryogenic Fluid. See 3.3.78.1.

63.1.3.14.2 Inert Cryogenic Fluid. See 3.3.78.2.

63.1.3.14.3 Oxidizing Cryogenic Fluid. See 3.3.78.3.

63.1.3.15 Cylinder. See 3.3.80.

63.1.3.16 Cylinder Containment Vessel. See 3.3.81.

63.1.3.17 Cylinder Pack. See 3.3.82.

63.1.3.18 Distributor. See 3.3.91.

63.1.3.19 Emergency Shutoff Valve. See 3.3.98.

63.1.3.20 Ethylene Oxide Drum. See 3.3.99.

63.1.3.21 Excess Flow Control. See 3.3.100.

63.1.3.22 Exhausted Enclosure. See 3.3.102.

63.1.3.23 Explosion Control. See 3.3.109.

63.1.3.24 Gallon. See 3.3.138.

63.1.3.25 Gas. See 3.3.140.

63.1.3.25.1 Compressed Gas. See 3.3.140.1.

63.1.3.25.2 Corrosive Gas. See 3.3.140.2.

63.1.3.25.3 Flammable Gas. See 3.3.140.3.

63.1.3.25.4 Flammable Liquefied Gas. See 3.3.140.4.

63.1.3.25.5 Highly Toxic Gas. See 3.3.140.5.

63.1.3.25.6 Inert Gas. See 3.3.140.6.

63.1.3.25.7 Nonflammable Gas. See 3.3.140.10.

63.1.3.25.8 Other Gas. See 3.3.140.11.

63.1.3.25.9 Oxidizing Gas. See 3.3.140.12.

63.1.3.25.10 Pyrophoric Gas. See 3.3.140.13.

63.1.3.25.11 Toxic Gas. See 3.3.140.16.

63.1.3.25.12 Unstable Reactive Gas. See 3.3.140.17.

63.1.3.26 Gas Cabinet. See 3.3.141.

63.1.3.27 Gas Manufacturer/Producer. See 3.3.142.

63.1.3.28 Gas Room. See 3.3.143.

63.1.3.29 Gaseous Hydrogen System. See 3.3.144.

63.1.3.30 Hazard Rating. See 3.3.148.

63.1.3.31 Immediately Dangerous to Life and Health (IDLH). See 3.3.158.

63.1.3.32 Indoor Area. See 3.3.14.5.

63.1.3.33 ISO Module. See 3.3.165.

63.1.3.34 Liquid Oxygen Ambulatory Container. A container used for liquid oxygen not exceeding 0.396 gal (1.5 L) specifically designed for use as a medical device as defined by 21 USC Chapter 9, the United States Food, Drug and Cosmetic Act that is intended for portable therapeutic use and to be filled from its companion base unit which is liquid oxygen home care container.

63.1.3.35 Liquid Oxygen Home Care Container. A container used for liquid oxygen not exceeding 15.8 gal (60 L) specifically designed for use as a medical device as defined by 21 USC Chapter 9, the United States Food, Drug and Cosmetic Act that is intended to deliver gaseous oxygen for therapeutic use in a home environment.

63.1.3.36 Manual Emergency Shutoff Valve. See 3.3.173.

63.1.3.37 Mechanical Code. See 3.3.54.3.

63.1.3.38 Mobile Supply Unit. See 3.3.186..

63.1.3.39 Nesting. See 3.3.189.

63.1.3.40* Normal Temperature and Pressure (NTP). See 3.3.190.

A.63.1.3.40 Normal Temperature and Pressure (NTP). There are different definitions of normal conditions. The normal conditions defined here are the ones most commonly used in the compressed gas and cryogenic fluid industry. [**55,** 2016]

63.1.3.41 OSHA. See 3.3.199.

63.1.3.42 Outdoor Area. See 3.3.14.8.

63.1.3.43 Permissible Exposure Limit (PEL). See 3.3.167.2.

63.1.3.44 Portable Tank. See 3.3.268.4.

63.1.3.45 Pressure Vessel. See 3.3.213.

63.1.3.46 Short-Term Exposure Limit (STEL). See 3.3.167.3.

63.1.3.47 Stationary Tank. See 3.3.268.6.

63.1.3.48 TC. See 3.3.271,

63.1.3.49 Treatment System. See 3.3.267.14.

63.1.3.50 Tube Trailer. See 3.3.275.

63.1.3.51 Valve Outlet Cap or Plug. See 3.3.282.3

63.1.3.52 Valve Protection Cap. See 3.3.282.4.

63.1.3.53 Valve Protection Device. See 3.3.282.5.

63.1.4 Hazardous Materials Classification.

Hazard classification of compressed gases is a critical decision, because the safety requirements are based on the material classification and the amount of material being stored.

Not all hazardous materials are placed into the high hazard category, and some of these materials have been recognized as being of low ordinary hazard, depending on their nature in a fire. Inert compressed gases and cryogenic fluids are two examples; there are others. Compressed gases and cryogenic fluids represent the gas phase of an array of hazardous materials. As the genre of hazardous materials is expanded, there are other materials in hazard categories or hazard classes that may in fact be high hazard materials by definition, but which in some cases do not have an MAQ and, therefore, are not required to comply with the requirements for high hazard occupancies. Examples of such materials are Class IIIB combustible liquids, Class 1 unstable reactive materials (including gases), Class 1 water-reactive solids and liquids, Class 1, 2, and 3 water-reactive gases, Class 1 oxidizing solids and liquids, and Class IV and V organic peroxides.

Δ **63.1.4.1* Pure Gases.** Hazardous materials shall be classified according to hazard categories as follows:

(1) Physical hazards, which shall include the following:
   (a) Flammable gas
   (b) Flammable cryogenic fluid
   (c) Oxidizing gas
   (d) Oxidizing cryogenic fluid
   (e) Pyrophoric gas
   (f) Unstable reactive (detonable) gas, Class 3 or Class 4
   (g) Unstable reactive (nondetonable) gas, Class 3
   (h) Unstable reactive gas, Class 1 or Class 2
(2) Health hazards, which shall include the following:
   (a) Corrosive gas
   (b) Cryogenic fluids
   (c) Highly toxic gas
   (d) Toxic gas

[**55:**5.1.1]

N **A.63.1.4.1** Not all hazardous materials are placed into the high hazard category, and some of these materials have been recognized as being of low ordinary hazard, depending on their nature in a fire. Inert compressed gases and cryogenic fluids are one example; there are others. Compressed gases and cryogenic fluids represent the gas phase of an array of hazardous materials. As the genre of hazardous materials is expanded, there are other materials in hazard categories or hazard classes that may in fact be high hazard materials by definition, but which in some cases do not have a MAQ and, therefore, are not required to comply with the requirements for high hazard occupancies. Examples of such materials are Class IIIB combustible liquids, Class 1 unstable reactive materials (including gases), Class 1 water-reactive solids and liquids, Class 1-3 water-reactive gases, Class 1 oxidizing solids and liquids, and Class IV and V organic peroxides. [**55:**A.5.1.1]

63.1.4.2 Other Hazards. Although it is possible that there are other known hazards, the classification of such gases is not within the scope of Chapter 63 and they shall be handled, stored, or used as an *other gas*. [**55:**5.1.2]

63.1.4.3 Mixtures. Mixtures shall be classified in accordance with the hazards of the mixture as a whole. [**55:**5.1.3]

63.1.4.4 Responsibility for Classification. Classification shall be performed by an approved organization, individual, or testing laboratory. [**55:**5.1.4]

63.1.4.4.1 Toxicity. The toxicity of gas mixtures shall be classified in accordance with CGA P-20, *Standard for the Classification of Toxic Gas Mixtures,* or by testing in accordance with the requirements of 29 CFR 1910.1000, DOT 49 CFR 173, or ISO 10298, *Determination of toxicity of a gas or gas mixture*. [**55:**5.1.4.1]

63.1.4.4.2 Flammability of Gas Mixtures. For gas mixtures other than those containing ammonia and nonflammable gases, flammability of gas mixtures shall be classified in accordance with CGA P-23, *Standard for Categorizing Gas Mixtures Containing Flammable and Nonflammable Components,* or by physical testing in accordance with the requirements of ASTM E681, *Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases),* or ISO 10156, *Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets*. [**55:**5.1.4.2]

63.2 Building-Related Controls

63.2.1 General.

63.2.1.1 Occupancy.

63.2.1.1.1 Occupancy Requirements. Occupancies containing compressed gases and cryogenic fluids shall comply with Section 63.2 in addition to other applicable requirements of NFPA 55. [**55:**6.1.1.1]

63.2.1.1.2 Occupancy Classification. The occupancy of a building or structure, or portion of a building or structure, shall be classified in accordance with the building code. [**55:**6.1.1.2]

63.2.2 Control Areas.

Δ **63.2.2.1 Construction Requirements.** Control areas shall be separated from each other by fire barriers in accordance with Table 63.2.2.1 [**55:**6.2.1]

Δ **63.2.2.2 Number of Control Areas.** The maximum number of control areas within a building shall be in accordance with Table 63.2.2.1. [**400:**5.2.2.1]

Δ **63.2.2.3** Where only one control area is present in a building, no special construction provisions shall be required. [**400:**5.2.2.2]

63.2.2.4 Quantities Less Than or Equal to the MAQ. Indoor control areas with compressed gases or cryogenic fluids stored or used in quantities less than or equal to those shown in Table 63.2.3.1.1 shall be in accordance with 63.2.1, 63.2.3.1.6, 63.2.3.1.7, 63.2.7, 63.2.8, 63.2.12, 63.2.15, 63.2.16, and the applicable provisions of Chapters 1 through 5 and Chapters 7 through 16 of NFPA 55. [**55:**6.2.4]

63.2.3 Occupancy Protection Levels.

63.2.3.1 Quantity Thresholds for Compressed Gases and Cryogenic Fluids Requiring Special Provisions.

Δ **63.2.3.1.1 Threshold Exceedences.** Where the quantities of compressed gases or cryogenic fluids stored or used within an indoor control area exceed those shown in Table 63.2.3.1.1, the area shall meet the requirements for Protection Levels 1 through 5 in accordance with the building code, based on the requirements of 63.2.3.2. [**55:**6.3.1.1]

Several concepts are important for the user to understand when using Table 63.2.3.1.1. First, the quantities shown in the table are those beneath which no requirements for specific protection levels apply. Therefore, to use the table, the protection level for the materials(s) being stored must be determined. Second, the amounts shown are the quantities per control area, not amounts for the entire facility or building. The provision establishes when the requirements for protection levels are to be applied. Reference to 63.2.3.2 is made in 63.2.3.1.1 in order to determine the specifics regarding the various protection levels.

The listing in the table for nonflammable gas was removed for the 2010 edition of NFPA 55, because it was not a regulatory hazard classification and was replaced by a new row for inert gas to clarify that MAQs are not applicable to gases that are considered to be nonreactive, noncorrosive, or nonflammable. Although there is no limitation on the amount being stored, other requirements still apply to inert gases as a class that must be distinguished from hazardous gases. The change also seeks to clarify circumstances where nonflammable gas — a term that can be used to define oxygen — might have been used in place of an inert agent and created an unintended level of risk.

63.2.3.1.2 Quantities Greater Than the MAQ. Building-related controls in areas with compressed gases or cryogenic fluids stored or used within an indoor area in quantities greater than those shown in Table 63.2.3.1.1 shall be in accordance with the requirements of Section 63.2. [**55:**6.3.1.2]

Δ ***TABLE 63.2.2.1*** *Design and Number of Control Areas*

Floor Level	Maximum Allowable Quantity per Control Area (%)*	Number of Control Areas per Floor	Fire Resistance Rating for Fire Barriers+ (hr)
Above grade			
>9	5.0	1	2
7–9	5.0	2	2
4–6	12.5	2	2
3	50	2	1
2	75	3	1
1	100	4	1
Below grade			
1	75	3	1
2	50	2	1
Lower than 2	NP	NP	N/A

NP: Not Permitted.

N/A: Not Applicable.

*Percentages represent the MAQ per control area shown in Table 60.4.2.1.1.3, with all of the increases permitted in the footnotes of that table.

+Fire barriers are required to include floors and walls, as necessary, to provide a complete separation from other control areas.

[**400:**Table 5.2.2.1]

Δ ***TABLE 63.2.3.1.1*** *Maximum Allowable Quantity (MAQ) of Hazardous Materials per Control Area*

Material	Class	High Hazard Protection Level	Storage			Use — Closed Systems			Use — Open Systems	
			Solid Pounds	Liquid Gallons	Gas[a] scf (lb)	Solid Pounds	Liquid Gallons	Gas[a] scf (lb)	Solid Pounds	Liquid Gallons
Cryogenic fluid	Flammable	2	NA	45[b,c]	NA	NA	45[b,c]	NA	NA	45[b,c]
	Oxidizing	3	NA	45[d,e]	NA	NA	45[d,e]	NA	NA	45[d,e]
	Inert	NA	NA	NL	NA	NA	NL	NA	NA	NL
Flammable, gas[f]	Gaseous	2	NA	NA	1000[d,e]	NA	NA	1000[d,e]	NA	NA
	Liquefied	2	NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
	LP	2	NA	NA	(300)[g,h,i]	NA	NA	(300)[g]	NA	NA
Inert gas	Gaseous	NA	NA	NA	NL	NA	NA	NL	NA	NA
	Liquefied	NA	NA	NA	NL	NA	NA	NL	NA	NA
Oxidizing gas	Gaseous	3	NA	NA	1500[d,e]	NA	NA	1500[d,e]	NA	NA
	Liquefied	3	NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
Pyrophoric gas	Gaseous	2	NA	NA	50[d,j]	NA	NA	50[d,j]	NA	NA
	Liquefied	2	NA	NA	(4)[d,j]	NA	NA	(4)[d,j]	NA	NA
Unstable (reactive) gas	Gaseous									
	4 or 3 detonable	1	NA	NA	10[d,j]	NA	NA	10[d,j]	NA	NA
	3 nondetonable	2	NA	NA	50[d,e]	NA	NA	50[d,e]	NA	NA
	2	3	NA	NA	750[d,e]	NA	NA	750[d,e]	NA	NA
	1	NA	NA	NA	NL	NA	NA	NL	NA	NA
Unstable (reactive) gas	Liquefied									
	4 or 3 detonable	1	NA	NA	(1)[d,j]	NA	NA	(1)[d,j]	NA	NA
	3 nondetonable	2	NA	NA	(2)[d,e]	NA	NA	(2)[d,e]	NA	NA
	2	3	NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
	1	NA	NA	NA	NL	NA	NA	NL	NA	NA
Corrosive gas	Gaseous	4	NA	NA	810[d,e]	NA	NA	810[d,e]	NA	NA
	Liquefied		NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
Highly toxic gas	Gaseous	4	NA	NA	20[e,k]	NA	NA	20[e,k]	NA	NA
	Liquefied		NA	NA	(4)[e,k]	NA	NA	(4)[e,k]	NA	NA
Toxic gas	Gaseous	4	NA	NA	810[d,e]	NA	NA	810[d,e]	NA	NA
	Liquefied		NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA

NA: Not applicable within the context of NFPA 55 (refer to the applicable building or fire code for additional information on these materials).

NL: Not limited in quantity.

Notes:

(1) For use of control areas, see Section 6.2 of NFPA 55.

(2) Table values in parentheses or brackets correspond to the unit name in parentheses or brackets at the top of the column.

(3) The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in the building code.

[a]Measured at NTP [70°F (20°C) and 14.7 psi (101.3 kPa)].

[b]None allowed in unsprinklered buildings unless stored or used in gas rooms or in approved gas cabinets or exhausted enclosures, as specified in this code.

[c]With pressure-relief devices for stationary or portable containers vented directly outdoors or to an exhaust hood.

[d]Quantities are permitted to be increased 100 percent where stored or used in approved cabinets, gas cabinets, exhausted enclosures, gas rooms, as appropriate for the material stored. Where Footnote e also applies, the increase for the quantities in both footnotes is permitted to be applied accumulatively.

[e]Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*. Where Footnote d also applies, the increase for the quantities in both footnotes is permitted to be applied accumulatively.

[f]Flammable gases in the fuel tanks of mobile equipment or vehicles are permitted to exceed the MAQ where the equipment is stored and operated in accordance with the applicable fire code.

[g]See NFPA 58, *Liquefied Petroleum Gas Code*, and Chapter 69 for requirements for liquefied petroleum gas (LP-Gas). LP-Gas is not within the scope of NFPA 55 or Chapter 63.

[h]Additional storage locations are required to be separated by a minimum of 300 ft (92 m).

[i]In mercantile occupancies, storage of LP-Gas is limited to a maximum of 200 lb (91 kg) in nominal 1 lb (0.45 kg) LP-Gas containers.

[j]Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

[k]Allowed only where stored or used in gas rooms or in approved gas cabinets or exhausted enclosures, as specified in this code.

[**55:**Table 6.3.1.1]

63.2.3.1.3 Aggregate Allowable Quantities. The aggregate quantity in use and storage shall not exceed the quantity listed for storage. [**55:**6.3.1.3]

63.2.3.1.4 Incompatible Materials. When the classification of materials in individual containers requires the area to be placed in more than one protection level, the separation of protection levels shall not be required, provided the area is constructed to meet the requirements of the most restrictive protection level and that the incompatible materials are separated as required by 63.3.1.11.2. [**55:**6.3.1.4]

63.2.3.1.5 Multiple Hazards. Where a compressed gas or cryogenic fluid has multiple hazards, all hazards shall be addressed and controlled in accordance with the provisions for the protection level for which the threshold quantity is exceeded. [**55:**6.3.1.5]

63.2.3.1.6 Flammable and Oxidizing Gases.

63.2.3.1.6.1 Flammable and oxidizing gases shall not be stored or used in other than industrial and storage occupancies. [**55:**6.3.1.6.1]

63.2.3.1.6.2 Cylinders, containers, or tanks not exceeding 250 scf (7.1 Nm^3) content at normal temperature and pressure (NTP) and used for maintenance purposes, patient care, or operation of equipment shall be permitted. [**55:**6.3.1.6.2]

The provision of 63.2.3.1.6.2 applies to all compressed gases; as specified in the language, all cylinders, containers, and tanks are size restricted unless they are dedicated to the uses indicated.

Δ **63.2.3.1.7 Toxic and Highly Toxic Compressed Gases.** Except for containers or cylinders not exceeding 20 scf (0.6 Nm^3) content at NTP stored or used within gas cabinets or exhausted enclosures of educational occupancies, toxic or highly toxic compressed gases shall not be stored or used in other than industrial and storage occupancies. [**55:**6.3.1.7]

63.2.3.2 Classification of Protection Levels. The protection level required shall be based on the hazard class of the material involved as indicated in 63.2.3.2.1 through 63.2.3.2.5. [**55:**6.3.2]

63.2.3.2.1 Protection Level 1. Occupancies used for the storage or use of unstable reactive Class 4 and unstable reactive Class 3 detonable compressed gases in quantities that exceed the quantity thresholds for gases requiring special provisions shall be classified Protection Level 1. [**55:**6.3.2.1]

63.2.3.2.2 Protection Level 2. Occupancies used for the storage or use of flammable, pyrophoric, and nondetonable, unstable reactive Class 3 compressed gases or cryogenic fluids in quantities that exceed the quantity thresholds for gases requiring special provisions shall be classified as Protection Level 2. [**55:**6.3.2.2]

63.2.3.2.3 Protection Level 3. Occupancies used for the storage or use of oxidizing and unstable reactive Class 2 compressed gases or cryogenic fluids in quantities that exceed the quantity thresholds for gases requiring special provisions shall be classified as Protection Level 3. [**55:**6.3.2.3]

For both Protection Level 2 and Protection Level 3 (63.2.3.2.2 and 63.2.3.2.3), Table 63.2.3.1.1 establishes the quantity thresholds for cryogenic fluids as well as compressed gases. The requirements for protection levels apply to certain cryogenic fluids as well as compressed gases.

63.2.3.2.4 Protection Level 4. Occupancies used for the storage or use of toxic, highly toxic, and corrosive compressed gases in quantities that exceed the quantity thresholds for gases requiring special provisions shall be classified as Protection Level 4. [**55:**6.3.2.4]

63.2.3.2.5 Protection Level 5. Buildings and portions thereof used for fabrication of semiconductors or semiconductor research and development and containing quantities of hazardous materials exceeding the maximum allowable quantities of high hazard level 5 contents permitted in control areas shall be classified as Protection Level 5. [**55:**6.3.2.5]

63.2.4 Gas Rooms. Where a gas room is used to increase the threshold quantity for a gas requiring special provisions or where otherwise required by the material- or application-specific requirements of Chapters 7 through 16 of NFPA 55, the room shall meet the requirements of 63.2.4.1 through 63.2.4.5. [**55:**6.4]

63.2.4.1 Pressure Control. Gas rooms shall operate at a negative pressure in relationship to the surrounding area. [**55:**6.4.1]

63.2.4.2 Exhaust Ventilation. Gas rooms shall be provided with an exhaust ventilation system. [**55:**6.4.2]

63.2.4.3 Construction. Gas rooms shall be constructed in accordance with the building code. [**55:**6.4.3]

63.2.4.4 Separation. Gas rooms shall be separated from other occupancies by a minimum of 1-hour fire resistance. [**55:**6.4.4]

63.2.4.5 Limitation on Contents. The function of compressed gas rooms shall be limited to storage and use of compressed gases and associated equipment and supplies. [**55:**6.4.5]

63.2.5* Detached Buildings. Occupancies used for the storage or use of compressed gases, including individual bulk hydrogen compressed gas systems in quantities exceeding those specified in Table 63.2.5, shall be in detached buildings constructed in accordance with the provisions of the building code. [**55:**6.5]

TABLE 63.2.5 *Detached Buildings Required Where Quantity of Material Exceeds Amount Shown*

Gas Hazard	Class	Quantity of Material: scf	Quantity of Material: Nm^3
Individual bulk hydrogen compressed gas systems	NA	15,000	425
Unstable reactive (detonable)	4 or 3	Quantity thresholds for gases requiring special provisions*	
Unstable reactive (nondetonable)	3	2,000	57
Unstable reactive (nondetonable)	2	10,000	283
Pyrophoric gas	NA	2,000	57

NA: Not applicable.

*See Table 63.2.3.1.1

[**55:** Table 6.5]

N **A.63.2.5** Bulk hydrogen compressed gas systems terminate at the source valve. In cylinder filling or packaging operations, cylinders located on filling manifolds located downstream of the source valve are not considered to be part of the bulk gas system. For definitions of source valve and bulk hydrogen compressed gas system, see 3.3.89 and 3.3.94.9.1 [of NFPA 55]. Additional requirements for source valves can be found in 63.2.19. [**55:**A.6.5]

63.2.6 Weather Protection.

Buildings or structures used for weather protection may or may not be independent detached structures. For example, the typical cylinder dock may abut a building used for the production or storage of compressed gas. It is part of the building that is sheltered by overhead cover but is considered as outdoor storage in order to provide relief from requirements such as mechanical ventilation, explosion control, and sprinkler systems in some cases. In order to "earn" the exemption, the area must be maintained substantially open to the surrounds. Some building codes allow for this dispensation, providing the weather-protected area is limited in size and of noncombustible construction. Allowances are made for area increase based on comparable areas of any building, including the use of sprinkler systems (when otherwise not required) and street frontage based on fire separation distance. To determine the allowable area increases, the construction type and occupancy of the sheltered area must first be determined.

Weather protection cannot be obstructed by enclosing it with perimeter walls that substantially block the free movement of air and accessibility. On the other hand, limited obstructions within a given set of prescriptive controls are acceptable. For example, a cylinder dock on the exterior of the building is allowed to abut the exterior building wall, providing the three remaining walls are open to the exterior. The provisions also allow for the obstruction of multiple walls, providing the total area of the perimeter walls that are obstructed does not exceed 25 percent of the total open perimeter area. To determine this mathematically, the designer would calculate the aggregate perimeter area of all open sides of the building or structure used for weather protection and then demonstrate that obstructed areas (covered by abutting buildings or partial walls) do not exceed 25 percent of the aggregate area.

63.2.6.1 For other than explosive materials and hazardous materials presenting a detonation hazard, a weather protection structure shall be permitted to be used for sheltering outdoor storage or use areas, without requiring such areas to be classified as indoor storage or use. [**55:**6.6.1]

63.2.6.2 Weather protected areas constructed in accordance with 63.2.6.4 shall be regulated as outdoor storage or use. [**55:**6.6.2]

63.2.6.3 Weather protected areas that are not constructed in accordance with 63.2.6.4 shall be regulated as indoor storage or use. [**55:**6.6.2.1]

63.2.6.4 Buildings or structures used for weather protection shall be in accordance with the following:

(1) The building or structure shall be constructed of noncombustible materials.
(2) Walls shall not obstruct more than one side of the structure.
(3) Walls shall be permitted to obstruct portions of multiple sides of the structure, provided that the obstructed area does not exceed 25 percent of the structure's perimeter area.
(4) The building or structure shall be limited to a maximum area of 1500 ft^2 (140 m^2), with increases in area allowed by the building code based on occupancy and type of construction.
(5) The distance from the structure constructed as weather protection to buildings, lot lines, public ways, or means of egress to a public way shall not be less than the distance required for an outside hazardous material storage or use area without weather protection based on the hazard classification of the materials contained.
(6) Reductions in separation distance shall be permitted based on the use of fire barrier walls where permitted for specific materials in accordance with the requirements of Chapters 7 through 11 of NFPA 55.

[**55:**6.6.3]

63.2.7* Electrical Equipment. Electrical wiring and equipment shall be in accordance with this subsection and *NFPA 70*. [**55:**6.7]

Δ **A.63.2.7** Electrical and electronic equipment and wiring for use in hazardous locations as defined in Article 500 of *NFPA 70* should meet the requirements of Articles 500 and 501 of *NFPA 70*. Note that Article 505 also details requirements for this equipment and wiring in hazardous locations and uses a zone classification method rather than the division method of Article 500. [**55:**A.6.7]

63.2.7.1 Standby Power.

63.2.7.1.1 Where the following systems are required by NFPA 55 for the storage or use of compressed gases or cryogenic fluids that exceed the quantity thresholds for gases requiring special provisions, such systems shall be connected to a standby power system in accordance with *NFPA 70*:

(1) Mechanical ventilation
(2) Treatment systems
(3) Temperature controls
(4) Alarms
(5) Detection systems
(6) Other electrically operated systems

[**55:**6.7.1.1]

63.2.7.1.2 The requirements of 63.2.7.1.1 shall not apply where emergency power is provided in accordance with 63.2.7.2 and *NFPA 70*. [**55:**6.7.1.2]

Δ **63.2.7.2 Emergency Power.** When emergency power is required, the system shall meet the requirements for a Level 2 system in accordance with NFPA 110. [**55:**6.7.2]

63.2.8* Employee Alarm System. Where required by government regulations, an employee alarm system shall be provided to allow warning for necessary emergency action as called for in the emergency action plan required by 4.2.1.1 of NFPA 55, or for reaction time for safe egress of employees from the workplace or the immediate work area, or both. [**55:**6.8]

A.63.2.8 Under the requirements of 29 CFR 1910.38 established by OSHA regulations, employers must establish an employee alarm system that complies with 29 CFR 1910.165. The requirements of 29 CFR 1910.165 for the employee alarm system include, but are not limited to, systems that are capable of being perceived above ambient noise or light levels by all employees in the affected portions of the workplace. Tactile devices may be used to alert those employees who would not otherwise be able to recognize the audible or visual alarm. The alarm system can be electrically powered or powered by pneumatic or other means. State, local, or other governmental regulations might also establish requirements for employee alarm systems. [**55:**A.6.8]

Δ **63.2.9 Explosion Control.** Explosion control shall be provided as required by Table 63.2.9 in accordance with NFPA 68 or NFPA 69 where amounts of compressed gases in storage or use exceed the quantity thresholds requiring special provisions. [**55:**6.9]

Explosion control is generally triggered when quantities of gas exceed MAQ limits. Once the potential for explosion hazard has been determined, a means of explosion control should be provided, regardless of the quantities involved.

63.2.10* Fire Protection Systems. Except as provided in 63.2.10.1, buildings or portions thereof required to comply with Protection Levels 1 through 5 shall be protected by an approved automatic fire sprinkler system complying with Section 13.3 and NFPA 13. [**55:**6.10]

Δ ***TABLE 63.2.9*** *Explosion Control Requirements*

Material	Class	Explosion Control Methods: Barricade Construction	Explosion Control Methods: Explosion Venting or Prevention Systems
Flammable cryogenic fluid	—	Not required	Required
Flammable gas	Nonliquefied	Not required	Required
	Liquefied	Not required	Required
Pyrophoric gas	—	Not required	Required
Unstable reactive gas	4	Required	Not required
	3 (detonable)	Required	Not required
	3 (nondetonable)	Not required	Required

[**55:** Table 6.9]

A.63.2.10 The intent of this section is to require a water-based fire extinguishing system to keep vessels containing compressed gases cool in the event of an exposure fire, thereby minimizing the likelihood of a release and associated consequences. Accordingly, alternative fire extinguishing systems, such as dry-chemical or gaseous agent systems, should not be substituted. [**55:**A.6.10]

63.2.10.1 Rooms or areas that are of noncombustible construction with wholly noncombustible contents shall not be required to be protected by an automatic fire sprinkler system. [**55:**6.10.1]

63.2.10.2 Sprinkler System Design.

63.2.10.2.1 Where sprinkler protection is required, the area in which compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by 11.2.3.1.1 of NFPA 13 for the Ordinary Hazard Group 2 density/area curve. [**55:**6.10.2.1]

63.2.10.2.2 When sprinkler protection is required, the area in which the flammable or pyrophoric compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by 11.2.3.1.1 of NFPA 13 for the Extra Hazard Group 1 density/area curve. [**55:**6.10.2.2]

63.2.11 Lighting. Approved lighting by natural or artificial means shall be provided for areas of storage or use. [**55:**6.11]

63.2.12 Hazard Identification Signs.

Δ **63.2.12.1 Location.** Hazard identification signs shall be placed at all entrances to locations where compressed gases are produced, stored, used, or handled in accordance with NFPA 704. [**55:**6.12.1]

63.2.12.1.1 Ratings shall be assigned in accordance with NFPA 704. [**55:**6.12.1.1]

• **63.2.12.1.2** The AHJ shall be permitted to waive 63.2.12.1 where consistent with safety. [**55:**6.12.1.2]

63.2.12.2 Application. Signage shall be provided as specified in 63.2.12.2.1 and 63.2.12.2.2. [**55:**6.12.2]

63.2.12.2.1 Signs. Signs shall not be obscured or removed. [**55:**6.12.2.1]

63.2.12.2.2 No Smoking. Signs prohibiting smoking or open flames within 25 ft (7.6 m) of area perimeters shall be provided in areas where toxic, highly toxic, corrosive, unstable reactive, flammable, oxidizing, or pyrophoric gases are produced, stored, or used. [**55:**6.12.2.2]

See Section 10.9 for smoking prohibitions.

63.2.13 Spill Control, Drainage, and Secondary Containment. Spill control, drainage, and secondary containment shall not be required for compressed gases. [**55:**6.13]

63.2.14 Shelving.

63.2.14.1 Shelves used for the storage of cylinders, containers, and tanks shall be of noncombustible construction and designed to support the weight of the materials stored. [**55:**6.14.1]

Compressed gases can be contained in cylinders, containers, and tanks, all of which can be stored on shelves. The provision clearly describes all the container types, thus eliminating any confusion.

63.2.14.2 In seismically active areas, shelves and containers shall be secured from overturning. [**55:**6.14.2]

63.2.15 Vent Pipe Termination. The termination point for piped vent systems serving cylinders, containers, tanks, and gas systems used for the purpose of operational or emergency venting shall be located to prevent impingement exposure on the system served and to minimize the effects of high temperature thermal radiation or the effects of contact with the gas from the escaping plume to the supply system, personnel, adjacent structures, and ignition sources. [**55:**6.15]

63.2.16 Ventilation. Indoor storage and use areas and storage buildings for compressed gases and cryogenic fluids shall be provided with mechanical exhaust ventilation or fixed natural ventilation, where natural ventilation is shown to be acceptable for the material as stored. [**55:**6.16]

Fixed natural ventilation is defined in NFPA 55 as the movement of air into and out of a space through permanent openings that are arranged in such a way that the required ventilation cannot be reduced by operating windows, doors, louvers, or similar devices. The concept of fixed natural ventilation was established in NFPA 51A, *Standard for Acetylene Cylinder Charging Plants,* which was integrated into the 2013 edition of NFPA 55. The revisions to 63.2.16 reflect those changes made to NFPA 55 to incorporate the ventilation concepts from NFPA 51A. The use of 1 scf/min/ft^2 (0.3048 Nm^3/min/m^2) has become the national norm for ventilation systems where hazardous materials are involved.

63.2.16.1 Compressed Air. The requirements of 63.2.16 shall not apply to cylinders, containers, and tanks containing compressed air. [**55:**6.16.1]

63.2.16.2 Ventilation Systems. In addition to the requirements of 63.2.16, ventilation systems shall be designed and installed in accordance with the requirements of the mechanical code. [**55:**6.16.2]

63.2.16.3 Mechanical Exhaust Ventilation. Where mechanical exhaust ventilation is provided, the system shall be operational during the time the building or space is occupied. [**55:**6.16.3]

63.2.16.4 Continuous Operation. When operation of ventilation systems is required, systems shall operate continuously unless an alternative design is approved by the AHJ. [**55:**6.16.3.1]

63.2.16.5 Ventilation Rate Mechanical exhaust or fixed natural ventilation shall be provided at a rate of not less than 1 scf/min/ft^2 (0.3048 Nm^3/min/m^2) of floor area over the area of storage or use. [**55:**6.16.3.2]

The ventilation rate should provide sufficient dilution to keep the concentration of any gas that is leaked into the space well below the concentration threshold at which the gas would have some physiological effect or present a fire or explosion hazard. See 63.3.6 for additional information on reducing fire and explosion hazards resulting from flammable gas leakage in buildings.

63.2.16.6 Shutoff Controls. Where powered ventilation is provided, a manual shutoff switch shall be provided outside the room in a position adjacent to the principal access door to the room or in an approved location. [**55:**6.16.3.3]

63.2.16.7 Manual Shutoff Switch. The switch shall be the break-glass or equivalent type and shall be labeled as follows:

WARNING:
VENTILATION SYSTEM EMERGENCY
SHUTOFF

[**55:**6.16.3.3.1]

63.2.16.8 Inlets to the Exhaust System.

63.2.16.8.1 The exhaust ventilation system design shall take into account the density of the potential gases released. [**55:**6.16.4.1]

63.2.16.8.2* For gases that are heavier than air, exhaust shall be taken from a point within 12 in. (305 mm) of the floor. The use of supplemental inlets shall be allowed to be installed at points above the 12 in. (305 mm) threshold level. [**55:**6.16.4.2]

N **A.63.2.16.8.2** Examples of gases that are heavier than air include, but are not limited to, carbon dioxide, argon, and nitrous oxide. [**55:**A.6.16.4.2]

N **63.2.16.8.3*** For gases that are lighter than air, exhaust shall be taken from a point within 12 in. (305 mm) of the ceiling. The use of supplemental inlets shall be allowed to be installed at points below the 12 in. (305 mm) threshold level. [**55:**6.16.4.3]

When gases that are lighter than air are involved, a high point pickup is normally placed as high in the room as possible. A maximum distance from the ceiling plane was also established in conjunction with the height now established at floor level for continuity.

N **A.63.2.16.8.3** Examples of gases that are lighter than air include, but are not limited to, hydrogen, helium, and methane. [**55:**A.6.16.4.3]

63.2.16.8.4 The location of both the exhaust and inlet air openings shall be designed to provide air movement across all portions of the floor or ceiling of the room to prevent the accumulation of vapors within the ventilated space. [**55:**6.16.4.4]

Δ **63.2.16.9 Recirculation of Exhaust.** Exhaust ventilation shall not be recirculated. [**55:**6.16.5]

Most interior spaces of rooms or buildings have obstructions that prevent complete mixing of recirculated air, so it is important not to recirculate air containing toxic materials. Because complete mixing of recirculated air is unlikely due to the patterns of air circulation, toxic materials can accumulate in areas of the room.

63.2.16.10 Ventilation Discharge. Ventilation discharge systems shall terminate at a point not less than 50 ft (15 m) from intakes of air-handling systems, air-conditioning equipment, and air compressors. [**55:**6.16.6]

This is to prevent air that may contain toxic or flammable materials from being introduced back into a building, where it could pose a hazard to personnel.

63.2.16.11 Air Intakes. Storage and use of compressed gases shall be located not less than 50 ft (15 m) from air intakes. For material-specific requirements, see 63.3.4 through 63.3.10. [**55:**6.16.7]

63.2.17 Gas Cabinets. Where a gas cabinet is required, is used to provide separation of gas hazards, or is used to increase the threshold quantity for a gas requiring special provisions, the gas cabinet shall be in accordance with the requirements of 63.2.17.1 through 63.2.17.5. [**55:**6.17]

63.2.17.1 Construction.

63.2.17.1.1 Materials of Construction. The gas cabinet shall be constructed of not less than 0.097 in. (2.46 mm) (12 gauge) steel. [**55:**6.17.1.1]

63.2.17.1.2 Access to Controls. The gas cabinet shall be provided with self-closing limited access ports or noncombustible windows to give access to equipment controls. [**55:**6.17.1.2]

63.2.17.1.3 Self-Closing Doors. The gas cabinet shall be provided with self-closing doors. [**55:**6.17.1.3]

63.2.17.2 Ventilation Requirements.

63.2.17.2.1 The gas cabinet shall be provided with an exhaust ventilation system designed to operate at a negative pressure relative to the surrounding area. [**55:**6.17.2.1]

This is to prevent, in case of a release, gas from being released into the surrounding area. Any release would be directed through the ventilation system discharge.

63.2.17.2.2 Where toxic, highly toxic, pyrophoric, unstable reactive Class 3 or Class 4, or corrosive gases are contained, the velocity at the face of access ports or windows, with the access port or window open, shall not be less than 200 ft/min (61 · m/min) average, with not less than 150 ft/min (46 m/min) at any single point. [**55:**6.17.2.2]

63.2.17.3 Fire Protection. Gas cabinets used to contain toxic, highly toxic, or pyrophoric gases shall be internally sprinklered. [**55:**6.17.3]

63.2.17.4 Quantity Limits. Gas cabinets shall contain not more than three cylinders, containers, or tanks. [**55:**6.17.4]

63.2.17.5 Separation of Incompatibles. Incompatible gases, as defined by Table 63.3.1.11.2, shall be stored or used within separate gas cabinets. [**55:**6.17.5]

63.2.18 Exhausted Enclosures.

63.2.18.1 Ventilation Requirements. Where an exhausted enclosure is required or used to increase the threshold quantity for a gas requiring special provisions, the exhausted enclosure shall be provided with an exhaust ventilation system designed to operate at a negative pressure in relationship to the surrounding area. [**55:**6.18.1]

The provision in 63.2.18.1 requiring negative pressure is intended to prevent any leaks in the system from releasing gas into the room.

63.2.18.1.1 Control Velocity at Access Openings. Where toxic, highly toxic, pyrophoric, unstable reactive Class 3 or Class 4, or corrosive gases are contained, the velocity at the face openings providing access shall be not less than 200 ft/min (61 m/min) average, with not less than 150 ft/min (46 m/min) at any single point. [**55:**6.18.1.1]

63.2.18.1.2 Separation of Incompatible Gases Within Enclosures. Cylinders, containers, and tanks within enclosures shall be separated in accordance with Table 63.3.1.11.2. [**55:**6.18.1.2]

63.2.18.1.3 Fire Protection. Exhausted enclosures shall be internally sprinklered. [**55:**6.18.1.3]

63.2.18.2 Separation. Incompatible gases, as defined by Table 63.3.1.11.2, shall be stored or used within separate exhausted enclosures. [**55:**6.18.2]

63.2.19* Source Valve. Bulk gas systems shall be provided with a source valve. [**55:**6.19]

A.63.2.19 Figure A.63.2.19 shows three possible locations of the source valve. [**55:**A.6.19]

• **63.2.19.1** The source valve shall be marked. [**55:**6.19.1]

63.2.19.2 The source valve shall be designated on the design drawings for the installation. [**55:**6.19.2]

63.3 Compressed Gases

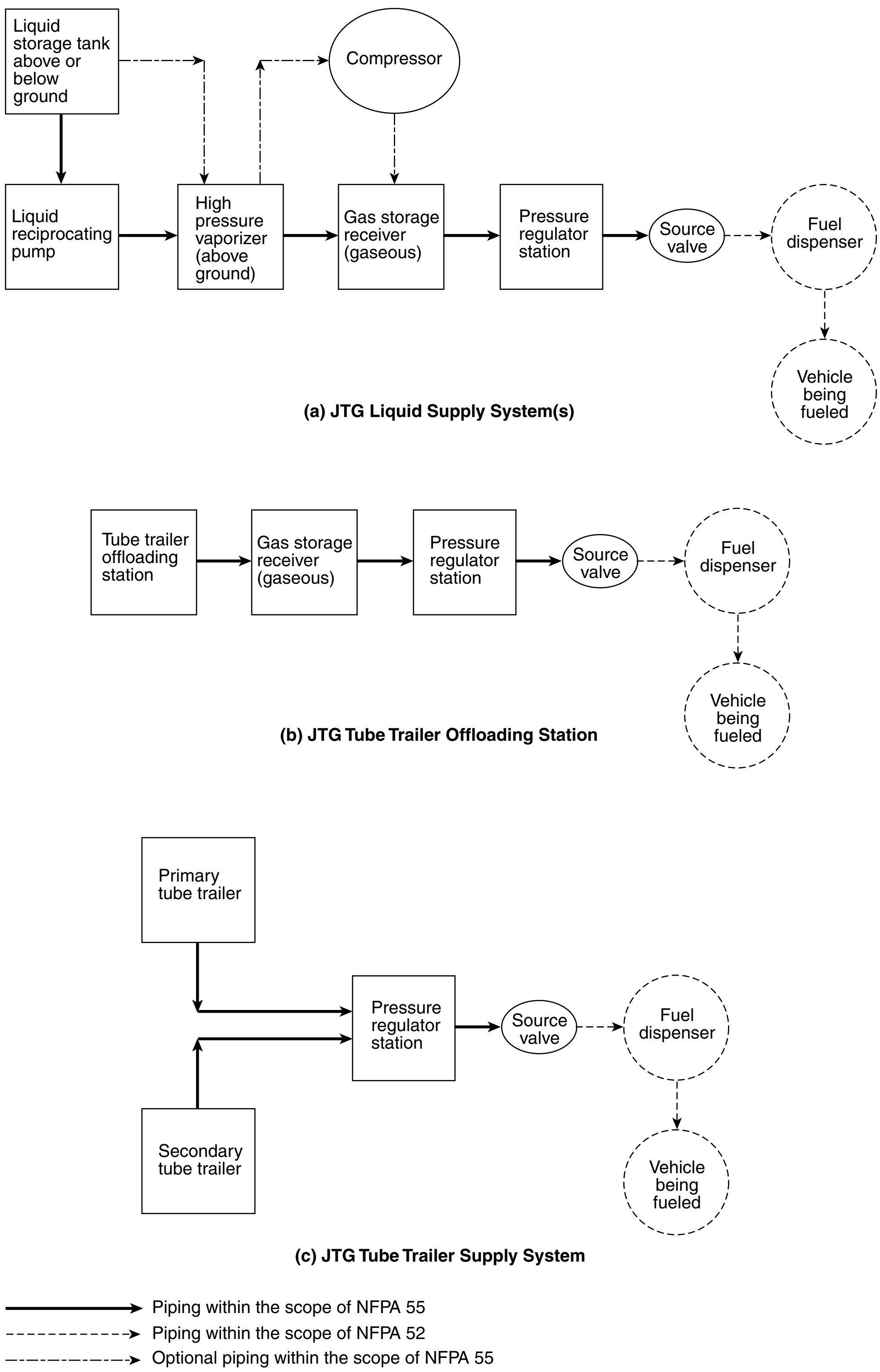
Δ **63.3.1 General.** The storage, use, and handling of compressed gases in cylinders, containers, and tanks shall be in accordance with the provisions of Chapters 1 through 7 of NFPA 55. [**55:**7.1]

63.3.1.1 Compressed Gas Systems.

63.3.1.1.1 Design. Compressed gas systems shall be designed for the intended use and shall be designed by persons competent in such design. [**55:**7.1.2.1]

63.3.1.1.2 Installation. Installation of bulk compressed gas systems shall be supervised by personnel knowledgeable in the application of the standards for their construction and use. [**55:**7.1.2.2]

63.3.1.2 Insulated Liquid Carbon Dioxide Systems. Insulated liquid carbon dioxide systems shall be in accordance with Chapter 13 of NFPA 55. [**55:**7.1.3]



Δ ***FIGURE A.63.2.19*** *Three Examples of Source Valve Locations. [**55:** Figure A.6.19]*

63.3.1.3 Insulated Liquid Nitrous Oxide Systems. (Reserved)

63.3.1.4* Listed or Approved Hydrogen Equipment.

A.63.3.1.4 The compressed gas system equipment referenced is intended to include fuel cell applications, generation of hydrogen from portable or transportable hydrogen generation equipment, batteries, and similar devices and equipment that utilize hydrogen for the purpose of power generation. It does not include hydrogen production facilities intended to produce hydrogen used for distribution or repackaging operations operated by gas producers, distributors, and repackagers. [**55:**A.10.2.8]

63.3.1.4.1 Listed or approved hydrogen–generating and hydrogen–consuming equipment shall be in accordance with the listing requirements and manufacturers' instructions. [**55:**10.2.8.1]

63.3.1.4.2 Such equipment shall not be required to meet the requirements of Chapter 7 of NFPA 55. [**55:**10.2.8.2]

63.3.1.5* Metal Hydride Storage Systems.

Requirements on metal hydride storage systems were added to the 2010 edition of NFPA 55. With the commercial introduction of fuel cell–based power systems and the proliferation of hydrogen as a fuel gas, systems that store hydrogen using alternative methods are becoming more prevalent than those traditionally used for compressed gas and cryogenic liquid. Therefore, there was a need in NFPA 55 for the dissemination of information on these alternative hydrogen storage technologies, as well as a fundamental set of controls to provide guidance to users and enforcement authorities alike.

Because the metal hydride storage system is a closed system that prevents the release of the metal hydride and the hydrogen-absorbing alloy under normal use, the hazard classification of the system considers only the contained hydrogen gas.

The closest analogy that can be made with respect to this approach is that of acetylene — a compressed gas that is dissolved in acetone — or dimethylformamide. These solvents are a Class IB flammable liquid and a Class II combustible liquid, respectively. However, in practice, it is the flammable gas hazard that is regulated; the solvent into which the gas is absorbed has not been independently assessed. The established reason for this approach is that the control strategy for the compressed gas hazard is suitable for that of the solvent hazard.

The control strategy for metal hydride systems, therefore, is heavily dependent on the control strategy for all compressed gases. A number of control procedures have been incorporated into this new section in order to focus on fundamental controls that might otherwise be missed by *Code* users. In addition, provisions have been added to address the refilling of containers, including containers that may be used on powered industrial trucks.

The early use of these systems was as a means to supply power attendant to portable equipment. Specific safeguards have been included to address the security of containers in mobile as well as motorized equipment. Fundamental controls for motorized equipment have been taken, in part, from NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*.

A.63.3.1.5 Numerous metal hydrides are currently being tested for gaseous hydrogen storage applications. While certain Class D extinguishing agents have been effective on some metal hydride materials, they have not been tested on the wide range of hydrides. It is crucial to understand any adverse chemical reactions between the hydride and the agent prior to using the fire suppressant. Additionally, it is important to understand that the application should be limited to small incipient stage fires. Larger fires would require the use of personal protective equipment in the application of the extinguishing agent. [**55:**A.10.2.9]

63.3.1.5.1 General Requirements.

63.3.1.5.1.1 Metal Hydride Storage System Requirements. The storage and use of metal hydride storage systems shall be in accordance with 63.3.1.5. [**55:**10.2.9.1.1]

63.3.1.5.1.2 Metal Hydride Systems Storing or Supplying Hydrogen. Those portions of the system that are used as a means to store or supply hydrogen shall also comply with Chapter 7 and Chapter 10 of NFPA 55 as applicable. [**55:**10.2.9.1.2]

63.3.1.5.1.3 Classification. The hazard classification of the metal hydride storage system, as required by 63.1.4.1 and 63.1.4.3, shall be based on the hydrogen stored without regard to the metal hydride content. [**55:**10.2.9.1.3]

63.3.1.5.1.4 Listed or Approved Systems. Metal hydride storage systems shall be listed or approved for the application and designed in a manner that prevents the addition or removal of the metal hydride by other than the original equipment manufacturer. [**55:**10.2.9.1.4]

63.3.1.5.1.5 Containers, Design, and Construction. Compressed gas cylinders, containers, and tanks used for metal hydride storage systems shall be designed and constructed in accordance with 63.3.1.6.1. [**55:**10.2.9.1.5]

63.3.1.5.1.6 Service Life and Inspection of Containers. Metal hydride storage system cylinders, containers, or tanks shall be inspected, tested, and requalified for service at not less than 5-year intervals. [**55:**10.2.9.1.6]

63.3.1.5.1.7 Marking and Labeling. Marking and labeling of cylinders, containers, tanks, and systems shall be in accordance with 63.3.1.6 and the requirements in 63.3.1.5.1.7.1 through 63.3.1.5.1.7.4. [**55:**10.2.9.1.7]

63.3.1.5.1.7.1 System Marking. Metal hydride storage systems shall be marked with the following:

(1) Manufacturer's name
(2) Service life indicating the last date the system can be used
(3) A unique code or serial number specific to the unit
(4) System name or product code that identifies the system by the type of chemistry used in the system

(5) Emergency contact name, telephone number, or other contact information
(6) Limitations on refilling of containers to include rated charging pressure and capacity

[**55:**10.2.9.1.7.1]

63.3.1.5.1.7.2 Valve Marking. Metal hydride storage system valves shall be marked with the following:

(1) Manufacturer's name
(2) Service life indicating the last date the valve can be used
(3) Metal hydride service in which the valve can be used or a product code that is traceable to this information

[**55:**10.2.9.1.7.2]

63.3.1.5.1.7.3 Pressure Relief Device Marking. Metal hydride storage system pressure relief devices shall be marked with the following:

(1) Manufacturer's name
(2) Metal hydride service in which the device can be used or a product code that is traceable to this information
(3) Activation parameters to include temperature, pressure, or both

[**55:**10.2.9.1.7.3]

(A) Pressure Relief Devices Integral to Container Valves. The required markings for pressure relief devices that are integral components of valves used on cylinders, containers, and tanks shall be allowed to be placed on the valve. [**55:**10.2.9.1.7.3(A)]

63.3.1.5.1.7.4 Pressure Vessel Markings. Cylinders, containers, and tanks used in metal hydride storage systems shall be marked with the following:

(1) Manufacturer's name
(2) Design specification to which the vessel was manufactured
(3) Authorized body approving the design and initial inspection and test of the vessel
(4) Manufacturer's original test date
(5) Unique serial number for the vessel
(6) Service life identifying the last date the vessel can be used
(7) System name or product code that identifies the system by the type of chemistry used in the system

[**55:**10.2.9.1.7.4]

63.3.1.5.1.8 Temperature Extremes. Metal hydride storage systems, whether full or partially full, shall not be exposed to artificially created high temperatures exceeding 125°F (52°C) or subambient (low) temperatures unless designed for use under the exposed conditions. [**55:**10.2.9.1.8]

63.3.1.5.1.9 Falling Objects. Metal hydride storage systems shall not be placed in areas where they are capable of being damaged by falling objects. [**55:**10.2.9.1.9]

63.3.1.5.1.10 Piping Systems. Piping, including tubing, valves, fittings, and pressure regulators, serving metal hydride storage systems shall be maintained gastight to prevent leakage. [**55:**10.2.9.1.10]

63.3.1.5.1.10.1 Leaking Systems. Leaking systems shall be removed from service. [**55:**10.2.9.1.10.1]

63.3.1.5.1.11 Refilling of Containers. The refilling of listed or approved metal hydride storage systems shall be in accordance with the listing requirements and manufacturers' instructions. [**55:**10.2.9.1.11]

Δ **63.3.1.5.1.11.1 Industrial Trucks.** The refilling of metal hydride storage systems serving powered industrial trucks shall be in accordance with NFPA 2. [**55:**10.2.9.1.11.1]

63.3.1.5.1.11.2 Hydrogen Purity. The purity of hydrogen used for the purpose of refilling containers shall be in accordance with the listing and the manufacturers' instructions. [**55:**10.2.9.1.11.2]

Δ **63.3.1.5.1.12 Electrical.** Electrical components for metal hydride storage systems shall be designed, constructed, and installed in accordance with *NFPA 70*. [**55:**10.2.9.1.12]

63.3.1.5.2 Portable Containers or Systems.

63.3.1.5.2.1 Securing Containers. Cylinders, containers, and tanks shall be secured in accordance with 63.3.1.9.5. [**55:**10.2.9.2.1]

63.3.1.5.2.1.1 Use on Mobile Equipment. Where a metal hydride storage system is used on mobile equipment, the equipment shall be designed to restrain cylinders, containers, or tanks from dislodgement, slipping, or rotating when the equipment is in motion. [**55:**10.2.9.2.1.1]

63.3.1.5.2.1.2 Motorized Equipment. Metal hydride storage systems used on motorized equipment shall be installed in a manner that protects valves, pressure regulators, fittings, and controls against accidental impact. [**55:**10.2.9.2.1.2]

(A) Protection from Damage. Metal hydride storage systems, including cylinders, containers, tanks, and fittings, shall not extend beyond the platform of the mobile equipment. [**55:**10.2.9.2.1.2(A)]

63.3.1.5.2.2 Valves. Valves on cylinders, containers, and tanks shall remain closed except when containers are connected to closed systems and ready for use. [**55:**10.2.9.2.2]

63.3.1.6 Cylinders, Containers, and Tanks.

63.3.1.6.1 Design and Construction. Cylinders, containers, and tanks shall be designed, fabricated, tested, and marked (stamped) in accordance with regulations of DOT, Transport Canada (TC) *Transportation of Dangerous Goods Regulations*, or the ASME *Boiler and Pressure Vessel Code*, "Rules for the Construction of Unfired Pressure Vessels," Section VIII. [**55:**7.1.5.1]

63.3.1.6.2 Defective Cylinders, Containers, and Tanks.

63.3.1.6.2.1 Defective cylinders, containers, and tanks shall be returned to the supplier. [**55:**7.1.5.2.1]

63.3.1.6.2.2 Suppliers shall repair the cylinders, containers, and tanks, remove them from service, or dispose of them in an approved manner. [**55:**7.1.5.2.2]

63.3.1.6.2.3 Suppliers shall ensure that defective cylinders, containers, and tanks that have been repaired are evaluated by qualified individuals to verify that the needed repairs and any required testing has been performed and that those repaired or tested are in a serviceable condition before returning them to service. [**55:**7.1.5.2.3]

63.3.1.6.3 Supports. Stationary cylinders, containers, and tanks shall be provided with engineered supports of noncombustible material on noncombustible foundations. [**55:**7.1.5.3]

63.3.1.6.4 Cylinders, Containers, and Tanks Containing Residual Gas. Compressed gas cylinders, containers, and tanks containing residual product shall be treated as full except when being examined, serviced, or refilled by a gas manufacturer, authorized cylinder requalifier, or distributor. [**55:**7.1.5.4]

Serious accidents have resulted from users assuming that no material was left in a cylinder that appeared to be empty. If a small amount of gas has been left in a cylinder, the atmosphere in the cylinder might no longer be saturated and could be in the flammable range.

63.3.1.6.5 Pressure Relief Devices.

63.3.1.6.5.1 When required by 63.3.1.6.5.2, pressure relief devices shall be provided to protect containers and systems containing compressed gases from rupture in the event of overpressure from thermal exposure. [**55:**7.1.5.1.1]

63.3.1.6.5.2 Pressure relief devices to protect containers shall be designed and provided in accordance with CGA S-1.1, *Pressure Relief Device Standards — Part 1 — Cylinders for Compressed Gases*, for cylinders; CGA S-1.2, *Pressure Relief Device Standards — Part 2 — Cargo and Portable Tanks for Compressed Gases,* for portable tanks; and CGA S-1.3, *Pressure Relief Device Standards — Part 3 — Stationary Storage Containers for Compressed Gases,* for stationary tanks or in accordance with applicable equivalent requirements in the country of use. [**55:**7.1.5.5.2]

63.3.1.6.5.3 Pressure relief devices shall be sized in accordance with the specifications to which the container was fabricated. [**55:**7.1.5.5.3]

63.3.1.6.5.4 The pressure relief device shall have the capacity to prevent the maximum design pressure of the container or system from being exceeded. [**55:**7.1.5.5.4]

63.3.1.6.5.5 Pressure relief devices shall be arranged to discharge unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container, adjacent structures, or personnel. This requirement shall not apply to DOT specification containers having an internal volume of 2.0 scf (0.057 Nm^3) or less. [**55:**7.1.5.5.5]

63.3.1.6.5.6 Pressure relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner that would interfere with operation of the device. [**55:**7.1.5.5.6]

63.3.1.7 Cathodic Protection. Where required, cathodic protection shall be in accordance with 63.3.1.7. [**55:**7.1.6]

63.3.1.7.1 Operation. Where installed, cathodic protection systems shall be operated and maintained to continuously provide corrosion protection. [**55:**7.1.6.1]

63.3.1.7.2 Inspection. Container systems equipped with cathodic protection shall be inspected for the intended operation by a cathodic protection tester. The frequency of inspection shall be determined by the designer of the cathodic protection system. [**55:**7.1.6.2]

63.3.1.7.2.1 The cathodic protection tester shall be certified as being qualified by the National Association of Corrosion Engineers, International (NACE). [**55:**7.1.6.2.1]

63.3.1.7.3 Impressed Current Systems. Systems equipped with impressed current cathodic protection systems shall be inspected in accordance with the requirements of the design and 63.3.1.7.2. [**55:**7.1.6.3]

63.3.1.7.3.1 The design limits of the cathodic protection system shall be available to the AHJ upon request. [**55:**7.1.6.3.1]

63.3.1.7.3.2 The system owner shall maintain the following records to demonstrate that the cathodic protection is in conformance with the requirements of the design:

(1) The results of inspections of the system
(2) The results of testing that has been completed

[**55:**7.1.6.3.2]

63.3.1.7.4 Repairs, maintenance, or replacement of a cathodic protection system shall be under the supervision of a corrosion expert certified by NACE. [**55:**7.1.6.4]

63.3.1.7.4.1 The corrosion expert shall be certified by NACE as a senior corrosion technologist, a cathodic protection specialist, or a corrosion specialist or shall be a registered engineer with registration in a field that includes education and experience in corrosion control. [**55:**7.1.6.4.1]

Cathodic protection is a technique used to resist the corrosion of a metal surface by making the surface the cathode of an electrochemical cell. This protection renders a metallic container, piping system, or component negatively charged with respect to its surrounding environment. Provisions for cathodic protection were added to the 2010 edition of NFPA 55 to provide proper maintenance and repair guidelines for cathodic protection systems. It is critical that a corrosion expert, certified by the National Association of Corrosion Engineers, International, is required to provide supervision during repairs, maintenance, or replacement of a cathodic protection system. As part of the certification, the corrosion expert is required to be certified as a senior corrosion technologist, a cathodic protection specialist, or a corrosion specialist. The corrosion expert may also be a registered engineer, but the registration must be in a field that includes education and experience in corrosion control.

63.3.1.8 Labeling Requirements.

63.3.1.8.1 Containers. Individual compressed gas cylinders, containers, and tanks shall be marked or labeled in accordance with DOT requirements or those of the applicable regulatory agency. [**55:**7.1.7.1]

63.3.1.8.2 Label Maintenance. The labels applied by the gas manufacturer to identify the liquefied or nonliquefied compressed gas cylinder contents shall not be altered or removed by the user. [**55:**7.1.7.2]

63.3.1.8.3 Stationary Compressed Gas Cylinders, Containers, and Tanks.

Δ **63.3.1.8.3.1** Stationary compressed gas cylinders, containers, and tanks shall be marked in accordance with NFPA 704. [**55:**7.1.7.3.1]

63.3.1.8.3.2 Markings shall be visible from any direction of approach. [**55:**7.1.7.3.2]

63.3.1.8.4 Piping Systems.

63.3.1.8.4.1 Except as provided in 63.3.1.8.4.2, piping systems shall be marked in accordance with ASME A13.1, *Scheme for the Identification of Piping Systems*, or other applicable approved standards as follows:

(1) Marking shall include the name of the gas and a direction-of-flow arrow.
(2) Piping that is used to convey more than one gas at various times shall be marked to provide clear identification and warning of the hazard.
(3) Markings for piping systems shall be provided at the following locations:
   (a) At each critical process control valve
   (b) At wall, floor, or ceiling penetrations
   (c) At each change of direction
   (d) At a minimum of every 20 ft (6.1 m) or fraction thereof throughout the piping run

[**55:**7.1.7.4.1]

63.3.1.8.4.2 Piping within gas manufacturing plants, gas processing plants, refineries, and similar occupancies shall be marked in an approved manner. [**55:**7.1.7.4.2]

63.3.1.9 Security.

63.3.1.9.1 General. Compressed gas cylinders, containers, tanks, and systems shall be secured against accidental dislodgement and against access by unauthorized personnel. [**55:**7.1.8.1]

63.3.1.9.2* Security of Areas. Storage, use, and handling areas shall be secured against unauthorized entry. [**55:**7.1.8.2]

A.63.3.1.9.2 The goal of this requirement is to prevent unauthorized personnel or those unfamiliar with gas storage systems from tampering with the equipment as well as to prevent the inadvertent or unauthorized removal or use of compressed gases from storage areas. Where the compressed gases are located in an area open to the general public, a common practice is to fence and lock the storage or use area, with access restricted to supplier and user personnel. When the storage or use area is located within the user's secure area and is not accessible by the general public, it is not always necessary to fence or otherwise secure the individual gas storage or use areas. Personnel access patterns may still mandate that the system be fenced, as determined by the supplier and the user. [**55:**A.7.1.8.2]

63.3.1.9.3 Administrative controls shall be allowed to be used to control access to individual storage, use, and handling areas located in secure facilities not accessible by the general public. [**55:**7.1.8.2.1]

63.3.1.9.4 Physical Protection.

63.3.1.9.4.1 Compressed gas cylinders, containers, tanks, and systems that could be exposed to physical damage shall be protected. [**55:**7.1.8.3.1]

63.3.1.9.4.2 Guard posts or other means shall be provided to protect compressed gas cylinders, containers, tanks, and systems indoors and outdoors from vehicular damage in accordance with Section 4.11 of NFPA 55. [**55:**7.1.8.3.2]

Δ **63.3.1.9.5 Securing Compressed Gas Cylinders, Containers, and Tanks.** Compressed gas cylinders, containers, and tanks in use or in storage shall be secured to prevent them from falling or being knocked over by corralling them and securing them to a cart, framework, or fixed object by use of a restraint, unless otherwise permitted by 63.3.1.9.5.1 and 63.3.1.9.5.2. [**55:**7.1.8.4]

Δ **63.3.1.9.5.1** Compressed gas cylinders, containers and tanks in the process of examination, servicing, and refilling shall not be required to be secured. [**55:**7.1.8.4.1]

63.3.1.9.5.2 At cylinder-filling plants, authorized cylinder requalifier's facilities, and distributors' warehouses, the nesting of cylinders shall be permitted as a means to secure cylinders. [**55:**7.1.8.4.2]

63.3.1.10 Valve Protection.

63.3.1.10.1 General. Compressed gas cylinder, container, and tank valves shall be protected from physical damage by means of protective caps, collars, or similar devices. [**55:**7.1.9.1]

63.3.1.10.1.1 Valve protection of individual valves shall not be required to be installed on individual cylinders, containers, or tanks installed on tube trailers or similar transportable bulk gas systems equipped with manifolds that are provided with a means of physical protection that will protect the valves from physical damage when the equipment is in use. Protective systems required by DOT for over the road transport shall provide an acceptable means of protection. [**55:**7.1.9.1.1]

63.3.1.10.1.1.1 Valve protection of individual valves shall not be required on cylinders, containers, or tanks that comprise bulk or non-bulk gas systems where the containers are stationary, or portable equipped with manifolds, that are provided with physical protection in accordance with Section 4.11 of NFPA 55 and 63.3.1.9.4 or other approved means. Protective systems required by DOT for over the road transport shall provide an acceptable means of protection. [**55:**7.1.9.1.1.1]

Paragraph 63.3.1.10.1.1.1 was written as a general requirement for all compressed gases. There are instances in which compressed gas cylinders could be used in a form not anticipated by NFPA 55 and this *Code* when this paragraph was developed. Tube trailers, cylinder packs, and similar arrangements conventionally are not equipped with protective caps, collars, or similar devices. On the other hand, such equipment generally is equipped with safeguards to protect the container valves from impact.

Adding requirements that recognize the requirements for manifold protection resolved the problem with tube trailer systems. Paragraph 63.3.1.10.1.1 addresses systems other than DOT (over the road) type systems, which may include equipment commonly known as 6 packs, 12 packs, and similar items consisting of cylinders equipped with a manifold that are attached to a wheeled frame. Physical protection is typically provided by the framework used as a supporting structure. In addition, stationary storage/use systems are not equipped with valve protection of the type suggested by 63.3.1.10.1. Systems of this nature are usually protected through the use of Section 4.11 of NFPA 55 or 63.3.1.9.4. The "other approved means" is an important consideration and recognizes that every possible circumstance cannot be addressed. Physical protection can be provided by means other than those specifically described in Section 4.11 of NFPA 55 or 7.1.8.3 of NFPA 55. Sufficient guidance is provided to inform the user of the need and of the exceptions to be applied.

63.3.1.10.2 Valve-Protective Caps. Where compressed gas cylinders, containers, and tanks are designed to accept valve-protective caps, the user shall keep such caps on the compressed gas cylinders, containers, and tanks at all times, except when empty, being processed, or connected for use. [**55:**7.1.9.2]

The cylinder valve is one of the most vulnerable points on the cylinder. For that reason, it is important that valve-protective caps are used and that they fit securely over the valve.

63.3.1.10.3 Valve Outlet Caps or Plugs.

63.3.1.10.3.1 Gastight valve outlet caps or plugs shall be provided and in place for all full or partially full cylinders, containers, and tanks containing toxic, highly toxic, pyrophoric, or unstable reactive Class 3 or Class 4 gases that are in storage. [**55:**7.1.9.3.1]

63.3.1.10.3.2 Valve outlet caps and plugs shall be designed and rated for the container service pressure. [**55:**7.1.9.3.2]

63.3.1.11 Separation from Hazardous Conditions.

63.3.1.11.1 General.

63.3.1.11.1.1 Compressed gas cylinders, containers, tanks, and systems in storage or use shall be separated from materials and conditions that present exposure hazards to or from each other. [**55:**7.1.10.1]

One of the most effective techniques for preventing accidents or reducing the severity of accidents is to separate hazardous materials from those materials and conditions that present exposure hazards or to separate hazardous materials from each other. Separation can prevent an incident involving one stored material from propagating to another stored material. Following this basic safety principle can also prevent minor incidents from becoming major incidents.

63.3.1.11.2* Incompatible Materials. Gas cylinders, containers, and tanks shall be separated in accordance with Table 63.3.1.11.2. [**55:**7.1.10.2]

A.63.3.1.11.2 Figure A.63.3.1.11.2 is a schematic showing the separation distances required by 63.3.1.11.2. [**55:**A.7.1.10.2]

63.3.1.11.2.1 Subparagraph 63.3.1.11.2 shall not apply to gases contained within closed piping systems. [**55:**7.1.10.2.1]

63.3.1.11.2.2 The distances shown in Table 63.3.1.11.2 shall be permitted to be reduced without limit where compressed gas cylinders, containers, and tanks are separated by a barrier of noncombustible construction that has a fire resistance rating of at least 0.5 hour and interrupts the line of sight between the containers. [**55:**7.1.10.2.2]

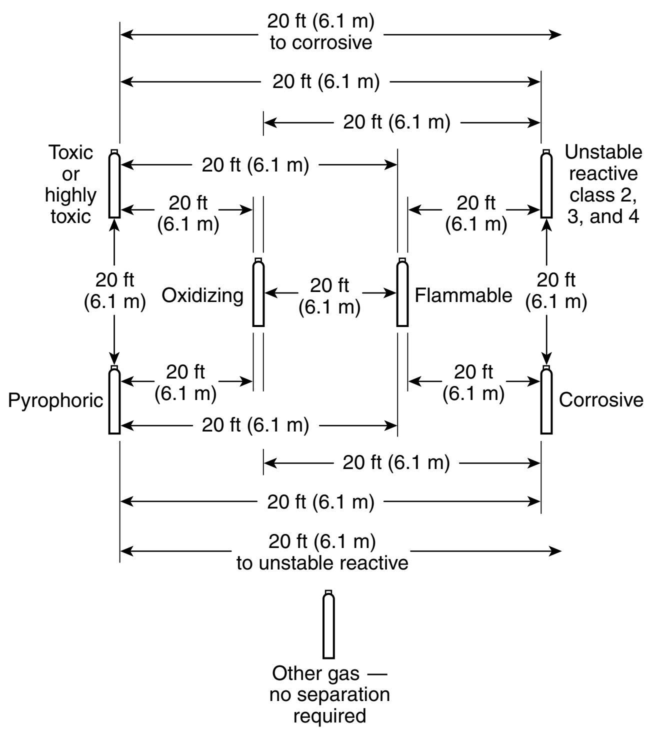
63.3.1.11.2.3 The 20 ft (6.1 m) distance shall be permitted to be reduced to 5 ft (1.5 m) where one of the gases is enclosed in a gas cabinet or without limit where both gases are enclosed in gas cabinets. [**55:**7.1.10.2.3]

63.3.1.11.2.4 Cylinders without pressure relief devices shall not be stored without separation from flammable and pyrophoric gases with pressure relief devices. [**55:**7.1.10.2.4]

Δ ***TABLE 63.3.1.11.2*** *Separation of Gas Cylinders, Containers, and Tanks by Hazard Class*

Gas Category	Other Gas	Unstable Reactive Class 2, Class 3, or Class 4		Corrosive		Oxidizing		Flammable		Pyrophoric		Toxic or Highly Toxic	
		ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
Toxic or highly toxic	NR	20	6.1	20	6.1	20	6.1	20	6.1	20	6.1	—	—
Pyrophoric	NR	20	6.1	20	6.1	20	6.1	20	6.1	—	—	20	6.1
Flammable	NR	20	6.1	20	6.1	20	6.1	—	—	20	6.1	20	6.1
Oxidizing	NR	20	6.1	20	6.1	—	—	20	6.1	20	6.1	20	6.1
Corrosive	NR	20	6.1	—	—	20	6.1	20	6.1	20	6.1	20	6.1
Unstable reactive Class 2, Class 3, or Class 4	NR	—	—	20	6.1	20	6.1	20	6.1	20	6.1	20	6.1
Other gas	—	NR		NR		NR		NR		NR		NR	

NR: No separation required.
[**55:** Table 7.1.10.2]



Δ *FIGURE A.63.3.1.11.2 Separation of Gas Cylinders by Hazard. [55:Figure A.7.1.10.2]*

63.3.1.11.2.5* Spatial separation shall not be required between cylinders deemed to be incompatible in gas production facilities where cylinders are connected to manifolds for the purposes of filling, analysis of compressed gases or, manufacturing procedures, assuming the prescribed controls for the manufacture of gas mixtures are in place. [**55:**7.1.10.2.5]

N **A.63.3.1.11.2.5** Analysis of gas mixtures often includes the analysis of individual cylinders that have been disconnected from the filling manifolds. The analysis procedure is a production step where cylinders of many different types and contents are processed. It is not unusual for an individual gas mixture to contain gases otherwise deemed to be incompatible in the pure state. For example, a mixture of hydrogen and air is routinely manufactured for use as a calibrating gas mixture used to validate the operation of flammable gas detection systems. Analytical operations involving incompatible gases, which may be located within an individual laboratory, typically require that the gases being analyzed be connected to individual work stations or analytical instruments as the process is conducted. The typical analytical process is an attended process where technicians have "hands on" control of the cylinder under examination, which serves to mitigate events that may otherwise occur in unattended operations, including storage or the use of an unattended source of supply. [**55:**A.7.1.10.2.5]

63.3.1.11.3* Clearance from Combustibles and Vegetation. Combustible waste, vegetation, and similar materials shall be kept a minimum of 10 ft (3.1 m) from compressed gas cylinders, containers, tanks, and systems. [**55:**7.1.10.3]

A.63.3.1.11.3 Clearance is required from combustible materials to minimize the effects of exposure fires to the materials stored or used. The requirement to separate the materials from vegetation should not be interpreted to mean that the area is maintained free of all vegetation. In some settings, gas systems are located on grounds that are maintained with formal landscaping. Some judgment must be exercised to determine whether the vegetation poses what might be viewed as an exposure hazard to the materials stored. Cut lawns, formal landscaping, and similar vegetation do not ordinarily present a hazard and should be allowed. On the other hand, tall, dry grass or weeds and vegetation that fringes on the border of an urban–wildland interface might be viewed as a hazard. [**55:**A.7.1.10.3]

Δ **63.3.1.11.3.1** A noncombustible partition without openings or penetrations and extending not less than 18 in. (457 mm) above and to the sides of the storage area shall be permitted in lieu of the minimum distance. [**55:**7.1.10.3.1]

63.3.1.11.3.2 The noncombustible partition shall be either an independent structure or the exterior wall of the building adjacent to the storage area. [**55:**7.1.10.3.2]

63.3.1.11.4 Ledges, Platforms, and Elevators. Compressed gas cylinders, containers, and tanks shall not be placed near elevators, unprotected platform ledges, or other areas where compressed gas cylinders, containers, or tanks could fall distances exceeding one-half the height of the container, cylinder, or tank. [**55:**7.1.10.4]

63.3.1.11.5 Temperature Extremes. Compressed gas cylinders, containers, and tanks, whether full or partially full, shall not be exposed to temperatures exceeding 125°F (52°C) or subambient (low) temperatures unless designed for use under such exposure. [**55:**7.1.10.5]

One of the most significant hazards that compressed gases present is the mechanical energy of compression. The Ideal Gas Law reveals that the pressure of a gas is directly proportional to the temperature of the gas. This law is the reason why it is important not to raise the temperature of the gas, which would then raise the pressure of the gas, increasing the risk of a release of the stored mechanical energy of the gas.

63.3.1.11.5.1 Compressed gas cylinders, containers, and tanks that have not been designed for use under elevated temperature conditions shall not be exposed to direct sunlight outdoors where ambient temperatures exceed 125°F (52°C). The use of a weather protected structure or shaded environment for storage or use shall be permitted as a means to protect against direct exposure to sunlight. [**55:**7.1.10.5.1]

The filling density for compressed gases is related to temperature and pressure. Filling densities and pressures are generally determined at 130°F (54°C). The 125°F (52°C) limitation provides a margin of safety to users of gaseous materials. When ambient temperatures exceed 125°F (52°C), and containers are exposed to direct sunlight, it is possible to exceed the 130°F threshold temperature limit internally, causing containers to become overpressurized and leak, pressure relief valves to release, or in the case of liquefied gas to expand to a point where the container may be subject to extreme hydraulic overpressure. In areas where ambient temperatures are expected to exceed 125°F (52°C), containers stored or used outdoors should be under weather protection, moved inside to a cooler environment, or otherwise provided with shade to avoid direct exposure to sunlight.

63.3.1.11.6 Falling Objects. Compressed gas cylinders, containers, and tanks shall not be placed in areas where they are capable of being damaged by falling objects. [**55:**7.1.10.6]

63.3.1.11.7 Heating. Compressed gas cylinders, containers, and tanks, whether full or partially full, shall not be heated by devices that could raise the surface temperature of the container, cylinder, or tank to above 125°F (52°C). [**55:**7.1.11.7]

63.3.1.11.7.1 Electrically Powered Heating Devices. Electrical heating devices shall be in accordance with *NFPA 70*. [**55:**7.1.10.7.1]

Δ **63.3.1.11.7.2 Fail-Safe Design.** Devices designed to maintain individual compressed gas cylinders, containers, and tanks at constant temperature shall be designed to be fail-safe. [**55:**7.1.10.7.2]

63.3.1.11.8 Sources of Ignition. Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition. [**55:**7.1.10.8]

63.3.1.11.9 Exposure to Chemicals. Compressed gas cylinders, containers, and tanks shall not be exposed to corrosive chemicals or fumes that could damage cylinders, containers, tanks, or valve-protective caps. [**55:**7.1.10.9]

63.3.1.11.10 Exposure to Electrical Circuits. Compressed gas cylinders, containers, and tanks shall not be placed where they could become a part of an electrical circuit. [**55:**7.1.10.10]

63.3.1.11.10.1* Electrical devices mounted on compressed gas piping, cylinders, containers, or tanks shall be installed, grounded, and bonded in accordance with the methods specified in *NFPA 70* (NEC). [**55:**7.1.10.10.1]

A.63.3.1.11.10.1 Electrical devices can include pressure transducers, signal transmitters, shutoff controls, and similar devices. Some of these devices may be nonincendive and suitable for use in hazardous areas. Flammability of gases is not the only concern with respect to electrical circuits, because piping serving systems in use can act as conductors of electrical energy, exposing unrelated portions of the system to electrical hazards if improperly installed. [**55:**A.7.1.10.10.1]

Δ **63.3.1.12 Service and Repair.** Service, repair, modification, or removal of valves, pressure relief devices, or other compressed gas cylinder, container, and tank appurtenances shall be performed by trained personnel and with the permission of the container owner. [**55:**7.1.11]

63.3.1.13 Unauthorized Use. Compressed gas cylinders, containers, and tanks shall not be used for any purpose other than to serve as a vessel for containing the product for which it was designed. [**55:**7.1.12]

63.3.1.14 Cylinders, Containers, and Tanks Exposed to Fire. Compressed gas cylinders, containers, and tanks exposed to fire shall not be used or shipped while full or partially full until they are requalified in accordance with the pressure vessel code under which they were manufactured. [**55:**7.1.13]

Although a container exposed to fire might not appear to have suffered any structural damage, the structural condition of the container cannot be known until the tank is properly examined.

63.3.1.15 Leaks, Damage, or Corrosion.

63.3.1.15.1 Removal from Service. Leaking, damaged, or corroded compressed gas cylinders, containers, and tanks shall be removed from service. [**55:**7.1.14.1]

63.3.1.15.2 Replacement and Repair. Leaking, damaged, or corroded compressed gas systems shall be replaced or repaired. [**55:**7.1.14.2]

63.3.1.15.3* Handling of Cylinders, Containers, and Tanks Removed from Service. Compressed gas cylinders, containers, and tanks that have been removed from service shall be handled in an approved manner. [**55:**7.1.14.3]

A.63.3.1.15.3 The gas supplier should be consulted for advice under these circumstances. [**55:**A.7.1.14.3]

63.3.1.15.4 Leaking Systems. Compressed gas systems that are determined to be leaking, damaged, or corroded shall be repaired to a serviceable condition or shall be removed from service. [**55:**7.1.14.4]

63.3.1.16 Surfaces.

63.3.1.16.1 To prevent bottom corrosion, cylinders, containers, and tanks shall be protected from direct contact with soil or surfaces where water might accumulate. [**55:**7.1.15.1]

63.3.1.16.2 Surfaces shall be graded to prevent accumulation of water. [**55:**7.1.15.2]

63.3.1.17 Storage Area Temperature.

63.3.1.17.1 Compressed Gas Containers. Storage area temperatures shall not exceed 125°F (52°C). [**55:**7.1.16.1]

63.3.1.18 Underground Piping.

63.3.1.18.1 Underground piping shall be of welded construction without valves, unwelded mechanical joints, or connections installed underground. [**55:**7.1.17.1]

63.3.1.18.1.1 Valves or connections located in boxes or enclosures shall be permitted to be installed underground where such boxes or enclosures are accessible from above ground and where the valves or connections contained are isolated from direct contact with earth or fill. [**55:**7.1.17.1.1]

63.3.1.18.1.1.1 Valve boxes or enclosures installed in areas subject to vehicular traffic shall be constructed to resist uniformly distributed and concentrated live loads in accordance with the building code for areas designated as vehicular driveways and yards, subject to trucking. [**55:**7.1.17.1.1.1]

63.3.1.18.1.2* Piping installed in trench systems located below grade where the trench is open to above shall not be considered to be underground. [**55:**7.1.17.1.2]

A.63.3.1.18.1.2 Underground piping systems are those systems that are buried and in contact with earth fill or similar materials. Piping located in open-top or grated-top trenches is not considered to be underground although it may be below grade. [**55:**A.7.1.17.1.2]

63.3.1.18.2 Gas piping in contact with earth or other material that could corrode the piping shall be protected against corrosion in an approved manner. [**55:**7.1.17.2]

63.3.1.18.2.1 When cathodic protection is provided, it shall be in accordance with 63.3.1.7. [**55:**7.1.17.2.1]

63.3.1.18.3 Underground piping shall be installed on at least 6 in. (150 mm) of well-compacted bedding material. [**30:**27.6.5.1]

63.3.1.18.4 In areas subject to vehicle traffic, the pipe trench shall be deep enough to permit a cover of at least 18 in. (450 mm) of well-compacted backfill material and pavement. [**30:**27.6.5.2]

63.3.1.18.5 In paved areas where a minimum 2 in. (50 mm) of asphalt is used, backfill between the pipe and the asphalt shall be permitted to be reduced to 8 in. (200 mm) minimum. [**30:**27.6.5.3]

63.3.1.18.6 In paved areas where a minimum 4 in. (100 mm) of reinforced concrete is used, backfill between the pipe and the concrete shall be permitted to be reduced to 4 in. (100 mm) minimum. [**30:**27.6.5.4]

Δ **63.3.1.18.7** In areas not subject to vehicle traffic, the pipe trench shall be deep enough to permit a cover of at least 12. in. (300 mm) of well-compacted backfill material. [**55:**7.1.17.7]

63.3.1.18.8 A greater burial depth shall be provided when required by the manufacturer's instructions or where frost conditions are present. [**30:**27.6.5.6]

Greater burial depth is required in areas where the ground is subject to frost heaves, because frost heaves cause upward movement of the soil, which, in turn, subjects piping to bending stresses that could cause failure of pipe joints.

63.3.1.18.9 Piping within the same trench shall be separated horizontally by at least two pipe diameters. Separation shall not need to exceed 9 in. (230 mm). [**30:**27.6.5.7]

63.3.1.18.10 Two or more levels of piping within the same trench shall be separated vertically by a minimum 6 in. (150 mm) of well-compacted bedding material. [**30:**27.6.5.8]

Paragraph 63.3.1.18.10 recognizes the general underground installation of piping containing compressed gases. The provisions for underground installation have been extended to include a requirement for all welded systems. Underground piping systems are those systems that are buried and in contact with earth fill or similar materials. Piping located in open-top or grated-top trenches is not considered to be underground, although it may be belowgrade. An allowance has been provided for the installation of valve boxes that provide access to valves or connections that may be used for operation of the system.

63.3.1.19 Cleaning and Purging of Gas Piping Systems.

On February 7, 2010, a deadly explosion occurred at Kleen Energy, a natural gas–fueled power plant under construction in Middletown, Connecticut. The explosion resulted in 6 fatalities and nearly 50 injuries to workers at the plant. It was determined by the U.S. Chemical Safety Board (CSB) that the explosion was caused by a "gas blow." Gas blows are a commonly used cleaning procedure in natural gas–fueled power plants, where flammable gas is blown through piping at high pressure to remove debris such as welding slag or other foreign materials. Ten minutes before the Kleen Energy explosion, for example, approximately 480,000 scf (13,592 m^3) of natural gas was released, according to the investigation. The gas was being vented from an open-ended pipe into an area where dissipation was impeded by other equipment at the level of discharge before it found an ignition source. Construction of the plant, which was close to completion when the explosion occurred, was heavily regulated, but no standard guided the gas-blowing procedure at the time of explosion.

Exhibit 63.1 is a photo of an earlier gas blow, showing the dirt and debris streaming out of the discharge location. Exhibit 63.2 shows before and after aerial photos of the explosion at the Kleen Energy plant.

As a result of the investigation and urgent recommendations put forth by the CSB, NFPA developed its first provisional standard, NFPA 56 (PS), *Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems*. NFPA 56 (PS) prohibited the use of flammable gas during cleaning procedures while safeguarding a range of activities related to cleaning and repairing piping systems. Since the provisional standard was issued, NFPA 56 has gone through two revision cycles in accordance with the NFPA Regulations Governing Committee Projects and is no longer a provisional standard.

The provisions of NFPA 56 (PS) related to the cleaning and purging of gas piping systems were the basis for a Tentative Interim Amendment (TIA) that was issued on the 2013 edition of NFPA 55 in October 2012. The emergency development of NFPA 56 (PS) brought to light the need to establish fundamental requirements for cleaning and purging relevant to all gases. The TIA issued on NFPA 55 provided a set of fundamental requirements that is applicable across the spectrum of gases regulated by NFPA 55. The TIA was incorporated into the 2016 edition of NFPA 55.

Exhibit 63.1

Gas blow. (Source: U.S. Chemical Safety Board)

Exhibit 63.2

Kleen Energy plant before and after explosion. (Source: U.S. Chemical Safety Board)

Additional language was also added to this *Code*, in Section 63.5 for bulk oxygen systems, Section 63.6 for bulk gaseous hydrogen systems, Section 63.7 for bulk liquified hydrogen systems, Section 63.8 for gas generation systems, and Section 63.10 for the storage, handling, and use of ethylene oxide for sterilization and fumigation. Each of these sections on specific systems refers to 63.3.1.19 for the provisions related to the cleaning and purging of piping systems.

63.3.1.19.1 General.

63.3.1.19.1.1 Piping systems shall be cleaned and purged in accordance with the requirements of 63.3.1.19 when one or more of the following conditions exist:

(1) The system is installed and prior to being placed into service
(2) There is a change in service
(3)* There are alterations or repair of the system involving the replacement of parts or addition to the piping system and prior to returning the system to service

Δ **A.63.3.1.19.1.1(3)** The replacement of parts in a system to repair leaks, the addition of gaskets, and similar routine maintenance is not intended to establish the need for cleaning of the entire piping system. Conversely, when a piping system is extended, or when the system needs to be rendered safe for maintenance purposes, purging the system before disassembly likely will be required as will internal cleaning if new piping or materials of construction are introduced. [**55:**A.7.1.18.1.1(3)]

(4)* The design standards or written procedures specify cleaning and purging

[**55:**7.1.18.1.1]

A.63.3.1.19.1.1(4) Cleaning and purging of piping systems can be conducted as individual functions, that is, just cleaning, just purging, or in combination as required to satisfy the requirements of the procedures. [**55:**A.7.1.18.1.1(4)]

63.3.1.19.1.2 Cleaning and purging of the internal surfaces of piping systems shall be conducted by qualified individuals trained in cleaning and purging operations and procedures, including the recognition of potential hazards associated with cleaning and purging. [**55:**7.1.18.1.2]

63.3.1.19.1.3* A written cleaning or purging procedure shall be provided to establish the requirements for the cleaning and purging operations to be conducted. [**55:**7.1.18.1.3]

A.63.3.1.19.1.3 It is not intended that a new written procedure be required each time the activity occurs within a facility. [**55:**A.7.1.18.1.3]

Δ **63.3.1.19.1.3.1*** An independent or third-party review of the written procedure shall be conducted after the procedure has been written and shall accomplish the following:

(1) Evaluate hazards, errors, and malfunctions related to each step in the procedure
(2) Review the measures prescribed in the procedure for applicability
(3) Make recommendations for additional hazard mitigation measures if deemed necessary

[**55:**7.1.18.1.3.1]

A.63.3.1.19.1.3.1 The review of the written procedures should not be performed solely by the same person(s) responsible for developing the procedures. It can be performed by an independent person or group within the company or department or by a third-party consultant. [**55:**A.7.1.18.1.3.1]

63.3.1.19.1.3.2 The completed written procedure shall be:

(1) Maintained on site by the facility owner/operator
(2) Provided to operating personnel engaged in cleaning or purging operations
(3) Made available to the AHJ upon request

[**55:**7.1.18.1.3.2]

63.3.1.19.1.3.3 Where generic cleaning or purging procedures have been established, a job-specific operating procedure shall not be required. [**55:**7.1.18.1.3.3]

63.3.1.19.1.3.4 Generic procedures shall be reviewed when originally published or when the procedure or operation is changed. [**55:**7.1.18.1.3.4]

63.3.1.19.1.4 Written procedures to manage a change in process materials, technology, equipment, procedures, and facilities shall be established by the facility owner/operator. [**55:**7.1.18.1.4]

63.3.1.19.1.4.1 The management-of-change procedures shall ensure that the following topics are addressed prior to any change in the configuration or design of the piping system:

(1) The technical basis for the proposed change
(2) The safety and health implications
(3) Whether the change is permanent or temporary
(4) Whether modifications to the cleaning and purging procedures are required as a result of the identified changes

[**55:**7.1.18.1.4.1]

63.3.1.19.1.4.2 When modifications to the cleaning and purging procedures are required, the written procedure shall be updated to incorporate any elements identified by the management-of-change procedures. [**55:**7.1.18.1.4.2]

63.3.1.19.1.5 Prior to cleaning or purging, piping systems shall be inspected and tested to determine that the installation, including the materials of construction, and method of fabrication, comply with the requirements of the design standard used and the intended application for which the system was designed. [**55:**7.1.18.1.5]

63.3.1.19.1.5.1 Inspection and testing of piping systems shall not be required to remove a system from service. [**55:**7.1.18.1.5.1]

Δ **63.3.1.19.1.5.2** Purging of piping systems shall not be required for systems that are utilized for operations designated by written operating procedures in accordance with the requirements of the cleaning or purging procedure specified in 63.3.1.19.1.1. [**55:**7.1.18.1.5.2]

63.3.1.19.1.5.3* Personnel in the affected area(s), as determined by the cleaning or purging procedure, shall be informed of the hazards associated with the operational activity and notified prior to the initiation of any such activity. [**55:**7.1.18.1.5.3]

Δ **A.63.3.1.19.1.5.3** The notification is given to warn personnel that such procedures are about to occur so that they will be out of zones potentially affected by the cleaning or purging procedure. The intended notification is to be commensurate with the operation to be conducted, and the timing of the notification should be relevant to the activity conducted so that personnel in the area can respond in a timely manner. Notification could be an audible and/or visible alarm or an announcement over a public address system, private network, radio, or similar and reliable means of electronic transmission. [**55:**A.7.1.18.1.5.3]

Verbal notification can be used in operations where the piping system is limited to the area occupied by those that will be conducting the cleaning or purging procedures and related operating personnel. These areas frequently are found in occupancies where the gas used to charge the piping system is supplied from portable containers, as well as those areas where the piping system is located primarily in the occupied work area. [**55:**A.7.1.18.1.5.3]

63.3.1.19.2* Cleaning. Piping system designs shall be documented to specify the requirements for the internal cleaning of the piping system prior to installation and initial use. [**55:**7.1.18.2]

A.63.3.1.19.2 For additional information on cleaning techniques used for stainless steel parts and equipment, see ASTM A380, *Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems*. [**55:**A.7.1.18.2]

63.3.1.19.2.1 The internal surfaces of gas piping systems shall be cleaned to ensure that the required standard of cleanliness specified by the design is met prior to placing the gas piping system into service. [**55:**7.1.18.2.1]

63.3.1.19.2.2* When piping systems are cleaned in stages during installation or assembly, the interior of the cleaned piping shall be protected against the infiltration of unwanted contaminants. [**55:**7.1.18.2.2]

Δ **A.63.3.1.19.2.2** During construction, visual inspection should be performed on sections of pipe as the piping system is being assembled to ensure that no gross contamination is left in the pipe. Where the standard of cleanliness is high, fabrication techniques should be utilized that do not introduce contamination into the pipe. Examples of these techniques can include, but are not limited to, constant inert gas purging, or assembly in a particulate controlled environment. The use of piping and components with a high-quality interior surface finish, and high-quality materials of construction all have an effect on the ability to maintain a high degree of cleanliness. Cleaning after construction can typically be accomplished by one or more of the following methods:

(1) Pigging
(2) Mechanical scraping
(3) High-velocity gas flow
(4) Liquid washing
(5) Use of cleaning media
(6) Application of high vacuum
(7) Solvent cleaning
(8) Water washing
(9) Steam cleaning

[**55:**A.7.1.18.2.2]

63.3.1.19.3* Purging. Piping systems used to contain gases with a physical or health hazard in any of the categories specified by 63.1.4 shall be purged prior to being placed into service for initial use. [**55:**7.1.18.3]

A.63.3.1.19.3 Purging can be accomplished by continuous media or gas flow, evacuation or vacuum, or repeated pressurizing and venting cycles commonly referred to as pulse purging or cycle purging. In some cases, purge procedures can involve more than one type of purging technique. Purging can be accomplished by manual or automatic means. Automated purge panels or manifold systems operated by a programmable logic controller are commonly used as a means to enhance the results of a purging process where high purity gas delivery systems are employed. [**55:**A.7.1.18.3]

Δ **63.3.1.19.3.1** Piping systems shall be purged to remove the internal contents preceding the following activities or operations:

(1) Activating or placing a piping system into service
(2) Deactivating or removing a piping system from service
(3) Changing the service of a piping system from one gas to another, except when such gas is supplied to a manifold or piping system designed for the purpose of filling or otherwise processing cylinders, containers, or tanks in a process with established procedures
(4) Performing service, maintenance, or modifications on a system where personnel or designated areas will potentially be exposed to the internal contents of the piping system
(5) Performing hot work, including but not limited to welding, cutting or brazing on the piping system

[**55:**7.1.18.3.1]

63.3.1.19.3.2 The termination point for the release of purged gases shall be in accordance with 63.2.15. [**55:**7.1.18.3.2]

63.3.1.19.3.2.1 The release of purged gases or mixtures containing any quantity of corrosive, toxic, or highly toxic gases shall be through a treatment system in accordance with the applicable requirements of 63.3.5.3.4 or 63.3.9.3. [**55:**7.1.18.3.2.1]

Δ **63.3.1.19.3.2.2** The termination point for the release of purged gases resultant from the purging of piping systems out of service, other than those in accordance with 63.3.1.19.3.2.1, shall not be required to be in accordance with 63.2.15 where the contained volume of the piping system when released to indoor areas does not result in a concentration in the room or area that will reduce the oxygen concentration in the room or area below a level of 19.5 percent or that exceeds any of the following limits:

(1) Ceiling limit
(2) Permissible exposure limit
(3) Short term exposure limit
(4) Twenty-five percent of the lower flammable limit

[**55:**7.1.18.3.2.2]

63.3.2 Storage.

63.3.2.1 General.

Δ **63.3.2.1.1 Applicability.** The storage of compressed gas cylinders, containers, and tanks shall be in accordance with 63.3.2. [**55:**7.2.1.1]

63.3.2.1.2 Upright Storage Flammable Gas in Solution and Liquefied Flammable Gas. Cylinders, containers, and tanks containing liquefied flammable gases and flammable gases in solution shall be positioned in the upright position. [**55:**7.2.1.2]

63.3.2.1.2.1 Cylinders and Containers of 1.3 Gal (5 L) or Less. Containers with a capacity of 1.3 gal (5 L) or less shall be permitted to be stored in a horizontal position. [**55:**7.2.1.2.1]

63.3.2.1.2.2 Cylinders, Containers, and Tanks Designed for Horizontal Use. Cylinders, containers, and tanks designed for use in a horizontal position shall be permitted to be stored in a horizontal position. [**55:**7.2.1.2.2]

63.3.2.1.2.3 Palletized Cylinders, Containers, and Tanks. Cylinders, containers, and tanks, with the exception of those containing flammable liquefied compressed gases, that are palletized for transportation purposes shall be permitted to be stored in a horizontal position. [**55:**7.2.1.2.3]

63.3.2.1.3 Classification of Weather Protection as an Indoor Versus an Outdoor Area. For other than explosive materials and hazardous materials presenting a detonation hazard, a weather protection structure shall be permitted to be used for sheltering outdoor storage or use areas without requiring such areas to be classified as indoor storage. [**55:**7.2.1.3]

63.3.2.2 Material-Specific Regulations.

63.3.2.2.1 Indoor Storage. Indoor storage of compressed gases shall be in accordance with the material-specific provisions of 63.3.4 through 63.3.10. [**55:**7.2.2.1]

63.3.2.2.2 Exterior Storage.

63.3.2.2.2.1 General. Exterior storage of compressed gases shall be in accordance with the material-specific provisions of 63.3.4 through 63.3.10. [**55:**7.2.2.2.1]

63.3.2.2.2.2 Separation. Distances from property lines, buildings, and exposures shall be in accordance with the material-specific provisions of 63.3.4 through 63.3.10. [**55:**7.2.2.2.2]

63.3.3 Use and Handling.

63.3.3.1 General.

63.3.3.1.1 Applicability. The use and handling of compressed gas cylinders, containers, tanks, and systems shall be in accordance with 63.3.3.1. [**55:**7.3.1.1]

63.3.3.1.2 Controls.

63.3.3.1.2.1 Compressed gas system controls shall be designed to prevent materials from entering or leaving the process at an unintended time, rate, or path. [**55:**7.3.1.2.1]

63.3.3.1.2.2 Automatic controls shall be designed to be fail-safe. [**55:**7.3.1.2.2]

Δ **63.3.3.1.3 Piping Systems.** Piping, tubing, fittings, and related components shall be designed, fabricated, and tested in accordance with the requirements of the applicable parts in ASME B31.3, *Process Piping*. [**55:**7.3.1.3]

63.3.3.1.3.1 Integrity. Piping, tubing, pressure regulators, valves, and other apparatus shall be kept gastight to prevent leakage. [**55:**7.3.1.3.1]

63.3.3.1.3.2 Backflow Prevention. Backflow prevention or check valves shall be provided where the backflow of hazardous materials could create a hazardous condition or cause the unauthorized discharge of hazardous materials. [**55:**7.3.1.3.2]

63.3.3.1.4 Valves.

63.3.3.1.4.1 Valves utilized on compressed gas systems shall be designed for the gas or gases and pressure intended and shall be accessible. [**55:**7.3.1.4.1]

63.3.3.1.4.2 Valve handles or operators for required shutoff valves shall not be removed or otherwise altered to prevent access. [**55:**7.3.1.4.2]

63.3.3.1.5 Vent Pipe Termination.

63.3.3.1.5.1 Venting of gases shall be directed to an approved location. [**55:**7.3.1.5.1]

63.3.3.1.5.2 The termination point for piped vent systems serving cylinders, containers, tanks, and gas systems used for the purpose of operational or emergency venting shall be in accordance with 63.2.15. [**55:**7.3.1.5.2]

63.3.3.1.6 Upright Use.

63.3.3.1.6.1 Compressed gas cylinders, containers, and tanks containing flammable liquefied gas, except those designed for use in a horizontal position and those compressed gas cylinders, containers, and tanks containing nonliquefied gases, shall be used in a "valve end up" upright position. [**55:**7.3.1.6.1]

63.3.3.1.6.2 An upright position shall include a position in which the cylinder, container, or tank axis is inclined as much as 45 degrees from the vertical and in which the relief device is always in direct communication with the gas phase. [**55:**7.3.1.6.2]

63.3.3.1.7 Inverted Use. Cylinders, containers, and tanks containing nonflammable liquefied gases shall be permitted to be used in the inverted position when the liquid phase is used. [**55:**7.3.1.7]

63.3.3.1.7.1 Flammable liquefied gases at processing plants shall be permitted to use this inverted position method while transfilling. [**55:**7.3.1.7.1]

63.3.3.1.7.2 The cylinder, container, or tank shall be secured, and the dispensing apparatus shall be designed for use with liquefied gas. [**55:**7.3.1.7.2]

63.3.3.1.8 Cylinders and Containers of 1.3 Gal (5 L) or Less. Cylinders or containers with a water volume of 1.3 gal (5 L) or less shall be permitted to be used in a horizontal position. [**55:**7.3.1.8]

63.3.3.1.9 Transfer. Transfer of gases between cylinders, containers, and tanks shall be performed by qualified personnel using equipment and operating procedures in accordance with CGA P-1, *Safe Handling of Compressed Gases in Containers*. [**55:**7.3.1.9]

63.3.3.1.10 Use of Compressed Gases for Inflation. Inflatable equipment, devices, or balloons shall only be pressurized or filled with compressed air or inert gases. [**55:**7.3.1.10]

The use of hydrogen, which is a flammable gas, for balloons or other inflatable equipment and devices, is prohibited by NFPA 55.

63.3.3.1.11 Emergency Shutoff Valves.

Δ **63.3.3.1.11.1** Accessible manual or automatic emergency shutoff valves shall be provided to shut off the flow of gas in case of emergency. [**55:**7.3.1.11.1]

63.3.3.1.11.1.1* Manual emergency shutoff valves or the device that activates an automatic emergency shutoff valve on a bulk source or piping system serving the bulk supply shall be identified by means of a sign. [**55:**7.3.1.11.1.1]

A.63.3.3.1.11.1.1 In operations where an automatic emergency shutoff valve is activated by a control system that is operated from a remote station or by remote station software, the software system should be designed to provide a visual indication of the emergency shutdown control system. The visual emergency shutdown function should be able to be identified by trained operators and recognizable to emergency response personnel. [**55:**A.7.3.1.11.1.1]

• **63.3.3.1.11.2** Emergency shutoffs shall be located at the point of use and at the tank, cylinder, or bulk source, and at the point where the system piping enters the building. [**55:**7.3.1.11.2]

63.3.3.1.12 Emergency Isolation.

63.3.3.1.12.1 Where compressed gases having a hazard ranking in one or more of the following hazard classes in accordance with NFPA 704 are carried in pressurized piping above a gauge pressure of 15 psi (103 kPa), an approved method of emergency isolation shall be provided:

(1) Health hazard Class 3 or Class 4
(2) Flammability Class 4
(3) Instability Class 3 or Class 4
[**55:**7.3.1.12.1]

• **63.3.3.1.12.2** Approved means of meeting the requirements for emergency isolation shall include any of the following:

(1) Automatic shutoff valves, located as close to the bulk source as practical, tied to leak detection systems
(2) Attended control stations where trained personnel can monitor alarms or supervisory signals and can trigger emergency responses
(3) A constantly monitored control station with an alarm and remote shut off of the gas supply system
(4) Excess flow valves at the bulk source
[**55:**7.3.1.12.2]

The purpose of excess flow control is to shut down the source of the gas if the piping system ruptures. The use of leak detection and emergency shutoff is a common method of accomplishing a shutdown, and it is used throughout the industry in instances where gases are located in gas cabinets or other enclosed spaces.

There are other portions of the system where excess flow control is not warranted, including those portions of the system designed to prevent the backflow from the source container, as well as for portions of the system serving pressure relief devices.

63.3.3.1.12.3 The requirements of 63.3.3.1.12 shall not be required for the following:

(1) Piping for inlet connections designed to prevent backflow at the source
(2) Piping for pressure relief devices
(3) Where the source of the gas is not in excess of the quantity threshold indicated in Table 63.2.3.1.1
[**55:**7.3.1.12.3]

• **63.3.3.1.12.4 Location Exemptions.** The requirements of 63.3.3.1.12 shall not apply to the following:

(1) Piping for inlet connections designed to prevent backflow
(2) Piping for pressure relief devices
(3) Systems containing 430 scf (12.7 m^3) or less of flammable gas
[**55:**7.3.1.12.4]

63.3.3.2 Material-Specific Regulations.

63.3.3.2.1 Indoor Use. Indoor use of compressed gases shall be in accordance with the requirements of 63.3.4 through 63.3.10. [**55:**7.3.2.1]

63.3.3.2.2 Exterior Use.

63.3.3.2.2.1 General. Exterior use of compressed gases shall be in accordance with the requirements of 63.3.4 through 63.3.10. [**55:**7.3.2.2.1]

63.3.3.2.2.2 Separation. Distances from property lines, buildings, and exposure hazards shall be in accordance with the material-specific provisions of 63.3.4 through 63.3.10. [**55:**7.3.2.2.2]

63.3.3.3 Handling.

Δ **63.3.3.3.1 Applicability.** The handling of compressed gas cylinders, containers, and tanks shall be in accordance with 63.3.3.3. [**55:**7.3.3.1]

63.3.3.3.2 Carts and Trucks.

63.3.3.3.2.1 Cylinders, containers, and tanks shall be moved using an approved method. [**55:**7.3.3.2.1]

Δ **63.3.3.3.2.2** Where cylinders, containers, and tanks are moved by hand cart, hand truck, or other mobile device, such carts, trucks, or devices shall be designed for the secure movement of cylinders, containers, and tanks. [**55:**7.3.3.2.2]

63.3.3.3.3 Lifting Devices. Ropes, chains, or slings shall not be used to suspend compressed gas cylinders, containers, and tanks unless provisions at time of manufacture have been made on the cylinder, container, or tank for appropriate lifting attachments, such as lugs. [**55:**7.3.3.3]

Δ **63.3.4 Medical Gas Systems.** Medical gas systems for health care shall be in accordance with NFPA 99. [**55:**7.4]

63.3.5 Corrosive Gases.

63.3.5.1 General. The storage or use of corrosive compressed gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 63.2.3.1.1 shall be in accordance with Chapters 1 through 6 of NFPA 55 and 63.3.1 through 63.3.3 and 63.3.5. [**55:**7.5.1]

63.3.5.2 Distance to Exposures. The outdoor storage or use of corrosive compressed gas shall not be within 20 ft (6.1 m) of buildings not associated with the manufacture or distribution of corrosive gases, lot lines, streets, alleys, public ways, or means of egress. [**55:**7.5.2]

63.3.5.2.1 A 2-hour fire barrier wall without openings or penetrations and that extends not less than 30 in. (762 mm) above and to the sides of the storage or use area shall be permitted in lieu of the 20 ft (6.1 m) distance. [**55:**7.5.2.1]

63.3.5.2.1.1* Where a fire barrier is used to protect compressed gas systems, the system shall terminate downstream of the source valve. [**55:**7.5.2.1.1]

Leaks in a piping system pose a risk for the system. However, the piping system is protected against major failure by the requirements for excess flow control. A protective structure provides a barrier to radiant heat, protecting elements on the side of the structure opposite the compressed gas system and shielding the compressed gas system from exposures on the other side of the structure.

A.63.3.5.2.1.1 Portions of the system upstream of the source valve include the containers or bulk supply as well as control equipment designed to control the flow of gas into a piping system. The piping system downstream of the source valve is protected by excess flow control should failure occur in the piping system and is not required to be protected by the fire barrier. The fire barrier serves to protect those portions of the system that are the most vulnerable along with the necessary controls used to operate the system. [**55:**A.7.5.2.1.1]

63.3.5.2.1.2 The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area. [**55:**7.5.2.1.2]

The use of a 2-hour fire barrier has been recognized as a suitable means to minimize exposure hazards to materials in storage or in use, as well as to act as a protective barrier between the material stored or used and the building structure. See the commentary following 63.3.5.2.1.1.

63.3.5.2.1.3 The 2-hour fire barrier shall be located at least 5 ft (1.5 m) from any exposure. [**55:**7.5.2.1.3]

63.3.5.2.1.4 The 2-hour fire barrier wall shall not have more than two sides at approximately 90 degree (1.57 rad) directions or not more than three sides with connecting angles of approximately 135 degrees (2.36 rad). [**55:**7.5.2.1.4]

63.3.5.3 Indoor Use. The indoor use of corrosive gases shall be provided with a gas cabinet, exhausted enclosure, or gas room. [**55:**7.5.3]

63.3.5.3.1 Gas Cabinets. Gas cabinets shall be in accordance with 63.2.17. [**55:**7.5.3.1]

63.3.5.3.2 Exhausted Enclosures. Exhausted enclosures shall be in accordance with 63.2.18. [**55:**7.5.3.2]

63.3.5.3.3 Gas Rooms. Gas rooms shall be in accordance with 63.2.4. [**55:**7.5.3.3]

63.3.5.3.4 Treatment Systems. Treatment systems, except as provided for in 63.3.5.3.4.1, gas cabinets, exhausted enclosures, and gas rooms containing corrosive gases in use shall be provided with exhaust ventilation, with all exhaust directed to a treatment system designed to process the accidental release of gas. [**55:**7.5.3.4]

63.3.5.3.4.1 Treatment systems shall not be required for corrosive gases in use where provided with the following:

(1) Gas detection in accordance with 63.3.9.3.2.1.1
(2) Fail-safe automatic closing valves in accordance with 63.3.9.3.2.2

[**55:**7.5.3.4.1]

63.3.5.3.4.2 Treatment systems shall be capable of diluting, adsorbing, absorbing, containing, neutralizing, burning, or otherwise processing the release of corrosive gas in accordance with 63.3.9.3.4.1. [**55:**7.5.3.4.2]

63.3.5.3.4.3 Treatment system sizing shall be in accordance with 63.3.9.3.4. [**55:**7.5.3.4.3]

63.3.6 Flammable Gases.

63.3.6.1 Storage, Use, and Handling.

63.3.6.1.1* The storage or use of flammable gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 63.2.3.1.1 shall be in accordance with Chapters 1 through 6 of NFPA 55 and 63.3.1 through 63.3.3 and 63.3.6. [**55:**7.6.1.1]

N **A.63.3.6.1.1** All liquefied and nonliquefied flammable compressed gases are regulated by 63.3.6 unless they are specifically indicated as not applicable in accordance with 63.1.1.4. [**55:**A.7.6.1.1]

63.3.6.1.2 Storage, use, and handling of gaseous hydrogen shall be in accordance with 63.3.6.1 and Chapter 10 of NFPA 55. [**55:**7.6.1.2]

N **63.3.6.1.3** Storage, use, and handling of compressed natural gas shall be in accordance with 63.3.6.1. [**55:**7.6.1.3]

The past few years have seen an increase in the use of "portable" compressed natural gas tube trailers being used to provide fuel for heating, steam generation, and so forth. These trailers are used to provide natural gas in locations where pipelines are not available. Empty trailers are swapped out for new ones as needed. Because compressed natural gas (CNG) is a flammable gas under NFPA 55, these installations must be designed and operated per NFPA 55.

Δ **63.3.6.2 Distance to Exposures.** The outdoor storage or use of non-bulk flammable compressed gas shall be located from lot lines, public streets, public alleys, public ways, or buildings not associated with the manufacture or distribution of such gases in accordance with Table 63.3.6.2. [**55:**7.6.2]

63.3.6.2.1 Bulk hydrogen gas installations shall be in accordance with Chapter 10 of NFPA 55. [**55:**7.6.2.1]

63.3.6.2.1.1* Where a protective structure is used to protect compressed gas systems, the system shall terminate downstream of the source valve. [**55:**7.6.2.1.1]

A.63.3.6.2.1.1 See A.63.3.5.2.1.1. [**55:**A.7.6.2.1.1]

63.3.6.2.1.2 The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area. [**55:**7.6.2.1.2]

63.3.6.2.2 Bulk gas systems for flammable gases other than hydrogen shall be in accordance with Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), or Table 10.4.2.2.1(c) of NFPA 55 where the quantity of flammable compressed gas exceeds 5000 scf (141.6 Nm^3). [**55:**7.6.2.2]

63.3.6.2.2.1 Where fire barriers are used as a means of distance reduction, fire barriers shall be in accordance with 10.4.2.2.4 of NFPA 55. [**55:**7.6.2.2.1]

Δ *TABLE 63.3.6.2 Distance to Exposures for Non—Bulk Flammable Gases*

Maximum Amount per Storage Area (scf)	Minimum Distance Between Storage Areas (ft)	Minimum Distance to Lot Lines of Property That Can Be Built Upon (ft)	Minimum Distance to Public Streets, Public Alleys or Public Ways (ft)	Minimum Distance to Buildings on the Same Property		
				Less Than 2-Hour Construction	2-Hour Construction	4-Hour Construction
0–4225	5	5	5	5	0	0
4226–21,125	10	10	10	10	5	0
21,126–50,700	10	15	15	20	5	0
50,701–84,500	10	20	20	20	5	0
84,501–200,000	20	25	25	20	5	0

For SI units, 1 ft = 304.8 mm; 1 scf = 0.02832 Nm^3.

Note: The minimum required distances does not apply where fire barriers without openings or penetrations having a minimum fire–resistive rating of 2 hours interrupt the line of sight between the storage and the exposure. The configuration of the fire barriers shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations. [**55:** Table 7.6.2]

63.3.6.2.2.2 Mobile acetylene trailer systems (MATS) shall be located in accordance with 15.2.3 of NFPA 55. [**55:**7.6.2.2.2]

63.3.6.2.3 The configuration of the protective structure shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations. [**55:**7.6.2.3]

63.3.6.2.4 Storage and use of flammable compressed gases shall not be located within 50 ft (15.2 m) of air intakes. [**55:**7.6.2.4]

63.3.6.2.5 Storage and use of flammable gases outside of buildings shall also be separated from building openings by 25 ft (7.6 m). Fire barriers shall be permitted to be used as a means to separate storage areas from openings or a means of egress used to access the public way. [**55:**7.6.2.5]

63.3.6.3 Indoor Non-Bulk Hydrogen Compressed Gas System Location.

Δ **63.3.6.3.1** Hydrogen systems of less than 5000 scf (141.6 Nm^3) and greater than the MAQ, where located inside buildings, shall be in accordance with the following:

(1) In a ventilated area in accordance with the provisions of 63.2.16
(2) Separated from incompatible materials in accordance with the provisions of 63.3.1.11.2
(3) A distance of 25 ft (7.6 m) from open flames and other sources of ignition
(4) A distance of 50 ft (15 m) from intakes of ventilation, air-conditioning equipment, and air compressors located in the same room or area as the hydrogen system
  (a) The distance shall be permitted to be reduced to 10 ft (3.1 m) where the room or area in which the hydrogen system is installed is protected by a listed detection system per Article 500.7(K) of *NFPA 70* and the detection system shuts down the fuel supply in the event of a leak that results in a concentration that exceeds 25 percent of the LFL.
  (b) Emergency shutoff valves shall be provided in accordance with 63.3.3.1.11.
(5) A distance of 50 ft (15 m) from other flammable gas storage
(6) Protected against damage in accordance with the provisions of 63.3.1.9.4.

[**55:**10.3.4.1]

63.3.6.3.2 Systems Installed in One Room.

63.3.6.3.2.1 More than one system of 5000 scf (141.6 Nm^3) or less shall be permitted to be installed in the same room or area, provided the systems are separated by at least 50 ft (15 m) or a full-height fire-resistive partition having a minimum fire resistance rating of 2 hours is located between the systems. [**55:**10.3.4.2.1]

Δ **63.3.6.3.2.2** The separation distance between multiple systems of 5000 scf (141.6 Nm^3) or less shall be permitted to be reduced to 25 ft (7.6 m) in buildings where the space between storage areas is free of combustible materials and protected with a sprinkler system designed for Extra Hazard, Group 1 occupancies in accordance with the requirements of 63.2.10. [**55:**10.3.4.2.2]

63.3.6.3.2.3 The required separation distance between individual portable systems in the process of being filled or serviced in facilities associated with the manufacture or distribution of hydrogen and its mixtures shall not be limited by 63.3.6.3.2.1 or 63.3.6.3.2.2 when such facilities are provided with Protection Level 2 controls and the applicable requirements of Chapters 1 through 7 of NFPA 55. [**55:**10.3.4.2.3]

63.3.6.4 Ignition Source Control. Ignition sources in areas containing flammable gases shall be in accordance with 63.3.6.4. [**55:**7.6.43]

63.3.6.4.1 Static Producing Equipment. Static producing equipment located in flammable gas areas shall be grounded. [**55:**7.6.3.1]

See NFPA 77, *Recommended Practice on Static Electricity*, for additional information on reducing ignition sources related to static electricity.

Δ TABLE 63.3.7.2 *Distance to Exposures for Oxidizing Gases*

Quantity of Gas Stored (at NTP)		Distance to a Building Not Associated with the Manufacture or Distribution of Oxidizing Gases or to a Public Way or Property Line		Minimum Distance Between Storage Areas	
scf	Nm³	ft	m	ft	m
0–50,000	0–1416	5	1.5	5	1.5
50,001–100,000	1417–2832	10	3.0	10	3.0
≤100,001	≤2833	15	4.6	15	4.6

[**55:** Table 7.7.2]

63.3.6.4.2 No Smoking or Open Flame. Signs shall be posted in areas containing flammable gases stating that smoking or the use of open flame, or both, is prohibited within 25 ft (7.6 m) of the storage or use area perimeter. [**55:**7.6.3.2]

See Section 10.9 for detailed guidance on smoking requirements.

63.3.6.4.3 Heating. Heating, where provided, shall be by indirect means. Equipment used for heating applications in rooms or areas where flammable gases are stored or used shall be listed and labeled for use in hazardous environments established by the gases present and shall be installed in accordance with the conditions of the listing and the manufacturer's installation instructions. [**55:**7.6.3.3]

63.3.6.5 Electrical. Areas in which the storage or use of compressed gases exceeds the quantity thresholds for gases requiring special provisions shall be in accordance with *NFPA 70*. [**55:**7.6.4]

63.3.6.6 Maintenance of Piping Systems.

63.3.6.6.1 Maintenance of flammable gas system piping and components shall be performed annually by a qualified representative of the equipment owner. [**55:**7.6.5.1]

63.3.6.6.2 This maintenance shall include inspection for physical damage, leak tightness, ground system integrity, vent system operation, equipment identification, warning signs, operator information and training records, scheduled maintenance and retest records, alarm operation, and other safety-related features. [**55:**7.6.5.2]

63.3.6.6.3 Scheduled maintenance and retest activities shall be formally documented, and records shall be maintained a minimum of 3 years. [**55:**7.6.5.3]

63.3.7 Oxidizing Gases.

63.3.7.1 General. The storage or use of oxidizing compressed gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 63.2.3.1.1 shall be in accordance with Chapters 1 through 6 of NFPA 55 and 63.3.1 through 63.3.3 and 63.3.7. [**55:**7.7.1]

63.3.7.2 Distance to Exposures. The outdoor storage or use of oxidizing compressed gas shall be in accordance with Table 63.3.7.2. [**55:**7.7.2]

63.3.7.2.1 The distances shall not apply where fire barriers having a minimum fire resistance of 2 hours interrupt the line of sight between the container and the exposure. [**55:**7.7.2.1]

63.3.7.2.1.1* Where a fire barrier is used to protect compressed gas systems, the system shall terminate downstream of the source valve. [**55:**7.7.2.1.1]

A.63.3.7.2.1.1 See A.63.3.5.2.1.1. [**55:**A.7.7.2.1.1]

63.3.7.2.1.2 The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area. [**55:**7.7.2.1.2]

The use of a 2-hour fire barrier has been recognized as a suitable means to minimize exposure hazards to materials in storage or in use, as well as to act as a protective barrier between the material stored or used and the building structure. See the commentary following 63.3.5.2.1.1.

63.3.7.2.2 The fire barrier shall be at least 5 ft (1.5 m) from the storage or use area perimeter. [**55:**7.7.2.2]

63.3.7.2.3 The configuration of the fire barrier shall allow natural ventilation to prevent the accumulation of hazardous gas concentrations. [**55:**7.7.2.3]

63.3.8 Pyrophoric Gases.

63.3.8.1 General. Pyrophoric compressed gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 63.2.3.1.1 shall be stored and used in accordance with Chapters 1 through 6 of NFPA 55 and 63.3.1 through 63.3.3 and 63.3.8. [**55:**7.8.1]

63.3.8.2 Silane and Silane Mixtures. Silane and silane mixtures shall be stored, used, and handled in accordance with the provisions of ANSI/CGA G-13, *Storage and Handling of Silane and Silane Mixtures*. [**55:**7.8.2]

63.3.8.3 Distance to Exposures. The outdoor storage or use of pyrophoric compressed gas shall be in accordance with Table 63.3.8.3. [**55:**7.8.3]

63.3.8.3.1 The distances shall be allowed to be reduced to 5 ft (1.5 m) where fire barriers having a minimum fire resistance of

Δ *TABLE 63.3.8.3 Distance to Exposures for Pyrophoric Gases*

Maximum Amount per Storage Area		Minimum Distance Between Storage Areas		Minimum Distance to Property Lines		Minimum Distance to Public Ways		Minimum Distance to Buildings on the Same Property					
								Less Than 2-Hour Construction		2-Hour Construction		4-Hour Construction	
scf	Nm^3	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
250	7.1	5	1.5	25	7.6	5	1.5	5	1.5	0	0	0	0
>250 to 2500	>7.1 to 71.0	10	3.0	50	15.2	10	3.0	10	3.0	5	1.5	0	0
>2500 to 7500	>71.0 to 212.4	20	6.0	100	30.5	20	6.0	20	6.0	10	3.0	0	0

[**55:** Table 7.8.3]

2 hours interrupt the line of sight between the container and the exposure. [**55:**7.8.3.1]

63.3.8.3.1.1* Where a fire barrier is used to protect compressed gas systems, the system shall terminate downstream of the source valve. [**55:**7.8.3.1.1]

A.63.3.8.3.1.1 See A.63.3.5.2.1.1. [**55:**A.7.8.3.1.1]

63.3.8.3.1.2 The fire barrier shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area. [**55:**7.8.3.1.2]

See the commentary following 63.3.5.2.1.1.

63.3.8.3.1.3 The fire barrier shall be at least 5 ft (1.5 m) from the storage or use area perimeter. [**55:**7.8.3.1.3]

63.3.8.3.1.4 The configuration of the fire barrier shall allow natural ventilation to prevent the accumulation of hazardous gas concentrations. [**55:**7.8.3.1.4]

63.3.8.3.2 Storage and use of pyrophoric gases outside buildings shall be separated from building openings by 25 ft (7.6 m). [**55:**7.8.3.2]

63.3.8.3.2.1 Fire barriers shall be permitted to be used as a means to separate storage areas from building openings that are used to access the public way. [**55:**7.8.3.2.1]

63.3.9 Toxic and Highly Toxic Gases.

63.3.9.1 General. The storage or use of toxic and highly toxic gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 63.2.3.1.1 shall be in accordance with Chapters 1 through 6 of NFPA 55 and 63.3.1 through 63.3.3 and 63.3.9. [**55:**7.9.1]

Because toxic gases can affect people quickly, the storage provisions of 63.3.9.1 are stringent. Many gases do not have an odor and, when they exceed safety thresholds, can incapacitate people before mitigating action can be taken.

63.3.9.2 Ventilation and Arrangement.

63.3.9.2.1 Indoors. The indoor storage or use of highly toxic gases or toxic gases shall be provided with a gas cabinet, exhausted enclosure, or gas room. [**55:**7.9.2.1]

63.3.9.2.1.1 Gas cabinets shall be in accordance with 63.2.17. [**55:**7.9.2.1.1]

63.3.9.2.1.2 Exhausted enclosures shall be in accordance with 63.2.18. [**55:**7.9.2.1.2]

63.3.9.2.1.3 Gas rooms shall be in accordance with 63.2.4. [**55:**7.9.2.1.3]

63.3.9.2.2 Distance to Exposures. The outdoor storage or use of toxic or highly toxic compressed gases shall not be within 75 ft (23 m) of lot lines, streets, alleys, public ways or means of egress, or buildings not associated with such storage or use. [**55:**7.9.2.2]

63.3.9.2.2.1 A 2-hour fire barrier wall without openings or penetrations that extends not less than 30 in. (762 mm) above and to the sides of the storage or use area and that interrupts the line of sight between the storage or use area and the exposure shall be permitted in lieu of the 75 ft (23 m) distance. [**55:**7.9.2.2.1]

63.3.9.2.2.1.1* Where a fire barrier is used to protect compressed gas systems, the system shall terminate downstream of the source valve. [**55:**7.9.2.2.1.1]

A.63.3.9.2.2.1.1 See A.63.3.5.2.1.1. [**55:**A.7.9.2.2.1.1]

See the commentary following 63.3.5.2.1.1.

63.3.9.2.2.1.2 The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area. [**55:**7.9.2.2.1.2]

63.3.9.2.2.1.3 The 2-hour fire barrier wall shall be located at least 5 ft (1.5 m) from any exposure. [**55:**7.9.2.2.1.3]

63.3.9.2.2.1.4 The 2-hour fire barrier wall shall not have more than two sides at approximately 90 degree (1.5 rad) directions or more than three sides with connecting angles of approximately 135 degrees (2.36 rad). [**55:**7.9.2.2.1.4]

63.3.9.2.2.2 Where the storage or use area is located closer than 75 ft (23 m) to a building not associated with the manufacture or distribution of toxic or highly toxic compressed gases, openings in the building other than for piping shall not be permitted above the height of the top of the 2-hour fire barrier wall or within 50 ft

(15 m) horizontally from the storage area, regardless of whether the openings are shielded by a fire barrier. [**55:**7.9.2.2.2]

63.3.9.2.3 Air Intakes. Storage and use of toxic and highly toxic compressed gases shall not be located within 75 ft (23 m) of air intakes. [**55:**7.9.2.3]

Because the dispersion patterns for gases are site specific, preventing toxic gases from entering structures is important.

Gases disperse on the basis of the meteorological conditions (wind speed and temperature), the release velocity and temperature, and the geometric relationship of the discharge point to nearby structures. At some locations, a gas release might move up and away from the release point. At other locations, downwash effects might occur, and the release might be pulled toward the ground (and possibly enter the facility through an opening in the building). Because dispersion patterns are site specific (based on how the parameters mentioned previously vary from site to site) and could require some complex air dispersion modeling, predicting where a release is headed might be difficult.

63.3.9.3 Treatment Systems. Except as provided in 63.3.9.3.1 and 63.3.9.3.2, gas cabinets, exhausted enclosures, and gas rooms containing toxic or highly toxic gases shall be provided with exhaust ventilation, with all exhaust directed to a treatment system designed to process accidental release of gas. [**55:**7.9.3]

Δ **63.3.9.3.1 Storage of Toxic or Highly Toxic Gases.** Treatment systems shall not be required for toxic or highly toxic gases in storage where cylinders, containers, and tanks are provided with the controls specified in 63.3.9.3.1.1 through 63.3.9.3.1.3. [**55:**7.9.3.1]

63.3.9.3.1.1 Valve Outlets Protected. Valve outlets shall be equipped with outlet plugs or caps, or both, rated for the container service pressure. [**55:**7.9.3.1.1]

63.3.9.3.1.2 Handwheels Secured. Where provided, handwheel-operated valves shall be secured to prevent movement. [**55:**7.9.3.1.2]

63.3.9.3.1.3 Containment Devices Provided. Approved cylinder containment vessels or cylinder containment systems shall be provided at an approved location. [**55:**7.9.3.1.3]

Δ **63.3.9.3.2 Use of Toxic Gases.** Treatment systems shall not be required for toxic gases in use where cylinders, containers, and tanks are provided with the controls specified in 63.3.9.3.2.1 and 63.3.9.3.2.2. [**55:**7.9.3.2]

63.3.9.3.2.1 Gas Detection.

63.3.9.3.2.1.1 A gas detection system with a sensing interval not exceeding 5 minutes shall be provided. [**55:**7.9.3.2.1.1]

63.3.9.3.2.1.2 The gas detection system shall monitor the exhaust system at the point of discharge from the gas cabinet, exhausted enclosure, or gas room. [**55:**7.9.3.2.1.2]

63.3.9.3.2.2 Fail-Safe Automatic Closing Valve. An approved automatic-closing fail-safe valve shall be located on or immediately adjacent to and downstream of active cylinder, container, or tank valves. [**55:**7.9.3.2.2]

63.3.9.3.2.2.1 The fail-safe valve shall close when gas is detected at the permissible exposure limit, short-term exposure limit (STEL), or ceiling limit by the gas detection system. [**55:**7.9.3.2.2.1]

63.3.9.3.2.2.2 For attended operations, a manual closing valve shall be permitted when in accordance with 63.3.9.3.4.3. [**55:**7.9.3.2.2.2]

63.3.9.3.2.2.3 For gases used at unattended operations for the protection of public health, such as chlorine at water or wastewater treatment sites, the automatic valve shall close if the concentration of gas detected by a gas detection system reaches one-half of the IDLH. [**55:**7.9.3.2.2.3]

63.3.9.3.2.2.4 The gas detection system shall also alert persons on-site and a responsible person off-site when the gas concentration in the storage/use area reaches the OSHA PEL, OSHA ceiling limit, or OSHA/STEL for the gas employed. [**55:**7.9.3.2.2.4]

Workplace exposures are commonly expressed as time-weighted average (TWA) concentrations that use one of two established terms to define the specific exposure limits permitted for a specific chemical substance: *permissible exposure limit* (PEL) and *threshold limit value* (TLV). Both terms represent the concentration levels that will not cause adverse effects, illness, or disease for persons exposed to a particular hazardous substance in the workplace. The U.S. Department of Labor Occupational Safety and Health Administration (OSHA) establishes the PEL in its regulations for toxic and hazardous substances, which are found in 29 CFR 1910.1000, "Air Contaminants." The PEL includes established limits that are valid on an 8-hour basis (TWA); on a short-term basis [short-term exposure limit (STEL)], which is usually 15 minutes; or as a ceiling concentration level, which means exposures are no longer treated as averages. The TLV, developed by the American Conference of Governmental Industrial Hygienists (ACGIH), essentially follows the same defining criteria to establish values for TWA levels, STEL levels, or ceiling levels for various materials as testing and/or anecdotal data suggest. These data are available from the following primary sources: the ACGIH publication *TLVs® and BEIs®: Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices;* and OSHA, 29 CFR 1910, Subpart Z, "Toxic and Hazardous Substances," for PEL values. In addition to the specific sources identified, these data can also be obtained from the *NIOSH Pocket Guide to Chemical Hazards* and material-specific material safety data sheets (MSDS).

63.3.9.3.3 Treatment System Design and Performance. Treatment systems shall be capable of diluting, adsorbing, absorbing, containing, neutralizing, burning, or otherwise processing stored or used toxic or highly toxic gas, or both. [**55:**7.9.3.3]

63.3.9.3.3.1 Where a total containment system is used, the system shall be designed to handle the maximum anticipated pressure of release to the system when it reaches equilibrium. [**55:**7.9.3.3.1]

63.3.9.3.3.2 Treatment systems shall be capable of reducing the allowable discharge concentrations to one-half the IDLH threshold at the point of discharge. [**55:**7.9.3.3.2]

63.3.9.3.4 Treatment System Sizing.

63.3.9.3.4.1 Worst-Case Release of Gas. Treatment systems shall be sized to process the maximum worst-case release of gas based on the maximum flow rate of release from the largest vessel utilized in accordance with 63.3.9.3.4.2. [**55:**7.9.3.4.1]

63.3.9.3.4.2 Largest Compressed Gas Vessel. The entire contents of the single largest compressed gas vessel shall be considered. [**55:**7.9.3.4.2]

63.3.9.3.4.3 Attended Operations — Alternative Method of System Sizing.

63.3.9.3.4.3.1 Where source cylinders, containers, and tanks are used in attended process operations, with an operator present at the enclosure where the activity occurs, the volume of the release shall be limited to the estimated amount released from the process piping system within a period not to exceed 5 minutes. [**55:**7.9.3.4.3.1]

63.3.9.3.4.3.2 Such process piping systems shall comply with the requirements of 63.3.9.3.4.3.2(A) through 63.3.9.3.4.3.2(E). [**55:**7.9.3.4.3.2]

(A) Local Exhaust. All gas transfer operations shall be conducted within a zone of local exhaust that is connected to a treatment system. [**55:**7.9.3.4.3.2(A)]

Δ **(B) Gas Detection.** Gas detection shall be used to provide a warning to alert the operators to emission of gas into the zone of local exhaust, and the following requirements also shall apply:

(1) The system shall be capable of detecting gas at the permissible exposure limit (PEL) or the ceiling limit for the gas being processed.
(2) Activation of the gas detection system shall provide a local alarm.

[**55:**7.9.3.4.3.2(B)]

(C) Process Shutdown. Operations involving the gas detected shall be shut down and leaks repaired. [**55:**7.9.3.4.3.2(C)]

(D) Piping System Construction. Piping systems used to convey gases shall be of all-welded construction throughout, with the exception of fittings used to connect cylinders, containers, or tanks, or any combination thereof, to the process system. [**55:**7.9.3.4.3.2(D)]

(E) Piping System Accessibility. Piping systems shall be designed to provide for readily accessible manual shutdown controls. [**55:**7.9.3.4.3.2(E)]

63.3.9.3.5 Rate of Release. The time release shall be in accordance with Table 63.3.9.3.5 for the type of container indicated. [**55:**7.9.3.5]

Although Table 63.3.9.3.5 is entitled Rates of Release, the table provides not release rates but the maximum times in which the entire contents of the container can be released. The rate referred to is actually the volume of the container divided by the time given in the table.

TABLE 63.3.9.3.5 *Rates of Release*

	Time Release	
Container Type	**Nonliquefied Gases**	**Liquefied Gases**
Cylinders without restrictive flow orifices	5 minutes	30 minutes
Portable tanks without restrictive flow orifices	40 minutes	240 minutes
All others	Based on peak flow from maximum valve orifice	Based on peak flow from maximum valve orifice

[**55:** Table 7.9.3.5]

63.3.9.3.6* Maximum Flow Rate of Release.

A.63.3.9.3.6 The areas for typical restricted flow orifices are shown in Table A.63.3.9.3.6. [**55:**A.7.9.3.6]

63.3.9.3.6.1 For portable cylinders, containers, and tanks, the maximum flow rate of release shall be calculated based on assuming the total release from the cylinder or tank within the time specified. [**55:**7.9.3.6.1]

63.3.9.3.6.2* When portable cylinders, containers, or tanks are equipped with reduced flow orifices, the worst-case rate of release shall be determined by the maximum achievable flow from the valve based on the following formula:

$$CFM = (767 \times A \times P)\frac{(28.96/MW)^{1/2}}{60} \qquad \textbf{[63.3.9.3.6.2]}$$

where:

CFM = standard cubic feet per minute of gas of concern under flow conditions

A = area of orifice in square inches *(See Table A.63.3.9.3.6 for areas of typical restricted flow orifices.)*

P = supply pressure of gas at NTP in pounds per square inch absolute

MW = molecular weight [**55:**7.9.3.6.2]

TABLE A.63.3.9.3.6 *Typical Orifice Areas*

Orifice Diameter in.	Orifice Diameter cm	Area in.²	Area cm²
0.006	0.015	2.83×10^{-5}	1.83×10^{-4}
0.010	0.025	7.85×10^{-5}	5.06×10^{-4}
0.014	0.036	1.54×10^{-4}	9.93×10^{-4}

[**55:** Table A.7.9.3.6]

A.63.3.9.3.6.2 The formula has been taken from industry publications including the Scott Specialty Gases *Design and Safety Handbook*. It is based on estimated flow rates for air at 70°F (21°C) discharging to normal atmospheric pressure through an average shape and quality orifice. It can be assumed to be ±15 percent accurate. Correction factors have been built into the formula as presented in 63.3.9.3.6.2 to accommodate the use of gases other than air (e.g., use of specific gravity data). [**55:**A.7.9.3.6.2]

The following information is provided courtesy of The Dow Chemical Company to explain how to calculate the derivation of the gas release rate given in 63.3.9.3.6.2.

The gas release rate starts with the following equation:

$$CFM = (767)\,AP\,\frac{(28.96/MW)}{60} \qquad (1)$$

where:

CFM = gas release rate (ft³/min)
A = area of orifice (in.²)
P = pressure of gas (psia)
MW = molecular weight of gas (lb/lb-mole)

The equation is derived as follows:

1. Start the derivation with the equation for choked flow, which is shown as Equation (2):

$$m = C_D A \quad P\rho\gamma \left(\frac{2}{\gamma + 1}\right)^{(\gamma+1)/(\gamma-1)} \qquad (2)$$

where:

m = mass release rate (kg/s)
C_D = discharge coefficient (dimensionless)
A = opening area (m²)
P = pressure of gas (Pascals)
ρ = gas density (kg/m³)
γ = ratio of specific heats (dimensionless)

2. Rewrite gas density based on the Ideal Gas Law, which is shown as Equation (3):

$$\rho = \frac{P(MW)}{RT} \qquad (3)$$

where:

MW = molecular weight (kg/kmole)
R = gas constant (8314 J/°K-kmole)
T = temperature (K)

Substituting Equation (3) into Equation (2),

$$m = C_D AP \quad \frac{1}{T} \quad \frac{MW}{8314} \quad \gamma \left(\frac{2}{\gamma + 1}\right)^{(\gamma+1)/(\gamma-1)} \qquad (4)$$

3. Convert metric units to English:

$$Q = (132.275)(6894.76)(6.452 \times 10^{-4}) \qquad (5)$$

$$C_D AP \quad \frac{1}{T} \quad \frac{MW}{8314} \quad \gamma \left(\frac{2}{\gamma + 1}\right)^{(\gamma+1)/(\gamma-1)}$$

$$Q = (6.45)C_D AP \quad \frac{1}{T} \quad MW \quad \gamma \left(\frac{2}{\gamma + 1}\right)^{(\gamma+1)/(\gamma-1)} \qquad (6)$$

where:

Q = release rate (pounds/minute)
132.275 = conversion factor for lb/min to kg/s
6894.76 = conversion factor for psi to Pascals
6.452×10^{-4} = conversion factor for in.² to m²

4. Solve Equation (6) for the following conditions since Equation (1) is based on air at 70°F (294.26 K):

$$\gamma_{air} = 1.401 \qquad \text{so} \qquad \gamma \left(\frac{2}{\gamma + 1}\right)^{(\gamma+1)/(\gamma-1)} = 0.685$$

$$Q = (6.45) \quad \frac{1}{294.26} \quad 28.96 \; (0.685) = 1.386\, C_D AP \qquad (7)$$

5. Use Equation (1) to determine the value of C_D, by using the *MW* of air to determine a relationship for *CFM* and then ratio the result from Equation (7) to determine the value of C_D:

$$CFM = (767)AP\,\frac{(28.96/MW)}{60} = 12.783\,AP \text{ (for air)}$$

$$Q/CFM = \frac{1.386\, C_D AP}{12.783\, AP} = 0.1084\, C_D$$

Note that at 70°F, air density is 0.0745 lb/ft³, so C_D would need to be 0.687, which is a reasonable value (range typically 0.6 to 1.0), and then calculate the following from Equation (6):

$$Q = (6.45)(0.687)\,AP \quad \frac{1}{294.26} \quad MW \; (0.685) = 0.177\,AP \quad MW \qquad (8)$$

Expressing release rate as volume flow (ft³/min) as follows:

$$Q_v = \frac{0.177\,AP \quad MW}{\rho} \qquad (9)$$

6. The final step in the derivation of the equation shown in Equation (1) is shown below:

Equation (1) is essentially a ratio of the release rate of a gas, compared to the release rate of air. To derive this equation from Equation (9), start with Equation (9) written for air as follows:

$$Q_{air} = \frac{0.177\,AP\ \ 28.96}{\rho_{air}} \quad (10)$$

Then, the ratio of Equation (9) to Equation (10) is calculated as follows:

$$\frac{Q_v}{Q_{air}} = \frac{0.177\,AP\ \ MW/\rho}{0.177\,AP\ \ 28.96/\rho_{air}} = \frac{MW\rho_{air}}{28.96\rho} \quad (11)$$

Substituting Equation (3) into Equation (11) as follows:

$$\frac{Q_v}{Q_{air}} = \frac{MW(28.96)}{(MW)\ \ 28.96} = \frac{28.96}{MW} \quad (12)$$

Therefore, the equation would be as follows:

$$Q_v = Q_{air}\ \frac{28.96}{MW} \quad (13)$$

Substituting Equation (10) into Equation (13), with ρ_{air} = 0.0745 lb/ft^3, gives the following calculation:

$$Q_v = Q_{air}\ \frac{28.96}{MW} = (12.78)\,AP\ \frac{28.96}{MW} = \frac{(767)\,AP\ \frac{28.96}{MW}}{60} \quad (14)$$

where:

Q = release rate (ft^3/min)

A = opening area (in.^{2})

P = pressure (psia)

Hence, the equation is as follows:

$$CFM = (767)\,AP\ \frac{(28.96/MW)}{60}$$

Note that NFPA 55 states that this equation is based on air at 70°F, with some built-in correction factors. Those correction factors are not stated. For gases other than air, the value of γ will be different. For the equation to be valid for other gases, the product of the γ-term and C_D would need to be 0.4705. From the U.S. Environmental Protection Agency document *Risk Management Program Guidance for Offsite Consequence Analysis*, γ ranges from 1.07 to 1.41. This determination would lead to a range of C_D values of 0.686 to 0.756. These values are in the range typically assigned for C_D (0.6 to 1.0). Therefore, the equation in 63.3.9.3.6.2 would be valid for gases other than air.

63.3.9.3.6.3 For mixtures, the average of the molecular weights shall be used. [**55:**7.9.3.6.3]

63.3.9.4 Leaking Cylinders, Containers, and Tanks. When cylinders, containers, or tanks are used outdoors in excess of the quantities specified in Table 63.2.3.1.1 in the column for unsprinklered areas (unprotected by gas cabinets or exhausted enclosures), a gas cabinet, exhausted enclosure, or containment vessel or system shall be provided to control leaks from leaking cylinders, containers, and tanks in accordance with 63.3.9.4.1 through 63.3.9.4.2.3. [**55:**7.9.4]

63.3.9.4.1 Gas Cabinets or Exhausted Enclosures. Where gas cabinets or exhausted enclosures are provided to handle leaks from cylinders, containers, or tanks, exhaust ventilation shall be provided that is directed to a treatment system in accordance with the provisions of 63.3.9.3. [**55:**7.9.4.1]

63.3.9.4.2 Containment Vessels or Systems. Where containment vessels or containment systems are provided, they shall comply with the requirements of 63.3.9.4.2.1 through 63.3.9.4.2.3. [**55:**7.9.4.2]

63.3.9.4.2.1 Performance. Containment vessels or containment systems shall be capable of fully containing or terminating a release. [**55:**7.9.4.2.1]

63.3.9.4.2.2 Personnel. Trained personnel capable of operating the containment vessel or containment system shall be available at an approved location. [**55:**7.9.4.2.2]

63.3.9.4.2.3 Location. Containment vessels or systems shall be capable of being transported to the leaking cylinder, container, or tank. [**55:**7.9.4.2.3]

63.3.9.5 Emergency Power.

63.3.9.5.1 General. Emergency power shall comply with the requirements of 63.3.9.5 in accordance with *NFPA 70*. [**55:**7.9.5.1]

63.3.9.5.2 Alternative to Emergency Power. Emergency power shall not be required where fail-safe engineering is provided for mechanical exhaust ventilation, treatment systems, and temperature control, and standby power is provided to alternative systems that utilize electrical energy. [**55:**7.9.5.2]

63.3.9.5.3 Where Required. Emergency power shall be provided for the following systems:

(1) Exhaust ventilation
(2) Treatment system
(3) Gas detection system
(4) Temperature control system
(5) Required alarm systems

[**55:**7.9.5.3]

63.3.9.5.4 Level. Emergency power systems shall comply with the requirements for a Level 2 system in accordance with NFPA 110. [**55:**7.9.5.4]

63.3.9.6 Gas Detection. Except as provided in 63.3.9.6.1, a continuous gas detection system in accordance with the requirements of 63.3.9.6.2 through 63.3.9.6.6 shall be provided for the indoor storage or use of toxic or highly toxic compressed gases. [**55:**7.9.6]

63.3.9.6.1 Where Gas Detection Is Not Required. A gas detection system shall not be required for toxic gases where the physiological warning properties for the gas are at a level below the accepted PEL or the ceiling limit for the gas. [**55:**7.9.6.1]

63.3.9.6.2 Local Alarm. The gas detection system shall initiate a local alarm that is both audible and visible. [**55:**7.9.6.2]

63.3.9.6.3 Alarm Monitored. The gas detection system shall transmit a signal to a constantly attended control station for quantities exceeding one toxic or highly toxic compressed gas cylinder. [**55:**7.9.6.3]

63.3.9.6.4 Automatic Shutdown.

63.3.9.6.4.1 Activation of the gas detection system shall automatically shut off the flow of gas related to the system being monitored. [**55:**7.9.6.4.1]

63.3.9.6.4.2 An automatic shutdown shall not be required for reactors utilized for the production of toxic or highly toxic gases when such reactors are operated at gauge pressures less than 15 psi (103.4 kPa), constantly attended, and provided with readily accessible emergency shutoff valves. [**55:**7.9.6.4.2]

63.3.9.6.5 Detection Points. Detection shall be provided at the locations specified in 63.3.9.6.5.1 through 63.3.9.6.5.4. [**55:**7.9.6.5]

63.3.9.6.5.1 Treatment System Discharge. Detection shall be provided at the discharge from the treatment system. [**55:**7.9.6.5.1]

63.3.9.6.5.2 Point of Use. Detection shall be provided in the room or area in which the gas is used. [**55:**7.9.6.5.2]

63.3.9.6.5.3 Source. Detection shall be provided at the source cylinder, container, or tank used for delivery of the gas to the point of use. [**55:**7.9.6.5.3]

63.3.9.6.5.4 Storage. Detection shall be provided in the room or area in which the gas is stored. [**55:**7.9.6.5.4]

63.3.9.6.6 Level of Detection. The gas detection system shall detect the presence of gas at or below the PEL or the ceiling limit of the gas for those points identified in 63.3.9.6.5.2 and 63.3.9.6.5.3 and at not less than one-half the IDLH level for points identified in 63.3.9.6.5.1. [**55:**7.9.6.6]

The provision of this requirement specifies that a gas detection system be used along with smoke detection. Advance warning when heat detection is being used in a sprinklered facility provides no specific benefit, because an increase in heat is not an indicator of dangerous levels of gas leakage. The heat being detected is not associated with the hazard of the leaking gas.

63.3.9.7 Automatic Smoke Detection System. An automatic smoke detection system shall be provided for the indoor storage or use of highly toxic compressed gases in accordance with *NFPA 72*. [**55:**7.9.7]

63.3.10 Unstable Reactive Gases (Nondetonable). The storage or use of unstable reactive (nondetonable) gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 63.2.3.1.1 shall be in accordance with Chapters 1 through 6 of NFPA 55 and 63.3.1 through 63.3.3 and 63.3.10. [**55:**7.10]

63.3.10.1 Distances to Exposures for Class 2.

63.3.10.1.1 The outdoor storage or use of unstable reactive Class 2 compressed gas shall not be within 20 ft (6 m) of buildings, lot lines, streets, alleys, or public ways or means of egress. [**55:**7.10.1.1]

63.3.10.1.2 A 2-hour fire barrier wall without openings or penetrations shall be permitted in lieu of the 20 ft (6 m) distance required by 63.3.10.1.1. [**55:**7.10.1.2]

63.3.10.1.2.1* Where a fire barrier wall is used to protect compressed gas systems, the system shall terminate downstream of the source valve. [**55:**7.10.1.2.1]

A.63.3.10.1.2.1 See A.63.3.5.2.1.1. [**55:**A.7.10.1.2.1]

A protective structure provides a barrier to radiant heat, protecting elements on the side of the structure opposite the compressed gas system and shielding the compressed gas system from exposures on the other side of the structure.

63.3.10.1.2.2 The fire barrier wall shall be either an independent structure or the exterior wall of the building. [**55:**7.10.1.2.2]

63.3.10.1.2.3 The 2-hour fire barrier wall shall be located at least 5 ft (1.5 m) from any exposure. [**55:**7.10.1.2.3]

63.3.10.1.2.4 The 2-hour fire barrier wall shall not have more than two sides at approximately 90 degree (1.57 rad) directions or not more than three sides with connecting angles of approximately 135 degrees (2.36 rad). [**55:**7.10.1.2.4]

63.3.10.2 Distances to Exposures for Class 3.

63.3.10.2.1 The outdoor storage or use of unstable reactive Class 3 (nondetonable) compressed gas shall not be within 75 ft (23 m) of buildings, lot lines, streets, alleys, or public ways or means of egress. [**55:**7.10.2.1]

63.3.10.2.2 A 2-hour fire barrier wall without openings or penetrations, extending not less than 30 in. (762 mm) above and to the sides of the storage or use area, that interrupts the line of sight between the storage or use and the exposure shall be permitted in lieu of the 75 ft (23 m) distance specified in 63.3.10.2.1. [**55:**7.10.2.2]

63.3.10.2.2.1* Where a fire barrier wall is used to protect compressed gas systems, the system shall terminate downstream of the source valve. [**55:**7.10.2.2.1]

A.63.3.10.2.2.1 See A.63.3.5.2.1.1. [**55:**A.7.10.2.2.1]

See the commentary following 63.3.5.2.1.1.

63.3.10.2.2.2 The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area. [**55:**7.10.2.2.2]

63.3.10.2.2.3 The 2-hour fire barrier wall shall be located at least 5 ft (1.5 m) from any exposure. [**55:**7.10.2.2.3]

63.3.10.2.2.4 The 2-hour fire barrier wall shall not have more than two sides at approximately 90 degree (1.57 rad) directions or more than three sides with connecting angles of approximately 135 degrees (2.36 rad). [**55:**7.10.2.2.4]

63.3.10.3 Storage Configuration.

63.3.10.3.1 Unstable reactive Class 3 compressed gases stored in cylinders, containers, or tanks shall be arranged to limit individual groups of cylinders, containers, or tanks to areas not exceeding 100 ft^2 (9.3 m^2). [**55:**7.10.3.1]

63.3.10.3.2 Multiple areas shall be separated by aisles. [**55:**7.10.3.2]

63.3.10.3.3 Aisle widths shall not be less than the height of the cylinders, containers, or tanks or 4 ft (1.2 m), whichever is greater. [**55:**7.10.3.3]

63.3.10.4 Basements. Unstable reactive compressed gases shall not be stored in basements. [**55:**7.10.4]

63.3.10.5 Unstable Reactive Gases (Detonable).

63.3.10.5.1 Storage or Use. The storage or use of unstable reactive (detonable) gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 63.2.3.1.1 shall be in accordance with Chapters 1 through 6 of NFPA 55, 63.3.1 through 63.3.3, and 63.3.10.5. [**55:**7.10.5.1]

63.3.10.5.2 Location. The location of storage areas shall be determined based on the requirements of the building code for explosive materials. [**55:**7.10.5.2]

63.4 Cryogenic Fluids

63.4.1 General. This section shall apply to all cryogenic fluids, including those fluids regulated elsewhere in this *Code*, except that where specific requirements are provided in Sections 63.5, 63.7, or 63.11, those specific requirements shall apply in accordance with the applicable chapter. [**55:**8.1]

63.4.1.1 Storage, use, and handling of cryogenic fluids shall be in accordance with Chapters 1 through 6 of NFPA 55 and Section 63.4 as applicable. [**55:**8.1.1]

63.4.2* Containers — Design, Construction, and Maintenance. Containers employed for the storage or use of cryogenic fluids shall be designed, fabricated, tested, marked (stamped), and maintained in accordance with DOT regulations; Transport Canada (TC), *Transportation of Dangerous Goods Regulations*; the ASME *Boiler and Pressure Vessel Code*, "Rules for the Construction of Unfired Pressure Vessels"; or regulations of other administering agencies. [**55:**8.2]

A.63.4.2 Pressure vessels of any type can be subject to additional regulations imposed by various states or other legal jurisdictions. Users should be aware that compliance with DOT or ASME requirements might not satisfy all the required regulations for the location in which the vessel is to be installed or used. [**55:**A.8.2]

63.4.2.1 Aboveground Tanks. Aboveground tanks for the storage of cryogenic fluids shall be in accordance with 63.4.2.1. [**55:**8.2.1]

The requirements of 63.4.2.1 and its subparagraphs were added to the 2010 edition of NFPA 55 to address aboveground tanks storing cryogenic fluids and the construction provisions for both the inner vessel and the vacuum jacket (outer vessel). In addition to the provisions specified, it is mandatory that the inner vessel of storage tanks used in cryogenic fluid service be designed and constructed in accordance with the applicable sections of ASME's *Boiler and Pressure Vessel Code*. Cryogenic fluids are defined as fluids with a boiling point lower than 130°F (90°C) at an absolute pressure of 14.7 psi (101.3 kPa).

63.4.2.1.1 Construction of the Inner Vessel. The inner vessel of storage tanks in cryogenic fluid service shall be designed and constructed in accordance with Section VIII, Division 1 of the ASME *Boiler and Pressure Vessel Code* and shall be vacuum jacketed in accordance with 63.4.2.1.2. [**55:**8.2.1.1]

63.4.2.1.2 Construction of the Vacuum Jacket (Outer Vessel).

63.4.2.1.2.1 The vacuum jacket used as an outer vessel for storage tanks in cryogenic fluid service shall be of welded steel construction designed to withstand the maximum internal and external pressure to which it will be subjected under operating conditions to include conditions of emergency pressure relief of the annular space between the inner vessel and the outer vessel. [**55:**8.2.1.2.1]

63.4.2.1.2.2 The jacket shall be designed to withstand a minimum collapsing pressure differential of 30 psi (207 kPa). [**55:**8.2.1.2.2]

63.4.2.1.2.3 Vacuum Level Monitoring.

63.4.2.1.2.3.1 A connection shall be provided on the exterior of the vacuum jacket to allow measurement of the pressure within the annular space between the inner vessel and the outer vessel. [**55:**8.2.1.2.3.1]

63.4.2.1.2.3.2 The connection shall be fitted with a bellows-sealed or diaphragm-type valve equipped with a vacuum gauge tube that is shielded to protect against damage from impact. [**55:**8.2.1.2.3.2]

63.4.2.2 Nonstandard Containers.

63.4.2.2.1 Containers, equipment, and devices that are not in compliance with recognized standards for design and construction shall be permitted if approved by the AHJ upon presentation of evidence that they are designed and constructed for safe operation. [**55:**8.2.2.1]

63.4.2.2.2 The following data shall be submitted to the AHJ with reference to the deviation from the standard with the application for approval:

(1) Type and use of container, equipment, or device
(2) Material to be stored, used, or transported
(3) Description showing dimensions and materials used in construction
(4) Design pressure, maximum operating pressure, and test pressure
(5) Type, size, and setting of pressure relief devices

[**55:**8.2.2.2]

63.4.2.3 Foundations and Supports. Stationary tanks shall be provided with concrete or masonry foundations or structural steel supports on firm concrete or masonry foundations, and the requirements of 63.4.2.3.1 through 63.4.2.3.5 also shall apply. [**55:**8.2.3]

63.4.2.3.1 Excessive Loads. Stationary tanks shall be supported to prevent the concentration of excessive loads on the supporting portion of the shell. [**55:**8.2.3.1]

63.4.2.3.2 Expansion and Contraction. Foundations for horizontal containers shall be constructed to accommodate expansion and contraction of the container. [**55:**8.2.3.2]

63.4.2.3.3* Support of Ancillary Equipment.

A.63.4.2.3.3 Vaporizers or heat exchangers used to vaporize cryogenic fluids can accumulate a large load of ice during operation. Additional requirements to be considered in the design include snow load for the area where the installation is located as well as the requirements for seismic conditions. The operating conditions of systems vary, and the designer has a responsibility to consider all the loads that might be imposed. Foundations that could be used to support delivery vehicles as well might require special consideration relevant to live loads as well as for the dead loads imposed by the equipment itself. [**55:**A.8.2.3.3]

63.4.2.3.3.1 Foundations shall be provided to support the weight of vaporizers or heat exchangers. [**55:**8.2.3.3.1]

63.4.2.3.3.2 Foundations shall be designed to withstand soil and frost conditions as well as the anticipated seismic, snow, wind, and hydrostatic loading under operating conditions. [**55:**8.2.3.3.2]

63.4.2.3.4 Temperature Effects. Where drainage systems, terrain, or surfaces beneath stationary tanks are arranged in a manner that can subject stationary tank foundations or supports to temperatures below –130°F (–90°C), the foundations or supports shall be constructed of materials that are capable of withstanding the low-temperature effects of cryogenic fluid spillage. [**55:**8.2.3.4]

If cryogenic fluids are released, they will immediately boil. The resulting cold vapor will likely cause water in the air to condense. The result might be a fog or mist that reduces visibility in the area of the release.

63.4.2.3.5 Corrosion Protection. Portions of stationary tanks in contact with foundations or saddles shall be painted to protect against corrosion. [**55:**8.2.3.5]

63.4.2.4 Pressure Relief Devices.

63.4.2.4.1 General.

63.4.2.4.1.1 Pressure relief devices shall be provided to protect containers and systems containing cryogenic fluids from rupture in the event of overpressure. [**55:**8.2.4.1.1]

63.4.2.4.1.2 Pressure relief devices shall be designed in accordance with CGA S-1.1, *Pressure Relief Device Standards — Part 1 — Cylinders for Compressed Gases*, and CGA S-1.2, *Pressure Relief Device Standards — Part 2 — Cargo and Portable Tanks for Compressed Gases,* for portable tanks; and CGA S-1.3, *Pressure Relief Device Standards — Part 3 — Stationary Storage Containers for Compressed Gases,* for stationary tanks. [**55:**8.2.4.1.2]

63.4.2.4.2 Containers Open to the Atmosphere. Portable containers that are open to the atmosphere and are designed to contain cryogenic fluids at atmospheric pressure shall not be required to be equipped with pressure relief devices. [**55:**8.2.4.2]

63.4.2.4.3 Equipment Other Than Containers. Heat exchangers, vaporizers, insulation casings surrounding containers, vessels, and coaxial piping systems in which liquefied cryogenic fluids could be trapped due to leakage from the primary container shall be provided with a pressure relief device. [**55:**8.2.4.3]

63.4.2.4.4 Sizing.

63.4.2.4.4.1 Pressure relief devices shall be sized in accordance with the specifications to which the container was fabricated. [**55:**8.2.4.4.1]

63.4.2.4.4.2 The pressure relief device shall have the capacity to prevent the maximum design pressure of the container or system from being exceeded. [**55:**8.2.4.4.2]

63.4.2.4.5 Accessibility. Pressure relief devices shall be located such that they are accessible for inspection and repair. [**55:**8.2.4.5]

63.4.2.4.5.1* ASME pressure relief valves shall be made to be tamper resistant in order to prevent adjusting of the set pressure by other than authorized personnel. [**55:**8.2.4.5.1]

A.63.4.2.4.5.1 Pressure relief valves typically are spring-loaded valves where the relief pressure is set by adjustment of a spring. Valves should be made to be tamper resistant in order to prevent adjustment by other than authorized personnel typically found at a retest facility. An ASME pressure relief valve is designed to comply with the requirements of the ASME *Boiler and Pressure Vessel Code* and typically is equipped with a wire and lead seal to resist tampering. [**55:**A.8.2.4.5.1]

63.4.2.4.5.2 Non-ASME pressure relief valves shall not be field adjusted. [**55:**8.2.4.5.2]

63.4.2.4.6 Arrangement.

63.4.2.4.6.1 Pressure Relief Devices. Pressure relief devices shall be arranged to discharge unobstructed to the open air in such a manner as to prevent impingement of escaping gas on personnel, containers, equipment, and adjacent structures or its entrance into enclosed spaces. [**55:**8.2.4.6.1]

63.4.2.4.6.2 Portable Containers with Volume Less Than 2.0 scf (0.057 Nm^3).

63.4.2.4.6.2.1 The arrangement of the discharge from pressure relief devices from DOT-specified containers with an internal water volume of 2.0 scf (0.057 Nm^3) or less shall be incorporated in the design of the container. [**55:**8.2.4.6.2.1]

63.4.2.4.6.2.2 Additional safeguards regarding placement or arrangement shall not be required. [**55:**8.2.4.6.2.2]

63.4.2.4.7 Shutoffs Between Pressure Relief Devices and Containers.

63.4.2.4.7.1 General. Shutoff valves installed between pressure relief devices and containers shall be in accordance with 63.4.2.4.7. [**55:**8.2.4.7.1]

63.4.2.4.7.2 Location. Shutoff valves shall not be installed between pressure relief devices and containers unless the valves or their use meet the requirements of 63.4.2.4.7.2.1 or 63.4.2.4.7.2.2. [**55:**8.2.4.7.2]

63.4.2.4.7.2.1* Security. Shutoff valves shall be locked in the open position, and their use shall be limited to service-related work performed by the supplier under the requirements of the ASME *Boiler and Pressure Vessel Code*. [**55:**8.2.4.7.2.1]

N **A.63.4.2.4.7.2.1** The ASME *Boiler and Pressure Vessel Code* requires that full-area stop valves be locked open and provided with manual vent valves for maintaining pressure during maintenance operations. Further, the ASME Code requires that if the full-area stop valve is closed, an operator must be present at all times to maintain the vessel pressure within acceptable limits and must lock the full-area stop valve in the open position before leaving the station. See the ASME *Boiler and Pressure Vessel Code* for complete details and requirements. [**55:**A.8.2.4.7.2.1]

Δ **63.4.2.4.7.2.2 Multiple Pressure Relief Devices.** Shutoff valves controlling multiple pressure relief devices on a container shall be installed so that either the type of valve installed or the arrangement provides the full required flow through the relief devices at all times. [**55:**8.2.4.7.2.2]

63.4.2.4.8 Temperature Limits. Pressure relief devices shall not be subjected to cryogenic fluid temperatures except when operating. [**55:**8.2.4.8]

63.4.3 Pressure Relief Vent Piping.

63.4.3.1 General. Pressure relief vent piping systems shall be constructed and arranged to direct the flow of gas to a safe location and in accordance with 63.4.3. [**55:**8.3.1]

63.4.3.2 Sizing. Pressure relief device vent piping shall have a cross-sectional area not less than that of the pressure relief device vent opening and shall be arranged so as not to restrict the flow of escaping gas. [**55:**8.3.2]

63.4.3.3 Arrangement. Pressure relief device vent piping and drains in vent lines shall be arranged so that escaping gas discharges unobstructed to the open air and does not impinge on personnel, containers, equipment, and adjacent structures or enter enclosed spaces. [**55:**8.3.3]

63.4.3.4 Installation. Pressure relief device vent lines shall be installed in a manner that excludes or removes moisture and condensation to prevent malfunction of the pressure relief device due to freezing or ice accumulation. [**55:**8.3.4]

63.4.3.5 Overfilling. Controls shall be provided to prevent overfilling of stationary containers. [**55:**8.3.5]

63.4.4 Marking.

63.4.4.1 General. Cryogenic containers and systems shall be marked in accordance with nationally recognized standards and in accordance with 63.4.4. [**55:**8.4.1]

63.4.4.1.1 Portable Containers.

63.4.4.1.1.1 Portable cryogenic containers shall be marked in accordance with CGA C-7, *Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers*. [**55:**8.4.1.1.1]

63.4.4.1.1.2* All DOT-4L/TC-4LM liquid cylinders shall have product identification visible from all directions with minimum 2 in. (51 mm) high letters. [**55:**8.4.1.1.2]

A.63.4.4.1.1.2 An example of this identification is 360 degree wraparound tape. [**55:**A.8.4.1.1.2]

63.4.4.1.2 Stationary Tanks. Stationary tanks shall be marked in accordance with NFPA 704. [**55:**8.4.1.2]

63.4.4.1.3 Identification Signs. Visible hazard identification signs shall be provided in accordance with NFPA 704 at entrances to buildings or areas in which cryogenic fluids are stored, handled, or used. [**55:**8.4.1.3]

63.4.4.2 Identification of Contents. Stationary containers shall be placarded with the identity of their contents to indicate the name of the material contained. [**55:**8.4.2]

The name on the required placard should not be a trade name or other name that would not be readily understood by emergency response personnel (see Exhibit 63.3).

63.4.4.3 Container Specification. Stationary containers shall be marked with the manufacturing specification and maximum allowable working pressure on a permanent nameplate. [**55:**8.4.3]

63.4.4.3.1 The nameplate shall be installed on the container in an accessible location. [**55:**8.4.3.1]

63.4.4.3.2 The nameplate shall be marked in accordance with nationally recognized standards. [**55:**8.4.3.2]

63.4.4.4 Identification of Container Connections.

63.4.4.4.1 Container inlet and outlet connections, liquid-level limit controls, valves, and pressure gauges shall be identified using one of the methods prescribed by 63.4.4.4.1.1 through 63.4.4.4.1.2. [**55:**8.4.4.1]

63.4.4.4.1.1 They shall be marked with a permanent tag or label identifying their function. [**55:**8.4.4.1.1]

63.4.4.4.1.2 They shall be identified by a schematic drawing that indicates their function and designates whether they are connected to the vapor or liquid space of the container. [**55:**8.4.4.1.2]

63.4.4.4.1.2.1 When a schematic drawing is provided, it shall be attached to the container and maintained in a legible condition. [**55:**8.4.4.1.2.1]

Exhibit 63.3

Signage on cryogenic fluid container.

63.4.4.5 Identification of Piping Systems. Piping systems shall be identified in accordance with ASME A13.1, *Scheme for the Identification of Piping Systems*. [**55:**8.4.5]

63.4.4.6 Identification of Emergency Shutoff Valves. Emergency shutoff valves on stationary containers shall be identified, visible, and indicated by means of a sign. [**55:**8.4.6]

63.4.5 Medical Cryogenic Systems.

63.4.5.1 Bulk cryogenic fluid systems in medical gas applications at health care facilities shall be in accordance with Section 63.4, 63.1.1.4(3), and the material-specific requirements of Chapter 9 of NFPA 55 as applicable. [**55:**8.5.1]

63.4.5.1.1 Bulk cryogenic fluid systems shall be in accordance with the following provisions as applicable:

(1) Where located in a court, systems shall be in accordance with 63.4.13.2.7.2.
(2) Where located indoors, systems shall be in accordance with 63.4.14.11.1.
(3) Systems shall be installed by personnel qualified in accordance with CGA M-1, *Guide for Medical Gas Installations at Consumer Sites,* or ASSE 6015, *Professional Qualification Standard for Bulk Medical Gas Systems Installers.*
(4) Systems shall be installed in compliance with Food and Drug Administration Current Good Manufacturing Practices as found in 21 CFR 210 and 21 CFR 211.

[**55:**8.5.1.1]

63.4.5.1.2 The following components of the bulk system shall be accessible and visible to delivery personnel during filling operations:

(1) Fill connection
(2) Top and bottom fill valves
(3) Hose purge valve
(4) Vent valve
(5) Full trycock valve
(6) Liquid level gauge
(7) Tank pressure gauge

[**55:**8.5.1.2]

63.4.5.1.3 Bulk cryogenic fluid systems shall be anchored with foundations in accordance with the provisions of CGA M-1, *Guide for Medical Gas Installations at Consumer Sites*. [**55:**8.5.1.3]

63.4.5.1.4 Bulk cryogenic fluid systems shall consist of the following:

(1) One or more main supply vessel(s), whose capacity shall be determined after consideration of the customer usage requirements, delivery schedules, proximity of the facility to alternative supplies, and the emergency plan
(2) A contents gauge on each of the main vessel(s)
(3) A reserve supply sized for greater than an average day's supply, with the size of vessel or number of cylinders being determined after consideration of delivery schedules, proximity of the facility to alternative supplies, and the facility's emergency plan

(4) At least two main vessel relief valves and rupture discs installed downstream of a three-way (three-port) valve
(5) A check valve located in the primary supply piping upstream of the intersection with a secondary supply or reserve supply

[**55:**8.5.1.4]

63.4.5.1.5 Bulk cryogenic fluid reserve supply systems consisting of either a second cryogenic fluid source or a compressed gas source shall include the following:

(1) When the reserve source is a compressed gas source, the reserve shall be equipped with the following:
   (a) A cylinder manifold having not less than three gas cylinder connections or as otherwise required for an average of one day's gas supply
   (b) A pressure switch to monitor the pressure in the cylinder manifold
(2) When the reserve source is a second cryogenic fluid vessel, the reserve tank shall be equipped with the following:
   (a) An actuating switch or sensor to monitor the internal tank pressure
   (b) A contents gauge to monitor the liquid level
(3) When the reserve source is either a cryogenic fluid or compressed gas source, a check valve shall be provided to prevent backflow into the reserve system

[**55:**8.5.1.5]

63.4.5.1.6 Bulk cryogenic fluid systems shall include a fill mechanism consisting of the following components:

(1) A nonremovable product-specific fill connection in compliance with CGA V-6, *Standard Cryogenic Liquid Transfer Connection*
(2) A means to cap and secure the fill connection inlet
(3) A check valve to prevent product backflow from the fill inlet
(4) A fill hose purge valve
(5) Supports that hold the fill piping off the ground
(6) A secure connection between the bulk tank and the fill piping
(7) Supports as necessary to hold the fill line in position during all operations associated with the filling procedure

[**55:**8.5.1.6]

63.4.5.1.7 Where vaporizers are required to convert cryogenic liquid to the gaseous state, the vaporizer units shall conform to the following:

(1) Be permitted to operate by either ambient heat transfer or external thermal source (e.g., electric heater, hot water, steam)
(2) Be designed to provide capacity for the customer's peak and average flow rates under local conditions, seasonal conditions for weather and humidity, and structures that obstruct air circulation flow and sunlight
(3) If switching is required as part of the system design, have piping and manual/automatic valving configured in such a manner that operating vaporizer(s) or sections of the vaporizer can be switched to nonoperating vaporizer or section of the vaporizer to de-ice through a valving configuration that ensures continuous flow to the facility through either or both vaporizers and/or sections of the vaporizer if valving switchover fails

[**55:**8.5.1.7]

63.4.5.1.8 Where a vaporizer requires an external thermal source, the flow from the source of supply shall be unaffected by the loss of the external thermal source through either of the following:

(1) Reserve ambient heat transfer vaporizers capable of providing capacity for at least one day's average supply and piped so as to be unaffected by flow stoppage through the main vaporizer
(2) A reserve noncryogenic source capable of providing at least one day's average supply

[**55:**8.5.1.8]

63.4.6 Security.

63.4.6.1 General. Cryogenic containers and systems shall be secured against accidental dislodgement and against access by unauthorized personnel in accordance with 63.4.6. [**55:**8.6.1]

63.4.6.2* Security of Areas. Areas used for the storage of containers and systems shall be secured against unauthorized entry. [**55:**8.6.2]

A.63.4.6.2 The purpose of this requirement is to prevent unauthorized personnel or those unfamiliar with cryogenic storage systems from tampering with the equipment. Where the bulk storage system is located in an area open to the general public, a common practice is to fence the system and lock it, with access restricted to supplier personnel and sometimes user personnel. When the bulk storage system is located within the user's secure area and is not open to the general public, it is not always necessary to fence the bulk storage system. Personnel access patterns may still mandate that the system be fenced, as determined by the supplier and the user. [**55:**A.8.6.2]

The Annex A material for 63.4.6.2 provides more specific guidance on fencing of bulk storage systems. As explained in the annex, the primary purpose of security is to prevent tampering and unauthorized use of cryogenic fluids by the general public. Many facilities are either fully fenced or otherwise provided with access control whereby only the users of the materials are permitted access. The intent of NFPA 55 was not to require that any storage or use be under lock and key or that the security provided be such that storage or use by facility employees was hampered by security controls. It is reasonable to expect that facilities that are not accessible by the general public have administrative procedures in place that directs the proper storage and use areas as well as specifying how the materials will be allowed to be used. Paragraph 63.3.1.9.3 does not mandate the use of administrative controls but allows administrative controls to be used as a means to limit access. In areas not accessible by the general public, the user has a choice as to whether to provide physical barriers as a means of protection or to otherwise restrict access through the use of policies and procedures. This flexibility is required by NFPA 55 to address practical application of these requirements.

63.4.6.2.1 Administrative controls shall be allowed to be used to control access to individual storage areas located in secure facilities not accessible by the general public. [**55:**8.6.2.1]

63.4.6.3 Securing of Containers. Stationary containers shall be secured to foundations in accordance with the building code. [**55:**8.6.3]

63.4.6.3.1 Portable containers subject to shifting or upset shall be secured. [**55:**8.6.3.1]

63.4.6.3.2 Nesting shall be permitted as a means of securing portable containers. [**55:**8.6.3.2]

63.4.6.4 Securing of Vaporizers. Vaporizers, heat exchangers, and similar equipment shall be secured to foundations, and their connecting piping shall be designed and constructed to provide for the effects of expansion and contraction due to temperature changes. [**55:**8.6.4]

The intent of 63.4.6.4 is for the design of the piping to accommodate expansion and contraction, so that the piping system does not fracture. In a portion of the system, expansion joints, as well as flexible connectors, can be used as a means of compensating for movement.

63.4.6.5 Physical Protection. Containers, piping, valves, pressure relief devices, regulating equipment, and other appurtenances shall be protected against physical damage and tampering. [**55:**8.6.5]

63.4.7 Separation from Hazardous Conditions.

63.4.7.1 General. Cryogenic containers and systems in storage or use shall be separated from materials and conditions that present exposure hazards to or from each other in accordance with 63.4.7. [**55:**8.7.1]

63.4.7.2* Stationary Cryogenic Containers. Stationary containers located outdoors shall be separated from exposure hazards in accordance with the minimum separation distances indicated in Table 63.4.7.2. [**55:**8.7.2]

TABLE 63.4.7.2 *Minimum Separation Distance Between Stationary Cryogenic Containers and Exposures*

Exposure	Minimum Distance ft	Minimum Distance m
(1) Buildings, regardless of construction type	1	0.3
(2) Wall openings	1	0.3
(3) Air intakes	10	3.1
(4) Property lines	5	1.5
(5) Places of public assembly (assembly occupancies)	50	15
(6) Nonambulatory patient areas	50	15
(7) Combustible materials, (e.g., paper, leaves, weeds, dry grass, debris)	15	4.5
(8) Incompatible hazardous materials	20	6.1
(9) Building exits	10	3.1

[**55:** Table 8.7.2]

A.63.4.7.2 It is not uncommon to have inert cryogenic fluids used to provide stage effects for theatrical performances that are conducted within assembly occupancies. The fluids are sometimes placed within these occupancies with special controls, including ventilation systems, fire detection systems, monitors for oxygen deficiency, warning signs, and remote fill indicating devices that indicate tank volume when a remote filling point is provided and stationary tanks are involved. Such installations are normally permitted on a case-by-case basis under the requirements of Section 1.5 of NFPA 55. [**55:**A.8.7]

Clearance is required from combustible materials to minimize the effects of exposure fires to the materials stored or used. The requirement to separate the materials from vegetation should not be interpreted to mean that the area is maintained free of all vegetation. In some settings, gas systems are located on grounds that are maintained with formal landscaping. Some judgment must be exercised to determine whether the vegetation poses what might be viewed as an exposure hazard to the materials stored. Cut lawns, formal landscaping, and similar vegetation do not ordinarily present a hazard, and should be allowed. On the other hand, tall, dry grass or weeds and vegetation that fringes on the border of an urban–wildland interface might be viewed as a hazard. [**55:**A.8.7.2]

Inert (i.e., nonflammable, nonoxidizing, and nontoxic) cryogenic fluids are used to provide stage effects for theatrical performances conducted within assembly occupancies. The fluids are sometimes used within these occupancies with special controls. In past editions of the *Code,* no requirement precluded the use of an inert cryogenic fluid in any assembly occupancy; however, by including the required separation in Table 63.4.7.2, it can be inferred that such use could be precluded. The provision of A.63.4.7.2 alerts the user and the AHJ to the potential hazards associated with such use without providing a prescriptive list of controls.

Formal landscaping in and around tanks in current modern facilities is not uncommon. Such installations are commonplace in medical and high tech facilities. The real problem is created by indiscriminate placement of waste materials, pallets, and wildland brush. The annex material alerts the user to the type of vegetation allowed.

63.4.7.2.1 Fire Barriers. A 2-hour fire barrier wall shall be permitted in lieu of the distances specified in Table 63.4.7.2 for items 1, 4, 7, 8 and 9, where in accordance with the provisions of 63.4.7.2.1.1 through 63.4.7.2.1.4. [**55:**8.7.2.1]

63.4.7.2.1.1 The fire barrier wall shall be without openings or penetrations. [**55:**8.7.2.1.1]

63.4.7.2.1.1.1 Penetrations of the fire barrier wall by conduit or piping shall be permitted provided that the penetration is protected with a firestop system in accordance with the building code. [**55:**8.7.2.1.1.1]

63.4.7.2.1.2 The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage system. [**55:**8.7.2.1.2]

63.4.7.2.1.3 The fire barrier wall shall be located not less than 5 ft (1.5 m) from any exposure. [**55:**8.7.2.1.3]

63.4.7.2.1.4 The fire barrier wall shall not have more than two sides at 90 degree (1.57 rad) directions or not more than three sides with connecting angles of 135 degrees (2.36 rad). [**55:**8.7.2.1.4]

63.4.7.2.1.4.1* The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 63.4.13.2.7.2. [**55:**8.7.2.1.4.1]

A.63.4.7.2.1.4.1 See Figure A.63.4.13.2.7.2.1, which addresses bulk cryogenic systems located in a courtyard. This figure also applies to the case where any or all of the three walls are constructed as fire barrier walls. [**55:**A.8.7.2.1.4.1]

Δ ***TABLE 63.4.7.3*** *Minimum Separation Distance Between Portable Cryogenic Containers and Exposures*

Exposure	Minimum Distance ft	Minimum Distance m
(1) Building exits	10	3.1
(2) Wall openings	1	0.3
(3) Air intakes	10	3.1
(4) Property lines	5	1.5
(5) Room or area exits	3	0.9
(6) Combustible materials, (e.g., paper, leaves, weeds, dry grass, or debris)	15	4.5
(7) Incompatible hazardous materials	20	6.1

[**55:** Table 8.7.3]

63.4.7.2.1.5 Where the requirement of 63.4.7.2.1.4 is met, the bulk system shall be a minimum distance of 1 ft (0.3 m) from the fire barrier wall. [**55:**8.7.2.1.5]

63.4.7.2.2 Point-of-Fill Connections. Point-of-fill connections serving stationary containers filled by mobile transport equipment shall not be positioned closer to exposures than the minimum distances in Table 63.4.7.2. [**55:**8.7.2.2]

63.4.7.2.3 Surfaces Beneath Containers. The surface of the area on which stationary containers are placed, including the surface of the area located below the point at which connections are made for the purpose of filling such containers, shall be compatible with the fluid in the container. [**55:**8.7.2.3]

63.4.7.3 Portable Cryogenic Containers. Portable containers used for cryogenic fluids located outdoors shall be separated from exposure hazards in accordance with Table 63.4.7.3. [**55:**8.7.3]

63.4.7.3.1 Non-bulk portable containers of liquefied hydrogen shall be separated from exposure hazards in accordance with Table 63.4.7.3.1. [**55:**8.7.3.1]

63.4.7.3.2 Fire Barriers. A 2-hour fire barrier wall shall be permitted in lieu of the distances specified by Table 63.4.7.3 or Table 63.4.7.3.1 when in accordance with the provisions of 63.4.7.3.2.1 through 63.4.7.3.2.4. [**55:**8.7.3.2]

63.4.7.3.2.1 The fire barrier wall shall be without openings or penetrations. [**55:**8.7.3.2.1]

63.4.7.3.2.1.1 Penetrations of the fire barrier wall by conduit or piping shall be permitted provided that the penetration is protected with a firestop system in accordance with the building code. [**55:**8.7.3.2.1.1]

Δ ***TABLE 63.4.7.3.1*** *Distance to Exposures for Non-Bulk Liquefied Hydrogen (LH_2)*

Maximum Amount per Storage Area (gal)	Minimum Distance Between Storage Areas (ft)	Minimum Distance to Lot Lines of Property That Can Be Built Upon (ft)	Minimum Distance to Public Streets, Public Alleys, or Public Ways (ft)	Minimum Distance to Buildings on the Same Property: Less than 2-Hour Construction	Minimum Distance to Buildings on the Same Property: 2-Hour Construction	Minimum Distance to Buildings on the Same Property: 4-Hour Construction
0–39.7	5	5	5	5	0	0
39.8–186.9	10	10	10	10	5	0
187–448.7	10	15	15	20	5	0
448.8–747.8	10	20	20	20	5	0
>747.8	20	25	25	20	5	0

For SI units: 1 ft = 305 mm.

Notes:

(1) For requirements on minimum distance to air intakes, see 63.3.6.2.4.

(2) For requirements on minimum distance to building openings including exits, see 63.3.6.2.5.

(3) When 63.4.7.3.2 is used as a means of distance reduction, the configuration of the fire barriers should be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

[**55:**Table 8.7.3.1]

63.4.7.3.2.2 The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage system. [**55:**8.7.3.2.2]

63.4.7.3.2.3 The fire barrier wall shall be located not less than 5 ft (1.5 m) from any exposure. [**55:**8.7.3.2.3]

63.4.7.3.2.4 The fire barrier wall shall not have more than two sides at approximately 90 degree (1.57 rad) directions, or not more than three sides with connecting angles of approximately 135 degrees (2.36 rad). [**55:**8.7.3.2.4]

63.4.8 Electrical Wiring and Equipment.

63.4.8.1 General. Electrical wiring and equipment shall be in accordance with *NFPA 70* and 63.4.8. [**55:**8.8.1]

63.4.8.2 Location. Containers and systems shall not be located where they could become part of an electrical circuit. [**55:**8.8.2]

63.4.8.3 Electrical Grounding and Bonding. Containers and systems shall not be used for electrical grounding. [**55:**8.8.3]

63.4.8.3.1 When electrical grounding and bonding are required, the system shall be in accordance with *NFPA 70*. [**55:**8.8.3.1]

63.4.8.3.2 The grounding system shall be protected against corrosion, including corrosion caused by stray electrical currents. [**55:**8.8.3.2]

63.4.9 Service and Repair. Service, repair, modification, or removal of valves, pressure relief devices, or other container appurtenances shall be in accordance with nationally recognized codes and standards. [**55:**8.9]

63.4.9.1 Containers. Containers that have been removed from service shall be handled in an approved manner. [**55:**8.9.1]

63.4.9.1.1 Testing. Containers out of service in excess of 1 year shall be inspected and tested as required under 63.4.9.1.2. [**55:**8.9.1.1]

63.4.9.1.2 Pressure Relief Device Testing. The pressure relief devices shall be tested for operability and to determine if they are set at the relief pressure required by the tank design. [**55:**8.9.1.2]

63.4.9.1.3 Containers that have previously been used for flammable cryogenic fluids and have been removed from service shall be purged with an inert gas to remove residual flammable gas and stored with all valves closed and the valve outlets plugged. [**55:**8.9.1.3]

63.4.9.2 Systems. Service and repair of containers or systems shall be performed by trained personnel in accordance with nationally recognized standards and with the permission of the container owner. [**55:**8.9.2]

Repairs to either containers or systems should be performed only when the owner of the container or system has full prior knowledge of the repairs and has given approval for such repairs. Repairs should be completed by personnel who have been trained to recognize standards and can provide adequate proof of such training to the owner of the container or system.

63.4.10 Unauthorized Use. Containers shall not be used for any purpose other than to serve as a vessel for containing the product for which it is designated. [**55:**8.10]

63.4.11 Leaks, Damage, and Corrosion.

63.4.11.1 Leaking, damaged, or corroded containers shall be removed from service. [**55:**8.11.1]

63.4.11.2 Leaking, damaged, or corroded systems shall be replaced, repaired, or removed from service. [**55:**8.11.2]

63.4.12 Lighting. Where required by the AHJ, lighting, including emergency lighting, shall be provided for fire appliances and operating facilities such as walkways, control valves, and gates ancillary to stationary containers. [**55:**8.12]

63.4.13 Storage.

63.4.13.1 Indoor Storage.

63.4.13.1.1 Installation. Stationary containers indoors shall be installed in accordance with Chapters 9 and 11 of NFPA 55 or with ANSI/CGA P-18, *Standard for Bulk Inert Gas Systems at Consumer Sites*. [**55:**8.13.1.1]

63.4.13.1.2 Stationary Containers. Stationary containers shall be in accordance with 63.4.2. [**55:**8.13.1.2]

63.4.13.1.3 Cryogenic Fluids. Cryogenic fluids in stationary or portable containers stored indoors shall be stored in buildings, rooms, or areas constructed in accordance with the building code. [**55:**8.13.1.3]

63.4.13.1.4 Ventilation. Ventilation shall be in accordance with 63.2.16. [**55:**8.13.1.4]

63.4.13.2 Outdoor Storage.

63.4.13.2.1 General. Cryogenic fluids in stationary or portable containers stored outdoors shall be in accordance with 63.4.13.2. [**55:**8.13.2.1]

63.4.13.2.2 Access. Stationary containers shall be located to provide access by mobile supply equipment and authorized personnel. [**55:**8.13.2.2]

63.4.13.2.2.1 Where exit access is provided to serve areas in which equipment is installed, the minimum width shall be not less than 28 in. (710 mm). [**55:**8.13.2.2.1]

Access is required in and around equipment. Some installations are quite complex, and designers should be aware that they need to provide egress from the area. NFPA *101®, Life Safety Code®*, establishes requirements for exit access.

63.4.13.2.3 Physical Protection. Cryogenic fluid containers, cylinders, tanks, and systems that could be exposed to physical damage shall be protected. [**55:**8.13.2.3]

63.4.13.2.3.1 Guard posts or other means shall be provided to protect cryogenic fluid containers, cylinders, tanks, and systems indoors and outdoors from vehicular damage. *(See Section 4.11 of NFPA 55.)* [**55:**8.13.2.3.1]

63.4.13.2.4 Diked Areas Containing Other Hazardous Materials. Containers of cryogenic fluids shall not be located within diked areas with other hazardous materials. [**55:**8.13.2.4]

63.4.13.2.5* Areas Subject to Flooding. Stationary containers located in flood hazard areas shall be anchored to prevent flotation during conditions of the design flood as designated by the building code. [**55:**8.13.2.5]

A.63.4.13.2.5 Flood hazard areas typically are identified on either (1) the special flood hazard area shown on the flood insurance rate map or (2) the area subject to flooding during the design flood and shown on a jurisdiction's flood hazard map or otherwise legally designated. [**55:**A.8.13.2.5]

Provisions were added to the 2010 edition of NFPA 55 to address elevated tanks and underground tanks in flood-prone areas. Areas subject to flooding are typically identified by the jurisdiction, with anticipated maximum flood levels designated by area. Underground tanks in areas subject to flooding are also of concern, and anchoring underground tanks to resist dislodgment due to buoyancy is an important consideration.

63.4.13.2.5.1 Elevated Tanks. Structures supporting elevated tanks and tanks that are supported at a level above that designated in the design flood shall be anchored to resist lateral shifting due to flood and other hydrostatic effects. [**55:**8.13.2.5.1]

63.4.13.2.5.2 Underground Tanks. Underground tanks in flood hazard areas shall be anchored to prevent flotation, collapse, or lateral movement resulting from hydrostatic loads, including the effects of buoyancy, during conditions of the design flood. [**55:**8.13.2.5.2]

63.4.13.2.6 Drainage.

Allowing spilled cryogens to pool is not a good idea, because pooling can delay evaporation and intensify the hazard. An important practice is to keep containers where such exposure will be limited (see 63.4.13.2.6.2) and to enhance the vaporization process (see 63.4.13.2.6.4) by swirling the liquid on a downgrade.

63.4.13.2.6.1 The area surrounding stationary and portable containers shall be provided with a means to prevent accidental discharge of fluids from endangering personnel, containers, equipment, and adjacent structures and from entering enclosed spaces in accordance with this *Code*. [**55:**8.13.2.6.1]

63.4.13.2.6.2 The stationary container shall not be placed where spilled or discharged fluids will be retained around the container. [**55:**8.13.2.6.2]

Δ **63.4.13.2.6.3** The provisions of 63.4.13.2.6.2 shall be permitted to be altered or waived where the AHJ determines that the container does not constitute a hazard after consideration of special features such as the following:

(1) Crushed rock utilized as a heat sink
(2) Topographical conditions
(3) Nature of occupancy
(4) Proximity to structures on the same or adjacent property
(5) Capacity and construction of containers and character of fluids to be stored

[**55:**8.13.2.6.3]

63.4.13.2.6.4 The grade for a distance of not less than 50 ft (15.2 m) from where cryogenic fluid storage or delivery systems are installed shall be higher than the grade on which flammable or combustible liquids are stored or used. [**55:**8.13.2.6.4]

63.4.13.2.6.4.1* Drainage Control.

(A) Where the grade differential between the storage or delivery system and the flammable or combustible liquids storage or use area is not in accordance with 63.4.13.2.6.4, diversion curbs or other means of drainage control shall be used to divert the flow of flammable or combustible liquids away from the cryogenic system. [**55:**8.13.2.6.4.1(A)]

(B) The means of drainage control shall prevent the flow of flammable or combustible liquid to a distance not less than 50 ft (15.2 m) from all parts of the delivery system. [**55:**8.13.2.6.4.1(B)]

Δ **A.63.4.13.2.6.4.1** The intent of these provisions is to make certain that the cryogenic installation is not exposed to the potential of a pool fire from the release of flammable or combustible liquids. Cryogenic fluids are not diked in order that they are allowed to dissipate should leakage occur. Studies conducted by NASA (NSS 1740.16, *Safety Standard for Hydrogen and Hydrogen Systems*) show that the use of dikes around liquid hydrogen storage facilities serves to prolong ground-level flammable cloud travel and that the dispersion mechanism is enhanced by vaporization-induced turbulence. The travel of spilled or leaked cryogenic fluid to distances greater than a few feet (meters) from the source given the nature of the typical leak is considered to be implausible due to the character of cryogenic fluids and their ability to quickly absorb heat from the surrounding environment. [**55:**A.8.13.2.6.4.1]

63.4.13.2.7 Outdoor Installations.

63.4.13.2.7.1 Enclosed Courts. Stationary containers shall not be installed within enclosed courts. [**55:**8.13.2.7.1]

63.4.13.2.7.2* Courts. Stationary containers shall be sited so that they are open to the surrounding environment except that encroachment by building walls of unlimited height shall be permitted when in accordance with the distances specified by Table 63.4.7.2 or the material-specific tables in Chapters 9, 11, 13, and 16 of NFPA 55. [**55:**8.13.2.7.2]

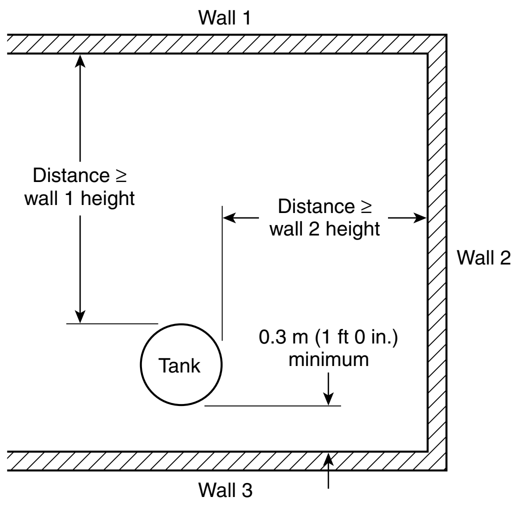
A.63.4.13.2.7.2 The placement of stationary containers is limited with respect to exposure hazards. Table 63.4.7.2 establishes the minimum separation distance between a building and any stationary tank at 1 ft (0.3 m). Additional limitations are placed on wall openings, air intakes, and other exposures. The material-specific tables for liquid hydrogen and liquid oxygen specify increased distances according to the type of construction adjacent to the tank. A problem arises when courtyards are configured so as to interrupt the free movement of air around a tank where an asphyxiation hazard, a flammable hazard, or an oxygen-enriched environment can be created. [**55:**A.8.13.2.7.2]

Placement of stationary containers proximate to the wall of the building served is allowable, provided the minimum separation distances for exposure hazards are met. When additional walls encroach on the installation to form a court, the focus of concern shifts away from the exposure hazards associated with the building itself to the hazards associated with personnel due to hazardous atmospheres that can be created due to the lack of free air movement and ventilation. [**55:**A.8.13.2.7.2]

By specifying the minimum distance between the tank and the encroaching walls that form the court, the circulation of adequate air is ensured. Placing the tank at not less than the height of two of the three encroaching walls results in creating an opening such that the angular dimension between the top of two of the three encroaching walls and the point over which the tank is placed is not greater than 45 degrees, thereby allowing the circulation of air through the space in which the tank is installed. [**55:**A.8.13.2.7.2]

63.4.13.2.7.2.1* Where exterior building walls encroach on the system to form a court, the system shall be located at a distance not less than the height of the wall from at least two court walls. [**55:**8.13.2.7.2.1]

Δ **A.63.4.13.2.7.2.1** The separation distances shown in Figure A.63.4.13.2.7.2.1 are required to provide for ventilation in the space in order to avoid creating a confined space. Chapter 8 of NFPA 55 is a generic chapter used to establish minimum requirements for all cryogens. Material-specific requirements for oxygen, hydrogen, or other gases might require greater separation distances based on the type of construction or the related exposure. For example, wall number 3 shown in Figure A.63.4.13.2.7.2.1 could be an exterior building wall, and the gas could be hydrogen. Refer to Table 63.4.7.2 of this *Code*, Table 9.3.2 and Table 11.3.2.2, Table 13.9.1, and Table 16.2 of NFPA 55 for specific details regarding building walls, wall openings, air intakes, and similar conditions. [**55:**A.8.13.2.7.2.1]



Δ ***FIGURE A.63.4.13.2.7.2.1** Bulk Cryogenic System Located in a Courtyard. [55:Figure A.8.13.2.7.2.1]*

63.4.13.2.7.2.2 The required distance between the exterior walls of the building forming the court and the container shall be determined independently without regard to fire barrier walls used to allow encroachment by fire exposure hazards. [**55:**8.13.2.7.2.2]

63.4.13.2.7.3 Fire Department Access. Fire department access roadways or other approved means shall be in accordance with Section 18.2. [**55:**8.13.2.7.3]

63.4.14 Use and Handling.

63.4.14.1 General. Use and handling of containers and systems shall be in accordance with 63.4.14. [**55:**8.14.1]

63.4.14.1.1 Operating Instructions. Operating instructions shall be provided for installations that require the operation of equipment. [**55:**8.14.1.1]

63.4.14.1.2 Attended Delivery. A qualified person shall be in attendance at all times cryogenic fluid is transferred from mobile supply units to a storage system. [**55:**8.14.1.2]

63.4.14.1.3 Cleaning and Purging of Gas Piping Systems. Cleaning and purging of piping systems shall be in accordance with 63.3.1.19. [**55:**8.14.1.3]

63.4.14.1.4 Inspection.

63.4.14.1.4.1 Cryogenic fluid storage systems shall be inspected and maintained by a qualified representative of the equipment owner as required by the material-specific requirements of Chapters 9, 11, 13, and 16 of NFPA 55. [**55:**8.14.1.4.1]

63.4.14.1.4.2* The interval between inspections other than those specified by material-specific requirements shall be based on nationally recognized good practices or standards. [**55:**8.14.1.4.1.1]

A.63.4.14.1.4.2 ANSI/CGA P-18, *Standard for Bulk Inert Gas Systems at Consumer Sites*, recommends periodic inspection intervals for inert gas systems. [**55:**A.8.14.1.4.1.1]

63.4.14.1.4.3 A record of the inspection shall be prepared and provided to the user or the AHJ upon request. [**55:**8.14.1.4.2]

63.4.14.1.5 Design.

63.4.14.1.5.1 Nationally Recognized Good Practices. Where nationally recognized good practices or standards have been established for the process employed, such practices and standards shall be followed. [**55:**8.14.1.5.1]

Δ **63.4.14.1.5.2 Piping Systems.** Piping, tubing, fittings, and related components shall be designed, fabricated, and tested in accordance with the requirements of ASME B31.3, *Process Piping*, or other approved standards and shall be in accordance with 63.4.14.2. [**55:**8.14.1.5.2]

63.4.14.2 Piping and Appurtenances.

63.4.14.2.1 Piping systems shall be designed for the use intended through the full range of pressure and temperature to which they will be subjected. [**55:**8.14.2.1]

63.4.14.2.2 Piping systems shall be designed and constructed to allow for expansion, contraction, vibration, settlement, and fire exposure. [**55:**8.14.2.2]

63.4.14.3 Joints. Joints in piping and tubing shall be in accordance with the requirements of ANSI/ASME B31.3, *Process Piping*, or other approved standards. [**55:**8.14.3]

The ASME B31 series standards are nationally recognized as the appropriate standards for use. While ANSI/ASME B31.3, *Process Piping*, is one of the most commonly recognized standards for this application, additional standards other than B31.3 may be appropriate. For example, ASME B31.8, *Gas Transmission and Distribution Pipelines,* can be used for systems designed to address carbon monoxide piping systems. CGA G-5.7, *Carbon Monoxide and Syngas Pipeline Systems,* can also be utilized. A design standard such as B31.3 provides a basic foundation, while the use of other approved standards grants flexibility to designers under the approval process granted by codes without attempting to specify the type of connections that are allowed.

63.4.14.4 Valves and Accessory Equipment. Valves and accessory equipment shall be acceptable for the intended use at the temperatures of the application and shall be designed and constructed to withstand the maximum pressure at the minimum temperature to which they will be subjected. [**55:**8.14.4]

63.4.14.5 Shutoff Valves on Containers. Shutoff valves shall be provided on all container connections, except for pressure relief devices. [**55:**8.14.5]

63.4.14.5.1 Shutoff valves for containers with multiple pressure relief devices shall be permitted in accordance with 63.4.2.4.7. [**55:**8.14.5.1]

63.4.14.5.2 Shutoff valves shall be accessible and located as close as practical to the container. [**55:**8.14.5.2]

63.4.14.6 Shutoff Valves on Piping.

63.4.14.6.1 Shutoff valves shall be installed in piping containing cryogenic fluids where needed to limit the volume of liquid discharged in the event of piping or equipment failure. [**55:**8.14.6.1]

63.4.14.6.2 Pressure relief valves shall be installed where liquid or cold gas can be trapped between shutoff valves in the piping system. *(See 63.4.2.4.)* [**55:**8.14.6.2]

63.4.14.7 Physical Protection and Support.

63.4.14.7.1 Aboveground piping systems shall be supported and protected from physical damage. [**55:**8.14.7.1]

63.4.14.7.2 Piping passing through walls shall be protected from mechanical damage. [**55:**8.14.7.2]

63.4.14.8 Corrosion Protection.

63.4.14.8.1 Aboveground piping that is subject to corrosion shall be protected against corrosion. [**55:**8.14.8.1]

63.4.14.8.2 Belowground piping shall be protected against corrosion. [**55:**8.14.8.2]

63.4.14.9 Cathodic Protection. Where required, cathodic protection shall be in accordance with 63.4.14.9. [**55:**8.14.9]

63.4.14.9.1 Operation. Where installed, cathodic protection systems shall be operated and maintained to continuously provide corrosion protection. [**55:**8.14.9.1]

63.4.14.9.2 Inspection.

63.4.14.9.2.1 Container systems equipped with cathodic protection shall be inspected for the intended operation by a cathodic protection tester. [**55:**8.14.9.2.1]

63.4.14.9.2.2 The cathodic protection tester shall be certified as being qualified by the National Association of Corrosion Engineers, International (NACE). [**55:**8.14.9.2.2]

63.4.14.9.3 Impressed Current Systems.

63.4.14.9.3.1 Systems equipped with impressed current cathodic protection systems shall be inspected in accordance with the requirements of the design and 63.4.14.9.2. [**55:**8.14.9.3.1]

63.4.14.9.3.2 The design limits shall be available to the AHJ upon request. [**55:**8.14.9.3.2]

63.4.14.9.3.3 The system owner shall maintain the following records to demonstrate that the cathodic protection is in conformance with the requirements of the design:

(1) The results of inspections of the system
(2) The results of testing that has been completed

[**55:**8.14.9.3.3]

63.4.14.9.4 Repairs, maintenance, or replacement of a cathodic protection system shall be under the supervision of a corrosion expert certified by NACE. [**55:**8.14.9.4]

63.4.14.9.4.1 The corrosion expert shall be certified by NACE as a senior corrosion technologist, a cathodic protection specialist, or a corrosion specialist or shall be a registered engineer with registration in a field that includes education and experience in corrosion control. [**55:**8.14.9.4.1]

Requirements for cathodic protection are established based on a "when required" provision that is triggered and referenced by material-specific applications when appropriate, including requirements for underground containers or piping systems. Similar provisions are provided for gaseous systems in 63.3.1.7.

63.4.14.10 Testing.

63.4.14.10.1 Piping systems shall be tested and proved free of leaks after installation as required by the codes and standards to which they are designed and constructed. [**55:**8.14.10.1]

63.4.14.10.2 Test pressures shall not be less than 150 percent of the maximum allowable working pressure when hydraulic testing is conducted or 110 percent when testing is conducted pneumatically. [**55:**8.14.10.2]

63.4.14.11 Material-Specific Requirements.

63.4.14.11.1 Indoor Use. Indoor use of cryogenic fluids shall be in accordance with the material-specific provisions of Chapters 9, 11, 13, and 16 of NFPA 55 or with ANSI/CGA P-18, *Standard for Bulk Inert Gas Systems at Consumer Sites,* and 63.4.14.2. [**55:**8.14.11.1]

63.4.14.11.2 Outdoor Use.

63.4.14.11.2.1 General. Outdoor use of cryogenic fluids shall be in accordance with the material-specific provisions of Chapters 9, 11, 13, and 16 of NFPA 55 or with ANSI/CGA P-18, *Standard for Bulk Inert Gas Systems at Consumer Sites,* and 63.4.14.2. [**55:**8.14.11.2.1]

63.4.14.11.2.2 Separation. Distances from property lines, buildings, and exposure hazards shall be in accordance with Table 63.4.7.2 and Table 63.4.7.3 and the material-specific provisions of Chapters 9, 11, 13, and 16 of NFPA 55 or with ANSI/CGA P-18, *Standard for Bulk Inert Gas Systems at Consumer Sites*. [**55:**8.14.11.2.2]

63.4.14.11.2.3 Emergency Shutoff Valves.

63.4.14.11.2.3.1* Accessible manual or automatic emergency shutoff valves shall be provided to shut off the cryogenic fluid supply in case of emergency. [**55:**8.14.11.2.3.1]

(A) Manual emergency shutoff valves or the device that activates an automatic emergency shutoff valve on a bulk source or piping systems serving the bulk supply shall be identified by means of a sign. [**55:**8.14.11.2.3.1(A)]

A.63.4.14.11.2.3.1 In operations where an automatic emergency shutoff valve is activated by a control system that is operated from a remote station or by remote station software, the software system should be designed to provide a visual indication of the emergency shutdown control system. The visual emergency shutdown function should be able to be identified by trained operators and recognizable to emergency response personnel. [**55:**A.8.14.11.2.3.1]

63.4.14.11.2.3.2 Emergency shutoff valves shall be located at the point of use, at the source of supply, and at the point where the system piping enters the building. [**55:**8.14.11.2.3.2]

63.4.14.11.3 Filling and Dispensing.

63.4.14.11.3.1 General. Filling and dispensing of cryogenic fluids shall be in accordance with 63.4.14.1.2. [**55:**8.14.11.3.1]

63.4.14.11.3.2 Dispensing Areas. Dispensing of cryogenic fluids associated with physical or health hazards shall be conducted in approved locations. [**55:**8.14.11.3.2]

63.4.14.11.3.2.1 Indoor Dispensing Areas. Dispensing indoors shall be conducted in areas constructed in accordance with the building code. [**55:**8.14.11.3.2.1]

63.4.14.11.3.2.2 Ventilation. Indoor areas in which cryogenic fluids are dispensed shall be ventilated in accordance with the requirements of 63.2.16 and the mechanical code. [**55:**8.14.11.3.2.2]

63.4.14.11.3.2.3 Piping Systems. Piping systems utilized for filling or dispensing of cryogenic fluids shall be designed and constructed in accordance with 63.4.14.2. [**55:**8.14.11.3.2.3]

63.4.14.11.3.3 Vehicle Loading and Unloading Areas. Loading and unloading areas shall be constructed in accordance with the requirements of Chapter 9 of NFPA 55 for liquid oxygen, Chapter 11 of NFPA 55 for liquid hydrogen, Chapter 13 of NFPA 55 for liquid carbon dioxide, and Chapter 16 of NFPA 55 for liquid nitrous oxide or ANSI/CGA P-18, *Standard for Bulk Inert Gas Systems at Consumer Sites,* for inert cryogenic fluids, as applicable. [**55:**8.14.11.3.3]

63.4.14.11.3.4* A noncombustible, delivery vehicle spill pad shall be provided when required by the material-specific requirements of Chapter 9 of NFPA 55 for liquid oxygen, Chapter 11 of NFPA 55 for liquid hydrogen, Chapter 13 of NFPA 55 for liquid carbon dioxide, and Chapter 16 of NFPA 55 for liquid nitrous oxide or ANSI/CGA P-18, *Standard for Bulk Inert Gas Systems at Consumer Sites*. [**55:**8.14.11.3.4]

A.63.4.14.11.3.4 The inert cryogens, nitrogen and argon, do not require the installation of a noncombustible spill pad, because they do not typically condense oxygen from the air in sufficient quantities to pose a hazard during transfer. [**55:**A.8.14.11.3.4]

63.4.14.11.3.4.1* A noncombustible spill pad shall be provided for delivery areas where bulk liquid helium is transferred from delivery vehicles. [**55:**8.14.11.3.4.1]

A.63.4.14.11.3.4.1 The noncombustible spill pad is provided for liquid helium transfer operations, because the cryogen is at a temperature that is sufficiently low enough to liquefy oxygen, presenting a hazard when in contact with combustible surfaces. [**55:**A.8.14.11.3.4.1]

63.4.14.11.3.5 Filling Controls. A pressure gauge and full trycock valve shall be provided and shall be visible from the delivery point to allow the delivery operator to monitor the internal pressure and liquid level of stationary containers during filling. [**55:**8.14.11.3.5]

63.4.14.11.3.5.1 When the containers being filled are remote from the delivery point and pressure gauges or full trycock valves are not visible, redundant gauges and valves shall be installed at the filling connection. [**55:**8.14.11.3.5.1]

63.4.14.11.4 Handling.

63.4.14.11.4.1 Applicability. Handling of cryogenic containers shall be in accordance 63.4.14.11.4. [**55:**8.14.11.4.1]

63.4.14.11.4.2 Carts and Trucks.

63.4.14.11.4.2.1 Cryogenic containers shall be moved using an approved method. [**55:**8.14.11.4.2.1]

63.4.14.11.4.2.2 Where cryogenic containers are moved by hand cart, hand truck, or other mobile device, that device shall be designed for the secure movement of the container. [**55:**8.14.11.4.2.2]

63.4.14.11.4.3 Design. Carts and trucks used to transport cryogenic containers shall be designed to provide a stable base for the commodities to be transported and shall have a means of restraining containers to prevent accidental dislodgement. [**55:**8.14.11.4.3]

63.4.14.11.4.4 Closed Containers.

63.4.14.11.4.4.1 Pressurized containers shall be closed while being transported. [**55:**8.14.11.4.4.1]

63.4.14.11.4.4.2 Containers designed for use at atmospheric conditions shall be transported with appropriate loose-fitting covers in place to prevent spillage. [**55:**8.14.11.4.4.2]

63.5 Bulk Oxygen Systems

63.5.1 Bulk oxygen systems shall comply with Chapter 9 of NFPA 55.

63.5.2 Cleaning and Purging of Gas Piping Systems. Cleaning and purging of piping systems shall be in accordance with 63.3.1.19. [**55:**9.4.1.9]

Δ **63.5.3** Cleaning of oxygen systems used in medical gas service shall be in accordance with NFPA 99. *(See also 9.4.3.1 of NFPA 55.)* [**55:**9.4.1.9.1]

63.6 Gas Hydrogen Systems

Bulk gaseous hydrogen systems, bulk liquefied hydrogen systems, and gas generation systems are required to comply with NFPA 2, *Hydrogen Technologies Code*, in addition to the specific chapter of NFPA 55. NFPA 2 provides fundamental safeguards for the generation, installation, storage, piping, use, and handling of hydrogen in compressed gas (GH2) form or cryogenic liquid (LH2) form. In addition, see also 63.3.1.19 and related commentary for additional details regarding the new provisions on cleaning and purging of piping systems also required for these hydrogen systems.

Δ **63.6.1** Bulk hydrogen compressed gas systems shall comply with NFPA 2 and Chapter 10 of NFPA 55.

63.6.2 Cleaning and purging of piping systems shall be in accordance with 63.3.1.19. [**55:**10.2.3.2]

63.7 Bulk Liquefied Hydrogen Systems

Δ **63.7.1** Bulk liquefied hydrogen systems shall comply with NFPA 2 and Chapter 11 of NFPA 55.

63.7.2 Cleaning and purging of piping systems shall be in accordance with 63.3.1.19. [**55:**11.2.3.9]

63.8 Gas Generation Systems

Δ **63.8.1 General.** Gas generation systems shall comply with NFPA 2 and Chapter 12 of NFPA 55.

63.8.2 Process purging and vents shall conform to the following:

(1) Pressure equipment and piping intended to be purged, pressure regulators, relief valves, and other potential sources of combustible gas shall be vented to the outside of the building in accordance with the applicable requirements of 63.2.15 or 63.3.1.19.
(2) The vent shall be designed to prevent entry of water or foreign objects.
(3) The vent gas shall be directed so as to not create additional hazards to the building openings, such as windows, doors, or HVAC intakes.

[**55:**12.3.2.8.5.7]

63.9 Insulated Liquid Carbon Dioxide Systems

Insulated liquid carbon dioxide systems shall comply with Chapter 13 of NFPA 55.

N **63.9.1 General.** The storage, use, and handling of liquid carbon dioxide in insulated systems shall be in accordance with the provisions of Chapter 13 and Chapters 1 through 7 of NFPA 55, as applicable.

N **63.9.2 Permits.**

N **63.9.2.1** For other than vehicles equipped for and using compressed gas as a fuel for propelling the vehicle, an operational permit shall be required for liquid carbon dioxide systems in excess of 100 lb (45.4 kg) of carbon dioxide.

N **63.9.2.2** A construction permit shall be required for the installation of, or modification to, a liquid carbon dioxide (CO_2) system where the quantity exceeds the amount listed in 63.9.2.

N **63.9.2.3** The following information shall be provided to the authority having jurisdiction with the application for permit:

(1) Total aggregate quantity of liquid CO_2 in pounds or cubic feet at normal temperature and pressure
(2) Location and total volume of the room where the liquid CO_2 will be located and whether the room is at or below grade
(3) Location of containers relative to equipment, building openings, and means of egress
(4) Manufacturer's specifications and pressure rating, including cut sheets, of all piping and/or tubing to be used
(5) A piping and instrumentation diagram that shows piping support and remote fill connections
(6) Details of container venting, including, but not limited to, vent line size, material, and termination location
(7) Alarm and detection system and equipment, if applicable
(8) Seismic support for containers

N **63.9.3 Pressure Relief Devices.** Containers used for liquid carbon dioxide shall be equipped with pressure relief devices piped from the uppermost part of the containers and communicating with the vapor space. [**55:**13.3.1]

N **63.9.4 Physical Protection.**

N **63.9.4.1** Pressure relief devices shall be located to minimize tampering, damage, and obstruction to flow. [**55:**13.3.1.1.1]

N **63.9.4.2** The inlet and outlet of the relief devices shall not be blocked by a valve or plug during normal operation. [**55:**13.3.1.1.2]

N **63.9.5 Vent Pipe Systems.** Pressure relief devices shall be piped to the outdoors where the discharge will not impinge on the structure, personnel, or means of egress and will not create a hazardous concentration of carbon dioxide. [**55:**13.3.1.2]

N **63.9.5.1** Pressure relief devices from portable DOT 4L containers that are not a component of a stationary system shall not be required to meet the requirements of 63.9.5. [**55:**13.3.1.2.1]

N **63.9.5.2** Vent piping systems serving pressure relief devices shall be protected from water intrusion to prevent moisture or solid carbon dioxide from collecting and freezing and interfering with the operation of the pressure relief device. [**55:**13.3.1.2.2]

N **63.9.5.3** Vent piping systems serving pressure relief devices shall be designed to prevent backflow restrictions exceeding 10 percent backpressure on the pressure relief device under full flow conditions. [**55:**13.3.1.2.3]

N **63.9.6 Pressure and Level Indicators.**

N **63.9.6.1** Cylinders, containers, and tanks shall be provided with a pressure gauge and a level gauge or device for indicating the quantity of liquid carbon dioxide. [**55:**13.3.2.1]

N **63.9.6.2** These devices shall be designed for the temperatures and pressures associated with liquid carbon dioxide service. [**55:**13.3.2.2]

N **63.9.6.3** Where cylinders, containers, and tanks are in locations remote from the filling connection, a means to determine when the containers have been filled to their design capacity shall be provided and shall be verifiable from the filling connection. [**55:**13.3.2.3]

N **63.9.7 Piping Systems.**

N **63.9.7.1** Carbon dioxide piping shall be located and supported to protect against damage from strain on piping and fittings; the effects of expansion, contraction, and vibration; mechanical damage; and heat sources. [**55:**13.3.3.1]

N **63.9.7.2** Piping, tubing, and hoses and fittings shall be designed to a bursting pressure of at least four times the system design pressure. [**55:**13.3.3.2]

N **63.9.7.3 Materials of Construction.** Materials of construction shall be employed for potential exposure to a temperature of −109.3°F (−78.5°C). [**55:**13.3.4]

N **63.9.7.4 Operating Instructions.** Operating instructions shall account for potential exposure of personnel to extremely low temperatures in accordance with 63.9.12. [**55:**13.5]

N **63.9.8 Safety Measures.**

N **63.9.8.1** Rooms or areas inside assembly, business, educational, institutional, and residential occupancies containing a liquid carbon dioxide (CO_2) system shall comply with the safety measures in 63.9.9.1.

N **63.9.8.2** The provisions of 63.9.9.1 shall not apply to liquid carbon dioxide (CO_2) systems located above grade in outdoor areas with enclosure walls obstructing on no more than 75 percent of the perimeter at ground level.

N **63.9.8.3 Gas Detection System.**

N **63.9.8.3.1** A continuous gas detection system shall be provided in the room or area where container systems are filled and used, and in areas where the heavier-than-air gas can congregate.

N **63.9.8.3.2** Carbon dioxide (CO_2) sensors shall be provided within 12 in. (305 mm) of the floor in the area where the gas is most likely to accumulate or leaks are most likely to occur.

N **63.9.8.3.3** The system shall be designed to detect and notify at a low-level alarm and high-level alarm.

N **63.9.8.4** The threshold for activation of the low-level alarm shall not exceed a carbon dioxide concentration of 5,000 ppm TWA (9,000 mg/m^3). When carbon dioxide is detected at the low-level alarm, the system shall activate a signal at a normally attended location within the building.

N **63.9.8.5** The threshold for activation of the high-level alarm shall not exceed a carbon dioxide concentration of 30,000 ppm (54,000 mg/m^3). When carbon dioxide is detected at the high-level alarm, the system shall activate an audible and visual alarm in an approved location.

N **63.9.9 Signage.**

N **63.9.9.1** Hazard identification signs shall be posted at the entrance to the room and confined to the area where liquid carbon dioxide containers are located. The sign shall be a minimum 8 in. (200 mm) wide and 6 in. (150 mm) high and indicate:

CAUTION — CARBON DIOXIDE GAS
Ventilate the area before entering.
A high carbon dioxide (CO_2) gas concentration
in this area can cause asphyxiation.

N **63.9.10 Performance Design Option.**

N **63.9.10.1** Carbon dioxide (CO_2) systems shall not be required to be provided with a gas detection system where a complete discharge of the stored carbon dioxide cannot result in a concentration exceeding 5,000 ppm in the room where the container is located or the area where the carbon dioxide is likely to congregate. The maximum concentration (ppm) shall be determined as follows:

(1) Calculate the volume (scf) of CO_2 gas at standard temperature and pressure that is contained in the storage containers as follows:
  (a) To convert pounds of liquid to volume (scf) of CO_2 gas, multiply the pounds by 8.741.
  (b) To convert gallons of liquid to volume (scf) of CO_2 gas, multiply the gallons by 74.04.
(2) Calculate the volume of the room containing the CO_2 containers, or the area where the CO_2 is likely to congregate, in cubic feet as follows:
  (a) The volume of the room or area shall be based on a height limitation of 5 ft (1524 mm) or the ceiling, whichever is less.
  (b) The boundary of the area shall be to walls or partitions 5 ft (1524 mm) or more in height that obstruct gas dispersion at the floor level.
  (c) All doors in the boundary walls shall be considered closed.
  (d) CO_2 shall be assumed to congregate in basements, pits, or lower floors where openings are present between the containers and the lower floor.
(3) Divide the volume of CO_2 gas by the volume of the room. If the result does not exceed 0.005 (5,000 ppm), the design meets the performance option criteria.

N 63.9.11 Seismic and Structural Design.

N **63.9.11.1** Liquid carbon dioxide system containers and piping shall comply with the seismic design requirements in accordance with the building code and shall not exceed the floor loading limitation of the building.

N **63.9.11.2** Container foundations or floors in multistoried buildings shall be designed to support the weight of the system at its full capacity in accordance with the building code.

N 63.9.12 Small Insulated Liquid Carbon Dioxide Outdoor Systems.

N **63.9.12.1** Container systems located in enclosed spaces shall be in accordance with 63.9.1 for indoor systems.

N **63.9.12.2** Aboveground outdoor locations shall not be required to be provided with a gas detection and alarm system in accordance with 63.9.1 where the system is unenclosed.

N **63.9.12.3** To be considered unenclosed, enclosures constructed to limit access or otherwise provide a visual or architectural barrier for the installation shall be constructed in accordance with the requirements in Section 6.6 for weather protection or with the following:

(1) The enclosure shall be constructed without a roof or overhead cover.
(2) Supports and walls shall not obstruct more than three sides nor more than 75 percent of the perimeter of the storage or use area, with 25 percent of the perimeter being open to the atmosphere.

[**55:**13.7.1.1]

N **63.9.12.4** Enclosures that do not meet the requirements of 63.9.14.2 shall be permitted when constructed in accordance with the following:

(1) The enclosure shall be constructed without a roof or overhead cover.
(2) Continuous mechanical exhaust ventilation shall be provided.

[**55:**13.7.1.2]

N **63.9.12.5** Where mechanical exhaust ventilation is provided, it shall be in accordance with the following:

(1) The exhaust system shall be installed in accordance with the requirements of the mechanical code.
(2) The exhaust system shall be designed to consider the density of the potential vapors released with exhaust taken from a point within 12 in. (305 mm) of the floor.
(3) The location of both the exhaust and the inlet air openings shall be designed to provide air movement across all portions of the enclosure to prevent the accumulation of vapors.
(4) The rate of exhaust ventilation shall be not less than 1 scf/min/ft^2 (0.028 Nm^3/min/m^2) of floor area within the enclosure.

[**55:**13.7.1.1.2.1]

N 63.9.13 Large Indoor Insulated Liquid Carbon Dioxide Systems. (Reserved)

N 63.9.14 Large Outdoor Insulated Liquid Carbon Dioxide Systems.

N **63.9.14.1 Location.** Outdoor stationary large insulated liquid carbon dioxide systems shall be located in accordance with Table 63.9.14.1. [**55:**13.9.1]

N **63.9.14.2 Point-of-Fill Connections.** Point-of-fill connections serving stationary containers filled by mobile transport equipment shall not be positioned closer to exposures than the minimum distances in Table 63.9.14.1. [**55:**13.9.1.1]

TABLE 63.9.14.1 *Minimum Separation Distance Between Outdoor Stationary Large Insulated Liquid Carbon Dioxide Containers and Exposures*

Exposure	Minimum Distance	
	ft	m
Buildings, regardless of construction type	2	0.6
Wall openings other than building exits	2	0.6
Air intakes	10	3.1
Property lines	5	1.5
Places of public assembly (assembly occupancies)	50	15
Nonambulatory patient areas	50	15
Combustible materials, (e.g., paper, leaves, weeds, dry grass, debris)	15	4.5
Incompatible hazardous materials	20	6.1
Building exits	10	3.1

[**55:**13.9.1]

N **63.9.14.3 Fire Barriers.** A 2-hour fire barrier wall shall be permitted in lieu of the distances specified by Table 63.9.14.1 when in accordance with the provisions of 63.9.15.4 through 63.9.15.8. [**55:**13.9.2]

N **63.9.14.3.1** The fire barrier wall shall be without openings or penetrations. [**55:**13.9.2.1]

N **63.9.14.3.1.1** Penetrations of the fire barrier wall by conduit or piping shall be permitted provided that the penetration is protected with a firestop system in accordance with the Building Code. [**55:**13.9.2.1.1]

N **63.9.14.3.2** The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage system. [**55:**13.9.2.2]

N **63.9.14.3.3** The fire barrier wall shall be located not less than 5 ft (1.5 m) from any exposure. [**55:**13.9.2.3]

N **63.9.14.3.4** The fire barrier wall shall not have more than two sides at approximately 90 degree (1.57 rad) directions or not more than three sides with connecting angles of approximately 135 degrees (2.36 rad). [**55:**13.9.2.4]

63.10 Storage, Handling, and Use of Ethylene Oxide for Sterilization and Fumigation

See 63.3.1.19 and related commentary for additional details regarding the language on cleaning and purging of piping systems.

63.10.1 General. Storage, handling, and use of ethylene oxide for sterilization and fumigation shall comply with Chapter 14 of NFPA 55.

63.10.2 Cleaning and Purging of Gas Piping Systems.

63.10.2.1 Cleaning and purging of piping systems shall be in accordance with 63.3.1.19. [**55:**14.4.1.3]

63.10.2.2 Piping and valves that have been used to transport ethylene oxide to or from a sterilizer to the emission control or release point shall be drained and purged in accordance with 63.3.1.19 prior to dismantling. [**55:**14.4.3.1]

63.11 Liquid Oxygen in Home Care

63.11.1 General. The storage and use of liquid oxygen (LOX) in home care shall comply with Sections 63.4 and 63.11.

Δ **63.11.1.1** Gas equipment used in the home for health care shall conform to applicable requirements of NFPA 99.

63.11.2 Information and Instructions. The seller of liquid oxygen shall provide the user with information in written form that includes, but is not limited to, the following:

(1) Manufacturer's instructions and labeling for storage and use of the containers
(2) Locating containers away from ignition sources, exits, electrical hazards, and high temperature devices in accordance with 63.11.3.2
(3) Restraint of containers to prevent falling in accordance with 63.11.3.3
(4) Requirements for handling containers in accordance with 63.11.3.4
(5) Safeguards for refilling of containers in accordance with 63.11.3.5

63.11.3 Containers. Containers of liquid oxygen in home care shall be in accordance with 63.11.3.1 through 63.11.3.5.

63.11.3.1* Containers shall be stored, used, and operated in accordance with the manufacturer's instructions and labeling.

A.63.11.3.1 The seller has a responsibility to provide written instructions to the user in accordance with 63.11.2. In fulfilling this responsibility the seller should explain to the user the use of the equipment being delivered and precautions that are to be taken. The seller's written instructions are intended to make the user aware of the hazards of the material and to provide recommendations that will address the location, restraint, movement, and refill of ambulatory containers when these containers are to be refilled by the user. However, the user has the responsibility to receive, read, and understand the written material regarding storage and use of liquid oxygen and the containers and equipment that is furnished by the seller. In addition to specific information or instructions provided by the seller or equipment manufacturer regarding the storage or use of the equipment and of the liquid oxygen or the containers used, the user remains responsible to see that the containers are used or maintained in accordance with the seller's instructions to ensure that they are as follows:

(1) Located and maintained in accordance with the requirements of 63.11.3.2
(2) Restrained in accordance with the requirements of 63.11.3.3
(3) Handled or transported in accordance with the requirements of 63.11.3.4
(4) When liquid oxygen ambulatory containers are to be refilled by the user, that the containers are refilled in accordance with the requirements of 63.11.3.5 and the manufacturer's instructions

63.11.3.2 Containers shall not be located in areas as follows:

(1) Where they can be overturned due to operation of a door
(2) Where they are in the direct path of egress
(3) Where they are subject to damage from falling objects
(4) Where they can become part of an electrical circuit
(5) Where open flames and high temperature devices could cause a hazard

63.11.3.3* Liquid oxygen home care containers shall be restrained by one of the following methods while in storage or use to prevent falling caused by contact, vibration, or seismic activity:

(1) Restraining containers to a fixed object with one or more restraints
(2) Restraining containers within a framework, stand, or assembly designed to resist container movement
(3) Restraining containers by locating a container against two points of contact

A.63.11.3.3 Two points of contact can be provided by using elements of a room or furnishings in the room such as the walls of a corner of a room or a wall and a furnishing or object such as a table or a desk.

63.11.3.4 Containers shall be transported by use of a cart or hand truck designed for such use.

63.11.3.4.1 Liquid oxygen home care containers equipped with a roller base shall not be required to be transported by use of a cart or truck.

63.11.3.4.2 Liquid oxygen ambulatory containers shall be permitted to be hand carried.

63.11.3.5 The filling of containers shall be in accordance with 63.11.3.5.1 through 63.11.3.5.2:

63.11.3.5.1 Liquid oxygen home care containers shall be filled outdoors.

63.11.3.5.1.1* A drip pan compatible with liquid oxygen shall be provided under home care container filling and vent connections used during the filling process.

A.63.11.3.5.1.1 Drip pans or similar containment devices are used in order to protect against liquid oxygen spillage from coming into contact with combustible surfaces, including asphalt thereby elevating the potential for ignition.

63.11.3.5.2 Liquid oxygen ambulatory containers shall be allowed to be filled indoors when the supply container is designed for filling such containers and written instructions are provided by the container manufacturer.

63.11.3.5.3* The use of open flames and high temperature devices shall be in accordance with the adopted fire prevention code.

A.63.11.3.5.3 Oxygen is not a flammable gas, and ignition of the gas itself is not the primary hazard. When oxygen is present in concentrations that exceed normal ambient concentrations of approximately 21 percent (by volume), ordinary combustible materials can be ignited more easily, and when combustion occurs, the combustion is more vigorous. As a general rule, the higher the concentration of oxygen present, the more likely ignition of ordinary combustibles will occur if ignition sources are present, and the more rapid the combustion process. Fire prevention codes frequently contain general statements cautioning against the use of open flames, and warnings are designed to prevent a hazardous condition caused by ignition sources. On the other hand, these codes assume that the normal ambient atmosphere is present, and they do not typically warn of the hazards of an oxygen-enriched atmosphere, which represents a condition out of the ordinary.

63.11.4 Maximum Quantity. The maximum aggregate quantity of liquid oxygen allowed in storage and in use in a single dwelling unit shall be 31.6 gal (120 L).

63.11.4.1 The maximum aggregate quantity of liquid oxygen allowed in day care occupancies shall be limited by the maximum allowable quantity set forth in the adopted fire prevention code or building code.

63.11.4.2 Where individual sleeping rooms are separated from the remainder of the dwelling unit by fire barriers and horizontal assemblies having a minimum fire-resistance rating of 1 hour in accordance with the adopted building code, the maximum aggregate quantity per dwelling unit shall be allowed to be increased to a maximum of 31.6 gal (120 L) of liquid oxygen per sleeping room.

63.11.5 Smoking. Smoking shall be prohibited in rooms or areas where liquid oxygen is in use.

63.11.5.1* A sign stating "OXYGEN — NO SMOKING" shall be posted in the room or area where the liquid oxygen containers are stored or used.

A.63.11.5.1 A sign prohibiting smoking in areas where oxygen is used may be provided by the seller. However, the posting of the sign within the user's premises and observing the prohibitions and precautionary information printed on the sign remains the responsibility of the user.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 2, *Hydrogen Technologies Code*, 2016 edition.
NFPA 51A, *Standard for Acetylene Cylinder Charging Plants*, 2012 edition (withdrawn, incorporated into NFPA 55).
NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2016 edition.
NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems*, 2017 edition.
NFPA 77, *Recommended Practice on Static Electricity*, 2014 edition.
NFPA *101®, Life Safety Code®*, 2018 edition.
NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations,* 2013 edition.

American Society of Mechanical Engineers, New York, NY.

ANSI/ASME B31.3, *Process Piping,* 2016.
ASME B31.8, *Gas Transmission and Distribution Pipelines,* 2016.
Boiler and Pressure Vessel Code, 2017.

CGA G-5.7, *Carbon Monoxide and Syngas Pipeline Systems*, 2nd edition, Compressed Gas Association, Chantilly, VA, 2014.

NIOSH Pocket Guide to Chemical Hazards, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Atlanta, GA, 2010.

U.S. Government Publishing Office, Washington, DC.

Title 29, Code of Federal Regulations, Part 1910, Subpart Z, "Toxic and Hazardous Substances."

Title 29, Code of Federal Regulations, Part 1910.1000, "Air contaminants."

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, *Risk Management Program Guidance for Offsite Consequence Analysis*, available online at https://epa.gov.

TLVs® and BEIs®: Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists (ACGIH), Cincinnati, OH, 2008.

Corrosive Solids and Liquids

64

64.1 General

64.1.1 The storage, use, and handling of corrosive solids and liquids shall comply with the requirements of Chapter 60.

Δ **64.1.2** The storage, use, and handling of corrosive solids and liquids in amounts exceeding the maximum allowable quantities permitted in control areas set forth in Chapter 60 shall comply with the requirements of NFPA 400.

The term *corrosive material* is defined in 3.3.180.3 as "a chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact." Examples of corrosive solids and liquids include acids (carboxylic, peroxy, mineral, and oxidizing), phenol alcohol, sodium, potassium and lithium metals, and bases (sodium carbonate, sodium hydroxide).

For requirements pertaining to the storage, use, and handling of corrosive solids and liquids, users are directed to Chapter 60 on hazardous materials. Where the storage, use, or handling of the corrosive solid or corrosive liquid exceeds the maximum allowable quantity (MAQ) per control area as set forth in that chapter, they must also comply with the provisions of NFPA 400, *Hazardous Materials Code*. The first edition of NFPA 400 was published in 2010, and the 2016 edition of the document is referenced throughout this edition of NFPA 1, *Fire Code*. NFPA 400 combined the NFPA hazardous materials documents into a single code. Rather than extracting the provisions, many of the chapters of this *Code* related to hazardous materials now reference NFPA 400.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 400, *Hazardous Materials Code,* 2016 edition.

Explosives, Fireworks, and Model Rocketry

65

Chapter 65 contains general provisions for regulating the storage, use, and manufacture of explosives, display fireworks, and pyrotechnics before a proximate audience; flame effects before a proximate audience; fireworks manufacturing; and model and high power rocketry.

This chapter covers the wide range of hazards associated with the use of materials that potentially can have disastrous consequences. Numerous incidents have been documented, such as explosions at fireworks manufacturing facilities and storage areas, display fireworks that have landed in a crowd, and special effects that have gone awry. The Station nightclub fire in Rhode Island in 2003 and the fireworks storage accident in Enschede, Netherlands, in 2000 further heightened the fire prevention and protection community's awareness of the hazards of these materials. In October 2017, at least 47 people were killed in explosions at a fireworks factory near Jakarta, Indonesia. A quick search of recent news reports will show many additional incidents involving fireworks and how quickly a situation can turn when they are involved.

See Commentary Table 65.1 for the applicability of NFPA documents to fireworks and rocketry regulation. Commentary Table 65.2 lists the previous and current explosive hazard classifications as of January 1, 1991.

COMMENTARY TABLE 65.1 *NFPA Document Key for Fireworks and Model and High Power Rocketry Applications*

NFPA Document	***Application***
NFPA 1122, *Code for Model Rocketry*	The design, construction, and limitations of propellant mass and power and the reliability of model rocket motors and model rocket motor reloading kits and their components produced commercially for sale to, or for use by, the public for purposes of education, recreation, and sporting competition
NFPA 1123, *Code for Fireworks Display*	The construction, handling, and use of fireworks intended solely for outdoor display, as well as the general conduct and operation of the display
NFPA 1124, *Code for the Manufacture, Transportation, and Storage of Fireworks and Pyrotechnic Articles*	The construction, use, and maintenance of buildings and facilities for manufacture and storage of fireworks, novelties, and pyrotechnic articles and manufacturing facilities; storage of display fireworks, pyrotechnic articles, salute powder, pyrotechnic and explosive compositions, and Black Powder at other than display sites; storage of consumer fireworks at display fireworks storage facilities; transportation on public highways or fireworks, pyrotechnic articles, and components containing pyrotechnic or explosive materials
NFPA 1125, *Code for the Manufacture of Model Rocket and High Power Rocket Motors*	The manufacture of model and high power rocket motors designed, sold, and used for the purpose of propelling recoverable aero models
NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*	The use of pyrotechnic special effects in the performing arts in conjunction with theatrical, musical, or similar productions before a proximate audience, performers, or support personnel
NFPA 1127, *Code for High Power Rocketry*	The design, construction, and limitations of propellant mass and power and the reliability of all high power rocket motors and motor components produced commercially for sale to, or for use by, the certified user for education, recreation, and sporting competition

***COMMENTARY TABLE 65.2** Comparison of Previous and Current Explosive Hazard Classification Names as of January 1, 1991*

Current Classification	***Classification Name Prior to January 1, 1991***
Division 1.1	Class A explosives
Division 1.2	Class A or B explosives
Division 1.3	Class B explosives
Division 1.4	Class C explosives
Division 1.5	Blasting agents
Division 1.6	No applicable hazard class

Source: *Fire Protection Handbook®*, Table 6.15.2.

65.1 General

65.1.1* The storage, use, and handling of explosives, fireworks, and model rocketry shall comply with the requirements of this chapter, NFPA standards referenced within this chapter, and Sections 60.1 through 60.4 of this *Code*.

N **A.65.1.1** Chapter 65 does not contain any prescriptive technical provisions to address the retail sale and associated storage of consumer fireworks. The AHJ can utilize 1.3.2.2 to develop a protection approach for new and existing consumer fireworks retail sale and storage facilities.

65.1.2 Where the provisions of this chapter or NFPA standards referenced herein conflict with the provisions of Chapter 60, the provisions of this chapter and referenced NFPA standards shall apply.

65.2 Display Fireworks

Δ **65.2.1** The construction, handling, and use of fireworks intended solely for outdoor display as well as the general conduct and operation of the display shall comply with the requirements of NFPA 1123.

The purpose of NFPA 1123 is to provide the following:

1. Minimum requirements for outdoor fireworks displays
2. Recommended local permit regulations
3. Recommended regulations for state certifications of display operators

The term *fireworks display* is defined in 3.3.16 of NFPA 1123 as "a presentation of fireworks for a public or private gathering."

Section 1.12 allows the authority having jurisdiction (AHJ) to issue permits for the discharge of fireworks within the jurisdiction. See Table 1.12.8(a) for permit requirements for display fireworks (1.3G). The following recommended regulations for applications for permits for the outdoor display of fireworks are extracted from Annex B of NFPA 1123:

(1) Application for permit to operate a display of outdoor fireworks in conformance with the terms of [*specific regulation*] of the General Laws of [*state or jurisdiction*] should be made in writing on forms provided by the AHJ.

(2) Such application should provide the following information:
   (a) The name, address, email address, and phone number of the individual, group, or organization sponsoring the outdoor fireworks display.
   (b) The name, address, email address, and phone number of the supplier of the fireworks, if different from that of the operator.
   (c) Evidence of financial responsibility by the sponsor of the event or festival and by the operator of the fireworks display. This could take the form of an insurance certificate or other document attesting to coverage or responsibility.
   (d) The date and time of day at which the outdoor fireworks display is to be held, with a proposed rain/wind date and time in the event the display is postponed.
   (e) The exact location planned for the outdoor fireworks display.
   (f) Confirmation of the license of the operator and the number of assistants who are to be present.
   (g) The approximate number and kinds of fireworks to be discharged.
   (h) The manner and place of storage of such fireworks prior to delivery to the outdoor fireworks display site.
   (i) A diagram of the grounds on which the outdoor fireworks display is to be held showing the point at which the fireworks are to be discharged; the display site; the approximate distances from mortars to spectator viewing areas; the location and approximate distances of all buildings, highways, and other lines of communication; the lines behind which the audience is to be restrained; the controls that will be used to maintain audience separation; and the location of other possible overhead obstructions.

(3) Upon receipt of such application ______ days in advance of the date set for this outdoor fireworks display, the AHJ should make or initiate an investigation of the site of the proposed display for the purpose of determining compliance with these regulations in the case of the particular display.

(4) The AHJ should approve or deny the permit application with comments provided to the permit applicant. If the application is denied, the AHJ should specify the reasons for the denial so that the permit

applicant can attempt to address the reasons for a denial with a resubmitted permit application.

Section 1.13 allows the AHJ to require certificates of fitness for individuals or companies performing fireworks displays. See Section 1.13 for information on certificates of fitness, also known as operator licensing requirements.

The following extract of Annex C from NFPA 1123 provides recommended requirements for operator licensing:

C.1 Operator Licensing Requirements.

C.1.1 A requirement of licensing is that the applicant has attained the age of 21 years.

C.1.2 A requirement of licensing is that the applicant has passed a comprehensive written examination covering state laws pertaining to the display of fireworks and this code [NFPA 1123]. At the option of the issuing office, an alternate requirement can be substituted, such as acceptance of competency certification by a national organization or of licensing by another state.

C.1.3 A requirement of licensing is that the applicant has provided evidence of actively participating in the performance of at least five outdoor fireworks displays. At the option of the issuing office, an alternate requirement can be substituted.

C.2 Provisions of Operator Licensing.

C.2.1 The license should be valid for a period of 4 years.

C.2.2 Renewal of the license should be automatic upon provision of proof of active participation in at least three outdoor fireworks displays and 8 hours of continuing education during the prior 4 years.

Δ **65.2.2** All storage of display fireworks shall comply with NFPA 1124.

The purpose of NFPA 1124 is to establish reasonable minimum fire and life safety requirements for the manufacture, transportation, and storage of fireworks, pyrotechnic articles, and any component(s) thereof containing pyrotechnic or explosive compositions. It also applies to:

(1) Testing of fireworks at a manufacturing facility
(2) Testing of pyrotechnic devices used in the entertainment industry
(3) Testing of any component(s) of fireworks or pyrotechnic devices used in the entertainment industry that contain pyrotechnic or explosive compositions

The 2017 edition of NFPA 1124 is referenced in this edition of the *Code*.

65.2.3 Permits. Permits, where required, shall comply with Section 1.12.

65.3 Pyrotechnics Before a Proximate Audience

Δ **65.3.1** The use of pyrotechnic special effects in the performing arts in conjunction with theatrical, musical, or any similar productions before a proximate audience, performers, or support personnel shall comply with NFPA 1126.

The purpose of NFPA 1126 is to provide requirements for the reasonable protection of pyrotechnic operators, performers, support personnel, and proximate audiences viewing a display, including property and buildings where indoor pyrotechnics are used. The requirements of Section 65.3 apply to both indoor and outdoor performances. NFPA 1126 also provides guidelines for the AHJ for approval of the use of pyrotechnics and for the development of requirements for local permits.

NFPA 1126 applies to any outdoor use of pyrotechnics at distances from audiences that are less than those required by NFPA 1123, with the exception of the use of aerial shells, which are required to comply with the provisions of NFPA 1123.

NFPA 1126 also applies to the performance specifications, instructions, notifications, and labeling by the manufacturer of pyrotechnics materials, devices, equipment, and supplies. Annex B of NFPA 1126 provides inspection requirements and an inspection routine that can be used as a model by the AHJ. The AHJ is required to judge the safety of any production. The recommended inspection items are reproduced as a checklist in Exhibit 65.1.

The American Pyrotechnics Association (APA) created a proximate pyrotechnics performance checklist based on

Exhibit 65.1

1. Access
   - ❑ Fire lane clear
   - ❑ Hydrants not blocked
   - ❑ Fire department connections clear
   - ❑ Standpipe connections clear
   - ❑ At least two fire extinguishers provided
   - ❑ Extinguishing equipment charged and in good working order
   - ❑ Warning signs in place
2. Exits
   - ❑ All designated exits clear
   - ❑ Exits visible
3. Pyrotechnic Materials and Devices
   - ❑ Proper and current license in the possession of the pyrotechnic operator
   - ❑ Permit on site
   - ❑ Fire department briefed on proposed activity
   - ❑ Proper ventilation
4. Electrical
   - ❑ Cords and connections in good condition
   - ❑ Power supply safely arranged
   - ❑ Pyrotechnic firing mechanism in good working order
5. Flameproofing
   - ❑ Set and scenic materials treated for flame retardance
   - ❑ Burlap and other protective materials used for rigging treated for flame retardance

Checklist for inspection of pyrotechnics display. (NFPA 1126, Annex B)

Exhibit 65.2

IV. Walkthrough Inspection Checklist (AHJ)
1. Pyrotechnic walkthrough and demonstration
   A. Confirm venue management consent to pyrotechnics
   B. Verify pyrotechnic plot with actual site dimensions/adjustments
2. Type of devices – verify indoor/proximate use and performance specifications (NFPA 1126: 5.1, 5.2, 5.3, 5.4)
3. Verify quantities, locations, and cueing of devices to be used
4. Verify secure areas and methods for restricting unauthorized persons from entering
5. Verify that all devices are securely fixed with proper audience separation
   A. Minimum 15 ft (4.6 m) or 2 times the fallout radius (NFPA 1126: 6.4.1)
   B. Concussion mortars min 25 ft (7.6 m) in secured area (NFPA 1126: 6.4.2)
   C. Trajectory of comets/mines not over audience (NFPA 1126: 6.2.11)
   D. Waterfall effect area to be free of flammable materials (NFPA 1126: 6.2.12)
   E. Wire rocket effects to be properly secured and terminated (NFPA 1126: 6.2.9)
   F. Airbursts over audience to be minimum height of 3 times the diameter of effect, and no sparks within 15 ft (4.6 m) of floor (NFPA 1126: 6.2.14(1) and (2))
6. Check fire-fighting equipment
   A. Minimum of 2 approved water fire extinguishers (NFPA 1126: 6.1.1.1)
   B. Other fire-fighting equipment as needed/required (NFPA 1126: 6.1.1 & 6.1.1.2)
   C. Existing on-site fire-fighting equipment/systems
7. Pyrotechnic firing systems
   A. Verify operational/safety features and functions of systems (NFPA 1126: 6.3.2 and 6.3.3)
   B. Verify operator and spotters have clear view of effects and communication with operator (NFPA 1126: 6.3.5)
8. Determine plan for HVAC/detectors, adjustments and notification of demonstration
9. Determine need for demonstration of representative effects
10. Check plans for approved and secure on-site storage and preparation areas (NFPA 1126: 4.3.2 (l), 6.1.3 and 6.1.4)
    A. Separation from heat/flame sparks (NFPA 1126: 3.3)
    B. No smoking within 25 ft (7.6 m) (signage) (NFPA 1126: 6.5.5)
    C. Materials stored/handled neatly and orderly (NFPA 1126: 6.5.1)
11. Check plan for personal protective equipment for preparation and loading of pyrotechnics (NFPA 1126: 6.5.7)

Proximate pyrotechnics performance checklist. (Courtesy of American Pyrotechnics Association)

NFPA 1126. The portion of the checklist that is specifically applicable to the inspection of a performance for use by AHJs is shown in Exhibit 65.2.

Chapter 1 of this *Code* allows the AHJ to require certificates of fitness for individuals or companies performing fireworks displays. See Section 1.13 for information on provisions relating to certificates of fitness. The following extract of Annex C of NFPA 1126 provides guidelines for the licensing of pyrotechnic operators:

> **C.1 Pyrotechnic Experience.** A license should be granted only to an individual who has actively participated in the setup and loading of at least five performances where pyrotechnic special effects were used. (The issuing office can substitute an alternative number of performances.)
>
> **C.2 Formal Requirements.** A license should be granted only to an individual who has met at least one of the following requirements:
>
> (1) Successful completion of a comprehensive written examination covering this standard [NFPA 1126] and state laws pertaining to the use of pyrotechnic special effects
> (2) Receipt of a competency certificate from a national organization that promotes the safe use of pyrotechnic special effects
> (3) Possession of a license for the use of pyrotechnic special effects issued by another state
>
> **C.3 Provisions for License Renewal.** A license should not be renewed unless the applicant's record proves active participation in at least three pyrotechnic special effect performances during the past four (4) years and that those performances were conducted in a safe manner. The pyrotechnic uses can be of the indoor or outdoor type.

65.3.2 Where any of the following conditions exist, they shall comply with NFPA 1126:

(1) Any indoor display of pyrotechnic special effects
(2) Any outdoor use of pyrotechnic special effects at distances less than those required by NFPA 1123
(3) The use of pyrotechnic special effects during any videotaping, audiotaping, or filming of any television, radio, or movie production if such production is before a proximate audience
(4) The rehearsal of any production in which pyrotechnic special effects are used

65.3.3 Permits. Permits, where required, shall comply with Section 1.12.

Subsection 1.12.8 requires a permit for the display and use of pyrotechnic materials before a proximate audience. See Table 1.12.8(a).

65.4 Flame Effects Before an Audience

Δ **65.4.1** The use of flame effects before an audience shall comply with NFPA 160.

NFPA 160, *Standard for the Use of Flame Effects Before an Audience*, provides requirements for the protection of property operators, performers, support personnel, and the viewing audiences where flame effects are used indoors or outdoors. The purpose of this standard is to provide minimum requirements to the operators and manufacturers for the safe operation of flame effects.

The circumstances of each show or attraction can be unique and can require individual evaluation when determining the need for protection systems. Factors such as the experience and qualifications of the operations and maintenance personnel, clearance distance between show elements and nonparticipants, visual conditions, and magnitude of the potential hazards are to be weighed in the development and presentation of the production.

NFPA 160 applies to flame effects for entertainment, exhibition, demonstration, or simulation before an audience. NFPA 160 also applies to the following:

1. Use of flame effects before an audience
2. Design, fabrication, installation, testing, control, operation, and maintenance of equipment, materials, procedures, and systems used to produce flame effects
3. Rehearsal, videotaping, audiotaping, or filming of any television, radio, or movie production, if such production is before an audience and includes the use of flame effects
4. Rehearsal of any production incorporating flame effects intended to be presented before an audience
5. Storage and holding at a venue where flammable and combustible materials are to be used to create flame effects
6. That portion or component of any hybrid flame effect that utilizes fuels, materials, devices, and methodologies governed by the standard

NFPA 160 does not apply to the following:

1. Flame effects produced solely by pyrotechnic special effects devices or pyrotechnic material
2. Use of pyrotechnic special effects (See Section 65.3 and NFPA 1126.)
3. Storage of flammable solids, liquids, and gases not to be used to create flame effects (See Chapter 66 and NFPA 30, *Flammable and Combustible Liquids Code*.)
4. Nitrocellulose-based flame projectors
5. Manufacture, off-site storage, and transportation of materials and equipment used to produce flame effects
6. Use of flame effects in fire training (NFPA 160 does apply when the audience is not part of the fire training.)
7. Manufacture, transportation, storage, sale, and use of model or high power rocket motors (See Sections 65.6, 65.7, and 65.8; NFPA 1122; NFPA 1125; and NFPA 1127.)
8. Traditional nontheatrical public display of flames, such as the following:
   a. Use of lighted candles in restaurants or religious services
   b. Fireplaces in areas open to the public
   c. Restaurant cooking visible to the patrons
   d. Listed Group II flame effects
   e. Flame effects used in a fireworks display (See NFPA 1123.)
9. Use of consumer fireworks by the public
10. Use of motor vehicles in races or sanctioned competitive sporting events
11. Use of ground-based effects utilizing explosive, liquid fuels, or other combustibles in air show environments

NFPA 160 identifies and defines the following seven classifications of flame effect:

1. *Group I Flame Effect.* An attended, manually controlled flame effect. Examples of Group I flame effect are handheld burning torches, cigarette lighters, candles, matches, paper lit in ashtrays, burning batons used by jugglers, fire rings that are jumped through by performers, and other fire effects that create the illusion of danger.

An example of the misapplication of the Group I flame effect is local ordinances that permit smoking in a venue for theatrical purposes. At issue is the intent of the definition of the term *Group I flame effect* in NFPA 160. It is not the intent of this *Code* or NFPA 160 to consider this incidental use of a flame as a prop (e.g., to portray smoking by a performer) in a theatrical performance as a Group I flame effect; nor would it be the intent if a few candles were used on stage as props. To assist the users of this *Code* and NFPA 160 in understanding the intent, consider the last line in the first paragraph of item 1, Group I Flame Effect, which concludes "... and other fire effects that create the illusion of danger." Smoking materials or candles used as props on stage are just that, props, and are not being used as special effects that establish some illusion of danger. The AHJ should consider the life safety features of the venue when evaluating the use of any ignition sources or ignited materials. Regarding permit requirements, if the item is not deemed a flame effect, NFPA 160 would not require a permit; however, local AHJ provisions might specify otherwise.

2. *Group II Flame Effect.* An individual or group flame effect designed for unattended operation that is temporarily or permanently installed outside any structure. Examples of Group II flame effect are unattended torches, burning urns, and small fires.

3. *Group III Flame Effect.* An attended, temporarily installed flame effect for a specific production with limited operation and fixed time for removal. Examples of Group III flame effect are effects used by traveling shows and concerts and effects used for limited-duration special events, such as the Olympics. This group also includes a traveling entertainment event that plays various venues, such as, but not limited to, circuses, operas, musicals, stage plays, trade shows, or corporate events. This group effect also includes a nontraveling entertainment event that plays a single venue.
4. *Group IV Flame Effect.* A large individual or group flame effect that is permanently installed inside or outside any structure designed for unattended operation without a main show supervisory control system. Examples of Group IV flame effect are a burning cabin or bonfire and large single or multiple flaming brazier entrance features used to create a theme atmosphere. A stand-alone-type flame effect control system without any significant control supervision by a main show control system is used.
5. *Group V Flame Effect.* A large individual or group flame effect that is temporarily or permanently installed inside or outside any structure and is designed for intermittent or continuous operation under the supervision of a main show control system but without full-time supervision by a technician. An example of Group V flame effect is a simulated building or vehicle explosion that is part of a larger theme-type attraction. The flame effect control system is totally dedicated to the operation of the flame effect elements. The flame effect control system maintains all its internal safety features, with the interface between the flame effect control system and the main show control system limited to those commands and status indicators that cannot alter or override the flame supervisory system control logic.
6. *Group VI Flame Effect.* A large individual or group flame effect that is temporarily or permanently installed inside or outside any structure and is designed for intermittent operation under the supervision of a main show control system and a technical director, with cast members in close proximity to the effect at the time of operation. An example of Group VI flame effect is a live-action stunt show that is part of a larger theme-type attraction. The flame effect control system is totally dedicated to the operation of the flame effect elements. The flame effect control system maintains all its internal safety features, with the interface between the flame effect control system and the main show control system limited to those commands and status indicators that cannot alter or override the flame supervisory system control logic.
7. *Group VII Flame Effect.* An individual flame effect that can be temporarily or permanently installed inside or outside any structure that, due to its unique operating requirements, does not fit into any other classification. An example of Group VII flame effect is a fire created as part of an illusion used to make an item or an individual disappear.

COMMENTARY TABLE 65.3 *Features Included in Flame Effect Groups*

Feature	Flame Effect Group						
	I	II	III	IV	V	VI	VII
Outside	X	X	X	X	X	X	X
Inside	X		X	X	X	X	X
Temporary installation	X	X	X		X	X	X
Permanent installation		X		X	X	X	X
Attended	X		X			X	X
Unattended		X		X	X		X
Visual flame verification	X		X				X
Automatic flame supervision		X		X	X	X	X
Manual fuel controls	X						X
Automatic fuel controls		X	X	X	X	X	X
Main show control					X	X	
Proximate cast			X			X	X

Note: A blank cell in the table means that the feature is not permitted to be in the group.
X — Group feature.
Source: NFPA 160, Table A.3.3.19.

Exhibit 65.3 is a schematic illustration of flame effect control and piping components that can be located at a supervisor station. Commentary Table 65.3 identifies the features of flame effects that are included in the various flame effect groups.

In accordance with A.3.3.19 of NFPA 160, the proximate cast feature applies to flame effect Groups III, VI, and VII, and this revision is shown in Commentary Table 65.3.

65.4.2 Permits. Permits, where required, shall comply with Section 1.12.

Subsection 1.12.8 requires a permit for the use of flame effects before an audience. See Table 1.12.8(a).

65.5 Fireworks Manufacturing

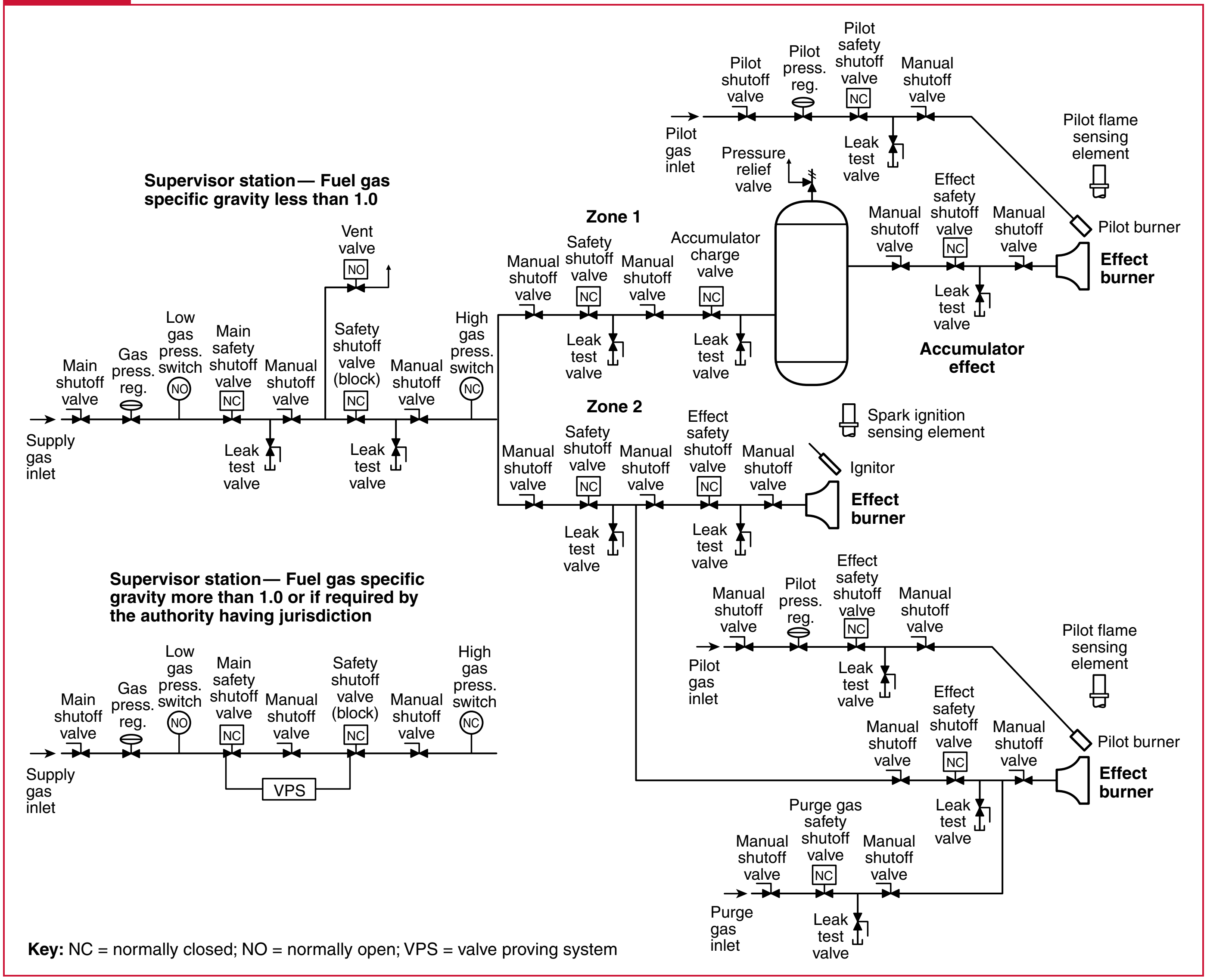
Δ **65.5.1** The manufacture, transportation, or storage of fireworks shall comply with NFPA 1124.

65.5.2 Permits. Permits, where required, shall comply with Section 1.12.

Δ 65.6 Model Rocketry

The design, construction, limitations of propellant mass and power, and reliability of model rocket motors and model rocket motor reloading kits and their components produced commercially for

Exhibit 65.3



Example of various flame effect control and piping components.

sale to or use by the public for purposes of education, recreation, and sporting competition shall comply with NFPA 1122.

The purpose of NFPA 1122 is to ensure the availability of commercial model rocket motors and components that meet standards of safety and reliability and to ensure that the creative and experimental use of model rocket devices by the public is reasonably safe. The intent of NFPA 1122 is also to discourage the creation and launching of homemade rockets and other rocket-like vehicles that are propelled by, or intended to be propelled by, homemade rocket propulsion devices. In addition, experiments with explosive or highly energetic rocket propellants are discouraged by NFPA 1122.

NFPA 1122 addresses not only model rocket motors but also the design and construction of model rockets propelled by model rocket motors and the conduct of launch operations of model rockets.

65.7 Rocketry Manufacturing

Δ **65.7.1** The manufacture of model rocket motors designed, sold, and used for the purpose of propelling recoverable aero models shall comply with NFPA 1125.

The purpose of NFPA 1125 is to provide reasonable safety in the manufacture of model rocket motors and high power rocket motors. The document is designed to supplement existing federal, state, or local regulations.

NFPA 1125 applies to the design, construction, and reliability of model and high power rocket motors and model rocket and high power motor-reloading kits and their components and to the limitation of propellant mass and power. These terms are defined in 3.3.24.2 and 3.3.24.4 of NFPA 1125 as follows:

1. *High Power Rocket Motor*. A rocket motor that has no more than 40,960 N-sec (9209 lb-sec) of total impulse and that does not otherwise meet all the requirements for a model rocket motor set forth in NFPA 1125.
2. *Model Rocket Motor*. A solid-propellant rocket motor that has a total impulse of no greater than 160 N-sec (36 lb-sec), an average thrust of no greater than 80 N (18 lbf), and that otherwise meets the other requirements set forth in NFPA 1125.

Model rocket motors include both assembled reloadable model rocket motors and manufactured expendable model rocket motors.

65.7.2 Permits. Permits, where required, shall comply with Section 1.12.

Subsection 1.12.8 requires a permit for the manufacture of model rocket motors and a permit for the manufacture, sale, and use of high power rocket motors. See Table 1.12.8(a).

65.8 High Power Rocketry

Δ **65.8.1** The design, construction, limitations of propellant mass and power, and reliability of all high-power rocket motors and motor components produced commercially for sale to or use by the certified user for education, recreation, and sporting competition shall comply with NFPA 1127.

The requirements of NFPA 1127 establish guidelines for reasonably safe operation of high power rockets that protect the user and the public and discourage experimentation with explosive or highly energetic rocket propellants, construction of homemade rocket propulsion motors, or attempted launches or other operation of homemade rocket devices.

NFPA 1127 addresses the design, construction, limitation of propellant mass and power, and reliability of high power rocket motors and motor components produced commercially for sale or for use by a certified user for education, recreation, and sporting competition. NFPA 1127 also covers the design and construction of high power rocket vehicles propelled by high power rocket motors, including the conduct of launch operations of high power rocket vehicles.

65.8.2 Permits. Permits, where required, shall comply with Section 1.12.

Subsection 1.12.8 requires a permit for the use of high power rockets. See Table 1.12.8(a.

65.9 Explosives

Δ **65.9.1** The manufacture, transportation, storage, sale, and use of explosive materials shall comply with NFPA 495 and NFPA 498.

NFPA 495, *Explosive Materials Code*, applies to, and is intended to provide reasonable safety for the manufacture, transportation, storage, sale, and use of explosive materials. NFPA 495 does not apply to the following:

1. Transportation of explosive materials where they are under the jurisdiction of the U.S. Department of Transportation (DOT). However, NFPA 495 does apply to state and municipal supervision of compliance with 49 CFR, Parts 100–199, "Hazardous Materials Regulations," U.S. Department of Transportation.
2. Transportation and use of military explosives by federal or state military agencies.
3. Transportation and use of explosive materials by federal, state, or municipal agencies while engaged in the performance of normal or emergency duties.
4. Manufacture of explosive materials under the jurisdiction of the U.S. Department of Defense.
5. Distribution of explosive materials to, or storage of explosive materials by, military agencies of the United States.
6. Arsenals, navy yards, depots, or other establishments owned by, operated by, or operated on behalf of the United States.
7. Pyrotechnics such as flares, fuses, and railway torpedoes.
8. Fireworks or pyrotechnic special effects, as defined in NFPA 1123, NFPA 1124, and NFPA 1126.
9. Model and high power rocketry, as defined in NFPA 1122, NFPA 1125, and NFPA 1127.
10. Use of explosive materials in medicines and medicinal agents in the forms prescribed by the United States Pharmacopoeia or the National Formulary.

NFPA 498, *Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives*, applies to safe havens that are used for the parking of vehicles transporting explosives and to interchange lots for explosives that are safe havens where less than truckloads of explosives are permitted to be held for transfer from one vehicle to another for continuance in transportation. NFPA 498 also applies to the design and operating features of facilities for motor vehicles that transport explosives, and it provides reasonable requirements for the prevention of fires, theft, and explosion within those facilities.

Facilities for motor vehicles that transport explosives provide safe havens for parking such vehicles and provide interchange areas where less than truckload quantities of explosives are permitted to be transferred from one vehicle to another for further transportation. Some explosives interchange lots also

COMMENTARY TABLE 65.4 *Classifications for Permit to Blast*

Class	Category	Blasting Permitted
A	Unlimited	All types of blasting
B	General aboveground	All phases of blasting operations in quarries, open pit mines, and aboveground construction
C	General underground	All phases of blasting operations in underground mines, shafts, tunnels, and drifts
D	Demolition	All phases of blasting in demolition projects
E	Seismic	All phases of blasting in seismic prospecting
F	Agriculture	All phases of blasting in agriculture but limited to not more than 22.7 kg (50 lb) per blast
G	Special	Special blasting as described on the permit

Source: NFPA 495, Table 4.3.2.

provide temporary holding facilities for less than truckload quantities of explosives.

Facilities for motor vehicles that transport explosives are considered part of the over-the-road transportation of explosives. These facilities not only provide the services previously specified, but they can also provide vehicle maintenance and areas in which drivers can rest.

Motor vehicles that use facilities that transport explosives operate under the regulations of the 49 CFR 100–199, U.S. Department of Transportation. Such vehicles are engaged in transporting explosives and ammunition on government bills of lading, or they often carry commercial explosives.

65.9.2 Permits.

65.9.2.1 Permits, where required, shall comply with Section 1.12.

Subsection 1.12.8 requires a permit for the manufacture, sale, disposal, purchase, storage, use, possession, or transportation of explosives within the jurisdiction, as well as for blasting operations. See Table 1.12.8(a).

65.9.2.2 A separate permit shall be required to conduct blasting operations.

Commentary Table 65.4 shows the classification for blasting permits as required by 65.9.2.2.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.

NFPA 160, *Standard for the Use of Flame Effects Before an Audience*, 2016 edition.

NFPA 495, *Explosive Materials Code*, 2013 edition.

NFPA 498, *Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives*, 2013 edition.

NFPA 1122, *Code for Model Rocketry*, 2018 edition.

NFPA 1123, *Code for Fireworks Display*, 2018 edition.

NFPA 1125, *Code for the Manufacture of Model Rocket and High Power Rocket Motors*, 2017 edition.

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*, 2016 edition.

NFPA 1127, *Code for High Power Rocketry*, 2018 edition.

Fire Protection Handbook®, Cote, A., ed., 20th edition, 2008.

National Formulary (NF), available for order online at www.uspnf.com.

Title 49, Code of Federal Regulations, Parts 100–199, "Hazardous Materials Regulations," U.S. Department of Transportation, U.S. Government Publishing Office, Washington, DC.

United States Pharmacopeia (USP), available for order online at www.uspnf.com.

Flammable and Combustible Liquids

66

Chapter 66 addresses the storage, use, and handling of flammable and combustible liquids, including waste liquids.

66.1 General

66.1.1* The storage, handling, and use of flammable and combustible liquids, including waste liquids, as herein defined and classified, shall comply with this chapter; NFPA 30, and Sections 60.1 through 60.4 of this *Code*.

A.66.1.1 See A.1.3.2.

66.1.2 Where the provisions of this chapter or NFPA 30 conflict with the provisions of Chapter 60, the provisions of this chapter and NFPA 30 shall apply.

66.1.3 This chapter shall not apply to the following:

(1)* Any liquid that has a melting point of 100°F (37.8°C) or greater

A.66.1.3(1) Liquids that are solid at 100°F (37.8°C) or above, but are handled, used, or stored at temperatures above their flash points, should be reviewed against pertinent sections of this *Code*. [**30:**A.1.1.2(1)]

A material whose melting point is at or above 100°F (37.8°C) is outside the scope of NFPA 30, *Flammable and Combustible Liquids Code*, and can be considered equivalent to a true solid. The provisions of NFPA 30 are not considered to be appropriate for these materials. Certain of these materials (e.g., camphor and naphthalene) are termed *volatile solids* in some technical references and might be reported as having flash points. However, this does not imply that they are liquids within the scope of NFPA 30. It does mean that these materials, like liquids, evolve vapors at ambient temperatures. For this reason, A.66.1.3(1) recommends review of any situation where such materials are handled at temperatures above their putative flash points, because they can take on some of the characteristics of a flammable liquid at elevated temperatures. Under such circumstances, application of specific provisions of NFPA 30 might be prudent, not because they are mandated but because they are simply good fire protection practice.

Conversely, a material that has a melting point below 100°F (37.8°C) is considered by NFPA 30 to be a liquid, even if it is not fluid at the temperature at which it is used or stored. Such a material is within the scope of NFPA 30 because it melts at a relatively low temperature and can then spread or flow toward an ignition source. Some of these materials (e.g., asphalt) do not have distinct melting points, so the dividing line between the liquid state and the solid state is not easily discerned. NFPA 30 defines a liquid as any material that is more fluid than 300 penetration asphalt or that is characterized as a liquid using the test protocol of ASTM D4359, *Standard Test for Determining Whether a Material Is a Liquid or a Solid*. An asphalt graded as 300 penetration is about the consistency of painter's putty or glazing compound, only more cohesive. It is quite resistant to flow.

For purposes of protection of ordinary combustible solid materials in storage, NFPA 13, *Standard for the Installation of Sprinkler Systems*, applies. For flammable solids, as defined by the U.S. Department of Transportation or as defined in 3.3.45 of NFPA 400, *Hazardous Materials Code*, NFPA 400 applies.

(2)* Any liquid that does not meet the criteria for fluidity given in the definition of *liquid* in 3.3.30 of NFPA 30 and Chapter 4 of NFPA 30

A.66.1.3(2) The information in A.66.1.3(1) also applies here. [**30:**A.1.1.2(2)]

(3) Any cryogenic fluid or liquefied gas, as defined in 3.3.140.7

NFPA 30's use of the term *liquid* excludes any material that has a vapor pressure greater than 40 psi (276 kPa) absolute at 100°F (37.8°C). One common material that meets this criterion, thereby excluding it from coverage under NFPA 30, is liquefied petroleum gas (LP-Gas), which is covered in NFPA 58, *Liquefied Petroleum Gas Code*. Other liquefied flammable gases are covered in NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, and NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*.

(4)* Any liquid that does not have a flash point, but which is capable of burning under certain conditions

A.66.1.3(4) Certain mixtures of flammable or combustible liquids and halogenated hydrocarbons either do not exhibit a flash point using the standard closed-cup test methods or will exhibit elevated flash points. However, if the halogenated hydrocarbon is the more volatile component, preferential evaporation of this component can result in a liquid that does have a flash point or has a flash point that is lower than the original mixture. In order to evaluate the fire hazard of such mixtures, flash point tests should be conducted after fractional evaporation of 10, 20, 40, 60, or even 90 percent of the original sample or other fractions representative of the conditions of use. For systems such as open process tanks or spills in open air, an open-cup test method might be more appropriate for estimating the fire hazard. [**30:**A.1.1.2(4)]

Examples of liquids that do not have flash points but that might be capable of burning under certain conditions (such as being heated in a closed vessel) include methyl bromide, dichloromethane, trichloroethane, and trichloroethylene. NFPA 49, *Hazardous Chemicals Data Compilation*, and NFPA 491, *Compilation of Hazardous Chemical Reactions*, which are available only as part of the *Fire Protection Guide to Hazardous Materials*, 14th edition, can be useful in identifying such materials.

(5)* Any aerosol product

Δ **A.66.1.3(5)** See NFPA 30B. [**30:**A.1.1.2(5)]

(6) Any mist, spray, or foam

Two processes that come under this exclusion are spray finishing using flammable or combustible materials and spray lay-up of glass fiber–reinforced plastic resins, both of which are covered in NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*.

(7)* Transportation of flammable and combustible liquids as governed by the U.S. Department of Transportation

A.66.1.3(7) Requirements for transportation of flammable and combustible liquids can be found in NFPA 385 and in the U.S. Department of Transportation's Hazardous Materials Regulations, Title 49, Code of Federal Regulations, Parts 100–199. [**30:**A.1.1.2(7)]

Transportation within the context of NFPA 30 includes the movement of liquids by air, rail, truck, ship, or pipeline beyond the facility from which the liquid is shipped to the point of delivery to the consignee. In this context, transportation does not include movement of liquids within a facility.

NFPA 30 does not apply to transportation. Specific regulations governing transportation of flammable and combustible liquids can be found in the U.S. Department of Transportation's (DOT) Hazardous Materials Transportation Regulations, in 49 CFR 172–179. The DOT has broad preemptive power and any intent by NFPA 30 to govern transportation would be overridden.

NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids*, is often used as the basis for local and state regulation of intrastate truck shipments, although the DOT regulations specified are more often adopted by reference for the same purpose. Tank vehicles licensed for interstate commerce are always regulated by the DOT, including those operating in intrastate service. The differences between NFPA 385 and the DOT regulations are minor.

In some long-term storage situations, applicability of NFPA 30 depends on how the term *temporary* is defined. A tank vehicle routinely used to store a liquid for periods of time exceeding several days could be considered a storage tank, especially if it never leaves the facility. In that case, Formal Interpretation 84-4 (NFPA 30, 2012 edition) states that the requirements of NFPA 30 would apply. However, the same tank vehicle holding the same liquid but temporarily parked for a few days while it awaits shipment to the consignee would be considered in transportation and, therefore, would not be subject to NFPA 30. Undoubtedly, some situations are not as clear and require the judgment of the authority having jurisdiction (AHJ).

(8)* Storage, handling, and use of fuel oil tanks and containers connected with oil-burning equipment

Δ **A.66.1.3(8)** See NFPA 31. [**30:**A.1.1.2(8)]

NFPA 30 defers to NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, for fuel oil storage tanks where the tanks are inside a building and supply oil-burning appliances such as boilers, hot air furnaces, and hot water heaters. However, NFPA 31 refers to NFPA 30 for outside aboveground fuel oil storage tanks whose capacity exceeds 660 gal (2500 L) and for those that are buried. Historically, the installation of fuel oil storage tanks in buildings to supply fuel to oil-burning appliances has proved to be safe. Although NFPA 31 is the only document referenced in A.66.1.3(8), this exemption applies just as well to fuel tanks installed inside a building under NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*.

(9)* Use and installation of alcohol-based hand rub (ABHR) dispensers. *(See 60.5.2.)*

[**30:**1.1.2]

Δ **A.66.1.3(9)** Requirements for the use and installation of alcohol-based hand rubs are covered in this *Code* and NFPA *101*. [**30:**A.1.1.2(9)]

66.1.4 Installations made in accordance with the applicable requirements of the following standards shall be deemed to be in compliance with this *Code*:

(1) NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*
(2) NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*
(3) NFPA 31, *Standard for the Installation of Oil-Burning Equipment*
(4) NFPA 32, *Standard for Drycleaning Plants*
(5) NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
(6) NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*
(7) NFPA 35, *Standard for the Manufacture of Organic Coatings*
(8) NFPA 36, *Standard for Solvent Extraction Plants*

(9) NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*
(10) NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*
(11) NFPA 99, *Health Care Facilities Code*
(12) NFPA *101, Life Safety Code*
[**30:**1.5.3]

NFPA publishes many standards that apply to specific hazards or processes. Compliance with the requirements of the more specifically oriented standards can take precedence over those of NFPA 30. NFPA 30 is a "base" standard for flammable and combustible liquids and applies to a wide range of activities, whereas most of the codes and standards listed in 66.1.4 address narrowly defined situations. Those specific codes and standards can be expected to deal directly with the fire and explosion hazards presented by the process, operation, or occupancy covered.

The exception is this *Code,* which includes a broad-based chapter on hazardous materials (Chapter 60). This *Code* also extracts many provisions of NFPA 30 into Chapter 66. The intent of 66.1.4(1), then, is to exempt from the requirements of NFPA 30 those occupancies in which there are only minor quantities of flammable and combustible liquids. Note that Chapter 9 of NFPA 30 contains basically the same provisions for flammable and combustible liquids as does Chapter 60 of NFPA 1. This allows comprehensive application of NFPA 30 in those jurisdictions where a fire prevention code other than NFPA 1 is used or in jurisdictions where NFPA 30 is referenced directly.

An example of the application of 66.1.4 is appropriate. NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, generally refers to NFPA 30 for the design and construction of aboveground fuel storage tanks, including any required appurtenances. However, NFPA 30A imposes separation distances between the tanks and property lines and exposures that greatly exceed those imposed by NFPA 30. This is because motor fuel dispensing sites are accessible by the general public, and this unrestricted access presents inherent risks of a vehicle hitting a tank. NFPA 30, on the other hand, anticipates a relatively controlled environment.

A second example involves the manufacturing of coatings, such as lacquers, paints, and inks. For this type of manufacturing, the provisions of NFPA 30, Chapter 17, Processing Facilities, are too generic. NFPA 35, *Standard for the Manufacture of Organic Coatings*, speaks specifically to the operations and processes involved in the manufacture of flammable coatings operations. In addition, NFPA 35 includes fire protection guidance for storage of nitrocellulose, which is used in the manufacture of lacquers. Such information is not found elsewhere in NFPA technical documents.

66.1.5 Permits. Permits, where required, shall comply with Section 1.12.

66.2 Reserved

66.3 Definitions

66.3.1 (Reserved)

66.3.2 (Reserved)

66.3.3 General Definitions.

66.3.3.1 Alcohol-Based Hand Rub. See 3.3.10.

66.3.3.2 Area.

66.3.3.2.1 Fire Area. See 3.3.14.3.

66.3.3.2.2 Inside Liquid Storage Area. See 3.3.14.6.

66.3.3.3 Barrel. See 3.3.21.

66.3.3.4 Basement. See 3.3.22.

66.3.3.5 Boiling Point. See 3.3.27.

66.3.3.6* Boil-Over. See 3.3.28.

A.66.3.3.6 See A.3.3.28.

66.3.3.7 Building.

66.3.3.7.1* Important Building. See 3.3.29.7.

A.66.3.3.7.1 See A.3.3.29.7.

66.3.3.7.2 Storage Tank Building. See 3.3.29.11.

66.3.3.8 Chemical Plant. See 3.3.45.

66.3.3.9 Closed-Top Diking. See 3.3.52.

66.3.3.10 Container. Any vessel of 119 gal (450 L) or less capacity used for transporting or storing liquids. [**30,** 2018]

NFPA 30 defines *container* so as to be consistent with the DOT definition of *non-bulk packaging,* in 49 CFR 171.8, part of which reads "a maximum capacity of 450 L (119 gal) or less as a receptacle for liquids." In the same section, DOT defines *bulk packaging*, as it applies to liquids, as packaging that has "a maximum capacity greater than 450 L (119 gal)." Bulk packaging includes transport vehicles (in this case, tank vehicles) and large shipping vessels, such as the ISO intermodal tank shown in Exhibit 66.1. Typical ISO tanks are 8 ft (2.4 m), 20 ft (6 m), and 30 ft (9 m) long, with capacities from 2600 gal (10,000 L) to 9800 gal (37,000 L). For the purpose of applying NFPA 30, ISO tanks are treated the same as fixed tanks, as covered in Chapters 21 through 25 of NFPA 30.

Note, however, that 49 CFR 178.700 includes specifications for what it refers to as an "intermediate bulk container" (IBC), a shipping container that has a capacity of not more than 3 m^3 (793 gal, or 3000 L), but not less than 0.45 m^3 (119 gal, or 450 L). Several types of IBCs are available; a metal IBC is shown in Exhibit 66.2. Most IBCs used in the United States tend to be 275 gal to 330 gal (1040 L to 1250 L) capacity and are about 48 in. × 48 in. × 48 in. (1200 mm × 1200 mm × 1200 mm) in size, although the length in any one dimension can range from

40 in. to 50 in. (1015 mm to 1270 mm). The dimensions are compatible with existing rack storage configurations used in warehouses. IBCs of these sizes occupy the same space as four 55 gal (208 L) drums on a pallet, so they represent a 25 to 50 percent increase in warehouse utilization. IBCs are being used more and more in the United States, having been used extensively in Europe for many years.

To minimize confusion, NFPA 30 uses a convention whereby containers used to store liquids are separated into three categories, as shown in Commentary Table 66.1.

Exhibit 66.1

Typical ISO intermodal tank. (Courtesy of Direct Logistics Pty Ltd.)

Exhibit 66.2

Typical metal intermediate bulk container (IBC). (Courtesy of National Packaging Services)

COMMENTARY TABLE 66.1 *Container Categories*

Container Type	*Capacity, gal (L)*
Non-bulk container	≤119 (450)
Intermediate bulk container	>119 (450) up to 793 (3,000)
Bulk container	>793 (>3,000)

66.3.3.10.1 Closed Container. See 3.3.70.2.

66.3.3.10.2 Intermediate Bulk Container. See 3.3.70.6.

66.3.3.11 Control Area. For the purposes of this chapter, a building or portion of a building within which flammable and combustible liquids are allowed to be stored, dispensed, and used or handled in quantities that do not exceed the maximum allowable quantity (MAQ). [**30,** 2018]

The concept of *control area* has been adopted by NFPA 30 as a means to establish requirements for managing the quantity of liquids that can be stored in a building or in a portion of a building, but its use in NFPA 30 is limited to flammable and combustible liquids. A control area might be a single room in a building, a floor in a multistory building, or an entire building.

66.3.3.12 Crude Petroleum. See 3.3.77.

66.3.3.13 Cryogenic Fluid. See 3.3.78.

66.3.3.14 Damage-Limiting Construction. See 3.3.83.

66.3.3.15 Distillery. See 3.3.90.

66.3.3.16 Fire Point. See 3.3.127.

66.3.3.17 Flash Point. See 3.3.134.

66.3.3.18* Fugitive Emissions. See 3.3.137.

A.66.3.3.18 See A.3.3.137.

66.3.3.19* Hazardous Material or Hazardous Chemical. Material presenting dangers beyond the fire problems relating to flash point and boiling point. [**30,** 2018]

A.66.3.3.19 Hazardous Material or Hazardous Chemical. These dangers can arise from, but are not limited to, toxicity, reactivity, instability, or corrosivity. [**30,** 2018]

66.3.3.20 Hazardous Materials Storage Locker. See 3.3.151.

66.3.3.21 Hazardous Reaction or Hazardous Chemical Reaction. See 3.3.152.

66.3.3.22 Heat Transfer Fluid (HTF). See 3.3.153.

66.3.3.23 High Hazard Level 2 Contents. Contents that present a deflagration hazard or a hazard from accelerated burning. For the purposes of this chapter, this includes Class I, Class II, or Class IIIA liquids that are used or stored in normally open containers or systems, or in closed containers or systems at gauge pressures 15 psi (103 kPa) or greater. [**30,** 2018]

66.3.3.24 High Hazard Level 3 Contents. Contents that readily support combustion or that present a physical hazard. For the purposes of this chapter, this includes Class I, Class II, or Class IIIA liquids that are used or stored in normally closed containers or in closed systems at gauge pressures of less than 15 psi (103 kPa). [**30,** 2018]

66.3.3.25 Incidental Liquid Use or Storage. See 3.3.161.

66.3.3.26 Liquid.

66.3.3.26.1 Combustible Liquid. See 3.3.169.1.

66.3.3.26.2* Flammable Liquid. See 3.3.169.2.

A.66.3.3.26.2 See A.3.3.169.2.

66.3.3.26.3 Stable Liquid. See 3.3.169.4.

66.3.3.27* Operating Unit (Vessel) or Process Unit (Vessel). See 3.3.196.

A.66.3.3.27 See A.3.3.196.

66.3.3.28 Operations. See 3.3.197.

66.3.3.29* Process or Processing. See 3.3.215.

A.66.3.3.29 See A.3.3.215.

66.3.3.30 Protection for Exposures. See 3.3.218.

66.3.3.31 Refinery. See 3.3.227.

66.3.3.32* Safety Can. See 3.3.233.

A.66.3.3.32 See A.3.3.233.

66.3.3.33 Storage Tank. See 3.3.268.7.

66.3.3.33.1 Aboveground Tank. See 3.3.268.2.

66.3.3.33.1.1 Protected Aboveground Tank. See 3.3.268.2.1.

66.3.3.33.2 Low-Pressure Tank. For the purposes of this chapter, a storage tank designed to withstand an internal pressure above a gauge pressure of 1.0 psig (6.9 kPa) but not more than a gauge pressure of 15 psi (103 kPa) measured at the top of the tank. [**30,** 2018]

Low-pressure storage tanks are constructed in accordance with API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, or an equivalent design standard. Low-pressure tanks are used to store commodities that are volatile enough to flash-vaporize or boil at ambient temperature and pressure, but not so volatile that the tank will experience a gauge pressure of 15 psi (gauge pressure of 1 bar or 103 kPa) or greater. Low-pressure tanks do not vent to the atmosphere except under unusual conditions, such as fire exposure.

66.3.3.33.3 Portable Tank. See 3.3.268.4.

66.3.3.33.3.1* Nonmetallic Portable Tank. A portable tank, as herein defined, constructed of plastic, fiber, or a material other than metal. [**30,** 2018]

A.66.3.3.33.3.1 Nonmetallic Portable Tank. Permissible nonmetallic portable tanks for shipping Class I, Class II, and Class IIIA liquids are governed by hazardous materials transportation regulations promulgated by the United Nations (UN) and the U.S. Department of Transportation (DOT). Small tanks for Class IIIB liquids are not governed by either UN or DOT hazardous materials regulations. Fiber portable tanks for Class IIIB liquids include composite designs consisting of a multi-ply corrugated box with a rigid or flexible inner plastic bladder. [**30,** 2018]

66.3.3.33.4 Secondary Containment Tank. See 3.3.268.5.

66.3.3.34 Unit Operation or Unit Process. See 3.3.277.

66.3.3.35 Vapor Pressure. See 3.3.283.

66.3.3.36 Vapor Processing Equipment. Those components of a vapor processing system designed to process vapors or liquids captured during transfer or filling operations. [**30,** 2018]

66.3.3.37* Vapor Processing System. See 3.3.267.15.

A.66.3.3.37 See A.3.3.267.15.

66.3.3.38 Vapor Recovery System. See 3.3.267.16.

66.3.3.39 Vent.

66.3.3.39.1 Emergency Relief Vent. See 3.3.97.

66.3.3.40* Warehouse.

A.66.3.3.40 Warehouse. Warehousing operations referred to in these definitions are those operations not accessible to the public and include general-purpose, merchandise, distribution, and industrial warehouse–type operations. [**30,** 2018]

66.3.3.40.1 General-Purpose Warehouse. See 3.3.286.1.

66.3.3.40.2 Liquid Warehouse. See 3.3.286.2.

66.4 Definition and Classification of Liquids

66.4.1 Definitions Specific to Liquids. For the purposes of this chapter, the terms in this subsection shall have the definitions given. [**30:**4.2]

On May 25, 2012, the U.S. Occupational Safety and Health Administration (OSHA) "Hazard Communication" standard, found in 29 CFR 1910.1200, was updated to align with the United Nations *Globally Harmonized System of Classification and Labelling of Chemicals*, otherwise known as GHS. GHS uses a classification system for liquids that burn that is very different from that used in NFPA 30. For one thing, the term *combustible* is not used at all. Every liquid with a flash point up to 200°F (93°C) is called "flammable."

GHS then assigns each liquid to a specific category, as shown in Commentary Table 66.2.

COMMENTARY TABLE 66.2 *GHS Category*

GHS Category	Flash Point, °C (°F)	Boiling Point, °C (°F)
1	<23 (73)	≤35 (95)
2	<23 (73)	>35 (95)
3	≥23 (73) & ≤60 (140)	NA
4	>60 (140) & ≤93 (200)	NA

NA = Not applicable.

A comparison of the NFPA 30 classification scheme with GHS is shown in Commentary Table 66.3.

There are some differences besides nomenclature between the two systems. For example, while the flash point criteria for NFPA 30 Classes IA and IB match those for GHS Categories I and II, the boiling point criteria are different: 100°F (37.8°C) versus 95°F (35°C). This is relatively minor and could probably be accommodated with little negative effect; also, the flash point range for NFPA 30 Class IIIA is effectively identical with that for GHS Category 4. The problem lies with NFPA 30 Classes IC and II compared with GHS Category 3. NFPA 30 considers Class IC liquids to be ignitible at high ambient temperatures, while Class II liquids seldom are. So, for example, open use of Class IC liquids typically would require such precautions as area ventilation and the use of classified electrical equipment. Such is not required by the *Code* for Class II liquids, unless they are heated to their flash points. However, the OSHA GHS scheme treats these two categories of liquid the same, which likely would cause confusion for users.

66.4.1.1* Boiling Point. See 3.3.27.

A.66.4.1.1 See A.3.3.27.

66.4.1.2 Combustible Liquid. See 3.3.169.1.

66.4.1.3 Flammable Liquid. See 3.3.169.2.

66.4.1.4* Flash Point. See 3.3.134.

A.66.4.1.4 See A.3.3.134.

66.4.1.5 Liquid. See 3.3.172.

66.4.1.6* Vapor Pressure. See 3.3.283.

A.66.4.1.6 See A.3.3.283.

66.4.2* Classification of Liquids. Any liquid within the scope of this *Code* and subject to the requirements of this *Code* shall be classified in accordance with this chapter. [**30:**4.3]

Δ **A.66.4.2** The classification of liquids is based on flash points that have been corrected to sea level, in accordance with the relevant ASTM test procedures. At high altitudes, the actual flash points will be significantly lower than those either observed at sea level or corrected to atmospheric pressure at sea level. Allowances could be necessary for this difference in order to appropriately assess the risk. [**30:**A.4.3]

Table A.66.4.2 presents a comparison of the definitions and classification of flammable and combustible liquids, as set forth in Chapter 66 of this *Code*, with similar definitions and classification systems used by other regulatory bodies. [**30:**A.4.3]

The Hazardous Materials Regulations of the U.S. Department of Transportation (DOT), as set forth in the 49 CFR 173.120(b)(2) and 173.150(f), provide an exception whereby a flammable liquid that has a flash point between 37.8°C (100°F) and 60.5°C (141°F) and does not also meet the definition of any other DOT hazard class can be reclassified as a combustible liquid [i.e., one having a flash point above 60.5°C (141°F)] for shipment by road or rail within the United States. [**30:**A.4.3]

COMMENTARY TABLE 66.3 *NFPA 30 Liquids Classification vs. OSHA Globally Harmonized Standard*

NFPA 30			OSHA GHS		
Liquid Class	Flash Point, °F (°C)	Boiling Point, °F (°C)	Flammable Category	Flash Point, °F (°C)	Boiling Point, °F (°C)
IA	<73 (23)	<100 (38)	1	<73 (23)	≤95 (35)
IB	<73 (23)	≥100 (38)	2	<73 (23)	>95 (35)
IC	73 to <100 (23 to <38)	—	3	73 to 140 (23 to 60)	—
II	100 to <140 (38 to <60)	—			
IIIA	140 to <200 (60 to <93)	—	4	>140 to 200 (> 60 to 93)	—
IIIB	≥200 (93)	—			

Δ *TABLE A.66.4.2 Comparative Classification of Liquids*

Agency	Agency Classification	Agency Flash Point		NFPA Definition	NFPA Classification	NFPA Flash Point	
		°F	°C			°F	°C
ANSI Z129.1	Flammable	<141	<60.5	Flammable	Class I	<100	<37.8
				Combustible	Class II	≥100 to <140	≥37.8 to <60
					Class IIIA	≥140 to <200	≥60 to <93
	Combustible	≥141 to <200	≥60.5 to <93	Combustible	Class IIIA	≥140 to <200	≥60 to <93
DOT	Flammable	<141	<60.5	Flammable	Class I	<100	<37.8
				Combustible	Class II	≥100 to <140	≥37.8 to <60
					Class IIIA	≥140 to <200	≥60 to <93
	Combustible	≥141 to <200	≥60.5 to <93	Combustible	Class IIIA	≥140 to <200	≥60 to <93
DOT	Flammable	<100	<37.8	Flammable	Class I	<100	<37.8
HM-181	Combustible	≥100 to <200	≥37.8 to <93	Combustible	Class II	≥100 to <140	≥37.8 to <60
Domestic Exemption*					Class IIIA	≥140 to <200	≥60 to <93
UN	Flammable	<141	<60.5	Flammable	Class I	<100	<37.8
				Combustible	Class II	≥100 to <140	≥37.8 to <60
					Class IIIA	≥140 to <200	≥60 to <93
	Combustible	≥141 to <200	≥60.5 to <93	Combustible	Class II	≥100 to <140	≥37.8 to <60
					Class IIIA	≥140 to <200	≥60 to <93
OSHA	Flammable	<100	<37.8	Flammable	Class I	<100	<37.8
	Combustible†	≥100	≥37.8	Combustible	Class II	≥100 to <140	≥37.8 to <60
					Class IIIA	≥140 to <200	≥60 to <93
					Class IIIB†	≥200	≥93

*See A.66.4.3.

†See 29 CFR 1910.106 for Class IIIB liquid exemptions. [**30:** Table A.4.3]

66.4.2.1 Flammable liquids, as defined in 3.3.169.2 and 66.4.1.3, shall be classified as Class I liquids and shall be further subclassified in accordance with the following:

(1) Class IA Liquid — Any liquid that has a flash point below 73°F (22.8°C) and a boiling point below 100°F (37.8°C)
(2) Class IB Liquid — Any liquid that has a flash point below 73°F (22.8°C) and a boiling point at or above 100°F (37.8°C)
(3) Class IC Liquid — Any liquid that has a flash point at or above 73°F (22.8°C), but below 100°F (37.8°C)

[**30:**4.3.1]

66.4.2.2 Combustible liquids, as defined in 3.3.169.1 and 66.4.1.2, shall be classified in accordance with the following:

(1) Class II Liquid — Any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C)
(2) Class III Liquid — Any liquid that has a flash point at or above 140°F (60°C)
    (a) Class IIIA Liquid — Any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C)
    (b) Class IIIB Liquid — Any liquid that has a flash point at or above 200°F (93°C)

[**30:**4.3.2]

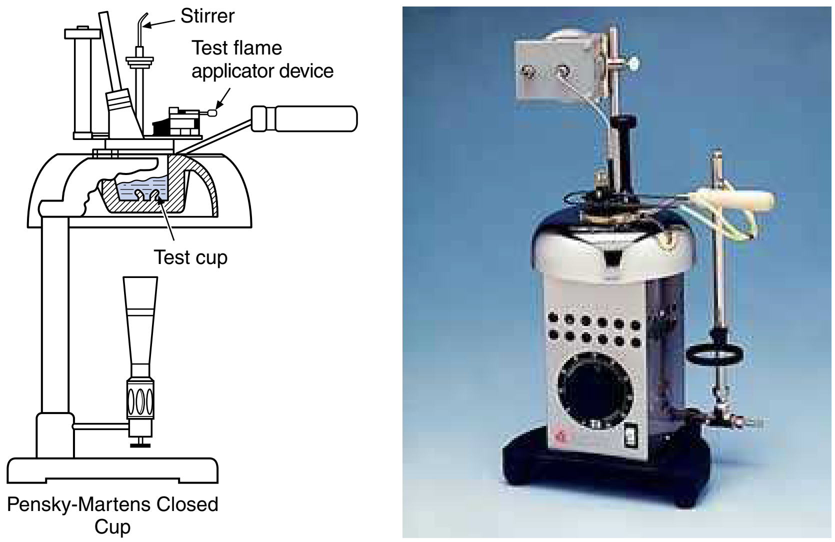
Note that there is no upper bound to the flash point range for Class IIIB liquids. However, if a Class IIIB liquid is diluted to the point where it no longer exhibits a flash point, it would no longer be so classified. That would also be the case for any Class IIIB liquid that is mixed with a noncombustible liquid in proportions in which the mixture does not exhibit a flash point.

66.4.3 Determination of Flash Point. The flash point of a liquid shall be determined according to the methods specified in 66.4.3.1 through 66.4.3.4. [**30:**4.4]

Flash point measurements are made using several different test methods, all sharing a common operation. The liquid being tested is placed in a small sample cup and heated to a certain temperature. A small pilot flame is introduced into the top of the cup, and the operator observes whether the vapor in the cup ignites. If the vapor does not ignite, the liquid is heated to a higher temperature and the pilot flame is reintroduced. These steps are repeated incrementally until ignition occurs. The temperature of the liquid at ignition is the flash point. Exhibit 66.3 shows a cutaway diagram and photograph of a Pensky-Martens closed-cup tester.

Currently, NFPA 30 specifically recognizes only the four closed-cup methods listed in Section 66.4.3. The most common

Exhibit 66.3



Cutaway drawing (left) and photograph (right) of a Pensky-Martens closed-cup flash tester. (Drawing courtesy of ASTM International, Conshohocken, PA; photo courtesy of Koehler Instrument Company, Inc., Bohemia, NY)

manual procedure is described in ASTM D56, *Standard Test Method for Flash Point by Tag Closed Cup Tester*. ASTM D93, *Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester*, is used for certain "problem" liquids — those that are viscous and those that tend to form a skin on the surface (experience has shown that the Tag closed-cup tester has difficulties testing those liquids). ASTM D3278, *Standard Test Method for Flash Point of Liquids by Small Scale Closed Cup Apparatus,* and ASTM D3828, *Standard Test Methods for Flash Point by Small Scale Closed Cup Tester,* cover small automated testers that are considerably easier to use and might totally replace the manual units in the future. Exhibit 66.4 shows one such automated tester.

Exhibit 66.4

Automated closed-cup flash point tester. (Courtesy Stanhope-Seta, Surrey, UK)

Using closed-cup procedures and apparatus rather than the open-cup methods offers some advantages. Closed-cup procedures are easier to use; the results are more reproducible, that is, different laboratories will produce the same test results; and closed-cup testers more easily indicate the presence of small amounts of a low flash point component in an otherwise high flash point mixture.

66.4.3.1 Except as specified in 66.4.3.1.1, the flash point of a liquid having a viscosity below 5.5 centiStokes at 104°F (40°C) or below 9.5 centiStokes at 77°F (25°C) shall be determined in accordance with ASTM D56, *Standard Test Method for Flash Point by Tag Closed Cup Tester*. [**30:**4.4.1]

66.4.3.1.1 Cut-back asphalts, liquids that tend to form a surface film, and liquids that contain suspended solids shall not be tested in accordance with ASTM D56, even if they otherwise meet the viscosity criteria. Such liquids shall be tested in accordance with 66.4.3.2. [**30:**4.4.1.1]

66.4.3.2 The flash point of a liquid having a viscosity of 5.5 centiStokes or more at 104°F (40°C) or 9.5 centiStokes or more at 77°F (25°C) or a flash point of 200°F (93.4°C) or higher shall be determined in accordance with ASTM D93, *Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester*. [**30:**4.4.2]

66.4.3.3 As an alternative, ASTM D3278, *Standard Test Method for Flash Point of Liquids by Small Scale Closed Cup Apparatus*, shall be permitted to be used for paints, enamels, lacquers, varnishes, and related products and their components that have flash points between 32°F (0°C) and 230°F (110°C) and viscosities below 150 Stokes at 77°F (25°C). [**30:**4.4.3]

66.4.3.4 As an alternative, ASTM D3828, *Standard Test Methods for Flash Point by Small Scale Closed Cup Tester*, shall be permitted to be used for materials other than those for which ASTM D3278 is specifically required. [**30:**4.4.4]

66.5 Reserved

66.6 Fire and Explosion Prevention and Risk Control

66.6.1* Scope. This section shall apply to the hazards associated with storage processing, handling, and use of liquids. This section shall also apply when specifically referenced by another section. [**30:**6.1]

A.66.6.1 These provisions might not provide adequate protection for all operations involving hazardous materials or chemical reactions, nor do they consider health hazards resulting from exposure to such materials. [**30:**A.6.1]

66.6.2 Reserved.

66.6.3* Management of Fire and Explosion Hazards. This chapter shall apply to the management methodology used to identify, evaluate, and control the hazards involved in the processing and handling of flammable and combustible liquids. These hazards include, but are not limited to, preparation, separation, purification, and change of state, energy content, or composition. [**30:**6.3]

Δ **A.66.6.3** The evaluation for management of fire hazards should consider probability of an ignitible mixture, the presence of a credible ignition source, and consequences of an ignition. Where the risk is unacceptable to the AHJ, explosion protection in accordance with NFPA 69 or deflagration venting in accordance with NFPA 68 or a combination of the two should be provided. See also *Guidelines for Chemical Process Quantitative Risk Analysis*, 2nd edition, from the Center for Chemical Process Safety/American Institute of Chemical Engineers. [**30:**A.6.3]

The intent of 66.6.3 is to bring about a holistic approach to the prevention and management of fire and explosion hazards in industries that store or use flammable and combustible liquids. The requirement bridges a gap between NFPA 30 and two important federal rules: OSHA's "Process Safety Management of Highly Hazardous Chemicals" (29 CFR 1910.119) and the U.S. Environmental Protection Agency's (EPA) "Accidental Release Prevention Requirements: Risk Management Programs Under the Clean Air Act," Section 112(r)7 (40 CFR 68). Both of these rules require certain industries and facilities that have the potential for either process-related accidents or release of hazardous materials to the environment to conduct analyses to determine the type, magnitude, and consequences of credible accidents. This information is then used to identify appropriate measures to mitigate the effects of such accidents. The typical means to conduct the analyses include process hazard analysis, what-if analysis, hazard and operability studies, failure modes and effects analysis, fault tree analysis, layer of protection analysis, and event tree analysis.

For further information, see *Guidelines for Hazard Evaluation Procedures*, published by the Center for Chemical Process Safety (CCPS) of the American Institute of Chemical Engineers (AIChE).

66.6.4 Hazards Analysis.

66.6.4.1 General. Operations involving flammable and combustible liquids shall be reviewed to ensure that fire and explosion hazards are addressed by fire prevention, fire control, and emergency action plans.

Exception No. 1: Operations where liquids are used solely for on-site consumption as fuels.

Exception No. 2: Operations where Class II or Class III liquids are stored in atmospheric tanks or transferred at temperatures below their flash points.

*Exception No. 3: Mercantile occupancies, crude petroleum exploration, drillings, and well servicing operations, and normally unoccupied facilities in remote locations. [**30:**6.4.1]*

66.6.4.1.1* The extent of fire prevention and control that is provided shall be determined in consultation with the AHJ or by means of an engineering evaluation of the operation and application of sound fire protection and process engineering principles. This evaluation shall include, but not be limited to, the following:

(1) Analysis of the fire and explosion hazards of the operation
(2) Analysis of emergency relief from process vessels, taking into consideration the properties of the materials used and the fire protection and control measures taken
(3) Analysis of applicable facility design requirements in Chapters 17, 18, 19, 28, and 29 of NFPA 30
(4) Analysis of applicable requirements for liquid handling, transfer, and use, as covered in Chapters 17, 18, 19, 28, and 29 of NFPA 30
(5) Analysis of local conditions, such as exposure to and from adjacent properties and exposure to floods, earthquakes, and windstorms
(6) Analysis of the emergency response capabilities of the local emergency services

[**30:**6.4.1.1]

Δ **A.66.6.4.1.1** The wide range in size, design, and location of liquid-processing facilities precludes the inclusion of detailed fire and hazard prevention and control systems and methods applicable to all such facilities. The user should seek further guidance from documents such as NFPA 551. [**30:**A.6.4.1.1]

The factors listed in 66.6.4.1.1 are not to be considered all-inclusive. Other factors to be considered include environmental exposure, the possible need to evacuate off-site neighboring areas, and the need to isolate each operation from adjacent operations or facilities. Additional useful information might include potential changes to process conditions that would reduce the hazard of the process and possible alternative raw materials that present less hazard.

66.6.4.1.2* Storage, processing, handling, and use of Class II and Class III liquids heated at or above their flash point shall follow the requirements for Class I liquids, unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. [**30:**6.4.1.2]

A.66.6.4.1.2 Storage, processing, handling, and use of Class II and Class III liquids at temperatures above the flash point can produce ignitible vapors if the liquid is released or vessels are vented. Class I liquid requirements address such events to minimize the likelihood of ignition and the consequences if ignition occurs, thus becoming a benchmark for design features when Class II and III liquids are handled above the flash point. However, their characteristics differ from those of Class I liquids. For example, the extent of travel of the Class II and III vapors is limited by the quick condensation of released vapors as they cool to lower temperatures. This might justify a more limited electrical area classification, different ventilation, elimination of explosion venting, and so forth. In addition, the process handling these Class II and III heated liquids may incorporate safety design features that accomplish the intent of NFPA 30, that is to address the hazards of released vapors. Further, the more restrictive building construction requirements in Table 17.6.1 of NFPA 30 might not be necessary for a particular process involving Class II, and III liquids heated above the flash point. The option of conducting an engineering evaluation in accordance with Section 66.6 was included to allow the use of alternative designs to address the level of hazards identified. [**30:**A.6.4.1.2]

This provision addresses an important issue: heating a Class II or Class III combustible liquid up to or beyond its flash point. This results in a risk similar to that presented by a Class I flammable liquid. The intent of this provision is to ensure that any such operation is treated as one involving Class I liquids or that an engineering and safety evaluation is conducted to confirm that such stricter rules are not necessary. This provision is the result of a review of the U.S. Chemical Safety and Hazard Investigation Board's (CSB) report on a serious explosion and fire at an ink and paint manufacturing facility, *Investigation Report: Confined Vapor Cloud Explosion*.

A cautionary note is in order here, having to do with a peculiarity in the OSHA rules for flammable and combustible liquids, as set forth in 29 CFR 1910.106. OSHA requires that, when a Category 3 liquid with a flash point at or above 100°F (37.8°C) is heated for use to within 30°F (16.7°C) of its flash point, it must be handled in accordance with the requirements established by OSHA for a Category 3 liquid with a flash point below 100°F (37.8°C). In terms of NFPA 30, this is equivalent to treating a Class II liquid as a Class IC liquid.

Likewise, when a Category 4 liquid is heated for use to within 30°F (16.7°C) of its flashpoint, OSHA requires that it be handled in accordance with the requirements for a Category 3 liquid whose flash point is at or above 100°F (37.8°C). In terms of NFPA 30, this is equivalent to treating a Class IIIA liquid as a Class II liquid. Conceptually, this is a similar rule to what is stated in 66.6.4.1.2, but it is important to note that the details are quite different.

66.6.4.2 Management of Change. The hazards analysis shall be repeated whenever the hazards leading to a fire or explosion change significantly. Conditions that might require repeating a review shall include, but are not limited to, the following:

(1) When changes occur in the materials in process
(2) When changes occur in process equipment
(3) When changes occur in process control
(4) When changes occur in operating procedures or assignments

[**30:**6.4.2]

66.6.5 Control of Ignition Sources.

Control of potential ignition sources is very important, but primary emphasis should always be on the prevention of the release of ignitible concentrations of vapors.

66.6.5.1 General. Precautions shall be taken to prevent the ignition of flammable vapors by sources such as the following:

(1) Open flames
(2) Lightning
(3) Hot surfaces
(4) Radiant heat
(5) Smoking
(6) Cutting and welding

Generally speaking, 25 percent of the lower flammable limit (LFL) is considered to be the dividing line between a safe condition and one that warrants special attention. For example, in an area where flammable liquids are being used in the open, ventilation would normally be provided to ensure that the concentration of vapor in the adjacent atmosphere is not more than 25 percent of the LFL. A concentration above 25 percent would warrant an alarm condition; a concentration above 50 percent would warrant stopping work.

Where cutting, welding, or similar hot work is involved, a safe condition is typically defined as a concentration of not more than 10 percent vapor in air. The following NFPA standards all use this 10 percent criterion to establish a safe condition for hot work:

- NFPA 306, *Standard for the Control of Gas Hazards on Vessels*
- NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-up*
- NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*

A stricter condition is appropriate for hot work because an ignition source is being deliberately introduced where control of ignitable vapors might be a problem.

(7) Spontaneous ignition
(8)* Frictional heat or sparks

A.66.6.5.1(8) With respect to frictional heat or sparks, it is recognized that there is a need to control sources of ignition, including mechanical sparks from hand tools, that have sufficient energy to ignite flammable vapors. Studies, anecdotes, codes, and referenced standards (e.g., API 2214, *Spark Ignition Properties of Hand Tools*) show that there is a potential for hand tool sparks to ignite flammable vapors from a limited number of chemicals and under certain unique conditions. These include flammable liquids with low minimum ignition energies, operations in which flammable or combustible liquids are heated, and atypical spark generation that can occur between specific types of hand tools and struck surfaces (i.e., thermite reactions or impact of steel tools on quartzitic materials). Even spark-resistant tools might not provide suitable protection against ignition. For example, hard metal particles can become imbedded in the relatively soft metal of spark-resistant tools, and these particles can cause sparks when the tools are used. [**30:**A.6.5.1(8)]

NFPA 30 requires analyses, such as job safety analyses or activity hazard analyses, of the hazards and risks of a given task and the application of appropriate protective measures to prevent or mitigate the hazards and risks. This includes identification and mitigation of ignition risk from multiple sources, including hand tools. Due to the complexity of the numerous operations involving flammable liquids, NFPA 30 cannot address all conditions in which spark-resistant tools should be made mandatory, might be advisable, or are unnecessary to help control the ignition risk of any given operation. [**30:**A.6.5.1(8)]

It is recognized that the adoption of the new Globally Harmonized System for labeling by the U.S. Occupational Safety and Health Administration (29 CFR 1910.1200, Appendix C) creates a generalized mandate for the use of spark-resistant tools. However, based on available technical information, this mandate goes beyond what is considered necessary for fire safety, given the fact that it applies to liquids that present little risk of ignition unless heated to or above their flash points. *(See A.66.6.4.1.2.)* [**30:**A.6.5.1(8)]

This Annex A language explains to the user that, although the use of spark-resistant tools is not mandated by the *Code*, there might be situations in which their use is warranted, based on a hazard analysis or job-safety analysis.

The last paragraph of A.66.6.5.1(8) was added in 2015 to explain NFPA 30's position that the new labeling requirements enacted in 29 CFR 1910.1200, Appendix C, also appear to overstate the hazard. In some cases, the mandate for spark-resistant tools applies to liquids that present little risk of ignition unless heated to or above their flash points. Also, experience does not appear to validate the need for spark-resistant tools, given that the incident history is mostly anecdotal.

(9) Static electricity
(10) Electrical sparks
(11) Stray currents
(12) Ovens, furnaces, and heating equipment
[**30:**6.5.1]

66.6.5.2 Smoking. Smoking shall be permitted only in designated and identified areas. [**30:**6.5.2]

66.6.5.3* Hot Work.

Δ **A.66.6.5.3** See NFPA 51B. [**30:**A.6.5.3]

66.6.5.3.1 Welding, cutting, and similar spark-producing operations shall not be permitted in areas containing flammable liquids until a written permit authorizing such work has been issued. [**30:**6.5.3.1]

It is important that no blanket permits be allowed. This responsibility belongs to both the responsible person who issues or approves the permit and the person to whom it is issued. The responsible person who issues or authorizes the permit should ensure that the permit covers only a specific task at one location or on one piece of equipment and should specify on the permit that it is valid only for the duration of the work shift. A new permit should be issued at the beginning of the next shift, because conditions likely will have changed and will need to be reevaluated and because different personnel might be involved.

Any time a significant interruption of work occurs, a new hot work permit should be issued. Separate permits should also be issued for the same task done at several different locations or on different equipment.

The worker(s) who receive the permit should verify that all pertinent restrictions are noted on the permit.

66.6.5.3.2 The permit shall be issued by a person in authority following inspection of the area to ensure that permit requirements have been implemented and will be followed until the job is completed. [**30:**6.5.3.2]

66.6.5.4* Static Electricity.

Δ **A.66.6.5.4** The prevention of electrostatic ignition in equipment is a complex subject. Refer to NFPA 77 for guidance. [**30:**A.6.5.4]

66.6.5.4.1 All equipment such as tanks, machinery, and piping shall be designed and operated to prevent electrostatic ignitions. [**30:**6.5.4.1]

66.6.5.4.2 All metallic equipment such as tanks, machinery, and piping where the potential exists for an ignitible mixture to be present shall be bonded and grounded. [**30:**6.5.4.2]

66.6.5.4.3 The bond and ground shall be physically applied or shall be inherently present by the nature of the installation. [**30:**6.5.4.3]

This requirement simply means that a system might be inherently adequately grounded throughout if all components of the system are in direct metal-to-metal contact with each other and the system is connected to or in contact with the earth at one or more points. If any component is isolated from direct metal contact, it must be connected to the grounded part of the system using a jumper wire.

66.6.5.4.4 Any electrically isolated section of metallic piping or equipment shall be bonded and grounded to prevent hazardous accumulation of static electricity. [**30:**6.5.4.4]

66.6.5.4.5 All nonmetallic equipment and piping where the potential exists for an ignitable mixture to be present shall be designed and operated to prevent electrostatic ignition. [**30:**6.5.4.5]

66.6.5.5 Electrical Systems. Design, selection, and installation of electrical wiring and electrical utilization equipment shall meet the requirements of Section 66.7. [**30:**6.5.5]

66.6.6 Detection and Alarm Systems and Procedures.

66.6.6.1* An approved means shall be provided for prompt notification of fire or other emergency to those identified in the emergency action plan in accordance with Section 66.6.8. [**30:**6.6.1]

Prior to the 2018 edition of this *Code*, 66.6.6.1 applied only to the "plant" itself. It was determined that notification should be made for any situation covered by the emergency action plan and to all entities identified in said plan.

Δ **A.66.6.6.1** One method of complying with this requirement could be through the installation of an automatic and/or manual fire alarm system as covered in *NFPA 72*. [**30:**A.6.6.1]

The 2016 edition of *NFPA 72®, National Fire Alarm and Signaling Code®*, contains information to address the integration of mass notification systems and other systems with fire alarm systems. (See Chapter 24 of *NFPA 72*.)

66.6.6.2 Those areas, including buildings, where a potential exists for a flammable liquid spill shall be monitored as appropriate. The following methods shall be permitted to be used:

(1) Personnel observation or patrol
(2) Process-monitoring equipment that would indicate a spill or leak could have occurred
(3) Provision of gas detectors to continuously monitor the area where facilities are unattended

[**30:**6.6.2]

66.6.7 Fire Protection and Fire Suppression Systems.

66.6.7.1* This section identifies recognized fire protection and fire suppression systems and methods used to prevent or minimize the loss from fire or explosion in liquid-processing facilities. The application of one or a combination of these systems and methods as well as the use of fire-resistive materials shall be determined in accordance with Sections 66.6.3 and 66.6.4. [**30:**6.7.1]

A.66.6.7.1 Other recognized fire prevention and control factors, involving construction, location, and separation, are addressed elsewhere in Section 66.6. [**30:**A.6.7.1]

A presentation of detailed information on fire protection and suppression systems applicable to all the types of facilities covered by this subsection and by Chapter 6 of NFPA 30 is not possible. Each facility is unique in some respects and requires judgment by both the facility operator and the AHJ regarding proper application of NFPA 30's requirements and adequate design of fire protection systems. Often, the assistance of outside consultants and design engineers is necessary.

66.6.7.2 A reliable water supply or other suitable fire control agent shall be available in pressure and quantity to meet the fire demands indicated by the specific hazards of liquids-processing operations, storage, or exposure. [**30:**6.7.2]

66.6.7.3* Permanent connections between the fire water system and any process system shall be prohibited, to prevent contamination of fire water with process fluids. [**30:**6.7.3]

A.66.6.7.3 Permanent connections to process water lines from the fire water system present an opportunity for contamination of the fire water with process fluids. Incidents have occurred where fire water was contaminated with flammable process liquids, with subsequent increased fire damage and, in some cases, injury. Temporary connections are permitted to meet extraordinary needs, as in turnaround and inspection periods, tank cleaning, and so forth. However, care should be taken to address the potential for contamination. Where such use occurs frequently enough to justify a more robust arrangement, double block-and-bleed valves, removable spool pieces, or other means should be used to assure that no contamination can occur. Check valves alone are not sufficient. [**30:**A.6.7.3]

Use of utility water sources, such as boiler feedwater, that are not contaminated, is acceptable for use as a supplemental fire water supply. [**30:**A.6.7.3]

Δ **66.6.7.4** Where required by this chapter, hydrants, with or without fixed monitor nozzles, shall be provided in accordance with this *Code* and NFPA 24. The number and placement shall depend on the hazards of the facility. [**30:**6.7.4]

66.6.7.5 Where the need is indicated by the hazards of liquid processing, storage, or exposure as determined by 66.6.4, fixed protection shall be provided. [**30:**6.7.5]

66.6.7.6 Where provided, fire control systems shall be designed, installed, and maintained in accordance with this *Code* and the following NFPA standards, as applicable:

(1) NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
(2) NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
(3) NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
(4) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(5) NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
(6) NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
(7) NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
(8) NFPA 750, *Standard on Water Mist Fire Protection Systems*
(9) NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

[**30:**6.7.6]

Δ **66.6.7.7** Where required by this chapter, standpipe and hose systems shall be installed in accordance with Section 13.2 and

NFPA 14 or hose connections from sprinkler systems using combination spray and straight stream nozzles shall be installed in accordance with NFPA 13. [**30:**6.7.7]

66.6.7.8* Where required by this chapter, listed portable fire extinguishers shall be provided in such quantities, sizes, and types as are needed for the specific hazards of operation and storage. [**30:**6.7.8]

Δ **A.66.6.7.8** NFPA 10 provides information on the suitability of various types of extinguishers. [**30:**A.6.7.8]

66.6.7.9 Where provided, mobile foam apparatus and supplies of foam concentrate shall be appropriate to the specific hazards. [**30:**6.7.9]

66.6.8 Emergency Planning and Training.

Emergency planning and training were addressed only briefly in older editions of NFPA 30. Considerably more detail is now provided, but it must still be recognized that each facility requires an individual approach, one that might necessitate considerable judgment and consultation among the operator, the AHJ, and local emergency services.

66.6.8.1 A written emergency action plan that is consistent with available equipment and personnel shall be established to respond to fires and related emergencies. This plan shall include the following:

(1) Procedures to be followed in case of fire or release of liquids or vapors, such as sounding the alarm, notifying the fire department, evacuating personnel, and controlling and extinguishing the fire
(2) Procedures and schedules for conducting drills of these procedures
(3) Appointment and training of personnel to carry out assigned duties, including review at the time of initial assignment, as responsibilities or response actions change, and whenever anticipated duties change
(4) Procedures for maintenance and operation of (a) fire protection equipment and systems, (b) drainage and containment systems, and (c) dispersion and ventilation equipment and systems
(5) Procedures for shutting down or isolating equipment to reduce, mitigate, or stop the release of liquid or vapors, including assigning personnel responsible for maintaining critical plant functions or shutdown of plant processes and safe start-up following isolation or shutdown
(6) Alternate measures for the safety of occupants

[**30:**6.8.1]

Paragraph 66.6.8.1 presents the minimum that should be addressed in an emergency action plan. While the development of an emergency action plan is beyond the scope of NFPA 30, the following references are recommended as starting points:

- NFPA 600, *Standard on Facility Fire Brigades*
- NFPA 601, *Standard for Security Services in Fire Loss Prevention*
- *NFPA 1600®, Standard on Disaster/Emergency Management and Business Continuity/Continuity of Operations Programs*
- "Industrial Fire Loss Prevention," Volume II, Section 12, Chapter 11 of the *Fire Protection Handbook®*
- *Facility Manager's Fire Protection Guide*

66.6.8.2 Personnel responsible for the use and operation of fire protection equipment shall be trained in the use of that equipment. Refresher training shall be conducted at least annually. [**30:**6.8.2]

66.6.8.3 Planning of effective fire control measures shall be coordinated with local emergency response agencies. [**30:**6.8.3]

Many organizations develop a pre-fire plan that contains a site plan and a plan of each floor in each building at the site, showing the location of likely fire occurrences. A pre-fire plan includes fire protection measures, such as installed fixed fire protection systems, manual actuators, and locations of emergency shutdown actuators. The plan is used for annual meetings with operations personnel and local emergency response teams, so that everyone understands the on-site hazards and the best way to work effectively and safely together to address a site emergency. See NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety*, for more information.

66.6.8.4 Procedures shall be established to provide for safe shutdown of operations under emergency conditions and for safe start-up following cessation of emergencies. Provisions shall be made for training of personnel in shutdown and start-up procedures, and in activation, use, and deactivation of associated alarms, interlocks, and controls. Procedures shall also be established and provisions shall also be made for inspection and testing of associated alarms, interlocks, and controls. [**30:**6.8.4]

66.6.8.5 The emergency procedures shall be kept readily available in the operating areas and shall be updated when conditions change, as identified in 66.6.4.2. [**30:**6.8.5]

66.6.8.5.1 Where premises are likely to be unattended for considerable periods of time, a summary of the emergency plan shall be posted or located in a strategic and accessible location. [**30:**6.8.5.1]

66.6.9 Inspection and Maintenance.

Δ **66.6.9.1** All fire protection equipment shall be properly maintained, and periodic inspections and tests shall be done in accordance with both standard practice and the equipment manufacturers recommendations. Water-based fire protection systems shall be inspected, tested, and maintained in accordance with this *Code* and NFPA 25. [**30:**6.9.1]

Δ **66.6.9.2** Maintenance and operating practices shall be established and implemented to prevent and control leakage and spillage of flammable and combustible liquids. [**30:**6.9.2]

This paragraph has been amended to emphasize prevention of spills, not just control of a spill. Should a spill occur, clean-up operations should be conducted in a manner that minimizes vapor loss. Many commercially available absorbents and adsorbents have been developed, primarily to mitigate environmental damage, but they are still of great benefit. Also, some fire-suppression foams and recently developed vapor-suppression foams are helpful in controlling vapors from large-scale spills.

66.6.9.3 Combustible waste material and residues in operating areas shall be kept to a minimum, stored in covered metal containers, and disposed of daily. [**30:**6.9.3]

66.6.9.4 Ground areas around facilities where liquids are stored, handled, or used shall be kept free of weeds, trash, or other unnecessary combustible materials. [**30:**6.9.4]

66.6.9.5 Aisles established for movement of personnel shall be kept clear of obstructions to permit orderly evacuation and ready access for manual fire-fighting activities. [**30:**6.9.5]

66.6.10 Management of Security. [**30:**6.10]

This section addresses the issue of facility security and the evaluation of how vulnerable a facility is to intrusion with malicious intent, including riots and civil unrest. The focus of this subsection is to provide a basic framework of accepted methods to address security and vulnerability assessments that parallel the regulations imposed by the U.S. Department of Homeland Security's Chemical Facility Anti-Terrorism Standards in 6 CFR 27 and the practices of major industrial groups such as the American Chemistry Council, the American Petroleum Institute (API), and the AIChE. See also Annex G of NFPA 30.

66.6.10.1 Scope. [**30:**6.10.1]

66.6.10.1.1 This section shall apply to the management methodology used to identify, evaluate, and control the security hazards involved in the processing, storage, and handling of flammable and combustible liquids. [**30:**6.10.1.1]

66.6.10.1.2 These hazards include, but are not limited to, vulnerability to terrorist or other malicious attacks. [**30:**6.10.1.2]

66.6.10.2 General. The methodology used shall incorporate a risk-based approach to site security and shall have the following objectives:

(1) Identification and evaluation of security risks
(2) Evaluation of the security performance of the facility
(3) Evaluation of protection for employees, the facility itself, the surrounding communities, and the environment. *(See Annex G of NFPA 30 for more detailed information.)*

[**30:**6.10.2]

66.6.10.3 Specific Requirements. [**30:**6.10.3]

66.6.10.3.1 Operations involving flammable and combustible liquids shall be reviewed to ensure that security vulnerabilities identified during the security vulnerability analysis (SVA) are addressed in a facility security program, with corresponding fire prevention and emergency action plans and drills. [**30:**6.10.3.1]

66.6.10.3.2 The balance of physical, electronic, and personnel techniques used to respond to the SVA shall be determined by means of an engineering evaluation of the operation and application of sound security principles. This evaluation shall include, but not be limited to, the following:

(1) Assessing overall facility
(2) Evaluating vulnerabilities
(3) Assessing threats/consequences
(4) Assessing physical factors/attractiveness
(5) Identifying mitigation factors
(6) Conducting security assessment or gap analysis

[**30:**6.10.3.2]

66.6.10.3.3 A written emergency action plan that is consistent with available equipment and personnel shall be established to respond to fires, security, and related emergencies. This plan shall include the following:

(1) Procedures to be followed such as initiating alarms, notifying appropriate agencies, evacuating personnel, and controlling and extinguishing the fire
(2) Procedures and schedules for conducting drills of these procedures
(3) Appointment and training of personnel to carry out assigned duties
(4) Maintenance of fire protection and response equipment
(5) Procedures for shutting down or isolating equipment to reduce the release of liquid
(6) Alternate measures for the safety of occupants

[**30:**6.10.3.3]

66.6.10.3.4 Specific duties of personnel shall be reviewed at the time of initial assignment, as responsibilities or response actions change, and whenever anticipated duties change. [**30:**6.10.3.4]

66.6.10.3.5 The security management review conducted in accordance with this section shall be repeated under the following conditions:

(1) For an initial review of all new relevant facilities and assets
(2) When substantial changes to the threat or process occur
(3) After a significant security incident
(4) For periodic revalidation of the SVA

[**30:**6.10.3.5]

66.7 Electrical Systems

The purpose of Section 66.7 is to establish the basic first steps to determine the proper classification of the area in which liquids are located for purposes of designing, installing, and maintaining the electrical system. Detailed requirements for the selection of the wiring methods that are allowed and for the selection and installation of electrical utilization equipment are covered in Chapter 5 of *NFPA 70®*, *National Electrical Code®* (*NEC®*).

66.7.1 Scope. This chapter shall apply to areas where Class I liquids are stored or handled and to areas where Class II or Class III liquids are stored or handled at or above their flash points. [**30:**7.1]

Where Class II and Class III liquids are handled at temperatures below their flash points, ignition is not a risk, and ordinary or general-purpose electrical equipment and wiring methods are acceptable. Where this is not the case — such as where a Class II or Class III liquid is handled at temperatures at or above its flash point — the liquid must be treated as if it were a Class I liquid, and the provisions of Section 66.7 might very well apply, unless an engineering evaluation of the installation indicates otherwise.

66.7.2 Reserved.

66.7.3 General Requirements.

66.7.3.1 Electrical utilization equipment and wiring shall not constitute a source of ignition for any ignitible vapor that might be present under normal operation or because of a spill. Compliance with 66.7.3.2 through 66.7.3.7.1 shall be deemed as meeting the requirements of this section. [**30:**7.3.1]

NFPA 70 specifies the types of electrical equipment, electrical equipment enclosures, and wiring methods that are acceptable for various locations, depending on the likelihood that an ignitible atmosphere is present. *NFPA 70* also has responsibility for the schemes by which an area is classified for purposes of proper electrical system installation and for the definitions related to area classification. *NFPA 70* is not responsible for classifying any particular area, nor is it responsible for determining the extent of a classified area. That is the responsibility of other NFPA codes and standards. NFPA 30 is concerned with those locations that might be hazardous due to the presence of ignitible concentrations of vapors from liquids. Such locations are designated as Class I hazardous locations by *NFPA 70*.

Δ **66.7.3.2** All electrical utilization equipment and wiring shall be of a type specified by and installed in accordance with *NFPA 70*. [**30:**7.3.2]

66.7.3.3* Table 66.7.3.3 shall be used to delineate and classify areas for the purpose of installation of electrical utilization equipment and wiring under normal operating conditions. [**30:**7.3.3]

Where ignitible concentrations (concentrations within flammable or explosive limits) are present, the atmosphere can be ignited by an arc, a spark, or high temperature. Hermetic sealing of all electrical equipment is impractical because equipment such as motors, conventional switches, and circuit breakers has movable parts that must be operated through the enclosing case. In addition, access to the inside of enclosures is often necessary for installation, servicing, or alterations. Therefore, it may be necessary to keep equipment in explosionproof enclosures or to use intrinsically safe equipment.

***TABLE 66.7.3.3** Electrical Area Classifications*

Location	NEC Class I Division	NEC Class I Zone	Extent of Classified Area
Indoor equipment installed in accordance with 66.7.3 where flammable vapor–air mixtures can exist under normal operation	1	0	The entire area associated with such equipment where flammable gases or vapors are present continuously or for long periods of time
	1	1	Area within 5 ft of any edge of such equipment, extending in all directions
	2	2	Area between 5 ft and 8 ft of any edge of such equipment, extending in all directions; also, space up to 3 ft above floor or grade level within 5 ft to 25 ft horizontally from any edge of such equipment[1]
Outdoor equipment of the type covered in 66.7.3 where flammable vapor–air mixtures can exist under normal operation	1	0	The entire area associated with such equipment where flammable gases or vapors are present continuously or for long periods of time
	1	1	Area within 3 ft of any edge of such equipment, extending in all directions
	2	2	Area between 3 ft and 8 ft of any edge of such equipment, extending in all directions; also, space up to 3 ft above floor or grade level within 3 ft to 10 ft horizontally from any edge of such equipment
Tank storage installations inside buildings	1	1	All equipment located below grade level
	2	2	Any equipment located at or above grade level

(continues)

TABLE 66.7.3.3 Continued

Location	NEC Class I Division	NEC Class I Zone	Extent of Classified Area
Tank — aboveground, fixed roof	1	0	Inside fixed-roof tank
	1	1	Area inside dike where dike height is greater than the distance from the tank to the dike for more than 50 percent of the tank circumference
	2	2	Within 10 ft from shell, ends, or roof of tank; also, area inside dike up to top of dike wall
	1	0	Area inside of vent piping or vent opening
	1	1	Within 5 ft of open end of vent, extending in all directions
	2	2	Area between 5 ft and 10 ft from open end of vent, extending in all directions
Tank — aboveground, floating roof			
With fixed outer roof	1	0	Area between the floating and fixed-roof sections and within the shell
With no fixed outer roof	1	1	Area above the floating roof and within the shell
Tank vault — interior	1	1	Entire interior volume, if Class I liquids are stored within
Underground tank fill opening	1	1	Any pit, box, or space below grade level, if any part is within a Division 1 or 2 or Zone 1 or 2 classified location
	2	2	Up to 18 in. above grade level within a horizontal radius of 10 ft from a loose fill connection and within a horizontal radius of 5 ft from a tight fill connection
Vent — discharging upward	1	0	Area inside of vent piping or opening
	1	1	Within 3 ft of open end of vent, extending in all directions
	2	2	Area between 3 ft and 5 ft of open end of vent, extending in all directions
Drum and container filling — outdoors or indoors	1	0	Area inside the drum or container
	1	1	Within 3 ft of vent and fill openings, extending in all directions
	2	2	Area between 3 ft and 5 ft from vent or fill opening, extending in all directions; also, up to 18 in. above floor or grade level within a horizontal radius of 10 ft from vent or fill opening
Pumps, bleeders, withdrawal fittings			
Indoor	2	2	Within 5 ft of any edge of such devices, extending in all directions; also, up to 3 ft above floor or grade level within 25 ft horizontally from any edge of such devices
Outdoor	2	2	Within 3 ft of any edge of such devices, extending in all directions; also, up to 18 in. above grade level within 10 ft horizontally from any edge of such devices
Pits and sumps			
Without mechanical ventilation	1	1	Entire area within a pit or sump if any part is within a Division 1 or 2 or Zone 1 or 2 classified location
With adequate mechanical ventilation	2	2	Entire area within a pit or sump if any part is within a Division 1 or 2 or Zone 1 or 2 classified location
Containing valves, fittings, or piping, and not within a Division 1 or 2 or Zone 1 or 2 classified location	2	2	Entire pit or sump

TABLE 66.7.3.3 Continued

Location	NEC Class I Division	NEC Class I Zone	Extent of Classified Area
Drainage ditches, separators, impounding basins			
Outdoor	2	2	Area up to 18 in. above ditch, separator, or basin; also, area up to 18 in. above grade within 15 ft horizontally from any edge
Indoor			Same as pits and sumps
Tank vehicle and tank car[2]			
Loading through open dome	1	0	Area inside of the tank
	1	1	Within 3 ft of edge of dome, extending in all directions
	2	2	Area between 3 ft and 15 ft from edge of dome, extending in all directions
Loading through bottom connections with atmospheric venting	1	0	Area inside of the tank
	1	1	Within 3 ft of point of venting to atmosphere, extending in all directions
	2	2	Area between 3 ft and 15 ft from point of venting to atmosphere, extending in all directions; also, up to 18 in. above grade within a horizontal radius of 10 ft from point of loading connection
Loading through closed dome with atmospheric venting	1	1	Within 3 ft of open end of vent, extending in all directions
	2	2	Area between 3 ft and 15 ft from open end of vent, extending in all directions; also, within 3 ft of edge of dome, extending in all directions
Loading through closed dome with vapor control	2	2	Within 3 ft of point of connection of both fill and vapor lines, extending in all directions
Bottom loading with vapor control or any bottom unloading	2	2	Within 3 ft of point of connections, extending in all directions; also, up to 18 in. above grade within a horizontal radius of 10 ft from point of connections
Storage and repair garage for tank vehicles	1	1	All pits or spaces below floor level
	2	2	Area up to 18 in. above floor or grade level for entire storage or repair garage
Garages for other than tank vehicles	Ordinary		If there is any opening to these rooms within the extent of an outdoor classified location, the entire room shall be classified the same as the area classification at the point of the opening
Outdoor drum storage	Ordinary		
Inside rooms or storage lockers used for the storage of Class I liquids	2	2	Entire room or locker
Indoor warehousing where there is no flammable liquid transfer	Ordinary		If there is any opening to these rooms within the extent of an indoor classified location, the classified location shall extend through the opening to the same extent as if the wall, curb, or partition did not exist
Office and rest rooms	Ordinary		If there is any opening to these rooms within the extent of an indoor classified location, the room shall be classified the same as if the wall, curb, or partition did not exist
Piers and wharves			See Figure 29.3.22 of NFPA 30.

For SI units, 1 in. = 25 mm; 1 ft = 0.3 m.

[1]The release of Class I liquids can generate vapors to the extent that the entire building, and possibly an area surrounding it, should be considered a Class I, Division 2, or Zone 2 location.

[2]When classifying extent of area, consideration should be given to the fact that tank cars or tank vehicles can be spotted at varying points. Therefore, the extremities of the loading or unloading positions should be used. [**30:** Table 7.3.3]

Electrical equipment that could cause ignition-capable arcs or sparks should be kept out of Class I locations, or the equipment must be identified for the appropriate hazardous location. It is practically impossible to make threaded joints gastight. The conduit system and apparatus enclosure "breathe" due to temperature changes, and any flammable gases or vapors in the room could slowly enter the conduit or enclosure, creating an explosive mixture. If an arc occurs, an explosion also could occur.

When an explosion occurs within the enclosure or conduit system, the burning mixture or hot gases must be sufficiently confined within the system to prevent ignition of any explosive mixture outside the system. An enclosure must be designed with sufficient strength to withstand the pressure generated by an internal explosion to prevent rupture and the release of burning or hot gases. During an explosion within an enclosure, gases escape through any paths or openings that exist, but the gases will be sufficiently cooled if they are carried out through an opening that is long in proportion to its width. The function of the joint is the same whether it is flanged, threaded, rabbeted, or any other type designed for this purpose.

The clearance between flat surfaces could increase somewhat under explosion conditions, because the internal pressures created by the explosion tend to force the surfaces apart, as shown in Exhibit 66.5. The amount of increase in the joint clearance depends on the stiffness of the enclosure parts; the size, strength, and spacing of the bolts; and the explosion pressure. When there are no internal pressures, measuring the joint width and the clearance does not indicate the actual clearances under the dynamic conditions of an explosion. Explosion tests are usually needed to demonstrate the acceptability of the design. Exhibit 66.5 illustrates the need to properly install all provided bolts, screws, fittings, and covers. If bolts are missing, it is essential that the manufacturer's specified bolts be used for replacement.

It is important to understand that an explosionproof electrical enclosure is not airtight or watertight, nor can it be considered waterproof or weatherproof. For additional information, see Supplement 3, Electrical Equipment in Hazardous Areas, of the NFPA 30 Handbook.

Table 66.7.3.3 includes two distinct classification systems that indicate the likelihood that a risk of ignition exists: the "Division" system of classification, which originated in and has been used by the United States almost exclusively, and the European "Zone" system. The rules for installations in an area classified by the Division system are located in Article 500 of *NFPA 70*, while those for the Zone system are in Article 505.

It is important to understand that the two systems cannot be comingled. In other words, in any installation or project, the design of the electrical system must be based on either the Division system or the Zone system, but not both. Also, the designer cannot use the Division system for some portions of the design and the Zone system for others.

Commentary Table 66.4 compares the two systems based on relative risk.

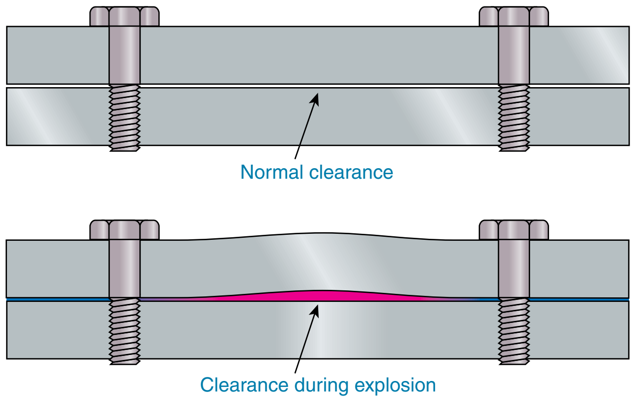
Δ **A.66.7.3.3** For additional information, see NFPA 497. [**30:**A.7.3.3]

Annex material A.66.7.3.3 refers the reader to NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*. NFPA 497 basically provides line diagram translations of the area classification tables that appear in this *Code* and in other codes and standards.

An example of these diagrams, and one that illustrates a major difference between the Division and Zone systems, is the guidance given in NFPA 497 for flammable liquids storage tanks. Exhibit 66.6 depicts the area classification for an ordinary cone roof storage tank storing a flammable liquid. Exhibit 66.7 is the equivalent diagram using the Zone system of classification. Note how the inside of the tank is designated Division 1 in Exhibit 66.6 but is designated Zone 0 in Exhibit 66.7.

Chapter 5, Article 500, of *NFPA 70* recognizes two levels of risk with regard to Class I hazardous locations: Division 1 and Division 2. In a Division 1 location, an ignitible atmosphere is

Exhibit 66.5



Effect of internal explosion (bottom) on cover-to-body joint clearance in an explosionproof enclosure. (Courtesy of UL LLC)

COMMENTARY TABLE 66.4 *Comparison of Division and Zone Systems from NFPA 70, National Electrical Code*

Hazard Description	NEC Article 500	NEC Article 505
Flammable materials present continuously or for long periods of time	Division 1	Zone 0
Flammable materials present intermittently during normal operations	Division 1	Zone 1
Flammable materials present only during abnormal operations	Division 2	Zone 2

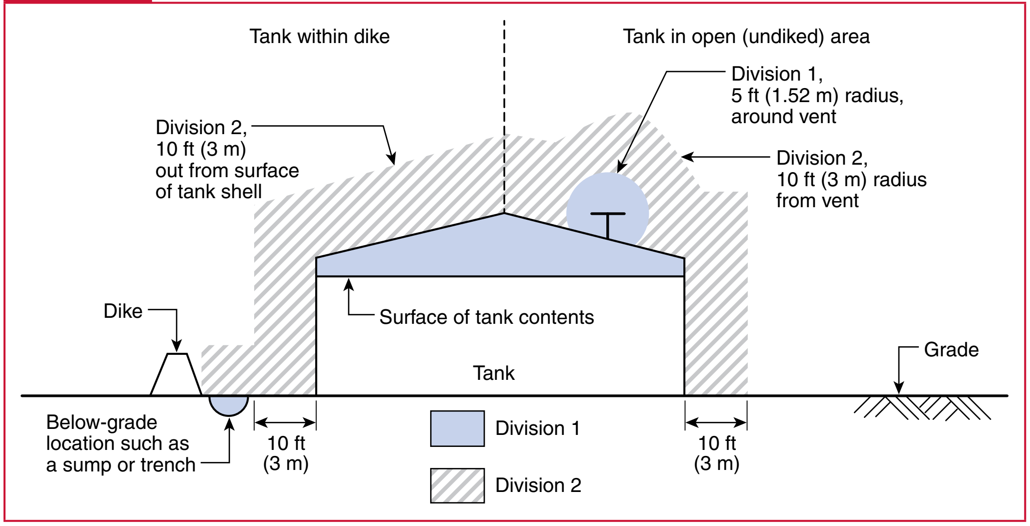
Source: Adapted from LeBlanc, J. A., and Lawrence, W. G., "Benefit from the Three-Zone National Electrical Code," *Chemical Engineering Progress*, American Institute of Chemical Engineers, New York, Dec. 2000, pp. 75–82.

assumed to be present all or most of the time, either because of open handling of liquids or because of frequent leaks or repairs. Therefore, any breakdown or malfunction of the electrical system that results in an arc or a spark will likely lead to an ignition. In a Division 2 location, an ignitible atmosphere is not normally present, but it might be produced because of an abnormal operating condition involving the equipment handling the liquid. Therefore, ignition is considered possible only if there is a simultaneous breakdown of both the process equipment and the electrical system — an unlikely event.

The basic design criteria for electrical equipment suitable for hazardous locations are the following:

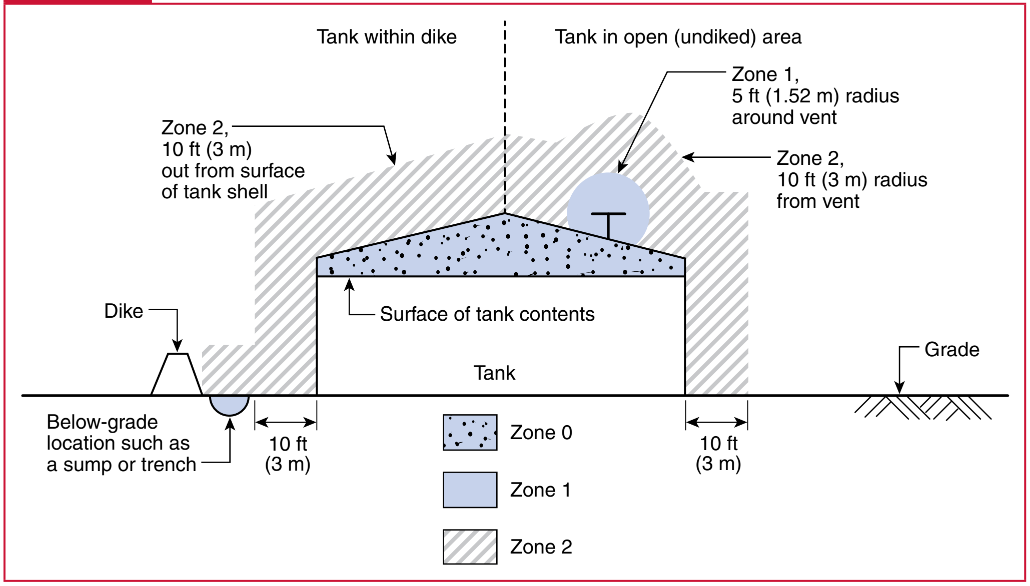
1. Arcing and sparking parts are enclosed.
2. Equipment enclosures are capable of withstanding an internal explosion, in case vapor finds its way inside and is ignited.
3. The hot gases resulting from an internal explosion are cooled by the time they are forced to the outside of the enclosure, so they cannot ignite the surrounding atmosphere.

Exhibit 66.6



Area classification for an aboveground storage tank — Division system.

Exhibit 66.7



Area classification for an aboveground storage tank — Zone system.

66.7.3.4 A classified area shall not extend beyond a floor, wall, roof, or other solid partition that has no openings within the classified area. [**30:**7.3.4]

66.7.3.5 The designation of classes, divisions, and zones shall be as defined in Chapter 5 of *NFPA 70*. [**30:**7.3.5]

66.7.3.6 The area classifications listed in Table 66.7.3.3 are based on the premise that all applicable requirements of this *Code* have been met. If this is not the case, the AHJ shall have the authority to classify the extent of the area. [**30:**7.3.6]

66.7.3.7* Where the provisions of 66.7.3.1 through 66.7.3.6 require the installation of electrical equipment suitable for Class I, Division 1 or 2, or Zone 1 or 2 locations, ordinary electrical equipment, including switchgear, shall be permitted to be used if installed in a room or enclosure that is maintained under positive pressure with respect to the classified area. [**30:**7.3.7]

Δ **A.66.7.3.7** NFPA 496 provides details for these types of installations. [**30:**A.7.3.7]

66.7.3.7.1 Ventilation make-up air shall be taken from an uncontaminated source. [**30:**7.3.7.1]

Δ 66.8 Application of Area Classification

Area classification is used to assure that fixed electrical utilization equipment, electrical fixtures, and wiring are properly installed within Class I, Division 1; Class I, Zone 1; Class I, Division 2; or Class I, Zone 2 designated areas, as defined by Article 500 of *NFPA 70*. [**30:**7.4.1]

Section 66.8 was added in the 2015 edition of the *Code* and is intended to explain the purpose of proper area classification. The important word here is *fixed*; Chapter 7 of NFPA 30 does not attempt to regulate, nor does it apply to, mobile motorized equipment or vehicles, such as industrial trucks or automobiles.

66.9 Storage of Liquids in Containers — General Requirements

Section 66.9 includes information on the following:

- The scope and general requirements involving the storage of flammable and combustible liquids in containers
- The design, construction, and capacity of containers, IBCs, and portable tanks
- The design, construction, and use of flammable liquids storage cabinets
- Control areas and the maximum allowable quantities (MAQs) per control area
- The classification of occupancies
- The design and construction of liquid storage rooms and liquid warehouses
- The general requirements for manual fire protection; electrical systems; containment, drainage, and spill control; ventilation; explosion control; separation of incompatible materials; and the dispensing, handling, and use of liquids in storage areas

The requirements in Section 66.9 are based on studies of fire incidents, research, and full-scale fire tests under various conditions.

66.9.1 Scope.

66.9.1.1 This section shall apply to the storage of flammable and combustible liquids in:

(1) Drums or other containers that do not exceed 119 gal (450 L) individual capacity
(2) Portable tanks that do not exceed 660 gal (2500 L) individual capacity
(3) Intermediate bulk containers that do not exceed 793 gal (3000 L)

[**30:**9.1.1]

The distinct capacity limitations listed in 66.9.1.1 should be kept in mind when applying the provisions of Section 66.9 and Chapter 9 of NFPA 30. Note also that, for the purposes of NFPA 30, portable tanks can be considered to be a subclass of IBCs.

In previous editions of NFPA 30, drum and container sizes were limited to 60 gal (230 L), which created a somewhat confusing gap because the DOT defines an IBC as having a capacity from 119 gal (450 L) to 793 gal (3000 L). The 2008 edition clarified the situation by increasing the size limitations for drums and containers to 119 gal (450 L). Not only did this change eliminate the apparent gap in coverage, it also accommodated environmental recovery drums of 85 gal (322 L) and 95 gal (360 L). Note that the fire protection system design criteria covered in Chapter 16 of NFPA 30 still utilize 60 gal (230 L) as one of the protection criteria limitations, with containers larger than 60 gal (230 L) being protected using the same design criteria as specified for IBCs and portable tanks.

For a number of years, the chemical and distilling industries have been shipping their products in vessels that have capacities up to 5500 gal (20,800 L) and that are built in accordance with DOT specifications. These vessels are referred to as portable tanks by the user industries. Also, the use of large portable vessels of several thousand gallons capacity in intermodal transportation service is common. Because the capacity of these vessels exceeds the 793 gal (3000 L) upper limit for IBCs, they are governed by the applicable requirements of Chapters 21 and 22 of NFPA 30.

66.9.1.2 This section shall also apply to limited transfer of liquids incidental thereto. [**30:**9.1.2]

66.9.1.3 This section shall also apply to overpack drums when used for temporary containment of containers that do not exceed 60 gal (230 L) capacity. Such overpack containers shall be treated as containers as defined in 66.3.3.10. [**30:**9.1.3]

66.9.1.4 This section shall not apply to the following:

(1) Containers, intermediate bulk containers, and portable tanks that are used in operations areas, as covered by Section 66.17
(2) Liquids in the fuel tanks of motor vehicles, aircraft, boats, or portable or stationary engines

The exemption in 66.9.1.4(2) from the provisions of Section 66.9 exists because the use of flammable and combustible fuels and oils stored in fuel tanks is covered by other NFPA standards and codes. See 66.1.4

(3) Beverages where packaged in individual containers that do not exceed 1.3 gal (5 L) capacity
(4) Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50 percent by volume of water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn and where packaged in individual containers that do not exceed 1.3 gal (5 L) capacity

The exemption in 66.9.1.4(4) has been part of the *Code* for many editions. It acknowledges that individually packaged consumer products, such as medicines, foodstuffs, and cosmetics in containers up to 1.3 gal (5 L) with a limited quantity of water-miscible flammable or combustible liquid component in the product, do not present a severe hazard. In the event of a leak or broken package, the amount of liquid spilled would be limited, and the limited quantity of water-miscible flammable or combustible liquid in the product would make ignition difficult. Note that the fire protection system design criteria in Chapter 16 of NFPA 30 generally require a lower sprinkler density when the flammable or combustible liquid concentration within a product is less than or equal to 50 percent, with the rest of the product consisting of components that do not burn.

(5) Liquids that have no fire point when tested in accordance with ASTM D92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup*, up to the boiling point of the liquid or up to a temperature at which the liquid shows an obvious physical change

The reference to an "obvious physical change" might be a change in state from a liquid to a solid or an obvious change in viscosity. Remember that the *fire point* is the temperature at which sustained burning takes place upon application of an outside ignition source. The fire point is usually several degrees higher than the flash point, but still several hundred degrees lower than the autoignition temperature of the liquid. Liquids meant to be excluded here are those that show flash points when tested in accordance with the Tag or other closed-cup test methods but do not exhibit sustained burning. Water-based paints, which are typically formulated with small amounts of flammable or combustible solvents, are one example. Although these products exhibit a flash point, the end product will not support combustion until the water boils off and the residue becomes very viscous. Note that the fire point has no influence on proper classification of the liquid.

(6) Liquids with a flash point greater than 95°F (35°C) in a water-miscible solution or water-miscible dispersion with a water and noncombustible solids content of more than 80 percent by weight, and which does not sustain combustion when tested in accordance with "Method of Testing for Sustained Combustibility," in accordance with Title 49, Code of Federal Regulations, Part 173, Appendix H, or the UN publication *Recommendations on the Transport of Dangerous Goods*

The exemption in 66.9.1.4(6) acknowledges certain liquids that are quite similar in fire hazard to those addressed in 66.9.1.4(5) but that exhibit opposite behavior in testing, in that no flash point is obtained using closed-cup test methods, but brief burning is exhibited at some point during tests using the Cleveland open-cup method. Overall, the fire hazard is minimal.

(7) Distilled spirits and wines in wooden barrels or casks [**30:**9.1.4]

The exemption in 66.9.1.4(7) acknowledges that even though distilled spirits and wines might be considered flammable liquids, the wooden barrels do not present the same rupture hazard as metal containers or the same spill hazards as plastic containers. When wooden barrels or casks are exposed to fire, they do not fail violently. Rather, the metal hoops on the barrels that secure the staves expand and allow loosening of the staves, which results in leaking distilled spirits adding fuel to the fire. However, sprinkler systems often control the fire before the metal hoops on the barrels are affected. Also, note that the distilled spirits industry and the Distilled Spirits Council of the United States (DISCUS) maintain their own guideline document entitled *Recommended Fire Protection Practices for Distilled Spirits Beverage Facilities*. Exhibit 66.8 shows the storage of wooden barrels containing distilled spirits in a warehouse.

Exhibit 66.8

Distilled spirits stored in wooden barrels in a bonded warehouse.

N **66.9.2 Definitions Specific to Section 66.9.**

N **66.9.2.1* Protected.** For the purposes of Section 66.9, this term shall apply to the storage of containers that meet the appropriate provisions of 66.16 or alternate provisions that have been approved by the authority having jurisdiction *(see 66.16.3.5 and Section 66.16.9)*. [**30:**9.2.1]

N **A.66.9.2.1** The term *protected* indicates that the fire risk is managed so as to control the fire and prevent it from spreading beyond the design area of the automatic fire protection system. [**30:**A.9.2.1]

N **66.9.2.2* Unprotected.** For the purposes of this chapter, this term shall apply to the storage of containers that do not meet the criteria to be considered protected, as defined in 66.9.2.1. [**30:**9.2.2]

N **A.66.9.2.2** The term *unprotected* indicates that the growth of a fire might exceed the capabilities of the automatic fire protection system and extend beyond the design area of the system. In such cases, the total contents of the fire area might become involved in a fire, regardless of the protection features provided. [**30:**A.9.2.2]

The intent of the definitions is to demonstrate that a fire involving any particular storage situation is either capable of being controlled or not capable of being controlled. The phrase "any particular storage situation" means the combination of (1) class of liquid, (2) type and capacity of container, and (3) design and capability of the means of protection. These factors are addressed in the various criteria set forth in Chapter 16 of NFPA 30. The two annex items, A.66.9.2.1 and A.66.9.2.2, explain the rationale for the definitions. The definitions and the Annex A items are repeated in Sections 12.2 and 16.2 of NFPA 30, for the sake of emphasis.

These definitions replace former 66.9.3.4, which previously defined *protected storage* and established an effective date of January 1, 1997, for application of the mandatory fire protection design criteria in Chapter 16 of NFPA 30.

Until the 2018 edition, the *Code* included the following requirements, most recently in 66.9.3.4: "For the purposes of this chapter and Chapters 10, 12, and 16 of NFPA 30, *protected storage* shall mean storage installed after January 1, 1997 that is protected in accordance with Section 66.16. All other storage shall be considered to be unprotected storage unless an alternative means of protection has been approved by the AHJ." To address the need of flexibility, the *Code* specifically allows the AHJ to accept an alternative protection scheme based on, for example, full-scale fire tests. Annex E of NFPA 30 includes information on fire test protocols for situations that are not specifically addressed in Chapter 16 of NFPA 30.

With the adoption of the definitions of *protected* and *unprotected*, 66.9.3.4 was rendered moot and was deleted from the *Code* for the 2018 edition.

66.9.3 General Requirements.

66.9.3.1 The general requirements of this chapter shall be applicable to the storage of liquids in liquid storage areas as covered in Chapters 10 through 14 of NFPA 30, regardless of the quantities being stored.

*Exception: Where more stringent requirements are set forth in Chapters 10 through 14 of NFPA 30, those requirements shall take precedence. [**30:**9.3.1]*

Since the inclusion of the control area concept in the 2008 edition, general requirements have applied to the storage of all flammable and combustible liquids, regardless of the overall quantities stored. Also, specific requirements apply if the quantities stored exceed the MAQs per control area.

The requirements addressed in 66.9.3 are the general requirements and are applicable to the storage of all flammable and combustible liquids. As indicated in the exception to 66.9.3.1, if a more stringent requirement exists in 66.10 through 66.14, that requirement takes precedence.

66.9.3.2 For the purposes of Sections 66.9 through 66.16, unstable liquids shall be treated as Class IA liquids. [**30:**9.3.2]

Unstable liquids might decompose or react vigorously during a fire, causing their containers to overpressure and rupture much more rapidly and violently than would containers of a stable liquid. Class IA liquids, because of their high volatility, would be expected to behave similarly in a fire. Even though most unstable liquids would not be classified as Class IA liquids by virtue of their flash points, additional requirements for their safe storage are deemed necessary, and thus they should be protected as a Class IA liquid would be.

Δ **66.9.3.3** Means of egress shall meet applicable requirements of NFPA *101*. [**30:**9.3.3]

In a liquid storage room or liquid warehouse, some of the more important means of egress requirements to be addressed are the number of exits, the travel distance to an exit, the common path of travel, and dead-end aisles. These requirements are contained in Chapter 42, Storage Occupancies, of NFPA *101*®, *Life Safety Code*®. Additionally, NFPA *101* contains the requirements for the size of door openings, type of doors, emergency lighting, and egress signage.

• **66.9.3.4** Wood of at least 1 in. (25 mm) nominal thickness shall be permitted to be used for shelving, racks, dunnage, scuffboards, floor overlay, and similar installations. [**30:**9.3.4]

Note that no mention is made of metal shelving, nor is there any control over its use. In fact, drum racks used in liquid storage rooms and liquid warehouses are almost always metal. Although wood adds to the fire load in a storage facility, it is preferred by users because it minimizes the chances of damage to or breakage of containers.

66.9.3.5 Class I liquids shall not be permitted to be stored in basements as defined in 3.3.22. [**30:**9.3.5]

Basement storage of Class I flammable liquids presents a firefighting problem. Access to most basements is restricted, and ventilation and removal of smoke and combustion products from the area are usually more difficult to achieve. The storage itself adds to the fire loading and further restricts movement. If the storage of Class I liquids were allowed, any vapors present would create a hazardous situation. For those reasons, the storage of Class I liquids is not allowed, and the storage of Class II and Class IIIA combustible liquids requires that the basement be protected, as stated in 66.9.3.6.

66.9.3.6 Class II and Class IIIA liquids shall be permitted to be stored in basements as defined in 3.3.22, provided the basement is protected in accordance with Section 66.16. [**30:**9.3.6]

66.9.3.7 Class IIIB liquids shall be permitted to be stored in basements as defined in 3.3.22. [**30:**9.3.7]

Class IIIB combustible liquids do not present the same degree of hazards and concerns that Class I flammable liquids do; therefore, Class IIIB liquids are permitted to be stored in basements. Due to their higher flash point, Class IIIB liquids are more difficult to ignite than Class I liquids, and the storage of Class IIIB liquids does not create a hazardous vapor situation in a basement.

66.9.3.8 Where containers, intermediate bulk containers, or portable tanks are stacked, they shall be stacked so that stability is maintained and excessive stress on container walls is prevented. [**30:**9.3.8]

66.9.3.8.1 Portable tanks and intermediate bulk containers stored more than one high shall be designed to stack securely, without the use of dunnage. [**30:**9.3.8.1]

66.9.3.8.2 Materials-handling equipment shall be capable of handling containers, portable tanks, and intermediate bulk containers that are stored at all storage levels. [**30:**9.3.8.2]

Materials-handling equipment, such as power-operated industrial trucks used to lift and place products in the upper levels of storage racks, must have the capability to lift and handle the gross weight of the product, including the weight of the containers and pallets. Also, the equipment's reach must be capable of safely placing the product in the desired storage level.

Δ **66.9.3.8.3*** Power-operated industrial trucks used to move Class I liquids shall be selected, operated, and maintained in accordance with NFPA 505. [**30:**9.3.8.3]

Δ **A.66.9.3.8.3** Section 5.1 of NFPA 505 states "In locations used for the storage of flammable liquids in sealed containers or liquefied or compressed flammable gases in containers, approved power-operated industrial trucks designated as Types CNS, DS, ES, GS, LPS, GS/CNS, or GS/LPS shall be permitted to be used where approved by the AHJ." Compared to the above types, industrial trucks that are designated DY and EE have significantly less potential for igniting flammable vapors (such as might result from a spill of Class I liquid) and should be used in inside liquid storage areas where conditions warrant. [**30:**A.9.3.8.3]

Although the use of ordinary electrical equipment is permitted in liquid warehouses where no Class I flammable liquid transfer operations take place (see Table 66.7.3.3), the use of spark-proof, power-operated industrial trucks is recommended as a minimum for handling containers of Class I flammable liquids. History has shown that power-operated industrial trucks have provided the ignition source for some major warehouse fires.

In some cases, powered industrial trucks might have to be specially selected to ensure that they do not constitute a source of ignition in an area that might be hazardous because of fugitive vapors.

66.9.3.9 Containers, intermediate bulk containers, and portable tanks in unprotected liquid storage areas shall not be stored closer than 36 in. (915 mm) to the nearest beam, chord, girder, or other roof or ceiling member. [**30:**9.3.9]

Because unprotected liquid storage areas might have inadequate sprinkler system designs or no sprinklers at all, the intent of 66.9.3.9 is to ensure that sufficient clearance exists between structural members and the top of storage to allow manual fire fighting using fire hose streams.

66.9.3.10 Liquids used for building maintenance, painting, or other similar infrequent maintenance purposes shall be permitted to be stored in closed containers outside of storage cabinets or inside liquid storage areas, if limited to an amount that does not exceed a 10-day supply at anticipated rates of use. [**30:**9.3.10]

The requirement in 66.9.3.10 acknowledges that situations exist where infrequent building maintenance activities — such as cleaning, painting, floor coating operations, or roof replacements — might require the use of materials that are considered flammable and combustible liquids and that such materials would be present in the facility during the duration of those activities. It is expected that the materials would be stored in an area free of other combustible materials and away from any hazardous processes and areas where hot work is performed. At the completion of the maintenance activity, all materials must be removed from the building or stored in an approved storage cabinet or inside the liquid storage area.

Δ **66.9.3.11** Storage, handling, and use of Class II and Class III liquids heated at or above their flash point shall follow the requirements for Class I liquids, unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. *(See 66.9.4.1.2 and A.66.6.4.1.2.)* [**30:**9.3.11]

66.9.4 Acceptable Containers.

66.9.4.1* Only the following approved containers, intermediate bulk containers, and portable tanks shall be used for Class I, Class II, and Class IIIA liquids:

A.66.9.4.1 It is not the intent of 66.9.4 to regulate containers and packaging systems for Class IIIB liquids, except as required for protected storage in accordance with Chapter 16 of NFPA 30. [**30:**A.9.4.1]

NFPA 30 attempts to reduce fire hazards by setting requirements for the design and construction of containers, IBCs, and portable tanks. Thus, only certain types are allowed. Subsection 66.9.4 specifies what might be considered "approved" and emphasizes that NFPA does not approve individual designs or specifications of containers. That is the responsibility of DOT for shipping containers and organizations such as ASTM, Underwriters Laboratories, and FM Global for consumer use containers and safety cans. Note that items (1), (4), and (6) of 66.9.4.1 reference the United Nations (UN) *Recommendations on the Transport of Dangerous Goods*. Current DOT regulations are compatible with these international rules, and the intent of the reference is to not restrict the use or importation of container types that might not be explicitly authorized by DOT.

Class IIIB liquids are not regulated as to the types of containers allowed, due to their low fire risk.

(1) Metal containers, metal intermediate bulk containers, and metal portable tanks meeting the requirements of and containing products authorized by the U.S. Department of Transportation Hazardous Materials Regulations in 49 CFR 100–199, or by Part 6 of the UN *Recommendations on the Transport of Dangerous Goods*

Item 66.9.4.1(1) is specific to containers and IBCs constructed entirely of metal. (DOT-specification portable tanks are made only of metal.) Some IBCs consist of a thin, flexible polymeric bottle that holds the liquid surrounded by a metal wire "cage," sheet metal, or a heavy corrugated "carton," which gives the assembly some degree of stability. The DOT allows the shipment of some Class IB and IC liquids in such IBCs. However, they do not meet the intent of this *Code* for safe warehousing. IBCs are required to be made completely of metal if they are to be recognized as acceptable "metal" containers under NFPA 30.

Unfortunately, this has led to some confusion regarding what constitutes a metal container. One problem is that the phrase "metal container" implies that the metal is liquidtight. Some drums consist of a rigid plastic container inserted into a metal shell. The metal shell has small weep holes around the bottom to allow moisture that accumulates between the metal and the plastic to drain. Thus, the metal shell cannot be considered to be liquidtight. Yet such a construction is probably just as suitable for the storage of liquids as is a completely liquidtight metal portable tank.

To compound the dilemma, several types of IBCs made of rigid plastic or plastic and metal have gained wide acceptance in the industry because of their durability, their light weight, and particularly their ability to hold corrosive materials without fear of leakage. And, indeed, several types of these IBCs are recognized by NFPA 30 for certain classes of liquid, as discussed in 66.9.4.1(2).

Exhibit 66.9 shows several types and sizes of metal containers. See Exhibit 66.9 for a photo of a metal IBC.

Exhibit 66.9

Metal drums and containers. (Courtesy of Greif, Inc.)

(2) Plastic or metal consumer-use containers meeting the requirements of, and used within the scope of, one or more of the following specifications:
   (a) ASTM F852, *Standard Specification for Portable Gasoline Containers for Consumer Use*
   (b) ASTM F976, *Standard Specification for Portable Kerosene and Diesel Containers for Consumer Use*

In prior editions of the *Code*, 66.9.4.1(2) included both consumer-use containers and industrial-grade safety cans. These two categories are now listed separately, the latter in 66.9.4.1(3).

ASTM F852, *Standard Specification for Portable Gasoline Containers for Consumer Use,* and ASTM F976, *Standard Specification for Portable Kerosene and Diesel Containers for Consumer Use,* cover both metal and high-density polyethylene (HDPE) plastic containers for gasoline and for kerosene and diesel fuel, respectively, although the manufacture of metal containers appears to have ceased. The market demand is now completely met by plastic containers, an example of which is shown in Exhibit 66.10. These containers are quite sturdy for the uses intended, being of thick-wall construction, and are approved by most jurisdictions for storing petroleum products.

(3) Nonmetallic or metallic commercial/industrial safety cans meeting the requirements of, and used with the scope of, one or more of the following specifications:
   (a) ANSI/UL 30, *Standard for Metal Safety Cans*
   (b) ANSI/UL 1313, *Standard for Nonmetallic Safety Cans for Petroleum Products*
   (c) FM Global *Approval Standard for Safety Containers and Filling, Supply, and Disposal Containers* — Class Number 6051 and 6052

Exhibit 66.10

Plastic gasoline can.

(4) Plastic containers that meet requirements set by and contain products authorized by the following:
  (a) The U. S. Department of Transportation Hazardous Materials Regulations in 49 CFR 100–199, or by Part 6 of the UN publication *Recommendations on the Transport of Dangerous Goods*
  (b) Items 256 or 258 of the *National Motor Freight Classification* (NMFC) for liquids that are not classified as hazardous by the U.S. Department of Transportation Hazardous Materials Regulations in 49 CFR 100–199, or by Part 6 of the UN publication *Recommendations on the Transport of Dangerous Goods*

Plastic containers of very thin-wall construction, such as those used for many consumer products and not intended for reuse, should not be used for routine, repeated storage of flammable and combustible liquids. Although these containers are allowed for one-time shipment of some classes of flammable and combustible liquids, they do not meet the rigid requirements established by the standards referenced in 66.9.4.1. See Exhibit 66.11 for some examples of acceptable plastic shipping containers.

(5) Fiber drums that meet the following:
  (a) Requirements of Items 294 and 296 of the *National Motor Freight Classification* (NMFC), or Rule 51 of the *Uniform Freight Classification* (UFC), for Types 2A, 3A, 3B-H, 3B-L, or 4A
  (b) Requirements of, and containing liquid products authorized by, either the U.S. Department of Transportation Hazardous Materials Regulations in 49 CFR Chapter I, or by U.S. Department of Transportation exemption

Exhibit 66.11

Plastic shipping containers. (Courtesy of Greif, Inc.)

(6)* Rigid nonmetallic intermediate bulk containers that meet requirements set by and contain products authorized by the following:
  (a) The U.S. Department of Transportation Hazardous Materials Regulations in 49 CFR 100–199, or by Part 6 of the UN publication *Recommendations on the Transport of Dangerous Goods,* for Classes 31H1, 31H2, and 31HZ1
  (b) The *National Motor Freight Classification* (NMFC), or the International Safe Transit Association for liquids that are not classified as hazardous by the U.S. Department of Transportation Hazardous Materials Regulations in 49 CFR 100–199, or by Part 6 of the UN publication *Recommendations on the Transport of Dangerous Goods*

Δ **A.66.9.4.1(6)** The term *rigid nonmetallic intermediate bulk container* is used to describe intermediate bulk containers that have a plastic vessel that serves as the primary liquid-holding component. This vessel can be enclosed in or encased by an outer structure consisting of a steel cage, a single-wall metal or plastic enclosure, a double wall of foamed or solid plastic, or a paperboard enclosure. These are often called *composite IBCs*, which is the term used by the U.S. Department of Transportation (DOT) to describe them. The term *rigid nonmetallic intermediate bulk container* also denotes an all-plastic single-wall IBC that might or might not have a separate plastic base and for which the containment vessel also serves as the support structure. IBCs that have an outer liquidtight metal structure are considered to be metal IBCs or metal portable tanks by DOT and are defined in 66.9.4.1(1). [**30:**A.9.4.1(6)]

N *TABLE 66.9.4.3 Maximum Allowable Size — Containers, Intermediate Bulk Containers (IBCs), and Portable Tanks*

Container Type	Flammable Liquids			Combustible Liquids	
	Class IA	Class IB	Class IC	Class II	Class IIIA
Glass	1 pt (0.5 L)	1 qt (1 L)	1.3 gal (5 L)	1.3 gal (5 L)	5.3 gal (20 L)
Metal (other than drums) or approved plastic	1.3 gal (5 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)
Safety cans	2.6 gal (10 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)
Metal drum (e.g., UN 1A1/1A2)	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)
Approved metal portable tanks and IBCs	793 gal (3000 L)	793 gal (3000 L)	793 gal (3000 L)	793 gal (3000 L)	793 gal (3000 L)
Rigid plastic IBCs (UN 31H1 or 31H2) and composite IBCs with rigid inner receptacle (UN31HZ1)†	NP	NP	NP	793 gal (3000 L)	793 gal (3000 L)
Composite IBCs with flexible inner receptacle (UN31HZ2) DOT/UN-approved flexible IBCs, and NMFC/ISTA-compliant IBCs†	NP	NP	NP	331 gal (1300 L)	331 gal (1300 L)
Non-bulk Bag-in-box	NP	NP	NP	NP	NP
Polyethylene UN1H1 and UN1H2, or as authorized by DOT exemption	1.3 gal (5 L)	5.3 gal (20 L)*	5.3 gal (20 L)*	119 gal (450 L)	119 gal (450 L)
Fiber drum NMFC or UFC Type 2A; Types 3A, 3B-H, or 3B-L; or Type 4A	NP	NP	NP	119 gal (450 L)	119 gal (450 L)

NP: Not permitted for the container categories so classified unless a fire protection system is provided that is developed in accordance with 66.16.3.6 and is approved for the specific container and protection against static electricity is provided.

*See 66.9.4.3.1.

†See 66.9.4.3.2

[**30:** Table 9.4.3]

Several types of IBCs are recognized by NFPA 30. Rigid nonmetallic IBCs have proved to be acceptable for warehouse storage under NFPA 30, having passed a fire exposure test in accordance with 66.9.4.1.1. However, unless protected with the fire protection system design criteria contained in Chapter 16 of NFPA 30, the storage of such containers is considered to be unprotected. Also, these containers are acceptable only for the storage of Class II and Class IIIA liquids as indicated in Table 66.9.4.3.

(7) Glass containers up to the capacity limits stated in Table 66.9.4.3 and in accordance with U.S. Department of Transportation Hazardous Materials Regulations in 49 CFR 100–199

(8) Other nonmetallic intermediate bulk containers that comply with 66.9.4.1.1

[**30:**9.4.1]

Item (8) has been added to allow for nonmetallic IBCs other than those covered by 66.9.4.1(6) that meet the provisions of 66.9.4.1.1, including those constructed of fiberboard.

Δ **66.9.4.1.1** For protected storage, nonmetallic intermediate bulk containers shall comply with Table 66.9.4.3 and shall be listed and labeled in accordance with UL 2389, *Standard for Fire Exposure Testing of Intermediate Bulk Containers or Flammable and Combustible Liquids*; FM Class 6020, *Approval Standard for Intermediate Bulk Containers*; or an equivalent test procedure. [**30:**9.4.1.1]

Paragraph 66.9.4.1.1 specifies the appropriate test protocols to demonstrate acceptable fire performance of nonmetallic IBCs. Addition of the references to the test protocols correlates with requirements stated in Tables 16.5.2.9 and 16.5.2.10 of NFPA 30 and with amendments made to Table 66.9.4.3.

66.9.4.1.2 Medicines, beverages, foodstuffs, cosmetics, and other common consumer products, where packaged according to commonly accepted practices for retail sales, shall be exempt from the requirements of 66.9.4.1 and 66.9.4.3. [**30:**9.4.1.2]

66.9.4.2 Each portable tank or intermediate bulk container shall be provided with one or more devices installed in the top with sufficient emergency venting capacity to limit internal pressure under fire exposure conditions to a gauge pressure of 10 psi (70 kPa) or 30 percent of the bursting pressure of the portable tank, whichever is greater. [**30:**9.4.2]

The portable tanks and IBCs described here generally are cylindrical or rectangular in shape and 225 gal to 375 gal (850 L to 1420 L) in capacity. They are used for transporting many liquid commodities, from coatings to edible oils. Metal portable tanks and IBCs are constructed of steel, aluminum, or alloys containing magnesium. The rigid plastic types are generally made of heavy gauge HDPE, while the composite types consist of a thinner HDPE vessel that is surrounded by a metal wire "cage" or a sheet metal overpack for structural stability. Almost all are designed to nest securely when stacked, without the need for pallets or dunnage.

Vents are installed in the top of portable tanks and IBCs to prevent the discharge of liquid under overpressure situations. Normally, the vents expel any vapors generated by an increase in temperature.

66.9.4.2.1 The total venting capacity shall be not less than that specified in 22.7.3.2 or 22.7.3.4 of NFPA 30. [**30:**9.4.2.1]

The vent requirements stated here attempt to meet the following two objectives:

1. Minimize the overpressure due to normal changes in ambient temperature
2. Provide the emergency relief venting required when the tank is subject to extreme temperature increases such as those generated by a fire

66.9.4.2.2 At least one pressure-actuated vent having a minimum capacity of 6000 ft^3 (170 m^3) of free air per hour at an absolute pressure of 14.7 psi (101 kPa) and 60°F (15.6°C) shall be used. It shall be set to open at not less than a gauge pressure of 5 psi (35 kPa). [**30:**9.4.2.2]

Note, however, that the 6000 ft^3 (170 m^3) of free air per hour specified might not be adequate for unstable liquids, especially if two-phase flow can be expected.

66.9.4.2.3 If fusible vents are used, they shall be actuated by elements that operate at a temperature not exceeding 300°F (150°C). Where plugging of a pressure-actuated vent can occur, such as when used for paints, drying oils, and similar materials, fusible plugs or venting devices that soften to failure at a maximum of 300°F (150°C) under fire exposure shall be permitted to be used for the entire emergency venting requirement. [**30:**9.4.2.3]

Δ **66.9.4.3** The maximum allowable size of a container, intermediate bulk container, or metal portable tank for Class I, Class II, and Class IIIA liquids shall not exceed that specified in Table 66.9.4.3.

*Exception: As provided for in 66.9.1, 66.9.4.3.1, 66.9.4.3.3, and 66.9.4.3.4. [**30:**9.4.3]*

Particular attention should be given to the fact that, for the purposes of NFPA 30, the use of rigid plastic IBCs, composite IBCs, and fiber drums is limited to the particular types specified in Table 66.9.4.3 and must be listed for fire exposure. Also, they are recognized only for storing Class II and Class IIIA liquids, even though some of them might be allowed for transporting liquids of a lower class.

In the 2018 edition, the following changes were made to the table:

- For composite IBCs with flexible inner receptacles (UN31HZ2) and for DOT/UN-approved flexible IBCs, units that have successfully met the criteria of ANSI/UL 2368, *Standard for Fire Exposure Testing of Rigid Nonmetallic and Composite Nonmetallic Intermediate Bulk Containers for Combustible Liquids*; FM 6020, *Approval Standard for Safety Intermediate Bulk Containers*; or an equivalent test procedure, as set forth in 66.9.4.1.1 and 66.9.4.3.2, are permitted for Class II and Class IIIA liquids up to 331 gal (1300 L) maximum capacity.
- Also included in the category described in item (1) are units that are NMFC/ISTA compliant. NMFC refers to the National Motor Freight Classification code, a product of the National Motor Freight Traffic Association, which classifies commodities for purposes of uniform treatment in transportation. ISTA refers to the International Safe Transit Association, an organization that develops testing protocols to ensure performance of packaging in shipment.
- A reference has been added to 66.9.4.3.2, which identifies the test protocols referenced in item (1).

66.9.4.3.1 Class IB and Class IC water-miscible liquids shall be permitted to be stored in plastic containers up to 60 gal (230 L) in size, if stored and protected in accordance with Table 66.16.5.2.7. [**30:**9.4.3.1]

Paragraph 66.9.4.3.1 acknowledges that Class IB and Class IC flammable liquids that are water-miscible, such as alcohols and flavorings, can be safely stored in plastic containers up to 60 gal (230 L), provided they are stored and protected with the fire protection system design criteria contained in Section 66.16.

N **66.9.4.3.2** Nonmetallic intermediate bulk containers shall be listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*; FM Class 6020, *Approval Standard for Intermediate Bulk Containers*; or an equivalent test procedure. [**30:**9.4.3.2]

66.9.4.3.3 Class IA and Class IB liquids shall be permitted to be stored in glass containers of not more than 1.3 gal (5 L) capacity if the required liquid purity (such as American Chemical Society analytical reagent grade or higher) would be affected by storage in metal containers or if the liquid can cause excessive corrosion of a metal container. [**30:**9.4.3.3]

This exception is included to avoid unnecessarily restricting laboratory use of flammable liquids, while still providing an acceptable degree of fire safety.

66.9.4.3.4 Leaking or damaged containers up to 60 gal (230 L) capacity shall be permitted to be stored temporarily in accordance with this section and Chapters 10 through 12 of NFPA 30, provided they are enclosed in overpack containers. [**30:**9.4.3.4]

66.9.4.3.4.1 To be considered protected storage as defined in 66.9.2.1 and in accordance with Section 66.16, an overpack container shall be constructed of the same material as the leaking or damaged container. [**30:**9.4.3.4.1]

66.9.4.3.4.2 Metal overpack containers shall be considered nonrelieving style containers. [**30:**9.4.3.4.2]

66.9.5* Flammable Liquids Storage Cabinets.

A.66.9.5 The requirements in 66.9.5 are based on hazards associated with fixed flammable liquids storage cabinets. They do not address potential hazards associated with mobile storage cabinets (i.e., cabinets with integral wheels) such as the following:

(1) Increased risk of spills
(2) Potential for tipover or blockage of egress
(3) Maintenance of vent and grounding integrity
(4) Variable condition of exposed floor surfaces under the cabinet

[**30:**A.9.5]

A number of commercially available and approved flammable liquids storage cabinets are built to hold flammable and combustible liquids from 4 gal (15 L) up to 120 gal (460 L). Exhibit 66.12 shows a typical flammable liquids storage cabinet for safety cans and small containers. Exhibit 66.13 (left) shows a cabinet designed to store a drum in the vertical position, with room to install a drum pump for dispensing. Exhibit 66.13 (right) shows a cabinet designed to store a drum horizontally, so that the user can gravity dispense from the drum.

The cabinets allow solvents and other flammable and combustible liquids to be stored at workplace locations, saving costly trips to a central liquid storage room. Cabinets are manufactured so they can be located under a counter, wall-mounted, or stacked piggyback style.

Exhibit 66.12

Typical flammable liquids storage cabinet. (Courtesy of Justrite Mfg. Co.)

Exhibit 66.13

A flammable liquids storage cabinet for vertical drum storage (left) and a flammable liquids storage cabinet for horizontal drum storage (right). (Courtesy of Justrite Mfg. Co.)

Although the cabinets are usually referred to as "flammable liquids storage cabinets," combustible liquids are allowed to be stored in them as well. Keep in mind that the liquids stored in a cabinet should be mutually compatible and that the cabinets are designed and constructed for liquid storage only. They are not intended for storing small cylinders of compressed or liquefied gases, especially those that are flammable. Likewise, incompatible materials, whether liquid or solid, should not be stored in these cabinets.

Also, ordinary glass containers exposed to heat will fail at about 212°F (100°C) due to thermally induced stress. Storage cabinets offer protection from radiant heat but only for a limited period of intense fire exposure. Their limitations must be recognized. Specially designed cabinets that provide extra protection for glass containers are available.

66.9.5.1 The volume of Class I, Class II, and Class IIIA liquids stored in an individual storage cabinet shall not exceed 120 gal (460 L). [**30:**9.5.1]

66.9.5.2 The total aggregate volume of Class I, Class II, and Class IIIA liquids in a group of storage cabinets shall not exceed the maximum allowable quantity of flammable and combustible liquids per control area based on the occupancy where the cabinets are located. [**30:**9.5.2]

The control area concept allows for increased storage of liquid quantities within a storage cabinet or multiple storage cabinets.

The number of storage cabinets present in one fire area no longer matters. Previous editions of the *Code* had limited the number of cabinets to three within any one fire area, with exceptions for industrial occupancies that allowed for additional storage cabinets, provided they were separated by 100 ft (30 m) or were located in an area equipped with an automatic sprinkler system. This requirement had an inherent flaw that was recognized by the Technical Committee in that, rather than focus on the number of cabinets, it was more important to consider the volume limitation of the cabinets.

Δ **66.9.5.3** Storage cabinets that meet at least one of the following sets of requirements shall be acceptable for storage of liquids:

(1) Storage cabinets designed and constructed to limit the internal temperature at the center of the cabinet and 1 in. (25 mm) from the top of the cabinet to not more than 325°F (163°C), when subjected to a 10-minute fire test that simulates the fire exposure of the standard time–temperature curve specified in NFPA 251, *Standard Methods of Tests of Fire Resistance of Building and Construction and Materials*, shall be acceptable. All joints and seams shall remain tight and the door shall remain securely closed during the test.

An approved storage cabinet is designed and constructed to protect the contents from external fires; it is not designed or intended to contain a fire. The 10-minute fire test criterion is based on the estimated time for a room or portion of a building to become seriously involved in a fire and, thus, is considered a measure of the time for occupants to evacuate the area. The standard temperature–time curve from which this information is taken can be found in ASTM E152, *Fire Tests of Door Assemblies*, and NFPA 252, *Standard Methods of Fire Tests of Door Assemblies.*

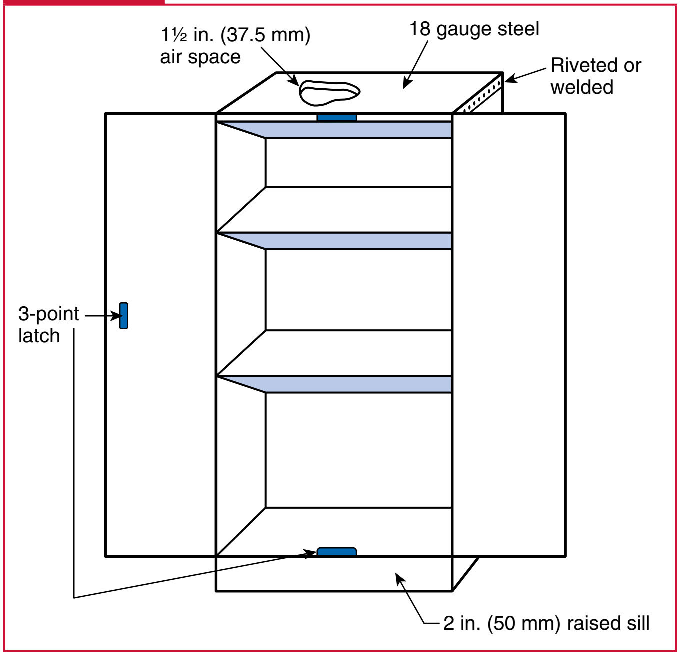
(2) Metal storage cabinets constructed in the following manner shall be acceptable:
   (a) The bottom, top, door, and sides of the cabinet shall be at least No. 18 gauge sheet steel and shall be double-walled, with 1½ in. (38 mm) air space.
   (b) Joints shall be riveted, welded, or made tight by some equally effective means.
   (c) The door shall be provided with a three-point latch arrangement, and the door sill shall be raised at least 2 in. (50 mm) above the bottom of the cabinet to retain spilled liquid within the cabinet.

The three-point latch arrangement on the metal storage cabinet doors is intended to maintain the integrity of the cabinet under fire exposure. Without a three-point latch arrangement, the metal would warp when exposed to a fire, resulting in exposure of the cabinet's contents to the fire. Note that the door is not required to be self-closing, although this feature is often found in commercially available cabinets. Note also that NFPA 30 does not mandate a test for cabinets built in accordance with these requirements. The 2 in. (50 mm) raised sill required here provides for retention of minor spills and leaks. This provision of the *Code* does not prohibit using the bottom of the cabinet for storage. See Exhibit 66.14 for an illustration of acceptable construction of a metal cabinet.

(3) Wooden cabinets constructed in the following manner shall be acceptable:
   (a) The bottom, sides, and top shall be constructed of exterior grade plywood that is at least 1 in. (25 mm) thick and of a type that will not break down or delaminate under fire conditions.
   (b) All joints shall be rabbetted and shall be fastened in two directions with wood screws.
   (c) Where more than one door is used, there shall be a rabbetted overlap of not less than 1 in. (25 mm).
   (d) Doors shall be equipped with a means of latching, and hinges shall be constructed and mounted in such a manner as to not lose their holding capacity when subjected to fire exposure.
   (e) A raised sill or pan capable of containing a 2 in. (50 mm) depth of liquid shall be provided at the bottom of the cabinet to retain spilled liquid within the cabinet.

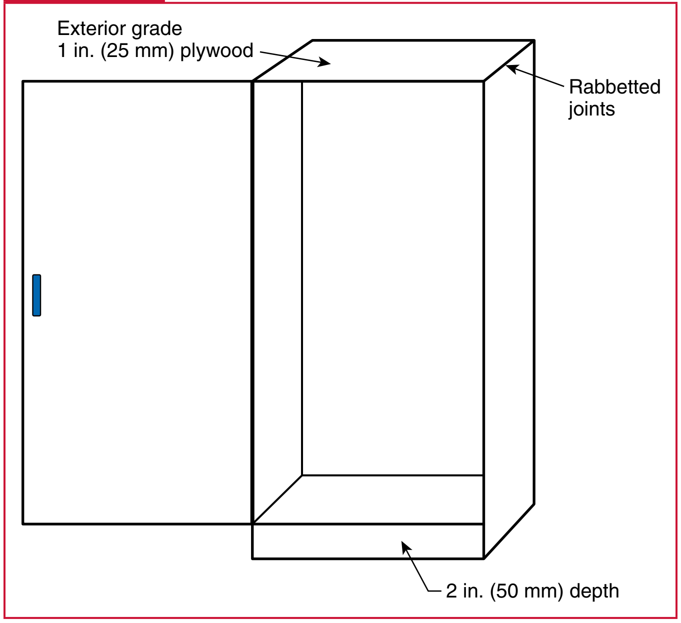
Although not required to do so, a cabinet built to these requirements will meet the test specifications of 66.9.5.3(1). Note that NFPA 30 does not require a three-point latch on wooden doors, because wood does not tend to warp or distort when exposed to fire as metal does. See Exhibit 66.15 for an illustration of acceptable construction of a wooden cabinet. Exhibit 66.16 shows a

Exhibit 66.14



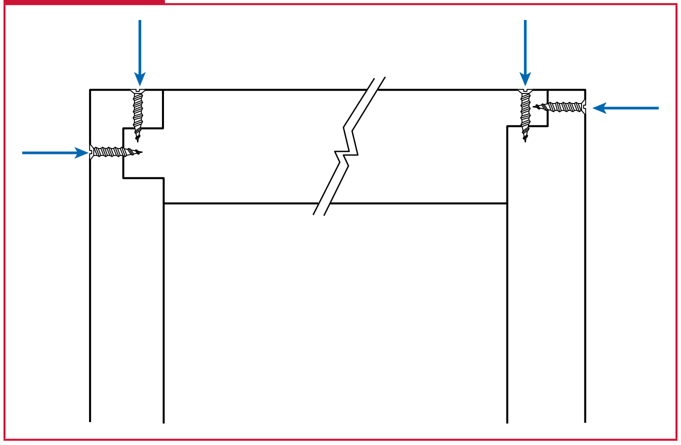
Acceptable construction for metal cabinets.

Exhibit 66.15



Acceptable construction for wooden cabinets.

Exhibit 66.16



Cross-section of two types of rabbetted joints used in construction of wooden cabinets.

cross-section view of a rabbetted joint. These joints, common in high-end cabinetry, are quite strong.

(4) Listed storage cabinets that have been constructed and tested in accordance with UL 1275, *Standard for Flammable Liquid Storage Cabinets*; FM Class Number 6050, *Approval Standard for Storage Cabinets (Flammable and Combustible Liquids)*; or equivalent shall be acceptable.

[**30:**9.5.3]

66.9.5.4* Storage cabinets shall not be required by this *Code* to be ventilated for fire protection purposes. [**30:**9.5.4]

Δ **A.66.9.5.4** Venting of storage cabinets has not been demonstrated to be necessary for fire protection purposes. Additionally, venting a cabinet could compromise the ability of the cabinet to adequately protect its contents from involvement in a fire, because cabinets are not generally tested with any venting. Therefore, venting of storage cabinets is not recommended. [**30:**A.9.5.4]

However, it is recognized that some jurisdictions might require storage cabinets to be vented and that venting can also be desirable for other reasons, such as health and safety. In such cases, the venting system should be installed so as to not affect substantially the desired performance of the cabinet during a fire. Means of accomplishing this can include thermally actuated dampers on the vent openings or sufficiently insulating the vent piping system to prevent the internal temperature of the cabinet from rising above that specified. Any make-up air to the cabinet should also be arranged in a similar manner. [**30:**A.9.5.4]

If vented, the cabinet should be vented from the bottom with make-up air supplied to the top. Also, mechanical exhaust ventilation is preferred and should comply with NFPA 91. Manifolding the vents of multiple storage cabinets should be avoided. [**30:**A.9.5.4]

66.9.5.4.1 If a storage cabinet is not ventilated, the vent openings shall be sealed with the bungs supplied with the cabinet or with bungs specified by the cabinet manufacturer. [**30:**9.5.4.1]

The storage cabinet is not required to be vented for fire protection purposes. However, vent openings are often provided by manufacturers because some jurisdictions mandate that the cabinet be vented to prevent possible vapor accumulation in the cabinet and because some users desire this feature if the cabinet is to be used for the storage of toxic or noxious materials. It should be understood that venting the cabinet might defeat its fire integrity. If it is not necessary nor required that the cabinet be vented, the vent openings should be kept tightly capped with the metal bungs provided for that purpose.

66.9.5.4.2* If a storage cabinet is ventilated for any reason, the vent openings shall be ducted directly to a safe location outdoors or to a treatment device designed to control volatile organic compounds (VOCs) and ignitible vapors in such a manner that will not compromise the specified performance of the cabinet and in a manner that is acceptable to the AHJ. [**30:**9.5.4.2]

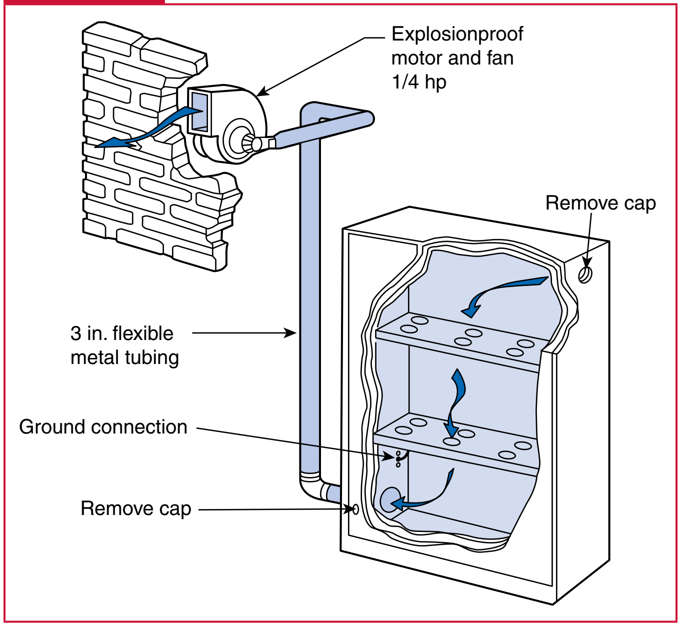
If the cabinet must be vented, the following procedures should be followed (see Exhibit 66.17 for details):

1. Remove both metal bungs and replace them with flash arrester screens (normally provided with the cabinets). The top opening will serve as the fresh air inlet.
2. Connect the bottom opening to an exhaust fan using substantial metal tubing having an inside diameter no smaller than the vent. The tubing should be rigid steel.
3. Position the fan so that it exhausts directly to the outside. The fan should have a nonsparking blade and nonsparking shroud.
4. Ensure that the total run of exhaust duct does not exceed 25 ft (7.6 m).

Venting the interior of a storage cabinet directly to the interior of a standard laboratory hood via flexible plastic duct is improper and dangerous. Not only is the cabinet's integrity violated, but safety of the hood and anyone using it is seriously compromised.

Flammable liquid storage cabinets are not required to be grounded. Notice that Exhibit 66.17 shows a ground connection. This ground connection is provided by the manufacturer for the convenience of the user. For example, the connection can provide a convenient grounding point for a bond wire for containers within the cabinet, which would be useful for containers inside the cabinet that are used to dispense to other smaller containers. Another example: Where a cabinet houses one or two drums of liquid that are equipped with drum pumps or dispensing spigots, the drums and the containers being dispensed to can be bonded to the ground connection.

Exhibit 66.17



Acceptable method to vent a flammable liquids storage cabinet.

A.66.9.5.4.2 A "safe location" should be selected as the location of a vent discharge to minimize the potential for ignitible vapors to travel to a source of ignition after discharge from the vent. Electrical equipment that does not meet the requirements for hazardous locations can serve as an ignition source. The Technical Committee advises that vent discharge locations should consider such factors as the following:

(1) Characteristics of the exhausted material (vapor density, toxicity, velocity of discharge, etc.)
(2) Proximity to potential ignition sources
(3) Building openings such as doors, windows, air intakes, and so forth
(4) Dispersion characteristics (distance to discharge within the flammable range, direction of discharge, atmospheric conditions, and the influence of building and neighboring buildings on discharged vapors)
(5) Likelihood of vapor accumulation following discharge, such as accumulation under building eaves
(6) Likelihood of sufficient discharge volume to allow an ignitible concentration to reach an ignition source

[**30:**A.9.5.4.2]

Historically, NFPA 30 has provided prescriptive guidance, often based on area classification requirements, and results have been acceptable. Closer distances should be accepted only if an analysis by a qualified person justifies closer distances. Similarly, the specified distances might not be acceptable for all installations, thus the guidance provided above. [**30:**A.9.5.4.2]

66.9.5.5* Storage cabinets shall include the following marking: [**30:**9.5.5]

FLAMMABLE
KEEP FIRE AWAY

A.66.9.5.5 ANSI Z535.2.2007, Environmental and Facility Safety Signs, Section 9.2, was used to determine the letter height, based on a safe viewing distance of 25 ft (7.5 m). Markings can be reflective to improve visibility. See ASTM D4956, *Standard Specification for Retroreflective Sheeting for Traffic Control*, for more information on providing reflective surfaces. If international symbols are used, they should be a minimum of 2.0 in. (50 mm) in size. [**30:**A.9.5.5]

The reference to ASTM D4956, *Standard Specification for Retroreflective Sheeting for Traffic Control,* provides the user with specifications for reflective sheeting that can be used for cabinet marking labels to improve visibility in emergency situations such as fires.

66.9.5.5.1 The minimum letter height for FLAMMABLE (signal word) shall be 2.0 in. (50 mm) and the minimum letter height for KEEP FIRE AWAY (message) shall be 1.0 in. (25 mm). [**30:**9.5.5.1]

66.9.5.5.2 All letters shall be uppercase and in contrasting color to the background. [**30:**9.5.5.2]

66.9.5.5.3 The marking shall be located on the upper portion of the cabinet's front door(s) or frame. [**30:**9.5.5.3]

66.9.5.5.4 Use of other languages, the international symbol for "flammable" (a flame in a triangle), the international symbol for "keep fire away" (a burning match in "no" circle) shall be permitted. [**30:**9.5.5.4]

The requirements for marking flammable liquids storage cabinets have been revised to incorporate internationally accepted guidelines for safety signs and to include a reference to ASTM D4956 for information on reflective markings. Specifically, the word "WARNING" is no longer required as part of the marking.

66.9.6 Maximum Allowable Quantities (MAQs) per Control Area.

66.9.6.1 General Occupancy Limits. The MAQs of liquids allowed in each control area shall not exceed the amounts specified in Table 66.9.6.1.

*Exception: As modified by 66.9.6.2 and Chapters 10 through 14 of NFPA 30. [**30:**9.6.1]*

The term *maximum allowable quantities (MAQs) per control area*, as used in *NFPA 5000®, Building Construction and Safety Code®*, and in the model building and fire codes, is perhaps one of the most confusing terms in these codes, in that quantities in excess of the MAQs per control area can — and commonly do — exist. However, when the MAQs per control area are exceeded,

TABLE 66.9.6.1 *MAQ of Flammable and Combustible Liquids per Control Area*

	Liquid Class(es)	Quantity		Notes
		gal	L	
Flammable liquids	IA	30	115	1, 2
	IB and IC	120	460	1, 2
	IA, IB, IC combined	120	460	1, 2, 3
Combustible liquids	II	120	460	1, 2
	IIIA	330	1,265	1, 2
	IIIB	13,200	50,600	1, 2, 4

Notes:
(1) Quantities are permitted to be increased 100 percent where stored in approved flammable liquids storage cabinets or in safety cans in accordance with this *Code*. Where Note 2 also applies, the increase for both notes is permitted to be applied accumulatively.
(2) Quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13. Where Note 1 also applies, the increase for both notes is permitted to be applied accumulatively.
(3) Containing not more than the maximum allowable quantity per control area of Class IA, Class IB, or Class IC flammable liquids, individually.
(4) Quantities are not limited in a building equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13 and designed in accordance with the protection criteria contained in Section 66.16 of this *Code*. [**30:** Table 9.6.1]

the occupancy of the area is reclassified to a Protection Level 2 (High-Hazard Level 2) or Protection Level 3 (High-Hazard Level 3) category.

When the volumes of stored flammable and combustible liquids are below the MAQs per control area, the facility's existing occupancy classification is maintained. For example, an industrial or storage occupancy that stores liquids below the MAQs per control area is considered to be an industrial or storage occupancy without further qualification. When such an occupancy stores liquids in excess of the MAQs per control area, it is reclassified as Protection Level 2 (High-Hazard Level 2) or Protection Level 3 (High-Hazard Level 3). In most cases, liquid storage rooms and liquid warehouses store liquids in excess of the MAQs per control area and thus would be considered Protection Level 2 or Protection Level 3 occupancies, because the containers are kept closed.

Class I, Class II, and Class IIIA flammable or combustible liquids that are used or stored in normally open containers or systems or in closed containers or systems at gauge pressures of 15 psi (103 kPa) or greater are considered High-Hazard Level 2 contents, which require protection in accordance with Protection Level 2. Class I, Class II, or Class IIIA liquids that are used or stored in normally closed containers or in closed systems at gauge pressures of less than 15 psi (103 kPa) are considered High-Hazard Level 3 contents, which require protection in accordance with Protection Level 3.

Table 66.9.6.1 contains several general notes that allow the MAQs per control area to be increased from the basic quantity listed in the table. For example, Note (1) allows a 100 percent increase to the basic MAQ when all the liquids are stored in approved flammable liquids storage cabinets or in safety cans. Note (2) allows a 100 percent increase to the basic MAQ when the liquids are stored in a building equipped throughout with an approved automatic sprinkler system. In some situations, both Note (1) and Note (2) can be applicable to a storage situation, in which case both 100 percent increases are applied cumulatively.

Example

Table 66.9.6.1 allows the basic MAQ per control area for a combination of Class IA, Class IB, and Class IC liquids to be 120 gal (460 L). However, if these liquids are stored in approved flammable liquids storage cabinets, then Note (1) allows the MAQ per control area to be increased 100 percent, to a volume of 240 gal (920 L). If the storage cabinets are located in an area provided with an approved automatic sprinkler system, then Note (2) allows the MAQ per control area to be increased another 100 percent. Thus, the 240 gal (920 L) is increased to 480 gal (1840 L) per control area.

In this example, Note (3) is also applicable, which limits the amount of Class IA liquids in the total quantity. Thus, of the total MAQ of 480 gal (1840 L), only 120 gal (460 L) can be a Class IA flammable liquid, based on the basic MAQ for Class IA liquids being 30 gal (115 L), then being increased to 60 gal (230 L) for storage in approved flammable liquids storage cabinets, and then being increased again to 120 gal (460 L) for the cabinets located in an area provided with automatic sprinklers.

Note 4 is applicable only to the storage of Class IIIB combustible liquids in an area provided with a fire protection system that meets the requirements of Chapter 16. In such situations, the quantities are unlimited and no MAQ exists. If the fire protection system does not comply with Chapter 16, then Note (2) applies instead.

66.9.6.2 Special Occupancy Limits.

66.9.6.2.1 For the following occupancies, the MAQs per control area shall not exceed the amounts specified in Table 66.9.6.2.1:

(1) Assembly
(2) Ambulatory health care
(3) Business
(4) Day care
(5) Detention and correctional
(6) Educational
(7) Health care
(8) Residential

[**30:**9.6.2.1]

As indicated in the example given in the commentary to 66.9.6.1, the MAQ per control area for flammable and combustible liquids can be fairly generous [up to 480 gal (1840 L)] when the liquids are stored in approved storage cabinets within an area provided with automatic sprinklers. It was determined that such a generous quantity was excessive for the occupancies listed in 66.9.6.2.1, because those occupancies have normally high occupant loads and generally do not warrant having such quantities of flammable liquids. Thus, the MAQs listed in Table 66.9.6.2.1 represent the reduced quantities that the Technical Committee believes are justified for such occupancies. For the most part, these quantities actually represent the long-standing quantity limitations that existed in previous editions of NFPA 30.

66.9.6.2.2 For the occupancies specified in 66.9.6.2.1, storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or in excess of 60 gal (227 L) of Class IIIA liquids shall be permitted where stored in flammable liquids storage cabinets and where the total aggregate quantity does not exceed 180 gal (680 L). [**30:**9.6.2.2]

TABLE 66.9.6.2.1 *MAQs — Special Occupancy Limits*

Liquid Class(es)	Quantity gal	Quantity L
I and II	10	38
IIIA	60	227
IIIB	120	454

[**30:** Table 9.6.2.1]

Some operations in the special occupancies listed in 66.9.6.2.1 might have a legitimate need for Class I and Class II liquids in excess of 10 gal (38 L) or for Class IIIA liquids in excess of 60 gal (230 L). For that reason, provisions were made in 66.9.6.2.2 to increase the MAQs provided that additional precautions exist, which in this situation requires the excess storage to be in flammable liquids storage cabinets. However, even storage in cabinets does not permit exceeding a maximum total quantity of liquid storage of 180 gal (680 L).

Regarding laboratories that might exist in some of the listed special occupancies, it should be noted that a laboratory stockroom is governed by NFPA 30, specifically the requirements for a liquid storage room, if the quantities exceed the MAQs. The quantities of liquids in the laboratory work area itself are governed by NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*.

66.9.6.2.3 Fuel in the tanks of operating mobile equipment shall be permitted to exceed the quantities specified in Table 66.9.6.1, where the equipment is operated in accordance with this *Code*. [**30:**9.6.2.3]

66.9.6.2.4 For ambulatory health care, day care, educational, and health care occupancies, the MAQ for Class IIIB liquids shall be permitted to be increased 100 percent if the building is protected throughout with an automatic sprinkler system installed in accordance with Section 13.3 and NFPA 13. [**30:**9.6.2.4]

66.9.7 Control Areas.

66.9.7.1 For the purpose of this *Code*, a control area shall be a space within a building where quantities of liquids that do not exceed the maximum quantities allowed by Table 66.9.6.1 or Table 66.9.6.2.1 are stored. [**30:**9.7.1]

Control areas are spaces or rooms within a building or an entire building where the quantities of hazardous materials, including flammable and combustible liquids, do not exceed the MAQs per control area when stored, used, or handled.

The *control area* concept, which encompasses 66.9.7 along with the MAQs addressed in 66.9.6, presents a method for the handling and storage of flammable and combustible liquids without classifying the occupancy as Protection Level 2 (High-Hazard Level 2) or Protection Level 3 (High-Hazard Level 3). To avoid being considered a Protection Level 2 or Protection Level 3 occupancy, the amount of flammable and combustible liquids within any single control area enclosed by fire barriers, horizontal assemblies, fire walls, and exterior walls cannot exceed the MAQ for the specific class of liquids listed in Table 66.9.6.1 or Table 66.9.6.2.1.

Note that some flammable and combustible liquid products might also have primary or secondary classifications that involve other hazardous properties, such as corrosivity or toxicity or that present some other hazard. For such products, the MAQs per control area for the other hazardous materials must also be considered in addition to the MAQs for the specific class of flammable or combustible liquids. The MAQs for other hazardous materials are listed in NFPA 400.

Δ **66.9.7.2** Control areas shall be separated from each other by fire barriers in accordance with Table 66.9.7.2. [**400:**5.2.2.1]

TABLE 66.9.7.2 *Design and Number of Control Areas*

Floor Level	Maximum Allowable Quantity per Control Area (percent)*	Number of Control Areas per Floor	Fire Resistance Rating for Fire Barriers (hr)†
Above grade			
>9	5	1	2
7–9	5	2	2
4–6	12.5	2	2
3	50	2	1
2	75	3	1
1	100	4	1
Below grade			
1	75	3	1
2	50	2	1
Lower than 2	NP	NP	N/A

NP: Not permitted. N/A: Not applicable.

*Percentages represent the MAQ per control area shown in Table 66.9.6.1, with all of the increases permitted in the footnotes of that table.

†Fire barriers are required to include floors and walls, as necessary, to provide a complete separation from other control areas.

[**400:**Table 5.2.2.1]

Control areas are compartments of a building surrounded by fire barrier walls and fire resistance–rated horizontal assemblies. If there are no fire barriers or fire resistance–rated horizontal assemblies, the entire building is considered a single control area. Thus, if the MAQs are exceeded in a building, fire barrier walls can be provided to create additional control areas, subject to the limitations of Table 66.9.7.2, so that the MAQs are not exceeded in any single control area. Doing so avoids classifying the building as Protection Level 2 (High-Hazard Level 2) or Protection Level 3 (High-Hazard Level 3).

Table 66.9.7.2 lists the number of control areas, the percentages of MAQs per control area, and the required fire resistance rating for fire barriers based on the location of the control area within a given floor level with respect to grade.

The noted percentages in the second column (Maximum Allowable Quantity per Control Area) of Table 66.9.7.2 are the percentages of the MAQs permitted per control area as listed in Table 66.9.6.1 and Table 66.9.6.2.1.

Example

For a first-floor control area, Table 66.9.6.1 allows an MAQ per control area of 240 gal (920 L) for Class IC flammable liquids when the building is equipped throughout with an approved automatic sprinkler system. If the control area were located on the second floor, Table 66.9.7.2 would limit the MAQ to 75 percent of that of the first floor, or 180 gal (680 L). Also, the number of control areas on the second floor would be limited to three, whereas four control areas would be permitted on the first floor.

The required fire resistance rating of the horizontal assembly above the control area is dictated by the required fire resistance rating of the fire barrier wall of the control area as listed in Table 66.9.7.2, the purpose of which is to maintain the continuity and integrity of the entire control area enclosure.

66.9.7.3 Control areas located below grade that are considered basements, as defined in 3.3.22, shall not be utilized for the storage of Class I liquids. [**30:**9.7.3]

66.9.8 Classification of Occupancies That Exceed the MAQs of Liquids per Control Area.

When the MAQs per control area are exceeded and no practical or economical options exist for reducing the quantities below the MAQs, the occupancy must be classified as a Protection Level 2 or Protection Level 3 for High-Hazard Level 2 or High-Hazard Level 3 contents, respectively.

Additional information on the protection level occupancy classifications and the high-hazard level content classifications can be found in *NFPA 5000*.

Exceeding the MAQs per control area for flammable and combustible liquids requires storage in a liquid storage room or a liquid warehouse constructed in accordance with Section 9.9 of NFPA 30.

66.9.8.1* Occupancy Classifications. Buildings and portions of buildings where liquids are stored shall be classified as Protection Level 2 or Protection Level 3, as established in this section, when the MAQs per control area are exceeded. [**30:**9.8.1]

Δ **A.66.9.8.1** The Protection Level classifications are taken from *NFPA 5000*. Protection Levels 1, 4, and 5 do not apply to the storage of flammable and combustible liquids and are therefore not extracted here. [**30:**A.9.8.1]

66.9.8.1.1 Protection Level 2. Buildings and portions thereof storing quantities of liquids that are considered as High-Hazard Level 2 liquids and that exceed the maximum allowable quantities per control area shall be classified as Protection Level 2 occupancies. [**30:**9.8.1.1]

Liquid storage rooms generally provide relatively large storage capacity for occupancies whose principal purpose is not the use of flammable and combustible liquids. For example, many hospitals, large university science departments, and private research and development facilities have a liquid storage room for storing bulk quantities of liquids to supply the various points of use throughout the facility. Because of the potential fire threat from inside liquid storage areas to the rest of the building, NFPA 30 sets rigid requirements for the design, construction, and operation of such rooms.

66.9.8.1.2 Protection Level 3. Buildings and portions thereof storing quantities of liquids that are considered as High-Hazard Level 3 liquids and that exceed the maximum allowable quantities per control area shall be classified as Protection Level 3 occupancies. [**30:**9.8.1.2]

Δ **66.9.8.2* Requirements for Specific Occupancies.** Liquids stored in Protection Level 2 or Protection Level 3 occupancies shall meet the applicable requirements for storage in a Liquid Storage Room or Liquid Warehouse as defined in this *Code* and in *NFPA 5000*. [**30:**9.8.2]

Δ **A.66.9.8.2** See *NFPA 5000* for additional requirements. [**30:**A.9.8.2]

66.9.9 Construction Requirements.

66.9.9.1 Storage areas shall be constructed to meet the fire resistance ratings specified in Table 66.9.9.1. Construction assemblies shall comply with the test specifications given in ASTM E119. [**30:**9.9.1]

Table 66.9.9.1 presents the required fire resistance ratings for the various construction elements of liquid storage rooms and liquid warehouses. The hourly ratings shown in the table are those that have been required in previous editions of the *Code*, with the

TABLE 66.9.9.1 *Fire Resistance Ratings for Liquid Storage Areas*

	Fire Resistance Rating (hr)		
Type of Storage Area	**Interior Walls[a], Ceilings, Intermediate Floors**	**Roofs**	**Exterior Walls**
Liquid storage room			
Floor area ≤ 150 ft²	1	—	—
Floor area > 150 ft², but ≤ 500 ft²	2	—	—
Liquid warehouse[b,c,g]	4[d]	—	2[e], 4[f]

For SI units, 1 ft² = 0.09 m².

[a]Between liquid storage areas and any adjacent areas not dedicated to liquid storage.

[b]Fire resistance ratings for liquid warehouses storing only Class IIIB liquids, which are not heated above their flash point, are permitted to be reduced to 2 hours.

[c]Fire resistance ratings for liquid warehouses protected in accordance with Section 66.16 are permitted to be reduced to 2 hours.

[d]This shall be a fire wall as defined in NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*.

[e]For exposing walls that are located more than 10 ft (3 m) but less than 50 ft (15 m) from an important building or line of adjoining property that can be built upon.

[f]For exposing walls that are located 10 ft (3 m) or less from an important building or line of adjoining property that can be built upon.

[g]For accessory use areas in protected liquid warehouses, such as offices and restrooms, whose combined area is less than 10 percent of the area of the warehouse, no fire resistance rating shall be required for the interior walls and ceilings.

[**30:** Table 9.9.1]

requirements for a liquid storage room being the same as those associated with the formerly used term *inside room*.

Liquid storage rooms cannot exceed 500 ft^2 (46 m^2) in area. This restriction limits the quantity of liquid present in any single liquid storage room, thus limiting the size of a potential fire (see also Table 12.6.1.1 of NFPA 30). Note that liquid storage rooms are not required to have direct access from outside the building. Thus, reaching any fire or related emergency situation within the room could be delayed, so it is reasonable to limit the quantity of liquid and the size of the area that will be involved.

Liquid warehouses must meet more restrictive construction standards than liquid storage rooms. This reflects the fact that the total quantity of liquid allowed to be stored in a protected liquid warehouse is not limited.

Note that at least 25 percent of the perimeter walls of a liquid warehouse must be an exterior wall (or walls) and any exterior wall area that exposes another building or another property line (that can be built on) is required to be of 4-hour fire-resistive construction if the adjacent building or property line is within 10 ft (3 m) and of 2-hour fire-resistive construction if the adjacent building or property line is more than 10 ft (3 m) but less than 50 ft (15 m) away. This requirement reflects the fact that a flammable or combustible liquid fire presents a greater-than-normal threat to exposed structures. A rating of 2- or 4-hour construction provides a lateral barrier to the transmission of thermal radiation to the exposed structures. Note that the requirement for fire-resistive exterior walls applies only if the separation distance between the liquid warehouse and the exposed property is 50 ft (15 m) or less.

66.9.9.2 Openings in interior walls to adjacent rooms or buildings and openings in exterior walls with fire resistance ratings shall be provided with normally closed, listed fire doors with fire protection ratings that correspond to the fire resistance rating of the wall as specified in Table 66.9.9.2. [**30:**9.9.2]

Note that for attached liquid warehouses requiring an interior 4-hour fire-resistive-rated wall in accordance with NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* one 3-hour-rated fire door is required on each side of any interior opening. This requirement is intended to ensure the integrity of the fire barrier even if the roof should collapse on the fire-exposed side of the wall. If the fire door on the exposed side is torn off its track, as is likely if roof collapse occurs, the door on the unexposed face of the wall would still protect the opening.

Δ ***TABLE 66.9.9.2*** *Protection Ratings for Fire Doors*

Fire Resistance Rating of Wall as Required by Table 66.9.9.1 (hr)	Fire Protection Rating of Door (hr)
1	¾
2	1½
4	3*

*One fire door required on each side of interior openings for attached liquid warehouses. [**30:** Table 9.9.2]

66.9.9.2.1 Such doors shall be permitted to be arranged to stay open during material-handling operations if the doors are designed to close automatically in a fire emergency by provision of listed closure devices. [**30:**9.9.2.1]

Δ **66.9.9.2.2** Fire doors shall be installed in accordance with NFPA 80. [**30:**9.9.2.2]

66.9.9.3 Exterior walls shall be constructed to provide ready access for fire-fighting operations by means of access openings, windows, or lightweight, noncombustible wall panels.

Exception: This requirement does not apply to liquid storage rooms totally enclosed within a building. [30:9.9.3]

66.9.10 Fire Protection.

66.9.10.1 Protected Storage. Fire protection requirements for protected storage shall meet the requirements of 66.9.10.2 and Section 66.16. [**30:**9.10.1]

66.9.10.2 Manual Fire Protection.

66.9.10.2.1 Portable fire extinguishers shall be provided in accordance with Section 13.6 and NFPA 10. [**30:**9.10.2.1]

Δ **66.9.10.2.2** Portable fire extinguishers shall meet the following requirements:

(1) At least one portable fire extinguisher having a capability of not less than 40:B shall be located outside of, but not more than 10 ft (3 m) from, the door opening into a liquid storage area.
(2) At least one portable fire extinguisher having a capability of not less than 40:B shall be located within 30 ft (9 m) of any Class I or Class II liquids located outside of a liquid storage area, or at least one portable fire extinguisher having a capacity of 80:B shall be located within 50 ft (15 m) of such a storage area.

[**30:**9.10.2.2]

Portable fire extinguishers are required to be located outside but relatively close to the liquid storage area because fires involving Class I and Class II liquids are likely to escalate rapidly. If the fire extinguisher is inside or too close to the storage area, it might be impossible to get to it once the fire has started.

66.9.10.2.3 Where provided, hose connections supplied from sprinkler systems shall be installed in accordance with Section 13.3 and NFPA 13. [**30:**9.10.2.3]

66.9.10.2.4 Where provided, hose connections supplied by a standpipe system shall be installed in accordance with Section 13.2 and NFPA 14. [**30:**9.10.2.4]

66.9.10.2.5 Where provided, hose connections shall also meet the following requirements:

(1) Hose connections shall be provided in protected general-purpose warehouses and in protected liquid warehouses.
(2) Where preconnected hose is provided, it shall be either 1½ in. (38 mm) lined fire hose or 1 in. (25 mm) hard rubber hose, using combination spray and straight stream nozzles.

[**30:**9.10.2.5]

66.9.10.2.6 Where hose connections are provided, the water supply shall be sufficient to meet the fixed fire protection demand plus a total of at least 500 gpm (1900 L/min) for inside and outside hose connections for at least 2 hours, unless otherwise specified in Section 66.16. [**30:**9.10.2.6]

The intent of 66.9.10.2.6 is to establish the minimum total water supply required for the entire storage area or facility. The 500 gpm (1900 L/min) for inside and outside hose streams is intended to be the combined demand, as opposed to 500 gpm (1900 L/min) for each.

66.9.11 Emergency Control Systems. (Reserved)

66.9.12 Electrical Systems.

66.9.12.1 Electrical area classification shall not be required for liquid storage areas where all containers, intermediate bulk containers, and portable tanks are sealed and are not opened, except as provided for in 66.9.12.2. [**30:**9.12.1]

66.9.12.2 For liquid storage rooms that are totally enclosed within the building, electrical wiring and utilization equipment for Class I liquid storage shall be Class I, Division 2 (Zone 2), and electrical wiring and utilization equipment in inside rooms used for the storage of Class II and Class III liquids shall be suitable for ordinary purpose.

*Exception: Class I, Division 2 (Zone 2) requirements shall apply to Class II and Class III liquids when stored at temperatures above their flash points. [**30:**9.12.2]*

In smaller liquid storage rooms utilized for the storage of Class I flammable liquids, particularly those rooms totally enclosed within a building (i.e., having no exterior walls), the provision of electrical wiring and utilization equipment for Class I, Division 2 (Zone 2) is necessary because of the potential for ignition of flammable vapors from a spill or leaking container.

Additionally, Class II and Class III combustible liquids handled at temperatures above their flash points have the combustibility characteristics of Class I flammable liquids and must be treated accordingly with respect to the choice of electrical equipment and wiring methods.

It is also noted that Class I, Division 1 electrical equipment must be used in the immediate vicinity of any points where ignitible vapor releases are expected, such as areas involving transfer operations.

Not all "vaporproof" types of lighting fixtures are suitable for use in atmospheres containing ignitible vapors. This designation often refers only to the fixture's capability to prevent moisture from entering its interior. Approved fixtures are properly labeled for their use and are indicated as being "vaportight" or "explosionproof."

66.9.13* Containment, Drainage, and Spill Control.

A.66.9.13 Spill containment can be accomplished by any of the following:

(1) Noncombustible, liquidtight raised sills, curbs, or ramps of suitable height at exterior openings
(2) Noncombustible, liquidtight raised sills, curbs, or ramps of suitable height, or other flow-diverting structures at interior openings
(3) Sloped floors
(4) Open-grate trenches or floor drains that are connected to a properly designed drainage system
(5) Wall scuppers that discharge to a safe location or to a properly designed drainage system
(6) Other means that are acceptable to the AHJ

[**30:**A.9.13]

Where sills, curbs, or ramps are used, the appropriate height will depend on a number of factors, including the maximum expected spill volume, the floor area, and the existence of any drainage systems. Historically, curbs and sills have been 4 in. (100 mm) high. [**30:**A.9.13]

A variety of curb, sill, and ramp heights can be used to obtain the desired containment volume. As a guide, 1 ft^2 of water at a depth of 1 in. equals 0.6 gal (1 m^2 of water @ 25 mm = 25 L). Once the total quantity of liquid containment has been established, the necessary curb, sill, or ramp height can then be calculated. [**30:**A.9.13]

Where open-grate trenches are used, the volume of the trench should be able to contain the maximum expected spill volume or otherwise be connected to a properly designed drainage system. [**30:**A.9.13]

It should be noted that these containment and drainage provisions address only fire protection concerns. Consult the appropriate environmental regulations for other restrictions that could apply. [**30:**A.9.13]

The containment, drainage, and spill control requirements of Section 9.13 apply to the storage of liquids in containers greater than 10 gal (38 L) stored in all liquid storage rooms and liquid warehouses, with the exception of those liquids covered in 66.9.13.4 and 66.9.13.5, which do not require containment, drainage, or spill control.

The primary concerns of the requirements in 66.9.13 are the mitigation of fire hazard resulting from a spill and the prevention of spilled liquids and contaminated fire water from reaching public waterways, public sewers, or adjoining property. The intent is also to prevent a spill from migrating to other parts of the facility where it might be ignited. If the spill has already been ignited, there is also concern that sprinkler discharge will float burning liquid beyond the immediate area.

Spill control must be sized for the largest credible spill. In most cases, this will constitute the single largest container present. Note that containment or drainage is not required if the individual containers do not exceed 10 gal (38 L). The Technical Committee on Storage and Warehousing of Containers and Portable Tanks is not convinced that justification exists for imposing such costly requirements on facilities that store such minimal quantities.

66.9.13.1 Storage areas shall be designed and operated to prevent the discharge of liquids to public waterways, public sewers, or adjoining property, unless such discharge has been specifically approved. [**30:**9.13.1]

66.9.13.1.1 Where the drainage system discharges to private or public sewers or waterways, the drainage system shall be equipped with traps and separators. [**30:**9.13.1.1]

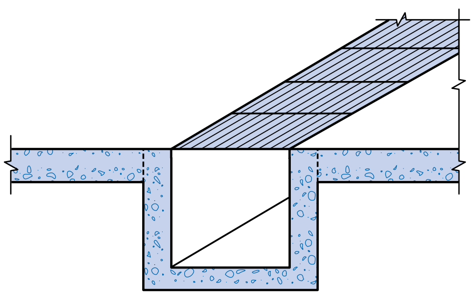
66.9.13.2 Where individual containers exceed 10 gal (38 L), curbs, scuppers, drains, or other suitable means shall be provided to prevent flow of liquids under emergency conditions into adjacent building areas. [**30:**9.13.2]

The intent of 66.9.13.2 is to prevent the flow of burning liquids to uninvolved parts of a building due to sprinkler discharge. This accomplishes two objectives: (1) By limiting the spread of burning liquid, adjacent storage arrays do not become involved in the fire; and (2) by preventing the spread of fire, sprinkler actuation is limited to those sprinklers directly over and adjacent to the principal fire area, thus minimizing the chance that the sprinkler system will be overtaxed. Because most liquids that are immiscible with water are also lighter than water, it is important that the capacity of the drainage system be sufficient to drain the water from the fire protection system and hose streams, as well as the flammable liquid itself. Curbs and sills are the most common method of meeting the requirement. If an open-grated trench is used, it must extend across the entire opening (door) into the room and must be located on the inside of the room. Use of a trench is sometimes preferred where there is an extensive need to transfer flammable liquids into and out of the room by means of hand trucks. Exhibit 66.18 illustrates some design features of trenches.

66.9.13.3 Containment or drainage to an approved location shall be provided. [**30:**9.13.3]

Depending on the estimated size of a spill and expected sprinkler discharge, any means used to contain a spill might need some means to transport the spilled liquid and sprinkler discharge out of the containment and to a safe place where it can be held. This consideration is obviously true for a drainage system or a doorway trench. The containment/drainage design in such cases must include some means to collect the spill and associated runoff in a place where the runoff will not expose either the facility itself or neighboring facilities, public roads, streams, and so on. Where expected quantities of runoff are reasonably small, one or more catch tanks can be used. These would typically be underground tanks. Where catch tanks are deemed impractical, an impoundment of some type should be used. In either case, environmental regulations must be considered. Although not intended for the use described here, some helpful information on impoundments can be found in 66.22.11.1.

Exhibit 66.18



Drainage trench with steel grating cover

Drainage trench details.

66.9.13.3.1 Where a drainage system is used, it shall also have sufficient capacity to carry the expected discharge of water from fire protection systems. [**30:**9.13.3.1]

66.9.13.4 Where only Class IIIB liquids are stored, spill control, containment, and drainage shall not be required. [**30:**9.13.4]

66.9.13.5 Where only unsaturated polyester resins (UPRs) containing not more than 50 percent by weight of Class IC, Class II, or Class IIIA liquid constituents are stored and are protected in accordance with 66.16.5.2.11, spill control, containment, and drainage shall not be required. [**30:**9.13.5]

66.9.13.6 Where storage is protected in accordance with Section 66.16, spill control, containment, and drainage shall also meet the requirements of 66.16.8. [**30:**9.13.6]

66.9.14 Ventilation. Liquid storage areas where dispensing is conducted shall be provided with ventilation that meets the requirements of 66.18.6. [**30:**9.14]

Ventilation is vital to the prevention of flammable liquid fires and explosions. In a room where the potential accumulation of vapors could fall within the flammable range of the stored material, every effort must be made to confine, remove, or dilute the vapors, thereby reducing the probability of ignition. The vapors from most liquids are denser than air, which is the reason for requiring exhaust ventilation to be initiated at or near the floor level. See 66.18.6 for more information.

66.9.15 Exhausted Enclosures. (Reserved)

66.9.16 Explosion Control.

Δ **66.9.16.1*** Where Class IA liquids are stored in containers larger than 1 gal (4 L), areas shall be provided with a means of explosion control that meets the requirements of NFPA 69. An approved engineered damage limiting construction design shall also be permitted.

*Exception: This shall not apply to a liquid storage room totally enclosed within a building. [**30:**9.16.1]*

Δ **A.66.9.16.1** Release of a Class IA liquid into a room or enclosure can result in the evolution of large quantities of flammable vapor. The ignition of this flammable mixture can result in a significant pressure rise, the production of hot combustion gases, and flame. Failure to adequately design a room or building for this type of event can result in the failure of the room or building walls and/or roof and the uncontrolled release of the hot combustion gases, flames, and pressure. An acceptable method of protection against this type of event is the use of damage-limiting construction consisting of a combination of pressure-relieving construction and pressure-resistant construction as described in NFPA 68. [**30:**A.9.16.1]

66.9.16.2* Where unstable liquids are stored, an approved engineered construction method that is designed to limit damage from a deflagration or detonation, depending on the liquid stored, shall be used. [**30:**9.16.2]

A.66.9.16.2 Unstable liquids can create deflagration or detonation hazards. A complete engineering review of the type of explosion event that might be produced by an unstable liquid is needed to define the necessary protection measures. Protection measures for detonations require construction features such as barricades. [**30:**A.9.16.2]

66.9.17 Separation from Incompatible Materials.

66.9.17.1 Except as provided for in 66.9.17.3, liquids shall be separated from incompatible materials where the stored materials are in containers having a capacity of more than 5 lb (2.268 kg) or ½ gal (1.89 L). [**30:**9.17.1]

A number of materials are incompatible with flammable and combustible liquids and must not be stored in the same area because a hazardous and/or exothermic reaction could occur upon contact. Such reactions could act as a potential ignition source.

The safety data sheet for each liquid should include information identifying any materials with which the liquid is incompatible. Another useful source of information is NFPA 491, *Compilation of Hazardous Chemical Reactions*, which is a part of the *Fire Protection Guide to Hazardous Materials*. See also 46 CFR 150, "Compatibility of Cargoes," for the U.S. Coast Guard's chemical incompatibility chart, which is used to isolate incompatible cargoes on marine vessels.

66.9.17.1.1 Separation shall be accomplished by one of the following methods:

(1) Segregating incompatible materials storage by a distance of not less than 20 ft (6.1 m)
(2) Isolating incompatible materials storage by a noncombustible partition extending not less than 18 in. (460 mm) above and to the sides of the stored materials
(3) Storing liquid materials in flammable liquids storage cabinets in accordance with 66.9.5

[**30:**9.17.1.1]

Δ **66.9.17.2** Liquids shall be separated from Level 2 and Level 3 aerosols in accordance with Chapter 61 and NFPA 30B. [**30:**9.17.2]

NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products,* contains several requirements that cover the storage of flammable liquids in areas used mainly for aerosol storage. One such requirement, involving the segregated storage of aerosols, requires flammable and combustible liquids to be separated from the aerosol storage area by a minimum distance of 25 ft (7.6 m). Another such requirement allows the storage of flammable and combustible liquids in metal containers of 1 qt (0.9 L) capacity or less in an aerosol warehouse if automatic sprinkler protection, as required for this situation by NFPA 30B, is provided.

66.9.17.3 Flammable and combustible liquids shall be separated from oxidizers by at least 25 ft (7.6 m). [**30:**9.17.3]

Δ **66.9.17.4** Materials that are water-reactive, as described in NFPA 704 shall not be stored in the same control area with liquids. [**30:**9.17.4]

Materials that are water-reactive can generate heat or become combustible when exposed to water or other liquids, which could result in a potential ignition source. For that reason, water-reactive materials must not be stored in the same area or room with flammable or combustible liquids.

66.9.18 Dispensing, Handling, and Use of Liquids in Storage Areas.

66.9.18.1 Dispensing, handling, and use of liquids shall meet all applicable requirements of Section 66.18. [**30:**9.18.1]

66.9.18.2 Dispensing of Class I liquids or Class II and Class III liquids at temperatures at or above their flash points shall not be permitted in storage areas that exceed 1000 ft^2 (93 m^2) in floor area unless the dispensing area is separated from the storage areas in accordance with Table 66.9.9.1 and meets all other requirements of 66.9.9. [**30:**9.18.2]

The rationale of 66.9.18.2 is that dispensing of liquids would introduce an additional hazard to the storage area. Therefore, the size of the room where dispensing is allowed is restricted. Where dispensing takes place, other restrictions are imposed in addition to the limitation on room size.

66.9.19 Outdoor Storage of Liquids. Storage of liquids outside of buildings shall meet the requirements of Section 66.14 or 66.15, whichever is applicable. [**30:**9.19]

66.10 Reserved

66.11 Reserved

66.12 Reserved

66.13 Reserved

66.14 Hazardous Materials Storage Lockers

66.14.1* Scope. This section shall apply to the storage of liquids in movable, modular, prefabricated storage lockers, also known as hazardous materials storage lockers (hereinafter referred to as lockers), specifically designed and manufactured for storage of hazardous materials, in the following:

(1) Containers that do not exceed 119 gal (450 L) individual capacity
(2) Portable tanks that do not exceed 660 gal (2500 L) individual capacity
(3) Intermediate bulk containers that do not exceed 793 gal (3000 L) individual capacity

[**30:**14.1]

Δ **A.66.14.1** Environmental concerns have dictated special handling of hazardous materials, chemicals, and wastes. Some of these have flammable and combustible liquid characteristics, in addition to their environmental and health problems, thus causing some questions as to how they should be stored and handled. [**30:**A.14.1]

Several manufacturers have met this problem by designing and manufacturing movable, modular prefabricated storage lockers, working diligently with various building officials and AHJs. This results in a product that is intended to meet government standards and regulations for hazardous materials storage. Several municipalities have passed model ordinances covering the design, construction, and location of hazardous materials storage lockers. Design features can include, but are not limited to, the following:

(1) Secondary spill containment sumps
(2) Deflagration venting
(3) Ventilation requirements, including mechanical ventilation where dispensing operations are expected
(4) Electrical equipment for hazardous locations in accordance with *NFPA 70*
(5) Static electricity control
(6) Fire suppression systems (dry chemical or sprinklers)
(7) Heavy structural design for the following:
    (a) Security provisions
    (b) Doors that lock and permit pallet loading
    (c) Wind load, snow load, and storage load conditions
    (d) Anchorage provisions
    (e) Skid design, permitting relocation using lift trucks
(8) Fire-related exterior walls, if required
(9) Interior partitions to segregate incompatible materials
(10) Size limits to limit quantities that can be stored within preassembled or ready-to-assemble designs
(11) Nonsparking floors
(12) Shelving, if required
(13) Heating or cooling units, if needed
(14) Corrosion protection as required
(15) Employee safety provisions (eye/face wash)
(16) NFPA 704 hazard symbols

[**30:**A.14.1]

Features provided are determined by specific storage requirements and needs of the owner, keeping in mind applicable regulations and ordinances that apply and the approval requirements of the AHJ. [**30:**A.14.1]

Several testing laboratories have developed internal procedures for the examination, testing, and listing or labeling of hazardous materials storage lockers submitted by manufacturers. [**30:**A.14.1]

Exhibit 66.19

A four-drum locker with 2-hour fire-rated construction and an automatic-closing roll-up door. This locker features a room for optional shelving for small containers, mechanical ventilation, and dry chemical fire suppression system with alarm. (Courtesy of DENIOS, Inc.)

Exhibit 66.20

A larger version of the locker shown in Exhibit 66.19. This model offers four times the storage capacity in addition to the same features as the locker shown in Exhibit 66.19. (Courtesy of DENIOS, Inc.)

Examples of hazardous materials storage lockers are shown in Exhibit 66.19 and Exhibit 66.20.

66.14.2 Reserved.

66.14.3 General Requirements.

66.14.3.1 Lockers that are used as liquid storage rooms shall meet the requirements of Section 66.9. [**30:**14.3.1]

A hazardous materials storage locker is an excellent means of providing a liquid storage room, particularly in manufacturing facilities where the room might have to be relocated to accommodate changes in the manufacturing process, such as in an automotive assembly plant where the assembly line might have to be changed. Where used as a liquid storage room inside a building, the walls and roof of the locker need to have a 1-hour or 2-hour fire rating, in accordance with Table 66.9.9.1. Note that a locker used outdoors is not required to be fire rated, although reductions from the separation distances imposed by Table 66.14.5.2 are allowed where the lockers are fire rated.

66.14.3.2 Lockers that are located outside shall meet the requirements of Sections 14.4 through 14.6 of NFPA 30. [**30:**14.3.2]

66.14.4 Design and Construction of Hazardous Materials Storage Lockers.

66.14.4.1 The design and construction of a locker shall meet all applicable local, state, and federal regulations and requirements and shall be subject to the approval of the AHJ. [**30:**14.4.1]

There are no construction standards, per se, for hazardous materials storage lockers. In most cases, they will be used as (or as a substitute for) a permanent building or structure. Therefore, they might have to meet certain local building code requirements. They must also meet all applicable federal requirements for the safe storage of hazardous materials.

66.14.4.2 Movable prefabricated structures that have been examined, listed, or labeled by an organization acceptable to the AHJ for use as a hazardous materials storage facility shall be acceptable. [**30:**14.4.2]

66.14.4.3 Lockers shall not exceed 1500 ft^2 (140 m^2) gross floor area. [**30:**14.4.3]

The largest locker currently manufactured is about 12 ft × 40 ft (3.7 m × 12 m), or about the size of the typical van semi-trailer. However, the concept of these lockers is so attractive that larger modular units could well be offered. These units likely would be supplied as a single large unit or in two or more modular sections that are connected on site, in much the same manner as modular housing is constructed and transported. In any case, it was felt that 1500 ft^2 (140 m^2) was a reasonable maximum size. If a larger structure is required, it should be a permanent structure meeting the requirements of an attached building or liquid warehouse.

66.14.4.4 Vertical stacking of lockers shall not be permitted. [**30:**14.4.4]

66.14.4.5 Where electrical wiring and equipment are required, they shall comply with Section 66.7 and 66.9.12. [**30:**14.4.5]

66.14.4.6 Where dispensing or filling is permitted inside a locker, operations shall comply with the provisions of Section 66.18. [**30:**14.4.6]

66.14.4.7 Ventilation shall be provided in accordance with 66.18.6. [**30:**14.4.7]

66.14.4.8 Lockers shall include a spill containment system to prevent the flow of liquids from the locker under emergency conditions. [**30:**14.4.8]

The word *structure* has been replaced with the word *locker* to ensure that this requirement is interpreted as applying to the locker itself and not to a building in which a locker might be located.

66.14.4.8.1 The containment system shall have sufficient capacity to contain 10 percent of the volume of containers allowed in the locker or the volume of the largest container, whichever is greater. [**30:**14.4.8.1]

The 10 percent retention capacity requirement is based on and equal to the EPA Resource Conservation and Recovery Act (RCRA) requirement for hazardous waste storage facilities. Because it was anticipated that these lockers would be used mainly (at least initially) for RCRA compliance, the 10 percent spill retention capability has become a de facto design standard.

66.14.5 Designated Sites for Hazardous Materials Storage Lockers.

66.14.5.1 Lockers shall be located on a designated approved site on the property. [**30:**14.5.1]

66.14.5.2 The designated site shall be arranged to provide the minimum separation distances specified in Table 66.14.5.2 between individual lockers, from locker to property line that is or can be

Δ ***TABLE 66.14.5.2*** *Designated Sites*

	Minimum Separation Distance (ft)		
Area of Designated Site[a] (ft^2)	Between Individual Lockers	From Locker to Property Line That Is or Can Be Built Upon[b]	From Locker to Nearest Side of Public Way or to Important Buildings on Same Property[b,c]
≤100	5	10	5
>100 and ≤500	5	20	10
>500 and ≤1500[d]	5	30	20

For SI units, 1 ft = 0.3 m; 1 ft^2 = 0.09 m^2.

Note: If the locker is provided with a fire resistance rating of not less than 4 hours and deflagration venting is not required in accordance with 66.9.15, all distances required by Table 66.14.5.2 are permitted to be waived.

[a]Site area limits are intended to differentiate the relative size and thus the number of lockers that are permitted in one designated site.

[b]Distances apply to properties that have protection for exposures, as defined. If there are exposures and such protection for exposures does not exist, the distances should be doubled.

[c]When the exposed building has an exterior wall, facing the designated site, that has a fire resistance rating of at least 2 hours and has no openings to above grade areas within 10 ft (3 m) horizontally and no openings to below grade areas within 50 ft (15 m) horizontally of the designated area, the distances can be reduced to half of those shown in the table, except they should never be less than 5 ft (1.5 m).

[d]When a single locker has a gross single story floor area that will require a site area limit of greater than 1500 ft^2 (140 m^2) or when multiple units exceed the area limit of 1500 ft^2 (140 m^2), the AHJ should be consulted for approval of distances. [**30:** Table 14.5.2]

built upon, and from locker to nearest side of public ways or to important buildings on the same property. [**30:**14.5.2]

As stated in footnote a to Table 66.14.5.2, the required separation distance between two adjacent lockers and the setback distances from property lines, public ways, and adjacent buildings are based on the relative sizes of lockers currently available. If the area available for a "designated site" is limited, it might well dictate the maximum size and/or the number of lockers that can be used in a given situation. Conversely, if a certain storage capacity is needed, then sufficient space must be found for the designated site.

Footnote c is similar to the provisions in 66.15.4.1 for outside storage and allows some leniency in siting where the exposure to the adjacent structure is minimal.

Footnote d establishes some additional flexibility. Obviously, if a single unit has the maximum gross floor area allowed — 1500 ft^2 (140 m^2) — the designated site must exceed the maximum allowable size given in the table. The same problem arises if several large units are located adjacent to each other. The AHJ should deal with such situations on a case-by-case basis.

Exhibit 66.21 illustrates application of the provisions of Table 66.14.5.2.

66.14.5.3 Once the designated site is approved, it shall not be changed without the approval of the AHJ. [**30:**14.5.3]

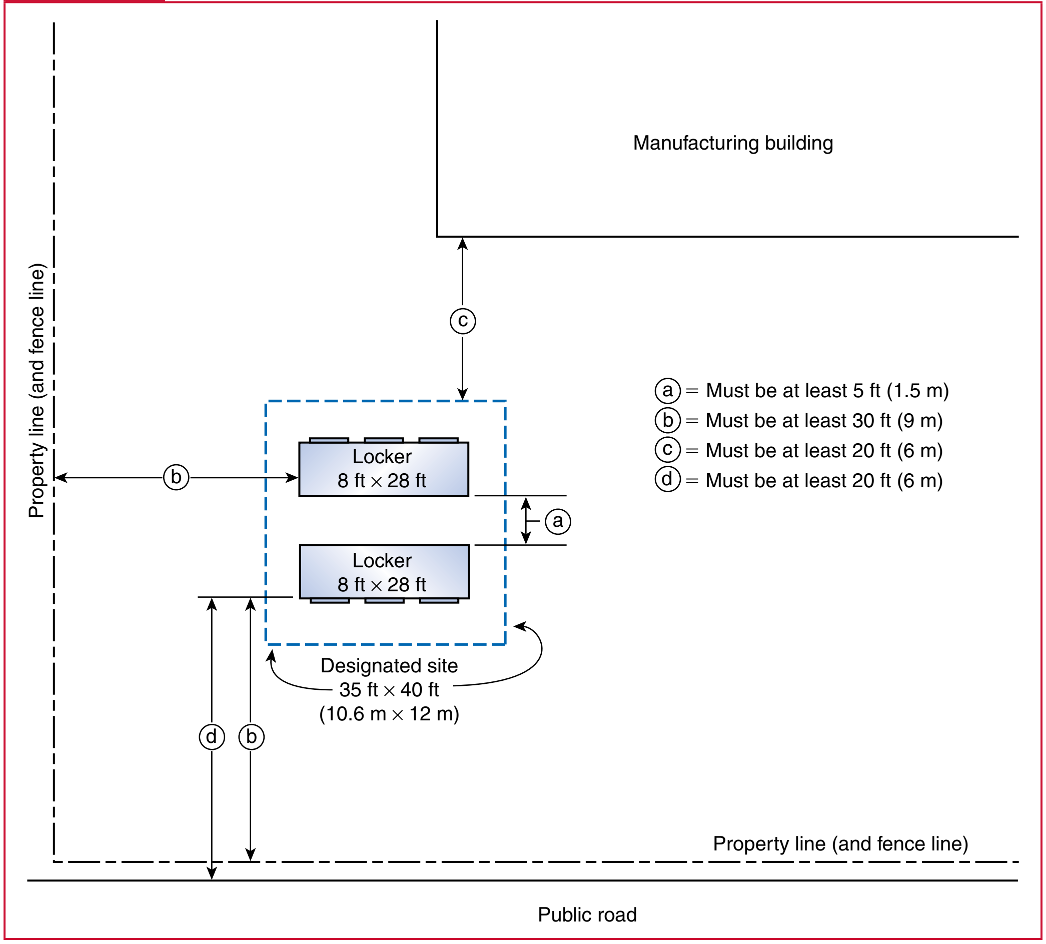
Because the lockers are movable, it is appropriate to establish a rule that, once the designated site has been chosen and approved by the AHJ, it cannot be changed or altered without the further consultation and approval of the AHJ.

66.14.5.4 More than one locker shall be permitted on a designated site, provided that the separation distance between individual lockers is maintained in accordance with Table 66.14.5.2. [**30:**14.5.4]

66.14.5.5 Where the approved designated storage site is accessible to the general public, it shall be protected from tampering or trespassing. [**30:**14.5.5]

The provision in 66.14.5.5 is an important requirement for these lockers. Even though the lockers are relatively secure by design, it was deemed necessary to protect the site from trespassing and vandalism. Compliance will likely require that the site be enclosed by a fence or a barricade, although the exact means is not specified by the *Code*.

Exhibit 66.21



Separation distances for hazardous materials storage lockers, in accordance with Table 66.14.5.2.

66.14.6 Storage Requirements.

66.14.6.1 Containers of liquid in their original shipping packages shall be permitted to be stored either palletized or solid piled within the locker. [**30:**14.6.1]

66.14.6.2 Unpackaged containers shall be permitted to be stored on shelves or directly on the floor of the locker. [**30:**14.6.2]

66.14.6.3 Containers over 30 gal (114 L) capacity storing Class I or Class II liquids shall not be stored more than two containers high. [**30:**14.6.3]

Stacking of larger containers is not allowed due to the potential for toppling of containers. Where storage needs dictate, a locker specifically designed for two-tier storage should be selected.

66.14.6.4 In all cases, the storage arrangement shall provide unrestricted access to and egress from the locker. [**30:**14.6.4]

Special attention needs to be paid to safe storage practices that maintain unrestricted movement of personnel when they are inside the locker. Space will typically be at a premium. Clear space needs to be provided for access for emergency activities should they be necessary. Likewise, anyone who is inside the locker must be able to evacuate quickly in an emergency.

66.14.6.5 Miscellaneous combustible materials, including but not limited to idle pallets, excessive vegetation, and packing materials, shall not be permitted within 5 ft (1.5 m) of the designated site approved for lockers. [**30:**14.6.5]

66.14.6.6 Warning signs for lockers shall be in accordance with applicable local, state, and federal regulations or with NFPA 704. [**30:**14.6.6]

66.15 Outdoor Storage

In some cases, flammable and combustible liquids will be stored outdoors rather than inside a building. While outdoor storage eliminates the possibility of a fire inside the building, a fire involving outdoor storage still presents a risk of damage to adjacent structures or storage. Outdoor storage does, however, allow for unrestricted dispersal of heat, smoke, and products of combustion. Additionally, because of the ease of access, a fire in an outdoor storage area can be more readily controlled by manual fire-fighting operations than one within a structure.

Outdoor storage does present security problems. While storage of liquids outdoors reduces the potential for fire damage to the main structure, the liquids are more accessible to vandals. Facility management should conduct a security vulnerability assessment in accordance with 66.6.10.

For the purposes of this chapter, outdoor storage is considered to include any storage area covered by a roof that provides weather protection for the containers, as long as the arrangement of the roof will not confine heat, smoke, and products of combustion. This same area might have one or two (but no more) walls without materially affecting natural ventilation, but the walls must not provide any confinement.

In addition to these requirements for outdoor storage, environmental requirements must also be considered, particularly in relation to groundwater pollution. Additional curbing or a drainage system might have to be provided to control any spill that might occur. Drainage or collection systems must be assessed from a fire protection standpoint to eliminate a fire hazard in areas to which the spilled liquids drain, no matter how remote from the storage.

66.15.1 Scope. This section shall apply to the storage of liquids outdoors in the following:

(1) Drums or other containers that do not exceed 119 gal (450 L) individual capacity
(2) Portable tanks that do not exceed 660 gal (2500 L) individual capacity
(3) Intermediate bulk containers that do not exceed 793 gal (3000 L) individual capacity

[**30:**15.1]

66.15.2 Reserved.

66.15.3 General Requirements. Outdoor storage of liquids in containers, intermediate bulk containers, and portable tanks shall comply with Table 66.15.3 and with all applicable requirements of this section. [**30:**15.3]

Note the eighth column, labeled "Minimum Separation Distance Between Piles or Rack Sections." This clearance must be maintained to allow emergency access for fire fighting.

66.15.3.1 Where two or more classes of liquids are stored in a single pile, the maximum quantity permitted in that pile shall be that of the most hazardous class of liquid present. [**30:**15.3.1]

The requirement in 66.15.3.1 means that the pile takes on the identity of the more hazardous class and that the total amount of liquids in the pile cannot exceed what is allowed for that class. The following three examples illustrate how Table 66.15.3 is applied.

Example 1

There are 1700 gal (6434.5 L) of a Class II liquid in drums stored outside a warehouse. How many gallons (liters) of a Class IB liquid can be stored in the same pile?

Solution:

The Class IB storage is more hazardous, so provisions governing IB pile storage are applicable. (See 66.15.3.1.) The maximum allowed per pile is 2200 gal (8327 L). Because the storage already consists of 1700 gal (6434.5 L) of a Class II liquid, only 500 gal (1892.5 L) of a Class IB liquid can be stored in the same pile.

Example 2

Consider a manufacturing plant where it has been decided that there is no protection for adjacent exposed properties. Several

TABLE 66.15.3 Storage Limitations for Outside Storage

	Containers		Portable Tanks and Metal IBCs		Rigid Plastic and Composite IBCs		Minimum Separation Distance (ft)		
Liquid Class	Maximum Quantity per Pile (gal)[a,b,c]	Maximum Storage Height (ft)	Maximum Quantity per Pile (gal)	Maximum Storage Height (ft)	Maximum Quantity per Pile (gal)[a,c]	Maximum Storage Height (ft)	Between Piles or Rack Sections	To Property Line That Is or Can Be Built Upon[b,d]	To Street, Alley, or Public Way[b]
IA	1,100	10	2,200	7	NP	NP	5	50	10
IB	2,200	12	4,400	14	NP	NP	5	50	10
IC	4,400	12	8,800	14	NP	NP	5	50	10
II	8,800	12	17,600	14	8,800	14	5	25	5
III	22,000	18	44,000	14	22,000	18	5	10	5

For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L.

NP: Not permitted.

[a]See 66.15.3.1 regarding mixed-class storage.

[b]See 66.15.3.4 for smaller pile sizes.

[c]For storage in racks, the quantity limits per pile do not apply, but the rack arrangements should be limited to a maximum of 50 ft (15 m) in length and two rows or 9 ft (2.7 m) in depth.

[d]See 66.15.3.3 regarding protection for exposures. [**30:** Table 15.3]

piles of drums containing a Class IB liquid are located 125 ft (38 m) from the nearest property line that can be built upon. An industrial plant on an adjacent property is in the process of forming its own fire brigade. What will be the new distance requirement for the containers?

Solution:

Where there is no protection for exposures, the distance specified in Table 66.15.3 must be doubled in accordance with 66.15.3.3. Thus, 100 ft (30 m) is needed. The plant in question has its storage 125 ft (38 m) away, so there is no violation. Where the protection for exposures is in effect, the plant can move its storage to within 50 ft (15 m) of its neighbor. See Exhibit 66.22.

Example 3

How close to an adjacent property that can be built upon and how close to a nearby street is a manufacturing plant allowed to place 2300 gal (8706 L) of kerosene (Class II) in drums? Assume there is no protection for exposures.

Solution:

With no protection for exposures, the distance to the property line, as given in Table 66.15.3, must be doubled, to 50 ft (15 m). (See 66.15.3.3.) However, the plant is allowed to store 8800 gal (33,308 L) but has stored only 2300 gal (8706 L). This amount is substantially less than 50 percent of the allowable amount, so the plant can reduce the required distance by 50 percent, back to 25 ft (7.5 m), per 66.15.3.4. Similarly, the plant can reduce the distance to the street by 50 percent, but to no less than 3 ft (0.90 m). Therefore, the plant's storage must be at least 25 ft (7.5 m) from the property line and at least 3 ft (0.90 m) from the nearest street. See Exhibit 66.23.

66.15.3.2 No container, intermediate bulk container, or portable tank in a pile shall be more than 200 ft (60 m) from a minimum 20 ft (6 m) wide access way to permit approach of fire control apparatus under all weather conditions. [**30:**15.3.2]

66.15.3.3 The distances specified in Table 66.15.3 shall apply to properties that have protection for exposures as defined. If there are exposures and protection for exposures does not exist, the distance to the property line that is or can be built upon shall be doubled. [**30:**15.3.3]

66.15.3.4 Where total quantity stored does not exceed 50 percent of the maximum quantity per pile, as specified in Table 66.15.3, the distances to a property line that is or can be built upon and to streets, alleys, or public ways shall be permitted to be reduced by 50 percent but in no case to less than 3 ft (0.9 m). [**30:**15.3.4]

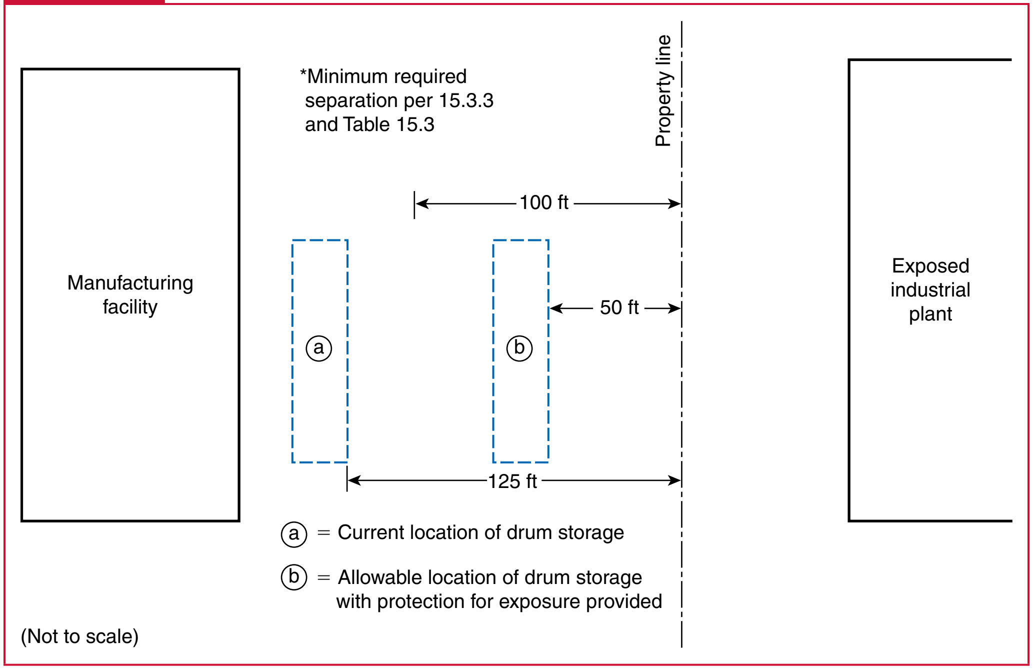
66.15.3.5 The storage area shall be graded in a manner to divert possible spills away from buildings or other exposures or shall be surrounded by a curb at least 6 in. (150 mm) high. [**30:**15.3.5]

66.15.3.5.1 Where curbs are used, provisions shall be made to drain accumulations of groundwater or rainwater or spills of liquids. Drains shall terminate at a safe location and shall flow freely under fire conditions. [**30:**15.3.5.1]

66.15.3.6 When accessible to the public, the storage area shall be protected against tampering and trespassing. [**30:**15.3.6]

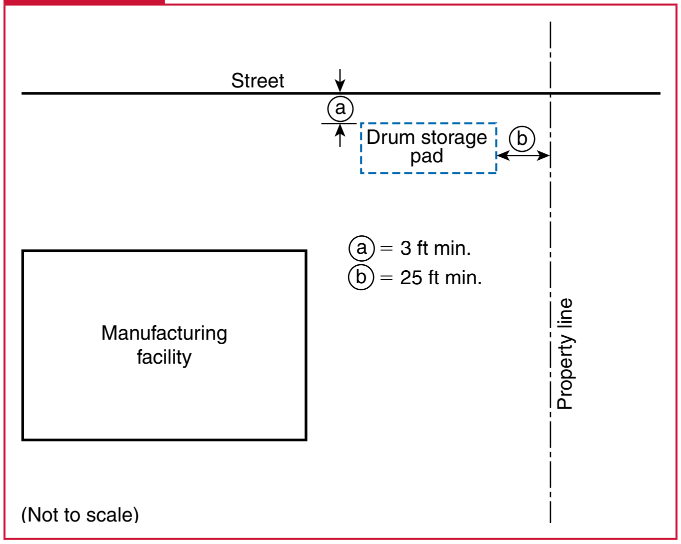
66.15.3.7 The storage area shall be kept free of weeds, debris, and other combustible materials not necessary to the storage for a distance of at least 10 ft (3 m) around the perimeter of the stored materials. [**30:**15.3.7]

Exhibit 66.22



Separation distances for Example 2.

Exhibit 66.23



Separation distances for Example 3.

66.15.3.8 The storage area shall be permitted to be protected from the weather by a canopy or roof that does not limit the dissipation of heat or dispersion of flammable vapors and does not restrict fire-fighting access and control. [**30:**15.3.8]

66.15.4 Outdoor Storage Adjacent to a Building.

66.15.4.1 A maximum of 1100 gal (4160 L) of liquids in containers, intermediate bulk containers, or portable tanks shall be permitted to be stored adjacent to a building under the same management, provided the following conditions apply:

(1) The adjacent building wall has an exterior fire resistance rating of 2 hours.
(2) The adjacent building wall has no openings at grade or above grade that are within 10 ft (3 m) horizontally of the storage.
(3) The adjacent building wall has no openings directly above the storage.
(4) The adjacent building wall has no openings below grade within 50 ft (15 m) horizontally of the storage.

[**30:**15.4.1]

66.15.4.2 The provisions of 66.15.4.1(1) through (4) shall be permitted to be waived, subject to the approval of the AHJ, if the building in question is one story, is of fire-resistive or noncombustible construction, and is devoted principally to the storage of liquids. [**30:**15.4.2]

66.15.4.3 The quantity of liquid stored adjacent to a building that meets the conditions of 66.15.4.1(1) through (4) shall be permitted to exceed that permitted in 66.15.4.1, provided the maximum quantity per pile does not exceed 1100 gal (4160 L) and each pile is separated by a 10 ft (3 m) minimum clear space along the common wall. [**30:**15.4.3]

66.15.4.4 The quantity of liquid stored shall be permitted to exceed the 1100 gal (4160 L) quantity specified by 66.15.4.1 where a minimum distance equal to that specified by Table 66.15.3 for distance to property line shall be maintained between buildings and the nearest container or portable tank. [**30:**15.4.4]

66.15.4.5 Where the provisions of 66.15.4.1 cannot be met, a minimum distance equal to that specified by Table 66.15.3 for distance to property line shall be maintained between buildings and the nearest container or portable tank. [**30:**15.4.5]

66.16 Automatic Fire Protection for Inside Liquid Storage Areas

Section 66.16 includes information on and requirements for fire protection and fire control for indoor storage of flammable and combustible liquids. These requirements are based on studies of fire incidents, research, and full-scale fire tests under various conditions.

To determine the proper fire protection system design criteria, the user must follow these steps:

1. Identify the class of liquid being stored and the type of container being used.
2. Identify the method of storage (palletized, stacked, nested, or rack).
3. Use Figures 66.16.4.1(a), 66.16.4.1(b), and 66.16.4.1(c) to identify the appropriate tables in 66.16.5.2 from which candidate fire protection designs can be selected.
4. From those candidates, choose the fire protection design that is most appropriate for the actual conditions.

Numerous factors are involved in selecting the appropriate fire protection system design criteria, including the following:

- Liquid type (liquid classification, water miscibility)
- Container size
- Container type (metal, plastic, glass)
- Packaging (cartoned, uncartoned)
- Storage arrangement (rack, palletized)
- Storage height
- Building height
- Aisle width
- Rack type (single row, double row, multiple row)

66.16.1 Scope.

66.16.1.1* This section shall apply to automatic fire protection systems for all inside storage of flammable and combustible liquids in containers, intermediate bulk containers, and portable tanks as specified in 66.9.4. [**30:**16.1.1]

A.66.16.1.1 See Annex E of NFPA 30 for limitations of the protection criteria of Table 16.5.2.1 through Table 16.5.2.12 of NFPA 30, particularly for intermediate bulk containers and portable tanks having capacities greater than 60 gal (230 L). [**30:**A.16.1.1]

Protected storage allowed under previous editions of NFPA 30 can be continued if the class of liquids stored, the quantity of liquids stored, fire protection, and building configuration remain unchanged. Table A.66.16.1.1(a) and Table A.66.16.1.1(b), reprinted here from the 1993 edition of NFPA 30, can be used as a reference for storage arrangements in previously approved, protected, inside liquid storage areas. [**30:**A.16.1.1]

For certain liquids such as ketones, esters, and alcohols, the minimum required densities established in the listing criteria for foam discharge devices are often higher than the general densities specified for protection of flammable and combustible liquids. When determining the design criteria for extinguishing systems using foam, it is important to ensure that the listing criteria, which are typically based on empirical data from fire tests, are not overlooked. Otherwise, the fire protection system design can be inadequate for proper protection. [**30:**A.16.1.1]

Early suppression fast-response (ESFR) sprinklers have been tested for protection of liquids only to the extent reflected in the tables in Section 16.5 of NFPA 30. Any other use of ESFR sprinklers for protection of liquids should be based on an engineering analysis that evaluates the potential failure of the sprinkler system based on a rapid-growth fire or a large pool fire that would operate more sprinklers than are accommodated by the design area. The use of ESFR protection, particularly without provisions for the control of spread of liquid, presents the possibility of a liquid pool fire that could exceed the limited design operating area of an ESFR system. [**30:**A.16.1.1]

The information in Table 16.5.2.1 through Table 16.5.2.12 of NFPA 30 was developed from full-scale fire tests. Where only one K-factor sprinkler is allowed, this was the only size proven to provide fire control. Where a choice of K-factors is allowed by the tables, each was able to provide fire control; however, the larger K-factor sprinklers sometimes demonstrated better fire control and further limited fire damage. Where only one response–type of sprinkler is allowed, this is the only type of sprinkler proven to provide fire control. Where a choice of response characteristics (SR or QR) is allowed by the tables, each was able to provide fire control; however, the QR sprinklers sometimes demonstrated better fire control and further limited fire damage. [**30:**A.16.1.1]

In the testing involving metal containers, only steel containers were tested. Other metal containers, such as aluminum, have not been tested. [**30:**A.16.1.1]

66.16.1.2* This section shall not apply to Class IA flammable liquids or to unstable flammable or combustible liquids. [**30:**16.1.2]

A.66.16.1.2 To date, there has been no full-scale testing to determine appropriate fire protection design criteria for Class IA liquids or unstable liquids. [**30:**A.16.1.2]

66.16.1.3 Storage of liquids that is protected in accordance with the applicable requirements of this section shall be considered protected, as defined in 66.16.2.3. All other storage shall be considered unprotected unless an alternate means of protection has been approved by the AHJ. [**30:**16.1.3]

The *Code* specifically allows the AHJ to accept an alternative protection scheme, for example, one based on full-scale fire tests. Annex E of NFPA 30 includes information on fire test protocols for situations that are not specifically addressed in Section 66.16.

Δ ***TABLE A.66.16.1.1(a)*** *Storage Arrangements for Protected Palletized or Solid Pile Storage of Liquids in Containers and Portable Tanks*

		Maximum Storage Height (ft)		Maximum Quantity per Pile (gal)		Maximum Quantity* (gal)	
Liquid Class	**Storage Level**	**Containers**	**Portable Tanks**	**Containers**	**Portable Tanks**	**Containers**	**Portable Tanks**
IA	Ground floor	5	—	3,000	—	12,000	—
	Upper floors	5	—	2,000	—	8,000	—
	Basement	NP	NP	—	—	—	—
IB	Ground floor	6½	7	5,000	20,000	15,000	40,000
	Upper floors	6½	7	3,000	10,000	12,000	20,000
	Basement	NP	NP	—	—	—	—
IC	Ground floor	6½†	7	5,000	20,000	15,000	40,000
	Upper floors	6½†	7	3,000	10,000	12,000	20,000
	Basement	NP	NP	—	—	—	—
II	Ground floor	10	14	10,000	40,000	25,000	80,000
	Upper floors	10	14	10,000	40,000	25,000	80,000
	Basement	5	7	7,500	20,000	7,500	20,000
III	Ground floor	20	14	15,000	60,000	55,000	100,000
	Upper floors	20	14	15,000	60,000	55,000	100,000
	Basement	10	7	10,000	20,000	25,000	40,000

For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L.

NP: Not permitted.

*Applies only to cut-off rooms and attached buildings.

†These height limitations can be increased to 10 ft for containers of 5 gal capacity or less. [**30:** Table A.16.1.1(a)]

Δ ***TABLE A.66.16.1.1(b)*** *Storage Arrangements for Protected Rack Storage of Liquids in Containers and Portable Tanks*

Liquid Class	**Type Rack**	**Storage Level**	**Maximum Storage Height of Containers (ft)**	**Maximum Quantity of Containers (gal)*†**
IA	Double row	Ground floor	25	7,500
	or	Upper floors	15	4,500
	single row	Basement	NP	—
IB	Double row	Ground floor	25	15,000
IC	or	Upper floors	15	9,000
	single row	Basement	NP	—
II	Double row	Ground floor	25	24,000
	or	Upper floors	25	24,000
	single row	Basement	15	9,000
III	Multirow,	Ground floor	40	55,000
	double row,	Upper floors	20	55,000
	or single row	Basement	20	25,000

For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L.

NP: Not permitted.

*Maximum quantity allowed on racks in cut-off rooms and attached buildings.

†Maximum quantity allowed per rack section in liquid warehouses. [**30:** Table A.16.1.1(b)]

66.16.2 Definitions Specific to Section 66.16. For the purpose of this section, the following terms shall have the definitions given. [**30:**16.2]

Δ **66.16.2.1* Protected.** For the purposes of 66.16, this term shall apply to the storage of containers that meet the appropriate provisions of 66.16 or alternate provisions that have been approved by the authority having jurisdiction *(see 66.16.3.5 and Section 66.16.9)*. [**30:**16.2.2]

N **A.66.16.2.1** The term *protected* indicates that the fire risk is managed so as to control the fire and prevent it from spreading beyond the design area of the automatic fire protection system. [**30:**A.16.2.2]

N **66.16.2.2* Unprotected.** For the purposes of this chapter, this term shall apply to the storage of containers that do not meet the criteria to be considered protected, as defined in 66.16.2.1. [**30:**16.2.3]

N **A.66.16.2.2** The term *unprotected* indicates that the growth of a fire might exceed the capabilities of the automatic fire protection system and extend beyond the design area of the system. In such cases, the total contents of the fire area might become involved in a fire, regardless of the protection features provided. [**30:**A.16.2.3]

Experience with actual fires and with full-scale fire tests shows that even a well-designed fire protection system cannot successfully control a fire involving flammable or combustible

TABLE A.66.16.2.3 *Common Relieving- and Nonrelieving-Style Metal Containers*

Container Type	Relieving Style	Nonrelieving Style
≤1 qt[a]	All	N/A
>1 qt and ≤6 gal[a]	Metal containers with plastic cap, or flexible or rigid plastic spout with plastic cap	Metal containers with steel spout and steel screw cap
≤1 gal, friction lid	Metal containers with metal friction-fit covers (e.g., paint can lid)	N/A
1 gal and ≤6 gal (lug cover)	Metal containers with metal covers held in place with a mechanical friction-fit (e.g., lug-type) closure mechanism	N/A
>6 gal and ≤60 gal[b,c] (drums)	Metal containers, tight or open-head (drums) having at least one 2 in. plastic plug (Note: Cap seals, if used, need to be plastic and nonmetallic)	Open head metal containers with steel covers having no steel flange openings; or open head and tight head metal containers with steel flange openings where only steel plugs and/or cap seals are used
>60 gal and ≤793 gal	Metal portable tanks or metal intermediate bulk containers with at least one relief device conforming to the design, construction, and capacity of the container's section	N/A

For SI units, 1 gal = 3.8 L.

N/A: Not applicable.

[a]All containers ≤1 qt are considered relieving style because their failure is inconsequential.

[b]In full-scale fire tests, where containers were provided with both ¾ in. (19 mm) and 2 in. (50 mm) relieving vent openings and, in some cases, both vents were obstructed by pallet slats, rupture of containers did not occur. Because it is not possible to determine if all conceivable obstruction scenarios were represented, where drums are stacked more than one high, provide an additional ¾ in. (19 mm) or 2 in. (50 mm) pressure-relieving mechanism.

[c]The use of plastic plugs instead of steel plugs (bungs) in a steel drum in order to achieve a relieving-style container should contemplate the following issues in order to assure the safe storage of liquids:

(1) The compatibility of the plastic plug materials and gaskets with the liquids being stored.

(2) The stability and shelf life of the liquids being stored as the plastic plugs can admit water vapor, oxygen, and light.

(3) The difference in expansion coefficients for plastic plugs and steel drums for those drums subject to temperature variations and hot or cold conditions.

(4) The tooling issues involved with the use of plastic plugs as the torque levels are different from those levels used for steel plugs.

(5) The training of fill line operators in order to avoid cross-threading and/or the stripping of threads.

(6) The voiding of the United Nations (UN) rating on the steel drum by installing plastic plugs. If the user needs to install a plug other than the one originally provided by the container manufacturer, then the user should contact the manufacturer to ensure that the UN rating will still be valid.

[**30:** Table A.16.2.4]

liquids if rupture of containers or collapse of the storage array results in a pool of burning liquid. The burning liquid spreads faster than the fire protection system can respond. By using relieving-style containers, the chance for such a spill is minimized and the ability of the protection system to gain control of the fire is enhanced.

Examples of relieving-style metal containers include friction lid containers (such as paint cans), lug head containers, F-style (rectangular) containers that have plastic spouts, tight-head metal containers that have plastic pull-up pour spouts, and steel drums fitted with approved pressure-relieving bung closures.

66.16.2.3* Relieving-Style Container. A metal container, a metal intermediate bulk container, or a metal portable tank that is equipped with at least one pressure-relieving mechanism at its top that is designed, sized, and arranged to relieve the internal pressure generated due to exposure to fire so that violent rupture is prevented. [**30:**16.2.4]

A.66.16.2.3 Table A.66.16.2.3 provides examples of commonly used metal containers that are considered either relieving style or nonrelieving style for use in developing protected storage arrangements in accordance with Table 16.5.2.1 through Table 16.5.2.12 of NFPA 30. [**30:**A.16.2.4]

66.16.2.4* Unsaturated Polyester Resin (UPR). A resin that contains up to 50 percent by weight of Class IC, Class II, or Class III liquid, but no Class IA or Class IB liquid. [**30:**16.2.5]

A.66.16.2.4 Unsaturated polyester resins (UPRs) are high molecular weight unsaturated polymers dissolved in a reactive monomer, usually styrene, in concentrations of 50 percent or less by weight. UPRs are combined with reinforcements such as fiberglass and/or fillers to produce a wide range of products. Examples of such products include automobile parts, bathroom tubs and shower stalls, cultured marble, and many products for architectural, recreational, construction, and corrosion-resistant applications. UPRs are normally packaged in 55 gal (208 L) drums. The U.S. Department of Transportation classification for UPRs is “UN 1866, Resin Solution”; however, it should be noted that this classification includes many materials that are not unsaturated polyester resins. [**30:**A.16.2.5]

66.16.2.5 Viscous Liquid. A liquid that gels, thickens, or solidifies when heated or whose viscosity at room temperature versus weight percent content of Class I, Class II, or Class III liquid is in the shaded portion of Figure 66.16.2.5. [**30:**16.2.6]

Viscous liquids include such products as thick resins, adhesives, and coatings. Some of these liquids are mixtures that contain a small percentage of volatile flammable or combustible liquids, with the balance being noncombustible. Others are mixtures containing minor amounts of volatile flammable liquids, with the balance being high flash point combustible liquids. Although these liquids might exhibit a low flash point, their rate of evaporation (volatility) is also low and they do not produce

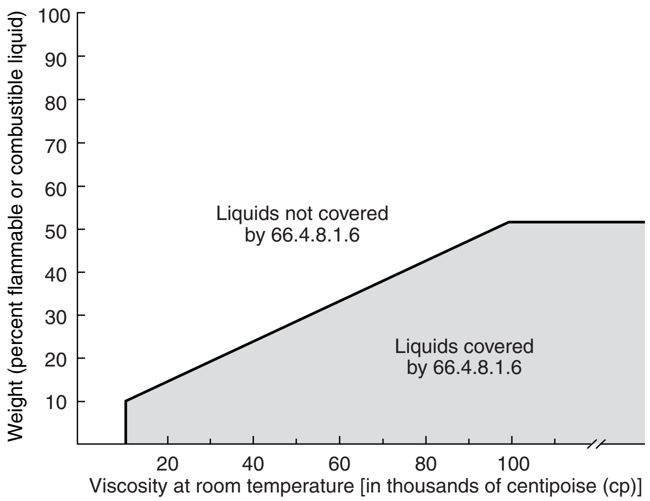


***FIGURE 66.16.2.5** Viscous Liquid: Viscosity Versus Weight Percent Flammable or Combustible Component. [**30:** Figure 16.2.6]*

large quantities of ignitible vapors. Also, spills tend to be localized and easily controlled.

66.16.2.6 Water-Miscible Liquid. A liquid that mixes in all proportions with water without the use of chemical additives, such as emulsifying agents. [**30:**16.2.7]

66.16.3 General Requirements.

66.16.3.1 Where different classes of liquids, container types, and storage configurations are stored in the same protected area, protection shall meet either of the following:

(1) Requirements of this section for the most severe storage fire hazard present
(2) Where areas are not physically separated by a barrier or partition capable of delaying heat from a fire in one hazard area from fusing sprinklers in an adjacent hazard area, the required protection for the more demanding hazard shall:
   (a) Extend 20 ft (6 m) beyond its perimeter, but not less than the required minimum sprinkler design area
   (b) Be provided with means to prevent the flow of burning liquid under emergency conditions into adjacent hazard areas
   (c) Provide containment and drainage as required by 66.16.8

[**30:**16.3.1]

66.16.3.2 Unless otherwise specified in this section, single-row racks shall not be more than 4.5 ft (1.4 m) in depth and double-row racks shall not be more than 9 ft (2.8 m) in depth. [**30:**16.3.2]

66.16.3.3 When applying the fire protection criteria of this section, a minimum aisle space of 6 ft (1.8 m) shall be provided between adjacent piles or adjacent rack sections, unless otherwise specified in the tables in 66.16.5. [**30:**16.3.3]

Δ **66.16.3.4** Viscous liquids, as defined in 66.16.2.5, shall be permitted to be protected using either of the following, as applicable:

(1) For metal containers, the criteria for a Class IIIB liquid in accordance with Figure 66.16.4.1(a)
(2) For nonmetallic containers, the criteria for Class IIIB liquids, as determined by Figure 66.16.4.1(b)
(3) For nonmetallic containers, the criteria for cartoned unexpanded Group A plastics in accordance with NFPA 13 as indicated in Figure 66.16.4.1(b).

[**30:**16.3.4]

66.16.3.5 Protection systems that are designed and developed based on full-scale fire tests performed at an approved test facility or on other engineered protection schemes shall be considered an acceptable alternative to the protection criteria set forth in this section. Such alternative protection systems shall be approved by the AHJ. [**30:**16.3.5]

66.16.3.6 For relieving-style containers of greater than 6.6 gal (25 L) and up to 119 gal (450 L) capacity, the following shall apply:

(1) The pressure-relieving mechanism shall be listed and labeled in accordance with FM Global *Approval Standard for Plastic Plugs for Steel Drums,* Class Number 6083, or equivalent.
(2) The pressure-relieving mechanism shall not be painted, and cap seals, if used, shall be made of thermoplastic material.
(3) For metal containers greater than 6.6 gal (25 L) capacity, the pressure-relieving mechanism shall be unobstructed or an additional pressure-relieving mechanism shall be provided.

[**30:**16.3.6]

66.16.3.7 To be considered protected by Table 66.16.5.2.9 and Table 66.16.5.2.10, rigid nonmetallic intermediate bulk containers shall be listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*; FM Class 6020, *Approval Standard for Intermediate Bulk Containers*; or an equivalent test procedure. [**30:**16.3.7]

66.16.4 Automatic Sprinkler and Foam-Water Sprinkler Fire Protection Systems.

66.16.4.1 Where automatic sprinkler systems or low-expansion foam-water sprinkler systems are used to protect storage of liquids, Figure 66.16.4.1(a), Figure 66.16.4.1(b), or Figure 66.16.4.1(c), whichever is applicable, and the appropriate table in 66.16.5 shall be used to determine protection criteria. [**30:**16.4.1]

66.16.4.1.1 Figure 66.16.4.1(a) shall be used for miscible and nonmiscible flammable and combustible liquids in metal containers, metal portable tanks, and metal intermediate bulk containers. [**30:**16.4.1.1]

66.16.4.1.2 Figure 66.16.4.1(b) shall be used for miscible and nonmiscible flammable and combustible liquids in nonmetallic containers and in nonmetallic intermediate bulk containers. [**30:**16.4.1.2]

66.16.4.1.3 Figure 66.16.4.1(c) shall be used for water-miscible flammable and combustible liquids in nonmetallic containers and in nonmetallic intermediate bulk containers. [**30:**16.4.1.3]

66.16.4.2 Automatic sprinkler and foam-water fire protection systems shall be wet pipe, deluge, or preaction systems. [**30:**16.4.2]

66.16.4.2.1 If a preaction system is used, it shall be designed so that water or foam solution will immediately discharge from the sprinkler upon sprinkler actuation. [**30:**16.4.2.1]

Δ **66.16.4.2.2** A foam-water sprinkler system that meets any of the design criteria specified in the water sprinkler tables in this section shall be acceptable, provided that the system is installed in accordance with NFPA 16. [**30:**16.4.2.2]

66.16.4.3 Water-based fire protection systems shall be inspected, tested, and maintained in accordance with NFPA 25. [**30:**16.4.3]

66.16.5 Fire Protection System Design Criteria.

66.16.5.1 General. Subsections 66.16.5.2.1 through 66.16.5.2.12 and their related tables, Table 66.16.5.2.1 through Table 66.16.5.2.12, shall be used to determine the protection criteria and storage arrangement for the applicable liquid class, container type, and storage configuration, as described in 66.16.5.2.1 through 66.16.5.2.12 and subject to the provisions of 66.16.5.1. [**30:**16.5.1]

66.16.5.1.1 Table 66.16.5.2.1 through Table 66.16.5.2.12 shall apply only to stable liquids. [**30:**16.5.1.1]

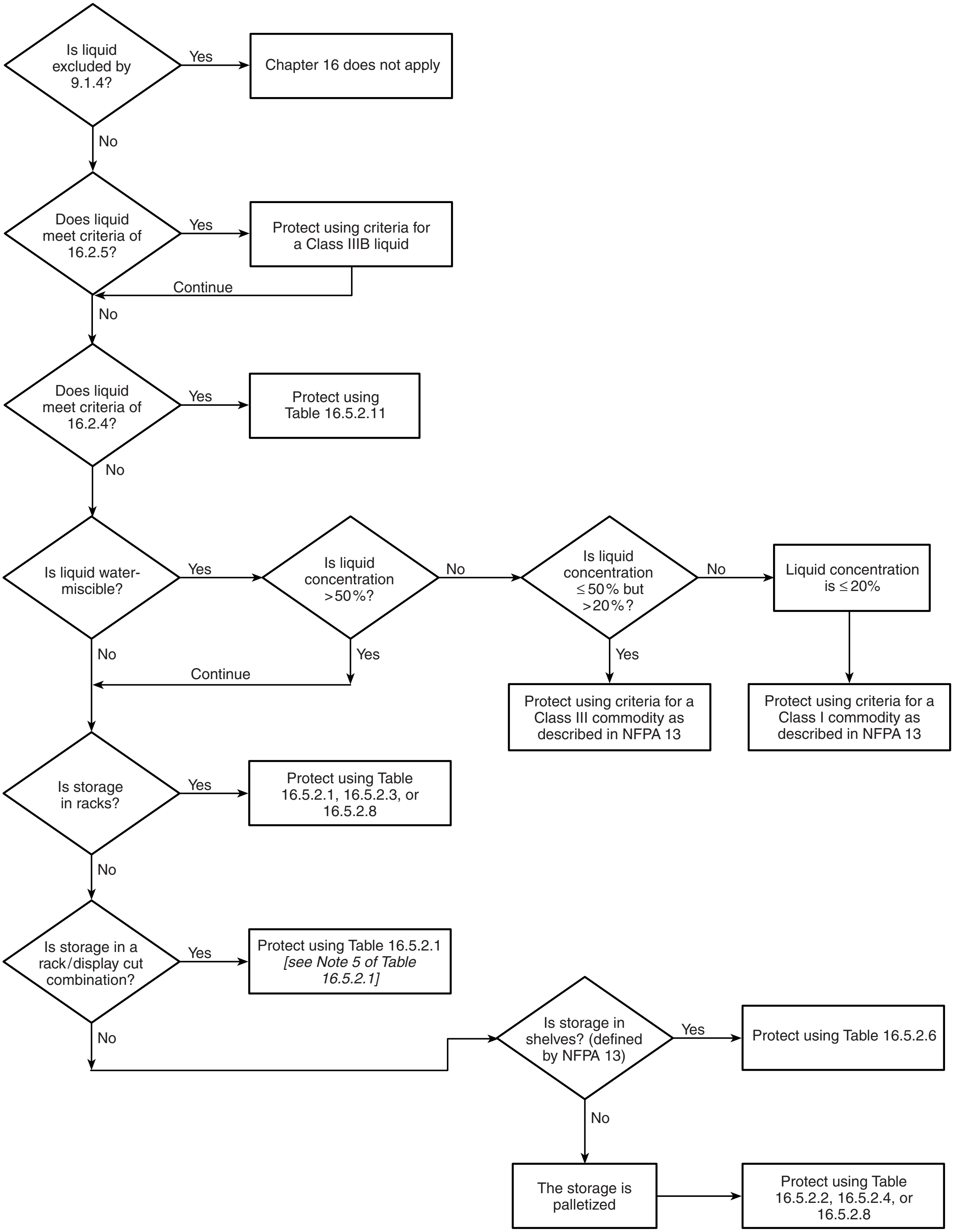
66.16.5.1.1.1 The protection criteria in Table 66.16.5.2.1 through Table 66.16.5.2.12 shall only be used with ceilings having a pitch of 2 in 12 or less. [**30:**16.5.1.1.1]

66.16.5.1.2 When foam or foam-water fire protection systems are provided, discharge densities shall be determined based on the listing criteria of the foam discharge devices selected, the foam concentrate, the specific liquids to be protected, and the criteria in the appropriate table in this section. Where the discharge densities given in the tables differ from those in the listing criteria for the discharge devices, the greater of the two shall be used. [**30:**16.5.1.2]

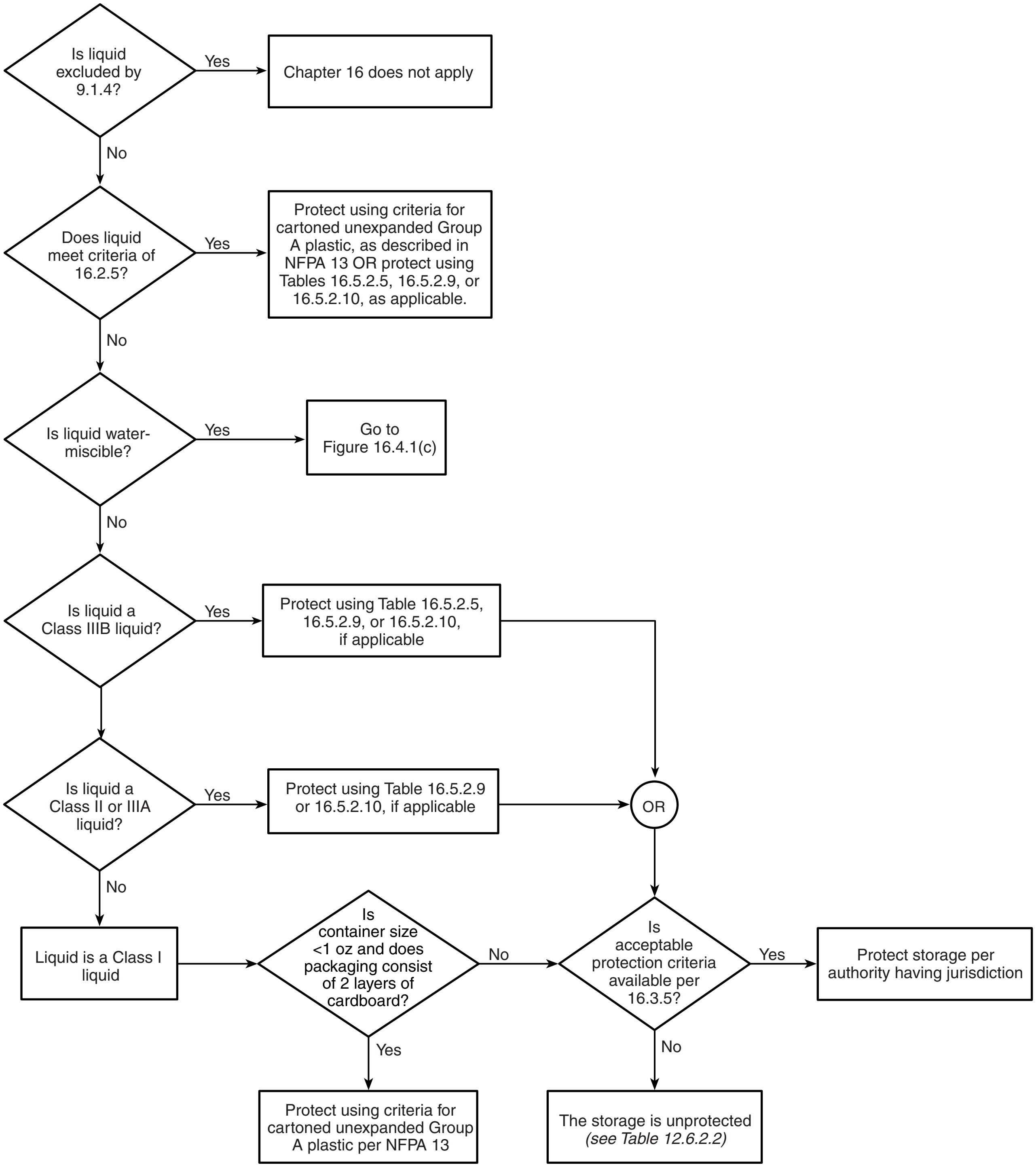
66.16.5.1.3 In-rack sprinklers shall be installed in accordance with the provisions of Section 13.3 and NFPA 13. In addition, the following modifications shall apply:

(1) In-rack sprinklers shall be laid out in accordance with 66.16.5.1.10 and 66.16.6, as applicable.
(2) Sprinklers in multiple-level in-rack sprinkler systems shall be provided with water shields unless they are separated by horizontal barriers or are specifically listed for installation without water shields.
(3) A vertical clear space of at least 6 in. (150 mm) shall be maintained between the sprinkler deflector and the top of the tier of storage.
(4) Sprinkler discharge shall not be obstructed by horizontal rack structural members.
(5) Where in-rack sprinklers are installed below horizontal barriers, the deflector shall be located a maximum of 7 in. (180 mm) below the barrier.
(6) Longitudinal and transverse flue spaces of at least 6 in. (150 mm) shall be maintained between each rack load.

[**30:**16.5.1.3]



Δ ***FIGURE 66.16.4.1(a)*** *Fire Protection Criteria Decision Tree for Miscible and Nonmiscible Flammable and Combustible Liquids in Metal Containers. [**30:** Figure 16.4.1(a)]*



Note: All cross-references refer to NFPA 30.

Δ ***FIGURE 66.16.4.1(b)*** *Fire Protection Criteria Decision Tree for Miscible and Nonmiscible Flammable and Combustible Liquids in Nonmetallic Containers. [**30:** Figure 16.4.1(b)]*

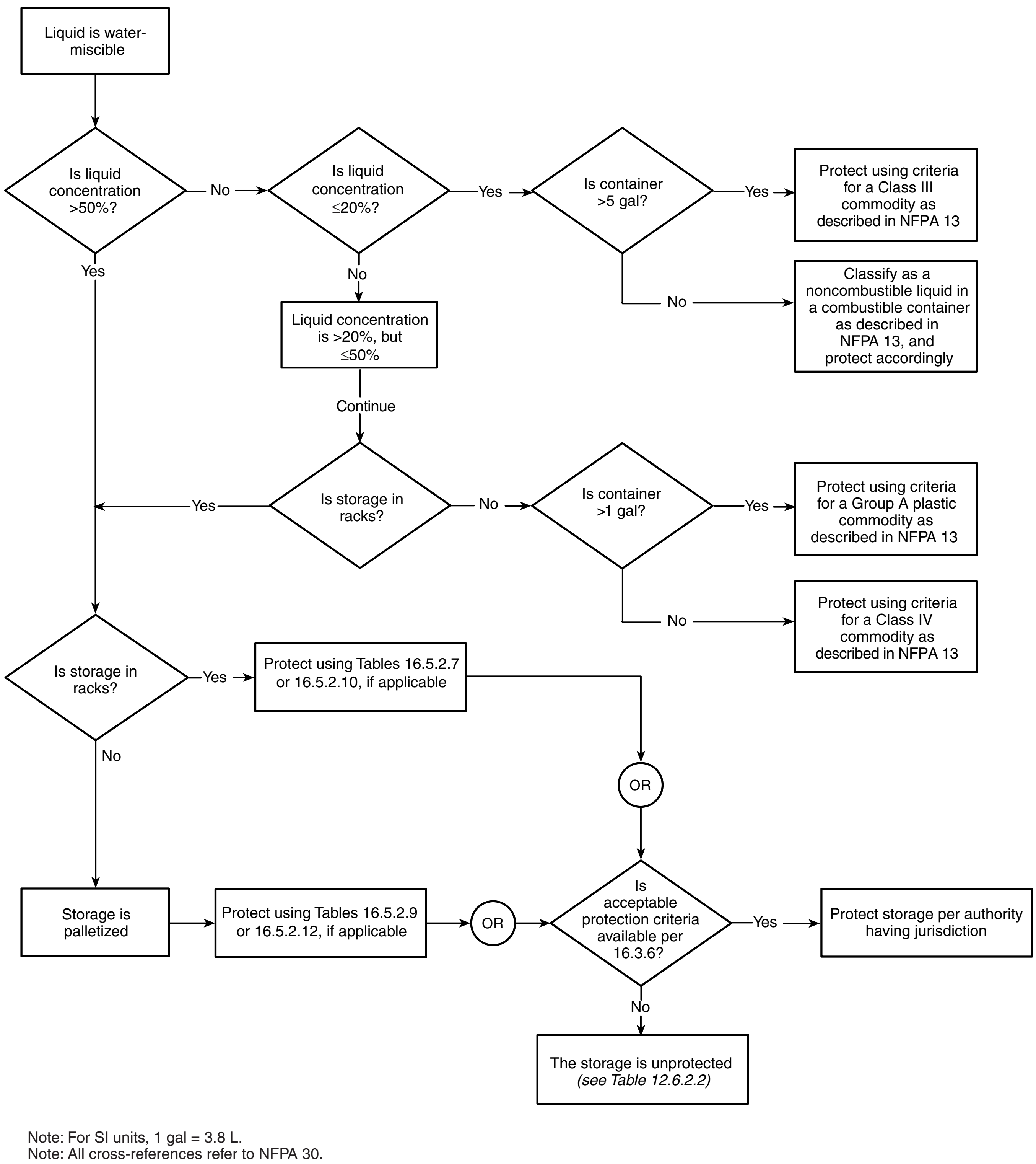


FIGURE 66.16.4.1(c) *Fire Protection Criteria Decision Tree for Miscible Flammable and Combustible Liquids in Nonmetallic Containers. [**30:** Figure 16.4.1(c)]*

66.16.5.1.4 Ceiling sprinklers shall be installed in accordance with Section 13.3 and NFPA 13 and shall be permitted to have the following maximum head spacing:

(1) Classes I, II, and IIIA liquids: 100 ft^2 (9.3 m^2) per sprinkler
(2) Class IIIB liquids: 120 ft^2 (11.1 m^2) per sprinkler

[**30:**16.5.1.4]

66.16.5.1.4.1 Ordinary or intermediate temperature–rated K-25 extended-coverage sprinklers shall be permitted to be used as standard response high temperature sprinklers at greater than 144 ft^2 (13 m^2) coverage, with 12 ft (3.7 m) minimum spacing and a maximum coverage area of 196 ft^2 (18 m^2) coverage. [**30:**16.5.1.4.1]

66.16.5.1.5 The ceiling heights given in Table 66.16.5.2.1 through Table 66.16.5.2.12, excluding Table 66.16.5.2.8, shall be permitted to be increased by a maximum of 10 percent if an equivalent percent increase in ceiling sprinkler design density is provided. [**30:**16.5.1.5]

Δ **66.16.5.1.6** Foam-water sprinkler systems shall be installed in accordance with NFPA 16. [**30:**16.5.1.6]

66.16.5.1.6.1 Foam-water sprinkler systems shall have at least 15 minutes of foam concentrate, based on the required design flow rate. [**30:**16.5.1.6.1]

66.16.5.1.6.2* Foam-water sprinkler systems shall provide foam solution at the minimum required concentration with as few as four sprinklers flowing. [**30:**16.5.1.6.2]

A.66.16.5.1.6.2 Most fire tests using foam-water protection schemes have been conducted with immediate foam solution discharge from the operating sprinklers. If an appreciable delay is encountered before properly proportioned foam is discharged, control of the fire might not be established. One method of accomplishing immediate foam solution discharge is by using an in-line balanced pressure (ILBP) proportioning system. [**30:**A.16.5.1.6.2]

66.16.5.1.7 When relieving style containers are used, both ¾ in. (20 mm) and 2 in. (50 mm) listed and labeled pressure-relieving mechanisms are required on containers greater than 6 gal (23 L) capacity. [**30:**16.5.1.7]

66.16.5.1.8 For the purposes of 66.16.5, a rigid nonmetallic intermediate bulk container is one that meets the maximum allowable capacity criteria of Table 66.9.4.3 and has been listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*, or equivalent. [**30:**16.5.1.8]

66.16.5.1.9 For the purposes of 66.16.5, the following shall apply:

(1) 1 gal = 3.8 L; 1 ft = 0.3 m; 1 ft^2 = 0.09 m^2
(2) 1 gpm/ft^2 is equivalent to 40.7 L/min/m^2 or 40.7 mm/min
(3) A gauge pressure of 1 psi is equivalent to a gauge pressure of 6.9 kPa
(4) SR = standard response sprinkler; QR = quick response sprinkler; ESFR = early suppression fast response sprinkler; OT = ordinary temperature; HT = high temperature
(5) Where an ordinary-temperature sprinkler is indicated, an intermediate-temperature sprinkler shall be used where ambient conditions require.

[**30:**16.5.1.9]

66.16.5.1.10 For the purposes of 66.16.5, the following shall apply to the in-rack sprinkler design layouts specified in Table 66.16.5.2.1 through Table 66.16.5.2.12:

(1) Layout 1, as referenced in Table 66.16.5.2.1, shall mean one line of in-rack sprinklers 8 ft (2.4 m) above the floor in the longitudinal flue space, with sprinklers spaced not more than 10 ft (3 m) on center.
(2) Layout 2, as referenced in Table 66.16.5.2.1, shall mean one line of in-rack sprinklers 6 ft (1.8 m) above the floor and one line of in-rack sprinklers 12 ft (3.6 m) above the floor in the longitudinal flue space, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically.
(3) Layout 3, as referenced in Table 66.16.5.2.1 and Table 66.16.5.2.1, shall mean one line of in-rack sprinklers in the longitudinal flue space at every storage level above the floor except above the top tier, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
(4) Layout 4, as referenced in Table 66.16.5.2.1 and Table 66.16.5.2.3, shall mean one line of in-rack sprinklers in the longitudinal flue space at every other storage level, except above the top tier, beginning above the first storage level, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically where more than one level of in-rack sprinklers is installed.
(5) Layout 5, as referenced in Table 66.16.5.2.1, shall mean one line of in-rack sprinklers in the longitudinal flue space at every storage level above the floor except above the top tier and face sprinklers at the first storage level at each rack upright. In-rack sprinklers shall be spaced not more than 9 ft (2.7 m) on center and shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
(6) Layout 6, as referenced in Table 66.16.5.2.1, shall mean one line of in-rack sprinklers in the longitudinal flue space at every other storage level above the first storage level except the top tier and face sprinklers at the first storage level at each rack upright. In-rack sprinklers shall be spaced not more than 10 ft (3 m) on center and shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
(7) Layout 7, as referenced in Table 66.16.5.2.8, shall be as shown in Figure 66.16.6.5(a).
(8) Layout 8, as referenced in Table 66.16.5.2.8, shall be as shown in Figure 66.16.6.5(b) or Figure 66.16.6.5(c).
(9) Layout 9, as referenced in Table 66.16.5.2.8, shall be as shown in Figure 66.16.6.5(d) or Figure 66.16.6.5(e).

[**30:**16.5.1.10]

66.16.5.1.11 The "Fire Test Ref." number given for each entry in Table 66.16.5.2.1 through Table 66.16.5.2.12 shall be used to identify in Section D.2 of NFPA 30 the information on the fire tests on which the protection criteria for that entry are based. [**30:**16.5.1.11]

66.16.5.1.12 The water supply shall be sufficient to meet the fixed fire protection demand plus a total of at least 500 gpm (1900 L/min) for inside and outside hose connections for at least 2 hours, unless otherwise specified in this chapter. [**30:**16.5.1.12]

66.16.5.2 Specific Design Criteria.

66.16.5.2.1 Table 66.16.5.2.1 shall apply to the following:

(1) Automatic sprinkler protection
(2) Single- or double-row rack storage
(3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Metal containers, metal portable tanks, metal intermediate bulk containers
(5) Relieving- or nonrelieving-style containers

[**30:**16.5.2.1]

In the 2015 edition of the *Code*, Table 66.16.5.2.1 was amended to allow the use of in-rack sprinklers having K-factors greater than 5.6 or 8.0, because larger K-factors have been shown to provide improved performance. The column under "In-Rack Sprinkler Protection" that was previously labeled "Design Flow" was amended to "Discharge Flow" to emphasize that a minimum flow rate is necessary, in addition to the minimum discharge pressure, to ensure proper operation. Note (1) of Table 66.16.5.2.1 was expanded to provide the designer with criteria for two levels of in-rack sprinklers. In prior editions of the *Code*, guidance was provided only for one level of in-rack sprinklers and for three or more levels of in-rack sprinklers. Note (7) was added to specify a minimum discharge pressure for in-rack sprinklers to allow for larger-orifice sprinklers and to ensure a proper discharge pattern.

66.16.5.2.2 Table 66.16.5.2.2 shall apply to the following:

(1) Automatic sprinkler protection
(2) Palletized or stacked storage
(3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Metal containers, metal portable tanks, metal intermediate bulk containers
(5) Relieving- or nonrelieving-style containers

[**30:**16.5.2.2]

66.16.5.2.3 Table 66.16.5.2.3 shall apply to the following:

(1) Foam water sprinkler protection
(2) Single- or double-row rack storage
(3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Metal containers, metal portable tanks, metal intermediate bulk containers
(5) Relieving- or nonrelieving-style containers

[**30:**16.5.2.3]

In the 2015 edition of the *Code*, Table 66.16.5.2.3 was amended to allow the use of in-rack sprinklers having K-factors greater than 5.6 or 8.0, because larger K-factors have been shown to provide improved performance. The column under "In-Rack Sprinkler Protection" that was previously labeled "Design Flow" was amended to "Discharge Flow" to emphasize that a minimum flow rate is necessary, in addition to the minimum discharge pressure, to ensure proper operation. Note (5) was added to specify a minimum discharge pressure for in-rack sprinklers to allow for larger-orifice sprinklers and to ensure a proper discharge pattern.

66.16.5.2.4 Table 66.16.5.2.4 shall apply to the following:

(1) Foam water sprinkler protection
(2) Palletized or stacked storage
(3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Metal containers, metal portable tanks, metal intermediate bulk containers
(5) Relieving- or nonrelieving-style containers

[**30:**16.5.2.4]

66.16.5.2.5 Table 66.16.5.2.5 shall apply to the following:

(1) Automatic sprinkler protection
(2) Single-, double-, or multiple-row rack storage
(3) Class IIIB nonmiscible liquids and Class IIIB miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Nonmetallic containers or intermediate bulk containers
(5) Cartoned or uncartoned

[**30:**16.5.2.5]

66.16.5.2.6 Table 66.16.5.2.6 shall apply to the following:

(1) Automatic sprinkler protection
(2) Shelf storage
(3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Nonrelieving-style metal containers

[**30:**16.5.2.6]

The sprinkler K-factor in Table 66.16.5.2.6 was corrected in the 2015 edition of the *Code* to reflect what was used in the actual tests on which the table is based. Note (3) was added to reflect the actual aisle space used in those tests.

66.16.5.2.7 Table 66.16.5.2.7 shall apply to the following:

(1) Automatic sprinkler protection
(2) Single- or double-row rack storage
(3) Water-miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Glass or plastic containers
(5) Cartoned or uncartoned
(6) Minimum 8 ft (2.4 m) aisle width

[**30:**16.5.2.7]

66.16.5.2.8 Table 66.16.5.2.8 shall apply to the following:

(1) Automatic sprinkler protection
(2) Single- or double-row rack storage or palletized storage

Δ ***TABLE 66.16.5.2.1*** *Design Criteria for Sprinkler Protection of Single- and Double-Row Rack Storage of Liquids in Metal Containers, Portable Tanks, and IBCs*

Container Style and Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection: Sprinkler Type	Ceiling Sprinkler Protection: Sprinkler Response	Ceiling Sprinkler Protection: Design Density (gpm/ft²)	Ceiling Sprinkler Protection: Design Area (ft²)	In-Rack Sprinkler Protection: Sprinkler Type	In-Rack Sprinkler Protection: Sprinkler Response	In-Rack Sprinkler Protection: Discharge Flow (gpm)	In-Rack Sprinkler Protection: Layout (*See 66.16.5.1.10*)	Notes	Fire Test Ref. *[See NFPA 30: Table D.2(a)]*
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA												
≤1	16	30	K ≥ 11.2	QR (HT)	0.6	2000	K ≥ 5.6	QR (OT)	30	1	1, 2, 7	1
	20	30	K ≥ 11.2	SR or QR (HT)	0.6	2000	K ≥ 5.6	QR (OT)	30	2	1, 2, 7	2
≤5	25	30	K ≥ 8.0	SR or QR (HT)	0.3	3000	K ≥ 5.6	QR (OT)	30	3	1, 7	3
>5 and ≤60	25	30	K ≥ 11.2	SR (HT)	0.4	3000	K ≥ 5.6	QR or SR (OT)	30	5	1, 7	5
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB												
≤5	40	50	K ≥ 8.0	SR or QR (HT)	0.3	2000	K ≥ 5.6	QR(OT)	30	4	1, 3, 7	4
>5 and ≤60	40	50	K ≥ 8.0	SR (HT)	0.3	3000	K ≥ 5.6	QR(OT)	30	4	1, 3, 7	6
RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA												
≤5	14	18	K ≥ 11.2 pendent only	QR (HT)	0.65	2000	No in-rack sprinklers required				4	7
	25	30	K ≥ 8.0	SR or QR (HT)	0.3	3000	K ≥ 5.6	QR (OT)	30	4, 7	1, 5	8
>5 and ≤60	25	30	K ≥ 11.2	SR (HT)	0.6	3000	K ≥ 5.6	QR (OT)	30	6, 7	1	10
Portable tanks and IBCs	25	30	K ≥ 11.2	SR (HT)	0.6	3000	K ≥ 5.6	QR or SR (OT)	30	5, 7	1	12
RELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB												
≤ 5 gal	40	50	K ≥ 8.0	SR or QR (HT)	0.3	2000	K ≥ 5.6	QR (OT)	30	4, 7	1	9
>5 and ≤60	40	50	K ≥ 8.0	SR (HT)	0.3	3000	K ≥ 5.6	QR (OT)	30	4, 7	1, 3	11
Portable tanks and IBCs	40	50	K ≥ 8.0	SR (HT)	0.3	3000	K ≥ 5.6	QR (OT)	30	4, 7	1, 6	13

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft² = 0.09 m², 1 gpm/ft² = 40.7 L/min/m² = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

(1) In-rack sprinkler design shall be based on the following:

(a) Where one level of in-rack sprinklers is installed, the design shall include the 8 most hydraulically remote sprinklers

(b) Where two levels of in-rack sprinklers are installed, the design shall include the 6 most hydraulically remote sprinklers on each level.

(c) Where three or more levels of in-rack sprinklers are installed, the design shall include the 6 most hydraulically remote sprinklers on the top three levels.

(2) Protection for uncartoned or case-cut nonsolid shelf display up to 6.5 ft. (2 m) and storage above on pallets in racking and stored on shelf materials, including open wire mesh, or 2 in. × 6 in. (50 mm × 150 mm) wooden slats, spaced a minimum of 2 in. (50 mm) apart.

(3) Increase ceiling density to 0.60 if more than one level of storage exists above the top level of in-rack sprinklers.

(4) Double-row racks limited to maximum 6 ft (1.8 m) depth.

(5) For K=8.0 and larger ceiling sprinklers, increase ceiling density to 0.60 over 2000 ft² if more than one level of storage exists above the top level of in-rack sprinklers.

(6) Reduce in-rack sprinkler spacing to maximum 9 ft (2.7 m) centers.

(7) The minimum in-rack discharge pressure shall not be less than 10 psi.

[**30:**Table 16.5.2.1]

Δ *TABLE 66.16.5.2.2 Design Criteria for Sprinkler Protection of Palletized and Stacked Storage of Liquids in Metal Containers, Portable Tanks, and IBCs*

Container Style and Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection: Sprinkler Type	Sprinkler Response	Design Density (gpm/ft^2)	Design Area (ft^2)	Notes	Fire Test Ref. *[See Table D.2(b) of NFPA 30]*
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA								
≤5	4	18	K≥8.0	SR or QR (HT)	0.21	1500	1	1
	5	18	K≥8.0	SR or QR (HT)	0.30	3000	—	2
	6.5	30	K≥11.2	QR (HT)	0.45	3000	—	3
>5 and ≤60	5	18	K≥11.2	SR (HT)	0.40	3000	—	4
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB								
≤5	18	30	K≥8.0	SR or QR (HT)	0.25	3000	—	5
>5 and ≤60	10	20	K≥8.0	SR (HT)	0.25	3000	—	6
	18	30	K≥8.0	SR (HT)	0.35	3000	—	7
RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA								
≤5	12	30	K≥11.2 pendent only	QR (HT)	0.60	3000	2	8
>5 and ≤60	5	30	K≥11.2	SR (HT)	0.40	3000	—	9
	6.5	30	K≥11.2	SR (HT)	0.60	3000	3	10
Portable tanks and IBCs	1-high	30	K≥8.0	SR (HT)	0.30	3000	—	14
	2-high	30	K≥11.2	SR (HT)	0.60	3000	—	15
RELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB								
≤5	18	30	K≥8.0	SR or QR (HT)	0.25	3000	—	11
>5 and ≤60	10	20	K≥8.0	SR (HT)	0.25	3000	—	12
	18	30	K≥8.0	SR (HT)	0.35	3000	—	13
Portable tanks and IBCs	1-high	30	K≥8.0	SR (HT)	0.25	3000	—	16
	2-high	30	K≥11.2	SR (HT)	0.50	3000	—	17

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft^2 = 0.09 m^2, 1 gpm/ft^2 = 40.7 L/min/m^2 = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

Notes:

(1) Minimum hose stream demand can be reduced to 250 gpm for 2 hours.

(2) Sprinklers must also be hydraulically calculated to provide a density of 0.80 gpm/ft^2 over 1000 ft^2.

(3) Drums must be placed on open slatted pallet, not nested, to allow pressure relief from drums on lower levels. [**30:** Table 16.5.2.2]

(3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Relieving-style metal containers

[**30:**16.5.2.8]

Table 66.16.5.2.8 was amended in the 2015 edition of the *Code* by changing the required minimum discharge pressure to a minimum discharge flow to ensure proper discharge distribution. Note (7) was added to specify a minimum discharge pressure for in-rack sprinklers to allow for larger-orifice sprinklers and to ensure a proper discharge pattern.

66.16.5.2.9 Table 66.16.5.2.9 shall apply to the following:

(1) Automatic sprinkler protection
(2) Palletized storage
(3) Class II and Class III nonmiscible and Class II and Class III miscible liquids
(4) Listed and labeled rigid nonmetallic intermediate bulk containers

[**30:**16.5.2.9]

In the 2015 edition of the *Code*, a reference to FM Class 6020, *Approval Standard for Intermediate Bulk Containers,* which is an equivalent evaluation procedure for IBCs, was added to Note (2) of Table 16.5.2.9.

△ ***TABLE 66.16.5.2.3** Design Criteria for Foam-Water Sprinkler Protection of Single- or Double-Row Rack Storage of Liquids in Metal Containers, Portable Tanks, and IBCs*

Container Style and Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection: Sprinkler		Ceiling Sprinkler Protection: Design		In-Rack Sprinkler Protection: Sprinkler		In-Rack Sprinkler Protection		Notes	Fire Test Ref. *[See NFPA 30: Table D.2(c)]*
			Type	Response	Density (gpm/ft^2)	Area (ft^2)	Type	Response	Discharge Flow (gpm)	Layout (See 66.16.5.1.10)		
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA												
≤5	25	30	K≥8.0	SR or QR (HT)	0.30	2000	K≥5.6	QR or SR (OT)	30	3	1, 2, 4, 5	1
>5 and ≤60	25	30	K≥8.0	SR (HT)	0.30	3000	K≥5.6	QR or SR (OT)	30	3	1, 3, 4, 5	2
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB												
≤60	40	50	K≥8.0	SR (HT)	0.30	2000	K≥5.6	QR or SR (OT)	30	4	1, 5	3
RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA												
≤5	25	30	K≥8.0	SR or QR (HT)	0.30	2000	K≥5.6	QR or SR (OT)	30	4	1, 2, 4, 5	4
>5 and ≤60, portable tanks and IBCs	25	30	K≥8.0	SR (HT)	0.30	3000	K≥5.6		30	4	1, 3, 4, 5	5
RELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB												
≤60	40	50	K≥8.0	SR (HT)	0.30	2000	K≥5.6	QR or SR (OT)	30	4	1, 5	6

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft^2 = 0.09 m^2, 1 gpm/ft^2 = 40.7 L/min/m^2 = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

Notes:

(1) In-rack sprinkler design based on the 6 most hydraulically remote sprinklers in each of the upper three levels.

(2) Design area can be reduced to 1500 ft^2 when using a preprimed foam-water system installed in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, and maintained according to NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

(3) Design area can be reduced to 2000 ft^2 when using a preprimed foam-water system installed in accordance with NFPA 16 and maintained according to NFPA 25.

(4) In-rack sprinkler hydraulic design can be reduced to three sprinklers operating per level, with three levels operating simultaneously, when using a preprimed foam-water sprinkler system designed in accordance with NFPA 16 and maintained in accordance with NFPA 25.

(5) The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi.

[**30:** Table 16.5.2.3]

66.16.5.2.10 Table 66.16.5.2.10 shall apply to the following:

(1) Automatic sprinkler protection
(2) Single- or double-row rack storage
(3) Class II and Class III nonmiscible and Class II and Class III miscible liquids
(4) Listed and labeled rigid nonmetallic intermediate bulk containers

[**30:**16.5.2.10]

66.16.5.2.11 Table 66.16.5.2.11 shall apply to the following:

(1) Automatic sprinkler protection
(2) Palletized or stacked storage
(3) Unsaturated polyester resins (UPRs) with not more than 50 percent by weight of Class IC, II, or IIIA liquid
(4) Metal containers; nonrelieving style allowed only up to 6 gal (23 L)

[**30:**16.5.2.11]

66.16.5.2.12 Table 66.16.5.2.12 shall apply to the following:

(1) Automatic sprinkler protection
(2) Palletized or stacked storage
(3) Miscible liquids with concentration of flammable or combustible components no greater than 80 percent by volume
(4) Glass or plastic containers

[**30:**16.5.2.12]

Δ ***TABLE 66.16.5.2.4*** *Design Criteria for Foam-Water Sprinkler Protection of Palletized and Stacked Storage of Liquids in Metal Containers, Portable Tanks, and IBCs*

Container Style and Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection: Sprinkler Type	Ceiling Sprinkler Protection: Sprinkler Response	Ceiling Sprinkler Protection: Design Density (gpm/ft²)	Ceiling Sprinkler Protection: Design Area (ft²)	Notes	Fire Test Ref. *[See Table D.2(d) of NFPA 30]*
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA								
≤5, cartoned	11	30	K≥11.2	SR or QR (HT)	0.40	3000	1	1
≤5, uncartoned	12	30	K≥8.0	SR or QR (HT)	0.30	3000	1	2
>5 and ≤60	5 (1-high)	30	K≥8.0	SR (HT)	0.30	3000	1	3
RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA								
>5 and ≤60	6.5 (2-high)	30	K≥8.0	SR (HT)	0.30	3000	2, 3	4
	10 (3-high)	33	K≥11.2	SR (HT)	0.45	3000	2, 3	6
	13.75 (4-high)	33	K≥11.2	SR (HT)	0.60	3000	2, 3	7
Portable tanks and IBCs	1- or 2-high	30	K≥8.0	SR (HT)	0.30	3000		5

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft² = 0.09 m², 1 gpm/ft² = 40.7 L/min/m² = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

Notes:

(1) Design area can be reduced to 2000 ft² when using a pre-primed foam-water system installed in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, and maintained according to NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

(2) Both ¾ in. (20 mm) and 2 in. (50 mm) listed pressure-relieving mechanisms are required on containers greater than 6 gal (23 L) capacity.

(3) Drums placed on open slatted pallet, not nested, to allow pressure relief from drums on lower levels. [**30:** Table 16.5.2.4]

Δ ***TABLE 66.16.5.2.5*** *Design Criteria for Sprinkler Protection of Single-, Double-, and Multiple-Row Rack Storage of Class IIIB Liquids*

Closed-Cup Flash Point (°F)	Container or IBC Capacity (gal)	Packaging	Maximum Storage Height (ft)	Maximum Ceiling Height ft)	Minimum Aisle Width (ft)	Rack Depth (ft)	Sprinkler Protection: Ceiling Sprinkler Type	Sprinkler Protection: Design	Fire Test Ref. *[See Table D.2(e) of NFPA 30]*
≥200	≤5	Plastic containers, cartoned or uncartoned	Unlimited	Unlimited	4	Any	Any	See 66.16.6.1, Fire Protection System Design Scheme "A"	1
≥375	≤275	Flexible plastic liner within a composite continuously wound corrugated paperboard intermediate bulk container (See Special Note 1)	28	30	8	Any	Any	See 66.16.6.3, Fire Protection System Design Scheme "C"	2
≥375	≤6	Flexible plastic liner within a composite corrugated paperboard box	Unlimited	Unlimited	8	Any	Any	See 66.16.6.3, Fire Protection System Design Scheme "C"	2

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 200°F = 93°C, 375°F = 190°C.

Note: Construction of intermediate bulk container to be a minimum of 8 layers of paperboard, with a minimum nominal thickness of 1½ in. (38 mm) at the center of any side panel. [**30:** Table 16.5.2.5]

△ *TABLE 66.16.5.2.6 Design Criteria for Sprinkler Protection of Shelf Storage of Liquids in Metal Containers*

Container Style and Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection: Sprinkler Type	Ceiling Sprinkler Protection: Sprinkler Response	Ceiling Sprinkler Protection: Design Density (gpm/ft^2)	Ceiling Sprinkler Protection: Design Area (ft^2)	Special Notes	Fire Test Ref. *[See Table D.2(f) of NFPA 30]*
≤1, nonrelieving style	6	18	K≥5.6	SR or QR (HT)	0.19	1500	1, 2	1

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft^2 = 0.09 m^2, 1 gpm/ft^2 = 40.7 $L/min/m^2$ = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

Notes:

(1) Protection limited to mercantile shelving that is 2 ft (600 mm) or less in depth per side, with backing between each side.

(2) Minimum hose stream demand can be reduced to 250 gpm for 2 hours. [**30:** Table 16.5.2.6]

(3) The minimum aisle width shall not be less than 5 ft (1.5 m) [**30:** Table 16.5.2.6]

△ *TABLE 66.16.5.2.7 Design Criteria for Sprinkler Protection of Single- and Double-Row Rack Storage of Water-Miscible Liquids in Glass or Plastic Containers*

Container Style and Capacity	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection: Ceiling Sprinkler Protection	Ceiling Sprinkler Protection: In-Rack Sprinklers	Notes	Fire Test Ref. *[See Table D.2(g) of NFPA 30]*
16 oz, cartoned	Unlimited	Unlimited	See 66.16.6.1, Fire Protection System Design Scheme "A"	See 66.16.6.1, Fire Protection System Design Scheme "A"	1, 2	3
≤1 gal, cartoned	Unlimited	Unlimited	See 66.16.6.2, Fire Protection System Design Scheme "B"	See 66.16.6.2, Fire Protection System Design Scheme "B"	1, 2	1
≤60 gal, cartoned or uncartoned	25	30	See 66.16.6.2, Fire Protection System Design Scheme "B"	See 66.16.6.2, Fire Protection System Design Scheme "B"	1, 2	2

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m.

Notes:

(1) Minimum aisle width in all cases is 8 ft (2.4 m).

(2) Maximum rack depth in all cases is 9 ft (2.7 m). [**30:** Table 16.5.2.7]

△ *TABLE 66.16.5.2.8 Design Criteria for Single-Row Rack, Double-Row Rack, and Palletized Storage of Liquids in Relieving-Style Metal Containers*

			Ceiling Sprinkler Protection		In-Rack Sprinkler Protection					
					Sprinkler					
Container Style and Capacity (gal)	**Maximum Storage Height (ft)**	**Maximum Ceiling Height (ft)**	**Sprinkler Type**	**Design (Number of Sprinklers @ Stated Pressure)**	**Type**	**Response**	**Minimum Discharge Flow**	**Layout (See 66.16.5.1.10 & 66.16.6.4)**	**Notes**	**Fire Test Ref. *[See NFPA 30: Table D.2(h)]***
LIQUID CLASSES IB, IC, II, IIIA, IIIB RACK STORAGE with MAXIMUM 6 ft RACK DEPTH and MINIMUM 7.5 ft AISLE WIDTH										
≤5, cartoned or uncartoned	14	24	Pendent ESFR K≥14.0 (OT)	12 @ 50 psi	K = 11.2	QR (OT) QR (OT)	36 gpm	7	1, 2, 3, 4, 5, 6, 7	1
	14	24	Pendent ESFR K≥25.0 (OT)	12 @ 25 psi	No in-rack sprinklers required				2, 3, 4, 5, 6	2
LIQUID CLASSES IB, IC, II, IIIA, IIIB RACK STORAGE with MAXIMUM 9 ft RACK DEPTH and 8 ft MINIMUM AISLE WIDTH										
≤1, cartoned only	20	30	Pendent ESFR K≥14.0 (OT)	12 @ 75 psi	No in-rack sprinklers required				—	3
≤1, cartoned only	25	30	Pendent ESFR K≥14.0 (OT)	12 @ 50 psi	K = 8.0	QR (OT)	31 gpm	8	1, 2, 5, 7	4
≤5, cartoned or uncartoned	25	30	Pendent ESFR K≥14.0 (OT)	12 @ 75 psi	K = 8.0	QR (OT)	44 gpm	9	1, 2, 5, 7	5
LIQUID CLASSES IB, IC, II, IIIA, IIIB PALLETIZED STORAGE with MINIMUM 7.5 ft AISLE WIDTH										
≤1, cartoned only	8	30	Pendent ESFR K≥14.0 (OT)	12 @ 50 psi	—	—	—	—	—	6
≤5, cartoned or uncartoned	12	30	Pendent ESFR K≥14.0 (OT)	12 @ 75 psi	—	—	—	—	—	7

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 psi = 6.9 kPa.

For definitions of abbreviations used in the Response column, see 16.5.1.9(4). See also 16.5.1.9(5).

Notes:

(1) The in-rack sprinkler water demand shall be based on the simultaneous operation of the most hydraulically remote sprinklers as follows:

(a) Seven sprinklers where only one level of in-rack sprinklers is installed.

(b) Fourteen sprinklers (seven on each of the two top levels) where more than one level of in-rack sprinklers is installed.

(2) The in-rack sprinkler water demand should be balanced with the ceiling sprinkler water demand at their point of connection.

(3) One-gallon and 1-quart containers are not required to be relieving style.

(4) Provide minimum 3 in. transverse flue at rack uprights.

(5) For Class IIIB liquids, see also Table 16.5.2.5.

(6) Racks can have open-mesh wire intermediate shelving on lower levels.

(7) The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi.

△ ***TABLE 66.16.5.2.9*** *Design Criteria for Sprinkler Protection of Palletized Storage of Class II and Class III Liquids in Listed and Labeled Rigid Nonmetallic IBCs*

Maximum Capacity (gal)	Maximum Storage Height	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection: Sprinkler Type	Ceiling Sprinkler Protection: Sprinkler Response	Ceiling Sprinkler Protection: Design Density (gpm/ft²)	Ceiling Sprinkler Protection: Design Area (ft²)	Notes	Fire Test Ref. *[See Table D.2(i) of NFPA 30]*
793	1-high	30	K≥11.2	SR (HT)	0.45	3000	1, 2	1
793	2-high	30	K≥11.2	SR (HT)	0.60	3000	1, 2, 3	2

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 gpm/ft^2 = 40.7 L/min/m^2 = 40.7 mm/min, 1 ft^2 = 0.9 m^2.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

Notes:

(1) Foam-water sprinkler protection shall be permitted to be substituted for water sprinkler protection, provided the same design criteria are used.

(2) Rigid nonmetallic intermediate bulk containers shall be listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*; *FM Class 6020, Approval Standard for Intermediate Bulk Containers*; or an equivalent test procedure.

(3) The sprinkler operating gauge pressure shall be a minimum 30 psi (207 kPa).

[**30:** Table 16.5.2.9]

△ ***TABLE 66.16.5.2.10*** *Design Criteria for Sprinkler Protection of Single- and Double-Row Rack Storage of Class II and Class III Liquids in Listed and Labeled Rigid Nonmetallic IBCs*

Maximum Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection: Sprinkler Type	Ceiling Sprinkler Protection: Design	Notes	Fire Test Ref. *[See Table D.2(j) of NFPA 30]*
793	25	30	Standard spray	See 66.16.6.2, Fire Protection System Design Scheme "B"	1, 2, 3	1

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m.

Notes:

(1) Rigid nonmetallic intermediate bulk containers are listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*, or an equivalent test procedure.

(2) Maximum rack depth is 9 ft (2.7 m).

(3) Minimum aisle width is 8 ft (2.4 m).

[**30:** Table 16.5.2.10]

Δ ***TABLE 66.16.5.2.11*** *Design Criteria for Sprinkler Protection of Palletized or Stacked Storage of Unsaturated Polyester Resins in Metal Containers*

Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection				Notes	Fire Test Ref. *[See Table D.2(k) of NFPA 30]*
			Sprinkler		Design			
			Type	Response	Density (gpm/ft^2)	Area (ft^2)		
>5 and <60	10	33	K≥11.2	SR (HT or OT)	0.45	3000	1, 2, 3	1

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft^2 = 0.09 m^2, 1 gpm/ft^2 = 40.7 $L/min/m^2$ = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

Notes:

(1) Drums placed on open, slatted pallet, not nested, to allow pressure relief from drums on lower levels.

(2) Storage areas containing unsaturated polyester resin (UPR) should not be located in the same spill containment area or drainage path of other Class I or Class II liquids, unless protected as required for such other liquids.

(3) Both ¾ in. (20 mm) and 2 in. (50 mm) listed and labeled pressure-relieving devices are required on containers that exceed 6 gal (23 L) capacity. [**30:** Table 16.5.2.11]

Δ ***TABLE 66.16.5.2.12*** *Design Criteria for Sprinkler Protection of Palletized or Stacked Storage of Miscible Liquids in Glass or Plastic Containers*

Container Style and Capacity	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection				Notes	Fire Test Ref. *[See Table Annex D.2(l) of NFPA 30]*
			Sprinkler		Design			
			Type	Response	Density (gpm/ft^2)	Area (ft^2)		
≤8 oz	5	38	K ≥ 11.2	QR (OT)	0.47	2000	—	P60 and P61

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft^2 = 0.09 m^2, 1 gpm/ft^2 = 40.7 $L/min/m^2$ = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). *(See also 66.16.5.1.9(5).)* [**30:** Table 16.5.2.12]

66.16.6 Fire Protection System Design Schemes.

66.16.6.1 Fire Protection System Design Scheme A.

66.16.6.1.1 Horizontal barriers of plywood having a minimum thickness of ⅜ in. (10 mm) or of sheet metal of minimum 22 gauge thickness shall be installed in accordance with Figure 66.16.6.1.1(a), Figure 66.16.6.1.1(b), or Figure 66.16.6.1.1(c), whichever is applicable. All liquid storage shall be located beneath a barrier. *[See also 66.16.6.1.9 for liquids with flash points equal to or greater than 450°F (230°C).]* [**30:**16.6.1.1]

66.16.6.1.2 In-rack sprinklers shall be installed in accordance with Figure 66.16.6.1.1(a), Figure 66.16.6.1.1(b), or Figure 66.16.6.1.1(c), whichever is applicable. [**30:**16.6.1.2]

66.16.6.1.3 Vertical barriers shall not be provided between in-rack sprinklers. [**30:**16.6.1.3]

66.16.6.1.4 In-rack sprinklers shall meet the following requirements:

(1) In-rack sprinklers shall be ordinary temperature–rated quick-response sprinklers and shall have a nominal K-factor equal to or greater than 8.0. Intermediate-temperature sprinklers shall be used where ambient conditions require.

(2) In-rack sprinklers shall be installed below each barrier level.

(3) In-rack sprinklers shall provide a minimum operating flow of 57 gpm (220 L/min) out of each of the hydraulically most remote six sprinklers (six on one line or three on two lines) if one barrier level is provided, or out of each of the hydraulically most remote eight sprinklers (eight on one line or four on two lines on the same level), if two or more barrier levels are provided. The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi (0.69 bar).

[**30:**16.6.1.4]

In the 2015 edition of the *Code*, item (1) was amended to allow intermediate-temperature sprinklers where ambient temperatures might exceed what is normally expected. Item (3) was amended to require a minimum flow rate in addition to the minimum discharge pressure, to ensure a proper discharge pattern.

For the 2018 edition of the *Code*, item (3) has been further amended to allow the use of either one or two lines of in-rack sprinklers for calculating the pressure demand for the most hydraulically remote sprinklers.

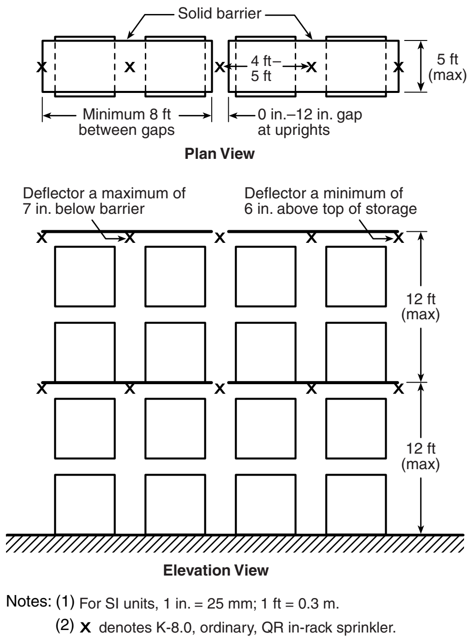


*FIGURE 66.16.6.1.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "A." [**30:** Figure 16.6.1.1(a)]*

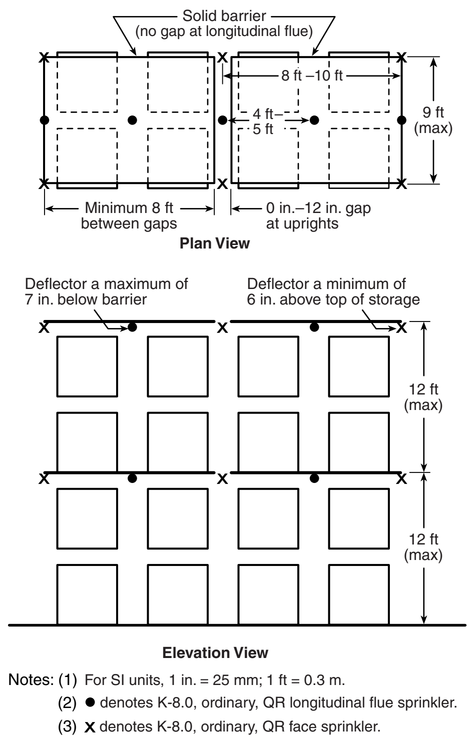


*FIGURE 66.16.6.1.1(b) Double-Row Rack Sprinkler Layout for Design Scheme "A." [**30:** Figure 16.6.1.1(b)]*

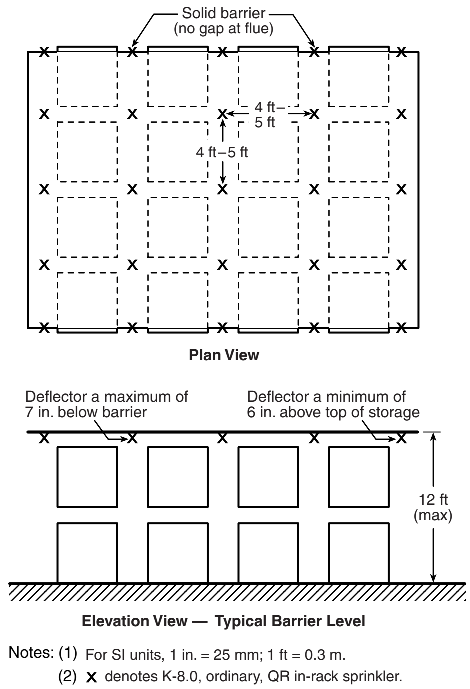


*FIGURE 66.16.6.1.1(c) Multiple-Row Rack Sprinkler Layout for Design Scheme "A." [**30:** Figure 16.6.1.1(c)]*

66.16.6.1.5* Where adjacent rack bays are not dedicated to storage of liquids, the barrier and in-rack sprinkler protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage. In addition, barrier and in-rack sprinkler protection shall be provided for any rack across the aisle within 8 ft (2.4 m) of the perimeter of the liquid storage in accordance with 66.16.6.1. [**30:**16.6.1.5]

A.66.16.6.1.5 The 8 ft (2.4 m) separation distance required in 66.16.6.1.5 is measured from the face of liquid storage in one rack to the face of liquid storage and/or other storage across the aisle in an adjacent rack. Rack designers, code officials, and plan reviewers are cautioned to the fact that many rack storage arrangements involve the storage of pallets that overhang the face of the rack. Therefore, although the structural rack members might be arranged to have an 8 ft (2.4 m) aisle between the racks, the distance between the face of the stored materials in the racks could be less than 8 ft (2.4 m) when the racks are filled with pallets. This will not be in compliance with the requirements of 66.16.6.1.5, unless the barrier and in-rack sprinkler protection is extended. [**30:**A.16.6.1.5]

66.16.6.1.6 Ceiling sprinkler demand shall not be included in the hydraulic calculations for in-rack sprinklers. [**30:**16.6.1.6]

66.16.6.1.7 Water demand at point of supply shall be calculated separately for in-rack and ceiling sprinklers and shall be based on the greater demand. [**30:**16.6.1.7]

66.16.6.1.8 Ceiling sprinklers shall meet the following requirements:

(1) Ceiling sprinkler protection shall be designed to protect the surrounding occupancy.
(2) Any sprinkler type shall be acceptable.
(3) If standard spray sprinklers are used, they shall be capable of providing not less than 0.20 gpm/ft^2 over 3000 ft^2 (8 mm/min over 270 m^2).
(4) If the liquid storage does not extend to the full height of the rack, protection for commodities stored above the top horizontal barrier shall meet the requirements of Section 13.3 and NFPA 13 for the commodities stored, based on the full height of the rack.

66.16.6.1.9 Barriers shall not be required for liquids with closed-cup flash points of 450°F (230°C) or greater. If barriers are omitted, the following shall apply:

(1) Ceiling sprinkler protection shall provide a minimum density of 0.3 gpm/ft^2 over the most hydraulically remote 2000 ft^2 (12 mm/min over 180 m^2) using ordinary temperature, standard-response sprinklers. Sprinklers shall have a nominal K-factor equal to or greater than 8.0. Intermediate-temperature sprinklers shall be used where ambient conditions require.
(2) The ceiling sprinkler water demand and the in-rack water demand shall be balanced at their point of connection.
(3) The sprinklers located at the rack face shall be staggered vertically.

[**30:**16.6.1.9]

Item (1) was amended in the 2015 edition of the *Code* to allow intermediate-temperature sprinklers where ambient temperatures might exceed what is normally expected.

66.16.6.1.10 A 500 gpm (1900 L/min) hose stream allowance shall be provided. [**30:**16.6.1.10]

66.16.6.2 Fire Protection System Design Scheme "B."

66.16.6.2.1 Horizontal barriers of plywood having a minimum thickness of ⅜ in. (10 mm) or of sheet metal of minimum 22 gauge thickness shall be installed in accordance with Figure 66.16.6.2.1(a), Figure 66.16.6.2.1(b), or Figure 66.16.6.2.1(c), whichever is applicable. All liquid storage shall be located beneath a barrier. [**30:**16.6.2.1]

66.16.6.2.2 In-rack sprinklers shall be installed in accordance with Figure 66.16.6.2.1(a), Figure 66.16.6.2.1(b), or Figure 66.16.6.2.1(c), whichever is applicable. [**30:**16.6.2.2]

66.16.6.2.3 Vertical barriers shall not be provided between in-rack sprinklers. [**30:**16.6.2.3]

Δ **66.16.6.2.4** In-rack sprinklers shall meet the following requirements:

(1) In-rack sprinklers shall be ordinary temperature–rated quick-response sprinklers and shall have a nominal K-factor equal to or greater than 8.0. Intermediate-temperature sprinklers shall be used where ambient conditions require.
(2) In-rack sprinklers shall be installed below each barrier level.

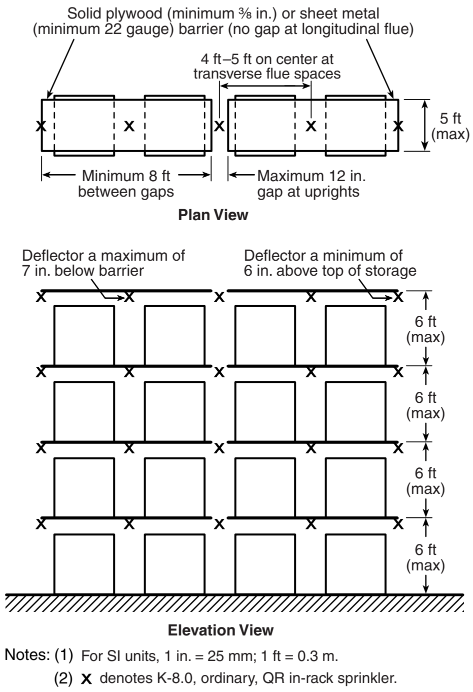


FIGURE 66.16.6.2.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "B" — Sprinklers in Center of Rack. [30: Figure 16.6.2.1(a)]

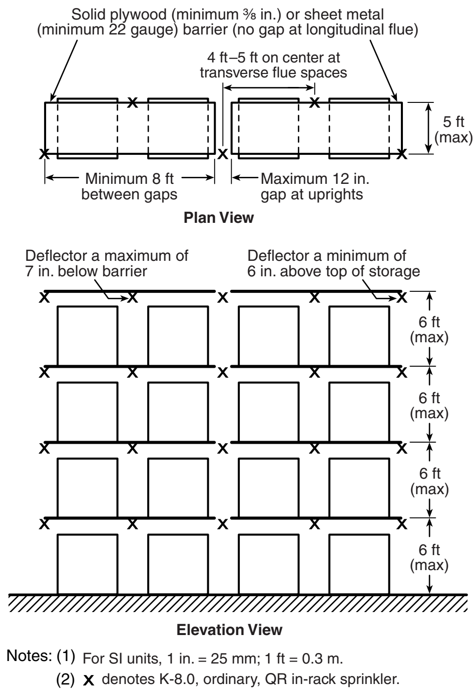
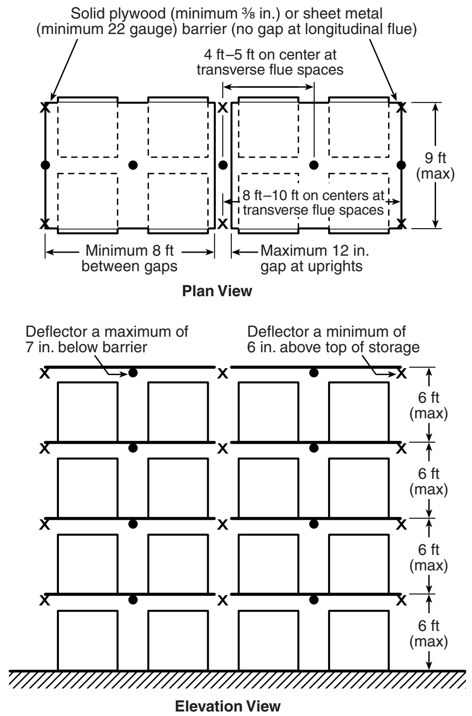


FIGURE 66.16.6.2.1(b) Single-Row Rack Sprinkler Layout for Design Scheme "B" — Sprinklers on Face of Rack. [30: Figure 16.6.2.1(b)]



Notes: (1) For SI units, 1 in. = 25 mm; 1 ft = 0.3 m.
(2) ● denotes K-8.0, ordinary, QR longitudinal flue sprinkler.
(3) X denotes K-8.0, ordinary, QR face sprinkler.

***FIGURE 66.16.6.2.1(c)** Double-Row Rack Sprinkler Layout for Design Scheme "B." [**30:** Figure 16.6.2.1(c)]*

(3) For containers that do not exceed 60 gal (230 L) capacity, in-rack sprinklers shall provide a minimum discharge flow of 57 gpm (220 L/min) out of each of the hydraulically most remote six sprinklers (six on one line or three on two lines) if one barrier level is provided, or out of each of the hydraulically most remote eight sprinklers (eight on one line or four on two lines on the same level), if two or more barrier levels are provided. The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi (0.69 bar).
(4) For containers that exceed 60 gal (230 L) capacity, but do not exceed 793 gal (3000 L), in-rack sprinklers shall provide a minimum discharge flow of 57 gpm out of each of the hydraulically most remote 12 sprinklers (12 on one line or six on two lines on the same level). The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi (0.69 bar).

[**30:**16.6.2.4]

Item (1) was amended in the 2015 edition of the *Code* to allow the use of in-rack sprinklers with K-factors greater than 8.0, to correlate with changes made elsewhere in the chapter. Item (1) was also amended to allow the use of intermediate-temperature sprinklers where ambient temperatures might exceed what is normally expected.

For the 2018 edition of the *Code*, items (3) and (4) have been amended to allow the use of either one or two lines of in-rack sprinklers for calculating the pressure demand for the most hydraulically remote sprinklers.

66.16.6.2.5 If there are adjacent rack bays that are not dedicated to storage of liquids, the barrier and in-rack sprinkler protection shall be extended beyond the area devoted to liquid storage as follows:

(1) For containers that do not exceed 1 gal (3.8 L) capacity, protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage. In addition, adjacent racks across the aisles on each side of the liquid storage shall be protected in accordance with Section 13.3 and NFPA 13 for the commodity stored.
(2) For containers that exceed 1 gal (3.8 L) capacity, but do not exceed 793 gal (3000 L), protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage. In addition, protection shall be provided to any rack across the aisle within 8 ft (2.4 m) of the perimeter of the liquid storage in accordance with 66.16.6.2.

[**30:**16.6.2.5]

66.16.6.2.6 Ceiling sprinklers for containers that do not exceed 1 gal (3.8 L) capacity shall meet the following requirements:

(1) Ceiling sprinklers shall be designed to protect the surrounding occupancy.
(2) Ceiling sprinkler water demand shall not be included in the hydraulic calculations for the in-rack sprinkler protection.
(3) Water demand at the point of supply shall be calculated separately for in-rack and ceiling sprinklers and shall be based on the greater of the two.
(4) Any sprinkler type shall be acceptable for the ceiling sprinkler protection.
(5) If standard spray sprinklers are used, they shall be capable of providing not less than 0.20 gpm/ft^2 over 3000 ft^2 (8 L/min over 270 m^2).
(6) If the liquid storage does not extend to the full height of the rack, protection for commodities stored above the top horizontal barrier shall meet the requirements of Section 13.3 and NFPA 13 for the commodities stored, based on the full height of the rack.

[**30:**16.6.2.6]

66.16.6.2.7 Ceiling sprinklers for containers that exceed 1 gal (3.8 L) capacity, but do not exceed 60 gal (230 L), shall meet the following requirements:

(1) Ceiling sprinkler protection shall provide a minimum density of 0.45 gpm/ft^2 (18.3 mm/min) over the most hydraulically remote 3000 ft^2 (270 m^2), using high-temperature, standard-response sprinklers of nominal K-factor of 11.2 or greater. Other types of sprinklers shall not be used.
(2) Ceiling sprinkler water demand and the in-rack sprinkler demand shall be balanced at the point of connection.

[**30:**16.6.2.7]

66.16.6.2.8 Ceiling sprinklers for containers that exceed 60 gal (230 L) capacity, but do not exceed 793 gal (3000 L), shall meet the following requirements:

(1) Ceiling sprinklers shall be designed to provide a minimum density of 0.60 gpm/ft^2 over 3000 ft^2 (24 mm/min over the most remote 270 m^2), using high-temperature–rated, standard-response sprinklers of nominal K-factor of 11.2 or greater. Other types of sprinklers shall not be used.

(2) Ceiling sprinkler water demand and the in-rack sprinkler demand shall be balanced at the point of connection.

[**30:**16.6.2.8]

66.16.6.2.9 A 500 gpm (1900 L/min) hose stream allowance shall be provided. [**30:**16.6.2.9]

66.16.6.3 Fire Protection System Design Scheme "C."

66.16.6.3.1 Horizontal barriers of plywood having a minimum thickness of ⅜ in. (10 mm) or of sheet metal of minimum 22 gauge thickness shall be installed in accordance with Figure 66.16.6.3.1(a), Figure 66.16.6.3.1(b), or Figure 66.16.6.3.1(c), whichever is applicable. All liquid storage shall be located beneath a barrier. [**30:**16.6.3.1]

66.16.6.3.2 Vertical baffles shall not be installed between in-rack sprinklers. [**30:**16.6.3.2]

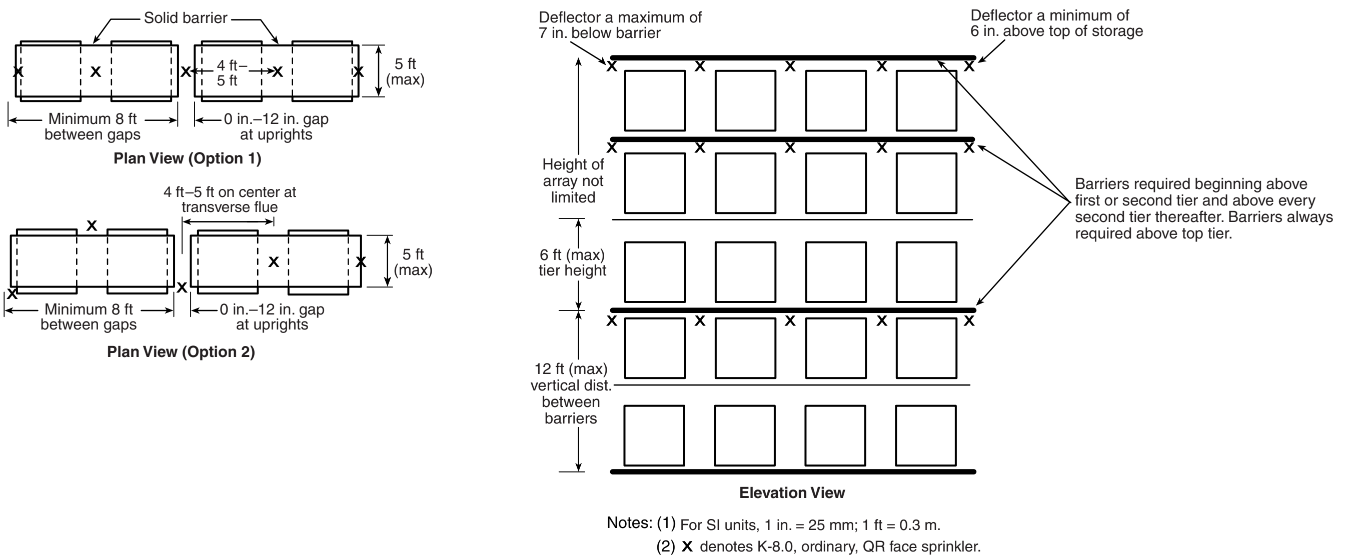


*FIGURE 66.16.6.3.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "C." [**30:** Figure 16.6.3.1(a)]*

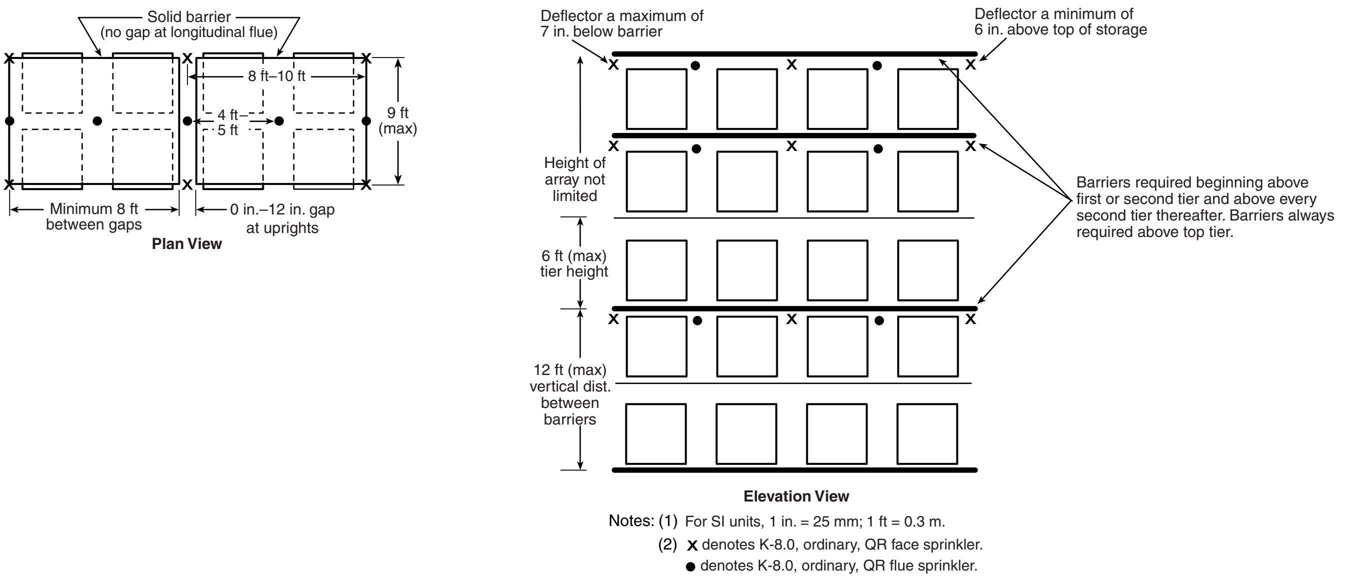


*FIGURE 66.16.6.3.1(b) Double-Row Rack Sprinkler Layout for Design Scheme "C." [**30:** Figure 16.6.3.1(b)]*

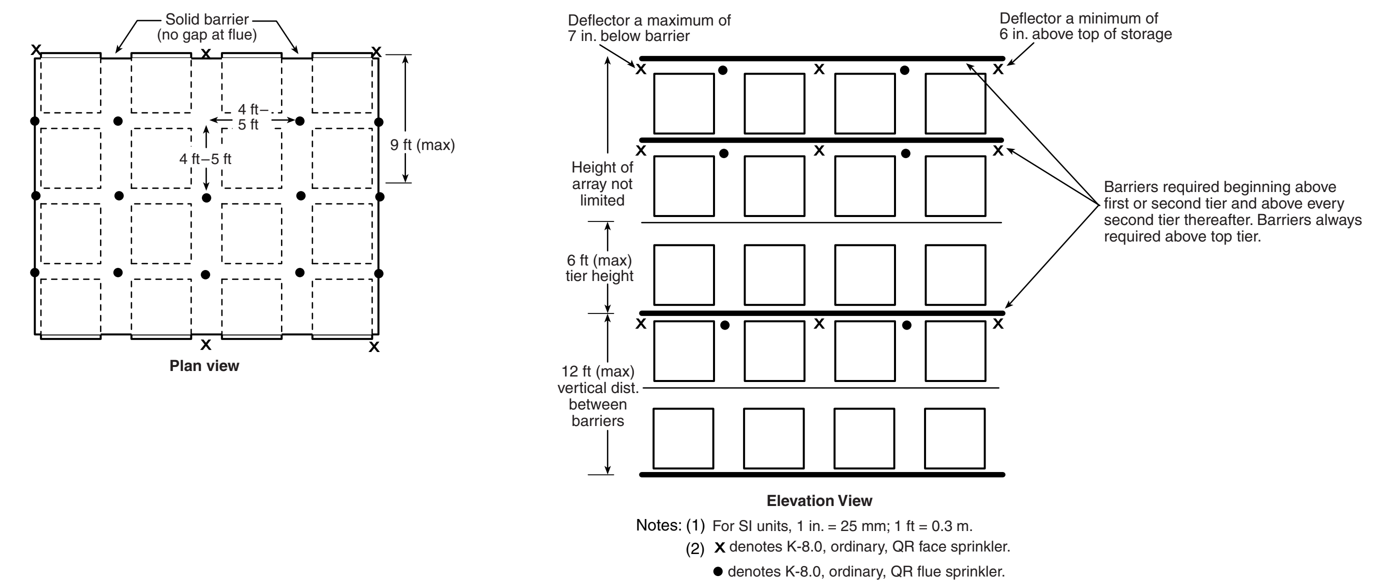


FIGURE 66.16.6.3.1(c) *Multiple-Row Rack Sprinkler Layout for Design Scheme "C." [**30:** Figure 16.6.3.1(c)]*

66.16.6.3.3 In-rack sprinklers shall meet the following requirements:

(1) In-rack sprinklers shall be ordinary temperature–rated, quick-response sprinklers. Sprinklers shall have a nominal K-factor equal to or greater than 8.0. An intermediate-temperature sprinkler shall be used where ambient conditions require.
(2) In-rack sprinklers shall be installed below each barrier level.
(3) In-rack sprinklers shall provide a minimum discharge flow of 30 gpm (110 L/min) out of each of the hydraulically most remote six sprinklers (six on one line or three on two lines), if one barrier level is provided, or out of each of the hydraulically most remote eight sprinklers (eight on one line or four on two lines on the same level), if two or more barrier levels are provided. The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi (0.69 bar).

[**30:**16.6.3.3]

Item (1) was amended in the 2015 edition of the *Code* to allow the use of in-rack sprinklers with K-factors greater than 8.0, to correlate with changes made elsewhere in the chapter. Item (1) was also amended to allow the use of intermediate-temperature sprinklers where ambient temperatures might exceed what is normally expected.

For the 2018 edition of the *Code*, item (3) has been amended to allow the use of either one or two lines of in-rack sprinklers for calculating the pressure demand for the most hydraulically remote sprinklers.

66.16.6.3.4 If there are adjacent bays of in-rack arrays that are not dedicated to storage of liquids, the barrier and in-rack sprinkler protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage. [**30:**16.6.3.4]

66.16.6.3.5 Ceiling sprinkler demand shall not be included in the hydraulic calculations for in-rack sprinklers. [**30:**16.6.3.5]

66.16.6.3.6 Water demand at point of supply shall be calculated separately for in-rack and ceiling sprinklers and shall be based on the greater demand. [**30:**16.6.3.6]

66.16.6.3.7 Ceiling sprinklers shall meet the following requirements:

(1) Ceiling sprinkler protection shall be designed to protect the surrounding occupancy.
(2) Any sprinkler type shall be acceptable.
(3) If standard spray sprinklers are used, they shall be capable of providing not less than 0.20 gpm/ft^2 over 3000 ft^2 (8 mm/min over 270 m^2).
(4) If the liquid storage does not extend to the full height of the rack, protection for commodities stored above the top horizontal barrier shall meet the requirements of Section 13.3 and NFPA 13 for the commodities stored, based on the full height of the rack.

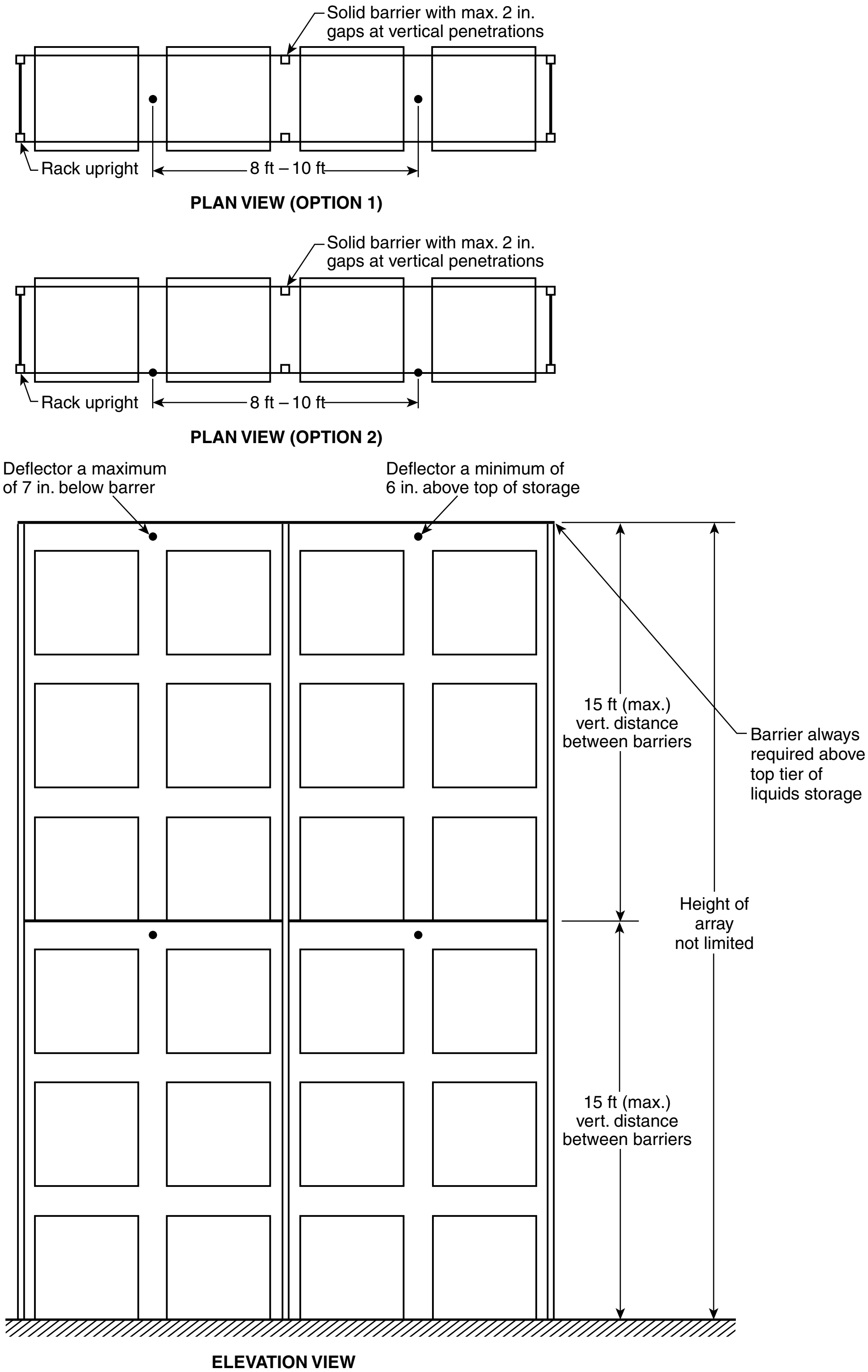
[**30:**16.6.3.7]

66.16.6.3.8 A 500 gpm (1900 L/min) hose stream allowance shall be provided. [**30:**16.6.3.8]

N **66.16.6.4 Fire Protection System Design Scheme "E."**

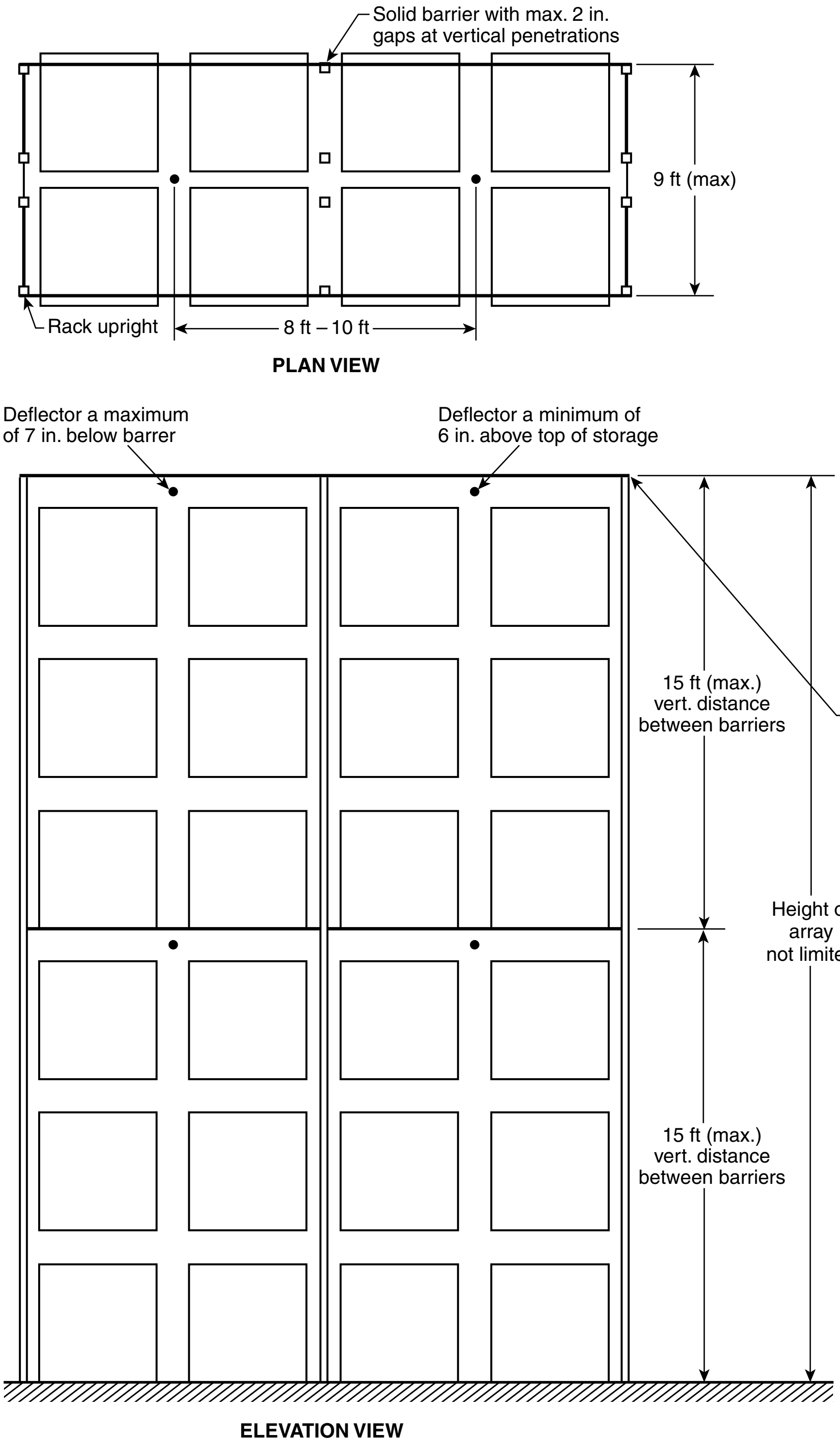
N **66.16.6.4.1** Sprinklers and horizontal barriers shall be installed in accordance with Figure 66.16.6.4.1(a) or Figure 66.16.6.4.1(b), whichever is applicable. Horizontal barriers shall be of plywood having a minimum thickness of ⅜ in. (10 mm) or of sheet metal of minimum 22 gauge thickness. All liquid storage shall be located beneath a barrier. [**30:**16.6.4.1]

N **66.16.6.4.2** Vertical baffles shall not be installed between in-rack sprinklers. [**30:**16.6.4.2]



Notes: (1) For SI units, 1 in. = 25 mm; 1 ft = 0.3 m.
(2) • Denotes K-25.2 extended coverage pendent CMDA storage sprinkler

*FIGURE 66.16.6.4.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "E." [**30:**16.6.4.1(a)]*



Notes: (1) For SI units, 1 in. = 25 mm; 1 ft = 0.3 m.
(2) • Denotes K-25.2 extended coverage pendent CMDA storage sprinkler

*FIGURE 66.16.6.4.1(b) Double-Row Rack Sprinkler Layout for Design Scheme "E." [**30:**16.6.4.1(b)]*

N **66.16.6.4.3** In-rack sprinklers shall meet the following requirements:

(1) In-rack sprinklers shall be intermediate temperature–rated, pendent sprinklers with a nominal K-factor of 25.2 and shall be listed as extended coverage control mode density/area storage sprinklers.
(2) In-rack sprinklers shall be positioned in a transverse flue below each barrier level.
(3) In-rack sprinklers shall not be positioned within 3.5 ft (1 m) of a rack upright.
(4) The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 30 psi (207 kPa).
(5) Where one level of in-rack sprinklers is installed, the design shall include the 3 most hydraulically remote sprinklers on a single line.
(6) Where two levels of in-rack sprinklers are installed, the design shall include the 3 most hydraulically remote sprinklers on a single line, and the 2 most hydraulically remote sprinklers on the next adjacent level.
(7) Where three or more levels of in-rack sprinklers are installed, the design shall include the 3 most hydraulically remote sprinklers on a single line, and the 2 most hydraulically remote sprinklers on the next two adjacent levels.
(8) Foam-water sprinkler protection shall be permitted to be substituted for water sprinkler protection, provided the same design criteria is used, and that the sprinkler is listed for use with foam.

[**30:**16.6.4.3]

N **66.16.6.4.4** If there are adjacent bays of in-rack arrays that are not dedicated to storage of liquids, the barrier and in-rack sprinkler protection shall be extended at least 6 ft (1.8 m) beyond the area devoted to liquid storage. [**30:**16.6.4.4]

N **66.16.6.4.5** Ceiling sprinkler demand shall not be included in the hydraulic calculations for in-rack sprinklers. [**30:**16.6.4.5]

N **66.16.6.4.6** Water demand at point of supply shall be calculated separately for in-rack and ceiling sprinklers and shall be based on the greater demand. [**30:**16.6.4.6]

N **66.16.6.4.7** Ceiling sprinklers shall meet the following requirements:

(1) Ceiling sprinkler protection shall be designed to protect the surrounding occupancy.
(2) Any sprinkler type shall be acceptable.
(3) If standard spray sprinklers are used, they shall be capable of providing not less than 0.30 gpm/ft^2 over 3000 ft^2 (8 mm/min over 270 m^2) when supplied with water. Design area can be reduced to 2000 ft^2 when using a preprimed foam-water system installed in accordance with NFPA 16 and maintained in accordance with NFPA 25.
(4) If the liquid storage does not extend to the full height of the rack, protection for commodities stored above the top horizontal barrier shall meet the requirements of NFPA 13 for the commodities stored, based on the full height of the rack.

[**30:**16.6.4.7]

N **66.16.6.4.8** A 500 gpm (1900 L/min) hose stream allowance shall be provided. [**30:**16.6.4.8]

Δ **66.16.6.5 In-Rack Sprinkler Layouts for Table 66.16.5.2.8.** Where indicated in Table 66.16.5.2.8, in-rack sprinklers shall be installed as follows:

(1) Where Layout 7 is required, in-rack sprinklers shall be installed in accordance with Figure 66.16.6.5(a),
(2) Where Layout 8 is required, in-rack sprinklers shall be installed in accordance with Figure 66.16.6.5(b) or Figure 66.16.6.5(c).
(3) Where Layout 9 is required, in-rack sprinklers shall be installed in accordance with Figure 66.16.6.5(d), or Figure 66.16.6.5(e), whichever is applicable. [**30:**16.6.5]

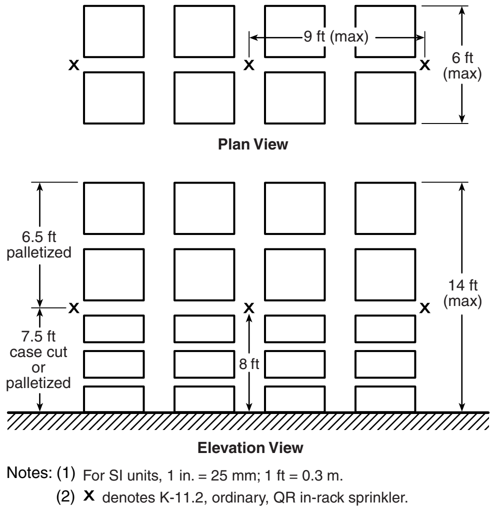


FIGURE 66.16.6.5(a) Double-Row Rack Sprinkler Layout G. [30: Figure 16.6.5(a)]

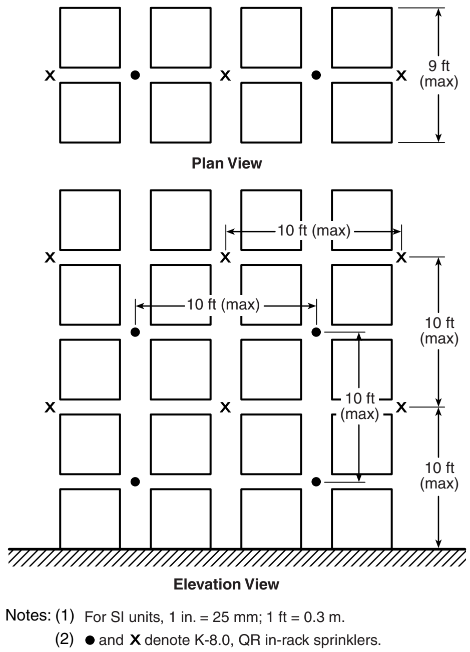


FIGURE 66.16.6.5(b) Double-Row Rack Sprinkler Layout I — Option #1. [30: Figure 16.6.5(b)]

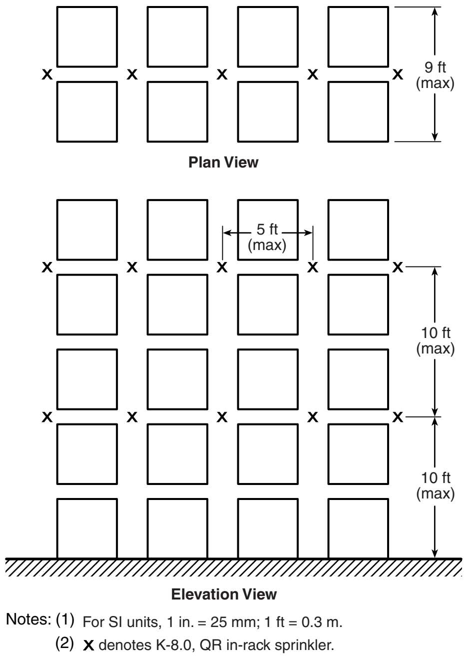


***FIGURE 66.16.6.5(c)** Double-Row Rack Sprinkler Layout I — Option #2. [**30:** Figure 16.6.5(c)]*

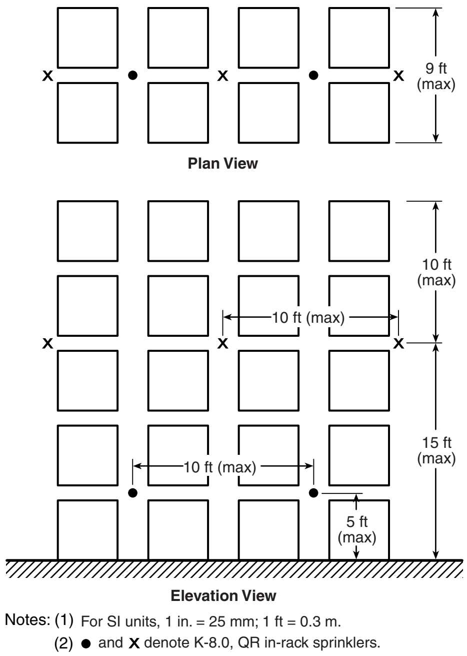


***FIGURE 66.16.6.5(d)** Double-Row Rack Sprinkler Layout H — Option #1. [**30:** Figure 16.6.5(d)]*

66.16.7 Water Supply. Water supplies for automatic sprinklers, other water-based protection systems, hose streams, and hydrants shall be capable of supplying the anticipated water flow demand for a minimum of 2 hours. [**30:**16.7]

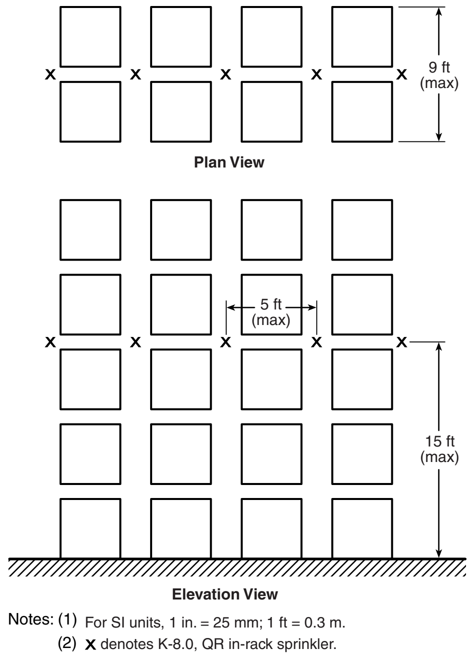


***FIGURE 66.16.6.5(e)** Double-Row Rack Sprinkler Layout H — Option #2. [**30:** Figure 16.6.5(e)]*

66.16.8 Containment, Drainage, and Spill Control.

66.16.8.1 Containment or containment and drainage shall be provided in accordance with Figure 66.16.8.1, when protection systems are installed in accordance with the provisions of this section. [**30:**16.8.1]

66.16.8.2* Where control of the spread of liquid is required, means to limit the spread of liquid to an area not greater than the design discharge area of the ceiling sprinkler system shall be provided. [**30:**16.8.2]

Δ **A.66.16.8.2** Subsection 66.16.8 requires that control of liquid spread be provided to prevent a pool fire on the floor from spreading and opening more sprinkler heads than the design of the sprinkler system anticipates. For example, if the sprinkler system is designed to provide 0.45 gpm/ft^2 over 3000 ft^2 (18 mm/min over 280 m^2), 66.16.8.2 requires that the spread of liquid also be limited to 3000 ft^2 (280 m^2). Various means are available to achieve this control. [**30:**A.16.8.2]

Typical methods use trench or spot drains that divide the floor of the storage area into rectangles having areas equal to or less than the design area of the sprinkler system. Drains are centered under racks, and the floor is sloped toward the drain trenches with a minimum slope of 1 percent. The floor is made highest at the walls. See Figure A.66.16.8.2(a) and Figure A.66.16.8.2(b). Trenches are arranged as described in NFPA 15 and as shown in Figure A.66.16.8.2(c). Note particularly the dimensions of the trenches, and note that the solid covering spans one-third of the width on either side of the open grate and the open grate spans the middle third. Spot drains can be similarly arranged. Another method, shown in

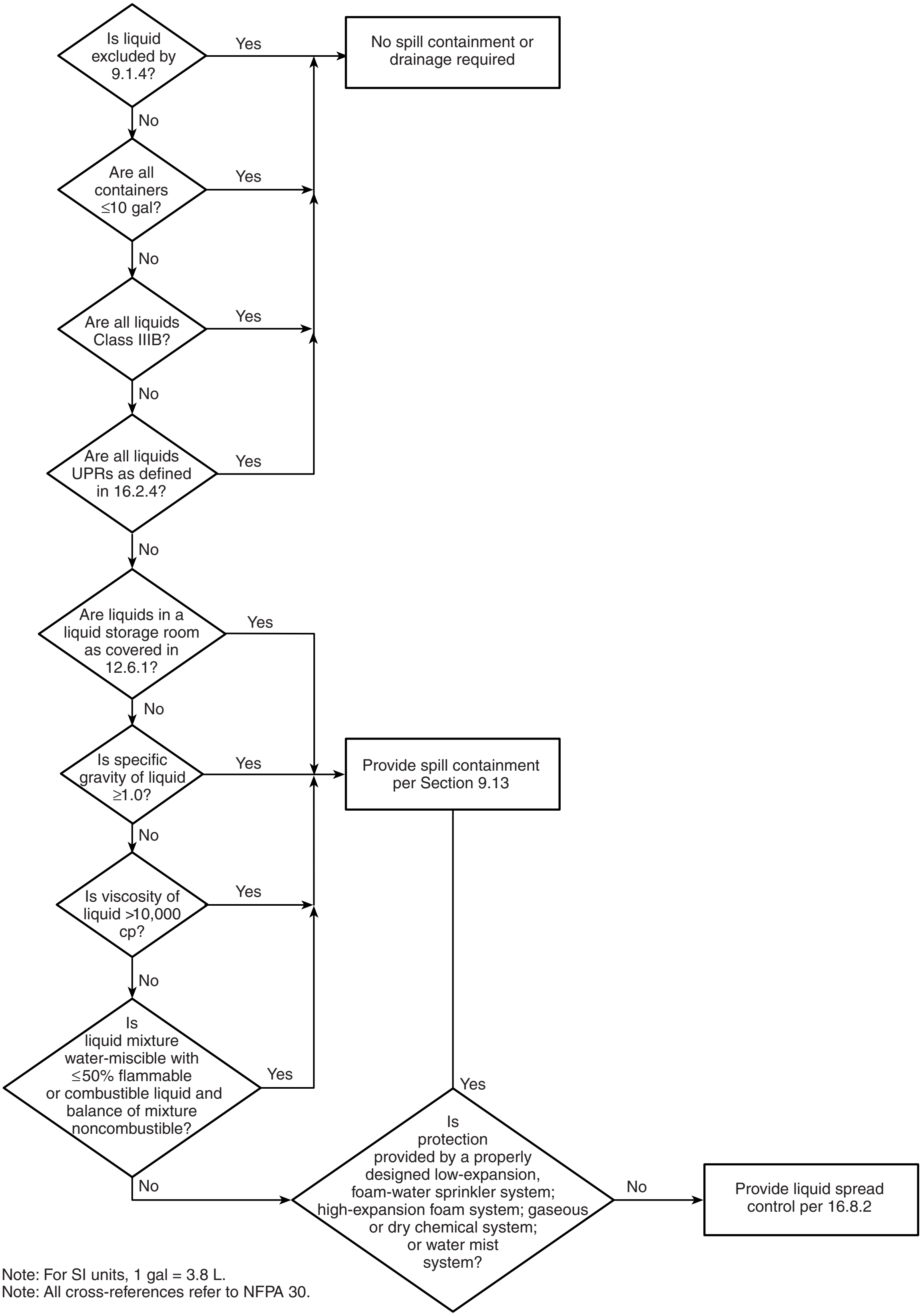


*FIGURE 66.16.8.1 Spill Containment and Liquid Spread Control for Protected Storage. [**30:**Figure 16.8.1]*

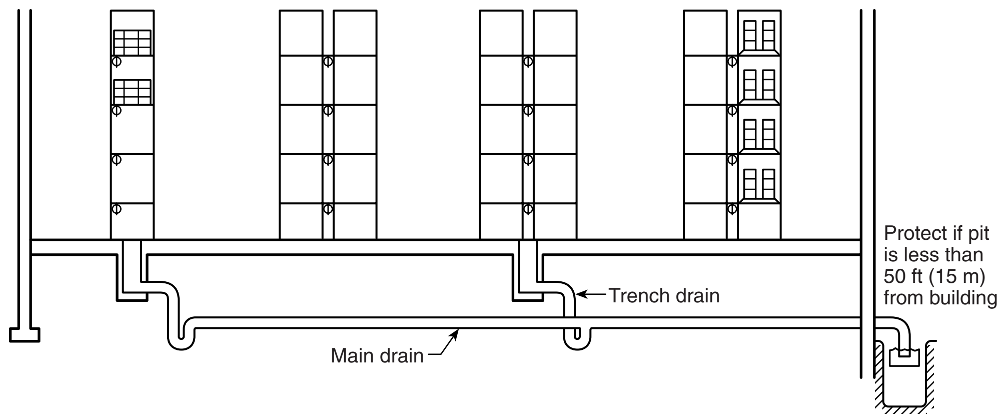


*FIGURE A.66.16.8.2(a) General Scheme for Warehouse Spill Control of Liquids. [**30:** Figure A.16.8.2(a)]*

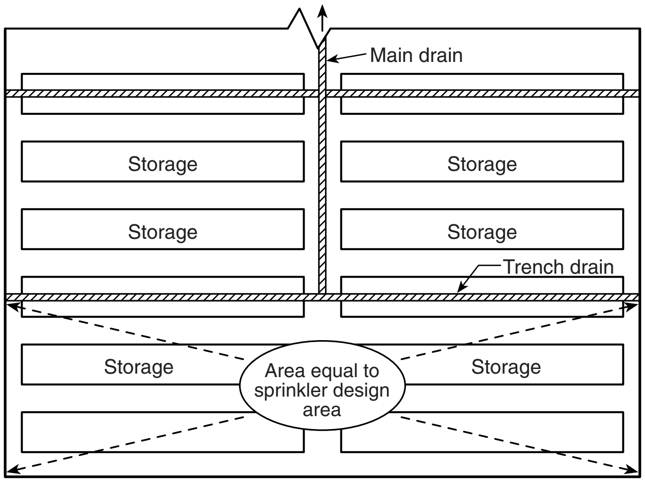


*FIGURE A.66.16.8.2(b) Plan View of Warehouse Spill Control of Liquids. [**30:** Figure A.16.8.2(b)]*

Figure A.66.16.8.2(d), uses spot drains located at building columns, where the area between any four columns does not exceed the design area of the sprinkler system. The floor is sloped to direct water flow to the drains. [**30:**A.16.8.2]

Connections to the drains are provided at trapped sumps, arranged as described in NFPA 15. See Figure A.66.16.8.2(e). To provide a safety factor, the drain pipes are sometimes sized to carry 150 percent of anticipated sprinkler discharge. The following equation can be used to calculate the flow of the drain pipe:

$$F = 1.5DA \qquad \textbf{[A.66.16.8.2]}$$

where:

F = flow (gpm or L/min)

D = sprinkler design density (gpm/ft^2 or L/min/m^2)

A = sprinkler design area (ft^2 or m^2)

[**30:**A.16.8.2]

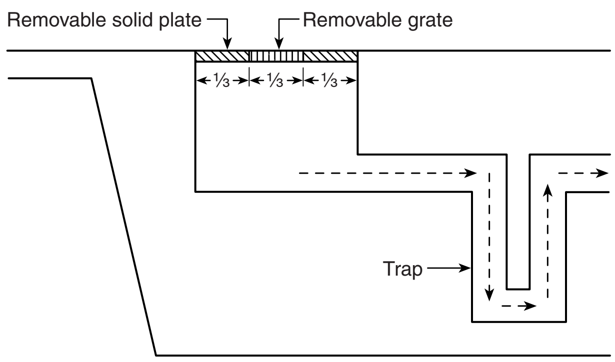


*FIGURE A.66.16.8.2(c) Details of Drainage Trench Design. [**30:** Figure A.16.8.2(c)]*

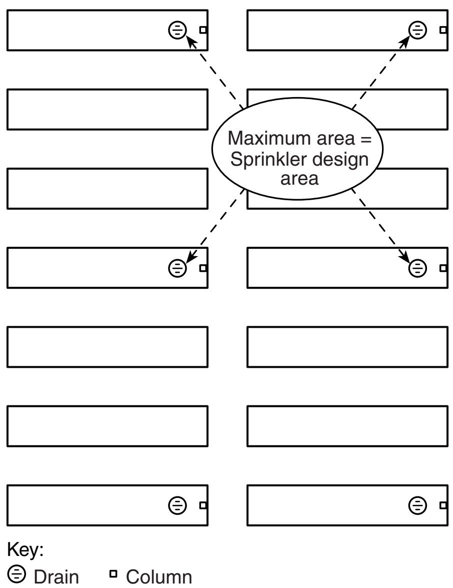


*FIGURE A.66.16.8.2(d) Typical Arrangement of Floor Drains. [**30:** Figure A.16.8.2(d)]*

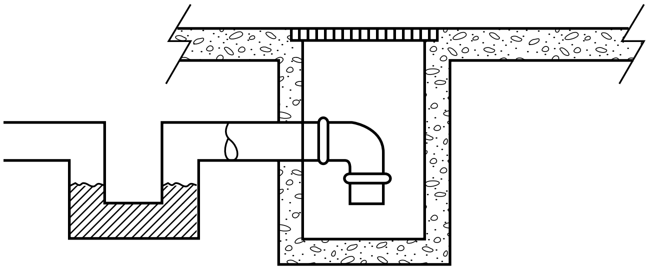


*FIGURE A.66.16.8.2(e) Details of Liquid-Seal Trap. [**30:** Figure A.16.8.2(e)]*

Additional information can be found in *Guidelines for Safe Warehousing of Chemicals*, Center for Chemical Process Safety, American Institute of Chemical Engineers. [**30:**A.16.8.2]

66.16.9 Other Automatic Fire Protection Systems. Alternate fire protection systems, such as automatic water spray systems, automatic water mist systems, high-expansion foam systems, dry chemical extinguishing systems, alternate sprinkler system configurations, or combinations of systems shall be permitted if approved by the AHJ. Such alternate systems shall be designed and installed in accordance with the appropriate NFPA standard and with manufacturer's recommendations for the system(s) selected. [**30:**16.9]

66.17 Processing Facilities

66.17.1 Scope.

66.17.1.1* This section shall apply where the processing of liquids is the principal activity, except as covered elsewhere in this *Code* or in other NFPA standards. *(See 66.1.4.)* [**30:**17.1.1]

A.66.17.1.1 Facilities designed in accordance with Chapter 17 of NFPA 30 do not use the maximum allowable quantity and control area concepts found in the building code. [**30:**A.17.1.1]

Section 66.17 is intended to cover facilities that both use and produce commodities that are flammable or combustible liquids, such as the chemical process plant shown in Exhibit 66.24. Such facilities range in scale and complexity from pharmaceutical manufacturing, whose process capacity might be not much greater than what would be considered a small pilot plant in other industries, up to 100,000 barrels (16,000 m^3) per day petroleum refineries, or large integrated chemical plants of similar size or larger.

66.17.1.2 Provisions of this chapter shall not prohibit the use of movable tanks for the dispensing of flammable or combustible liquids into fuel tanks of motorized equipment outside on premises not accessible to the public, where such use has the approval of the AHJ. [**30:**17.1.2]

There is a demonstrated need for refueling motorized equipment that is not self-propelled — for example, an air compressor, welding cart, or generator — for maintenance operations, particularly during plant shutdowns, turnarounds, and major process upgrades at larger facilities such as refineries and large petrochemical plants. Paragraph 66.17.1.2, which allows the use of a tank vehicle for such refueling, is based on a similar provision in 42.7.6 .

Exhibit 66.24

A typical chemical process plant.

66.17.2 Reserved.

66.17.3 General Requirements.

66.17.3.1 Liquid processing operations shall be located and operated so that they do not constitute a significant fire or explosion hazard to life, to property of others, or to important buildings or facilities within the same plant. [**30:**17.3.1]

66.17.3.2 Specific requirements shall depend on the inherent risk in the operations themselves, including the liquids being processed, operating temperatures and pressures, and the capability to control any liquid or vapor releases or fire incidents that could occur. [**30:**17.3.2]

66.17.3.3 The interrelationship of the many factors involved shall be based on good engineering and management practices to establish suitable physical and operating requirements. [**30:**17.3.3]

66.17.3.4 Process facilities shall comply with the applicable requirements for specific operations set forth in Sections 66.18, 66.19, 66.28, or 66.29. [**30:**17.3.4]

66.17.3.5 Process facilities shall comply with the applicable requirements for procedures and practices for fire and explosion prevention, protection, and control set forth in Section 66.6. [**30:**17.3.5]

66.17.3.6 Processing and handling of Class II and Class III liquids heated at or above their flash point shall follow the requirements for Class I liquids, unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. *(See 66.4.1.2 and A.66.6.4.1.2.)* [**30:**17.3.6]

66.17.3.7 When a process heats a liquid to a temperature at or above its flashpoint, the following shall apply:

(1) The process vessel shall be closed to the room in which it is located and vented to the outside of the building.
(2) If the vessel needs to be opened to add ingredients, the room ventilation shall meet the requirements of 66.17.11 and the process heating controls will be interlocked with the ventilation such that the process heat will shut down if the ventilation fails or is turned off.
(3) The process vessel shall be equipped with an excess temperature control set to limit excessive heating of the liquid and the subsequent release of vapors.
(4) If a heat transfer medium is used to heat the liquid and the heat transfer fluid can heat the liquid to its boiling point on failure of the process and excess temperature heat controls, a redundant excess temperature control shall be provided.

[**30:**17.3.7]

66.17.4 Location of Process Vessels and Equipment.

66.17.4.1 Liquid-processing vessels and equipment shall be located in accordance with the requirements of this section. [**30:**17.4.1]

66.17.4.2 Processing vessels and buildings containing such processing vessels shall be located so that a fire involving the vessels does not constitute an exposure hazard to other occupancies. [**30:**17.4.2]

66.17.4.3 The minimum distance of a processing vessel to a property line that is or can be built upon, including the opposite side of a public way; to the nearest side of a public way; or to the nearest important building on the same property shall be determined by one of the following:

(1) In accordance with Table 66.17.4.3
(2) In accordance with an engineering evaluation of the process, followed by application of sound fire protection and process engineering principles

[**30:**17.4.3]

The primary performance objective required by 66.17.4.2 and 66.17.4.3 is that the processing vessel or the building housing will not constitute a fire exposure to adjacent buildings or structures. To that end, Table 66.17.4.3 specifies minimum separation distances based on vessel capacity, process operating pressure, and whether the liquid is stable or unstable. However, it must be understood that the separation distances in Table 66.17.4.3 are minimums: If the separation distances based on an engineering evaluation indicate that the minimum separation distances given in the table are not appropriate for the hazard, then greater separation distances as determined by the engineering evaluation are to be used. The engineering evaluation is not optional; it is specifically required by 66.6.4 and 66.17.15.

The maximum operating liquid capacity of a processing vessel is analogous to the maximum capacity of a storage tank. However, some processing vessels are designed to operate only partially filled with liquid, with the remainder of the vessel containing a gas or a vapor. The liquid capacity of the vessel is what is of importance here. One major difference is that the "nearest important building on the same property" is qualified to mean a building that is not directly related to the process. The vessel might or might not be housed in a building, so the distances are measured from the vessel itself.

The greater spacing required by Table 66.17.4.3 for unstable liquids recognizes the possibility that a runaway chemical reaction might produce pressures and flow rates that exceed the capacity of the vent system. The distances specified in the table are doubled if protection for exposures is not provided.

As an example of the application of Table 66.17.4.3, consider two 12,000 gal (45,400 L) batch processing vessels that might or might not be located in a building. The vessels operate at atmospheric pressure and are vented to atmosphere through a reflux condenser. The process involves an exothermic (heat releasing) reaction, and at least one of the reactants can be considered unstable.

The appropriate separation distances, taken from the third row and the fourth and eighth columns of the table, are as follows: 50 ft (15 m) from the nearest property line; 50 ft (15 m) from the opposite side of any public way; 50 ft (15 m) from the nearest important building on the same property that is not directly related to the process; and 50 ft (15 m) from the nearest side of any public way.

Exhibit 66.25 illustrates the separation distances. Note that the presence or absence of the building wall, as indicated by the double-dashed line in the diagram, has no influence on the separation distances.

66.17.4.3.1 Processing vessels used solely to process stable Class IIIB liquids shall be located in accordance with Table 22.4.1.6 of NFPA 30. [**30:**17.4.3.1]

66.17.4.4 Where process vessels are located in a building and the exterior wall facing the exposure (line of adjoining property that is or can be built upon or nearest important building on the same property) is greater than 25 ft (7.6 m) from the exposure and is a blank wall having a fire resistance rating of not less than 2 hours, any greater distances required by Table 66.17.4.3 shall be permitted to be waived. If the exterior wall is a blank wall having a fire resistance rating of not less than 4 hours, all distances required by Table 66.17.4.3 shall be permitted to be waived. [**30:**17.4.4]

66.17.4.5 All the distances given in Table 66.17.4.3 shall be doubled where protection for exposures is not provided. [**30:**17.4.5]

66.17.4.6* Liquid-processing equipment, such as pumps, heaters, filters, and exchangers, shall not be located closer than 25 ft (7.6 m) to property lines where the adjoining property is or can be built upon or to the nearest important building on the same property that is not an integral part of the process. This spacing requirement shall be permitted to be waived where exposures are protected in accordance with 66.17.4.3. [**30:**17.4.6]

A.66.17.4.6 Equipment operated at gauge pressures that exceed 1000 psi (6900 kPa) might require greater spacing. [**30:**A.17.4.6]

The 25 ft (7.6 m) minimum separation distance required by 66.17.4.6 reflects the philosophy that such equipment is

TABLE 66.17.4.3 *Location of Process Vessels with Respect to Property Lines, Public Ways, and the Nearest Important Building on the Same Property — Protection for Exposures Is Provided*

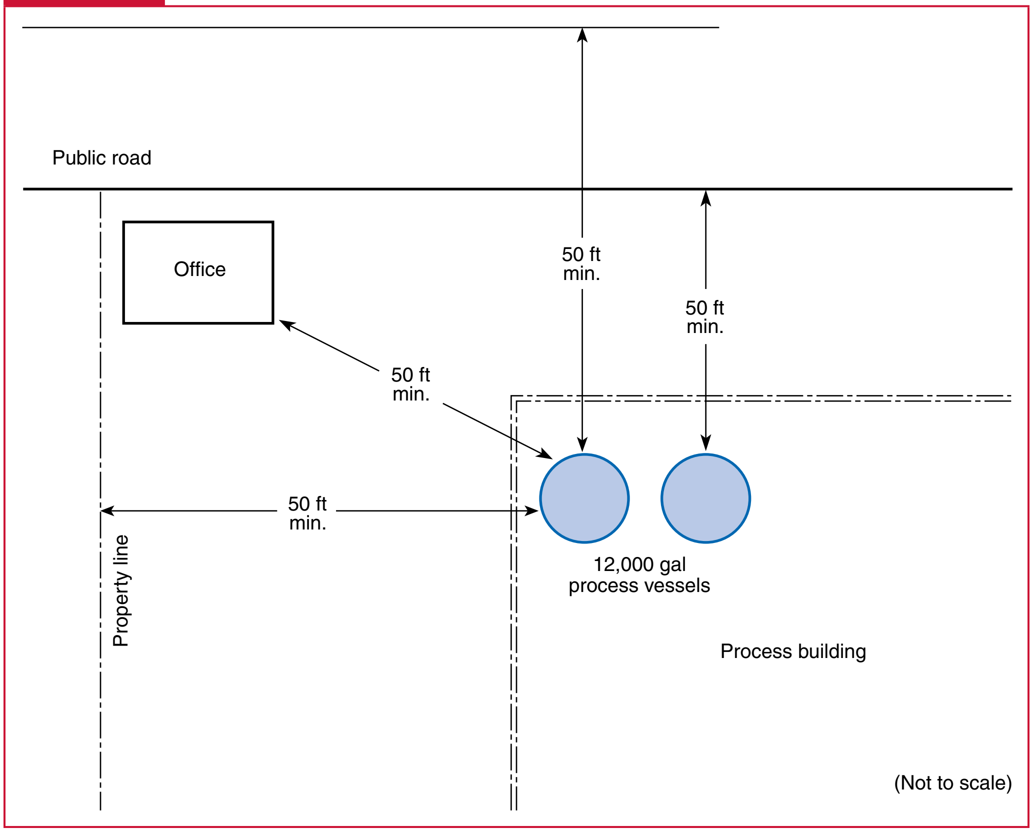
	Minimum Distance (ft)							
	From Property Line that Is or Can Be Built upon, Including Opposite Side of Public Way				From Nearest Side of Any Public Way or from Nearest Important Building on Same Property that Is Not an Integral Part of the Process			
	Stable Liquid Emergency Relief*		Unstable Liquid Emergency Relief*		Stable Liquid Emergency Relief*		Unstable Liquid Emergency Relief*	
Vessel Maximum Operating Liquid Capacity (gal)	**Not Over 2.5 psi**	**Over 2.5 psi**	**Not Over 2.5 psi**	**Over 2.5 psi**	**Not Over 2.5 psi**	**Over 2.5 psi**	**Not Over 2.5 psi**	**Over 2.5 psi**
275 or less	5	25	50	100	5	25	50	100
276 to 750	10	25	50	100	5	25	50	100
751 to 12,000	15	25	50	100	5	25	50	100
12,001 to 30,000	20	30	50	100	5	25	50	100
30,001 to 50,000	30	45	75	120	10	25	50	100
50,001 to 100,000	50	75	125	200	15	25	50	100
Over 100,000	80	120	200	300	25	40	50	100

For SI units, 1 gal = 3.8 L; 1 ft = 0.3 m; 1 psi = a gauge pressure of 6.9 kPa.

Note: Double all of above distances where protection for exposures is not provided.

*Gauge pressure. [**30:** Table 17.4.3]

Exhibit 66.25



Example of the application of Table 66.17.4.3.

inherently more prone to leakage and periodic repair than process vessels. The Annex A note is an important reminder that process equipment operating at high pressures requires special consideration. Leaks in equipment operating at high pressures can result in sizable releases of vapor or atomized liquid, sometimes culminating in explosions.

66.17.4.7 Processing equipment in which unstable liquids are handled shall be separated from unrelated plant facilities by either of the following:

(1) 25 ft (7.6 m) clear spacing
(2) A wall having a fire resistance rating of not less than 2 hours and explosion resistance consistent with the expected hazard

[**30:**17.4.7]

66.17.5 Accessibility. Each process unit or building containing liquid-processing equipment shall be accessible from at least one side for fire fighting and fire control. [**30:**17.5]

66.17.6 Construction Requirements.

66.17.6.1 Process buildings or structures used for liquid operations shall be constructed consistent with the operations being conducted and with the classes of liquids handled. They shall be constructed to minimum Type II (000) construction, as defined in *NFPA 5000*, and shall be constructed in accordance with Table 66.17.6.1. [**30:**17.6.1]

***TABLE 66.17.6.1** Minimum Separation Distances for Buildings or Structures Used for Liquid Handling and Operations*

Liquid Class	Minimum Type of Construction*	Minimum Separation Distance (ft): To Street, Alley, or Public Way	Minimum Separation Distance (ft): To Adjacent Property Line that Is or Can Be Built Upon
Class I liquids; unstable liquids of any class; liquids of any class heated above their flash points†	II (222)	5	10
	II (111)	5	25
	II (000)	10	50
Class II	II (111)	5	10
	II (000)	5	25
Class III	II (000)	5	10

For SI units, 1 ft = 0.3 m.

Note: Distances apply to properties that have protection for exposures, as defined in this code. If there are exposures for which protection does not exist, the distances should be doubled, in accordance with 66.17.6.3.

*Construction types are defined in NFPA 220, *Standard on Types of Building Construction*. [**30:** Table 17.6.1]

†For stable liquids of any class heated above their flash points, see 66.6.4.1.2 and A.66.6.4.1.2.

66.17.6.2 Construction types shall be as defined in *NFPA 5000*. [**30:**17.6.2]

66.17.6.3 Where protection for exposures is not provided, the applicable distances given in Table 66.17.6.1 shall be doubled. [**30:**17.6.3]

66.17.6.4 For buildings or structures that are not provided with approved automatic sprinkler protection, the separation distances otherwise required by Table 66.17.6.1 shall be determined by an engineering evaluation of the process, but shall not be less than the separation distances required by Table 66.17.4.3. [**30:**17.6.4]

66.17.6.5 Buildings or structures used solely for blending, mixing, or dispensing of Class IIIB liquids at temperatures below their flash points shall be permitted to be constructed of combustible construction, subject to the approval of the AHJ. [**30:**17.6.5]

66.17.6.6 Buildings or structures used for processing or handling of liquids where the quantities of liquids do not exceed 360 gal (1360 L) of Class I and Class II liquids and 720 gal (2725 L) of Class IIIA liquids shall be permitted to be constructed of combustible construction, subject to the approval of the AHJ. [**30:**17.6.6]

66.17.6.7 Buildings or structures used for processing or handling of liquids protected with automatic sprinklers or equivalent fire protection systems shall be permitted to be constructed of combustible construction, subject to the approval of the AHJ. [**30:**17.6.7]

Δ **66.17.6.8*** Load-bearing building supports and load-bearing supports of vessels and equipment capable of releasing quantities of liquids that could result in a fire capable of causing substantial property damage shall be protected by one or more of the following:

(1) Drainage to a safe location to prevent liquids from accumulating under vessels or equipment or around load-bearing supports
(2) Fire-resistive construction
(3) Fire-resistant protective coatings or systems
(4) Water spray systems designed and installed in accordance with NFPA 15
(5) Other alternate means acceptable to the AHJ

[**30:**17.6.8]

A.66.17.6.8 API 2218, *Fireproofing Practices in Petroleum and Petrochemical Processing Plants*, contains guidance on selecting and installing fire-resistant coatings to protect exposed steel supports from a high-challenge fire exposure. It also contains a general discussion on determining need for such protection and estimating the extent of the area exposed. [**30:**A.17.6.8]

66.17.6.9 Class I liquids shall not be handled or used in basements. [**30:**17.6.9]

This requirement is based on several incidents in which spilled liquid or vapors from a spill migrated to belowgrade levels and were ignited. Fighting the ensuing fires proved challenging, because of the difficulties in accessing the belowgrade areas.

66.17.6.9.1 Where Class I liquids are handled or used above grade within buildings with basements or closed pits into which flammable vapors can travel, such belowgrade areas shall be provided with mechanical ventilation designed to prevent the accumulation of flammable vapors. [**30:**17.6.9.1]

66.17.6.9.2 Means shall be provided to prevent liquid spills from running into basements. [**30:**17.6.9.2]

66.17.6.10* Smoke and heat venting shall be permitted to be used where it assists access for fire fighting. [**30:**17.6.10]

Δ **A.66.17.6.10** NFPA 204 provides information on this subject. [**30:**A.17.6.10]

66.17.6.11* Areas shall have exit facilities arranged to prevent occupants from being trapped in the event of fire. [**30:**17.6.11]

When the provisions of NFPA *101*®, *Life Safety Code*®, are to be applied, the requirements for high-hazard industrial occupancies should be followed.

Δ **A.66.17.6.11** NFPA *101* provides information on this subject. [**30:**A.17.6.11]

66.17.6.11.1 Exits shall not be exposed by the drainage facilities described in 66.17.10. [**30:**17.6.11.1]

66.17.6.12 Aisles shall be maintained for unobstructed movement of personnel and fire protection equipment. [**30:**17.6.12]

Δ **66.17.6.13** Indoor areas where Class IA or unstable liquids are in use shall be designed to direct flame, combustion gases, and pressures resulting from a deflagration away from important buildings or occupied areas through the use of damage-limiting construction in accordance with NFPA 68. [**30:**17.6.13]

Paragraph 66.17.6.13 is a minimum requirement. Explosion venting (more correctly, deflagration venting) might also be desirable where stable liquids or other classes of liquids are heated and their vapors released. Hot vapors will cool and condense and might form an ignitible cloud of mist.

66.17.6.13.1 The damage-limiting construction design shall be in accordance with recognized standards and shall be acceptable to the AHJ. *(See A.66.9.16.1.)* [**30:**17.6.13.1]

66.17.6.13.2 Where unstable liquids are in use, an approved engineered construction method that is designed to limit damage from an explosion (deflagration or detonation, depending on the characteristics of the liquid) shall be used. [**30:**17.6.13.2]

66.17.7 Reserved.

66.17.8 Reserved.

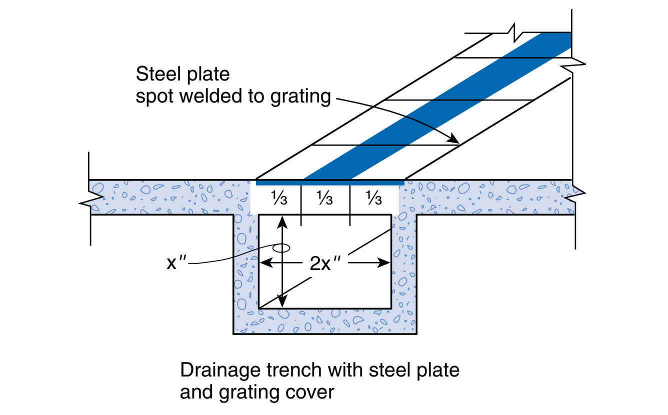
66.17.9 Electrical Systems. Electrical wiring and electrical utilization equipment shall comply with Section 66.7. [**30:**17.9]

66.17.10 Containment, Drainage, and Spill Control.

66.17.10.1* A facility shall be designed and operated to prevent the discharge of liquids to public waterways, public sewers, or adjoining property. [**30:**17.10.1]

Δ **A.66.17.10.1** This might require curbs, scuppers, or special drainage systems to control the spread of fire. Annex A of NFPA 15 provides information on this subject. [**30:**A.17.10.2]

Exhibit 66.26



Details of a well-designed drainage trench.

If scuppers are used to direct liquid leakage, they must not be located in a wall that is immediately adjacent to a diked area; otherwise, a spill drained from within a process building could endanger the storage tanks within the dike. The reference to Annex A of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, is to a description of a vented trench (see Exhibit 66.26). A vented trench is designed so that any flame propagation through it is "lazy" due to lack of air, which minimizes damage. In all cases, the system must discharge to a location acceptable to local, state, and federal environmental authorities.

66.17.10.2 Emergency drainage systems shall be provided to direct liquid leakage and fire protection water to a safe location. [**30:**17.10.2]

66.17.10.3 Emergency drainage systems, if connected to public sewers or discharged into public waterways, shall be equipped with traps or separators. [**30:**17.10.3]

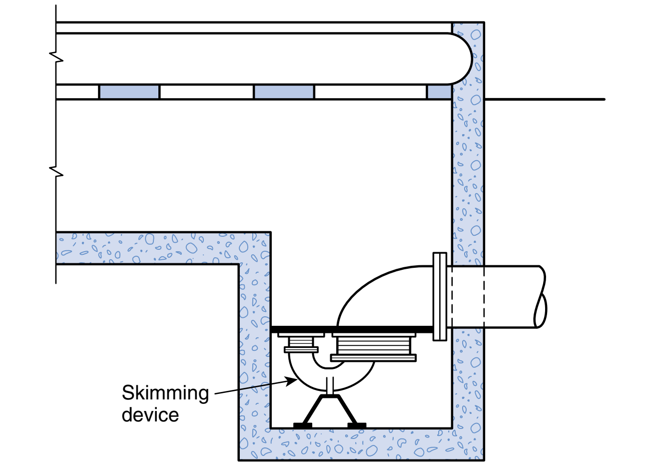
A trap ensures that a liquid seal is maintained as material flows through it, thus preventing flame propagation beyond the trap. Separators are most useful where a two-phase system — oil and water, for example — is discharged and only one phase requires control. See Exhibit 66.27 for an illustration of a suitable trap.

66.17.11 Ventilation.

NFPA 30 requires that the estimated ventilation rate be confirmed either by calculation or by actual test. Once again, environmental legislation is driving the technology of fire protection. Recent regulations that seek to limit discharge of volatile organic gases and vapors have spurred the development of rigorous modeling methods and calculation procedures for estimating the quantity of vapors emitted to a reasonable degree of accuracy (see 66.17.11.2). Annex F of NFPA 30 provides details on the calculation procedure recommended. Undoubtedly, other methods are available and more will be developed.

66.17.11.1 Enclosed processing areas handling or using Class I liquids, or Class II or Class III liquids heated to temperatures at

Exhibit 66.27



Details of a drainage system trap.

or above their flash points, shall be ventilated at a rate sufficient to maintain the concentration of vapors within the area at or below 25 percent of the lower flammable limit (LFL). Compliance with 66.17.11.2 through 66.17.11.10 shall be deemed as meeting the requirements of this section. [**30:**17.11.1]

66.17.11.2* Ventilation requirements shall be confirmed by one of the following:

(1) Calculations based on the anticipated fugitive emissions *(see Annex F of NFPA 30 for calculation method)*.
(2) Sampling of the actual vapor concentration under normal operating conditions. Sampling shall be conducted at a 5 ft (1.5 m) radius from each potential vapor source extending to or toward the bottom and the top of the enclosed processing area. The vapor concentration used to determine the required ventilation rate shall be the highest measured concentration during the sampling procedure.

[**30:**17.11.2]

A.66.17.11.2 Equipment in enclosed processing areas can deteriorate over time, and periodic evaluation should be conducted to ensure that leakage rates have not increased or that the ventilation rate is adequate for any increase in leakage rates. [**30:**A.17.11.2]

66.17.11.3 A ventilation rate of not less than 1 $ft^3/min/ft^2$ (0.3 $m^3/min/m^2$) of solid floor area shall be considered as meeting the requirements of 66.17.11.1. [**30:**17.11.3]

66.17.11.4 Ventilation shall be accomplished by mechanical or natural means. [**30:**17.11.4]

66.17.11.5 Exhaust ventilation discharge shall be to a safe location outside the building. [**30:**17.11.5]

66.17.11.6 Recirculation of the exhaust air shall be permitted only when it is monitored continuously using a fail-safe system that is designed to automatically sound an alarm, stop recirculation, and provide full exhaust to the outside in the event that vapor–air mixtures in concentrations over one-fourth of the lower flammable limit are detected. [**30:**17.11.6]

66.17.11.7* Provision shall be made for introduction of make-up air in such a manner as to avoid short-circuiting the ventilation. [**30:**17.11.7]

Δ **A.66.17.11.7** NFPA 91 and NFPA 90A provide information on this subject. [**30:**A.17.11.7]

66.17.11.8 Ventilation shall be arranged to include all floor areas or pits where flammable vapors can collect. [**30:**17.11.8]

66.17.11.9 Local or spot ventilation to control special fire or health hazards, if provided, shall be permitted to be utilized for up to 75 percent of the required ventilation. [**30:**17.11.9]

66.17.11.10 Where equipment such as dispensing stations, open centrifuges, plate and frame filters, and open vacuum filters is used in a building, the equipment and ventilation of the building shall be designed to limit flammable vapor–air mixtures under normal operating conditions to the interior of equipment and to not more than 5 ft (1.5 m) from equipment that exposes Class I liquids to the air. [**30:**17.11.10]

66.17.12 Reserved.

66.17.13 Reserved.

66.17.14* Process Equipment and Vessels. Equipment shall be designed and arranged to prevent the unintentional escape of liquids and vapors and to minimize the quantity escaping in the event of accidental release. [**30:**17.14]

Δ **A.66.17.14** Where the vapor space of equipment is usually within the flammable range, the probability of explosion damage to the equipment can be limited by inerting, by providing an explosion suppression system, or by designing the equipment to contain the peak explosion pressure that can be modified by explosion relief. Where the special hazards of operation, sources of ignition, or exposures indicate a need, consideration should be given to providing protection by one or more of the above means. [**30:**A.17.14]

See NFPA 68 and NFPA 69 for additional information on various methods of mitigating losses from explosions. [**30:**A.17.14]

66.17.15 Management of Operations Hazards.

66.17.15.1 This section shall apply to the management methodology used to identify, evaluate, and control the hazards involved in processing and handling of flammable and combustible liquids. These hazards include, but are not limited to, preparation; separation; purification; and change of state, energy content, or composition. [**30:**17.15.1]

66.17.15.2 Operations involving flammable and combustible liquids shall be reviewed to ensure that fire and explosion hazards resulting from loss of containment of liquids are provided with corresponding fire prevention and emergency action plans.

Exception No. 1: Operations where liquids are used solely for on-site consumption as fuels.

Exception No. 2: Operations where Class II or Class III liquids are stored in atmospheric tanks or transferred at temperatures below their flash points.

Exception No. 3: Mercantile occupancies, crude petroleum exploration, drillings, and well servicing operations, and normally unoccupied facilities in remote locations.
*[**30:**17.15.2]*

66.17.15.3 The extent of fire prevention and control that is provided shall be determined by means of an engineering evaluation of the operation and application of sound fire protection and process engineering principles. This evaluation shall include, but not be limited to, the following:

(1) Analysis of the fire and explosion hazards of the operation
(2) Analysis of emergency relief from process vessels, taking into consideration the properties of the materials used and the fire-protection and control measures taken
(3) Analysis of applicable facility design requirements in 66.17.3 through 66.17.4
(4) Analysis of applicable requirements in Sections 66.18, 66.19, 66.28, and 66.29 for liquid handling, transfer, and use
(5) Analysis of local conditions, such as exposure to and from adjacent properties and exposure to floods, earthquakes, and windstorms
(6) Analysis of the emergency response capabilities of the local emergency services

[**30:**17.15.3]

66.17.15.4 A written emergency action plan that is consistent with available equipment and personnel shall be established to respond to fires and related emergencies. This plan shall include the following:

(1) Procedures to be followed in case of fire or release of liquids or vapors, such as sounding the alarm, notifying the fire department, evacuating personnel, and controlling and extinguishing the fire
(2) Procedures and schedules for conducting drills of these procedures
(3) Appointment and training of personnel to carry out assigned duties, which shall be reviewed at the time of initial assignment, as responsibilities or response actions change, and whenever anticipated duties change
(4) Procedures for maintenance of the following:
    (a) Fire protection equipment and systems
    (b) Drainage and containment systems
    (c) Ventilation equipment and systems
(5) Procedures for shutting down or isolating equipment to reduce, control, or stop the release of liquid or vapors, including assigning personnel responsible for maintaining critical plant functions or shutdown of plant processes and safe startup following isolation or shutdown
(6) Alternate measures for the safety of occupants

[**30:**17.15.4]

66.17.15.5 The fire hazards management review conducted in accordance with 66.17.15.2 shall be repeated whenever the hazards leading to a fire or explosion change significantly. Conditions that might require repeating a review shall include, but are not limited to, the following:

(1) When changes occur in the materials in process
(2) When changes occur in process equipment
(3) When changes occur in process control
(4) When changes occur in operating procedures or assignments

[**30:**17.15.5]

66.18 Dispensing, Handling, Transfer, and Use of Liquids

66.18.1 Scope. This section applies where liquids are handled, dispensed, transferred, or used, including in process areas. [**30:**18.1]

66.18.2 Reserved.

66.18.3 General Requirements. Processing and handling of Class II and Class III liquids heated at or above their flash point shall follow the requirements for Class I liquids, unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. *(See 66.4.1.2 and A.66.6.4.1.2.)* [**30:**18.3]

66.18.4 Dispensing, Handling, Transfer, and Use.

66.18.4.1 Class I liquids shall be kept in closed tanks or containers when not actually in use. Class II and Class III liquids shall be kept in closed tanks or containers when not actually in use when the ambient or process temperature is at or above their flash points. [**30:**18.4.1]

Note that Class II and Class III liquids are required to be kept in closed containers only if they are exposed to ambient temperatures or process temperatures that exceed their flash points. Good practice dictates that all containers be kept tightly capped or sealed when not in use.

66.18.4.2 Where liquids are used or handled, provisions shall be made to promptly and safely mitigate and dispose of leakage or spills. [**30:**18.4.2]

66.18.4.3 Class I liquids shall not be used outside closed systems where there are open flames or other ignition sources within the classified areas set forth in Section 66.7. [**30:**18.4.3]

66.18.4.4 Transfer of liquids among vessels, containers, tanks, and piping systems by means of air or inert gas pressure shall be permitted only under all of the following conditions:

(1) The vessels, containers, tanks, and piping systems shall be designed for such pressurized transfer and shall be capable of withstanding the anticipated operating pressure.
(2) Safety and operating controls, including pressure-relief devices, shall be provided to prevent overpressure of any part of the system.
(3) Only inert gas shall be used to transfer Class I liquids. Only inert gas shall be used to transfer Class II and Class III liquids that are heated above their flash points.

[**30:**18.4.4]

The provisions of 66.18.4.4 provide a reasonable balance between safety and flexibility, based on current industry practices. Inert gas must still be used for any Class I liquid or any other liquid being handled at or above its flash point except as provided for in 66.18.4.4.1.

66.18.4.4.1 Dispensing of Class I liquids from a container by means of air shall be permitted under the following conditions:

(1) The pressure shall be generated by means of a listed hand-operated device.
(2) Pressure shall not exceed a gauge pressure of 6 psi (41 kPa) and pressure relief shall be provided.
(3) The container shall not exceed 119 gal (450 L) and shall be capable of withstanding the maximum pressure generated by the device.
(4) The device shall be bonded and grounded or shall be demonstrated as not being capable of generating a static charge under any operating condition.
(5) The material of construction of the device shall be compatible with the liquid dispensed.

[**30:**18.4.4.1]

Paragraph 66.18.4.4.1 was added to the 2015 edition of the *Code*. It addresses manually operated pumps, such as the one shown in Exhibit 66.28. Such pumps are already allowed for transferring Class II and Class III liquids by inference in 66.18.4.4. This provision of the *Code* extends the use of compressed air to transfer Class I liquids, albeit with considerable restrictions. First, only a manual pump can be used; a compressed air system is still prohibited. A maximum pressure is imposed, and use is restricted to containers as they are defined in this *Code*. Because 66.18.4.4.1 addresses liquids that are ignitible at ambient conditions, control of static electric charges is mandated.

66.18.4.5 Positive displacement pumps shall be provided with pressure relief that discharges back to the tank, pump suction, or other suitable location or shall be provided with interlocks to prevent overpressure. [**30:**18.4.5]

Exhibit 66.28

Example of a hand pump for liquids. (Courtesy of GoatThroat® Pumps)

The intent of 66.18.4.5 is to prevent failure of the piping system due to overpressure caused by a line blockage, shut valve, and so on. Unlike a centrifugal pump, in such cases a positive displacement pump will continue to pressurize the discharge piping until it fails.

66.18.4.6 Piping, valves, and fittings shall meet the requirements of Section 66.27. [**30:**18.4.6]

Δ **66.18.4.7** Approved hose shall be permitted to be used at transfer stations. [**30:**18.4.7]

Prior to the 2018 edition of the *Code*, 66.18.4.7 also referred to flexible connectors. This reference was deleted because flexible connectors are addressed in 66.27.5.2.

66.18.4.8* The staging of liquids in containers, intermediate bulk containers, and portable tanks shall be limited to the following:

(1) Containers, intermediate bulk containers, and portable tanks that are in use
(2) Containers, intermediate bulk containers, and portable tanks that were filled during a single shift
(3) Containers, intermediate bulk containers, and portable tanks needed to supply the process for one continuous 24-hour period
(4) Containers, intermediate bulk containers, and portable tanks that are stored in accordance with Section 66.9

[**30:**18.4.8]

A.66.18.4.8 The process area is not intended to be a storage area for liquid containers. However, it is recognized that containers will be brought into the process area either for transfer of liquids to the process or for dispensing liquids from the process to the containers. [**30:**A.18.4.8]

The amount of liquid in containers in the process area should be limited as much as possible. Full containers should not be stored in the process area but can be staged there. Only the amount of liquid needed for one continuous 24-hour period should be brought into the process area in full containers. Partial containers can remain in the process area as long as they do not increase the hazard present. Containers that were filled in the process area can remain there during the shift that they were filled but should be relocated to the appropriate storage area before the end of the workday or shift in the case of 24-hour-a-day operations. [**30:**A.18.4.8]

66.18.4.9 Class I, Class II, or Class IIIA liquids used in a process and staged in the process area shall not be filled in the process area.

Exception No. 1: Intermediate bulk containers and portable tanks that meet the requirements of Section 66.9.

*Exception No. 2: Intermediate products that are manufactured in the process area. [**30:**18.4.9]*

66.18.5 Incidental Operations.

66.18.5.1* This section shall apply to areas where the use, handling, and storage of liquids is only a limited activity to the established occupancy classification. [**30:**18.5.1]

A.66.18.5.1 Incidental operations are operations that utilize liquids only as a limited activity to that which establishes the occupancy classification. Examples include automobile assembly, assembly of electronic equipment, furniture manufacturing, and areas within refineries, distilleries, and chemical plants where the use of liquids is incidental, such as in maintenance shops, offices, or vehicle repair shops. Some more detailed descriptions follow:

(1) *Vehicle Assembly.* Vehicle assembly operations usually involve both process and incidental use of liquids. An example of a process operation would be paint storage and mixing utilized for application of the vehicle primer, color coats, and clear coats. For these operations, the requirements of Chapter 17 of NFPA 30 apply. Examples of incidental use would be sealer deck wipedown operations, windshield washer solvent dispensing, brake fluid filling, and final line paint repair operations. These operations might be continuous. However, the quantities of liquids used and the vapor exposures are significantly reduced from larger volume usage found within vehicle body component paint mixing and storage operations.
(2) *Assembly of Electrical Equipment.* Examples of incidental use of liquids in these types of occupancies might include "photoresist" coating operations, "softbaking" operations, wave solder operations, and wipedown operations.
(3) *Chemical Plant Maintenance Shop.* Incidental use of liquids is commonplace in maintenance shops located within a chemical plant. Examples are cutting oils used in a machine shop, Class II solvents for degreasing, and Class I and II paint solvents and fuels associated with automotive and industrial truck repair.
(4) *Cleaning and Sanitation.* Under provisions established by the U.S. Food and Drug Administration (FDA) in 21 CFR, "GMP for Medical Devices," Class I and Class II liquids can be used for cleaning and sanitation purposes. Limited quantities are used to remove manufacturing materials, mold release compounds, and other contaminants not intended to be on the final product. An example would be the use of isopropyl alcohol (IPA), transferred to a cleaning wipe via a plunger-type liquid-dispensing container. The cleaning wipe is then used to remove manufacturing materials not intended to be on the final product. The key point here is not that the liquid is not part of the final product, but that limited quantities of liquid are used and the use is incidental to the manufacturing operation that produces the product.

[**30:**A.18.5.1]

66.18.5.2 Class I liquids or Class II and Class III liquids that are heated up to or above their flash points shall be drawn from or transferred into vessels, containers, or portable tanks as follows:

(1) From original shipping containers with a capacity of 5.3 gal (20 L) or less
(2) From safety cans
(3) Through a closed piping system
(4) From portable tanks or containers by means of a device that has antisiphoning protection and that draws through an opening in the top of the tank or container
(5) By gravity through a listed self-closing valve or self-closing faucet

[**30:**18.5.2]

66.18.5.2.1 If hose is used in the transfer operation, it shall be equipped with a self-closing valve without a hold-open latch in addition to the outlet valve. Only listed or approved hose shall be used. [**30:**18.5.2.1]

66.18.5.2.2 Means shall be provided to minimize generation of static electricity. Such means shall meet the requirements of 66.6.5.4. [**30:**18.5.2.2]

66.18.5.2.3 Where pumps are used for liquid transfer, means shall be provided to deactivate liquid transfer in the event of a liquid spill or fire. [**30:**18.5.2.3]

66.18.5.3 Storage of liquids other than those governed by 66.18.5.4 and 66.18.5.5 shall comply with Section 66.9. [**30:**18.5.3]

66.18.5.4 The maximum allowable quantities (MAQs) of liquids in containers in use in incidental operations in a control area shall not exceed the greater of the following:

(1)* The amount required to supply incidental operations for one continuous 24-hour period, provided the hazard analysis required in Section 66.6 accounts for these quantities

A.66.18.5.4(1) The intent of this requirement is to allow the quantities of flammable and combustible liquids needed to safely and efficiently operate for the actual operating hours in any 24-hour period. As an example, if the facility operates only 8 hours out of 24 (i.e., a single shift) and uses 50 gal (190 L) of liquid during that time, then 50 gal (190 L) is the allowable quantity for the continuous 24-hour period. If the facility increases operations to two shifts, then the allowable quantity doubles to 100 gal (380 L). [**30:**A.18.5.4(1)]

(2) The aggregate sum of the quantities provided in Table 66.18.5.4

N ***TABLE 66.18.5.4*** *MAQ of Flammable and Combustible Liquids Per Control Area for Incidental Operations*

	Open Use		Use — Closed Containers	
Liquid Class(es)	**gal**	**L**	**gal**	**L**
IA	10	38	30	115
IB and IC	30	115	120	460
II	30	115	120	460
IIIA	80	300	330	1,265
IIIB	3,300	12,650	13,200	50,600

Notes:

Quantities are permitted to be increased 100 percent where stored in approved flammable liquids storage cabinets or in safety cans. Where note (2) also applies, the increase for both notes is permitted to be applied accumulatively.

Quantities are permitted to be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system installed in accordance with NFPA 13. Where Note (1) also applies, the increase for both notes is permitted to be applied accumulatively.

[**30:**18.5.4]

N **66.18.5.4.1** Where the quantities of liquids in incidental operations are governed by 66.18.5.4(2), the aggregate quantity of liquids in storage and in use shall not exceed the maximum allowable quantity per control area in Section 66.9. [**30:**18.5.4.1]

N **66.18.5.4.2** Control areas shall be in accordance with Section 66.9. [**30:**18.5.4.2]

• **66.18.5.5** Where quantities of liquids in excess of the limits in 66.18.5.4.1 are necessary, storage shall be in tanks that meet all applicable requirements of Section 66.17, Sections 66.21 through 66.25, and Section 66.27. [**30:**18.5.5]

The use of tanks, pumps, and piping systems eliminates the need for frequent opening and handling of small containers, greatly reducing the likelihood of spills.

66.18.5.6 Areas in which liquids are transferred from one tank or container to another container shall be provided with the following:

(1) Separation from other operations where potential ignition sources are present by distance or by fire-resistant construction

With respect to the separation distance or fire-resistive construction required by 66.17.6, no specific distance and no specific hourly fire resistance rating are cited to address the intent of 66.18.5.6(1). The appropriate determination requires considerable judgment on the part of the user. For example, a 1 gpm (3.8 L/min) leak will feed an 8 ft^2 (0.75 m^2) pool of burning liquid. While no one would want to stand close to such a fire, a simple metal partition would effectively stop the radiant heat.

(2) Drainage or other means to control spills
(3) Natural or mechanical ventilation that meets the requirements of 66.17.11

[**30:**18.5.6]

66.18.6 Ventilation for Dispensing Areas. Liquid storage areas where dispensing is conducted shall be provided with either a gravity system or a continuous mechanical exhaust ventilation system. Mechanical ventilation shall be used if Class I liquids are dispensed within the room. [**30:**18.6]

66.18.6.1 Exhaust air shall be taken from a point near a wall on one side of the room and within 12 in. (300 mm) of the floor, with one or more make-up inlets located on the opposite side of the room within 12 in. (300 mm) of the floor. [**30:**18.6.1]

66.18.6.2 The location of both the exhaust and inlet air openings shall be arranged to provide air movement across all portions of the floor to prevent accumulation of flammable vapors. [**30:**18.6.2]

66.18.6.3* Exhaust ventilation discharge shall be to a safe location outside the building. [**30:**18.6.3]

A.66.18.6.3 A "safe location" should be selected as the location of a vent discharge to minimize the potential for ignitible vapors to travel to a source of ignition after discharge from the vent. Electrical equipment that does not meet the requirements for hazardous locations can serve as an ignition source. The Technical Committee advises that vent discharge locations should consider such factors as the following:

(1) Characteristics of the exhausted material (vapor density, toxicity, velocity of discharge, etc.)
(2) Proximity to potential ignition sources
(3) Building openings such as doors, windows, air intakes, and so forth.
(4) Dispersion characteristics (distance to discharge within the flammable range, direction of discharge, atmospheric conditions, and the influence of building and neighboring buildings on discharged vapors)
(5) Likelihood of vapor accumulation following discharge, such as accumulation under building eaves
(6) Likelihood of sufficient discharge volume to allow an ignitible concentration to reach an ignition source

[**30:**A.18.6.3]

Historically, NFPA 30 has provided prescriptive guidance, often based on area classification requirements, and results have been acceptable. Closer distances should be accepted only if an engineering study by a qualified engineer justifies closer distances. Similarly, the specified distances might not be acceptable for all installations, thus the guidance provided above. [**30:**A.18.6.3]

66.18.6.3.1 Recirculation of the exhaust air shall be permitted only when it is monitored continuously using a fail-safe system that is designed to automatically sound an alarm, stop recirculation, and provide full exhaust to the outside in the event that vapor-air mixtures in concentrations over one-fourth of the lower flammable limit are detected. [**30:**18.6.3.1]

Δ **66.18.6.4** If ducts are used, they shall not be used for any other purpose and shall comply with NFPA 91. [**30:**18.6.4]

Δ **66.18.6.4.1** If make-up air to a mechanical system is taken from within the building, the opening shall be equipped with a fire door or damper, as required in NFPA 91. [**30:**18.6.4.1]

66.18.6.4.2 For gravity systems, the make-up air shall be supplied from outside the building. [**30:**18.6.4.2]

66.18.6.5 Mechanical ventilation systems shall provide at least 1 cfm of exhaust air for each square foot of floor area (0.3 $m^3/min/m^2$), but not less than 150 cfm (4 m^3/min). [**30:**18.6.5]

66.18.6.5.1 The mechanical ventilation system for dispensing areas shall be equipped with an airflow switch or other equally reliable method that is interlocked to sound an audible alarm upon failure of the ventilation system. [**30:**18.6.5.1]

66.19 Specific Operations

66.19.1 Scope. This section shall apply to the handling and use of flammable and combustible liquids in specific operations as herein described. [**30:**19.1]

66.19.2 Definitions Specific to Section 66.19.

66.19.2.1* Cooking Oil. Where used in this chapter, cooking oil shall be defined as a Class IIIB combustible liquid. This definition shall apply to both fresh, or new, cooking oil and waste, or used, cooking oil. [**30:**19.2.1]

A.66.19.2.1 Cooking oil is a Class IIIB liquid with a high flash point typically above 500°F (260°C). Because of its high flash point, cooking oil presents a lower fire hazard than Class IIIB liquids having flash points lower than 500°F (260°C). Fresh, or new, cooking oil is supplied to the user for cooking operations. As the oil becomes degraded through repeated use, it must be replaced with fresh oil. This waste, or used, cooking oil is recovered from the cooking appliance and temporarily stored for offsite removal. To maintain fluidity in the transfer process, the waste oil is heated to approximately 100°F (38°C), well below the flash point temperature. [**30:**A.19.2.1]

This definition of *cooking oil* was added to support 66.19.7, which was added to the 2015 edition of the *Code*. The definition explicitly recognizes that cooking oil is a Class IIIB liquid.

66.19.3 Reserved.

66.19.4 Recirculating Heat Transfer Systems.

Recirculating heat transfer systems are considered to be — and indeed are — much safer than systems involving direct-fired units. However, if the fluid used in the system is combustible and is heated up to or above its flash point, the potential for a fire is present. Even if the fluid is not heated to its flash point, a release under pressure, which does happen, can result in a cloud of very fine mist that can quite easily be ignited.

66.19.4.1 Scope.

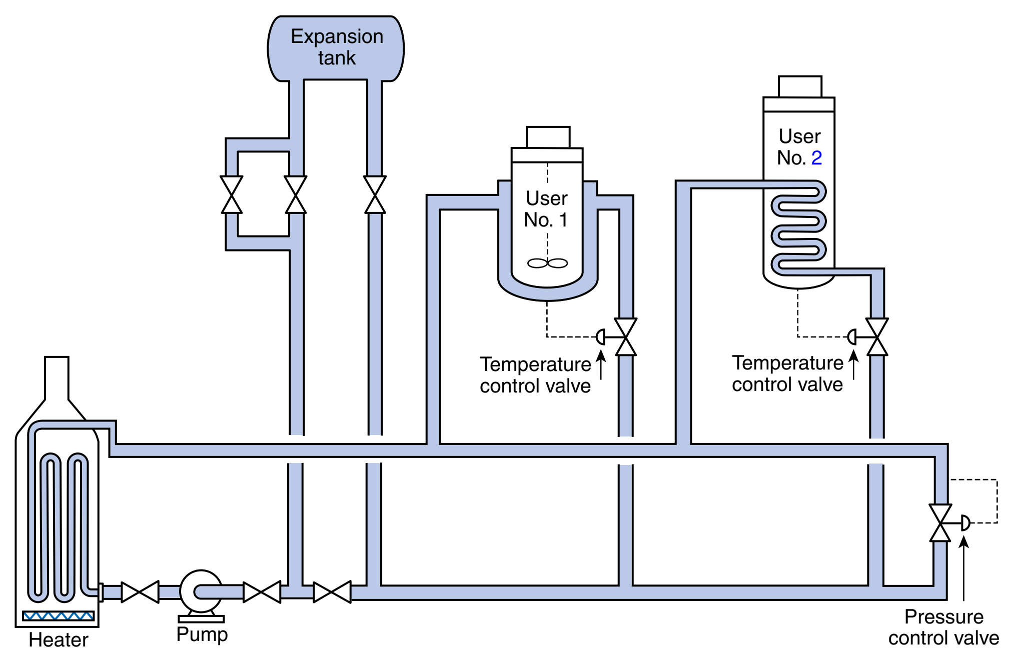
The types of heating systems covered in 66.19.4 use a fluid to transfer heat from the point at which it is generated, usually a boiler, to the process where the heat is used. The liquid circulates back and forth between its starting point and the point at which the heat is expended. The heat transfer fluid does not take part in any kind of reaction, and it is not otherwise used in any kind of a process. See Exhibit 66.29.

66.19.4.1.1 This section shall apply only to recirculating heat transfer systems that use a heat transfer fluid that is heated up to or above its flash point under normal operation. [**30:**19.4.1.1]

66.19.4.1.2 This section shall not apply to process streams used as a means of heat transfer or to any heat transfer system of 60 gal (230 L) capacity or less. [**30:**19.4.1.2]

It is common in chemical and refining processes to use heated process streams to transfer thermal energy from an outgoing process stream to an incoming one. This strategy saves enormous amounts of fuel by utilizing heat that otherwise might be wasted.

Exhibit 66.29



Schematic of a recirculating heat transfer system.

66.19.4.2* General Requirements. A heater or vaporizer for heat transfer fluid that is located inside a building shall meet all applicable requirements of Section 66.17. [**30:**19.4.2]

A.66.19.4.2 Mist explosions have occurred when heat transfer fluid that is above its boiling point has been released in an enclosed area. Consideration should be given to locating heaters or vaporizers either in a detached building or in a room with damage-limiting construction. [**30:**A.19.4.2]

66.19.4.3* System Design.

A.66.19.4.3 The system should be interlocked to stop circulation of the heat transfer fluid through the system and to shut off the system heater or vaporizer in the event of a fire, abnormally low pressure in the system, or operation of an approved heat detection system. Where the refractory inside the heater or vaporizer can retain enough heat to cause either breakdown of the heat transfer fluid or tube fouling if fluid circulation through the unit is stopped, circulation could have to be continued. In the event of a confirmed fire, it is desirable to subdivide the piping system by means of interlocked safety shutoff valves. A practical way of accomplishing this is to isolate all secondary circulating loops from the primary loop that runs into and out of the vaporizer or heater. [**30:**A.19.4.3]

A well-marked remote emergency shutoff switch or electrical disconnect should be provided to shut down the entire system in the event of an emergency. This should be located either in a constantly attended location or at a location that would be accessible in the event of a leak or a fire. [**30:**A.19.4.3]

If there are any process or utility lines running in or through rooms or areas containing parts of the heat transfer system, consideration should be given to providing emergency shutoff valves. They should be located so they are readily accessible in the event of a fire. [**30:**A.19.4.3]

Where the liquid level in the system expansion tank is maintained by an automatically actuated supply pump taking suction from the heat transfer fluid storage tank, an interlock should be provided to shut down the supply pump when a high level indicator is actuated, regardless of whether the pump is in automatic or manual mode. [**30:**A.19.4.3]

66.19.4.3.1* Drainage shall be provided at strategic low points in the heat transfer system. Drains shall be piped to a safe location that is capable of accommodating the total capacity of the system or the capacity of that part of the system that is isolated. [**30:**19.4.3.1]

A.66.19.4.3.1 Heat transfer fluid systems have the potential for releasing large quantities of heated flammable or combustible liquid. Low point drains piped to a safe location provide the ability to remove heat transfer fluid from a breached piping system in order to minimize the total quantity of fluid released. An engineering analysis should be used to determine the location and design of low-point drains. The engineering analysis should consider system inventory, the amount of heat transfer fluid that can be released in a specific fire area, the exposure created by a release, and the fire protection provided. [**30:**A.19.4.3.1]

66.19.4.3.2* Where the heat transfer system expansion tank is located above floor level and has a capacity of more than 250 gal (950 L), it shall be provided with a low-point drain line that can allow the expansion tank to drain to a drain tank on a lower level. The drain line valve shall be operable from a safe location. [**30:**19.4.3.2]

A.66.19.4.3.2 Where possible, the drain tank(s) should be located below the lowest system drain opening to permit gravity flow. Breather vents should be provided based on the maximum emptying or filling rates. [**30:**A.19.4.3.2]

66.19.4.3.3 A heat transfer fluid system shall not be used to provide direct building heat. [**30:**19.4.3.3]

66.19.4.3.4 All pressure-relief device outlets shall be piped to a safe location. [**30:**19.4.3.4]

Δ **66.19.4.4* Fuel Burner Controls and Interlocks.** Oil- or gas-fired heaters or vaporizers shall be designed and installed in accordance with the applicable requirements of NFPA 31 or NFPA 85 whichever is applicable. Wood dust suspension-fired heaters or vaporizers shall be designed and installed in accordance with the applicable requirements of NFPA 85. [**30:**19.4.4]

A.66.19.4.4 If stack gas from a heater or vaporizer is recovered to provide auxiliary heat for other equipment (e.g., rotary dryers), suitable dampers, isolation gates, burner control logic, or other means should be provided to ensure that all equipment is properly purged and will operate in a safe manner. The control logic should anticipate all possible operating modes of the individual pieces of equipment, whether operating singly or together, to ensure safe startup and shutdown under normal or upset conditions. [**30:**A.19.4.4]

Instrumentation and interlocks should be provided to sound an alarm and to automatically shut down the fuel source to the heater or vaporizer when any of the following conditions are detected:

(1) Low flow of heat transfer fluid through the heat exchange tubes of the heater, as measured at the discharge.
(2) High temperature or pressure of the fluid at the heater or vaporizer outlet. The high-temperature interlock should be set at or below the manufacturer's maximum recommended bulk fluid temperature.
(3) Low pressure at the heater or vaporizer outlet or elsewhere in the system. This interlock could require a bypass to allow for startup.
(4) Low fluid level in the expansion tank.
(5) Low liquid level in the vaporizer.
(6) Sprinkler system flow in any area containing the heat transfer equipment or piping.

[**30:**A.19.4.4]

Alarm set points should be provided at levels below or above the automatic shutoff setpoints to monitor the above-mentioned variables and provide an opportunity for operators to correct the problem before conditions reach an unsafe level. [**30:**A.19.4.4]

66.19.4.5 Piping.

66.19.4.5.1* Piping shall meet all applicable requirements of Section 66.27. [**30:**19.4.5.1]

A.66.19.4.5.1 Where possible, piping should be run underground, outside, or in floor trenches. Overhead routing of heat transfer fluid piping should be minimized. [**30:**A.19.4.5.1]

66.19.4.5.2 All pipe connections shall be welded. [**30:**19.4.5.2]

66.19.4.5.2.1 Welded, threaded connections shall be permitted to be used for piping 2 in. (50 mm) and smaller. [**30:**19.4.5.2.1]

66.19.4.5.2.2 Mechanical joints shall be permitted to be used at pump, valve, and equipment connections. [**30:**19.4.5.2.2]

66.19.4.5.3 New piping that is to be insulated with permanent insulation and existing piping that has been disturbed and is to be reinsulated with permanent insulation shall be covered with a closed-cell, nonabsorbent insulation material. [**30:**19.4.5.3]

The reason for requiring closed-cell, nonabsorbent insulation is to prevent a minor piping leak from soaking into the insulation without being noticed, which creates a fire hazard. First, detection of the leak is delayed. Second, the heat transfer fluid is kept in contact with the heated pipe and can thermally degrade; the longer the leak goes undetected, the greater the fluid degrades. Finally, if the leak goes undetected for too long, degradation might lead to spontaneous heating and subsequent ignition of the leaked fluid.

66.19.4.5.3.1 Where all pipe joints are welded and where there are no other points in the system subject to leakage, such as at valves or pumps, other types of insulation shall be permitted. [**30:**19.4.5.3.1]

66.19.4.5.3.2 Where dams are formed around possible leak-producing areas, using metal "donut" flanges that are welded to the pipe or using a "donut" segment of nonabsorbent insulation sealed to the pipe to prevent migration of leakage into adjacent insulation, the piping from dam to dam shall be considered to be a closed system and other types of insulation shall be permitted. The area subject to leakage where the dam has been constructed shall be insulated with nonabsorbent insulation or a nonabsorbent insulation system. [**30:**19.4.5.3.2]

66.19.4.5.3.3 Where removable, reusable insulated covers are required for access, the covers shall be fabricated of flexible or rigid insulation that is encapsulated in a manner to provide a nonabsorbent insulation system to prevent absorption of leakage into the insulation. [**30:**19.4.5.3.3]

66.19.4.6 Fire Protection.

Δ **66.19.4.6.1*** Automatic sprinkler protection meeting the requirements of Section 13.3 and NFPA 13 for Extra Hazard (Group I) Occupancies shall be provided for building areas containing a heat transfer system heater or vaporizer. [**30:**19.4.6.1]

A.66.19.4.6.1 Historical records show that fires involving heat transfer fluids can be very severe and long lasting. It is recommended that automatic sprinkler or deluge protection be provided throughout all building areas potentially exposed to a heat transfer fluid spill fire. [**30:**A.19.4.6.1]

66.19.4.6.2 An alternate fire protection system shall be permitted to be used, if approved by the AHJ. Such alternate system shall be designed and installed in accordance with the appropriate NFPA standard and with manufacturer's recommendations for the system selected. [**30:**19.4.6.2]

66.19.4.7 Operation.

66.19.4.7.1* Operations involving heat transfer fluid systems and equipment shall be reviewed to ensure that the fire and explosion hazards resulting from loss of containment of the fluid or failure of the system are provided with corresponding fire prevention and emergency action plans. [**30:**19.4.7.1]

A.66.19.4.7.1 Some factors that should be considered as part of such a review include the following:

(1) Infiltration of material being heated into the heat transfer system. In this case, the system should be shut down and the internal leak point found and repaired as soon as possible.
(2) Leaks in the system. Any leak should be corrected promptly regardless of how small. Corrections should be permanent, such as repacking valve stems and replacing leaky gaskets. Any heat transfer fluid released as a result of a leak or operation of a safety valve should be cleaned up immediately if it is or can come in contact with a hot surface. Other spills can be cleaned up at the first available opportunity.
(3) Pipe or equipment insulation that is soaked with heat transfer fluid. In this case, the cause of the leak should be corrected promptly and the insulation replaced with clean, dry insulation.
(4) High temperature anywhere in the system. In this case, operating procedures should specify shutdown of the heater or vaporizer fuel supply as soon as the temperature of the heat transfer fluid exceeds the manufacturer's recommended maximum bulk fluid temperature. Any corrective actions taken to correct a high temperature condition should only be done with the heat source shut off.

[**30:**A.19.4.7.1]

66.19.4.7.2 Operators of heat transfer systems shall be trained in the hazards of improper operation of the system and leakage and shall be trained to recognize upset conditions that can lead to dangerous situations. [**30:**19.4.7.2]

66.19.4.7.3 Safety interlocks shall be inspected, calibrated, and tested annually or at other intervals established in accordance with other applicable standards to determine that they are in proper operating condition. [**30:**19.4.7.3]

66.19.5 Vapor Recovery and Vapor Processing Systems.

Vapor recovery and vapor processing systems (referred to in the commentary that follows as "vapor-handling systems") can present a significant risk of fire and explosion because, under normal operating conditions, they handle vapor-air mixtures that are in the flammable range. Of necessity, they interconnect all the tanks and process equipment that they serve with long runs of fairly large-diameter piping. The piping collects the vapors that would otherwise be discharged to the atmosphere and directs them to a central collection point, where they are either condensed to liquid and recovered or processed in some fashion. Unfortunately, the piping also provides a means for fire or explosion to travel between storage tanks and equipment. In addition, a flame front that travels through a pipe that is long enough will "pressure pile" and accelerate. If the flame front reaches its detonation velocity, it will rupture the piping. For that reason, the U.S. Coast Guard requires the use of approved detonation arresters in vapor recovery and collection piping installed at marine terminals. These detonation arresters are much more robustly built than simple flame arresters in order to accommodate the much higher pressures that can result from occurrences of ignition.

66.19.5.1 Scope.

66.19.5.1.1 This section shall apply to vapor recovery and vapor processing systems where the vapor source operates at pressures from vacuum up to and including a gauge pressure of 1.0 psi (6.9 kPa), or where there is a potential for vapor mixtures in the flammable range. [**30:**19.5.1.1]

Δ **66.19.5.1.2** This section shall not apply to the following:

(1) Marine systems that comply with U.S. Department of Transportation Regulations in Title 33, Code of Federal Regulations, Parts 154, 155, and 156, and U.S. Coast Guard Regulations in Title 46, Code of Federal Regulations, Parts 30, 32, 35, and 39
(2) Marine and automotive service station systems that comply with Chapter 30 and NFPA 30A

[**30:**19.5.1.2]

The DOT and the U.S. Coast Guard have jurisdiction over and have promulgated standards for pipeline terminals and marine terminals, respectively. Hence, those facilities are not covered by NFPA 30 or by this *Code*. NFPA 30A addresses the small vapor recovery systems used at automotive and marine service stations (see Section 42.9).

66.19.5.2 Overpressure Protection and Vacuum Protection. Tanks and equipment shall have independent venting for overpressure or vacuum conditions that could occur from malfunction of the vapor recovery or vapor processing system.

Exception: For tanks, venting shall comply with 66.21.4.3. [30:19.5.2]

66.19.5.3 Vent Location.

66.19.5.3.1 Vents on vapor processing systems shall be not less than 12 ft (3.7 m) from adjacent ground level, with outlets located and directed so that ignitible vapors will disperse to a concentration below the lower flammable limit before reaching any location that contains an ignition source. [**30:**19.5.3.1]

66.19.5.3.2 Vent outlets shall be located so that vapors will not be trapped by eaves or other obstructions and shall be at least 5 ft (1.5 m) from building openings and at least 15 ft (4.5 m) from powered ventilation air intake devices. [**30:**19.5.3.2]

66.19.5.3.3 Vapor processing equipment and their vents shall be located in accordance with 66.17.3. [**30:**19.5.3.3]

66.19.5.4 Vapor Collection Systems.

66.19.5.4.1 Vapor collection piping shall be designed to prevent trapping liquid. [**30:**19.5.4.1]

The vapor handled by the collection piping can be expected to condense to some degree, depending on environmental factors and ambient conditions. The condensate collects in low points in the piping, potentially isolating some parts of the system. The condensate acts like the water seal in a reverse trap in a plumbing system. If condensate collects and isolates a storage tank from the rest of the collection system, vapors from the tank can no longer be directed to the vapor-handling system. A worst-case condition might lead to damaging back pressure on the tank the next time it is filled. Therefore, it is imperative that the piping system be designed and installed to eliminate any low points and to ensure that condensate can drain to a receiver at the vapor collection point. Alternatively, points in the system where condensate can collect can be fitted with collection pots and drains.

66.19.5.4.2 Vapor recovery and vapor processing systems that are not designed to handle liquid shall be provided with a means to eliminate any liquid that carries over to or condenses in the vapor collection system. [**30:**19.5.4.2]

66.19.5.5 Liquid Level Monitoring.

66.19.5.5.1* A liquid knock-out vessel used in the vapor collection system shall have means to verify the liquid level and a high liquid level sensor that activates an alarm. [**30:**19.5.5.1]

A.66.19.5.5.1 If the liquid knock-out vessel utilizes a pump for automatic liquid removal, consideration should be given to a low-level alarm and shutdown to avoid running the pump dry, resulting in a potential source of ignition. [**30:**A.19.5.5.1]

66.19.5.5.2 For unattended facilities, the high liquid level sensor shall initiate shutdown of liquid transfer into the vessel and shutdown of vapor recovery or vapor processing systems. [**30:**19.5.5.2]

66.19.5.6 Overfill Protection.

66.19.5.6.1 Storage tanks served by vapor processing or vapor recovery systems shall be equipped with overfill protection in accordance with 66.21.7.1. [**30:**19.5.6.1]

66.19.5.6.2 Overfill protection of tank vehicles shall be in accordance with applicable provisions of 66.28.11.1. [**30:**19.5.6.2]

66.19.5.7 Sources of Ignition.

66.19.5.7.1 Vapor Release. Tank or equipment openings provided for purposes of vapor recovery shall be protected against possible vapor release in accordance with 66.23.13.7 and 66.28.11.1.8.1. [**30:**19.5.7.1]

66.19.5.7.2* Electrical Area Classification. Electrical area classification shall be in accordance with Section 66.7. [**30:**19.5.7.2]

A.66.19.5.7.2 Electrical enclosures that need to be opened frequently for maintenance (i.e., enclosures housing vapor processing system controls) have a higher potential for mechanical damage that could render the enclosures unable to contain an explosion. Additional inspection could be needed to ensure the integrity of the enclosure. [**30:**A.19.5.7.2]

66.19.5.7.3* Static Electricity. Vapor collection and vapor processing equipment shall be protected against static electricity in accordance with 66.6.5.4. [**30:**19.5.7.3]

Δ **A.66.19.5.7.3** NFPA 77 and API RP 2003, *Protection Against Ignition Arising Out of Static, Lightning, and Stray Currents*, can be used as a reference for protections against static ignition. [**30:**A.19.5.7.3]

66.19.5.7.4* Spontaneous Ignition. Equipment shall be designed or written procedures established and implemented to prevent ignition where the potential exists for spontaneous ignition. [**30:**19.5.7.4]

A.66.19.5.7.4 Spontaneous ignition can be a problem in the following:

(1) Facilities where pyrophoric deposits can accumulate from the handling of oxygen-deficient vapors containing sulfur compounds or asphaltic materials. When air is introduced into the system, the pyrophoric materials can react, resulting in potential ignition and fire.
(2) Facilities that handle fluids in such a way that mixing of hypergolic or otherwise incompatible materials can occur. Such mixing could occur with fluids remaining in the vapor recovery system from prior loading activities.
(3) Facilities handling oxygenated hydrocarbons in carbon absorption units. Higher heats of absorption for these types of vapors can potentially lead to overheated carbon beds and increase the chance that an oxidation reaction can be initiated. (For further information, refer to API Report, "An Engineering Analysis of the Effects of Oxygenated Fuels on Marketing Vapor Recovery Equipment.")

[**30:**A.19.5.7.4]

66.19.5.7.5* Friction Heat or Sparks from Mechanical Equipment. Mechanical equipment used to move vapors that are in the flammable range shall be designed to prevent sparks or other ignition sources under both normal and equipment malfunction conditions. [**30:**19.5.7.5]

A.66.19.5.7.5 U.S. Coast Guard Regulations in Title 33, Code of Federal Regulations, Part 154, Section 154.826(b), (c), and (d), can be used as a reference for vapor mover designs that minimize the potential for ignition. [**30:**A.19.5.7.5]

66.19.5.7.6* Flame Propagation. Where there is reasonable potential for ignition of a vapor mixture in the flammable range, means shall be provided to stop the propagation of flame through the vapor collection system. The means chosen shall prevent flame propagation under the conditions with which they will be used. [**30:**19.5.7.6]

Δ **A.66.19.5.7.6** The potential for ignition in the vapor collection system needs to be evaluated on a case-by-case basis. If ignition occurs, flame propagation in piping systems containing vapor mixtures in the flammable range normally starts with low-speed burning (deflagration). As the flame moves through the piping, it accelerates and, within a short distance, can reach supersonic speeds (detonation). Initial low-speed flame propagation can be stopped by flame arresters, liquid seals, or automatic fast-acting valve systems where designed, operated, and tested within the requirements of NFPA 69. Flame propagation can also be stopped for both deflagrations and detonations by use of detonation arresters tested in accordance with U.S. Department of Transportation Coast Guard Regulations of the 33 CFR 154, Appendix A, or other procedures acceptable to the AHJ, or automatic fast-acting valve systems tested under the appropriate conditions. [**30:**A.19.5.7.6]

66.19.5.7.7 Explosion Protection. Where used, explosion protection systems shall comply with NFPA 69. [**30:**19.5.7.7]

66.19.5.8 Emergency Shutdown Systems. Emergency shutdown systems shall be designed to fail to a safe position in the event of loss of normal system power (i.e., air or electric) or equipment malfunction. [**30:**19.5.8]

66.19.6 Solvent Distillation Units.

66.19.6.1 Scope.

66.19.6.1.1 This section shall apply to solvent distillation units having distillation chambers or still pots that do not exceed 60 gal (227 L) nominal capacity and are used to recycle Class I, Class II, or Class IIIA liquids. [**30:**19.6.1.1]

The capacity of the typical solvent distillation unit is of such size that the recovered solvent can be collected in a common 55 gal (208 L) drum. The intent of 66.19.6 is that units with a capacity greater than 60 gal (227 L) should be treated as a process under the scope of Section 66.17.

66.19.6.1.2 This section shall not apply to research, testing, or experimental processes; to distillation processes carried out in petroleum refineries, chemical plants, or distilleries; or to distillation equipment used in dry cleaning operations. [**30:**19.6.1.2]

66.19.6.2 Equipment. Solvent distillation units shall be approved or shall be listed in accordance with ANSI/UL 2208, *Standard for Solvent Distillation Units.* [**30:**19.6.2]

66.19.6.3 Solvents. Solvent distillation units shall only be used to distill liquids for which they have been investigated and that are listed on the unit's marking or contained within the manufacturers' literature. [**30:**19.6.3]

66.19.6.3.1 Unstable or reactive liquids or materials shall not be processed unless they have been specifically listed on the system's markings or contained within the manufacturer's literature. [**30:**19.6.3.1]

Handling an unstable or reactive material in a solvent distillation unit can lead to an uncontrolled chemical reaction, with the possibility of fire or rupture of the unit due to overpressure.

66.19.6.4 Location.

66.19.6.4.1 Solvent distillation units shall be located and operated in locations in accordance with their approval or listing. [**30:**19.6.4.1]

66.19.6.4.2 Solvent distillation units shall not be used in basements. [**30:**19.6.4.2]

66.19.6.4.3 Solvent distillation units shall be located away from potential sources of ignition, as indicated on the unit's marking. [**30:**19.6.4.3]

66.19.6.5 Liquid Storage. Distilled liquids and liquids awaiting distillation shall be stored in accordance with this *Code*. [**30:**19.6.5]

66.19.7 Cooking Oil Storage Tank Systems in Commercial Kitchens.

66.19.7.1 Scope.

66.19.7.1.1 This section shall apply to storage tank systems for cooking oil, as defined in 66.19.2.1, located in commercial kitchens where tank capacities are greater than 60 gal (227 L). [**30:**19.7.1.1]

Prior design criteria in NFPA 30 were more relevant to industrial usage of storage tanks for flammable and combustible liquids, and the requirements reflected that bias. High flash point cooking oils in a restaurant back-of-house setting represent a different, and generally lower, hazard than commonly anticipated by Subsection 66.19.7 unifies all pertinent fire safety requirements for such storage and handling, providing ease of use for operators of commercial kitchens and fire officials, and establishes a level of safety commensurate with the hazard.

66.19.7.1.2 This section shall apply to both fresh and waste cooking oil storage tank systems. [**30:**19.7.1.2]

Previously, *Code* requirements focused on used, spent, and inedible cooking oil. For systems that hold fresh cooking oil, tanks and components must be certified as food grade. The steel oil burner and industrial aboveground storage tank standards previously referenced in the codes and associated tank standards did not anticipate food grade processes. This requirement emphasizes that both fresh and waste oil tank storage systems are in use. An example of a combined system is shown in Exhibit 66.30.

66.19.7.1.3* Where there are conflicts between the requirements of this section and requirements of other sections of this code, the requirements of this section shall take precedence. [**30:**19.7.1.3]

A.66.19.7.1.3 The goal of 66.19.7 is to consolidate in one location all requirements for commercial kitchen cooking oil storage and operations. There are a number of chapters in NFPA 30 that apply to these systems, including chapters on storage tanks and piping systems, transferring and dispensing of liquids, and so forth. Many of these requirements are more applicable to industrial or process situations and commercial kitchen cooking oil storage and use was not anticipated. All applicable chapters have been assessed in detail. Those specific requirements in this section that are in potential conflict with other sections of this code have been identified, and alternate methods or exceptions have been developed where

Exhibit 66.30

Example of a combined cooking oil storage system that handles fresh and used cooking oil. (Courtesy of Restaurant Technologies, Inc.)

appropriate. This approach eliminates the need to add exceptions throughout the existing code, improving ease of use particularly for fire officials. [**30:**A.19.7.1.3]

66.19.7.2 Design and Construction of Cooking Oil Storage Tanks.

66.19.7.2.1 Materials of Construction. Tanks shall be constructed of materials of metallic or nonmetallic construction. [**30:**19.7.2.1]

There are limitations on the use of currently listed metallic tanks for food grade processes, including requirements for welds and fillets for metallic tanks that conflict with food grade use. The new requirements address those limitations by adding provisions for food grade–approved nonmetallic tanks, as well as traditional listed flammable or combustible liquid steel tanks.

66.19.7.2.1.1 Tanks and their appurtenances shall be constructed of materials compatible with cooking oil. [**30:**19.7.2.1.1]

66.19.7.2.1.2* For tanks storing waste cooking oil, the materials of construction of the tanks and their appurtenances shall be compatible with cooking oil at minimum temperatures of 140°F (60°C) continuous and 235°F (113°C) intermittent. [**30:**19.7.2.1.2]

A.66.19.7.2.1.2 Waste oil is drained from commercial cooking equipment via a transfer pump and transfer lines to a waste oil storage tank. The oil might be as hot as 375°F (190°C), still well below the oil's flash point. Experience shows that the oil loses significant heat in the transfer process. The maximum temperature of waste cooking oil entering the storage tank is typically below 235°F (113°C). The storage tank should be constructed of materials compatible with cooking oil in that temperature range. [**30:**A.19.7.2.1.2]

Waste cooking oil is normally disposed of at elevated temperatures to ensure fluidity. Filter boxes, transfer pumps, shuttles, and other devices are used to transfer the oil to minimize the risk of burns to personnel. Because the devices are at room temperature when employed, the cooking oil loses temperature immediately upon exposure. Empirical data suggest that the temperature of the cooking oil as it enters the waste oil tank is typically below 235°F (113°C). Also, any residual oil in the waste oil tank acts as a heat sink to immediately cool hot incoming oil.

66.19.7.2.2 Design Standards.

66.19.7.2.2.1* Metallic cooking oil storage tanks shall be listed in accordance with ANSI/UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*, or ANSI/UL 80, *Standard for Steel Tanks for Oil-Burner Fuels and Other Combustible Liquids*. [**30:**19.7.2.2.1]

A.66.19.7.2.2.1 Existing steel tanks listed for flammable and combustible liquids are considered acceptable for waste oil use. These tank standards contain design and construction requirements that would not meet food code requirements, making the tanks unacceptable for storage of liquid food products (i.e., fresh cooking oil). [**30:**A.19.7.2.2.1]

Δ **66.19.7.2.2.2** Nonmetallic cooking oil storage tanks shall be listed in accordance with UL 2152, *Outline of Investigation for Special Purpose Nonmetallic Containers and Tanks for Specific Combustible or Noncombustible Liquids,* and shall not exceed 200 gal (757 L) per tank. [**30:**19.7.2.2.2]

An important aspect of a metallic or nonmetallic storage tank is its listing by a recognized third-party approval agency. When 66.19.7 was added to the 2015 edition of the *Code*, no listing requirements existed for nonmetallic cooking oil storage tanks. This situation has been remedied with the development of UL 2152, *Outline of Investigation for Special Purpose Nonmetallic Containers and Tanks for Specific Combustible or Noncombustible Liquids*, and it is therefore appropriate to reference it here. The 200 gal (760 L) maximum tank capacity for nonmetallic tanks was qualitatively established after discussions with AHJs to limit the overall size of a single tank. This capacity is also well below the maximum allowed for portable tanks, as established elsewhere in the *Code*. Note that there is no limit to the number of tanks that are permitted to be installed. However, local or state building and fire codes might restrict the total aggregate amount of Class IIIB liquidq, based on specific protection features and specific situations. It is not intended that any special containment or drainage be provided with this installation. An example of a nonmetallic combined fresh and waste oil tank system is shown in Exhibit 66.31.

Exhibit 66.31

Example of a nonmetallic combined cooking oil storage system that handles fresh and waste cooking oil. (Courtesy of Restaurant Technologies, Inc.)

66.19.7.2.3 Normal Venting.

66.19.7.2.3.1 The normal vent(s) shall be located above the maximum normal liquid level. [**30:**19.7.2.3.1]

66.19.7.2.3.2 The normal vent shall be at least as large as the largest filling or withdrawal connection. [**30:**19.7.2.3.2]

66.19.7.2.3.3 Where used, normal vents, including vent piping, that are smaller than 1.25 in. (32 mm) nominal inside diameter shall be tested to verify that internal tank pressures will remain below a gauge pressure of 0.5 psi (3.5 kPa) under maximum expected flow rates for tank filling and withdrawal. These tests shall be permitted to be conducted by a qualified outside agency or by the manufacturer, if certified by a qualified observer. [**30:**19.7.2.3.3]

The size of the normal vent must be engineered to prevent excessive back pressure during filling and withdrawal. Vents for cooking oil tanks usually contain a screen or similar device to prevent entry by insects or rodents, which must be taken into consideration.

66.19.7.2.3.4* Normal vents shall be permitted to discharge inside the building. [**30:**19.7.2.3.4]

A.66.19.7.2.3.4 High flash point cooking oils do not create ignitable vapors when stored under the conditions specified in 66.19.7. [**30:**A.19.7.2.3.4]

66.19.7.2.4 Emergency Venting.

66.19.7.2.4.1 Cooking oil storage tanks shall be provided with emergency relief venting in accordance with Section 66.22. [**30:**19.7.2.4.1]

66.19.7.2.4.2* For nonmetallic cooking oil storage tanks, emergency relief venting by form of construction shall be permitted. This shall include the low melting point of the material of construction of the tank. [**30:**19.7.2.4.2]

This concept of emergency relief venting is applicable only to cooking oil tanks. Normally, tanks storing Class IIIB liquids are exempt from the emergency venting requirements of 66.22.7 only if they exceed 12,000 gal (45,400 L) capacity (see 66.22.7.1.1.3). FM Global, in Data Sheet 7-88, *Storage Tanks for Flammable Liquids*, notes that emergency venting for plastic tanks, such as glass fiber reinforced plastic, is not required since the plastic is expected to melt.

A.66.19.7.2.4.2 Nonmetallic tanks will melt above the liquid level as an external exposure fire progresses, venting the vapor space of the tank. [**30:**A.19.7.2.4.2]

66.19.7.2.4.3 For metallic cooking oil storage tanks, emergency relief venting by form of construction shall be prohibited. [**30:**19.7.2.4.3]

Industry and authorities having jurisdiction have agreed that current emergency vent designs should apply, with the exception of venting by form of construction (i.e., weak roof-to-shell seam). A weak roof-to-shell seam is not a reliable means of providing for emergency venting for such small tanks.

66.19.7.2.4.4 Emergency vents shall be permitted to discharge inside the building. [**30:**19.7.2.4.4]

It is reasonable to allow emergency vents from these tanks to vent into the building. The emergency vent would operate only if an exposure fire were boiling the contents of the tank. Cooking oils have boiling points well above 500°F (260°C), so it would take considerable time for the tank contents to boil. By the time the emergency vent opened, the surrounding fire would have progressed to the point where release of vapors would be inconsequential.

66.19.7.2.5* Prevention of Overfilling of Cooking Oil Storage Tanks. Every cooking oil storage tank shall be provided with means to prevent an accidental overfill. Such means shall be automatic and fail-safe in nature. [**30:**19.7.2.5]

A.66.19.7.2.5 Although generally not required for tanks storing Class IIIB liquids, overfill protection is considered necessary for cooking oil storage tanks to prevent inadvertent spillage. [**30:**A.19.7.2.5]

An example of overfill protection for a fresh oil tank would be a high level switch that automatically shuts off the delivery pump. The system can be designed as a fail-safe system, with the communication circuit normally being closed. Any disconnected wire, break in the wire, or other compromise to the communication circuit would result in the shutdown of the delivery pump.

Tank fill pipes are not required to terminate within 6 in. (150 mm) of the bottom of the tank unless required by the tank listing. Flammable vapors and static charges are not anticipated.

66.19.7.2.6 Tank Heating.

Δ **66.19.7.2.6.1*** Electrical equipment used for heating cooking oil shall be listed to ANSI/UL 499, *Standard for Electrical Heating Appliances*, and shall comply with *NFPA 70*. [**30:**19.7.2.6.1]

A.66.19.7.2.6.1 The prohibition of electrical immersion heaters in nonmetallic tanks eliminates a primary ignition source for the oil stored in the tank. [**30:**A.19.7.2.6.1]

Δ **66.19.7.2.6.2*** Electrical equipment used for heating cooking oil shall comply with *NFPA 70* and shall be equipped with automatic means to limit the temperature of the oil to less than 140°F (60°C). [**30:**19.7.2.6.2]

A.66.19.7.2.6.2 The temperature limitation of 140°F (60°C) corresponds to ASTM C1055 (ISO 13732-1) restrictions for maximum allowable temperatures of nonmetallic industrial surfaces for human contact. [**30:**A.19.7.2.6.2]

Due to the low fire hazard associated with high flash point cooking oils, NFPA 30 permits nonclassified electrical equipment for Class IIIB storage installations inside buildings.

66.19.7.2.6.3 Use of electrical immersion heaters in nonmetallic tanks shall be prohibited. [**30:**19.7.2.6.3]

66.19.7.3 Tank Installation and Testing.

66.19.7.3.1 Location of Cooking Oil Storage Tanks. Tanks shall be installed in locations appropriate for storage of foodstuffs or inventory and shall not be installed in areas designated as cooking areas. [**30:**19.7.3.1]

66.19.7.3.1.1* Tanks shall be spaced at least 3 ft (0.9 m) away from any cooking appliance or any surface heated to a temperature above 140°F (60°C) continuous and at least 6 ft (1.8 m) away from any open flame. [**30:**19.7.3.1.1]

A.66.19.7.3.1.1 The kitchen cooking area has historically been an area where fires occur. Tanks should, therefore, be located away from the kitchen cooking area. [**30:**A.19.7.3.1.1]

66.19.7.3.1.2* Tanks shall not be installed under commercial kitchen ventilation hoods. [**30:**19.7.3.1.2]

A.66.19.7.3.1.2 The area beneath the ventilation hood is another area of potential accidental ignition. [**30:**A.19.7.3.1.2]

Ventilation hoods in kitchens usually have their own listed fire protection systems. The installation of cooking oil tanks under ventilation hoods might void their listing.

66.19.7.3.1.3 Tanks shall not be required to be separated from one another. [**30:**19.7.3.1.3]

The tank spacing requirements in Section 66.22 are not intended to be applied to cooking oil systems. They were developed based on the needs of much larger tanks. Even the minimal 3 ft (0.9 m) separation allowed by 66.22.4.2.1.2 might be problematic in a food preparation area.

66.19.7.3.2 Foundations for and Anchoring of Cooking Oil Storage Tanks.

Δ **66.19.7.3.2.1*** Tanks shall be secured to prevent the tank from tipping over. [**30:**19.7.3.2.1]

N **A.66.19.7.3.2.1** Guidance on securing tanks from tipping over is provided by the manufacturer's instructions in accordance with the tank listing. [**30:**A.19.7.3.2.1]

66.19.7.3.2.2 In areas subject to earthquakes, tank supports, the foundation, and anchoring shall meet the requirements of the applicable building code for the specific seismic zone. Engineering evaluation by a qualified, impartial outside agency shall be an acceptable method of meeting this requirement. [**30:**19.7.3.2.2]

66.19.7.3.2.3 Where a tank is located in areas subject to flooding, the method for anchoring the tank to the floor shall be capable of preventing the tank, either full or empty, from floating during a rise in water level up to the established maximum flood stage. Engineering evaluation by a qualified, impartial outside agency shall be an acceptable method of meeting this requirement. [**30:**19.7.3.2.3]

66.19.7.3.3 Tank Openings Other than Vents.

66.19.7.3.3.1 Each connection to the tank below the normal liquid level through which liquid can normally flow shall be provided with an internal or external valve located as close as possible to the shell of the tank, in accordance with Section 66.22. [**30:**19.7.3.3.1]

66.19.7.3.3.2* Connections to the tank above the normal liquid level through which liquid can normally flow shall not be required to have a valve, provided there exists a liquid-tight closure at the opposite end of the line. The liquidtight closure shall be in the form of a valve, a plug, or a coupling or fitting with positive shutoff. [**30:**19.7.3.3.2]

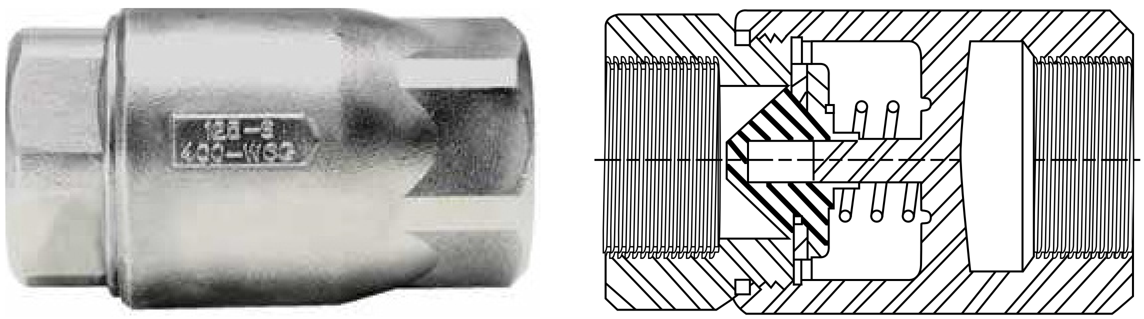
A.66.19.7.3.3.2 An example of a fitting with a positive shutoff is a spring-loaded check valve or a hydraulic quick-coupling with a spring-loaded poppet. [**30:**A.19.7.3.3.2]

An example of a suitable check valve is shown in Exhibit 66.32. Exhibit 66.33 shows an example of a suitable hydraulic quick-coupling.

66.19.7.3.4 Field Testing.

66.19.7.3.4.1* As an alternate method to the testing requirements in Section 66.21, cooking oil storage tanks shall be tested for leaks at the time of installation by filling the tank with cooking oil to a liquid level above the highest tank seam or connection within the normal liquid level. Before the tank is placed in service, all leaks shall be corrected in an approved manner or the tank shall be replaced. [**30:**19.7.3.4.1]

Exhibit 66.32



Example of a suitable check valve for use in a cooking oil storage system. (Courtesy of Conbraco Industries)

Exhibit 66.33

Example of suitable hydraulic quick-couplings for use in a cooking oil storage system. (Courtesy of Parker-Hannifin)

A.66.19.7.3.4.1 Cooking oil storage tanks are atmospheric tanks with open vents. The requirement in Section 66.21 to pressurize the tank for leak testing would be difficult to achieve in the field, due to tank construction and configuration. It is also desirable to prevent water contamination of the cooking oil. A more appropriate test would be to fill the tank with cooking oil to cover all connections and seams below the normal liquid level. [**30:**A.19.7.3.4.1]

66.19.7.3.4.2 An approved listing mark on a cooking oil storage tank shall be considered to be evidence of compliance with tank testing requirements. [**30:**19.7.3.4.2]

66.19.7.4 Fire Protection for Cooking Oil Storage Tanks.

Δ **66.19.7.4.1 Identification for Emergency Responders.** A sign or marking that meets the requirements of NFPA 704 or another approved system, shall be applied to each cooking oil storage tank in accordance with Section 66.21. Additional signage shall be applied to each tank identifying the contents of the tank as cooking oil, either fresh or waste. [**30:**19.7.4.1]

Δ **66.19.7.4.2*** In areas where tanks are located, no additional ventilation shall be required beyond that required for comfort ventilation and provided that all cooking equipment is provided with exhaust systems in accordance with NFPA 96. [**30:**19.7.4.2]

A.66.19.7.4.2 Supplemental ventilation, as is required for cooking operations, is not needed for cooking oil storage tanks. [**30:**A.19.7.4.2]

66.19.7.4.3 If ventilation is not provided as specified in 66.19.7.4.2, then the tank shall be vented to another room inside the building that meets these requirements, or the tank shall be vented to the outside of the building. [**30:**19.7.4.3]

The installation of these cooking oil systems does not require a dedicated ventilation system, assuming that sufficient comfort ventilation is provided in the area and all the cooking equipment is provided with exhaust systems as required and in accordance with NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*.

66.19.7.5 Transfer Lines.

66.19.7.5.1* Design and Construction of Fresh Cooking Oil Transfer Lines. Transfer lines for fresh cooking oil shall be permitted to be constructed of metallic or nonmetallic materials that are compatible with cooking oil and food products. Nonmetallic transfer lines shall also meet the following requirements:

(1) Transfer lines in pressure applications shall be rated for a working gauge pressure of 100 psi (689 kPa) at 70°F (21°C), or the maximum output pressure of the transfer pump, whichever is higher.
(2) Transfer lines in suction applications shall be rated for full vacuum at 70°F (21°C).
(3) Transfer lines shall be rated for temperatures up to 120°F (49°C) continuous.
(4) The maximum nominal inside diameter shall be no larger than 1.25 in. (32 mm).
(5) Leakage shall be controlled through the use of check valves or antisiphon valves at points where the lines connect to the fresh oil tank.

[**30:**19.7.5.1]

Δ **A.66.19.7.5.1** Waste oil lines are generally pumped until there is little residual oil remaining in the lines. Fresh cooking oil lines are likely to contain residual oil after fill and removal operations. Restricting the fresh oil line size to 1.25 in. (32 mm) maximum inside diameter limits the amount of oil in the line. Additionally, the requirement for check valves or antisiphon valves on the lines at points where the lines connect to the tank eliminates the possibility of a compromised line siphoning the contents of the tank. To the extent possible, transfer lines should avoid being routed over seating areas. These requirements are designed to minimize fire risk by limiting cooking oil quantities in transfer lines that could become involved in a fire. In buildings protected by automatic fire sprinklers, the need to add sprinklers in previously unprotected spaces (assuming the transfer lines are located in these spaces) should be considered in accordance with the requirements of NFPA 13. [**30:**A.19.7.5.1]

The transfer process in waste oil systems requires that the oil be above ambient temperature to ensure fluidity. Materials used in the transfer process must be able to withstand those temperatures. As an example of listed equipment that might be used, pumps used for fresh and waste oil use might be listed in accordance with ANSI/NSF 4, *Commercial Cooking, Rethermalization and Powered Hot Food Holding and Transport Equipment*. Filters might be listed in accordance with UL 1889, *Standard for Commercial Filters for Cooking Oil*.

66.19.7.5.2* Design and Construction of Waste Cooking Oil Transfer Lines. Waste cooking oil transfer lines shall be permitted to be constructed of metallic or nonmetallic materials that are compatible with cooking oil. [**30:**19.7.5.2]

The transfer process in waste oil systems requires that the oil be above ambient temperature to ensure fluidity. Materials used in the transfer process must be able to withstand those temperatures. As an example of listed equipment that might be used, pumps used for fresh and waste oil use might be listed in accordance with ANSI/NSF-4. Filters might be listed in accordance with ANSI/UL 1889.

A.66.19.7.5.2 The temperature and pressure ratings for the waste oil lines are consistent with the maximum expected conditions. [**30:**A.19.7.5.2]

It was determined that the requirements for piping and transfer in Section 66.27 were more applicable to industrial applications. Hose or pipe material must be rated for cooking oil at working pressures and temperatures. The requirements in 66.19.7.5.2.1 through 66.19.7.5.5 are based on hose manufacturers' ratings for hoses specifically designed and currently in use for hot cooking oil transfer in commercial deep fat fryers and filtration systems.

66.19.7.5.2.1 Transfer lines shall be rated for use with cooking oil at elevated temperatures of 275°F (135°C) continuous and 350°F (177°C) intermittent. [**30:**19.7.5.2.1]

66.19.7.5.2.2 Nonmetallic transfer lines shall be rated for working pressures up to 250 psi (1724 kPa) at 275°F (135°C). [**30:**19.7.5.2.2]

66.19.7.5.3 Flow Control. Cooking oil transfer lines shall be equipped with means to prevent unintended transfer or dispensing of cooking oil. These means shall be permitted to be in the form of momentary control switches, valves, check valves, antisiphon valves, plugs, couplings, fittings, or any combination thereof that are fail-safe in nature. [**30:**19.7.5.3]

66.19.7.5.4 Pressure Control. Pumping systems used to transfer cooking oil shall have means to prevent overpressurization of transfer lines. These means shall be in the form of relief valves, bypass valves, pressure sensor devices, or the pressure limitation of the pump itself. [**30:**19.7.5.4]

66.19.7.5.5 Installation of Cooking Oil Transfer Lines in Plenum-Rated Spaces. Cooking oil transfer lines installed in plenum-rated spaces shall be enclosed in noncombustible raceways or enclosures, or shall be covered with a material listed and labeled for installation within a plenum. [**30:**19.7.5.5]

Although the installation of cooking oil lines in a return air plenum is not encouraged, sometimes it cannot be avoided. This requirement is intended to ensure that the lines do not contribute to combustible loading within the plenum space.

66.19.7.5.6 Testing of Cooking Oil Transfer Lines. Cooking oil transfer lines shall be tested after installation and prior to use. Testing shall be with cooking oil at the normal operating pressures. Any leaks discovered in transfer lines as a result of testing shall be repaired or the transfer lines replaced prior to placing the transfer lines into service. [**30:**19.7.5.6]

66.20 Reserved

66.21 Storage of Liquids in Tanks — Requirements for All Storage Tanks

66.21.1 Scope. This section shall apply to the following:

(1) The storage of flammable and combustible liquids, as defined in 3.3.169.1 and 3.3.169.2 and Section 66.4, in fixed tanks that exceed 60 gal (230 L) capacity
(2) The storage of flammable and combustible liquids in portable tanks that exceed 660 gal (2500 L) capacity
(3) The storage of flammable and combustible liquids in intermediate bulk containers that exceed 793 gal (3000 L) capacity
(4) The design, installation, testing, operation, and maintenance of such tanks, portable tanks, and bulk containers

[**30:**21.1]

Section 66.21 applies to any fixed tank, as long as the capacity is greater than 60 gal (230 L). The "793 gal" originally specified in 66.21.1 referred only to portable tanks and intermodal containers used in transportation. Recall that Section 66.9 covers portable tanks up to 660 gal (2500 L) and IBCs up to 793 gal (3000 L). Also, Section 66.9 applies only to the storage of portable tanks. If a portable tank or an IBC is connected to a fixed piping system, it takes on the characteristics of a fixed tank, and the appropriate requirements of Section 66.21 and subsequent chapters apply.

66.21.2 Definitions Specific to Section 66.21. For the purpose of this section, the following definitions shall apply. [**30:**21.2]

66.21.2.1 Compartmented Tank. A tank that is divided into two or more compartments intended to contain the same or different liquids. [**30:**21.2.1]

66.21.3 General Requirements.

66.21.3.1 Storage of Class II and Class III liquids heated at or above their flash point shall follow the requirements for Class I liquids, unless an engineering evaluation conducted in accordance with Section 66.6 and 66.21.6 justifies following the requirements for some other liquid class. [**30:**21.3.1]

66.21.3.2 Tanks shall be permitted to be of any shape, size, or type consistent with recognized engineering standards. Metal tanks shall be welded, riveted, and caulked, or bolted or constructed using a combination of these methods. [**30:**21.3.2]

A structurally acceptable tank of any shape can be designed using sound engineering practices. However, as a practical matter, factors such as economy in fabrication, the material of construction used, and the operating pressure combine to limit the shape of a tank to one of the following:

1. Vertical cylindrical tank with a flat or nearly flat bottom and a flat, coned, or domed fixed roof or open top with floating roof
2. Horizontal cylindrical tank with flat or dished ends
3. Spherical or toroidal tank

In all cases, the foundation and supporting structure must be considered integral parts of the design.

66.21.3.3 Tanks designed and intended for aboveground use shall not be used as underground tanks. [**30:**21.3.3]

66.21.3.4 Tanks designed and intended for underground use shall not be used as aboveground tanks. [**30:**21.3.4]

Paragraph 66.21.3.4 is intended primarily to prevent an underground tank from being excavated and reused aboveground. The design of an underground tank is based on the support of the surrounding backfill. It does not anticipate the saddle-type supports normally provided for horizontal aboveground tanks. Also, an underground tank is not provided with emergency relief venting, as is required for aboveground tanks by 66.22.7.

Paragraph 66.21.3.3 is justified by the fact that typical aboveground tanks are not manufactured to resist the corrosion of the underground environment.

66.21.3.5 Tanks shall be designed and built in accordance with recognized engineering standards for the material of construction being used. [**30:**21.3.5]

66.21.4 Design and Construction of Storage Tanks.

Δ **66.21.4.1 Materials of Construction.** Tanks shall be of steel or other approved noncombustible material in accordance with 66.21.4.1.1 through 66.21.4.1.4, or of combustible materials in accordance with 66.21.4.1.1 and 66.21.4.1.3 through 66.21.4.1.5. [**30:**21.4.1]

66.21.4.1.1 The materials of construction for tanks and their appurtenances shall be compatible with the liquid to be stored. In case of doubt about the properties of the liquid to be stored, the supplier, producer of the liquid, or other competent authority shall be consulted. [**30:**21.4.1.1]

• **66.21.4.1.2** Unlined concrete tanks shall be permitted to be used for storing liquids that have a gravity of 40°API or heavier. Concrete tanks with special linings shall be permitted to be used for other liquids, provided they are designed and constructed in accordance with recognized engineering standards. [**30:**21.4.1.2]

API gravity is a measure of a liquid's density. The API gravities for petroleum products range from about 10° for heavy lubricating oils up to 80° or more for natural gas condensates. A low number indicates a denser, more viscous, less volatile fluid. Normal motor grade gasoline has an API gravity in the range of 55° to 65°. The "40° API" specified in 66.21.4.1.2 corresponds roughly to kerosene or light distillate oil. Such materials have flash points of about 130°F (54.4°C). Thus, a minor leak of a 40° API liquid from an unlined concrete tank would not create an unusual ignition hazard, and such tanks are therefore permitted.

66.21.4.1.3 Tanks shall be permitted to have combustible or noncombustible linings. The selection, specification, and type of lining material and its required thickness shall be based on the properties of the liquid to be stored. When there is a change in the characteristics of the liquid to be stored, the compatibility of the lining and the liquid shall be verified. [**30:**21.4.1.3]

Tanks are occasionally lined with a plastic or elastomeric material, such as spray-on epoxy resins and rubber liners, to provide corrosion protection, provide protection against minor leaks, or maintain product quality. (Some liquids are adversely affected by contact with metals.) Whether the lining material is combustible or noncombustible does not matter because the quantity is small and will not contribute to fire loss. Even though such a lining is electrically insulating, it will not increase the risk of ignition from static electricity. (See NFPA 77, *Recommended Practice on Static Electricity*.)

Paragraph 66.21.4.1.3 is the basis for allowing tanks that have developed minor leaks to be repaired using a spray-on application of an epoxy resin liner to the inside wall of the tank. The decision to allow such a repair has historically been left to the AHJ. However, environmental regulations for underground storage systems might disallow such repairs on underground tanks in any given case or might exert more stringent control. At the least, it is expected that such a repair will be allowed only once in the lifetime of a tank.

As noted in the second sentence of 66.21.4.1.3, care must be exercised in the selection of a lining material. The lining is required to be compatible with and resistant to degradation from any liquid that is likely to be stored in the tank.

The purpose of the third sentence is to warn the *Code* user that any change in service initiates a re-evaluation of the suitability of the lining to the liquid to be stored.

66.21.4.1.4 An engineering evaluation shall be made if the specific gravity of the liquid to be stored exceeds that of water or if the tank is designed to contain liquids at a liquid temperature below 0°F (–18°C). [**30:**21.4.1.4]

N **66.21.4.1.5** Tanks shall be permitted to be constructed of combustible materials when approved. Tanks constructed of combustible materials shall be limited to any of the following:

(1) Underground installation
(2) Use where required by the properties of the liquid stored
(3) Aboveground storage of Class IIIB liquids in areas not exposed to a spill or leak of Class I or Class II liquid
(4) Storage of Class IIIB liquids inside a building protected by an approved automatic fire-extinguishing system

[**30:**21.4.1.5]

There simply is no fire hazard to worry about with underground tanks. Indeed, a significant portion of underground tanks are of glass fiber–reinforced plastic construction. Items (3) and (4) are justified by the very low risk of ignition of Class IIIB liquids. Again, the potential for a fire is very low. Item (2) does leave the door open for use of an aboveground tank constructed of combustible materials for lower classes of liquids if warranted by the chemical characteristics of the liquid, such as when the liquid is severely corrosive to metal. However, in such a case, it would be preferable to use a metal tank with an appropriate lining. The AHJ should be consulted in such situations.

66.21.4.2 Design Standards for Storage Tanks.

66.21.4.2.1 Design Standards for Atmospheric Tanks.

Δ **66.21.4.2.1.1*** Atmospheric tanks shall be designed and constructed in accordance with recognized engineering standards. Atmospheric tanks that meet any of the following standards shall be deemed as meeting the requirements of 66.21.4.2.1:

(1) API Specification 12B, *Bolted Tanks for Storage of Production Liquids*
(2) API Specification 12D, *Field Welded Tanks for Storage of Production Liquids*
(3) API Specification 12F, *Shop Welded Tanks for Storage of Production Liquids*
(4) API Standard 650, *Welded Tanks for Oil Storage*
(5) UL 58, *Standard for Steel Underground Tanks for Flammable and Combustible Liquids*
(6) ANSI/UL 80, *Standard for Steel Tanks for Oil Burner Fuel*
(7) ANSI/UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*
(8) UL 1316, *Standard for Glass-Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures*
(9) ANSI/UL 1746, *Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks*
(10) UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*
(11) ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*

[**30:**21.4.2.1.1]

The wording of 66.21.4.2.1.1 is broad enough to allow flexibility in tank design and installation methods. The AHJ might allow departures from recognized standards where special needs or unusual situations warrant, as long as equivalent performance is ensured. This enhanced flexibility has proven to be beneficial for aboveground tanks as well as underground tanks, as environmental protection receives more attention. Note the many factory-built "new technology" tanks being produced today, such as concrete-encased tanks, recognized by addition of the reference to ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*, and the several types of secondary containment-type tanks now included under the listing criteria of UL 58, *Standard for Steel Underground Tanks for Flammable and Combustible Liquids*, and ANSI/UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*.

The allowance for bolted tanks for storage of oil in producing areas, as given in 66.21.4.2.1.1(1), recognizes that the tanks are usually small, they can be easily relocated, and their use at a particular site might be temporary. A bolted tank is easily dismantled and moved to a new location. Although such tanks are vulnerable to fire damage from a ground fire because of damage to the gaskets, the advantages outweigh the shortcomings. At main gathering stations and pipeline terminals, more substantial tanks would be required.

Δ **A.66.21.4.2.1.1** Atmospheric tanks include tanks of compartmented design and tanks that incorporate secondary containment.

For shop-fabricated steel generator base, work bench, lube oil, used oil, and day tanks, see UL 142A, *Outline of Investigation for Special Purpose Aboveground Tanks for Specific Flammable or Combustible Liquids.* [**30:**A.21.4.2.1.1]

Δ **66.21.4.2.1.2** Atmospheric tanks designed and constructed in accordance with Appendix F of API Standard 650, *Welded Tanks for Oil Storage*, shall be permitted to operate at pressures from atmospheric to a gauge pressure of 1.0 psi (6.9 kPa). All other tanks shall be limited to operation from atmospheric to a gauge pressure of 0.5 psi (3.5 kPa) except as permitted in 66.21.4.2.1.3 and 66.21.4.2.1.4. [**30:**21.4.2.1.2]

Δ **66.21.4.2.1.3** Atmospheric tanks that are not designed and constructed in accordance with Appendix F of API Standard 650, *Welded Tanks for Oil Storage*, shall be permitted to operate at pressures from atmospheric to a gauge pressure of 1.0 psi (6.9 kPa) only if an engineering analysis is performed to determine that the tank can withstand the elevated pressure. [**30:**21.4.2.1.3]

66.21.4.2.1.4 Horizontal cylindrical and rectangular tanks built according to any of the standards specified in 66.21.4.2.1.1 shall be permitted to operate at pressures from atmospheric to a gauge pressure of 1.0 psi (6.9 kPa) and shall be limited to a gauge pressure of 2.5 psi (17 kPa) under emergency venting conditions. [**30:**21.4.2.1.4]

Tanks constructed to the specifications of ANSI/UL 142 are shop-built and leak-tested prior to shipment as completely assembled units. Although horizontal tanks are pressure-tested to a gauge pressure of 5 psi to 7 psi (34.4 kPa to 48.2 kPa), they are limited to service at a gauge pressure of 1 psi (6.9 kPa) maximum internal operating pressure and to a gauge pressure of 2.5 psi (17 kPa) under emergency venting conditions. These restrictions recognize that failure of a horizontal tank is invariably accompanied by release of the tank contents. Vertical tanks are required to be tested only to a pressure that exceeds a gauge pressure of 1.5 psi (10.3 kPa); however, they are also subject to liquid release upon failure, so the same service restrictions apply. There is an exception: Vertical tanks built to prior editions of ANSI/UL 142 and labeled "built to weak shell-to-roof joint design" are not expected to fail in such a manner as to release the contents. It is assumed that the weak seam will fail upon overpressure and only vapors will be released. The current edition of ANSI/UL 142 does not recognize weak shell-to-roof joint design

The term *emergency venting conditions* is not defined in Chapter 3. It is meant to describe a situation in which a tank is fully exposed to flame, resulting in heating and boiling of its contents. Normal venting is based solely on liquid addition or withdrawal and atmospheric temperature and pressure changes. (See 66.21.4.3.) Because consequences of fire exposure can have a substantial effect on the allowable spacing and location of tanks as set forth in 66.22.4, this subject must be dealt with before comment is made on specific requirements. Subsection 66.22.7 addresses the venting capabilities necessary if the tank is exposed to a fire.

Flames contacting aboveground tanks can heat the contained liquid, causing it to boil, and can also damage tank supports and the unwet portion of the tank shell. Boiling effects can be mitigated by design (see 66.22.7.2) or by additional relief valves (see 66.22.7.3). Supports for elevated tanks can be constructed of fire-resistive materials, as covered in 66.22.5.2, or insulated to delay failure. Flame contact on the unwet portion of the shell of a tank can heat that portion of the shell to the point that it loses much of its structural strength. For a vertical tank, this heating can result in distortion at the top of the shell, but tank collapse and spill of contents are not likely. Heating the top of the shell of a horizontal tank, however, is likely to result in structural failure with release of contents.

For a pressure tank, the result of heating the unwet portion of the shell can be serious. Such tanks usually store liquids having boiling points below atmospheric temperature, and therefore their relief valves are set to maintain the resulting higher pressure. When heated sufficiently, the shell loses strength and the resulting tear is likely to spread below the liquid level. The tear can extend completely around a horizontal tank so as to sever the head, release the contents, and cause the pieces to rocket. The possibility of this type of failure is accounted for in Table 66.22.4.1.3. This phenomenon is known as a "BLEVE" (boiling liquid expanding vapor explosion) and is defined as catastrophic failure of a container into two or more major pieces when the contained liquid is at a temperature well above its boiling point at normal atmospheric pressure. The classic cases of BLEVEs have involved tank cars of liquefied petroleum gases, but the phenomenon is applicable to liquids as well.

66.21.4.2.1.5 Low-pressure tanks and pressure vessels shall be permitted to be used as atmospheric tanks. [**30:**21.4.2.1.5]

Section 66.21.4.2.1.5 simply means that a tank designed for pressure will be acceptable for a less demanding service. However, the more stringent spacing requirements for pressure tanks that are specified in 66.22.4.1 are not to be waived unless the emergency venting system has the required capacity at atmospheric pressure.

66.21.4.2.1.6 Atmospheric tanks shall not be used to store a liquid at a temperature at or above its boiling point. [**30:**21.4.2.1.6]

A liquid having a boiling point below the prevailing atmospheric temperature would be expected to boil continuously if stored in an atmospheric tank, which would result in considerable product loss and greatly increase the risk of ignition. (The boiling rate would depend on the rate at which the tank received heat from the surrounding atmosphere and from solar radiation.) Interpretation of 66.21.4.2.1.6 should take the liquid's atmospheric boiling point as that at the location of the tank, not at sea level. The boiling point of a liquid at an altitude of 10,000 ft (3050 m) can be as much as 20°F (11°C) lower than it would be at sea level. As a practical matter, this usually dictates that liquids at temperatures close to their boiling points be stored in pressure tanks, simply to avoid product loss.

66.21.4.2.2 Design Standards for Low-Pressure Tanks.

Δ **66.21.4.2.2.1** Low-pressure tanks shall be designed and constructed in accordance with recognized engineering standards. Low-pressure tanks that meet either of the following standards shall be deemed as meeting the requirements of 66.21.4.2.2:

(1) API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*
(2) ASME *Code for Unfired Pressure Vessels*, Section VIII, Division 1

[**30:**21.4.2.2.1]

66.21.4.2.2.2 Low-pressure tanks shall not be operated above their design pressures. [**30:**21.4.2.2.2]

66.21.4.2.2.3 Pressure vessels shall be permitted to be used as low-pressure tanks. [**30:**21.4.2.2.3]

66.21.4.2.3 Design Standards for Pressure Vessels.

66.21.4.2.3.1 Tanks with storage pressures above a gauge pressure of 15 psi (100 kPa) shall be designed and constructed in accordance with recognized engineering standards. Pressure vessels that meet any of the following standards shall be deemed as meeting the requirements of 66.21.4.2.3:

(1) Fired pressure vessels shall be designed and constructed in accordance with Section I (Power Boilers), or Section VIII, Division 1 or Division 2 (Pressure Vessels), as applicable, of the ASME *Boiler and Pressure Vessel Code*.
(2) Unfired pressure vessels shall be designed and constructed in accordance with Section VIII, Division 1 or Division 2, of the ASME *Boiler and Pressure Vessel Code*. [**30:**21.4.2.3.1]

Δ **66.21.4.2.3.2*** Pressure vessels that do not meet the requirements of 66.21.4.2.3.1(1) or 66.21.4.2.3.1(2) shall be permitted to be used, provided they are approved by the AHJ. [**30:**21.4.2.3.2]

A.66.21.4.2.3.2 Such pressure vessels are generally referred to as "state special." [**30:**A.21.4.2.3.2]

66.21.4.2.3.3 Pressure vessels shall not be operated above their design pressures. The normal operating pressure of the vessel shall not exceed the design pressure of the vessel. [**30:**21.4.2.3.3]

66.21.4.3 Normal Venting for Storage Tanks.

Paragraphs 66.21.4.3.1 through 66.21.4.3.12 consider venting only from the fire protection standpoint. Stricter requirements might be imposed by the EPA or by local regulations to control and capture evaporative emissions. As stated previously, environmental regulations might require the use of vapor collection systems, which could involve lengthy runs of piping to handle the vapor-air mixtures expelled from a tank during filling. Because

Exhibit 66.34

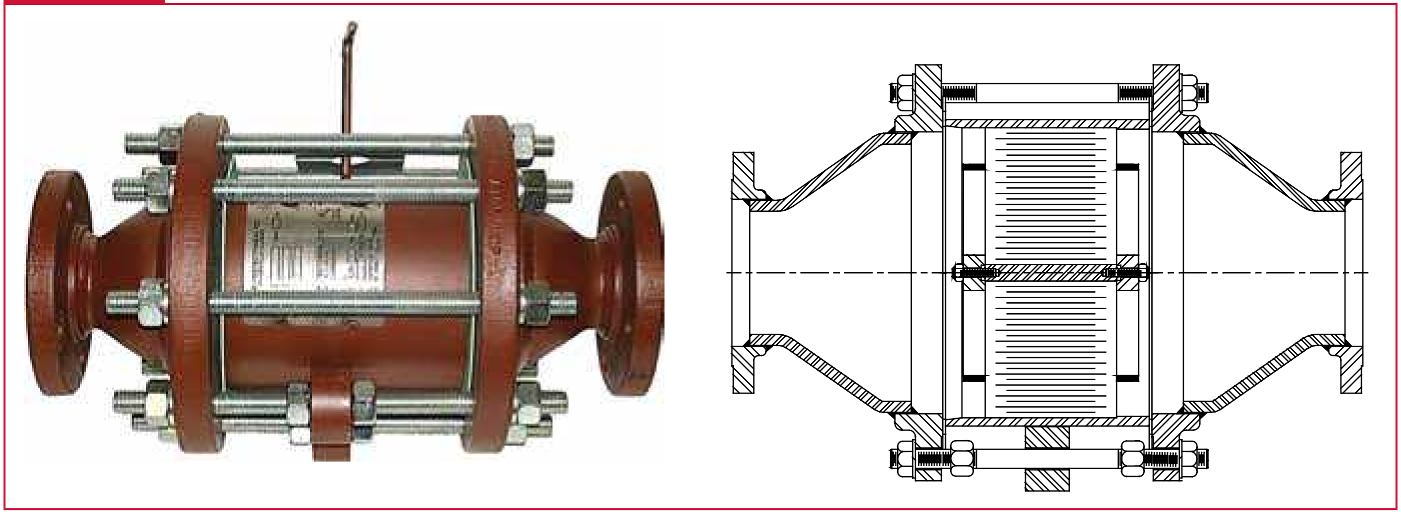


Photo (left) and diagram (right) of a pipeline detonation arrester. (Courtesy of Protectoseal Company)

flame arresters are not effective in long vent lines, special detonation arresters must be used. These arresters are designed and tested to withstand the pressures imposed by compression ignition ("dieseling") and "pressure piling." (See Exhibit 66.34 for an example.) Inerting of the manifold system or other means might be necessary to avoid hazardous situations. (See NFPA 69, *Standard on Explosion Prevention Systems*.)

66.21.4.3.1 Storage tanks shall be vented to prevent the development of vacuum or pressure that can distort the tank or exceed the rated design pressure of the tank when the tank is filled or emptied or because of atmospheric temperature changes. Normal vents shall be located above the maximum normal liquid level. [**30:**21.4.3.1]

The prohibition against distorting the roof of a cone roof tank applies specifically to tanks built in accordance with API 650, *Welded Tanks for Oil Storage*. Roof distortion should, by design, cause failure of the weak roof-to-shell type of construction typically used with API 650 tanks. Failure should occur only under emergency conditions. For all other tanks, the design is proven by pressure test.

In order for a tank to be filled, air and vapor must get out, or the tank will become pressurized. Pushing out the air and vapor requires that the pressure in the tank be slightly above atmospheric pressure. For that reason, tanks are designed to withstand an internal gauge pressure of at least 8 in. (20 cm) of water [$1/3$ psi (2.3 kPa)]. Similarly, in order for a tank to be emptied, air must get in, or the tank will become underpressurized. To allow air to get in, the pressure in the tank must be slightly below atmospheric pressure. For that reason, tanks are designed to withstand a vacuum of 2.5 in. (6.35 cm) of water [$1/10$ psi (0.689 kPa)].

Consideration of the low pressure for which a tank is designed might lead one to question why more tanks do not fail, even given safety factors of 2 to 1 or higher. Adequate normal venting is the answer. If an atmospheric storage tank is equipped with a normal vent of sufficient size — to prevent the development of an internal vacuum or pressure sufficient to distort the roof or to exceed the design pressure — *and* the vent is kept clear at all times, the tank will neither implode nor explode.

Exhibit 66.35 illustrates the deformation that can be expected if the normal vent's outflow capacity is not great enough for the rate of flow of liquid into the tank. Likewise, Exhibit 66.36 shows what can happen if the flow rate out of the tank is too great for the normal vent to accommodate it.

Exhibit 66.35

Damage to tanks caused by inadequate normal outflow venting capacity.

Exhibit 66.36

Damage to tanks caused by inadequate normal inflow venting capacity.

66.21.4.3.2* Normal venting shall be provided for primary tanks and each primary compartment of a compartmented tank. [**30:**21.4.3.2]

A.66.21.4.3.2 Normal venting is not required for the interstitial space of a secondary containment tank. [**30:**A.21.4.3.2]

This requirement addresses those rare occasions when a single compartment tank is retrofitted with one or more internal bulkheads to create two or more compartments. Each compartment will need its own normal vent and its own emergency vent if necessary.

66.21.4.3.3 Normal vents shall be sized in accordance with either API Standard 2000, *Venting Atmospheric and Low-Pressure Storage Tanks*, or another approved standard. Alternatively, the normal vent shall be at least as large as the largest filling or withdrawal connection, but in no case shall it be less than 1.25 in. (32 mm) nominal inside diameter. [**30:**21.4.3.3]

66.21.4.3.4* Atmospheric storage tanks shall be vented so as not to exceed the tank's design operating pressure or a gauge pressure of 1.0 psi (6.9 kPa), whichever is less, and shall be vented to prevent the development of vacuum. [**30:**21.4.3.4]

N **A.66.21.4.3.4** Tanks intended for normal operation at pressures greater than a gauge pressure of 1.0 psi (6.9 kPa) are designed in accordance with 66.21.4.2.3. It is recognized that a slight vacuum is necessary to operate a vacuum vent. [**30:**A.21.4.3.4]

This paragraph has been revised for the 2018 edition of the *Code* to eliminate any potential conflict with 66.21.4.2.1.2. This paragraph now specifically states that the means of venting must also prevent development of excessive vacuum that might distort the tank. The Annex A item references the section that applies to low-pressure tanks.

66.21.4.3.5 Low-pressure tanks and pressure vessels shall be vented to prevent the development of pressure or vacuum that exceeds the rated design pressure of the tank or vessel. Means shall also be provided to prevent overpressure from any pump discharging into the tank or vessel when the pump discharge pressure can exceed the design pressure of the tank or vessel. [**30:**21.4.3.5]

In flammable and combustible liquids service, a low-pressure tank or a pressure vessel would be used only for storing liquids with unusually high vapor pressures, such as Class IA liquids. For pressures of up to 1 psi (6.89 kPa) or so, pallet-type (weighted) check valves can be used to prevent overpressure. Many of these valves also incorporate vacuum breakers. For tanks built to the specifications of API 620, a conventional relief valve can be used. In that case, a separate vacuum-breaking device might be needed unless the vapor pressure of the stored product, under all conditions of storage, is high enough to prevent the development of a dangerous vacuum under conditions of maximum possible withdrawal rate. Tanks built to the ASME *Code for Unfired Pressure Vessels* are often built to withstand full vacuum, so they might not need a vacuum breaker. Although an open vent might be adequate to protect the tank from pressure rupture or vacuum collapse, an open vent must not be used if the tank contains a Class I liquid and should not be used for any liquid heated above its flash point, except as permitted in 66.21.4.3.8.

66.21.4.3.6 If any tank or pressure vessel has more than one fill or withdrawal connection and simultaneous filling or withdrawal can be made, the vent size shall be based on the maximum anticipated simultaneous flow. [**30:**21.4.3.6]

66.21.4.3.7 For tanks equipped with vents that permit pressures to exceed a gauge pressure of 2.5 psi (17 kPa) and for low-pressure tanks and for pressure vessels, the outlet of all vents and vent drains shall be arranged to discharge in a manner that prevents localized overheating of or flame impingement on any part of the tank, if vapors from the vents are ignited. [**30:**21.4.3.7]

66.21.4.3.8 Tanks and pressure vessels that store Class IA liquids shall be equipped with venting devices that are closed, except when venting under pressure or vacuum conditions. [**30:**21.4.3.8]

This requirement is intended to limit the escape of hazardous quantities of vapors from Class IA liquids, which boil at temperatures below 100°F (37.8°C). If a Class IA liquid were stored in a tank that is open to the atmosphere, it would always be at a temperature below ambient because it would be continuously cooled by the loss of heat of vaporization required to produce the vapors that fill the vapor space of the tank. Vaporization would continue because the tank would always be absorbing heat from its surroundings. This continuous generation of vapors is significant and would constitute unacceptable loss of product and generation of dangerous quantities of vapor. With a normally closed vent, however, vaporization can be controlled to a great degree. See also the commentary to 66.21.4.3.9.

66.21.4.3.9 Tanks and pressure vessels that store Class IB and Class IC liquids shall be equipped with venting devices or with listed flame arresters. When used, vent devices shall be closed, except when venting under pressure or vacuum conditions. [**30:**21.4.3.9]

With Class IB and Class IC liquids, less vaporization takes place than with Class IA liquids, so an open vent can be used, except where the vapor space might be in the flammable range.

Therefore, a vent fitted with a flame arrester is permitted as an alternative to a normally closed vent device. Because of the higher boiling points and accompanying lower vapor pressures of Class IB and Class IC liquids, the degree of liquid supercooling caused by vaporization, and hence the rate of vaporization, is insignificant from a fire protection standpoint. See also the commentary to 66.21.4.3.8. Note that tanks storing Class II and Class III liquids are not required to have any sort of venting device.

66.21.4.3.10 Tanks of 3000 barrels (bbl) [126,000 gal or (475 m^3)] capacity or less that store crude petroleum in crude-producing areas and outside aboveground atmospheric tanks of less than 1000 gal (3785 L) capacity that contain other than Class IA liquids shall be permitted to have open vents. [**30:**21.4.3.10]

The exemption for relatively small crude gathering tanks is allowed because such tanks are generally in sparsely populated areas and usually have vapor spaces too rich to burn as a result of release of dissolved gases. The exemption for tanks under 1000 gal (3785 L) capacity containing other than Class IA liquids is due to the relatively insignificant rate of vapor release. In addition, the vent location requirements of 66.27.8.1 make it highly improbable that a continuous vapor trail in the flammable range would exist between the vapor space of the tank and any exterior source of ignition.

66.21.4.3.11* Flame arresters or venting devices required in 66.21.4.3.8 and 66.21.4.3.9 shall be permitted to be omitted on tanks that store Class IB or Class IC liquids where conditions are such that their use can, in case of obstruction, result in damage to the tank. [**30:**21.4.3.11]

Δ **A.66.21.4.3.11** Liquid properties that justify omitting such devices include, but are not limited to, condensation, corrosiveness, crystallization, polymerization, freezing, or plugging. When any of these conditions exist, consideration should be given to heating, use of devices that employ special materials of construction, use of liquid seals, or inerting. See NFPA 69. [**30:**A.21.4.3.11]

66.21.4.3.12 Piping for normal vents shall be designed in accordance with Section 66.27. [**30:**21.4.3.12]

66.21.4.4* Tank Fill Pipes. Fill pipes that enter the top of a tank shall terminate within 6 in. (150 mm) of the bottom of the tank. Fill pipes shall be installed or arranged so that vibration is minimized.

Exception No. 1: Fill pipes in tanks whose vapor space under the expected range of operating conditions is not in the flammable range or is inerted need not meet this requirement.

*Exception No. 2: Fill pipes in tanks handling liquids with minimal potential for accumulation of static charge need not meet this requirement, provided that the fill line is designed and the system is operated to avoid mist generation and to provide residence time downstream of filters or screens to allow dissipation of the generated static charge. [**30:**21.4.4]*

Δ **A.66.21.4.4** In Exception No. 2, examples of liquids with minimal potential for accumulation of static charge include crude oil, asphalt, and water-miscible liquids. For additional information, see NFPA 77. [**30:**A.21.4.4]

The manner in which liquid enters a tank can cause turbulence and splashing, particularly if the inlet pipe terminates above the liquid surface. The intent of 66.21.4.4 is to require that the fill pipe terminate close to the bottom of the tank to minimize the generation of a static electrical charge from the free-fall and splashing of liquid entering the tank. The second sentence, regarding vibration, is a warning that a pipe supported only at the top might vibrate and break off, without anyone becoming aware of it. The resulting falling stream would defeat the purpose of having the fill pipe extend to within 6 in. (150 mm) of the bottom.

Several incidents involving Class II liquids have prompted the general application of this requirement to all liquids. Note that fine droplets of a combustible liquid are easily ignited at temperatures below the liquid's flash point, as demonstrated by the ease of ignition of No. 2 fuel oil when pumped through the atomizer of an oil burner.

Exception No. 2 recognizes that (1) crude oils, residual oils, and asphalts have such a low electrical resistivity that static generation has not proved to be a problem; and (2) water-miscible liquids allow free movement of the static charge so that the charge easily bleeds off to the grounded tank shell.

Static charge can accumulate in a liquid in many ways. Charged mists can develop when a falling stream of liquid breaks up into fine droplets. Flow of liquid through a pipe generates a charge in the liquid; the effect is more pronounced at high flow velocities and is greatly enhanced if the flow involves two or more phases. In the specific case of filling a tank, the quantity of static charge accumulates as the volume of liquid increases in the tank. In some cases, the charge reaches such high levels that it spontaneously leaks off to grounded objects by nonincendive corona discharge instead of gradual dissipation. (This phenomenon does not occur in liquids with resistivity of less than 10^{10} ohm-centimeters; the charges are able to migrate too easily through the liquid and recombine.) *Nonincendive* means that although the voltage is high enough to cause discharge, insufficient energy is released to cause ignition.

The risk of producing an incendive (i.e., ignition-capable) spark is dramatically increased when a charged, high-resistivity fluid flows either over or adjacent to an isolated (i.e., ungrounded) conductor. The conductor accumulates a static charge. If the isolated conductor is then brought near a grounded conductor, an immediate discharge occurs in the form of a spark of relatively high energy, usually well above that required for ignition of a flammable atmosphere. No isolated conductors should be introduced into a system that is prone to static generation. Such parts include metal floats on liquid level gauges, metal sampling cups on wooden rods or nylon cords, metal parts in plastic dip tubes, and isolated metal parts on intrinsically safe electrical equipment.

For further information, see NFPA 77; API RP 2003, *Protection Against Ignition Arising Out of Static, Lightning and Stray*

Currents; and *Electrostatic Hazards: Their Evaluation and Control*, by H. Haase. See also Supplement 5, Electrostatics, of the NFPA 30 Handbook.

66.21.4.5* Corrosion Protection.

A.66.21.4.5 Other means of internal corrosion protection include protective coatings and linings and cathodic protection. [**30:**A.21.4.5]

66.21.4.5.1 Corrosion protection shall meet the requirements of 66.21.4.5.2 or 66.21.4.5.3, whichever is applicable. [**30:**21.4.5.1]

66.21.4.5.2 Internal Corrosion Protection for Metal Storage Tanks. Where tanks are not designed in accordance with standards of the American Petroleum Institute, the American Society of Mechanical Engineers, or Underwriters Laboratories Inc., or if corrosion is anticipated beyond that provided for in the design formulas or standards used, additional metal thickness or approved protective coatings or linings shall be provided to compensate for the corrosion loss expected during the design life of the tank. [**30:**21.4.5.2]

66.21.4.5.3 Internal Corrosion Protection for Nonmetallic Tanks. Where tanks are not designed in accordance with standards of the American Petroleum Institute, the American Society of Mechanical Engineers, ASTM International, or Underwriters Laboratories Inc., or if degradation is anticipated beyond that provided for in the design formulas or standards used, degradation shall be compensated for by providing additional tank material thickness or by application of protective coatings or linings, as determined by an engineering analysis. [**30:**21.4.5.3]

66.21.5 Testing Requirements for Tanks.

66.21.5.1 General. All tanks, whether shop-built or field-erected, shall be tested before they are placed in service in accordance with the requirements of the code under which they were built. [**30:**21.5.1]

66.21.5.1.1 An approved listing mark on a tank shall be considered to be evidence of compliance with 66.21.5.1. Tanks not so marked shall be tested before they are placed in service in accordance with the applicable requirements for testing in the codes listed in 66.21.4.2.1.1, 66.21.4.2.2.1, or 66.21.4.2.3.1 or in accordance with recognized engineering standards. Upon satisfactory completion of testing, a permanent record of the test results shall be maintained by the owner. [**30:**21.5.1.1]

This provision of the *Code* requires the owner to maintain a permanent record of the test results, to avoid future questions about the tank's original listing.

66.21.5.1.2 Where the vertical length of the fill and vent pipes is such that, when filled with liquid, the static head imposed on the bottom of the tank exceeds a gauge pressure of 10 psi (70 kPa), the tank and its related piping shall be tested hydrostatically to a pressure equal to the static head thus imposed by using recognized engineering standards. [**30:**21.5.1.2]

The intent of 66.21.5.1.2 is that the tank be tested to the pressure that would be developed if the tank were accidentally overfilled, causing liquid to rise into the vent pipe. However, under no circumstances should the pressure exceed the design pressure of the tank.

66.21.5.1.3 Before the tank is initially placed in service, all leaks or deformations shall be corrected in an approved manner. Mechanical caulking shall not be permitted for correcting leaks in welded tanks except for pinhole leaks in the roof. [**30:**21.5.1.3]

66.21.5.1.4 Tanks to be operated at pressures below their design pressure shall be tested by the applicable provisions of 66.21.5.1.1 or 66.21.5.1.2 based upon the pressure developed under full emergency venting of the tank. [**30:**21.5.1.4]

66.21.5.2* Tightness Testing. In addition to the tests called for in 66.21.5.1, all tanks and connections shall be tested for tightness after installation and before being placed in service in accordance with 66.21.5.2.2 and 66.21.5.2.3, as applicable. Except for underground tanks, this test shall be made at operating pressure with air, inert gas, or water. [**30:**21.5.2]

A.66.21.5.2 See PEI RP200, *Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling*, and STI R 931, *Double Wall AST Installation and Testing Instructions*, for additional requirements to test secondary containment tanks. [**30:**A.21.5.2]

When testing with air or inert gas is done, positive means such as a relief valve or regulator should be incorporated into the air or inert gas supply to ensure that the test pressure does not exceed that specified. Tests using air should not be made on top of stored product, which means that the test must be made prior to putting any liquid into the tank. Nor should air tests be made on tanks that have been emptied of liquid but not purged of vapors. These safety precautions prevent formation of an ignitible atmosphere in the tank.

66.21.5.2.1 Testing required by 66.21.5.2 shall not be required for a primary tank or an interstitial space that continues to maintain a factory-applied vacuum in accordance with the manufacturer's instructions. Such components shall be considered to be tight until such time that the vacuum is broken. Final tightness testing of an interstitial space shall not be required if the factory-applied vacuum is maintained until one of the following conditions is met:

(1) For aboveground tanks, the tank is set on the site at the location where it is intended to be installed.
(2) For underground tanks, backfill has been completed to the top of the tank.

[**30:**21.5.2.1]

Nearly all factory-built aboveground and underground storage tanks that incorporate secondary containment are shipped from the factory with the interstitial space under vacuum. As long as the vacuum stays intact and meets manufacturers' specifications, both the primary vessel and the secondary containment are demonstrated as being tight and there is no need to test.

66.21.5.2.2 Air pressure shall not be used to test tanks that contain flammable or combustible liquids or vapors. *(See 66.27.7 for testing pressure piping.)* [**30:**21.5.2.2]

66.21.5.2.3 For field-erected tanks, the tests required by 66.21.5.1.1 or 66.21.5.1.2 shall be permitted to be considered the test for tank tightness. [**30:**21.5.2.3]

66.21.5.2.4 Horizontal shop-fabricated aboveground tanks shall be tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 3 psi (20 kPa) and not more than a gauge pressure of 5 psi (35 kPa). [**30:**21.5.2.4]

66.21.5.2.5 Vertical shop-fabricated aboveground tanks shall be tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 1.5 psi (10 kPa) and not more than a gauge pressure of 2.5 psi (17 kPa). [**30:**21.5.2.5]

66.21.5.2.6 Single-wall underground tanks and piping, before being covered, enclosed, or placed in use, shall be tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 3 psi (20 kPa) and not more than a gauge pressure of 5 psi (35 kPa). [**30:**21.5.2.6]

66.21.5.2.7* Underground secondary containment tanks and horizontal aboveground secondary containment tanks shall have the primary (inner) tank tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 3 psi (20 kPa) and not more than a gauge pressure of 5 psi (35 kPa). [**30:**21.5.2.7]

A.66.21.5.2.7 Underground double-wall tanks can be considered to be a type of secondary containment. The terms "double-wall tank" and "jacketed tank" are sometimes used to describe underground secondary containment tanks. [**30:**A.21.5.2.7]

66.21.5.2.7.1 The interstitial space of such tanks shall be tested either hydrostatically or with air pressure at a gauge pressure of 3 to 5 psi (20 to 35 kPa), by vacuum at 5.3 in. Hg (18 kPa), or in accordance with the tank's listing or the manufacturer's instructions. These limits shall not be exceeded. [**30:**21.5.2.7.1]

66.21.5.2.7.2 The pressure or vacuum shall be held for not less than 1 hour or for the duration specified in the listing procedures for the tank. [**30:**21.5.2.7.2]

The 1-hour test duration ensures sufficient time for pressure to bleed down to a detectable level should there be a pinhole leak. The test procedures required by 66.21.5.2.7.1 and 66.21.5.2.8.1 do not apply if the tank is shipped with a factory-applied vacuum in the interstitial space and the vacuum complies with 66.21.5.2.1.

66.21.5.2.8 Vertical aboveground secondary containment–type tanks shall have their primary (inner) tank tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 1.5 psi (10 kPa) and not more than a gauge pressure of 2.5 psi (17 kPa). [**30:**21.5.2.8]

66.21.5.2.8.1 The interstitial space of such tanks shall be tested either hydrostatically or with air pressure at a gauge pressure of 1.5 to 2.5 psi (10 to 17 kPa), by vacuum at 5.3 in. Hg (18 kPa), or in accordance with the tank's listing or manufacturer's instructions. These limits shall not be exceeded. [**30:**21.5.2.8.1]

66.21.5.2.8.2 The pressure or vacuum shall be held for not less than 1 hour or for the duration specified in the listing procedures for the tank. [**30:**21.5.2.8.2]

66.21.5.3* Periodic Testing. Each tank shall be tested when required by the manufacturer's instructions and applicable standards to ensure the integrity of the tank. [**30:**21.5.3]

Δ **A.66.21.5.3** For information on testing of underground tanks, see NFPA 329. For information on testing aboveground tanks, see API 653, *Tank Inspection, Repair, Alteration, and Reconstruction*. [**30:**A.21.5.3]

66.21.6 Fire Prevention and Control.

66.21.6.1 General Requirements.

66.21.6.1.1 This section shall apply to the commonly recognized management techniques and fire control methods used to prevent or minimize the loss from fire or explosion in tank storage facilities. The wide range in size, design, and location of tank storage facilities shall preclude the inclusion of detailed fire prevention and control methods applicable to all such facilities. [**30:**21.6.1.1]

66.21.6.1.2 Tank storage facilities shall establish and implement fire prevention and control methods for life safety, for minimizing property loss, and for reducing fire exposure to adjoining facilities resulting from fire and explosion. Compliance with 66.21.6.2 through 66.21.6.6 shall be deemed as meeting the requirements of 66.21.6.1. [**30:**21.6.1.2]

66.21.6.2 Control of Ignition Sources. In order to prevent the ignition of flammable vapors in tank storage facilities, ignition sources shall be controlled in accordance with Section 66.6. [**30:**21.6.2]

66.21.6.3 Management of Fire Hazards. The extent of fire and explosion prevention and control procedures and measures provided for tank storage facilities shall be determined by an engineering evaluation of the installation and operation, followed by the application of recognized fire and explosion protection and process engineering principles. The evaluation shall include, but not be limited to, the following:

(1) Analysis of fire and explosion hazards of the facility
(2) Analysis of local conditions, such as exposure to and from adjacent properties, flood potential, or earthquake potential
(3) Facility, fire department or mutual aid response

[**30:**21.6.3]

66.21.6.4 Fire Control. Tank storage facilities for flammable and combustible liquids shall be reviewed to ensure that fire and explosion hazards resulting from loss of containment of liquids are provided with corresponding fire prevention and emergency action plans. *(See also 66.6.3.)* [**30:**21.6.4]

66.21.6.5 Emergency Planning and Training.

As is the case for fire control, emergency planning and training must be tailored for each individual facility, which will require considerable judgment and consultation among the facility operator, the AHJ, and local emergency response services. Much of what follows in this subsection is mandated in more detail by OSHA in 29 CFR 1910.

66.21.6.5.1* An emergency plan, consistent with the available equipment, resources, and personnel, shall be established and implemented to respond to fires and explosions, and other emergencies. This plan shall address the following:

(1) Procedures to be used in case of fire, explosion, or accidental release of liquid or vapor including, but not limited to, sounding the alarm, notifying the fire department, evacuating personnel, controlling and mitigating the explosion, and controlling and extinguishing the fire
(2) Appointing and training of personnel to carry out emergency response duties
(3) Maintenance of fire protection, spill control and containment, and other emergency response equipment
(4) Conducting emergency response drills
(5) Shutdown or isolation of equipment to control unintentional releases
(6) Alternative measures for the safety of personnel while any fire protection or other emergency response equipment is shut down or inoperative

[**30:**21.6.5.1]

A.66.21.6.5.1 Resources include, but are not limited to, the following:

(1) Mutual aid
(2) Water supply
(3) Extinguishing agent supply

[**30:**A.21.6.5.1]

66.21.6.5.2 Personnel responsible for the use and operation of fire protection equipment shall be trained in the use of and be able to demonstrate knowledge of the use or operation of that equipment. Refresher training shall be conducted at least annually. [**30:**21.6.5.2]

66.21.6.5.3 Planning of effective fire control measures shall be coordinated with local emergency response agencies and shall include, but not be limited to, the identification of all tanks by location, contents, size, and hazard identification as required in 66.21.7.2.1. [**30:**21.6.5.3]

66.21.6.5.4 Procedures shall be established to provide for safe shutdown of tank storage facilities under emergency conditions and for safe return to service. These procedures shall provide requirements for periodic training of personnel and inspection and testing of associated alarms, interlocks, and controls. [**30:**21.6.5.4]

66.21.6.5.5 Emergency procedures shall be kept available in an operating area. The procedures shall be reviewed and updated in accordance with 66.6.4.2. [**30:**21.6.5.5]

66.21.6.5.6 Where tank storage facilities are unattended, a summary of the emergency plan shall be posted or located in a strategic location that is accessible to emergency responders. [**30:**21.6.5.6]

66.21.6.6 Inspection and Maintenance of Fire Protection and Emergency Response Equipment.

66.21.6.6.1* All fire protection and emergency response equipment shall be maintained, inspected, and tested in accordance with regulatory requirements, standard practices, and equipment manufacturers' recommendations. [**30:**21.6.6.1]

Δ **A.66.21.6.6.1** See NFPA 25 or other specific fire protection system standards. [**30:**A.21.6.6.1]

66.21.6.6.2 Maintenance and operating procedures and practices at tank storage facilities shall be established and implemented to control leakage and prevent spillage and release of liquids. [**30:**21.6.6.2]

Cleanup operations should be conducted in a manner that minimizes vapor loss. Many commercially available absorbents and adsorbents have been developed, primarily to mitigate environmental damage, but are still of great benefit. Also, some fire-suppression foams and recently developed vapor-suppression foams are helpful in controlling vapors from large-scale spills.

66.21.6.6.3 Ground areas around tank storage facilities shall be kept free of weeds, trash, or other unnecessary combustible materials. [**30:**21.6.6.3]

66.21.6.6.4 Accessways established for movement of personnel shall be maintained clear of obstructions to permit evacuation and access for manual fire fighting and emergency response in accordance with regulatory requirements and the emergency plan. [**30:**21.6.6.4]

66.21.6.6.5 Combustible waste material and residues in operating areas shall be kept to a minimum, stored in covered metal containers, and disposed of daily. [**30:**21.6.6.5]

66.21.6.6.6 Personnel responsible for the inspection and maintenance of fire protection and emergency response equipment shall be trained and shall be able to demonstrate knowledge of the inspection and maintenance of that equipment. Refresher training shall be conducted as needed to maintain proficiency. [**30:**21.6.6.6]

66.21.7 Operation of Storage Tanks.

66.21.7.1* Prevention of Overfilling of Storage Tanks. Facilities with aboveground tanks larger than 1320 gal (5000 L) storing Class I or Class II liquids shall establish procedures or shall provide equipment, or both, to prevent overfilling of tanks. [**30:**21.7.1]

A.66.21.7.1 Further guidance is given in API 2350, *Overfill Protection for Storage Tanks in Petroleum Facilities*. [**30:**A.21.7.1]

66.21.7.1.1 Facilities with aboveground tanks that receive and transfer Class I liquids from mainline pipelines or marine vessels shall establish and follow formal written procedures to prevent overfilling of tanks utilizing one of the following methods of protection:

(1) Tanks shall be gauged at intervals in accordance with established procedures by personnel continuously on the premises during product receipt. Acknowledged communication shall be

maintained with the supplier so flow can be shut down or diverted in accordance with established procedures.

(2) Tanks shall be equipped with a high-level detection device that is either independent of any gauging equipment or incorporates a gauging and alarm system that provides electronic self-checking to indicate when the gauging and alarm system has failed. Alarms shall be located where personnel who are on duty throughout product transfer can arrange for flow stoppage or diversion in accordance with established procedures.

(3) Tanks shall be equipped with an independent high-level detection system that will automatically shut down or divert flow in accordance with established procedures.

[**30:**21.7.1.1]

Δ **66.21.7.1.2** Alternatives to instrumentation described in 66.21.7.1.1(2) and 66.21.7.1.1(3) shall be allowed where approved as affording equivalent protection. [**30:**21.7.1.2]

Δ **66.21.7.1.3** Instrumentation systems covered in 66.21.7.1.1(2) and 66.21.7.1.1(3) shall be wired fail-safe, such that valid alarm conditions or system failures create an alarm condition that will notify personnel or automatically shut down or divert flow. [**30:**21.7.1.3]

66.21.7.1.3.1 Written instrumentation performance procedures shall be established to define valid alarm conditions and system failures in accordance with API 2350, *Overfill Protection for Storage Tanks in Petroleum Facilities*. [**30:**21.7.1.3.1]

66.21.7.1.3.2 System failure shall include but not be limited to the following:

(1) Loss of main electrical power
(2) Electrical break, short circuit, or ground fault in the level detection system circuit or the alarm and signal circuit
(3) Failure or malfunction of the level detection system control equipment or signaling devices

[**30:**21.7.1.3.2]

66.21.7.1.4 Formal written procedures required by 66.21.7.1.1 shall include the following:

(1) Instructions covering methods to check for lineup and receipt of initial delivery to tank designated to receive shipment.
(2) Provision for training and monitoring the performance of operating personnel by supervisors.
(3) Schedules and procedures for inspection and testing of gauging equipment and high-level instrumentation and related systems. Inspection and testing intervals shall be approved but shall not exceed 1 year.

[**30:**21.7.1.4]

66.21.7.1.5 An underground tank shall be equipped with overfill prevention equipment that will operate as follows either alert the transfer operator when the tank is no more than 90 percent full by triggering an audible and visual high-level alarm or automatically shut off the flow of liquid into the tank when the tank is no more than 95 percent full. [**30:**21.7.1.5]

66.21.7.1.5.1 Other methods of overfill protection shall be permitted as approved by the AHJ. [**30:**21.7.1.5.1]

The requirements in 66.21.7.1.5 apply specifically to underground storage tanks and are intended to coordinate with the rules established by the EPA.

66.21.7.1.6 Shop-fabricated aboveground atmospheric storage tanks, constructed to the recognized standards of 66.21.4.2.1.1, shall meet the requirements of 66.21.7.1.6.1 through 66.21.7.1.6.4 whenever the vertical length from the tank bottom to the top of the fill, normal vent, or emergency vent exceeds 12 ft (3.7 m). [**30:**21.7.1.6]

66.21.7.1.6.1 An approved means shall be provided to notify the tank filling operator of the pending completion of the tank fill operation at the fill connection. [**30:**21.7.1.6.1]

66.21.7.1.6.2 An approved means shall be provided to stop delivery of liquid to the tank prior to the complete filling of the tank. [**30:**21.7.1.6.2]

66.21.7.1.6.3 In no case shall these provisions restrict or interfere with the functioning of the normal vent or emergency vent. [**30:**21.7.1.6.3]

Any interference with the proper functioning of the normal vent or the emergency vent could, in an extreme event, cause catastrophic failure of the tank.

66.21.7.1.6.4 The manufacturer of the tank shall be consulted to determine if reinforcement of the tank is required. If reinforcement is deemed necessary, it shall be done. [**30:**21.7.1.6.4]

66.21.7.2 Identification and Security.

Δ **66.21.7.2.1 Identification for Emergency Responders.** A sign or marking that meets the requirements of NFPA 704 or another approved system, shall be applied to storage tanks containing liquids. The marking shall be located where it can be seen, such as on the side of the tank, the shoulder of an accessway or walkway to the tank or tanks, or on the piping outside of the diked area. If more than one tank is involved, the markings shall be so located that each tank can be identified. [**30:**21.7.2.1]

See Exhibit 66.37.

Exhibit 66.37

NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response, placards on small storage tanks.

66.21.7.2.2* Security for Unsupervised Storage Tanks. Unsupervised, isolated aboveground storage tanks shall be secured and shall be marked to identify the fire hazards of the tank and the tank's contents to the general public. Where necessary to protect the tank from tampering or trespassing, the area where the tank is located shall be secured. [**30:**21.7.2.2]

A.66.21.7.2.2 Protection from tampering or trespassing might include one or more of the following: appropriate fencing around isolated tanks in remote areas; "No Trespassing" signs; warning signs indicating the fire hazard of the tank or its contents; locked or secured access to stairways and ladders; locked or secured hatches, valves, and so forth. [**30:**A.21.7.2.2]

66.21.7.3 Storage Tanks in Areas Subject to Flooding.

In several instances, high water levels have floated full or partially full tanks from their foundations, resulting in release of tank contents and damage to piping systems and to other tanks. The provisions of 66.21.7.3 are intended to prevent such incidents from occurring. See Exhibit 66.38.

Exhibit 66.38

Storage tanks dislodged from their foundations due to Hurricane Katrina floodwaters.

66.21.7.3.1 Water Loading.

66.21.7.3.1.1 The filling of a tank to be protected by water loading shall be started as soon as floodwaters are predicted to reach a dangerous flood stage. [**30:**21.7.3.1.1]

66.21.7.3.1.2 Where independently fueled water pumps are relied on, sufficient fuel shall be available at all times to permit continuing operations until all tanks are filled. [**30:**21.7.3.1.2]

66.21.7.3.1.3 Tank valves shall be locked in a closed position when water loading has been completed. [**30:**21.7.3.1.3]

66.21.7.3.2 Operating Instructions. Operating instructions or procedures to be followed in a flood emergency shall be established and implemented by personnel identified in 66.21.7.3.3. [**30:**21.7.3.2]

66.21.7.3.3 Personnel Training. Personnel responsible for activating and performing flood emergency procedures shall be trained in their implementation and shall be informed of the location and operation of valves and other controls and equipment necessary to effect the intent of these procedures. Personnel shall also be trained in the procedures required to place the facility back into service following a flood emergency. [**30:**21.7.3.3]

66.21.7.4 Removal from Service of Storage Tanks.

66.21.7.4.1* Closure of Aboveground Storage Tanks. Aboveground tanks taken out of service or abandoned shall be emptied of liquid, rendered vapor-free, and safeguarded against trespassing in accordance with NFPA 326, or in accordance with the requirements of the AHJ. [**30:**21.7.4.1]

These requirements are basic precautions that must be taken for any tank, whether aboveground or underground, that is taken out of service on a temporary or permanent basis. Many jurisdictions require these precautions for a tank that has been empty for more than 60 days and require that the tank be completely removed if permanently abandoned. See Annex C of NFPA 30 for further information.

A.66.21.7.4.1 For further information, see API 2015, *Safe Entry and Cleaning of Petroleum Storage Tanks*; and API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*. [**30:**A.21.7.4.1]

66.21.7.4.2 Reuse of Aboveground Storage Tanks. Aboveground tanks shall be permitted to be reused for flammable or combustible liquids service provided they comply with applicable sections of this *Code* and are approved. [**30:**21.7.4.2]

66.21.7.4.3 Removal from Service of Underground Storage Tanks.

Δ **66.21.7.4.3.1 General.** Underground tanks taken out of service or abandoned shall be emptied of liquid, rendered vapor-free, and safeguarded against trespassing in accordance with this section and in accordance with NFPA 326 or the requirements of the AHJ. The procedures outlined in this section shall be followed when taking underground tanks temporarily out of service, closing them in place permanently, or removing them. [**30:**21.7.4.3.1]

66.21.7.4.3.2 Temporary Closure. Underground tanks shall be rendered temporarily out of service only when it is planned that they will be returned to active service, closed in place permanently, or removed within an approved period not exceeding 1 year. The following requirements shall be met:

(1) Corrosion protection and release detection systems shall be maintained in operation.
(2) The vent line shall be left open and functioning.
(3) The tank shall be secured against tampering.
(4) All other lines shall be capped or plugged.

[**30:**21.7.4.3.2]

66.21.7.4.3.2.1 Tanks remaining temporarily out of service for more than 1 year shall be permanently closed in place or removed in accordance with 66.21.7.4.3.3 or 66.21.7.4.3.4, as applicable. [**30:**21.7.4.3.2.1]

Prior to a tank being taken temporarily out of service, federal, state, and local fire and environmental authorities must be notified to determine the maximum duration a tank is allowed to be temporarily closed. Some jurisdictions do not allow temporary closure at all.

66.21.7.4.3.3 Permanent Closure in Place. Underground tanks shall be permitted to be permanently closed in place if approved by the AHJ. All of the following requirements shall be met:

(1) All applicable AHJs shall be notified.
(2)* A safe workplace shall be maintained throughout the prescribed activities.

A.66.21.7.4.3.3(2) Special training might be required. [**30:**A.21.7.4.3.3(2)]

(3) All flammable and combustible liquids and residues shall be removed from the tank, appurtenances, and piping and shall be disposed of in accordance with regulatory requirements and industry practices, using a written procedure.
(4) The tank, appurtenances, and piping shall be made safe by either purging them of flammable vapors or inerting the potential explosive atmosphere. Confirmation that the atmosphere in the tank is safe shall be by testing of the atmosphere using a combustible gas indicator if purging, or an oxygen meter if inerting, at intervals in accordance with written procedures.
(5) Access to the tank shall be made by careful excavation to the top of the tank.
(6) All exposed piping, gauging and tank fixtures, and other appurtenances, except the vent, shall be disconnected and removed.
(7) The tank shall be completely filled with an inert solid material.
(8) The tank vent and remaining underground piping shall be capped or removed.
(9) The tank excavation shall be backfilled.

[**30:**21.7.4.3.3]

Δ **66.21.7.4.3.4 Removal and Disposal.** Underground tanks and piping shall be removed in accordance with the following requirements:

(1) The steps described in 66.21.7.4.3.3(1) through 66.21.7.4.3.3(5) shall be followed.
(2) All exposed piping, gauging and tank fixtures, and other appurtenances, including the vent, shall be disconnected and removed.
(3) All openings shall be plugged, leaving a ¼ in. (6 mm) opening to avoid buildup of pressure in the tank.
(4) The tank shall be removed from the excavated site and shall be secured against movement.
(5) Any corrosion holes shall be plugged.
(6) The tank shall be labeled with its former contents, present vapor state, vapor-freeing method, and a warning against reuse.
(7) The tank shall be removed from the site as authorized by the AHJ, preferably the same day.

[**30:**21.7.4.3.4]

66.21.7.4.3.5 Temporary Storage of Removed Tanks. If it is necessary to temporarily store an underground tank that has been removed, it shall be placed in a secure area where public access is restricted. A ¼ in. (6 mm) opening shall be maintained to avoid buildup of pressure in the tank. [**30:**21.7.4.3.5]

Δ **66.21.7.4.3.6 Disposal of Tanks.** Disposal of underground tanks shall meet the following requirements:

(1) Before a tank is cut up for scrap or landfill, the atmosphere in the tank shall be tested in accordance with 66.21.7.4.3.3(4) to ensure that it is safe.
(2) The tank shall be made unfit for further use by cutting holes in the tank heads and shell.

[**30:**21.7.4.3.6]

66.21.7.4.3.7 Documentation. All necessary documentation shall be prepared and maintained in accordance with all federal, state, and local rules and regulations. [**30:**21.7.4.3.7]

66.21.7.4.3.8 Reuse of Underground Storage Tanks. Underground tanks shall be permitted to be reused for underground storage of flammable or combustible liquids provided they comply with applicable sections of this *Code* and are approved. [**30:**21.7.4.3.8]

This provision requires that approval for reuse of tanks be received to confirm that the tanks meet all appropriate sections of this *Code* and NFPA 30.

66.21.7.5* Leak Detection and Inventory Records for Underground Storage Tanks. Accurate inventory records or a leak detection program shall be maintained on all Class I liquid storage tanks for indication of leakage from the tanks or associated piping. [**30:**21.7.5]

A.66.21.7.5 See NFPA 329 for information on testing methods. [**30:**A.21.7.5]

66.21.8 Inspection and Maintenance of Storage Tanks and Storage Tank Appurtenances.

66.21.8.1* Each storage tank constructed of steel shall be inspected and maintained in accordance with API Standard 653, *Tank Inspection, Repair, Alteration, and Reconstruction*, or STI SP001, *Standard for the Inspection of Aboveground Storage Tanks*, whichever is applicable. [**30:**21.8.1]

A.66.21.8.1 Regular inspections of aboveground storage tanks, including shop fabricated aboveground storage tanks, performed in accordance with national standards, provide a means to ensure system maintenance. Acceptable standards include, but are not limited to, the following:

(1) API 653, *Tank Inspection, Repair, Alteration, and Reconstruction*
(2) STI SP001, *Standard for Inspection of Aboveground Storage Tanks*
(3) API 12R1, *Setting, Maintenance, Inspection, Operation, and Repair of Tanks in Production Service*
(4) API 2350, *Overfill Protection for Storage Tanks in Petroleum Facilities*

[**30:**A.21.8.1]

66.21.8.2 Each storage tank constructed of other materials shall be inspected and maintained in accordance with the manufacturer's instructions and applicable standards to ensure compliance with the requirements of this *Code*. [**30:**21.8.2]

66.21.8.3 Testing of storage tanks shall meet the requirements of 66.21.5. [**30:**21.8.3]

66.21.8.4 Each storage tank shall be maintained liquidtight. Each storage tank that is leaking shall be emptied of liquid or repaired in a manner acceptable to the AHJ. [**30:**21.8.4]

This requirement ensures that any tank that shows evidence of leaking will be repaired or taken out of service reasonably quickly, before environmental damage occurs or a dangerous fire hazard develops.

66.21.8.5 Each storage tank that has been structurally damaged, repaired, reconstructed, relocated, jacked, or damaged by impact, flood, or other trauma, or is suspected of leaking shall be inspected and tested in accordance with 66.21.5 or in a manner acceptable to the AHJ. [**30:**21.8.5]

66.21.8.6* Storage tanks and their appurtenances, including normal vents, emergency vents, overfill prevention devices, and related devices, shall be inspected and maintained to ensure that they function as intended in accordance with written procedures. [**30:**21.8.6]

A.66.21.8.6 For additional information, see API 653, *Tank Inspection, Repair, Alteration, and Reconstruction*, API RP 2350, *Overfill Protection for Storage Tanks in Petroleum Facilities*, and PEI RP600, *Recommended Practices for Overfill Prevention for Shop-Fabricated Aboveground Tanks*. [**30:**A.21.8.6]

66.21.8.7 Openings for gauging on storage tanks storing Class I liquids shall be provided with a vaportight cap or cover. Such covers shall be closed when not gauging. [**30:**21.8.7]

66.21.8.8* Facilities with aboveground storage tanks shall establish and implement a procedure to check for and remove water from the bottom of storage tanks that contain nonmiscible liquids. [**30:**21.8.8]

A.66.21.8.8 The accumulation of water in the bottom of a tank encourages microbial activity that hampers operations and increases the risk of product release. It is imperative that tank owners and operators routinely monitor the tank bottom for accumulation of water and establish a procedure for when and how the water is to be removed. Additional information can be found in API 1501, *Filtration and Dehydration of Aviation Fuels*, API RP 1621, *Bulk Liquid Stock Control at Retail Outlets*, and API Standard 2610, *Design, Construction, Operation, Maintenance, and Inspection of Terminal and Tank Facilities*. Other sources of information are ASTM D6469, *Standard Guide for Microbial Contamination in Fuels and Fuel Systems*, the National Oilheat Research Alliance *Oilheat Technician's Manual*, and the STI publication *Keeping Water Out of Your Storage System*. [**30:**A.21.8.8]

66.21.9 Change of Stored Liquid. Storage tanks that undergo any change of stored liquid shall be re-evaluated for compliance with Sections 66.21 through 66.25, as applicable. [**30:**21.9]

66.22 Storage of Liquids in Tanks — Aboveground Storage Tanks

66.22.1 Scope. This chapter shall apply to the following:

(1) The storage of flammable and combustible liquids, as defined in 3.3.169.1 and 3.3.169.2 and Section 66.4, in fixed tanks that exceed 60 gal (230 L) capacity
(2) The storage of flammable and combustible liquids in portable tanks that exceed 660 gal (2500 L) capacity
(3) The storage of flammable and combustible liquids in intermediate bulk containers that exceed 793 gal (3000 L)
(4) The design, installation, testing, operation, and maintenance of such tanks, portable tanks, and bulk containers

[**30:**22.1]

66.22.2 Definitions Specific to Section 66.22. For the purpose of this section, the terms in this section shall have the definition given. [**30:**22.2]

66.22.2.1 Fire-Resistant Tank. An atmospheric aboveground storage tank with thermal insulation that has been evaluated for resistance to physical damage and for limiting the heat transferred to the primary tank when exposed to a hydrocarbon fuel fire and is listed in accordance with UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*, or an equivalent test procedure. [**30:**22.2.1]

66.22.2.2 Floating Roof Tank. An aboveground storage tank that incorporates one of the following designs:

(1) A closed-top pontoon or double-deck metal floating roof in an open-top tank constructed in accordance with API Standard 650, *Welded Steel Tanks for Oil Storage*
(2) A fixed metal roof with ventilation at the top and roof eaves constructed in accordance with API Standard 650 and containing a closed-top pontoon or double-deck metal floating roof meeting the requirements of API Standard 650
(3) A fixed metal roof with ventilation at the top and roof eaves constructed in accordance with API Standard 650 and containing a metal floating cover supported by liquidtight metal floating devices that provide buoyancy to prevent the liquid surface from being exposed when half of the flotation is lost

[**30:**22.2.2]

A floating roof tank is a tank in which a pan or cover actually floats on the surface of the liquid. The floating roof rides up and down as the liquid level in the tank changes and moves within the tank shell, much like a piston in a cylinder. A floating roof tank can be of the open-top type, where there is no fixed roof at the top of the shell (see Exhibit 66.39), or it can be of the internal type, where the tank has a fixed roof (see Exhibit 66.40). The latter is recognized by its "eyebrow" vents, located just below the tank eave.

Experience has shown that tanks with floating roofs that meet the criteria of 66.22.2.1 are not likely to be involved in serious fires. Most fires in such tanks have involved burning only at the resilient seal between the floating roof and the shell and are

Exhibit 66.39

Open-top floating roof tanks.

Exhibit 66.40

Closed-top floating roof tank.

usually easily extinguished. If the tank is of the open-top type, handheld extinguishing equipment might prove adequate. If the tank is of the internal type, with a fixed cone or geodesic dome roof, fire fighting is obviously more complex.

In fires involving open-top floating roof tanks where a floating roof has sunk, resulting in a full-surface fire, there is only one reported incident of boil-over, which occurred at the Trieste, Italy, pipeline terminal in the early 1970s. In that incident, two 500 ft (153 m) diameter crude oil tanks were set afire by explosive charges set by a terrorist group. The floating roofs sank, and boil-over occurred about 12 hours later. However, in most cases, it is thought that the sunken roof presents a barrier to the downward progress of the hot oil layer, thus preventing a boil-over. For those reasons, floating roof tanks are given preferred treatment in 66.22.4.1.

Item (3) of 66.22.2.2 recognizes flotation devices other than pontoons or floats — honeycomb panels, for example — but the requirement is somewhat stricter in that the cover cannot tip in any manner that results in exposure of the liquid surface. Previously, NFPA 30 required only that the pan or cover not sink completely. It is now recognized that a cover that tips and exposes any liquid presents as great a degree of fire risk as one that sinks and exposes the entire surface of the liquid.

66.22.2.2.1 For the purposes of this section, an aboveground storage tank with an internal metal floating pan, roof, or cover that does not meet 66.22.2.2 or one that uses plastic foam (except for seals) for flotation, even if encapsulated in metal or fiberglass, shall meet the requirements for a fixed roof tank. [**30:**22.2.2.1]

Cone roof tanks with internal floating pans, such as those described here, are considered to be the equivalent of a fixed roof tank because the internal floating pans are prone to sinking and because foamed plastic and similar flotation devices will not withstand the conditions imposed by a fire.

66.22.2.3 Protected Aboveground Tank. An atmospheric aboveground storage tank with integral secondary containment and thermal insulation that has been evaluated for resistance to physical damage and for limiting the heat transferred to the primary tank when exposed to a hydrocarbon pool fire and is listed in accordance with ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*, or an equivalent test procedure. [**30:**22.2.3]

66.22.3 General Requirements. Storage of Class II and Class III liquids heated at or above their flash point shall follow the requirements for Class I liquids, unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. [**30:**22.3]

66.22.4* Location of Aboveground Storage Tanks.

The provisions of this subsection are intended to ensure that tanks are located such that they will not jeopardize structures on the property of others. In the days when tanks had wood-supported combustible roofs, it was not uncommon for fire to spread from one tank to another. Therefore, regulations provided that tanks be widely spaced from each other and from all other facilities. With the advent of roofs made completely of steel, this risk greatly decreased. Experience indicated that, given no ground-spill fire, one tank could burn without damaging neighboring tanks or adjoining property. However, distance between adjacent tanks and distance between tanks and property lines or adjacent structures remain principal planning criteria. Instead of basing the spacing on an arbitrarily selected distance, it is now considered more practical and realistic to base it on a fraction of the tank diameter, except for those tanks that use emergency relief devices, which are based on capacity, to limit internal pressures. The tables in 66.22.4 use both tank diameter and tank capacity, as appropriate.

A.66.22.4 See PEI RP200, *Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling*, for additional information. [**30:**A.22.4]

66.22.4.1 Location with Respect to Property Lines, Public Ways, and Important Buildings.

Sections 66.22.4.1.1 through 66.22.4.1.8 and Tables 66.22.4.1.1(a) through 66.22.4.1.6 govern the siting of tanks in relation to surrounding buildings, public roads and highways, and property lines. Table 66.22.4.1.1(a), Table 66.22.4.1.3, Table 66.22.4.1.4, and Table 66.22.4.1.5, used in conjunction with Table 66.22.4.1.1(b), apply to Class I, II, and IIIA liquids and base their spacing requirements on the characteristics of the liquid, the manner in which it is stored, the type of tank used, the protection provided for the tank, and the protection provided for exposures. Class IIIB liquids are covered in 66.22.4.1.6.

The tables recognize that it can be difficult, sometimes impossible, to extinguish a tank fire. Therefore, efforts are directed at protecting adjacent buildings and adjoining properties. Fire protection for exposures should not be confused with fire suppression systems and equipment used to fight a tank fire. The tables also recognize that there is little possibility of extinguishing a fire in a tank that exceeds 150 ft (45 m) in diameter without specialized equipment and tactics. Even with fixed fire-suppression equipment installed, set-up time is often required, during which exposed tanks or structures need to be protected from radiant heat to prevent fire spread.

Detailed commentary that outlines the terminology in these tables as well as the use and application of 66.22.4.1 is provided in *NFPA 30 and NFPA 30A: Flammable and Combustible Liquids Code Handbook*. Where applicable, users of this *Code* should reference the *NFPA 30 Handbook* for additional information. It is not copied here as it is generally outside the scope of this *Code*, but it may be useful to users seeking additional information on this topic. See 22.4.1 of *NFPA 30 Handbook*.

Δ **66.22.4.1.1** Tanks storing Class I, Class II, or Class IIIA stable liquids whose internal pressure is not permitted to exceed a gauge pressure of 2.5 psi (17 kPa) shall be located in accordance with Table 66.22.4.1.1(a) and Table 66.22.4.1.1(b). Where tank spacing is based on a weak roof-to-shell seam design, the user shall present evidence certifying such construction to the AHJ upon request. [**30:**22.4.1.1]

Δ ***TABLE 66.22.4.1.1(a)*** *Location of Aboveground Storage Tanks Storing Stable Liquids — Internal Pressure Not to Exceed a Gauge Pressure of 2.5 psi (17 kPa)*

Type of Tank	Protection	Minimum Distance (ft): From Property Line That Is or Can Be Built Upon, Including the Opposite Side of a Public Way[a]	Minimum Distance (ft): From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property[a]
Floating roof	Protection for exposures[c]	½ × diameter of tank	⅙ × diameter of tank
	None	Diameter of tank but need not exceed 175 ft	⅙ × diameter of tank
Vertical with weak roof-to-shell seam	Approved foam or inerting system[c] on tanks not exceeding 150 ft in diameter[d]	½ × diameter of tank	⅙ × diameter of tank
	Protection for exposures[c]	Diameter of tank	⅓ × diameter of tank
	None	2 × diameter of tank but need not exceed 350 ft	⅓ × diameter of tank
Horizontal and vertical tanks with emergency relief venting to limit pressures to 2.5 psi (gauge pressure of 17 kPa)	Approved inerting system[b] on the tank or approved foam system on vertical tanks	½ × value in Table 66.22.4.1.1(b)	½ × value in Table 66.22.4.1.1(b)
	Protection for exposures[b]	Value in Table 66.22.4.1.1(b)	Value in Table 66.22.4.1.1(b)
	None	2 × value in Table 66.22.4.1.1(b)	Value in Table 66.22.4.1.1(b)
Protected aboveground tank	None	½ × value in Table 66.22.4.1.1(b)	½ × value in Table 66.22.4.1.1(b)

For SI units, 1 ft = 0.3 m.

[a]The minimum distance cannot be less than 5 ft (1.5 m).

[b]See definition 3.3.46 of NFPA 30, Protection for Exposures.

[c]See NFPA 69.

[d]For tanks over 150 ft (45 m) in diameter, use “Protection for Exposures” or “None,” as applicable. [**30:** Table 22.4.1.1(a)]

TABLE 66.22.4.1.1(b) *Reference Table for Use with Tables 66.22.4.1.1(a), 66.22.4.1.3, and 66.22.4.1.5*

Tank Capacity (gal)	Minimum Distance (ft) From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance (ft) From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
275 or less	5	5
276 to 750	10	5
751 to 12,000	15	5
12,001 to 30,000	20	5
30,001 to 50,000	30	10
50,001 to 100,000	50	15
100,001 to 500,000	80	25
500,001 to 1,000,000	100	35
1,000,001 to 2,000,000	135	45
2,000,001 to 3,000,000	165	55
3,000,001 or more	175	60

For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L. [**30:** Table 22.4.1.1(b)]

Δ ***TABLE 66.22.4.1.3*** *Location of Aboveground Storage Tanks Storing Stable Liquids — Internal Pressure Permitted to Exceed a Gauge Pressure of 2.5 psi (17 kPa)*

Type of Tank	Protection	Minimum Distance (ft) From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance (ft) From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
Any type	Protection for exposures*	1½ × value in Table 66.22.4.1.1(b) but not less than 25 ft	1½ × value in Table 66.22.4.1.1(b) but not less than 25 ft
	None	3 × value in Table 66.22.4.1.1(b) but not less than 50 ft	1½ × value in Table 66.22.4.1.1(b) but not less than 25 ft

For SI units, 1 ft = 0.3 m.

*See definition 3.3.46 of NFPA 30, Protection for Exposures.
[**30:** Table 22.4.1.3]

66.22.4.1.2 Vertical tanks with weak roof-to-shell seams *(see 66.22.7.2)* that store Class IIIA liquids shall be permitted to be located at one-half the distances specified in Table 66.22.4.1.1(a), provided the tanks are not within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid. [**30:**22.4.1.2]

66.22.4.1.3 Tanks storing Class I, Class II, or Class IIIA stable liquids and operating at pressures that exceed a gauge pressure of 2.5 psi (17 kPa), or are equipped with emergency venting that will permit pressures to exceed a gauge pressure of 2.5 psi (17 kPa), shall be located in accordance with Table 66.22.4.1.3 and Table 66.22.4.1.1(b). [**30:**22.4.1.3]

66.22.4.1.4 Tanks storing liquids with boil-over characteristics shall be located in accordance with Table 66.22.4.1.4. Liquids with boil-over characteristics shall not be stored in fixed roof tanks larger than 150 ft (45 m) in diameter, unless an approved inerting system is provided on the tank. [**30:**22.4.1.4]

Δ ***TABLE 66.22.4.1.4*** *Location of Aboveground Storage Tanks Storing Boil-Over Liquids*

Type of Tank	Protection	Minimum Distance (ft) From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way[a]	Minimum Distance (ft) From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property[a]
Floating roof	Protection for exposures[b]	½ × diameter of tank	⅙ × diameter of tank
	None	Diameter of tank	⅙ × diameter of tank
Fixed roof	Approved foam or inerting system[c]	Diameter of tank	⅓ × diameter of tank
	Protection for exposures[b]	2 × diameter of tank	⅔ × diameter of tank
	None	4 × diameter of tank but need not exceed 350 ft	⅔ × diameter of tank

For SI units, 1 ft = 0.3 m.

[a]The minimum distance cannot be less than 5 ft.

[b]See definition 3.3.46 of NFPA 30, Protection for Exposures.

[c]See NFPA 69, *Standard on Explosion Prevention Systems*.
[**30:** Table 22.4.1.4]

TABLE 66.22.4.1.5 Location of Aboveground Storage Tanks Storing Unstable Liquids

Type of Tank	Protection	Minimum Distance (ft): From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance (ft): From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property[a]
Horizontal and vertical tanks with emergency relief venting to permit pressure not in excess of a gauge pressure of 2.5 psi (17 kPa)	Tank protected with any one of the following: approved water spray, approved inerting,[a] approved insulation and refrigeration, approved barricade	Value in Table 66.22.4.1.1(b) but not less than 25 ft	Not less than 25 ft
	Protection for exposures[b]	2½ × value in Table 66.22.4.1.1(b) but not less than 50 ft	Not less than 50 ft
	None	5 × value in Table 66.22.4.1.1(b) but not less than 100 ft	Not less than 100 ft
Horizontal and vertical tanks with emergency relief venting to permit pressure over a gauge pressure of 2.5 psi (17 kPa)	Tank protected with any one of the following: approved water spray, approved inerting,[a] approved insulation and refrigeration, approved barricade	2 × value in Table 66.22.4.1.1(b) but not less than 50 ft	Not less than 50 ft
	Protection for exposures[b]	4 × value in Table 66.22.4.1.1(b) but not less than 100 ft	Not less than 100 ft
	None	8 × value in Table 66.22.4.1.1(b) but not less than 150 ft	Not less than 150 ft

For SI units, 1 ft = 0.3 m.

[a]See NFPA 69, *Standard on Explosion Prevention Systems*.

[b]See definition 3.3.46 of NFPA 30, Protection for Exposures. [**30:** Table 22.4.1.5]

66.22.4.1.5 Tanks storing unstable liquids shall be located in accordance with Table 66.22.4.1.5 and Table 66.22.4.1.1(b). [**30:**22.4.1.5]

To contain the possibly violent reaction caused by heating under fire conditions, greater spacing for these tanks than for tanks storing stable liquids is mandated. Tanks storing unstable liquids have the most stringent spacing requirements.

66.22.4.1.6 Tanks storing Class IIIB stable liquids shall be located in accordance with Table 66.22.4.1.6.

*Exception: If located within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid, the tank storing Class IIIB liquid shall be located in accordance with 66.22.4.1.1. [**30:**22.4.1.6]*

Class IIIB liquids are considered to be almost immune from accidental fire because of their high flash points and extremely low

TABLE 66.22.4.1.6 Location of Aboveground Storage Tanks Storing Class IIIB Liquids

Tank Capacity (gal)	Minimum Distance (ft): From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance (ft): From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
12,000 or less	5	5
12,001 to 30,000	10	5
30,001 to 50,000	10	10
50,001 to 100,000	15	10
100,001 or more	15	15

For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L. [**30:** Table 22.4.1.6] vapor pressures. Thus, required distances from tanks to property lines are minimal. However, if a tank containing a Class IIIB liquid is situated in the drainage path of a Class I or Class II liquid (e.g., in the same diked area), the tank could be exposed by a spill fire.

66.22.4.1.7 Where two tank properties of diverse ownership have a common boundary, the AHJ shall be permitted, with the written consent of the owners of the two properties, to substitute the distances provided in 66.22.4.2 for the minimum distances set forth in 66.22.4.1.1. [**30:**22.4.1.7]

Simply put, when two owners sharing a common boundary agree, each may accept the risk from any of the tanks on the other's property to the same extent that risk is accepted from one's own. The separation distance tables are applied as if the tanks were on the same property.

66.22.4.1.8 Where end failure of a horizontal pressure tank or vessel can expose property, the tank or vessel shall be placed with its longitudinal axis parallel to the nearest important exposure. [**30:**22.4.1.8]

Paragraph 66.22.4.1.8 is based on the fact that a horizontal pressure tank exposed to fire is likely to travel (rocket) axially upon failure. Application of this rule involves the difficult decision as to which structure constitutes the nearest important risk. An office building on the same property or any occupied building on adjoining property would be considered an "important exposure." A tank containing flammable liquids might also be considered an important exposure; a normally unoccupied storage shed likely would not. See Exhibit 66.41.

66.22.4.2 Shell-to-Shell Spacing of Adjacent Aboveground Storage Tanks.

66.22.4.2.1* Tanks storing Class I, Class II, or Class IIIA stable liquids shall be separated by the distances given in Table 66.22.4.2.1. [**30:**22.4.2.1]

Exhibit 66.41

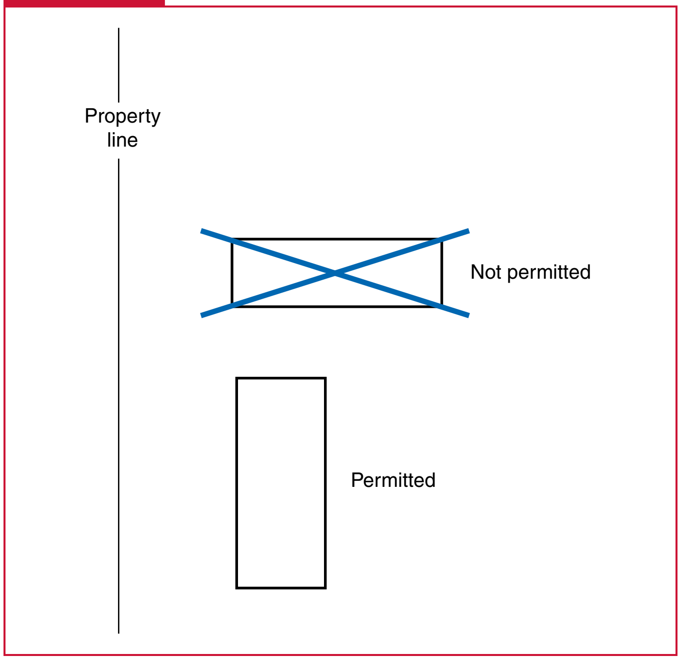


Illustration of proper orientation of pressure vessel to nearest exposure.

The minimum spacing between tanks storing stable liquids is given in Table 66.22.4.2.1. The 3 ft (0.9 m) minimum is based on the need for access for maintenance and painting and for application of hose streams to cool a fire-exposed tank. Spacing for larger tanks is an arbitrary fraction of tank diameter, sufficient to permit an orderly and safe arrangement for pipelines and to prevent spread of fire from one tank to another. Spacing alone is not a safeguard against fire spread from spilled liquid. The control of spills is covered in 66.22.11. Exceptions to the

***TABLE 66.22.4.2.1** Minimum Shell-to-Shell Spacing of Aboveground Storage Tanks*

		Fixed or Horizontal Tanks	
Tank Diameter	**Floating Roof Tanks**	**Class I or II Liquids**	**Class IIIA Liquids**
All tanks not over 150 ft (45 m) in diameter	⅙ × sum of adjacent tank diameters but not less than 3 ft (0.9 m)	⅙ × sum of adjacent tank diameters but not less than 3 ft (0.9 m)	⅙ × sum of adjacent tank diameters but not less than 3 ft (0.9 m)
Tanks larger than 150 ft (45 m) in diameter:			
If remote impounding is provided in accordance with 66.22.11.1	⅙ × sum of adjacent tank diameters	¼ × sum of adjacent tank diameters	⅙ × sum of adjacent tank diameters
If open diking is provided in accordance with 66.22.11.2	¼ × sum of adjacent tank diameters	⅓ × sum of adjacent tank diameters	¼ × sum of adjacent tank diameters

Note: The "sum of adjacent tank diameters" means the sum of the diameters of each pair of tanks that are adjacent to each other. See also A.66.22.4.2.1. [**30:** Table 22.4.2.1] spacing requirements in 66.22.4.2.1 are found in 66.22.4.2.1.1 and 66.22.4.2.1.2.

A.66.22.4.2.1 Where more than two tanks are involved, the sum of the diameters of each possible pair of tanks is calculated. For example, assume four tanks in a common diked area, numbered 1 through 4 clockwise from tank #1. The diameter of each pair of tanks is summed, as follows: 1 and 2, 1 and 3, 1 and 4, 2 and 3, 2 and 4, and 3 and 4. [**30:**A.22.4.2.1]

As an example of the application of "sum of adjacent tank diameters," assume a diked area containing three fixed roof cylindrical tanks set in a row, all three tanks of differing diameters: from left to right, 65 ft (20 m), 30 ft (9 m), and 20 ft (6 m). From left to right, designate the tanks A, B, and C. The tanks store Class I liquids.

Consider tank A first. According to Table 66.22.4.2.1, the required separation between it and adjacent tank B is one-quarter the sum of the adjacent tank diameters:

$$\tfrac{1}{4}(65 + 30) = \tfrac{1}{4}(95) = 23.75 \text{ ft, or } 23 \text{ ft } 9 \text{ in.}$$

The required separation between tank A and tank C is:

$$\tfrac{1}{4}(65 + 20) = \tfrac{1}{4}(85) = 21.25 \text{ ft, or } 21 \text{ ft } 3 \text{ in.}$$

Obviously, if the required separation between tanks A and B is satisfied, then the required separation between tanks A and C is also satisfied.

Consider, then, tank B. The required separation between tanks A and B has already been calculated. Only the required separation between tanks B and C needs to be found:

$$\tfrac{1}{4}(30 + 20) = \tfrac{1}{4}(50) = 12.5 \text{ ft, or } 12 \text{ ft } 6 \text{ in.}$$

Thus, the installation described is compliant with the *Code*'s provisions for shell-to-shell spacing.

66.22.4.2.1.1 Tanks that store crude petroleum, have individual capacities not exceeding 3000 bbl (126,000 gal or 480 m^3), and are located at production facilities in isolated locations shall not be required to be separated by more than 3 ft (0.9 m). [**30:**22.4.2.1.1]

66.22.4.2.1.2 Tanks used only for storing Class IIIB liquids shall not be required to be separated by more than 3 ft (0.9 m) provided they are not within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid. If located within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid, the tank storing Class IIIB liquid shall be spaced in accordance with the requirements for Class IIIA liquids in Table 66.22.4.2.1. [**30:**22.4.2.1.2]

66.22.4.2.2 A tank storing unstable liquid shall be separated from any other tank containing either an unstable liquid or a Class I, II, or III liquid by a distance not less than one-half the sum of their diameters. [**30:**22.4.2.2]

66.22.4.2.3 Where tanks are in a diked area containing Class I or Class II liquids or in the drainage path of Class I or Class II liquids and are compacted in three or more rows or in an irregular pattern, greater spacing or other means shall be permitted to be required by the AHJ to make tanks in the interior of the pattern accessible for fire-fighting purposes. [**30:**22.4.2.3]

66.22.4.2.4 The minimum horizontal separation between an LP-Gas container and a Class I, Class II, or Class IIIA liquid storage tank shall be 20 ft (6 m). [**30:**22.4.2.4]

66.22.4.2.4.1 Means shall be provided to prevent Class I, Class II, or Class IIIA liquids from accumulating under adjacent LP-Gas containers by means of dikes, diversion curbs, or grading. [**30:**22.4.2.4.1]

66.22.4.2.4.2 Where flammable or combustible liquid storage tanks are within a diked area, the LP-Gas containers shall be outside the diked area and at least 10 ft (3 m) away from the centerline of the wall of the diked area. [**30:**22.4.2.4.2]

66.22.4.2.5 If a tank storing a Class I, Class II, or Class IIIA liquid operates at pressures exceeding a gauge pressure of 2.5 psi (17 kPa) or is equipped with emergency relief venting that will permit pressures to exceed a gauge pressure of 2.5 psi (17 kPa), it shall be separated from an LP-Gas container by the appropriate distance given in Table 66.22.4.2.1. [**30:**22.4.2.5]

66.22.4.2.6 The requirements of 66.22.4.2.4 shall not apply where LP-Gas containers of 125 gal (475 L) or less capacity are installed adjacent to fuel oil supply tanks of 660 gal (2500 L) or less capacity. [**30:**22.4.2.6]

66.22.5 Installation of Aboveground Storage Tanks.

66.22.5.1 Tank Supports.

66.22.5.1.1 Tank supports shall be designed and constructed in accordance with recognized engineering standards. [**30:**22.5.1.1]

66.22.5.1.2 Tanks shall be supported in a manner that prevents excessive concentration of loads on the supported portion of the shell. [**30:**22.5.1.2]

66.22.5.1.3 In areas subject to earthquakes, tank supports and connections shall be designed to resist damage as a result of such shocks. [**30:**22.5.1.3]

66.22.5.2 Foundations for and Anchoring of Aboveground Storage Tanks.

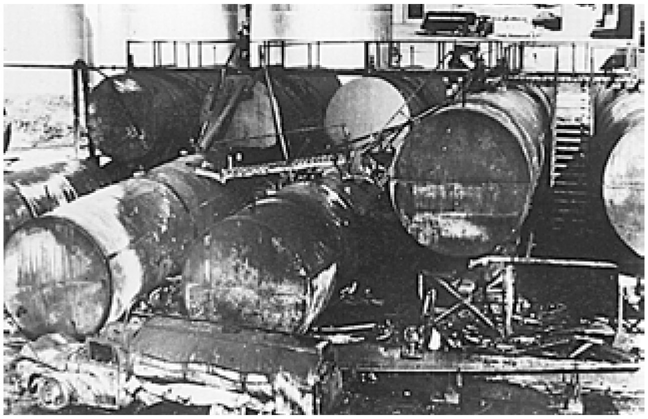
66.22.5.2.1* Tanks shall rest on the ground or on foundations made of concrete, masonry, piling, or steel. [**30:**22.5.2.1]

A.66.22.5.2.1 Appendix E of API Standard 650, *Welded Steel Tanks for Oil Storage*, and Appendix B of API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, provide information on tank foundations. [**30:**A.22.5.2.1]

66.22.5.2.2 Tank foundations shall be designed to minimize the possibility of uneven settling of the tank and to minimize corrosion in any part of the tank resting on the foundation. [**30:**22.5.2.2]

66.22.5.2.3 Where tanks storing Class I, Class II, or Class IIIA liquids are supported above their foundations, tank supports shall be of concrete, masonry, or protected steel.

Exhibit 66.42



Aboveground tanks on unprotected steel supports (left). Aftermath of a fire where tanks were supported on unprotected steel supports (right).

*Exception: Single wood timber supports (not cribbing), laid horizontally, shall be permitted to be used for outside aboveground tanks if not more than 12 in. (300 mm) high at their lowest point. [**30:**22.5.2.3]*

Unprotected steel supports are prohibited. Experience has shown that they soften and buckle after only brief exposure to fire, allowing the tank to tip or fall to the ground and breaking piping connections, resulting in release of tank contents. Exhibit 66.42 dramatically illustrates this danger. One can still find storage tanks installed on unprotected steel supports, even though the practice has been prohibited since the first edition of NFPA 30, in 1913.

The exception for solid timber supports less than 12 in. (300 mm) high is based on the slow burning characteristic of heavy timber construction. The premise is fire suppression will have taken place before an exposure fire degrades the timber supports to the point where stability of the tanks is compromised. Note that this requirement is intended to apply only to fixed tanks. Portable tanks would not be expected to comply, especially if located in areas where loss of the tank contents would not significantly add to consequences of the fire, such as at an isolated construction site.

Δ **66.22.5.2.4*** Steel support structures or exposed piling for tanks storing Class I, Class II, or Class IIIA liquids shall be protected by materials having a fire resistance rating of not less than 2 hours.

Exception No. 1: Steel saddles do not need to be protected if less than 12 in. (300 mm) high at their lowest point.

*Exception No. 2: At the discretion of the AHJ, water spray protection in accordance with NFPA 15 or NFPA 13, is permitted to be used. [**30:**22.5.2.4]*

A.66.22.5.2.4 For further information, see ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, and ANSI/UL 1709, *Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel*. [**30:**A.22.5.2.4]

Experience has shown that unprotected steel saddles of the size specified in Exception No. 1 to 66.22.5.2.4 can be mounted directly on the tank foundation or can be supported above the foundation on fire-resistant steel piers or masonry piers without presenting a risk to the stability of the tanks.

66.22.5.2.5 Where a tank is located in an area subject to flooding, provisions shall be taken to prevent tanks, either full or empty, from floating during a rise in water level up to the established maximum flood stage. *(See 66.21.7.3.)* [**30:**22.5.2.5]

66.22.6 Vent Piping for Aboveground Tanks. Piping for normal and emergency relief venting shall be constructed in accordance with Section 66.27. [**30:**22.6]

66.22.7 Emergency Relief Venting for Fire Exposure for Aboveground Storage Tanks.

When exposed to fire, the liquid contents of a tank are heated and can be expected to boil, evolving vapor at a rate greater than can be handled by the normal vent, as described in 66.21.4.3 for normal operating conditions. Provisions for safely releasing the additional vapor are described in 66.22.7. Failure to provide adequate emergency relief venting can cause tanks to explode violently or rocket great distances, as shown in Exhibit 66.43.

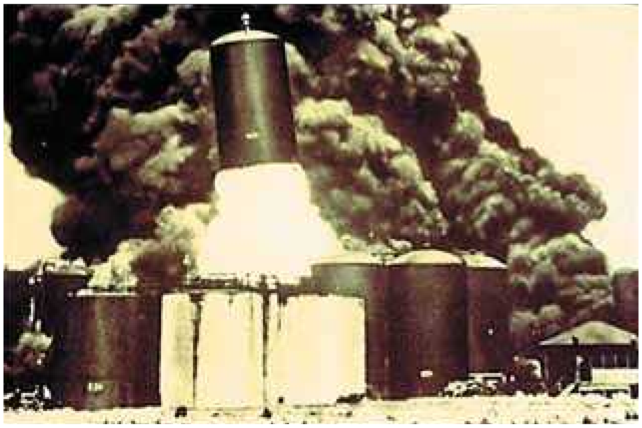
66.22.7.1 General.

66.22.7.1.1 Every aboveground storage tank shall have emergency relief venting in the form of construction or a device or devices that will relieve excessive internal pressure caused by an exposure fire. [**30:**22.7.1.1]

66.22.7.1.1.1 This requirement shall apply to each compartment of a compartmented tank, the interstitial space (annulus) of a secondary containment–type tank, and the enclosed space of tanks of closed-top dike construction. [**30:**22.7.1.1.1]

66.22.7.1.1.2 This requirement shall also apply to spaces or enclosed volumes, such as those intended for insulation,

Exhibit 66.43



Catastrophic failure and rocketing of a tank due to inadequate emergency relief venting.

membranes, or weather shields, that are capable of containing liquid because of a leak from the primary vessel. The insulation, membrane, or weather shield shall not interfere with emergency venting. [**30:**22.7.1.1.2]

66.22.7.1.1.3 Tanks storing Class IIIB liquids that are larger than 12,000 gal (45,400 L) capacity and are not within the diked area or the drainage path of tanks storing Class I or Class II liquids shall not be required to meet the requirements of 66.22.7.1.1. [**30:**22.7.1.1.3]

Class IIIB liquids have such low vapor pressures and high boiling points that, in the time required to reach boiling and thus cause excessive internal pressure, the metal shell above the internal liquid level of tanks of this size will have softened and failed. In effect, the tank will have self-vented. The additional provision that such tanks not be in a diked area with or in the drainage path of Class I and II liquids is to minimize the chance of these tanks being exposed to an external fire.

66.22.7.1.2 For vertical tanks, the emergency relief venting construction referred to in 66.22.7.1.1 shall be permitted to be a floating roof, a lifter roof, a weak roof-to-shell seam, or another approved pressure-relieving construction. [**30:**22.7.1.2]

66.22.7.1.3 If unstable liquids are stored, the effects of heat or gas resulting from polymerization, decomposition, condensation, or self-reactivity shall be taken into account. [**30:**22.7.1.3]

66.22.7.1.4 If two-phase flow is anticipated during emergency venting, an engineering evaluation shall be conducted in order to size the pressure-relieving devices. [**30:**22.7.1.4]

66.22.7.2 Weak Roof-to-Shell Seam Construction. If used, a weak roof-to-shell seam shall be constructed to fail preferential to any other seam and shall be designed in accordance with API Standard 650, *Welded Steel Tanks for Oil Storage*. [**30:**22.7.2]

66.22.7.3 Pressure-Relieving Devices.

66.22.7.3.1* Where entire dependence for emergency relief venting is placed upon pressure-relieving devices, the total venting capacity of both normal and emergency vents shall be sufficient to prevent rupture of the shell or bottom of a vertical tank or of the shell or heads of a horizontal tank. [**30:**22.7.3.1]

A.66.22.7.3.1 An engineering evaluation should be performed whenever two-phase flow is anticipated. The objective of the engineering evaluation determining emergency vent requirements and design of the relief system is to protect against catastrophic failure resulting in unacceptable risk to persons or to the facility. Factors that should be included in the evaluation are as follows:

(1) Properties of the materials including evaluated influence of two-phase flow and thermally induced instability. See the following references from the Design Institute for Emergency Relief Systems of the Center for Chemical Process Safety/American Institute of Chemical Engineers:
   (a) Fisher, H. G. and Forrest, H. S., "Protection of Storage Tanks from Two-Phase Flow Due to Fire Exposure"
   (b) Houser, J., et al., "Vent Sizing for Fire Considerations: External Fire Duration, Jacketed Vessels, and Heat Flux Variations Owing to Fuel Consumption"
   (c) *Guidelines for Pressure Relief and Effluent Handling Systems*
(2) Rate of heat input to the tank and contents. Computer models such as PLGS (supported by the UK Health and Safety Executive) can be useful in making the analysis.
(3) Fire duration. For pool fires this analysis can be based on burning rate and pool depth. Computer programs can be useful in making this analysis.

[**30:**A.22.7.3.1]

66.22.7.3.2 Emergency relief vent devices shall be vaportight and shall be permitted to be any one of the following:

(1) Self-closing manway cover
(2) Manway cover provided with long bolts that permit the cover to lift under internal pressure
(3) Additional or larger relief valve or valves

[**30:**22.7.3.2.1]

66.22.7.3.3 The outlets of all vents and vent drains on tanks equipped with emergency relief venting that permits pressures to exceed a gauge pressure of 2.5 psi (17.2 kPa) shall be arranged to discharge so that localized overheating of or flame impingement on any part of the tank will not occur if vapors from the vents are ignited. [**30:**22.7.3.9]

66.22.7.3.4 Each commercial tank venting device shall have the following information either stamped or cast into the metal body of the device or included on a metal nameplate permanently affixed to it.

(1) Start-to-open pressure
(2) Pressure at which the valve reaches the full open position
(3) Flow capacity at the pressure indicated by 66.22.7.3.4(2)

[**30:**22.7.3.10]

66.22.7.4* Extension of Emergency Vent Piping. Piping to or from approved emergency vent devices for atmospheric and low-pressure tanks shall be sized to provide emergency vent flows that limit the back pressure to less than the maximum pressure permitted by the design of the tank. Piping to or from approved emergency vent devices for pressure vessels shall be sized in accordance with the ASME *Boiler and Pressure Vessel Code*. [**30:**22.7.4]

A.66.22.7.4 Vent sizing formulae and prescriptive vent sizes, such as those established by ANSI/UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*, are typically based on the direct installation of a venting device on to a tank with a nipple not exceeding 12 in. (300 mm). When the outlet of a vent must be extended to a remote location, such as for tanks located in buildings, which require vent discharges to be located outside, a significant reduction in vent flow can occur unless the size of the vent and connecting piping is increased. In such cases, the size of vents and vent pipe extensions should be calculated to ensure that a tank will not be over-pressurized during a fire exposure. [**30:**A.22.7.4]

66.22.8 Fire Control.

66.22.8.1* A fire-extinguishing system in accordance with an applicable NFPA standard shall be provided or shall be available for vertical atmospheric fixed-roof storage tanks larger than 50,000 gal (190 m^3) capacity, storing Class I liquids, if located in a congested area where there is an unusual exposure hazard to the tank from adjacent property or to adjacent property from the tank. [**30:**22.8.1]

Δ **A.66.22.8.1** Protection against fire or explosion required for large flammable liquid storage tanks should consider the use of fixed, semi-fixed, or portable protection system designed in conformance with good engineering practice such as those described in NFPA 11, NFPA 15 and NFPA 69. Ordinary combustibles (such as wood) would be subject to radiant heat unpiloted ignition from a burning tank, when such exposures are located a distance of less than about 150 percent of the tank diameter (assuming no wind effects). Exposure from adjacent property to the tanks would depend on the specific products and storage arrangement and may require some engineering analysis based on the occupancy and its exposure potential. [**30:**A.22.8.1]

The criteria set forth in 66.22.8.1 are the only conditions in which NFPA 30 mandates fire protection for a storage tank, and even here there is an element of subjectivity because the AHJ will have to determine if an unusual exposure hazard truly exists. In all other cases, the determination of whether to provide fixed fire protection and, if so, the type of protection to be provided, is based strictly on engineering and fire hazard evaluations of the facility.

Fire-extinguishing systems are not required for small fixed roof tanks because such tanks are seldom involved in a fire. If these tanks should become involved, there is little risk that the fire will spread. Spill fires cannot be extinguished by equipment designed for tank fires and are usually controlled by public fire departments.

The separation distances in Table 66.22.4.2.1 are based on the considerations contained in 66.22.8.1.

66.22.8.2 Fixed-roof tanks storing Class II or Class III liquids at temperatures below their flash points and floating-roof tanks storing any liquid shall not require protection when installed in accordance with this section. [**30:**22.8.2]

66.22.9 Additional Requirements for Fire-Resistant Aboveground Storage Tanks.

66.22.9.1 Fire-resistant tanks shall be tested and listed in accordance with UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*. [**30:**22.9.1]

66.22.10 Additional Requirements for Protected Aboveground Storage Tanks.

66.22.10.1 Protected aboveground tanks shall be tested and listed in accordance with ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*. [**30:**22.10.1]

66.22.11* Control of Spills from Aboveground Storage Tanks. Every tank that contains a Class I, Class II, or Class IIIA liquid shall be provided with means to prevent an accidental release of liquid from endangering important facilities and adjoining property or from reaching waterways. Such means shall meet the requirements of 66.22.11.1, 66.22.11.2, 66.22.11.3, or 66.22.11.4, whichever is applicable. [**30:**22.11]

A.66.22.11 "Accidental release" includes but is not limited to the following:

(1) Leakage from the tank shell
(2) Overfill
(3) Leakage from piping connected to the tank

[**30:**A.22.11]

The requirements of 66.22.11 are based on the rationale that release of product from a tank, whatever the cause, must not be permitted to endanger important facilities and adjoining property or to reach any waterways. The principal fear is that such a spill might be ignited and cause extensive spread of fire. Another major concern is environmental pollution that might be difficult to control.

These spill control requirements are primarily directed at releases due to overfilling the tank or to a major leak from piping connected to the tank. Releases due to a leaking shell are also covered, but they are minor and tend to be much smaller. The spill control provisions of NFPA 30 do not, however, anticipate catastrophic failure of the entire tank shell, such as occurred in Floreffe, Pennsylvania, in January 1988. See Exhibit 66.44.

Tanks storing Class IIIB liquids do not require spill control for fire protection purposes alone because it is highly unlikely that ignition of a spill will occur, although environmental contamination will likely result regardless of whether a fire occurs.

Exhibit 66.44

Destroyed oil storage tank, Floreffe, Pennsylvania, January 2, 1988.

66.22.11.1 Remote Impounding. Where control of spills is provided by drainage to a remote impounding area so that spilled liquid does not collect around tanks, the requirements of 66.22.11.1.1 through 66.22.11.1.4 shall apply. [**30:**22.11.1]

66.22.11.1.1 The drainage route shall have a slope of not less than 1 percent away from the tank for at least 50 ft (15 m) toward the impounding area. [**30:**22.11.1.1]

The concept of remote impounding is that any spilled liquid will be led, by grading, swales, ditches, or other channels, to an impounding area large enough to contain all the liquid from the largest tank that can drain into it. The impounding area must be located so that, if a spill ignites, the fire will not seriously expose other tanks or adjoining property. A reasonable slope away from the tank is required so that liquid will not come to rest closer than 50 ft (15 m) from the tank or 50 ft (15 m) from any property line that can be built upon.

In early tank installations where tanks were often placed on hills to achieve gravity flow, sloping the surrounding terrain away from the tank was easily attained. Installations on relatively flat terrain present a much more difficult problem. Nonetheless, significant drainage control with a minimum of grading is possible. This method is much preferred to the shortcut practice of placing each tank in the center of a flat diked area, where even a minor spill would likely make piping and control valves inaccessible and subject to fire damage. The remote impounding area must be large enough to contain all the liquid from the largest tank that can drain into it. A 1 percent slope away from the tank generally ensures adequate drainage control. Exhibit 66.45 illustrates the concept of remote impounding.

66.22.11.1.2 The impounding area shall have a capacity not less than that of the largest tank that drains into it.

*Exception: Where compliance with 66.22.11.1.2 is not possible because there is not enough open area around the tanks, "partial" remote impounding for a percentage of the required capacity is permitted. The remainder of the volume required for spill control can be provided by open diking meeting the requirements of 66.22.11.2. [**30:**22.11.1.2]*

Most liquid releases are small, involving only a small percentage of the total capacity of the spill control system. Combined spill control systems allow the facility to take advantage of remote impounding to reduce the risk of small releases while still providing 100 percent containment for the largest tank should a major incident occur. Note that there is no specific percentage of the largest tank's capacity that the remote impounding basin needs to contain.

66.22.11.1.3 The drainage route shall be located so that, if the liquid in the drainage system is ignited, the fire will not seriously expose tanks or adjoining property. [**30:**22.11.1.3]

66.22.11.1.4 The impounding area shall be located so that, when filled to capacity, the liquid will not be closer than 50 ft (15 m) from any property line that is or can be built upon or from any tank.

*Exception: Where partial remote impounding as provided for in 66.22.11.1.2 is used, the liquid in the partial remote impounding area shall meet the requirements of 66.22.11.1.4. Tank spacing shall be determined based on the diked tank provisions of Table 66.22.4.2.1. [**30:**22.11.1.4]*

66.22.11.2 Impounding Around Tanks by Open Diking. Where control of spills is provided by means of impounding by open diking around the tanks, such systems shall meet the requirements of 66.22.11.2.1 through 66.22.11.2.8. [**30:**22.11.2]

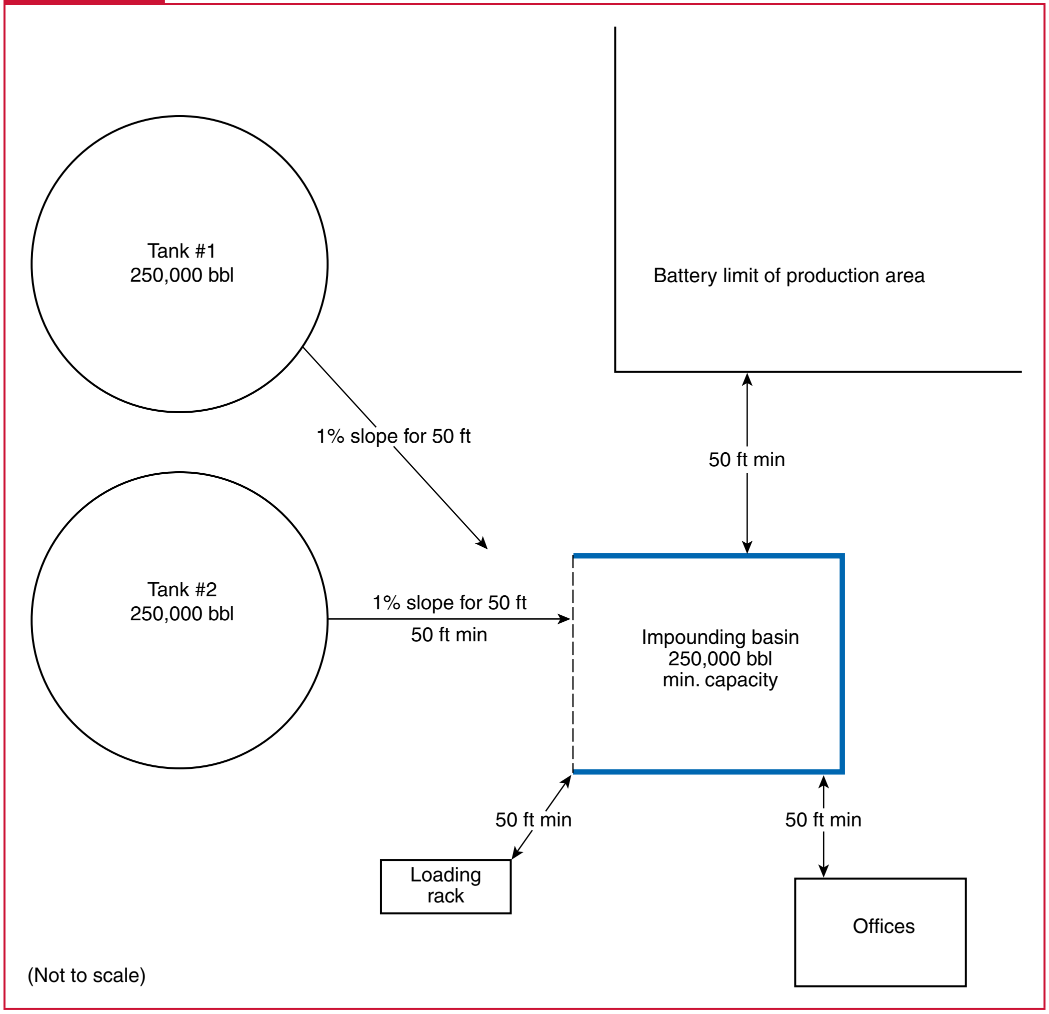
Diking is less desirable than remote impounding because it allows a ground fire to expose tanks within the diked area. However, it is often difficult to provide remote impounding, either because there is not enough open area around the tanks or because environmental regulations prohibit the use of an open impounding basin. Thus, diking becomes an important alternative. The exception to 66.22.11.1.2, which allows a combined spill control system consisting of both remote impounding and diking, provides obvious benefits: A facility that cannot meet the requirements for remote impounding completely might be able to provide partial impounding, with diking providing protection from a major incident.

66.22.11.2.1 A slope of not less than 1 percent away from the tank shall be provided for at least 50 ft (15 m) or to the dike base, whichever is less. [**30:**22.11.2.1]

66.22.11.2.2* The volumetric capacity of the diked area shall not be less than the greatest amount of liquid that can be released from the largest tank within the diked area, assuming a full tank. [**30:**22.11.2.2]

A.66.22.11.2.2 An aboveground storage tank dike is normally sized to contain the entire contents of the largest single tank within it. Some designs incorporate sufficient freeboard (additional capacity) to accommodate precipitation or fire-fighting water. The

Exhibit 66.45



Concept of a remote impounding area.

amount of this freeboard is usually governed by local conditions. [**30:**A.22.11.2.2]

NFPA 30 does not provide a specific definition of *full tank*. However, the intent is for "the greatest amount of liquid that can be released" to be some reasonable quantity. Normally, this is considered to be that quantity represented by the maximum fill height or the overfill point. Also, note that a few jurisdictions require the dike to be able to hold 110 percent of the largest tank's capacity to provide some "freeboard" for foam application and some additional containment to hold runoff from fire-fighting operations.

66.22.11.2.2.1 To allow for volume occupied by tanks, the capacity of the diked area enclosing more than one tank shall be calculated after deducting the volume of the tanks, other than the largest tank, below the height of the dike. [**30:**22.11.2.2.1]

66.22.11.2.3 To permit access, the outside base of the dike at ground level shall be no closer than 10 ft (3 m) to any property line that is or can be built upon. [**30:**22.11.2.3]

Paragraph 66.22.11.2.3 is intended to permit access for fire fighting and to provide additional protection for buildings on adjoining property in the event of a fire in the diked area.

66.22.11.2.4 Walls of the diked area shall be of earth, steel, concrete, or solid masonry designed to be liquidtight and to withstand a full hydrostatic head. [**30:**22.11.2.4]

An understanding of the meaning of *liquidtight* is important, because several jurisdictions require that the floor and walls of a dike meet a maximum permeability standard. (Permeability measures how easily a liquid can penetrate, or "soak" into, a barrier material.) For the purposes of 66.22.11.2.4, *liquidtight* means that the liquid will not breach or soak through the dike wall, at least for some reasonable length of time. Of course, because the dike is expected to hold liquid only in an emergency condition that results in a spill, the spilled liquid will presumably be removed as soon as the emergency has been stabilized. Well-compacted clays can resist the permeation of liquid for a reasonable period and are allowed for dike walls, at least for purposes of fire protection. However, environmental protection regulations might require more substantial treatment, such as an impervious lining.

66.22.11.2.4.1* Earthen walls 3 ft (0.9 m) or more in height shall have a flat section at the top not less than 2 ft (0.6 m) wide and shall have a slope that is consistent with the angle of repose of the material of which the wall is constructed. [**30:**22.11.2.4.1]

A.66.22.11.2.4.1 Diked areas for tanks containing Class I liquids located in extremely porous soils might require special treatment to prevent seepage of hazardous quantities of liquids to low-lying areas or waterways in case of spills. [**30:**A.22.11.2.4.1]

66.22.11.2.5 Where the average interior height of the walls of the diked area exceeds 6 ft (1.8 m), provisions shall be made for normal access; necessary emergency access to tanks, valves, and other equipment; and egress from the diked enclosure. The following requirements shall apply:

(1) Where the average height of a dike containing Class I liquids is over 12 ft (3.6 m) high, measured from interior grade, or where the distance between any tank and the top inside edge of the dike wall is less than the height of the dike wall, provisions shall be made for operation of valves and for access to tank roof(s) without entering below the top of the dike. These provisions shall be permitted to be met through the use of remote-operated valves, elevated walkways, or other arrangements.
(2) Piping passing through dike walls shall be designed to withstand imposed stresses as a result of settlement or fire exposure.
(3) The distance between the shell of any tank and the toe of the interior of the dike wall shall be not less than 5 ft (1.5 m).

[**30:**22.11.2.5]

The premise behind 66.22.11.2.5 is that the height of the dike should be limited to 6 ft (1.8 m) to provide relatively easy escape from the diked area for fire fighters engaged in combating small fires within the dike. The dike might need to exceed 6 ft (1.8 m), however, where the area available for the dike is limited or where a particular jurisdiction requires all tanks to be individually diked. A dike height exceeding 6 ft (1.8 m) requires further precautions, as specified in 66.22.11.2.5(1) through (3). For example, where the dike exceeds this height, the minimum distance between tanks and the toe of the interior of the dike wall must be 5 ft (1.5 m), as shown in Exhibit 66.46. Where a dike wall is unusually high, as described in 66.22.11.2.5(1) and as shown in Exhibit 66.47, special considerations apply. These provisions also reflect a concern for Class I vapors reaching unsafe concentrations when confined in the small space between the dike wall and the tank. Remotely operated valves or elevated walkways eliminate the need for personnel to enter the bottom of the diked area to operate a valve. Also, the space between the tank shell and the dike wall in Exhibit 66.47 is very likely a permit-required confined space under OSHA regulations.

Note that the provisions of 66.22.11.2.5(1), (2), and (3) are required only where the height of the dike wall exceeds 6 ft (1.8 m), as permitted in 66.22.11.2.5.

Exhibit 66.46

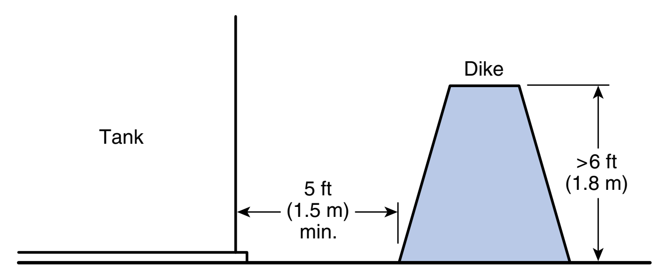


Illustration of dike wall exceeding 6 ft (1.8 m) high and application of 66.22.11.2.5(3).

Exhibit 66.47

Diked tank to which 66.22.11.2.5(1) applies.

66.22.11.2.6 Each diked area containing two or more tanks shall be subdivided, preferably by drainage channels or at least by intermediate dikes, in order to prevent minor spills from a tank from endangering adjacent tanks within the diked area. [**30:**22.11.2.6]

66.22.11.2.6.1 The drainage channels or intermediate dikes shall be located between tanks so as to take full advantage of the space with due regard for the individual tank capacities. [**30:**22.11.2.6.1]

66.22.11.2.6.2 Intermediate dikes shall be not less than 18 in. (450 mm) in height. [**30:**22.11.2.6.2]

66.22.11.2.6.3 Subdivision shall be provided according to the requirements of 66.22.11.2.6.3.1, 66.22.11.2.6.3.2, 66.22.11.2.6.3.3, 66.22.11.2.6.3.4, or 66.22.11.2.6.3.5, whichever is applicable. [**30:**22.11.2.6.3]

66.22.11.2.6.3.1 Where stable liquids are stored in vertical cone roof tanks of weak roof-to-shell seam design or in floating roof tanks, one subdivision shall be provided for each tank greater than 10,000 bbl (420,000 gal or 1590 m^3) capacity. In addition, one subdivision shall be provided for each group of tanks [with no individual tank exceeding 10,000 bbl (420,000 gal or 1590 m^3) capacity] having an aggregate capacity not greater than 15,000 bbl (630,000 gal or 2385 m^3). [**30:**22.11.2.6.3.1]

66.22.11.2.6.3.2 Where crude petroleum is stored in producing areas in any type of tank, one subdivision shall be provided for each tank greater than 10,000 bbl (420,000 gal or 1590 m^3) capacity. In addition, one subdivision shall be provided for each group of tanks [with no individual tank exceeding 10,000 bbl (420,000 gal or 1590 m^3) capacity] having an aggregate capacity not greater than 15,000 bbl (630,000 gal or 2385 m^3). [**30:**22.11.2.6.3.2]

66.22.11.2.6.3.3 Where stable liquids are stored in tanks not covered in 66.22.11.2.6.3.1, one subdivision shall be provided for each tank greater than 2380 bbl (100,000 gal or 380 m^3) capacity. In addition, one subdivision shall be provided for each group of tanks [with no individual tank exceeding 2380 bbl (100,000 gal or 380 m^3) capacity] having an aggregate capacity not greater than 3750 bbl (150,000 gal or 570 m^3). [**30:**22.11.2.6.3.3]

66.22.11.2.6.3.4* Where unstable liquids are stored in any type of tank, one subdivision shall be provided for each tank.

*Exception: Tanks that store unstable liquids and that are installed with drainage meeting the requirements of NFPA 15 need not meet this requirement. [**30:**22.11.2.6.3.4]*

A.66.22.11.2.6.3.4 Because unstable liquids will react more rapidly when heated than when at ambient temperatures, subdivision by drainage channels is the preferred method. [**30:**A.22.11.2.6.3.4]

66.22.11.2.6.3.5 Whenever two or more tanks storing Class I liquids, any one of which is over 150 ft (45 m) in diameter, are located in a common diked area, intermediate dikes shall be provided between adjacent tanks to hold at least 10 percent of the capacity of the tank so enclosed, not including the volume displaced by the tank. [**30:**22.11.2.6.3.5]

Intermediate dikes, such as those shown in Exhibit 66.48, are required to hold at least 10 percent of the capacity of the tank, not including the volume displaced by the tank, if any tank within the diked area exceeds 150 ft (45 m) in diameter. This requirement is designed to control those relatively small spills that, in the past, have resulted in major fires and destruction of all tanks within a dike enclosure.

Exhibit 66.48

Intermediate dikes around tanks.

66.22.11.2.7 Where provision is made for draining water from diked areas, such drains shall be controlled to prevent liquids from entering natural water courses, public sewers, or public drains. [**30:**22.11.2.7]

66.22.11.2.7.1 Control of drainage shall be accessible under fire conditions from outside the dike. [**30:**22.11.2.7.1]

66.22.11.2.8 Storage of combustible materials, empty drums, full drums, or barrels shall not be permitted within the diked area. [**30:**22.11.2.8]

66.22.11.3 Impounding Around Tanks by Closed-Top Diking. Where control of spills is provided by means of impounding by closed-top diking around the tanks, such systems shall meet all of the requirements of 66.22.11.4 or shall meet the requirements of 66.22.11.3.1 through 66.22.11.3.4. [**30:**22.11.3]

66.22.11.3.1* The volumetric capacity of the diked area shall not be less than the greatest amount of liquid that can be released from the largest tank within the diked area, assuming a full tank. [**30:**22.11.3.1]

A.66.22.11.3.1 See 66.22.11.2.2. [**30:**A.22.11.3.1]

66.22.11.3.2 To allow for volume occupied by tanks, the capacity of the diked area enclosing more than one tank shall be calculated after deducting the volume of the tanks, other than the largest tank, below the height of the dike. [**30:**22.11.3.2]

66.22.11.3.3 To permit access, the outside base of the dike at ground level shall be no closer than 10 ft (3 m) to any property line that is or can be built upon. [**30:**22.11.3.3]

66.22.11.3.4 Walls of the diked area shall be of steel, concrete, or solid masonry designed to be liquidtight and to withstand a full hydrostatic head. [**30:**22.11.3.4]

66.22.11.3.5 Where provision is made for draining water from diked areas, such drains shall be controlled to prevent liquids from entering natural water courses, public sewers, or public drains. [**30:**22.11.3.5]

66.22.11.3.5.1 Control of drainage shall be accessible under fire conditions from outside the dike. [**30:**22.11.3.5.1]

66.22.11.3.6 Storage of combustible materials, empty drums, full drums, or barrels shall not be permitted within the diked area. [**30:**22.11.3.6]

66.22.11.3.7 The capacity of the primary tank shall not exceed that given in 66.22.11.4.1. [**30:**22.11.3.7]

66.22.11.3.8 All piping connections to the tank shall be made above the normal maximum liquid level. [**30:**22.11.3.8]

66.22.11.3.9 The tank shall be capable of resisting the damage from the impact of a motor vehicle, or collision barriers shall be provided. [**30:**22.11.3.9]

66.22.11.3.10 Where the means of secondary containment is enclosed, it shall be provided with emergency venting in accordance with 66.22.7. [**30:**22.11.3.10]

66.22.11.3.11 Means shall be provided to establish the integrity of the secondary containment, in accordance with Section 66.21. [**30:**22.11.3.11]

66.22.11.3.12 Where the normal vent or the emergency vent device or both discharge outside the enclosure created by the closed-top diking, the tank within the enclosure shall comply with 66.22.11.4.4 and 66.22.11.4.5. [**30:**22.11.3.12]

66.22.11.3.13 Where the fill connection for the tank within the enclosure created by the closed-top diking is not located within the enclosure, the tank shall meet the requirements of 66.22.11.4.4 and 66.22.11.4.5. [**30:**22.11.3.13]

66.22.11.4 Secondary Containment–Type Aboveground Storage Tanks. Where a secondary containment–type tank is used to provide spill control, the tank shall meet all of the requirements of 66.22.11.4.1 through 66.22.11.4.10. [**30:**22.11.4]

66.22.11.4.1 The capacity of the listed primary tank for Classes I, II, and IIIA liquids shall not exceed 50,000 gal (189,000 L). [**30:**22.11.4.1]

66.22.11.4.2 All piping connections to the tank shall be made above the maximum liquid level. [**30:**22.11.4.2]

66.22.11.4.3 Means shall be provided to prevent the release of liquid from the tank by siphon flow. [**30:**22.11.4.3]

66.22.11.4.4 Means shall be provided for determining the level of liquid in the tank. This means shall be accessible to the delivery operator. [**30:**22.11.4.4]

66.22.11.4.5 Means shall be provided to prevent overfilling by sounding an alarm when the liquid level in the tank reaches 90 percent of capacity and by automatically stopping delivery of liquid to the tank when the liquid level in the tank reaches 95 percent of capacity. [**30:**22.11.4.5]

66.22.11.4.5.1 In no case shall these provisions restrict or interfere with the functioning of the normal vent or the emergency vent. [**30:**22.11.4.5.1]

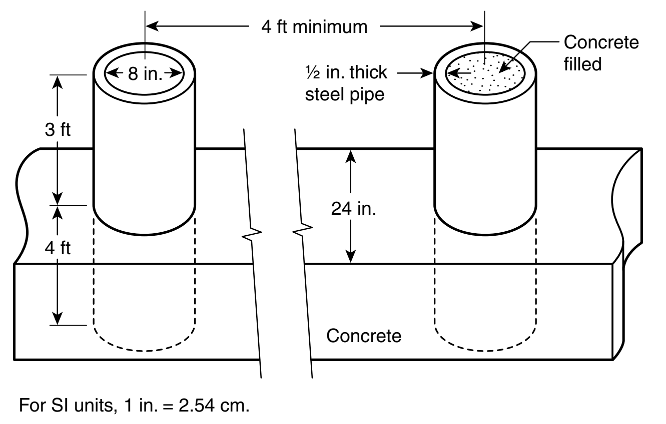
The provisions of 66.22.11.4.4 and 66.22.11.4.5 are intended to prevent spills due to overfilling the tank. It is important to understand that the overfill prevention features must not interfere with proper operation of the normal (breather) vent or the emergency vent. This rules out the use of any float-type device that can block the normal vent, resulting in overpressure of the tank.

66.22.11.4.6 Spacing between adjacent tanks shall comply with Table 66.22.4.2.1. [**30:**22.11.4.6]

66.22.11.4.7 The tank shall be capable of resisting the damage from the impact of a motor vehicle, or collision barriers shall be provided. [**30:**22.11.4.7]

Some types of secondary containment tanks are concrete-encased and, therefore, are inherently capable of absorbing a vehicle impact. Others will have to be provided with collision barriers or bollards. See Exhibit 66.49 for a typical design of a collision barrier. For additional information, see Annex E of NFPA 730, *Guide for Premises Security*.

Exhibit 66.49



Bollard-type security barrier. (Source: U.S. Army Corps of Engineers, Field Manual 19-30.)

66.22.11.4.8 Where the means of secondary containment is enclosed, it shall be provided with emergency venting in accordance with 66.22.7. [**30:**22.11.4.8]

66.22.11.4.9 Means shall be provided to establish the integrity of the secondary containment, in accordance with Section 66.21. [**30:**22.11.4.9]

66.22.11.4.10 The secondary containment shall be designed to withstand the hydrostatic head resulting from a leak from the primary tank of the maximum amount of liquid that can be stored in the primary tank. [**30:**22.11.4.10]

66.22.12 Equipment, Piping, and Fire Protection Systems in Remote Impoundment Areas and Diked Areas.

66.22.12.1* Location of Piping. Only piping for product, utility, or fire protection purposes directly connected to a tank or tanks within a single diked area shall be routed through a diked area, a remote impoundment area, a spillway draining to a remote impoundment area, or above a storage tank drainage area where the piping can be exposed to a fire.

*Exception: Piping for other product lines and from adjacent tanks is permitted to be routed through such areas if engineering designs are provided to incorporate features to prevent the piping from creating an exposure hazard. [**30:**22.12.1]*

A.66.22.12.1 As noted in the exception, engineering designs that can reduce exposure hazards include use of sealed sleeve piping and secondary containment piping to prevent leakage and the use of remotely controlled isolation valves on product lines to stop the flow of liquids when the piping is subjected to fire exposure. [**30:**A.22.12.1]

66.22.12.2 Drainage.

66.22.12.2.1 Drainage shall be provided to prevent accumulation of any liquid under the piping by providing a slope of not less than 1 percent away from the piping for at least 50 ft (15 m). [**30:**22.12.2.1]

66.22.12.2.2 Corrosion-resistant piping and piping that is protected against corrosion shall be permitted to be buried where such drainage is not provided. [**30:**22.12.2.2]

66.22.12.3* Location of Equipment. If located in a remote impoundment area, a diked area, or a spillway draining to a remote impoundment area, process equipment, pumps, instrumentation, and electrical utilization equipment shall be located or protected so that a fire involving such equipment does not constitute an exposure hazard to the tank or tanks in the same area for a period of time consistent with emergency response capabilities. [**30:**22.12.3]

A.66.22.12.3 Methods of preventing an exposure hazard include intermediate diking, drainage, or fire protection features such as water spray systems, monitors, or fire-resistive coatings. High integrity pumps or equipment also constitute a method of limiting exposure hazards. [**30:**A.22.12.3]

66.22.12.4 Fire Protection Systems. Hose connections, controls, and control valves for application of fire protection foam or water to tanks shall be located outside remote impoundment areas, diked areas, or spillways draining to a remote impoundment area. [**30:**22.12.4]

66.22.12.5 Combustible Materials. Structures such as stairways, walkways, instrumentation shelters, and supports for piping and equipment that are located in a remote impoundment area, diked area, or spillway draining to a remote impoundment area shall be constructed of noncombustible materials. [**30:**22.12.5]

66.22.13 Tank Openings Other Than Vents.

66.22.13.1 Each connection to an aboveground tank through which liquid can normally flow shall be provided with an internal or an external valve located as close as practical to the shell of the tank. [**30:**22.13.1]

Paragraph 66.22.13.1 requires a manual or remotely operated valve that can be used to isolate the tank from its piping during an emergency. A check valve alone cannot be used to meet this requirement, although one can be used in conjunction with the operating valve. A word of caution: A check valve in the inlet pipeline prevents that pipeline from being used as an emergency outlet. In a fire emergency, pumping liquid from a fire-involved tank to another tank outside the fire area can be practical.

Because repair or maintenance of internal valves usually requires that tanks be emptied, they are seldom used on larger tanks.

66.22.13.2 Each connection below the liquid level through which liquid does not normally flow shall be provided with a liquidtight closure such as a valve, plug, or blind, or a combination of these. [**30:**22.13.2]

Because a valve can be opened by mistake, resulting in a spill of tank contents, it is advisable to plug or blank the outlet of any valve not intended for operating purposes immediately after it is installed.

66.22.13.3 Openings for gauging on tanks storing Class I liquids shall be provided with a vaportight cap or cover. [**30:**22.13.3]

Gauge openings can also be used for taking samples. Metallic cups, floats, and so on, should have electrical continuity with the tank shell to avoid the possibility of ignition by static discharge, and a 30-minute static "relaxation" period should be allowed before manual gauging or sampling after a tank is filled unless the tank is fitted with a gauging tube or well. Although the atmosphere in a tank containing a Class I liquid is normally too rich to burn, vapors escaping from the gauging opening will form a hazardous zone in the immediate vicinity. If the tank is being emptied or has recently had liquid withdrawn from it, much of the vapor space in the tank might be in the flammable range and ignition might propagate into the tank, causing an explosion.

66.22.13.4 Filling and emptying connections for Class I, Class II, and Class IIIA liquids that are connected and disconnected shall be located outside of buildings at a location free from any source of ignition. [**30:**22.13.4]

66.22.13.4.1 Such connections shall be located not less than 5 ft (1.5 m) away from any building opening. [**30:**22.13.4.1]

66.22.13.4.2 Such connections for any liquid shall be closed and liquidtight when not in use and shall be properly identified. [**30:**22.13.4.2]

66.22.14 Aboveground Storage Tanks Located in Areas Subject to Flooding.

A tank located according to the requirements of this subsection will not float if filled with gasoline (specific gravity 0.7). It might, however, float if only partially full. To contend with the possibility that a tank might not be full at the time of a flood, the availability of a water supply to fill the tank in case of a flood emergency is required by 66.22.14.4.

66.22.14.1 Vertical tanks shall be located so that the tops of the tanks extend above the maximum flood stage by at least 30 percent of their allowable storage capacity. [**30:**22.14.1]

66.22.14.2 Horizontal tanks that are located where more than 70 percent of the tank's storage capacity will be submerged at the established flood stage shall be secured by one of the following methods:

(1) Anchored to resist movement
(2) Attached to a foundation of steel and concrete or of concrete having sufficient weight to provide load for the tank when filled with liquid and submerged by flood water to the established flood stage
(3) Secured from floating by other means

[**30:**22.14.2]

66.22.14.3 Tank vents or other openings that are not liquid-tight shall extend above the maximum flood stage water level. [**30:**22.14.3]

66.22.14.4 A dependable water supply shall be used for filling an empty or partially filled tank.

*Exception: Where filling the tank with water is impractical or hazardous because of the contents of the tank, the tank should be protected by other means against movement or collapse. [**30:**22.14.4]*

66.22.14.5 Spherical or spheroid tanks shall be protected by any of the methods specified in 66.22.14. [**30:**22.14.5]

66.22.15 Collision Protection for Aboveground Storage Tanks. Where a tank is exposed to vehicular impact, protection shall be provided to prevent damage to the tank. [**30:**22.15]

66.22.16 Installation Instructions for Aboveground Storage Tanks. Factory-built aboveground tanks shall be provided with instructions for testing the tanks and for installation of the normal and emergency vents. [**30:**22.16]

66.22.17 Inspection and Maintenance of Aboveground Storage Tanks.

66.22.17.1 Inspection and maintenance of aboveground tanks shall meet the requirements of 66.21.8. [**30:**22.17.1]

66.22.17.2 Each aboveground steel tank shall be inspected and maintained in accordance with API 653, *Tank Inspection, Repair, Alteration, and Reconstruction*, or STI SP001, *Standard for Inspection of Aboveground Storage Tanks*, whichever is applicable. [**30:**22.17.2]

66.22.17.3 Each tank constructed of materials other than steel shall be inspected and maintained in accordance with manufacturers' instructions and applicable standards. [**30:**22.17.3]

66.22.17.4* Pontoons in external floating roof tanks shall be inspected, at intervals not exceeding 5 years, by visual and atmospheric testing methods to ensure that the pontoon covers are mechanically secured to the floating roof deck and to ensure the pontoons do not contain liquids or vapors resulting from leaks or corrosion holes in the pontoons. If liquids, or flammable vapor concentrations at or above 25 percent of the LFL are found, the liquids or vapors shall be safely removed and the source of the leak shall be repaired. The finding of vapors at levels below 25 percent of the LFL shall result either in the implementation of monitoring of the tank pontoons at least annually to assure that vapors in the flammable range are not achieved before corrective action is taken or removal of the tank from service. Rim vents, if any, shall also be inspected to ensure that they are not frozen open. [**30:**22.17.4]

A.66.22.17.4 An explosion hazard can exist due to flammable liquids or vapors within the pontoon. Ignition can be caused by lightning strikes or general maintenance activities. Lightning protection systems and other means of tank grounding cannot prevent sparking caused by lightning across gaps such as those between pontoon covers and the tank roof, between the tank wall and the roof, or at shunts. Such sparks can serve as a source of ignition causing a fire or explosion that can result in sufficient overpressure to throw portions of the pontoon assembly completely away from the tank with subsequent, partial, or complete loss of the tank due to fire. Caution is particularly advisable where tanks with vapor-containing pontoons are located within lightning-prone areas. [**30:**A.22.17.4]

66.23 Storage of Liquids in Tanks — Underground Tanks

66.23.1 Scope. This section shall apply to the following:

(1) The storage of flammable and combustible liquids, as defined in 3.3.169.1 and 3.3.169.2, in fixed underground tanks
(2) The installation and operation of underground tanks

[**30:**23.1]

66.23.2 Definitions Specific to Chapter 23. (Reserved)

66.23.3 General Requirements.

66.23.3.1 Class II and Class III Liquids at Elevated Temperatures. Storage of Class II and Class III liquids heated at or above their flash point shall follow the requirements for Class I liquids, unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. [**30:**23.3.1]

66.23.3.2 Installation. All underground tanks shall be installed in accordance with the manufacturer's instructions. [**30:**23.3.2]

66.23.3.3 Excavation. Excavation for underground tanks shall not undermine foundations of existing structures. [**30:**23.3.3]

66.23.3.4* Care in Handling of Tank. The tank shall not be damaged during delivery, unloading, and placement into the tank excavation. [**30:**23.3.4]

A.66.23.3.4 Dropping or rolling the tank into the hole can break a weld, puncture or damage the tank, or scrape off the protective coating of coated tanks. See PEI RP100, *Recommended Practices for Installation of Underground Liquid Storage Systems*. [**30:**A.23.3.4]

Backfilling with gravel or sand containing large stones can damage a tank's coating or even cause dents or gouges. Gravel should be in accordance with its dictionary definition, "consisting of rounded pebbles." Sea sand should not be used because it might contain corrosive salt.

66.23.3.5* External Corrosion Protection for Underground Storage Tank. Underground tanks and their piping shall be protected by either of the following:

(1) A properly engineered, installed, and maintained cathodic protection system in accordance with recognized engineering standards of design
(2) Approved or listed corrosion-resistant materials or systems

[**30:**23.3.5]

A.66.23.3.5 See UL 1316, *Standard for Glass-Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures*; UL 1746, *Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks;* and STI ACT-100, *Specification for External Corrosion Protection of FRP Composite Steel Underground Tanks*, F894. [**30:**A.23.3.5]

66.23.3.5.1* Selection of the type of protection to be employed shall be based upon the corrosion history of the area and the judgment of a qualified engineer. [**30:**23.3.5.1]

A.66.23.3.5.1 See API RP 1615, *Installation of Underground Petroleum Storage Systems*, for further information. [**30:**A.23.3.5.1]

66.23.3.5.2* The AHJ shall be permitted to waive the requirements for corrosion protection where an engineering evaluation demonstrates that such protection is not necessary. [**30:**23.3.5.2]

A.66.23.3.5.2 Acceptable design standards for cathodic protection systems include the following:

(1) API RP 1632, *Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems*
(2) CAN/ULC-S603.1, *Standard for External Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids*
(3) STI-P3, *Specification and Manual for External Corrosion Protection of Underground Steel Storage Tanks*
(4) NACE RP-0169, *Recommended Practice, Control of External Corrosion on Underground or Submerged Metallic Piping Systems*
(5) NACE RP-0285, *Recommended Practice, Corrosion Control of Underground Storage Tank Systems by Cathodic Protection*
(6) ANSI/UL 1746, *Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks*, Part 1
(7) STI RP 892, *Recommended Practice for Corrosion of Underground Piping Networks Associated with Liquid Storage and Dispensing Systems*

[**30:**23.3.5.2]

Buried tanks must remain leaktight for the extent of their service life. Requiring maximum corrosion protection for tanks in all locations is unrealistic. In favorable soils, tanks have lasted leak-free for 20 years and longer; in other locations, tanks have leaked from corrosion within a few years of installation.

The current requirement directs the user to appropriate standards for guidance in designing corrosion protection for the underground tank installation. Local code officials need assistance in determining what a properly engineered cathodic protection system is, and the list of references can provide guidance. Paragraph 66.23.3.5.2 allows the AHJ to waive the requirement for corrosion protection, based on previous experience and consultation with an expert. However, environmental regulations might mandate corrosion protection in all cases, thus preempting local control.

STI RP 892, *Recommended Practice for Corrosion Protection of Underground Piping Networks Associated with Liquid Storage and Dispensing Systems*, is referenced because it is a standard on corrosion protection, not on tank design.

66.23.4 Location of Underground Storage Tanks.

66.23.4.1 Underground tanks or tanks under buildings shall be located with respect to existing building foundations and supports so that the loads carried by the foundation are not transmitted to the tank. [**30:**23.4.1]

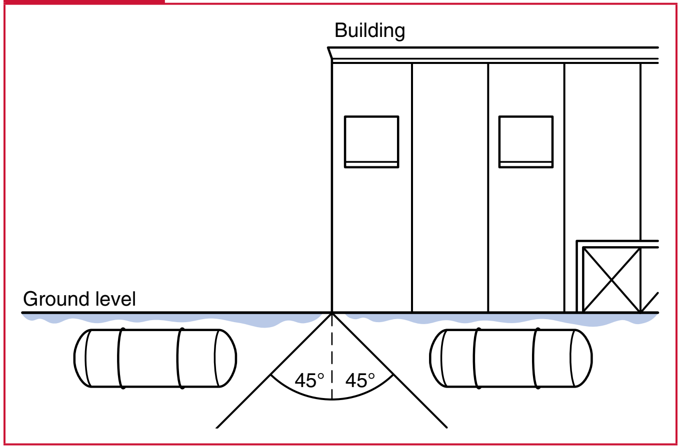
66.23.4.2 The distance from any part of a tank storing Class I liquids to the nearest wall of any basement or pit shall be not less than 1 ft (0.3 m) and to any property line that is or can be built upon shall not be less than 3 ft (0.9 m). [**30:**23.4.2]

66.23.4.3 The distance from any part of a tank storing Class II or Class III liquids to the nearest wall of any basement, pit, or property line shall be not less than 1 ft (0.3 m). [**30:**23.4.3]

The first requirement in restricting the location of underground tanks is that the excavation not jeopardize the foundation of any structure or be so placed that settlement of the structure can damage the tank. The minimum spacing of 1 ft (0.3 m) from the tank to the wall of a basement or pit provides space for protective measures, such as excavation and well points. If a leak should develop in the case of Class I liquids, it could result in the presence of flammable vapors in the adjacent underground space.

The distance requirements provide the minimum necessary for installation purposes. With Class I liquids, the 3 ft (0.9 m) distance to a property line that can be built upon is required to minimize the possibility of damage to a tank or to its protective sand or gravel envelope by construction activities on adjacent property. A common rule of thumb used by many engineers when locating a tank below the bottom foundation of a building is to place the tank outside a 45 degree angle, measured from the extension of the foundation. This rule of thumb applies to tanks located under a building or just outside a building. See Exhibit 66.50.

Exhibit 66.50



Siting of underground tanks with respect to building footings and foundations.

66.23.5 Reserved.

66.23.6 Normal Venting for Underground Storage Tanks.

66.23.6.1* Tank venting systems shall be provided with sufficient capacity to prevent blowback of vapor or liquid at the fill opening while the tank is being filled. [**30:**23.6.1]

A.66.23.6.1 The required venting capacity depends upon the filling or withdrawal rate, whichever is greater, and the vent line length. Unrestricted vent piping sized in accordance with Table 66.23.6.2 will prevent back pressure development in tanks from exceeding a gauge pressure of 2.5 psi (17.2 kPa). [**30:**A.23.6.1]

Paragraph 66.23.6.1 recognizes that vent lines might run a considerable distance, usually below ground, before rising up to the termination point. Piping larger than that shown in Table 66.23.6.2 is usually needed if a flame arrester or pressure-vacuum vent is installed, as would be the case with many Class IB and IC liquids, because of the reduced flow rate through the vent device.

66.23.6.2 Vent piping shall be sized in accordance with Table 66.23.6.2, but shall not be less than 1.25 in. (32 mm) nominal inside diameter. [**30:**23.6.2]

66.23.6.3 Where tank venting devices are installed in vent lines, their flow capacities shall be determined in accordance with 66.22.7.3.4. [**30:**23.6.3]

66.23.6.4 Piping for normal venting shall be designed in accordance with Section 66.27. [**30:**23.6.4]

66.23.7 Reserved.

66.23.8 Reserved.

66.23.9 Reserved.

66.23.10 Reserved.

TABLE 66.23.6.2 *Nominal Vent Line Diameter in Inches*

Maximum Flow (gpm)	Pipe Length*		
	50 ft	100 ft	200 ft
100	1.25	1.25	1.25
200	1.25	1.25	1.25
300	1.25	1.25	1.5
400	1.25	1.5	2
500	1.5	1.5	2
600	1.5	2	2
700	2	2	2
800	2	2	3
900	2	2	3
1000	2	2	3

For SI units, 1 in. = 25 mm; 1 ft = 0.3 m; 1 gal = 3.8 L.

*Assumes stated length of piping, plus 7 ells. [**30:** Table 23.6.2]

66.23.11 Reserved.

66.23.12 Reserved.

66.23.13 Tank Openings Other than Vents.

66.23.13.1 Connections for all tank openings shall be liquidtight and vaportight. [**30:**23.13.1]

66.23.13.2 Openings for manual gauging, if independent of the fill pipe, shall be provided with a liquidtight and vaportight cap or cover. Covers shall be kept closed when not gauging. [**30:**23.13.2]

66.23.13.2.1 If inside a building, each such opening shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other approved device. [**30:**23.13.2.1]

Note that Section 66.23.4 does not prohibit having a tank under a building on the same premises, provided that the restrictions with respect to walls, foundations, and supports are met. However, the only access permitted to the tank from within the building is the specially equipped gauging opening.

66.23.13.3 Fill and discharge lines shall enter tanks only through the top. [**30:**23.13.3]

66.23.13.4 Fill lines shall be sloped toward the tank. [**30:**23.13.4]

66.23.13.5 Underground tanks for Class I liquids having a capacity of more than 1000 gal (3800 L) shall be equipped with a tight fill device for connecting the fill hose to the tank. [**30:**23.13.5]

66.23.13.6 Filling, emptying, and vapor recovery connections for Class I, Class II, or Class IIIA liquids that are connected and disconnected shall be located outside of buildings at a location free from any source of ignition and not less than 5 ft (1.5 m) from any building opening or air intake. [**30:**23.13.6]

By omission, just as vents from tanks containing Class IIIB liquids are permitted to terminate indoors, filling connections for such tanks are also permitted indoors.

66.23.13.6.1 Such connections shall be closed and liquidtight and vaportight when not in use. [**30:**23.13.6.1]

66.23.13.6.2 Such connections shall be identified. [**30:**23.13.6.2]

66.23.13.7 Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connection, or other approved device, unless the opening is pipe-connected to a vapor processing system. [**30:**23.13.7]

Subsection 66.23.13.7 is intended to regulate two types of systems. In one type, a vapor recovery system, vapor that is displaced when a storage tank is being filled is piped back to the vapor space of the unit from which the liquid is discharged. The opening must not permit vapor to escape from the buried tank, except when it is flowing back to the unit from which the tank is being filled. In the second type, the vapor is connected to a special unit where it is incinerated, absorbed into oil or other liquid, or adsorbed on activated carbon or similar material for later recovery or disposal by other environmentally acceptable means.

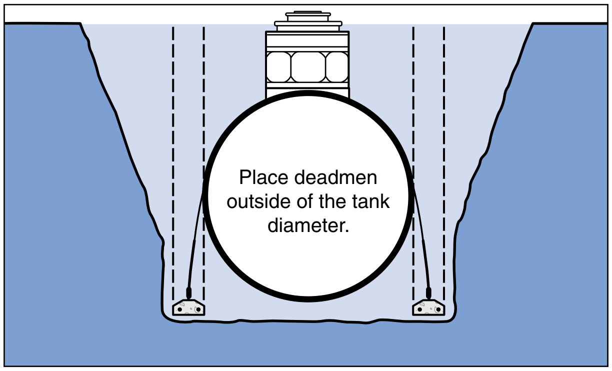
66.23.13.7.1 Openings designed for combined fill and vapor recovery shall also be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. [**30:**23.13.7.1]

66.23.13.7.2 All connections shall be vaportight. [**30:**23.13.7.2]

66.23.14 Underground Storage Tanks Located in Areas Subject to Flooding.

Buried tanks have been known to float up out of the ground because of a high water table or floodwaters. Means for preventing tanks from becoming unsecured are prescribed in 66.23.14. One method is to place 6 in. (150 mm) of reinforced concrete over the tank, extending 12 in. (300 mm) horizontally beyond the tank in all directions. A second method uses a 6 in. (150 mm) reinforced concrete base at the bottom of the hole, with hold-down straps securing the tank to the base. A third (and the most often used) method uses deadman anchors on either side of the tank, with hold-down straps securing the tank to the anchors, as shown in Exhibit 66.51. With each of these methods, the weight of the concrete offsets the buoyancy of the tank.

Exhibit 66.51



An underground tank secured to deadman anchors with hold-down straps. (Adapted with permission from PEI/RP 100-11, Recommended Practices for Installation of Underground Liquid Storage Systems, Petroleum Equipment Institute, Figure 6-2)

66.23.14.1* Tanks shall be anchored or shall be secured by approved means to resist movement when subjected to hydrostatic forces associated with high groundwater or floodwater. [**30:**23.14.1]

A.66.23.14.1 Anchoring can be accomplished using nonmetallic straps or metallic straps that are separated from the tank shell by inert insulating dielectric material. The straps should be connected to a bottom hold-down pad or deadman anchors. For additional information, see reference to API RP 1615, *Installation of Underground Petroleum Storage Systems*; PEI RP100, *Recommended Practices for Installation of Underground Liquid Storage Systems*; and STI RP R011, *Recommended Practice for Anchoring of Steel Underground Storage Tanks*. [**30:**A.23.14.1]

Previous editions of NFPA 30 included provisions for the use of water ballast as a means to weight a tank to prevent movement during a flood. In anticipation of a flood event, water could be used to fill the tank to reduce buoyancy. While this approach remains technically viable for existing tanks that are not properly secured to prevent movement, the use of water as a means of providing ballast is no longer considered an acceptable basis of design for new tank installations. [**30:**A.23.14.1]

It is not the intent of this section to prohibit the use of water as ballast in underground tanks during system installation and prior to the initial introduction of the stored liquid. [**30:**A.23.14.1]

66.23.14.1.1 The design of the anchoring or securing method shall be based on the buoyancy of an empty tank that is fully submerged. [**30:**23.14.1.1]

66.23.14.1.2 Tank vents and other openings that are not liquid-tight shall be extended above maximum flood stage water level. [**30:**23.14.1.2]

66.23.14.1.3 Each tank shall be so constructed and installed that it will safely resist external pressures if submerged. [**30:**23.14.1.3]

66.23.15 Reserved.

66.23.16 Installation Instructions for Underground Storage Tanks. Factory-built underground tanks shall be provided with instructions for testing and for installation of the normal vents. [**30:**23.16]

66.23.17 Inspection and Maintenance of Underground Storage Tanks.

66.23.17.1 Inspection and maintenance for underground tanks shall meet the requirements of 66.21.8. [**30:**23.17.1]

66.23.17.2 Overfill protection devices or systems shall be inspected and tested annually to ensure proper operation. [**30:**23.17.2]

66.24 Storage Tank Buildings

66.24.1* Scope.

A.66.24.1 Section 66.24 provides an approach that allows considerable flexibility for compliance without compromising fire safety, while fostering ingenuity in application of fire safety principles to achieve the intended objectives, outlined in the performance criteria set out at the beginning of each subsection. Each subsection has been written with the first sentence outlining the performance criteria that, if implemented, would achieve compliance with that subsection. In order to clarify the intent of each performance criterion, the subsequent paragraphs constitute one method of achieving compliance with the intent envisioned in the performance requirements. It is recognized that other combinations of requirements can also be used to meet the intent of the performance criteria, provided such requirements are acceptable to the AHJ. [**30:**A.24.1]

66.24.1.1 This section shall apply to installations of tanks storing Class I, Class II, and Class IIIA liquids in storage tank buildings. [**30:**24.1.1]

66.24.1.2 This section shall also apply to installations of aboveground storage tanks storing Class II, Class IIIA, or Class IIIB liquids in storage tank buildings where the liquids are heated at or above their flash points. In such cases, the liquids shall be regulated as Class I liquids unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. [**30:**24.1.2]

66.24.1.3 This section shall not apply to the following:

(1) Tanks covered by Sections 66.17, 66.18, and 66.19.
(2) A tank that has a canopy or roof that does not limit the dissipation of heat or dispersion of flammable vapors and does not restrict fire-fighting access and control. Such tanks shall comply with the provisions of this *Code*.

[**30:**24.1.3]

66.24.2 Definitions Specific to Chapter 24. (Reserved)

66.24.3 Reserved.

66.24.4 Location of Storage Tank Buildings.

66.24.4.1 Tanks and associated equipment within the storage tank building shall be so located that a fire in the area shall not constitute an exposure hazard to adjoining buildings or tanks for a period of time consistent with the response and suppression capabilities of the fire-fighting operations available to the location. Compliance with 66.24.4.2 through 66.24.4.8 shall be deemed as meeting the requirements of 66.24.4.1. [**30:**24.4.1]

66.24.4.2 The minimum distance from exposed property lines and buildings for tank installations within structures having walls with a fire resistance rating of less than 2 hours shall be in accordance with Table 66.24.4.2. [**30:**24.4.2]

The separation distances given in Table 66.24.4.2, as well as the adjustments allowed by 66.24.4.5 and the requirements of 66.24.4.6 and 66.24.4.7, are similar to those found in Section 66.17.4 for process vessels and can be considered to provide a greater degree of safety for this application because process vessels can be expected to present a greater risk than storage tanks. Note, however, that the table does not allow storage tanks greater than 100,000 gal (380 m^3) without the approval of the AHJ.

Exhibit 66.52 illustrates application of the separation distances required by Table 66.24.4.2. In the exhibit, a small storage tank building houses four 15,000 gal (56,800 L) storage tanks, two of which store unstable resins at atmospheric pressure. The liquid resins can polymerize if exposed to fire, so the separation distances to be used are those for "Unstable Liquid — Emergency Relief — Not over 2.5 psi." Protection for exposures is provided; therefore, the provision of 66.24.4.4 does not apply. However, because of the unstable liquids, 66.24.4.5(3) does apply.

66.24.4.3 The capacity of any individual tank shall not exceed 100,000 gal (380 m^3) without the approval of the AHJ. [**30:**24.4.3]

66.24.4.4 Where protection for exposures is not provided, the distances given in Table 66.24.4.2 shall be doubled. The distances shall not be required to exceed 300 ft (90 m). [**30:**24.4.4]

66.24.4.5 Where a storage tank building has an exterior wall facing an exposure, the distances in Table 66.24.4.2 shall be permitted to be modified as follows:

(1) Where the wall is a blank wall having a fire resistance rating of not less than 2 hours, separation distance between the storage tank building and its exposure shall not be required to be greater than 25 ft (7.6 m).
(2) Where a blank wall having a fire resistance rating of not less than 4 hours is provided, the distance requirements of Table 66.24.4.2 shall not apply.
(3)* Where Class IA liquids or unstable liquids are stored, the exposing wall shall have explosion resistance in accordance with recognized engineering standards, and deflagration venting designed in accordance with NFPA 68 shall be provided in the nonexposing walls and roof.

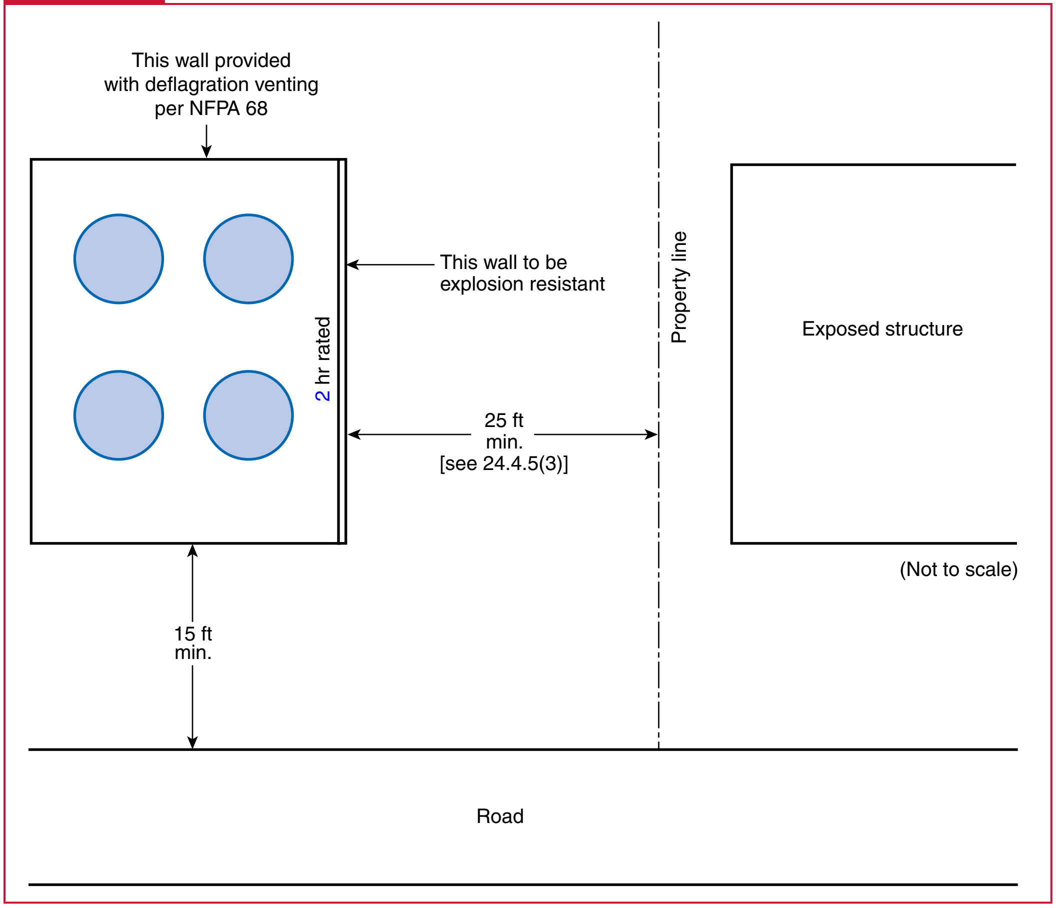
[**30:**24.4.5]

***TABLE 66.24.4.2** Location of Storage Tank Buildings with Respect to Property Lines, Public Ways, and the Nearest Important Building on the Same Property*

Largest Tank — Operating Liquid Capacity (gal)	Minimum Distance from Property Line that Is or Can Be Built Upon, Including Opposite Side of Public Way (ft)				Minimum Distance from Nearest Side of Any Public Way or from Nearest Important Building on Same Property (ft)			
	Stable Liquid Emergency Relief		Unstable Liquid Emergency Relief		Stable Liquid Emergency Relief		Unstable Liquid Emergency Relief	
	Not over 2.5 psi	Over 2.5 psi	Not over 2.5 psi	Over 2.5 psi	Not over 2.5 psi	Over 2.5 psi	Not over 2.5 psi	Over 2.5 psi
Up to 12,000	15	25	40	60	5	10	15	20
12,001 to 30,000	20	30	50	80	5	10	15	20
30,001 to 50,000	30	45	75	120	10	15	25	40
50,001 to 100,000	50	75	125	200	15	25	40	60

For SI units, 1 gal = 3.8 L; 1 ft = 0.3 m; 1 psi = 6.9 kPa. [**30:**Table 24.4.2]

Exhibit 66.52



Application of Table 24.4.2 to a storage tank building with tanks storing unstable liquids.

Δ **A.66.24.4.5(3)** See NFPA 68 for information on deflagration venting. [**30:**A.24.4.5(3)]

66.24.4.6 Other equipment associated with tanks, such as pumps, heaters, filters, and exchangers, shall not be located closer than 25 ft (7.6 m) to property lines where the adjoining property is or can be built upon or to the nearest important building on the same property that is not an integral part of the storage tank building. This spacing requirement shall not apply where exposures are protected as outlined in 66.24.4.2. [**30:**24.4.6]

66.24.4.7 Tanks in which unstable liquids are stored shall be separated from potential fire exposures by a clear space of at least 25 ft (7.6 m) or by a wall having a fire resistance rating of not less than 2 hours. [**30:**24.4.7]

66.24.4.8 Each storage tank building and each tank within the building shall be accessible from at least two sides for fire fighting and fire control. [**30:**24.4.8]

66.24.4.9 Class I liquids and Class II or Class IIIA liquids heated above their flash points shall not be stored in basements. [**30:**24.4.9]

66.24.5 Construction of Storage Tank Buildings.

66.24.5.1 Storage tank buildings shall be constructed so as to maintain structural integrity for 2 hours under fire exposure conditions and to provide access and egress for unobstructed movement of all personnel and fire protection equipment. Compliance with 66.24.5.2 through 66.24.5.7 shall be deemed as meeting the requirements of 66.24.5.1. [**30:**24.5.1]

66.24.5.2* Buildings or structures shall be of at least 2-hour fire resistance rating. [**30:**24.5.2]

Δ **A.66.24.5.2** See NFPA 220. [**30:**A.24.5.2]

66.24.5.2.1 Noncombustible or combustible construction shall be permitted when protected by automatic sprinklers or equivalent protection subject to the approval of the AHJ. [**30:**24.5.2.1]

66.24.5.3 Where Class I liquids are stored above grade within buildings with basements or other belowgrade areas into which flammable vapors can travel, such belowgrade areas shall be provided with mechanical ventilation designed to prevent the accumulation of flammable vapors. Enclosed storage tank pits shall not be considered basements. [**30:**24.5.3]

The requirements in 66.24.5.3 are intended to prevent the entrapment of vapors in an area where there might be an ignition source. The second sentence applies to those situations where the tanks are installed in a spill containment area similar to a dike, that is, below the level of the surrounding floor.

66.24.5.4* Storage tank buildings where Class IA liquids are stored shall be designed to direct flame, combustion gases, and pressure resulting from a deflagration away from important buildings or occupied areas through the use of damage-limiting construction. The damage-limiting construction design shall be designed in accordance with NFPA 68 and shall be acceptable to the AHJ. [**30:**24.5.4]

Δ **A.66.24.5.4** See NFPA 68 for information on deflagration venting. [**30:**A.24.5.4]

This provision of the *Code* recognizes that a spill involving Class IA liquids can immediately fill the area with vapors and result in an explosion. Any walls separating the storage tanks from other parts of the building or from other buildings must be capable of withstanding the anticipated overpressure. This requirement entails careful engineering.

66.24.5.5 Storage tank buildings where unstable liquids are stored shall be designed using an approved engineered construction method that is intended to limit damage from an explosion (deflagration or detonation, depending on the liquid). [**30:**24.5.5]

66.24.5.6* Access aisles not less than 3 ft (0.9 m) in width shall be provided and maintained from the exterior of the storage tank building into the building and around all storage tanks. [**30:**24.5.6]

A.66.24.5.6 The purpose of the access aisles is to provide for ease of maintenance and emergency operations. [**30:**A.24.5.6]

66.24.5.7 A clear space of at least 3 ft (0.9 m) shall be maintained between the top of each tank and the building structure for buildings protected in accordance with 66.24.6.2.3. For buildings without fixed fire suppression systems, sufficient clear space shall be provided to allow for the application of hose streams to the top of the tank(s) for cooling purposes. [**30:**24.5.7]

66.24.6 Fire Protection for Storage Tank Buildings.

66.24.6.1 Manual Fire Control Equipment for Storage Tank Buildings.

66.24.6.1.1* Listed portable fire extinguishers shall be provided for facilities in such quantities, sizes, and types as could be needed for special storage hazards as determined in accordance with 66.21.6.1.2. [**30:**24.6.1.1]

Δ **A.66.24.6.1.1** NFPA 10 provides information on the suitability of various types of extinguishers. [**30:**A.24.6.1.1]

66.24.6.1.2* Where the need is indicated in accordance with 66.21.6.3, water shall be utilized through standpipe and hose systems, or through hose connections from sprinkler systems using combination spray and straight stream nozzles to permit effective fire control. [**30:**24.6.1.2]

Δ **A.66.24.6.1.2** See NFPA 13 and NFPA 14. [**30:**A.24.6.1.2]

66.24.6.1.3 Where the need is indicated in accordance with 66.21.6.3, mobile foam apparatus shall be provided. [**30:**24.6.1.3]

66.24.6.2 Fixed Fire Control Equipment for Tank Buildings.

66.24.6.2.1 A reliable water supply or other suitable fire control agent shall be available in pressure and quantity to meet the fire demands indicated by special storage hazards or exposure as determined by 66.21.6.3. [**30:**24.6.2.1]

66.24.6.2.2* Hydrants, with or without fixed monitor nozzles, shall be provided in accordance with accepted practice. The number and placement shall depend on the hazard of the storage, or exposure, as determined by 66.21.6.3. [**30:**24.6.2.2]

A.66.24.6.2.2 See NFPA 24 for information on this subject. [**30:**A.24.6.2.2]

66.24.6.2.3* Where the need is indicated by the hazards of storage or exposure as determined by 66.21.6.3, fixed protection shall be required utilizing approved foam, foam-water sprinkler systems, sprinkler systems, water spray systems, deluge systems, gaseous extinguishing systems, dry chemical extinguishing systems, fire-resistive materials, or a combination of these. [**30:**24.6.2.3]

Δ **A.66.24.6.2.3** See NFPA 13, NFPA 15, and NFPA 16 for information on these subjects. [**30:**A.24.6.2.3]

For certain fuel types, such as ketones, esters, and alcohols, the minimum required densities established in the listing criteria for foam discharge devices are often higher than the general densities specified for protection of flammable and combustible liquids. When determining the design criteria for extinguishing systems using foam, it is important to ensure that the listing criteria, which are typically based on empirical data from fire tests, are not overlooked. Otherwise, the fire protection system design can be inadequate for proper protection. [**30:**A.24.6.2.3]

66.24.6.2.3.1 When foam or foam-water fire protection systems are provided, discharge densities shall be determined based on the listing criteria for selected foam discharge devices, the foam concentrate, and the specific flammable or combustible liquids to be protected. [**30:**24.6.2.3.1]

66.24.6.2.4 If provided, fire control systems shall be designed, installed, and maintained in accordance with the following NFPA standards:

(1) NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
(2) NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
(3) NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
(4) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(5) NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
(6) NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
(7) NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
(8) NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*

[**30:**24.6.2.4]

66.24.7 Reserved.

66.24.8 Electrical Systems for Storage Tank Buildings.

66.24.8.1 Installation of electrical utilization equipment and wiring shall meet the requirements of Section 66.7. [**30:**24.8.1]

66.24.8.2 Section 66.7 shall be used to determine the extent of classified locations for the purpose of installation of electrical equipment. [**30:**24.8.2]

66.24.8.2.1 In establishing the extent of a classified location, it shall not extend beyond a floor, wall, roof, or other solid partition that has no openings within the classified area. [**30:**24.8.2.1]

66.24.9 Containment, Drainage, and Spill Control from Storage Tank Buildings.

66.24.9.1 Drainage systems shall be designed to minimize fire exposure to other tanks and adjacent properties or waterways. Compliance with 66.24.9.2 through 66.24.9.6 shall be deemed as meeting the requirements of 66.24.9.1. [**30:**24.9.1]

66.24.9.2 The facility shall be designed and operated to prevent the discharge of flammable or combustible liquids to public waterways, public sewers, or adjoining property under normal operating conditions. [**30:**24.9.2]

66.24.9.3 Except for drains, solid floors shall be liquidtight and walls shall be liquidtight where they join the floor and for at least 4 in. (100 mm) above the floor. [**30:**24.9.3]

66.24.9.4 Openings to adjacent rooms or buildings shall be provided with noncombustible, liquidtight raised sills or ramps at least 4 in. (100 mm) in height or shall be otherwise designed to prevent the flow of liquids to the adjoining areas. [**30:**24.9.4]

The intent of this requirement is to limit the spread of any spilled liquid, especially if it is already burning, to the area in which the spill originates. Note that this is a "two-way" provision: It protects the rest of the building from a spill that originates at the tanks and protects the tanks from a spill that might originate in an adjacent process area.

66.24.9.4.1 An open-grated trench across the width of the opening inside of the room that drains to a safe location shall be permitted to be used as an alternative to a sill or ramp. [**30:**24.9.4.1]

66.24.9.5 Means shall be provided to prevent liquid spills from running into basements. [**30:**24.9.5]

66.24.9.6* The containment shall have a capacity not less than that of the largest tank that can drain into it. [**30:**24.9.6]

Δ **A.66.24.9.6** Annex A of NFPA 15 provides information on this subject. [**30:**A.24.9.6]

A spill containment area inside a building is sized exactly as if it were an outside diked area — large enough to hold the contents of the largest tank. However, for inside tanks, an additional provision requires that spilled liquid and the water from fire-fighting operations be drained to a safe location, in recognition that the tanks are not outside but in an enclosed area. To protect the rest of the facility and to minimize hindrance to fire-fighting operations, spilled liquid and fire-fighting water must be removed. Note that an outside diked area would likely have means of drainage as well. For an inside tank installation, such provisions are critical.

66.24.9.7 Emergency drainage systems shall be provided to direct flammable or combustible liquid leakage and fire-protection water to a safe location. [**30:**24.9.7]

Any liquid that is drained from the building must be retained in a safe location. It must not be allowed to enter waterways or a municipal sewer system or storm drain, where it can present the threat of fire or explosion.

66.24.9.8 Curbs, scuppers, or special drainage systems shall be permitted to be used. [**30:**24.9.8]

66.24.9.9 Emergency drainage systems, if connected to public sewers or discharged into public waterways, shall be equipped with traps or separators. [**30:**24.9.9]

66.24.10 Ventilation for Storage Tank Buildings.

66.24.10.1 Storage tank buildings storing Class I liquids or Class II or Class III liquids at temperatures at or above their flash points shall be ventilated at a rate sufficient to maintain the concentration of vapors within the building at or below 25 percent of the lower flammable limit. Compliance with 66.24.10.2 through 66.24.10.7 shall be deemed as meeting the requirements of 66.24.10.1. [**30:**24.10.1]

Δ **66.24.10.2*** Ventilation shall be designed based on one of the following:

(1) Calculations based on the anticipated fugitive emissions *(See Annex E of NFPA 30 for calculation methods.)*
(2) Sampling of the actual vapor concentration under normal operating conditions
(3) Ventilation at a rate of not less than 1 cfm of exhaust air for each square foot of solid floor area (0.3 $m^3/min/m^2$)

[**30:**24.10.2]

Recognizing that some storage tank buildings might be quite large, A.66.24.10.2 offers two alternatives to the traditional ventilation rate specified in 66.24.10.2(3). A more detailed discussion is included in the commentary to Section 66.17.11.

A.66.24.10.2 Equipment in enclosed storage areas can deteriorate over time and periodic evaluation should be conducted to assure that leakage rates have not increased or that the ventilation rate is adequate for any increase in leakage rates. [**30:**A.24.10.2]

66.24.10.2.1 If vapor concentrations are confirmed by sampling, the sampling shall be conducted at a distance of a 5 ft (1.5 m) radius from each potential vapor source extending to or toward the bottom and the top of the enclosed storage area. The vapor concentration used to determine the required ventilation rate shall be the highest measured concentration during the sampling procedure. [**30:**24.10.2.1]

66.24.10.3 Ventilation shall be accomplished by natural or mechanical ventilation, with discharge or exhaust to a safe location outside the building. [**30:**24.10.3]

66.24.10.3.1 Recirculation of exhaust air shall be permitted only when it is monitored continuously using a fail-safe system that is designed to automatically sound an alarm, stop recirculation, and provide full exhaust to the outside in the event that vapor–air mixtures having concentrations over 25 percent of the lower flammable limit are detected. [**30:**24.10.3.1]

66.24.10.4* Provision shall be made for introduction of make-up air in such a manner as to avoid short-circuiting the ventilation. [**30:**24.10.4]

Δ **A.66.24.10.4** Local or spot ventilation might be needed for the control of special fire or health hazards. NFPA 91 and NFPA 90A provide information on this subject. [**30:**A.24.10.4]

The ventilation system intake ducts must be located in an area where they are unlikely to pick up any vapors from the discharge side of the system.

66.24.10.5 Ventilation shall be arranged to include all floor areas or pits where flammable vapors can collect. [**30:**24.10.5]

66.24.10.6 Where natural ventilation is inadequate, mechanical ventilation shall be provided and shall be kept in operation while flammable liquids are being handled. [**30:**24.10.6]

66.24.10.6.1 Local or spot ventilation, if provided, shall be permitted to be used for up to 75 percent of the required ventilation. [**30:**24.10.6.1]

Δ **66.24.10.7** Storage tank buildings with the interior grade more than 12 in. (300 mm) below the average exterior grade shall be provided with one of the following:

(1) Continuous mechanical ventilation in accordance with 66.24.10.2(3)
(2) A vapor detection system set to sound a warning alarm at a constantly attended location at 25 percent of the lower flammable limit, and to start the mechanical ventilation system

[**30:**24.10.7]

Vapors tend to accumulate in belowgrade spaces. Because some installations include spill containment basins, vapor detection is mandated. This requirement applies equally to separate storage tank buildings and to tanks located in a building in an area that is lower than the surrounding floor area.

66.24.11 Reserved.

66.24.12 Reserved.

66.24.13 Vents for Tanks Inside Storage Tank Buildings.

66.24.13.1 Vents for tanks inside tank buildings shall be designed to ensure that vapors are not released inside the building. Compliance with 66.24.13.2 through 66.24.13.6 shall be deemed as meeting the requirements of 66.24.13.1. [**30:**24.13.1]

66.24.13.2 Vents for tanks inside tank buildings shall be as required in 66.21.4.3 and 66.22.7. [**30:**24.13.2]

66.24.13.3 Emergency venting by the use of a weak roof-to-shell seam shall not be permitted. [**30:**24.13.3]

Rupture of a weak roof-to-shell seam would likely damage the building structure and any automatic sprinkler or water spray systems protecting the tank and would needlessly expose uninvolved tanks.

66.24.13.4 Automatic sprinkler systems designed in accordance with the requirements of Section 13.3 and NFPA 13 shall be accepted by the AHJ as equivalent to water spray systems for purposes of calculating the required airflow rates for emergency vents in 22.7.3.5 of NFPA 30, provided the density and coverage requirements of NFPA 15 are met. [**30:**24.13.4]

66.24.13.5 Vents shall terminate outside the building in accordance with 66.27.8.1. [**30:**24.13.5]

66.24.13.5.1 Emergency relief vents on protected aboveground tanks complying with UL 2085 containing Class II and Class III liquids shall be allowed to discharge inside the building. [**30:** 24.13.5.1]

This requirement was added to the *Code* in 2015. Protected aboveground tanks complying with ANSI/UL 2085 are designed and constructed to withstand a 2-hour fire test of 2000°F (1093°C) during which no single point on the inside wall of the primary vessel can exceed 400°F (204°C), and the average temperature rise on the inside wall cannot exceed 260°F (127°C). Given this stringent requirement, activation of the emergency vent is likely only under extreme fire conditions over an extended period of time. Further, NFPA 30 states that the required capacity of an emergency vent placed on a vent pipe that extends beyond 12 in. (300 mm) from the tank be recalculated to account for the potential back pressure and ensure activation at the appropriate pressure. It is not unusual to see vent lines extending 30 ft (9 m) or more through a building in order to achieve the exterior discharge. Allowing the emergency vent to discharge inside eliminates the need for recalculating the vent capacity and ensures proper sizing and activation of the emergency vent.

66.24.13.6 Piping for normal and emergency relief venting shall meet the requirements of Section 66.27. [**30:**24.13.6]

66.24.14 Tank Openings Other than Vents for Tanks Inside Storage Tank Buildings.

66.24.14.1 Tank openings other than vents for tanks inside tank buildings shall be designed to ensure that flammable liquids or vapors are not released inside the building. Compliance with 66.24.14.2 through 66.24.14.9 shall be deemed as meeting the requirements of 66.24.14.1. [**30:**24.14.1]

66.24.14.2 All tank openings that are located at or below the maximum liquid level shall be liquidtight. Those that are located above the maximum liquid level shall be normally closed and shall be mechanically secured to prevent release of vapors. [**30:**24.14.2]

Tank openings that are below the normal maximum liquid level must, obviously, be liquidtight and must be maintained that way. Tank openings above this level do not have to be liquidtight, but they must be secured so that no vapors escape to the inside of the building.

66.24.14.3 Each liquid transfer connection on any tank storing Class I or Class II liquids inside buildings shall be provided with one of the following:

(1) A normally closed, remotely activated valve
(2) An automatic-closing, heat-activated valve
(3) Another approved device
[**30:**24.14.3]

66.24.14.4 Connections used for emergency disposal or to provide for quick cutoff of flow in the event of fire in the vicinity of the tank shall not be required to meet the requirement of 66.24.14.3. [**30:**24.14.4]

66.24.14.5 Each connection through which liquid can gravity flow from a tank inside a building shall be provided with an internal or an external valve located as close as practical to the shell of the tank. This valve shall be considered to be in compliance with 66.24.14.3. If a separate valve is used, both valves shall be located adjacent to each other. [**30:**24.14.5]

66.24.14.6* Openings for manual gauging of Class I or Class II liquids, if independent of the fill pipe, shall be provided with a vaportight cap or cover that shall be kept closed when not in use. [**30:**24.14.6]

A.66.24.14.6 Substitutes for manual gauging include, but are not limited to, heavy-duty flat gauge glasses; magnetic, hydraulic, or hydrostatic remote reading devices; and sealed float gauges. [**30:**A.24.14.6]

66.24.14.6.1 Each such opening for any liquid shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other approved device. [**30:**24.14.6.1]

66.24.14.7 The inlet of the fill pipe and the outlet of a vapor recovery line for which connections to tank vehicles and tank cars are made and broken shall be as follows:

(1) Located outside of buildings at a location free from any source of ignition
(2) Located not less than 5 ft (1.5 m) away from any building opening
(3) Closed tight and protected against tampering when not in use
(4) Identified
[**30:**24.14.7]

66.24.14.8* Tanks storing Class I, Class II, or Class IIIA liquids inside buildings shall be equipped with a device, or other means shall be provided, to prevent overflow into the building. [**30:**24.14.8]

A.66.24.14.8 Suitable devices include, but are not limited to, a float valve; a pre-set meter on the fill line; a low head pump incapable of producing overflow; or a liquidtight overflow pipe, sized at least one pipe size larger than the fill pipe, that discharges by gravity back to the outside source of liquid or to an approved location. [**30:**A.24.14.8]

An overfill cannot be allowed to simply collect in the containment area, as would be allowed with an outside aboveground tank. Paragraph 66.24.14.8 allows considerable flexibility in complying with the requirements.

66.24.14.9 Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connection or other approved device, unless the opening is pipe-connected to a vapor processing system. [**30:**24.14.9]

66.24.14.9.1 Openings designed for combined fill and vapor recovery shall also be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. [**30:**24.14.9.1]

66.24.14.9.2 All connections shall be vaportight. [**30:**24.14.9.2]

66.24.15 Detection and Alarm Systems for Storage Tank Buildings.

66.24.15.1 An approved means shall be provided to promptly notify those within the plant and the available public or mutual aid fire department of any fire or other emergency. [**30:**24.15.1]

66.24.15.2 Those areas, including buildings, where the potential exists for a flammable liquid spill shall be monitored as appropriate. Such methods shall include both of the following:

(1) Personnel observation or patrol
(2) Monitoring equipment that indicates a spill or leak has occurred in an unattended area
[**30:**24.15.2]

66.24.16 Inspection and Maintenance for Storage Tank Buildings.

66.24.16.1 Combustible waste material and residues in operating areas shall be kept to a minimum, stored in covered metal containers, and disposed of daily. [**30:**24.16.1]

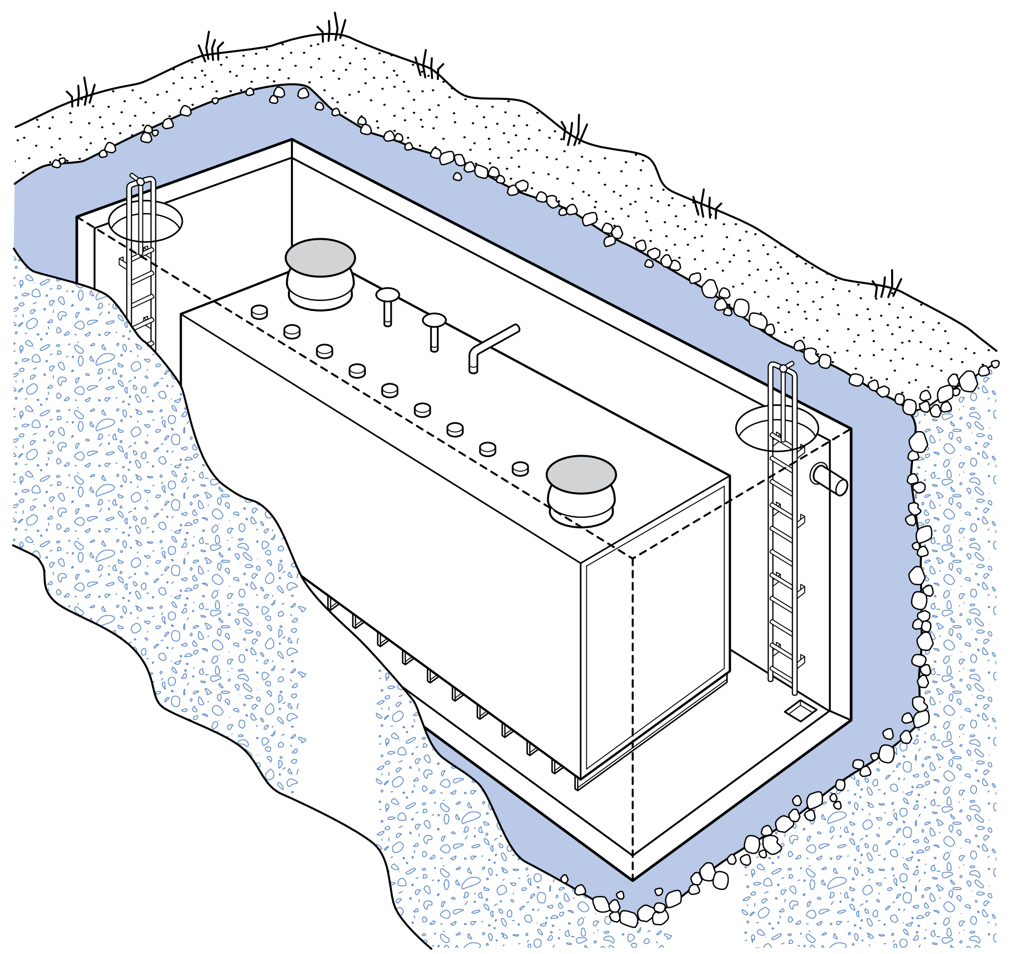
66.24.16.2 Storage of combustible materials and empty or full drums or barrels shall not be permitted within the storage tank building. [**30:**24.16.2]

66.25 Storage Tank Vaults

66.25.1 Scope. This section shall apply to the design, construction, and installation of vaults for aboveground tanks. [**30:**25.1]

Section 66.25 covers storage tank vaults. Vaults provide a secure installation and a high degree of protection for a liquid storage tank.

Exhibit 66.53



Typical underground storage tank vault.

Exhibit 66.53 is a diagram of a typical storage tank vault that is installed below grade and backfilled. Exhibit 66.54 shows an on-site installation of a vault and its storage tank.

66.25.2 Definitions Specific to Section 66.25. (Reserved)

66.25.3 General Requirements.

66.25.3.1* Storage Tank Selection and Arrangement.

A.66.25.3.1 Inspections are recommended for shop fabricated aboveground tanks. One guide is SP001, *Standard for Inspection of Aboveground Storage Tanks*, which is published by the Steel Tank Institute. In addition, the tank owner might desire to conduct additional inspections to ensure the ongoing integrity of tanks and equipment. Because the interior of a vault will ordinarily remain dry and temperature-moderated, environmental effects on tanks and equipment inside vaults will be reduced as compared to aboveground tanks that are not protected from weather exposure. Accordingly, inspection and maintenance frequencies for exterior surfaces of tanks and piping in vaults are typically less critical than for aboveground tanks installed outdoors. Nevertheless, inspection

Exhibit 66.54

Vault and its storage tank being installed at a service station site. (Courtesy of Core Engineered Solutions, Inc.)

and maintenance of emergency vents and overfill prevention devices are still necessary. [**30:**A.25.3.1]

Clearance between the shell of a tank or equipment in a vault and the interior vault wall should be sufficient to accommodate visual inspections and maintenance that might be needed. In addition, consideration should be given to the need for inspection and maintenance of tank interior surfaces that may be impacted by internal corrosion. [**30:**A.25.3.1]

Clearance should be adequate to permit the following:

(1) Entry into the vault interior by an inspector or maintenance worker
(2) Access to manipulate, repair, or replace any equipment or fittings in the vault
(3) Access within the vault to visually inspect, either by direct sight or with the aid of an optical vision extension tools, interior vault surfaces and exterior surfaces of tanks and equipment, to determine the source of any leakage that may occur, and to conduct any needed repairs

[**30:**A.25.3.1]

Because vaults are designed to provide for entry by inspectors or maintenance workers, consideration should also be given to providing access for rescue by emergency responders who might be called upon to rescue an individual from a vault. Such consideration can include providing a minimum access hatch dimension of 36 in. (915 mm) and a minimum dimension for walkways in vault interior spaces of 30 in. (760 mm) to permit an emergency responder with an SCBA to maneuver and providing, in some cases, a second means of access to the vault interior. [**30:**A.25.3.1]

66.25.3.1.1 Aboveground tanks shall be permitted to be installed in vaults that meet the requirements of this section. [**30:**25.3.1.1]

66.25.3.1.2 Vaults shall be constructed and listed in accordance with UL 2245, *Standard for Below-Grade Vaults for Flammable Liquid Storage Tanks*. [**30:**25.3.1.2]

66.25.3.1.3 Except as modified by the provisions of this section, vaults shall meet all other applicable provisions of this *Code*. [**30:**25.3.1.3]

66.25.3.1.4 Tanks installed in storage tank vaults shall be listed for aboveground use. [**30:**25.3.1.4]

66.25.3.1.5 Each tank shall be in its own vault and shall be completely enclosed by the vault. [**30:**25.3.1.5]

66.25.3.1.6 Sufficient clearance between the tank and the vault shall be provided to allow for visual inspection and maintenance of the tank and its appurtenances. [**30:**25.3.1.6]

66.25.3.1.7 Backfill shall not be permitted around the tank. [**30:**25.3.1.7]

Δ **66.25.3.1.8** Dispensing devices shall be permitted to be installed on the tops of vaults. Dispensing devices used for motor fuels shall be installed in accordance with NFPA 30A. [**30:**25.3.1.8]

66.25.3.1.9 At each entry point into the vault, a warning sign indicating the need for procedures for safe entry into confined spaces shall be posted. Each entry point shall be secured against unauthorized entry and vandalism. [**30:**25.3.1.9]

The interior of the vault qualifies as a permit-required confined space in accordance with 29 CFR 1910.146, "Permit-Required Confined Spaces."

66.25.3.2 Storage Tank Appurtenances.

66.25.3.2.1 An approved means of overfill protection shall be provided for the tanks in the vaults. The use of ball float valves shall be prohibited. [**30:**25.3.2.1]

Ball float valves cannot be used as a means for overfill protection because of the potential for damage to the tank. If the tank is filled using a pumped delivery, closure of the ball float would cause immediate and potentially damaging excess pressure in the tank.

66.25.3.2.2 Fill connections for vaults installed inside buildings shall comply with 66.22.13.4. [**30:**25.3.2.2]

66.25.3.3 Vault Arrangement.

66.25.3.3.1 Vaults shall be permitted to be either above or below grade. [**30:**25.3.3.1]

A vault can be installed completely buried, with its top at grade or with its top partly or wholly above grade. See Exhibit 66.55.

66.25.4 Location of Storage Tank Vaults. In lieu of the separation distance requirements given in 66.22.4, separation distances between the vault and any of the following shall be permitted to be reduced to 0 ft (0 m), as measured from the outer perimeter of the vault wall:

(1) Any property line that is or can be built upon
(2) The near and far sides of a public way
(3) The nearest important building on the same property

[**30:**25.4]

Given the robust construction of a vault, the protection from an exposure fire provided by the vault to the tank and by the requirements imposed by this chapter, applying the separation distances required for an exposed tank cannot be justified.

66.25.5* Construction and Installation of Storage Tank Vaults.

A.66.25.5 Some of the specifications for vault design and construction include the following:

(1) The walls and floor of the vault are to be constructed of reinforced concrete at least 6 in. (50 mm) thick.
(2) The top and floor of the vault and the tank foundation must be designed to withstand all anticipated loading, including loading from vehicular traffic, where applicable.
(3) The walls and floor of a belowgrade vault must be designed to withstand anticipated soil and hydrostatic loading.
(4) The vault must be liquidtight.
(5) The vault enclosure must have no openings except those necessary for access to, inspection of, and filling, emptying, and venting of the tank.

Exhibit 66.55

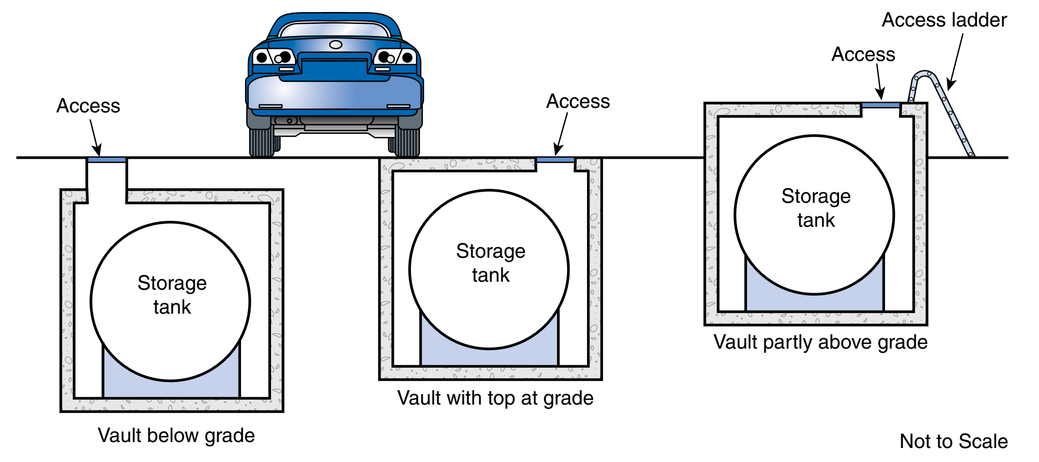


Diagram showing vault installations with respect to grade.

(6) The vault must be provided with connections to permit ventilation to dilute, disperse, and remove any vapors prior to personnel entering the vault.
(7) The vault must be provided with a means for personnel entry.
(8) The vault must be provided with an approved means to admit a fire suppression agent.

[**30:**A.25.5]

66.25.5.1 Construction Requirements. Vaults shall be designed and constructed in accordance with 66.25.5.1.1 through 66.25.5.1.4. [**30:**25.5.1]

66.25.5.1.1 The top of an abovegrade vault that contains a tank storing Class I liquid or Class II liquid stored at a temperature above its flash point shall be constructed of noncombustible material and shall be designed to be weaker than the walls of the vault to ensure that the thrust of any explosion occurring inside the vault is directed upward before destructive internal pressure develops within the vault. [**30:**25.5.1.1]

66.25.5.1.2 The top of an at-grade or belowgrade vault that contains a tank storing Class I liquid or Class II liquid stored at a temperature above its flash point shall be designed to relieve or contain the force of any explosion occurring inside the vault. [**30:**25.5.1.2]

To effectively vent an explosion within a belowgrade vault, the design has to incorporate a duct that extends to a safe distance above grade. This duct has to be strong enough so that it does not fail before the deflagration vent can operate. See NFPA 68, *Standard on Explosion Protection by Deflagration Venting*. Alternatively, the vault can be designed to withstand the overpressure of an explosion. This technique is known as *deflagration pressure containment* and is the option almost universally chosen. See Chapter 13 of NFPA 69.

66.25.5.1.3 Adjacent vaults shall be permitted to share a common wall. [**30:**25.5.1.3]

66.25.5.1.4 Where required, the vault shall be wind and earthquake resistant, in accordance with recognized engineering standards. [**30:**25.5.1.4]

66.25.5.2 Installation Requirements. Storage tank vaults shall be installed in accordance with the requirements of 66.25.5.2.1 and 66.25.5.2.2. [**30:**25.5.2]

66.25.5.2.1 Each vault and its tank shall be anchored to resist uplifting by groundwater or flooding, including when the tank is empty. [**30:**25.5.2.1]

66.25.5.2.2 Vaults that are not resistant to damage from the impact of a motor vehicle shall be protected by collision barriers. [**30:**25.5.2.2]

66.25.6 Reserved.

66.25.7 Reserved.

66.25.8 Reserved.

66.25.9 Containment, Drainage, and Spill Control for Storage Tank Vaults.

66.25.9.1 Means shall be provided to recover liquid from the vault. [**30:**25.9.1]

66.25.9.2 If a pump is used to meet this requirement, the pump shall not be permanently installed in the vault. [**30:**25.9.2]

66.25.9.3 Electric-powered portable pumps shall be approved for use in Class I, Division 1 locations, as defined in *NFPA 70*. [**30:**25.9.3]

66.25.10 Ventilation Systems for Storage Tank Vaults.

66.25.10.1 Vaults that contain tanks storing Class I liquids shall be ventilated at a rate of not less than 1 cfm/ft^2 of floor area (0.3 m^3/min/m^2), but not less than 150 cfm (4 m^3/min). [**30:**25.10.1]

66.25.10.2 Such ventilation shall operate continuously or shall be designed to operate upon activation of a vapor and liquid detection system. [**30:**25.10.2]

66.25.10.3 Failure of the exhaust airflow shall automatically shut down the dispensing system. [**30:**25.10.3]

66.25.10.4 The exhaust system shall be designed to provide air movement across all parts of the vault floor. [**30:**25.10.4]

66.25.10.5 Supply and exhaust ducts shall extend to within 3 in. (75 mm), but not more than 12 in. (300 mm) of the floor. [**30:**25.10.5]

Δ **66.25.10.6** The exhaust system shall be installed in accordance with the provisions of NFPA 91. [**30:**25.10.6]

66.25.11 Reserved.

66.25.12 Reserved.

66.25.13 Vents for Tanks Inside Storage Tank Vaults.

66.25.13.1 Vent pipes that are provided for normal tank venting shall terminate outside the vault and at least 12 ft (3.6 m) above ground level and shall meet the requirements of 66.27.8.1. [**30:**25.13.1]

66.25.13.2 Emergency vents shall be vaportight and shall be permitted to discharge inside the vault. Long-bolt manhole covers shall not be permitted for this purpose. [**30:**25.13.2]

Emergency vents are allowed to discharge inside the vault because they would operate only if an exposure fire within the vault is boiling the contents of the tank. Vapors released by the emergency vent would not materially add to the fire. The rationale is that it is safer for the vapors to be burned in the vault than to be discharged in quantity outside the vault, where they could be ignited and trigger a second fire.

Long-bolt manhole covers are not sufficiently vaportight to be used.

66.25.14 Reserved.

66.25.15 Detection and Alarm Systems for Storage Tank Vaults.

66.25.15.1 Each vault shall be provided with an approved vapor and liquid detection system that is equipped with on-site audible and visual warning devices with battery backup. [**30:**25.15.1]

66.25.15.2 The vapor detection system shall sound an alarm when the system detects vapors that reach or exceed 25 percent of the lower flammable limit of the liquid stored. [**30:**25.15.2]

66.25.15.3 Vapor detectors shall be located no higher than 12 in. (300 mm) above the lowest point in the vault. [**30:**25.15.3]

66.25.15.4 The liquid detection system shall sound an alarm upon detection of any liquid, including water. [**30:**25.15.4]

The liquid detection system is intended to sound an alarm not just for a spill but also for any infiltration of groundwater into the vault, which could indicate failure of the vault's floor, wall, or top or failure of a seal at the wall-to-top joint.

66.25.15.5 Liquid detectors shall be located in accordance with the manufacturer's instructions. [**30:**25.15.5]

66.25.15.6 Activation of either the vapor detection system or the liquid detection system shall cause a signal to be sounded at an approved, constantly attended location within the facility serving the tanks or at an approved location. [**30:**25.15.6]

66.25.16 Inspection and Maintenance of Storage Tank Vaults and Equipment. Vaults and their required equipment shall be maintained in accordance with the requirements of this section. [**30:**25.16]

66.26 Reserved

66.27 Piping Systems

66.27.1 Scope.

Section 66.27 covers piping systems used to transfer flammable and combustible liquid from one point to another (see Exhibit 66.56). Any piping system is susceptible to leaks or spills of liquids. Because of the fire hazard involved in handling flammable and combustible liquids, piping systems must be able to withstand the intense heat generated by fire for reasonable periods of time while emergency shutdown procedures are implemented and fire-fighting measures begin. Failure of pipes, valves, and fittings from exposure to a fire can turn a moderate hazard into an extreme emergency.

Exhibit 66.56

Piping in a process plant undergoing routine maintenance.

66.27.1.1 This section shall apply to the design, installation, testing, operation, and maintenance of piping systems for flammable and combustible liquids or vapors. Such piping systems shall include but not be limited to pipe, tubing, flanges, bolting, gaskets, valves, fittings, flexible connectors, the pressure-containing parts of other components including but not limited to expansion joints and strainers, and devices that serve such purposes as mixing, separating, snubbing, distributing, metering, control of flow, or secondary containment. [**30:**27.1.1]

66.27.1.2 This section shall not apply to any of the following:

(1) Tubing or casing on any oil or gas wells and any piping connected directly thereto
(2) Motor vehicles, aircraft, boats, or piping that are integral to a stationary engine assembly
(3) Piping within the scope of any applicable boiler and pressure vessel code

[**30:**27.1.2]

Paragraph 66.27.1.2 clearly identifies those elements of piping systems that are not addressed by the *Code*. Note that this chapter does not apply to the fuel supply piping that connects a stationary internal combustion engine with its primary fuel supply, often referred to as a "day tank," or its integral fuel tank, such as a "base tank." This chapter does apply to piping for any fuel storage tank from which the day tank is replenished. Although not specifically stated here, the same applies to fuel supply tanks for oil-burning appliances. The requirements of Chapter 8 of NFPA 31 apply to the tank that directly supplies the appliance, while this chapter applies to any storage tank upstream.

66.27.2 Definitions Specific to Section 66.27. For the purpose of this section, terms in this section shall have the definitions given. [**30:**27.2]

66.27.2.1 Corrosion Protection. A means to lessen or prevent the deterioration of the piping system from exposure to its contents or its environment. [**30:**27.2.1]

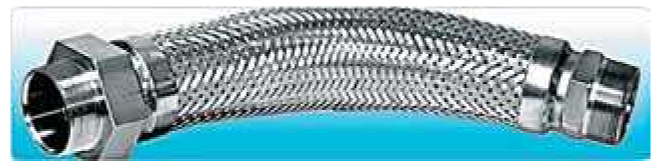
66.27.2.2 Flexible Connector. A connection joint in a piping system that allows differential movement of the piping system and limits system stress and mechanical damage. [**30:**27.2.2]

Flexible connectors are often needed between process equipment and connected piping systems to accommodate vibration or to absorb piping stresses developed by temperature and pressure changes in the process system. Flexible connectors are required to be listed (see 66.27.5.2), while hose need only be acceptable to the AHJ (see 66.18.4.7 and 66.18.5.2.1). Exhibit 66.57 shows a stainless steel flexible connector used for providing a flexible joint in fuel piping. For more information on flexible connectors, see the commentary to 66.27.5.2.

66.27.2.3 Leak. An unintended release of liquid or vapor from the piping system due to failure of the piping system. [**30:**27.2.3]

66.27.2.4 Low Melting Point Materials. Materials that melt at a low temperature, including but not limited to aluminum, copper, or brass; materials that soften on fire exposure, such as plastics; or nonductile materials, such as cast iron. [**30:**27.2.4]

Exhibit 66.57



Stainless steel flexible connector used for fuel service. (Courtesy of OPW)

With respect to metals, *low melting* describes metals that have melting points significantly lower than that of steel. For example, aluminum alloys melt at about 1225°F (660°C) and copper at about 2000°F (1090°C). Carbon steel and wrought iron have melting points around 2800°F (1540°C). Although not a low melting point material, cast iron is treated similarly because it is brittle and easily fractured. See the commentary for 66.27.4.2.

Plastics is a broad term that includes thermoset resins. Thermoset resins are usually liquids and are fashioned into their final form and thermally cured. Once cured, thermosets cannot be softened by heat. That being the case, not all piping fabricated from thermoset resins qualifies as a low melting point material. However, thermoset piping should still be evaluated to determine how well it can withstand an exposure fire.

66.27.2.5 Secondary Containment. Containment that is external to and separate from the primary piping system. [**30:**27.2.5]

66.27.3 General Requirements.

66.27.3.1 Performance Standards. The design, fabrication, assembly, test, and inspection of piping systems shall be suitable for the working pressures and structural stresses to be encountered by the piping system. Compliance with applicable sections of ASME B31, *Code for Pressure Piping*, and the provisions of this section shall be considered *prima facie* evidence of compliance with the foregoing provisions. [**30:**27.3.1]

Consideration of the expected (or normal) working pressures of the piping system and structural stresses to which it will be exposed is important, particularly when high vapor–pressure flammable liquids are involved or when tanks and piping systems are subject to heating. Heating can result from exposure to direct sunlight, from heat radiating off a process or piece of equipment, or from the liquid itself at elevated temperature.

66.27.3.2 Tightness of Piping. Piping systems shall be maintained liquidtight. A piping system that has leaks that constitute a hazard shall be repaired in a manner acceptable to the AHJ, or it shall be emptied of liquid, vapor freed, and no longer used. [**30:**27.3.2]

66.27.4 Materials of Construction for Piping Systems.

66.27.4.1 Materials Specifications. Pipe, valves, faucets, couplings, flexible connectors, fittings, and other pressure-containing parts shall meet the material specifications and pressure and temperature limitations of ASME B31, *Code for Pressure Piping*, except as provided for in 66.27.4.2, 66.27.4.3, and 66.27.4.4. [**30:**27.4.1]

66.27.4.2 Ductile Iron. Ductile (nodular) iron shall meet the specifications of ASTM A395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*. [**30:**27.4.2]

Ductile (nodular) iron is another term for *malleable wrought iron*. This type of iron is distinct from cast iron, which should be used only for piping systems that handle Class IIIB liquids, in accordance with 66.27.4.3.3. Cast iron is brittle and fractures on impact. Malleable iron bends or deforms instead and is less likely to result in a serious leak if damaged.

Paragraph 66.27.4.2 does not apply to the internal working parts of a valve or other similar components of the piping system. These parts are referred to as "valve trim" and include such components as the valve gate or disk, the internal surfaces on which the gate or disk seats to stop or throttle flow, the stem, and the sleeves needed to guide the stem. These components are commonly fabricated from brass or bronze.

66.27.4.3 Materials of Construction for Valves. Valves at storage tanks, as required by 66.22.13 and 66.24.14, and their connections to the tank shall be of steel or ductile iron, except as provided for in 66.27.4.3.1, 66.27.4.3.2, or 66.27.4.4. [**30:**27.4.3]

66.27.4.3.1 Valves at storage tanks shall be permitted to be other than steel or ductile iron where the chemical characteristics of the liquid stored are not compatible with steel or where the valves are installed internally to the tank. [**30:**27.4.3.1]

Internally mounted shutoff valves, sometimes referred to as "fire-safe" valves, have their internal mechanism mounted inside the tank shell where the liquid can absorb heat, thus keeping the valve mechanism cool and avoiding failure of and leakage past the valve seat. See Exhibit 66.58. A fusible link is typically provided to automatically shut the valve if exposed to a fire. Because the components of the valve mechanism are protected from the thermal stress of the fire, they can be of materials other than steel or nodular iron, such as brass. These valves are not readily available in sizes larger than 4 in. (100 mm).

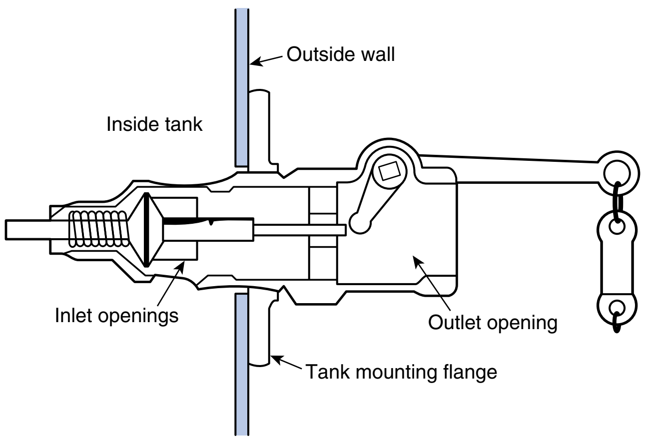
There are two negative features of this type of valve, particularly for sizes larger than 4 in. (100 mm). First, if part of the internal mechanism fails or breaks, access for repair usually involves draining the tank, then entering the tank to effect a repair, a procedure that is time-consuming, costly, and not without hazard. Second — this is significant only for situations involving large field-erected tanks [>75,000 gal (284 m^3)] — when the valve closes due to a fire, as it is designed to do, the option of pumping the contents of the tank to another tank that is removed from the fire is not available. Being able to pump out a fire-exposed tank is a valuable option in a fire situation, particularly where very large tanks are involved. For those reasons, the Technical Committee on Tank Storage and Piping Systems does not favor mandating internally mounted shutoff valves.

66.27.4.3.2* Valves installed externally to the tank shall be permitted to be other than steel or ductile iron if the material of construction has a ductility and melting point comparable to steel or ductile iron and is capable of withstanding the stresses and temperatures involved in fire exposure or the valves are otherwise protected from fire exposures, such as by materials having a fire resistance rating of not less than 2 hours. [**30:**27.4.3.2]

A.66.27.4.3.2 For further information, see ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, and ANSI/UL 1709, *Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel*. [**30:**A.27.4.3.2]

The reason for requiring steel or ductile iron wherever possible is to ensure that the valve or fittings are able to withstand the

Exhibit 66.58



Typical installation of an internal valve with a fusible link operator (left) and internal valve with a fusible link operator (right). (Photo courtesy of Morrison Bros. Inc.)

stresses and temperatures created by fire exposure. An alternative to using steel, ductile iron, or materials of similar properties is to protect the valve so it will have a fire resistance rating of 2 hours.

66.27.4.3.3 Cast iron, brass, copper, aluminum, malleable iron, and similar materials shall be permitted to be used on tanks described in 66.22.4.2.1.1 or on tanks storing Class IIIB liquids where the tanks are located outdoors and not within a diked area or drainage path of a tank storing a Class I, Class II, or Class IIIA liquid. [**30:**27.4.3.3]

The relaxed requirement in 27.4.3.3 is justified by the fact that a spill of a Class IIIB liquid entails very little fire risk.

66.27.4.4 Low Melting Point Materials.

66.27.4.4.1 Low melting point materials, as defined in 66.27.2.4, shall be compatible with the liquids being handled and shall be used within the pressure and temperature limitations of ASME B31, *Code for Pressure Piping*. [**30:**27.4.4.1]

66.27.4.4.2 Low melting point materials shall not be used as part of a tank's normal or emergency vent piping. [**30:**27.4.4.2]

This provision is intended to prevent situations in which an exposure fire causes the vent piping to soften, shrink, and close in on itself to the point where its capacity is restricted or blocked completely.

66.27.4.4.3 Low melting point materials shall be permitted to be used underground. [**30:**27.4.4.3]

66.27.4.4.4 Low melting point materials shall be permitted to be used outdoors aboveground, outside a dike, outside a remote impounding area, or inside buildings, provided they meet one of the following conditions:

(1) They are resistant to damage by fire.
(2) They are located so that any leakage resulting from failure will not expose persons, important buildings, tanks, or structures.
(3) They are located where leakage can be controlled by operation of one or more accessible, remotely located valves.

[**30:**27.4.4.4]

66.27.4.4.5 Low melting point materials shall be permitted to be used within a dike or within a remote impounding area provided they meet one of the following:

(1) They are connected above the normal operating liquid level of the tank.
(2) They are connected below the normal operating liquid level of the tank and one of the following conditions is met:
    (a) The stored liquid is a Class IIIB liquid, the tank is located outdoors, and the piping is not exposed to a potential spill or leak of Class I, Class II or Class IIIA liquid.
    (b) The low melting point material is protected from fire exposure, such as by using materials that have a fire resistance of not less than 2 hours.

[**30:**27.4.4.5]

Exhibit 66.59

Internally lined valve. (Courtesy of Aegis Flow Technologies)

66.27.4.4.6 Piping systems of these materials shall be designed and built in accordance with recognized standards of design for the particular materials chosen or with approved equivalent standards or shall be listed. [**30:**27.4.4.6]

66.27.4.5 Lining Materials. Piping, valves, and fittings shall be permitted to have combustible or noncombustible linings. [**30:**27.4.5]

Depending on the liquids being handled, corrosion can be a serious problem in piping, valves, and fittings, often leading to early failure or leaks. Linings made of plastic or rubber-based materials can be useful in preventing corrosion, thus preserving the integrity of the piping system and lengthening its life span. See Exhibit 66.59.

66.27.4.6 Nonmetallic Piping.

66.27.4.6.1 Piping systems of nonmetallic materials, including piping systems incorporating secondary containment, shall be designed and built in accordance with recognized standards of design or approved equivalents and shall be installed in accordance with 66.27.4.4. [**30:**27.4.6.1]

The *Code* treats nonmetallic piping systems and components in essentially the same way it treats piping and piping components of low melting point metallic materials. The susceptibility of these piping systems to damage by fire is considered to be equivalent. Nonmetallic piping might be indicated where the piping is exposed to a particularly corrosive environment, such as a process area where corrosive vapors are released.

66.27.4.6.2 Nonmetallic piping shall be built and used within the scope of their approvals or within the scope of UL 971, *Standard for Nonmetallic Underground Piping for Flammable Liquids*. [**30:**27.4.6.2]

66.27.4.6.3 Nonmetallic piping systems and components shall be installed in accordance with manufacturer's instructions. [**30:**27.4.6.3]

66.27.5 Pipe Joints.

66.27.5.1 Tightness of Pipe Joints.

66.27.5.1.1 Joints shall be made liquidtight and shall be welded, flanged, threaded, or mechanically attached. [**30:**27.5.1.1]

To prevent the loss of liquid, all joints must be liquidtight. This is particularly critical with the more hazardous Class I liquids and explains the requirement of 66.27.5.1.4 for welded joints in concealed areas of a building.

Some weeping is to be expected at some points in a piping system, for example, from valve stem packing glands or from a gasket flange where the flange might need additional tightening. Such weeping is quite minor and is eventually taken care of during routine maintenance.

66.27.5.1.2* Joints shall be designed and installed so that the mechanical strength of the joint will not be impaired if exposed to a fire. [**30:**27.5.1.2]

A.66.27.5.1.2 It is expected that some joints might leak under fire conditions but will not come apart. [**30:**A.27.5.1.2]

66.27.5.1.3 Threaded joints shall be made with a suitable thread sealant or lubricant. [**30:**27.5.1.3]

66.27.5.1.4 Joints in piping systems handling Class I liquids shall be welded when located in concealed spaces within buildings. [**30:**27.5.1.4]

66.27.5.2 Flexible Connectors. Flexible connectors shall be listed and labeled in accordance with UL 2039, *Standard for Flexible Connector Pipe for Fuels,* and shall be installed in accordance with 66.27.5.3. [**30:**27.5.2]

Flexible connectors are used in piping systems wherever the connection would be subject to movement or vibration in normal use. Examples include connections between pumps and fixed piping and at piping headers where connections are made and broken. See Exhibit 66.57

Flexible connectors are often used in underground piping systems to avoid damage to the piping system should the tank move due to, for example, an unusually high groundwater level. Before the advent of flexible connectors in underground service, swing joints made with screwed elbows and short lengths of pipe were used to provide flexibility in underground piping systems. The arrangement of pipe and elbows allowed movement to occur around several axes of rotation, so that shifting of the tank did not break the piping connection. These arrangements were found to complicate the proper installation of emergency shutoff valves under dispensers and to be frequent sources of leaks at their many joints. Because of the EPA's rules on the installation of underground storage tank systems, swing joints have been, for the most part, supplanted by flexible connectors. The appropriate listing document is now referenced.

66.27.5.3 Friction Joints.

66.27.5.3.1 Pipe joints dependent upon the friction characteristics of combustible materials for mechanical continuity or liquidtightness of piping shall only be used outside of buildings above ground, except as provided for in 66.27.5.3.3, or below ground. [**30:**27.5.3.1]

The restrictions on pipe joints that depend on friction or resiliency to maintain tightness are necessary because of their susceptibility to softening under fire exposure and because frost heaves can shift underground piping or supports for aboveground piping and thus disengage the joint. This latter problem is particularly noticeable in the northern latitudes, often in motor fuel dispensing facilities. NFPA 30 generally limits use of this type of joint to underground piping and aboveground piping outside buildings. In the latter case, the piping must be designed and installed so that disengagement of the connection will not occur. Alternatively, as set forth in 66.27.5.3.2, the piping must be located and installed so that a release from the pipe joints will not result in an exposure hazard, and the piping must be remotely controlled. See 66.27.5.3.3 and its commentary for use of these friction joints inside a building.

66.27.5.3.2 Where such joints are used aboveground, either the piping shall be secured to prevent disengagement at the fitting or the piping system shall be so designed that any spill or leak resulting from disengagement will not expose persons, important buildings, or structures and can be controlled by remote valves. [**30:**27.5.3.2]

66.27.5.3.3 Pipe joints dependent on the friction characteristics of their components shall be permitted to be used inside buildings provided both of the following are met:

(1) They are located where leakage can be controlled by operation of an accessible, remotely located valve that is outside the fire risk area.
(2) The mechanical strength and liquidtightness of the joint is not dependent on the resiliency of a combustible material or component.

[**30:**27.5.3.3]

The provision in 66.27.5.3.3 was incorporated into NFPA 30 to accommodate the use of special piping components that are manufactured for easy disassembly and reassembly. These piping system components were originally developed for use in the food processing industry, then found acceptance in the pharmaceutical industry, where U.S. Food and Drug Administration rules mandate frequent flushing and cleaning of piping systems.

These piping system components have now found widespread use in the semiconductor industry, which uses some very volatile flammable liquids and where even minute contamination of fluids cannot be tolerated. Therefore, frequent cleaning of piping systems is the norm and ease of breaking down components of the system is critical.

66.27.6 Installation of Piping Systems.

66.27.6.1 General Requirements. Piping systems shall be supported and protected against physical damage, including damage from stresses arising from settlement, vibration, expansion, or contraction. The installation of nonmetallic piping shall be in accordance with the manufacturer's instructions. [**30:**27.6.1]

66.27.6.2* Load-Bearing Supports. Load-bearing piping supports that are located in areas with a high fire exposure risk shall be protected by one or more of the following:

(1) Drainage to a safe location to prevent liquid from accumulating under pipeways
(2) Fire-resistive construction
(3) Fire-resistant protective coatings or systems
(4) Water spray systems designed and installed in accordance with NFPA 15
(5) Other alternate means acceptable to the AHJ

[**30:**27.6.2]

A.66.27.6.2 API 2218, *Fireproofing Practices in Petroleum and Petrochemical Processing Plants*, contains guidance on selecting and installing fire-resistant coatings to protect exposed steel supports from a high-challenge fire exposure. It also contains a general discussion on determining need for such protection and estimating the extent of the area exposed. [**30:**A.27.6.2]

In refineries, process plants, bulk plants and terminals, and other bulk storage facilities, it is common practice to install piping above ground or overhead on supports, thus leaving the piping and its supports exposed to fires. Failure of piping supports can lead to rapid and extensive spread of the original fire. Paragraph 66.27.6.2 addresses those concerns by requiring protection for load-bearing supports using one of four acceptable options, with the flexibility of allowing other equally effective means if approved by the AHJ.

66.27.6.3 Pipe Penetrations. Piping that passes through or pierces a dike wall or the wall of a structure shall be designed to prevent damaging stresses and leakage due to settlement or fire exposure. [**30:**27.6.3]

66.27.6.4* Corrosion Protection. Aboveground piping systems that are subject to external corrosion shall be suitably protected. Underground piping systems shall be protected against corrosion in accordance with 66.23.3.5. [**30:**27.6.4]

A.66.27.6.4 Buried steel piping should be coated with a suitable material and should be cathodically protected. Galvanized steel pipe, by itself and without other corrosion protection methods, is not acceptable for underground piping. Steel swing joints and stainless steel flexible connectors should also be made corrosion resistant when in contact with the soil. Thus, such fittings should also be coated and cathodically protected when installed between nonmetallic, compatible tanks and piping, such as fiberglass-reinforced plastic. [**30:**A.27.6.4]

The *Code* requires underground storage tanks to be protected from external corrosion. More important, the piping system and all its elements must be similarly protected. Most leaks that occur in underground storage tank systems originate in some part of the piping system.

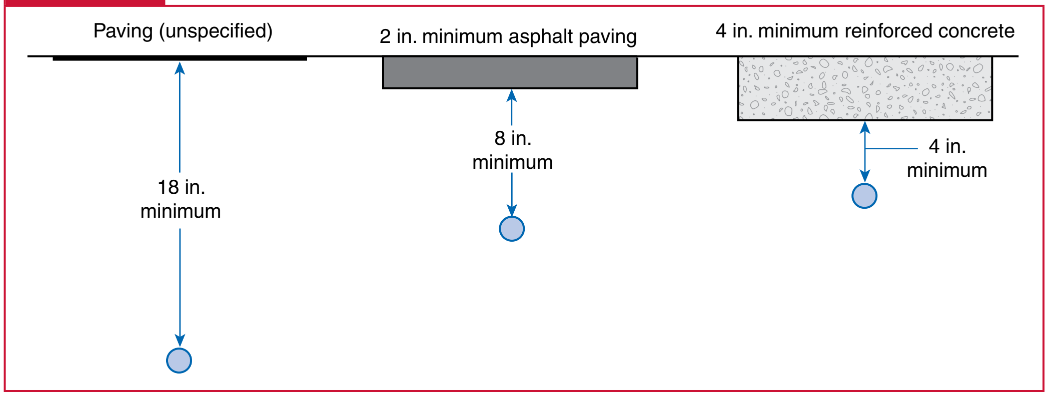
66.27.6.5 Installation of Underground Piping. Underground piping shall be installed in accordance with 27.6.5 of NFPA 30.

The requirements of 66.27.6.5 provide for proper installation procedures for underground (buried) piping, including depth of burial and lateral and vertical clearance between parallel runs of piping, and are based on long-accepted industry practices. The intent is to provide buried piping with firm support to resist movement that might result in leaking, broken joints, or undue stress on the pipe itself. See Exhibits 66.60 and 66.61 for illustrations of the intent of these provisions

66.27.6.6 Valves.

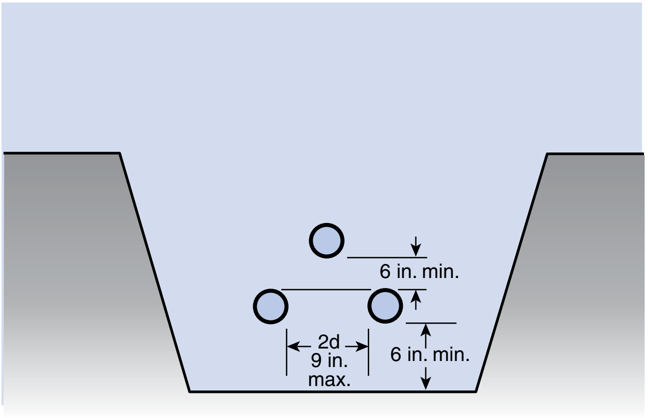
The number of valves actually needed to meet the requirements of 66.27.6.6 and their location in the piping system vary considerably from one installation to another because each piping system differs from another in some respect. No two systems are identical, and the design of each is dictated by operating considerations. Each piping system must, therefore, be evaluated on its own merits, based on good engineering practice. If

Exhibit 66.60



Burial depth for underground piping subject to loading from vehicular traffic.

Exhibit 66.61



Horizontal and vertical separation of underground parallel runs of piping.

consideration is given to general safety guidelines and to the potential results of failure, a determination of the number and placement of valves can be made. Check valves are required only if backflow is possible.

66.27.6.6.1 Piping systems shall contain valves to operate the system properly and to isolate the equipment in the event of an emergency. [**30:**27.6.6.1]

66.27.6.6.2 Piping systems in connection with pumps shall contain valves to properly control the flow of liquid both in normal operation and in the event of an emergency. [**30:**27.6.6.2]

66.27.6.6.3 Each connection to a piping system by which equipment such as tank cars, tank vehicles, or marine vessels discharges liquids into storage tanks shall be provided with a check valve for automatic protection against backflow if the piping arrangement is such that backflow from the system is possible. *(See also 66.22.13.1.)* [**30:**27.6.6.3]

66.27.6.7 Common Loading and Unloading Piping. If loading and unloading is done through a common pipe system, a check valve shall not be required. However, an isolation valve shall be provided. This valve shall be located so that it is accessible or shall be remotely operable. [**30:**27.6.7]

The use of check valves is not mandatory where the same piping system is used for both loading and unloading, but valves are required to isolate the piping system in an emergency so that the flow of liquid can be stopped, and the valves must be readily accessible to operating personnel or be remotely operable during the emergency.

66.27.7 Testing of Piping Systems.

Tests are not a guarantee that a piping system is or will remain leak free; they are one method to help ensure that the system will perform as desired under normal circumstances and predictable emergency situations. Three methods to help ensure performance are acceptable:

1. Meeting the requirements of ASME B31, *Code for Pressure Piping*
2. Hydrostatically testing to 150 percent of the maximum system design pressure
3. Pneumatically testing to 110 percent of the maximum system design pressure

In any case, tests must be conducted for at least 10 minutes or until a complete visual inspection of all joints and connections can be made. The reason for the percentage differences between the pneumatic and hydrostatic test limits is safety. A piping system that is overpressurized with water or other liquid contains much less potential energy than one that is overpressurized with air, nitrogen, or other gas, simply because water and similar fluids are noncompressible, whereas gases can be greatly compressed. In the event of failure, a piping system undergoing a hydrostatic test quickly depressurizes, minimizing the chance for a catastrophic rupture. A pneumatic failure, on the other hand, sometimes involves a violent rupture of the system being tested. As in the testing of tanks, the piping should be cleaned and purged of any flammable vapors, and flammable or combustible liquids should not be used as the test fluid.

Subsection 66.27.7 applies to all new piping systems and any piping system that has undergone major repair or replacement. Minor repairs — such as replacement of a gasket, repair of a valve packing gland, or tightening of flange bolts — would not require testing.

66.27.7.1 Initial Testing. Unless tested in accordance with the applicable sections of ASME B31, *Code for Pressure Piping*, all piping shall be tested before being covered, enclosed, or placed in use. [**30:**27.7.1]

66.27.7.1.1 Testing shall be done hydrostatically to 150 percent of the maximum anticipated pressure of the system or pneumatically to 110 percent of the maximum anticipated pressure of the system, and the test pressure shall be maintained while a complete visual inspection of all joints and connections is conducted. [**30:**27.7.1.1]

66.27.7.1.2 In no case shall the test pressure be less than a gauge pressure of 5 psi (35 kPa) measured at the highest point of the system, and in no case shall the test pressure be maintained for less than 10 minutes. [**30:**27.7.1.2]

66.27.7.2 Initial Testing of Secondary Containment Piping. The interstitial space of secondary containment–type piping shall be tested hydrostatically or with air pressure at a gauge pressure of 5 psi (35 kPa) or shall be tested in accordance with its listing or with the manufacturer's instructions. [**30:**27.7.2]

66.27.7.2.1 The pressure source shall be disconnected from the interstitial space to ensure that the test is being conducted on a closed system. [**30:**27.7.2.1]

66.27.7.2.2 The pressure shall be maintained for a minimum of 1 hour. [**30:**27.7.2.2]

66.27.7.3 Testing During Maintenance. Existing piping shall be tested in accordance with this subsection if the piping is leaking. [**30:**27.7.3]

66.27.7.3.1 Piping that could contain a Class I, Class II, or Class IIIA liquid or vapor shall not be tested using air. [**30:**27.7.3.1]

66.27.8 Vent Piping. Vent piping shall be designed, constructed, and installed in accordance with this section. [**30:**27.8]

66.27.8.1 Vent Piping for Aboveground Storage Tanks.

The provisions of 66.27.8.1 through 66.27.8.1.6 are intended to ensure that flammable vapors are discharged high enough above grade level and far enough away from openings into buildings that they dissipate before being able to accumulate where they might be ignited. Remember that these provisions apply only to fire and explosion hazards. The vent termination locations permitted here might not be suitable if the vapors are also toxic, irritating, or corrosive or have an objectionable odor.

The 5 ft (1.5 m) separation from building openings and the 12 ft (3.6 m) elevation above ground level are based on an engineering estimate of the distance from the end of a vent pipe that an ignitible concentration of vapors can exist. If the hazard extends 5 ft (1.5 m) down, its edge is 12 minus 5, or 7 ft (2 m), above grade, so that ignition is not considered a likely event by any action of a person on the ground.

The size of the hazardous volume can be estimated by taking the case of hexane, as described in the following example.

Example

Consider hexane, whose LFL is about 1.1 percent by volume. For simplicity, use 1 percent. A sphere of 5 ft (1.5 m) radius has a volume of 524 ft^3 (14.8 m^3). If the LFL is 1 percent, then, for a sphere of 5 ft radius to enclose an atmosphere at the LFL requires 5.24 ft^3 (0.15 m^3) of pure hexane vapor. At 60°F (15.6°C), hexane has a vapor pressure of 100 mm of mercury (13.3 kPa), so the vapors discharging from the vent would be 100/760, or 13 percent hexane — too rich to burn. These vapors would produce 5.236/0.13, or 40 ft^3 (1.13 m^3) of vapor, more than enough to fill the 5 ft (1.5 m) sphere with a mixture at the LFL. Assume that the vapor is discharged into air moving at 1 mph, or 88 ft/min (1609 m/sec). (At that speed, the leaves on trees do not move and smoke goes straight up.) The vapors would be diluted out of the hazardous range long before they filled a 5 ft (1.5 m) radius sphere. The conclusion is that the 5 ft (1.5 m) rule gives ample protection.

When vent piping is modified by the addition of items such as devices to absorb or adsorb unwanted components from the stream being vented, the devices should not unduly restrict the flow of vapors. Also, the piping should not be modified in such a way that liquid collecting in low points could either permit the tank to be overpressurized or start a siphoning action that could implode the tank.

66.27.8.1.1 Where the outlets of vent pipes for tanks storing Class I liquids are adjacent to buildings or public ways, they shall be located so that vapors are released at a safe point outside of buildings and not less than 12 ft (3.6 m) above the adjacent ground level. [**30:**27.8.1.1]

66.27.8.1.2 Vapors shall be discharged upward or horizontally away from adjacent walls. [**30:**27.8.1.2]

66.27.8.1.3 Vent outlets shall be located so that vapors will not be trapped by eaves or other obstructions and shall be at least 5 ft (1.5 m) from building openings and at least 15 ft (4.5 m) from powered ventilation air intake devices. [**30:**27.8.1.3]

66.27.8.1.4 Manifolding of vent piping shall be prohibited except where required for special purposes such as vapor recovery, vapor conservation, or air pollution control. [**30:**27.8.1.4]

From a fire safety standpoint, manifolding of vent piping is discouraged because it creates a potential explosion hazard. The entire vent system might, at some time, contain a vapor-air mixture within the flammable range and thus allow a direct path for flame to travel from the vapor space of one tank to that of others, if the vapors were to be ignited. Listed flame arresters that are designed to prevent flame propagation through piping must be installed within a specified distance from the open end of the pipe. The listing is based on ignition at the open end, where the pressure is initially atmospheric.

In the piping systems considered here, ignition occurring in one of the tanks can also propagate toward the open end. So-called flame-checks used in piping that feeds premixed air-gas mixtures to burners are usually of small diameter and can prevent propagation in only one direction. In a vent system, flame propagation can proceed in *both* directions, and so the flame arrester must be able to function bidirectionally.

66.27.8.1.4.1 Where vent piping is manifolded, pipe sizes shall be capable of discharging, within the pressure limitations of the system, the vapors they are required to handle when all manifolded tanks are subject to the same fire exposure. [**30:**27.8.1.4.1]

66.27.8.1.5 Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II or Class III liquids unless positive means are provided to prevent the following:

(1) Vapors of Class I liquids from entering tanks storing Class II or Class III liquids
(2) Contamination
(3) Possible change in classification of the less volatile liquid

[**30:**27.8.1.5]

66.27.8.1.6* Extension of Emergency Vent Piping. Piping to or from approved emergency vent devices for atmospheric and low-pressure tanks shall be sized to provide emergency vent flows that limit the back pressure to less than the maximum pressure permitted by the design of the tank. Piping to or from approved emergency vent devices for pressure vessels shall be sized in accordance with the ASME *Boiler and Pressure Vessel Code*. [**30:**27.8.1.6]

A.66.27.8.1.6 Vent sizing formulae and prescriptive vent sizes, such as those established by ANSI/UL 142, *Standard for Steel*

Aboveground Tanks for Flammable and Combustible Liquids, are typically based on the direct installation of a venting device onto a tank. When the outlet of a vent must be extended to a remote location, such as for tanks located in buildings, which require vent discharges, to be located outside, a significant reduction in vent flow can occur unless the size of the vent and connecting piping is increased. In such cases, the size of vents and vent pipe extensions should be calculated to ensure that a tank will not be overpressurized during a fire exposure. [**30:**A.27.8.1.6]

The text of A.66.27.8.1.6 is self-explanatory, but the increasing use of emergency generators powered by diesel engine prime movers has resulted in more instances in which tank vent piping is extended from a basement-level fuel storage tank up through all floors of the building to the roof. Providing the tank with automatic shutdown of delivery needs to be considered so that fuel is not inadvertently backed up into the vent line, which could subject the tank to a static pressure for which it might not be designed.

66.27.8.2 Vent Piping for Underground Tanks.

The treatment of vents for underground tanks differs slightly from that for aboveground tanks for several reasons:

- Buried tanks are of the horizontal cylindrical type (except on rare occasions).
- Buried tanks cannot be seen when being filled or emptied.
- The contents of buried tanks are never heated by the sun or severely chilled in cold weather.

66.27.8.2.1* Vent pipes from underground tanks storing Class I liquids shall be located so that the discharge point is outside of buildings, higher than the fill pipe opening, and not less than 12 ft (3.6 m) above the adjacent ground level. [**30:**27.8.2.1]

A.66.27.8.2.1 API RP 500, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2,* and API RP 505, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2,* establish a 10 ft (3 m) classified zone around most tank vents that are potential sources of ignitible vapors. However, neither document provides specific distances for a belowgrade tank. Applying these strategies to 66.27.8.2.1 resulted in a minimum height for these tank vents of 10 ft (3 m) above grade. Since the majority of these vents exist at retail service station tanks, and since vehicles and other publicly introduced ignition sources could be located close to the vent, an additional 2 ft (0.6 m) was added to the minimum height as a safety factor to ensure the vehicle does not introduce a potential ignition source into the vapor space surrounding the vent. This results in a total height for the vent stack from a belowgrade tank of 12 ft (3.6 m). [**30:**A.27.8.2.1]

66.27.8.2.2 Vent pipe outlets shall be located and directed so that vapors will not accumulate or travel to an unsafe location, enter building openings, or be trapped under eaves and shall be at least 5 ft (1.5 m) from building openings and at least 15 ft (4.5 m) from powered ventilation air intake devices. [**30:**27.8.2.2]

66.27.8.2.3 Vent pipes shall not be obstructed by devices provided for vapor recovery or other purposes unless the tank and associated piping and equipment are otherwise protected to limit backpressure development to less than the maximum working pressure of the tank and equipment by the provision of pressure-vacuum vents, rupture discs, or other tank-venting devices installed in the tank vent lines. [**30:**27.8.2.3]

66.27.8.2.4 Vent outlets and devices shall be protected to minimize the possibility of blockage from weather, dirt, or insect nests. [**30:**27.8.2.4]

66.27.8.2.5 Vent piping shall be sized in accordance with Table 66.23.6.2. [**30:**27.8.2.5]

66.27.8.2.6 Vent pipes from tanks storing Class II or Class IIIA liquids shall terminate outside of the building and higher than the fill pipe opening. [**30:**27.8.2.6]

By their omission from this paragraph, vents for Class IIIB liquids are allowed to terminate indoors. However, doing so is not considered safe for heated Class IIIB liquids.

66.27.8.2.7 Vent outlets shall be above normal snow level. [**30:**27.8.2.7]

66.27.8.2.8 Vent pipes shall be permitted to be fitted with return bends, coarse screens, or other devices to minimize ingress of foreign material. [**30:**27.8.2.8]

66.27.8.2.9 Vent pipes and vapor return piping shall be installed without sags or traps in which liquid can collect. [**30:**27.8.2.9]

66.27.8.2.10 Condensate tanks, if utilized, shall be installed and maintained so that blocking of the vapor return piping by liquid is prevented. [**30:**27.8.2.10]

66.27.8.2.11 Vent pipes and condensate tanks shall be located so that they will not be subjected to physical damage. The tank end of the vent pipe shall enter the tank through the top. [**30:**27.8.2.11]

66.27.8.2.12 Where tank vent piping is manifolded, pipe sizes shall be such as to discharge, within the pressure limitations of the system, the vapors they could be required to handle when manifolded tanks are filled simultaneously. [**30:**27.8.2.12]

66.27.8.2.12.1 Float-type check valves installed in tank openings connected to manifolded vent piping to prevent product contamination shall be permitted to be used, provided that the tank pressure will not exceed that permitted by 23.5.3.2 of NFPA 30 when the valves close. [**30:**27.8.2.12.1]

66.27.8.2.13 Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II or Class III liquids unless positive means are provided to prevent the following:

(1) Vapors of Class I liquids from entering tanks storing Class II or Class III liquids
(2) Contamination
(3) Possible change in classification of the less volatile liquid

[**30:**27.8.2.13]

66.27.9 Bonding and Grounding. Piping systems shall be bonded and grounded in accordance with 66.6.5.4. [**30:**27.9]

66.27.10* Identification and Marking of Piping Systems. Each loading and unloading riser shall be marked to identify the product for which it is to be used. [**30:**27.10]

A.66.27.10 Where loading and unloading risers for Class II or Class IIIA liquids are located in the same immediate area as loading and unloading risers for Class I liquids, consideration should be given to providing positive means, such as different pipe sizes, connection devices, special locks, or other methods designed to prevent the erroneous transfer of Class I liquids into or from any container or tank used for Class II or Class IIIA liquids. Note that such consideration might not be necessary for water-miscible liquids, where the class is determined by the concentration of liquid in water, or where the equipment is cleaned between transfers. [**30:**A.27.10]

66.27.11 Special Requirements for Marine Piping Systems.

66.27.11.1 Where piping is from a floating structure or pier, an approved flexible connector shall be permitted between the fixed shore piping and the piping on the floating structure or pier and between separate sections of the floating structure to accommodate changes in water level. [**30:**27.11.1]

Ensuring adequate flexibility of piping on and between floating structures is important. In such installations, failure of piping can release liquid that, if ignited, could result in a serious fire. The spread of burning liquid on water is likely to endanger all the wharf piping, since much of it is frequently installed beneath the wharf surface to provide clear space for handling of dry cargo. In addition, the wharf structure would not be able to withstand the effects of a prolonged fire in most instances.

66.27.11.2 The interior of the flexible connectors shall be compatible with the liquid handled. [**30:**27.11.2]

66.27.11.3 The exterior of the flexible connectors shall be resistant to or shielded from salt water and fresh water, ultraviolet radiation, physical damage, and damage by fire. [**30:**27.11.3]

66.27.11.4 The flexible connectors shall be suitable for the intended pressures and shall be tested in accordance with 66.27.7. [**30:**27.11.4]

66.27.12 Removal from Service of Piping Systems. Piping systems taken out of service or abandoned shall be temporarily or permanently closed in accordance with 66.27.12. [**30:**27.12]

66.27.12.1 Temporary Closure. (Reserved)

66.27.12.2 Permanent Closure in Place. (Reserved)

66.27.12.3 Permanent Removal. (Reserved)

66.28 Bulk Loading and Unloading Facilities for Tank Cars and Tank Vehicles

66.28.1 Scope. This section shall apply to operations involving the loading or unloading of tank cars and tank vehicles. [**30:**28.1]

66.28.2 Reserved.

66.28.3 General Requirements.

66.28.3.1 Bonding and Grounding and Stray Currents.

66.28.3.1.1 Bonding for the control of static electricity shall not be required where the following conditions exist:

(1) Where tank cars and tank vehicles are loaded exclusively with products that do not have static-accumulating properties, such as asphalts (including cutback asphalts), most crude oils, residual oils, and water-soluble liquids
(2) Where no Class I liquids are handled at the loading facility and where the tank cars and tank vehicles loaded are used exclusively for Class II and Class III liquids at temperatures below their flash points
(3) Where tank cars and tank vehicles are loaded or unloaded through closed connections

[**30:**28.3.1.1]

66.28.3.1.2* Loading and unloading facilities that are used to load liquids into tank vehicles through open domes shall be provided with a means for electrically bonding to protect against static electricity hazards. [**30:**28.3.1.2]

A.66.28.3.1.2 The use of nonconductive materials in the fill pipe assembly should be avoided to prevent any electrical discontinuity in the piping of the system. Serious accidents have occurred when nonconductive materials, such as plastic or rubber hose, have been used in the fill pipe assembly. [**30:**A.28.3.1.2]

Filling tank vehicles at high flow rates through open domes has always presented a risk of ignition by static discharge, and the requirement in 66.28.3.1.2 is an attempt to minimize the problem. Bonding the vehicle to the fill line ensures that it and the dome opening are at equal potential and minimizes the chance for static discharge between the two. Normally, either the vehicle or the fill line (or both) are grounded so that static charge can be bled off to earth. In practice, bonding should be required during all top-loading and top-unloading operations, because the operator usually has no knowledge about previous cargoes. For additional information, see NFPA 77 and API 2003.

The bonding methods specified are usually effective in preventing the buildup of a static charge. As noted in 66.28.3.1.1, liquids that inherently do not accumulate a charge do not require bonding. Understand, however, that bonding will not totally eliminate the problem inside the tank, because the charge residing on the surface of the liquid will not be bled off to the tank shell. (On rare occasions, nonconductive liquids might accumulate enough charge to lead to nonincendive corona discharge.) When the liquid being loaded has a low conductivity, charge generation is reduced by discharging the liquid close to the bottom of the tank.

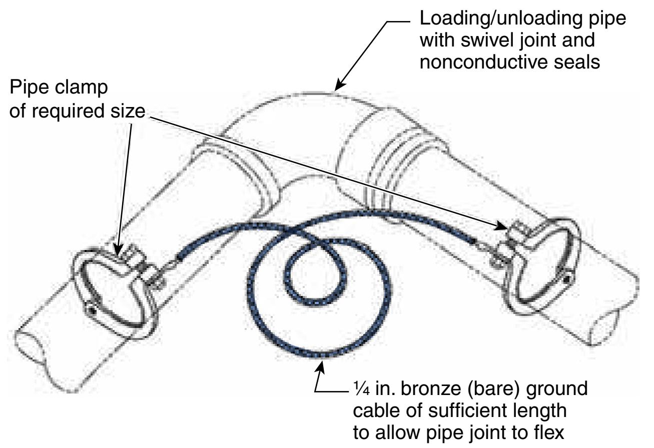
66.28.3.1.2.1 Such means shall consist of a metallic bond wire that is permanently electrically connected to the fill pipe assembly or to some part of the rack structure that is in electrical contact with the fill pipe assembly. [**30:**28.3.1.2.1]

66.28.3.1.2.2 The free end of this wire shall be provided with a clamp or an equivalent device for convenient attachment to some metallic part that is in electrical contact with the cargo tank of the tank vehicle. [**30:**28.3.1.2.2]

66.28.3.1.2.3 All parts of the fill pipe assembly, including, but not limited to, the drop tube, rack structure and piping, shall form a continuous electrically conductive path that is directed to ground through the rack assembly or by conductive wiring. [**30:**28.3.1.2.3]

Where gaskets and seals in movable parts of the loading/unloading system might interfere with the ground path, jumper wires might have to be installed to ensure continuity. See Exhibit 66.62 for an example of the use of bonding jumpers around seals.

Exhibit 66.62



Use of jumper wires to ensure continuity around a gasketed swivel joint. (Source: ACA, Generation and Control of Static Electricity)

66.28.3.1.3 Loading and unloading facilities that are used to transfer liquids into and from tank cars through open domes shall be protected against stray currents by permanently bonding the fill pipe to at least one rail and to the facility structure, if of metal. [**30:**28.3.1.3]

Stray currents can result where there is a major defect in an electrical installation in the area of the loading or unloading facility. If the defect can be identified, it should be corrected. Permanent rail-to-pipe rack bonding should always be provided. If stray currents cannot be controlled, the best practice is to electrically isolate the piping at the loading rack from its supply lines and bond that piping to the rail adjacent to the rack. Temporary bonding during loading and unloading operations is likely to be inadequate and should not be used.

Stray currents are not a problem with tank vehicles, because the rubber tires afford adequate insulation.

66.28.3.1.3.1 Multiple pipelines that enter the area shall be permanently bonded together. [**30:**28.3.1.3.1]

66.28.3.1.3.2 In areas where excessive stray currents are known to exist, all pipelines entering the area shall be provided with insulating sections to electrically isolate them from the facility piping.

*Exception: These precautions need not be required where only Class II or Class III liquids, at temperatures below their flash points, are handled and where there is no probability that tank cars will contain vapors from previous cargoes of Class I liquids. [**30:**28.3.1.3.2]*

66.28.4 Location of Loading and Unloading Facilities.

66.28.4.1 Tank vehicle and tank car loading and unloading facilities shall be separated from aboveground tanks, warehouses, other plant buildings, or the nearest line of adjoining property that can be built upon by a distance of at least 25 ft (7.6 m) for Class I liquids and for Class II and Class III liquids handled at temperatures at or above their flash points and at least 15 ft (4.6 m) for Class II and Class III liquids handled at temperatures below their flash points, measured from the nearest fill spout or transfer connection. [**30:**28.4.1]

66.28.4.2* These distances shall be permitted to be reduced if there is suitable protection for exposures. [**30:**28.4.2]

A.66.28.4.2 Use of fixed fire protection systems, dikes, fire-rated barriers, or a combination of any of these can provide suitable protection from exposures. [**30:**A.28.4.2]

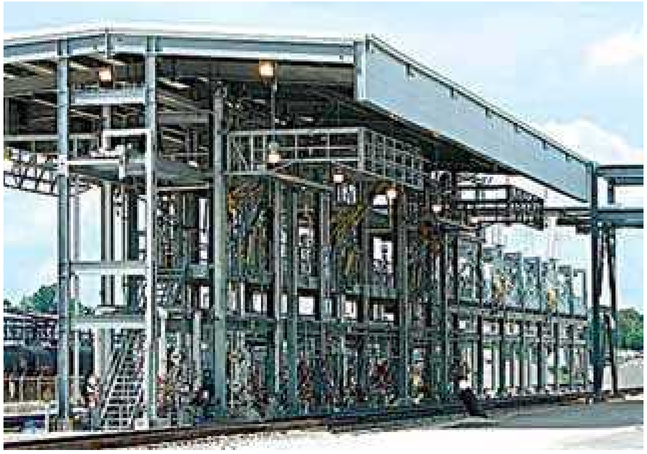
A loading/unloading station would be considered an "important building" or important structure within the context of NFPA 30. Therefore, the separation distances specified in 66.28.4.1 take precedence over those specified in Tables 66.22.4.1.3, 66.22.4.1.5, and 66.22.4.1.6 that relate to separation between a tank and the nearest important building, but only where the separation distances in those tables are less than what is required by 66.28.4.1. If the tables in Section 66.22 call for separation that exceeds those in 66.28.4.1, the greater distances apply. The reason for the separation specified by 66.28.4.1 is to increase the chance of controlling a fire originating at a tank vehicle before it spreads to nearby tanks or buildings. The specified distances reflect the fact that there is increased possibility of a spill, due to the making and breaking of connections between the fixed piping and the tank vehicles.

Paragraph 66.28.4.2 uses the term *protection for exposures*. Fixed fire protection as indicated here might meet the requirement of protection for exposures, provided that either the exposure protection systems are automatically activated or plant personnel are trained and available to put the systems into service. The AHJ can determine whether fixed fire protection justifies a reduced separation distance.

66.28.4.3 Buildings for pumps or shelters for personnel shall be permitted to be a part of the facility. [**30:**28.4.3]

66.28.5 Roofed Structures. A loading or unloading facility that has a canopy or roof that does not limit the dissipation of heat or dispersion of flammable vapors and does not restrict firefighting access and control shall be treated as an outdoor facility. [**30:**28.5]

Exhibit 66.63



Loading rack protected with a canopy. (Courtesy of Carbis, Inc.)

See Exhibit 66.63 for an example of a canopy at a loading facility.

66.28.6 Reserved.

66.28.7 Reserved.

66.28.8 Reserved.

66.28.9* Containment, Drainage, and Spill Control. Loading and unloading facilities shall be provided with drainage systems or other means to contain spills. [**30:**28.9]

A.66.28.9 The intent of this requirement is to prevent the spread of uncontrolled, spilled liquid from traveling beyond the loading or unloading area and exposing surrounding equipment and buildings. [**30:**A.28.9]

Exhibit 66.64 shows a rail tank car loading/unloading position being retrofitted with spill retention capability.

66.28.10 Equipment.

66.28.10.1 Equipment such as piping, pumps, and meters used for the transfer of Class I liquids between storage tanks and the fill stem of the loading facility shall not be used for the transfer of Class II or Class III liquids unless one of the following conditions exists:

(1) Only water-miscible liquid mixtures are handled, and the class of the mixture is determined by the concentration of liquid in water.
(2) The equipment is cleaned between transfers.

[**30:**28.10.1]

66.28.10.2 Remote pumps located in underground tanks shall have a listed leak detection device installed on the pump discharge side that will indicate if the piping system is not essentially liquid-tight. [**30:**28.10.2]

66.28.10.2.1 This device shall be checked and tested at least annually according to the manufacturer's specifications to ensure proper installation and operation. [**30:**28.10.2.1]

Exhibit 66.64

Rail tank car loading/unloading position being retrofitted with spill retention capability. (Courtesy of UltraTech International, Inc.)

66.28.11 Operating Requirements.

66.28.11.1 Loading and Unloading of Tank Vehicles.

66.28.11.1.1 Liquids shall be loaded only into cargo tanks whose material of construction is compatible with the chemical characteristics of the liquid. The liquid being loaded shall also be chemically compatible with the liquid hauled on the previous load unless the cargo tank has been cleaned. [**30:**28.11.1.1]

Two different hazards are addressed here. First, it is imperative that the liquid and the material of construction of the cargo tank itself or of the tank liner, if the cargo tank is lined, be mutually compatible to prevent damage to the cargo tank. Second, the presence of an incompatible residue in the cargo tank from a previous load means that an unwanted chemical reaction could develop between the residue and the new load. Such a reaction might involve the development of gases and might not become apparent until the cargo tank is closed, leading to possible overpressure damage.

66.28.11.1.2 Before loading tank vehicles through open domes, a bonding connection shall be made to the vehicle or tank before dome covers are raised and shall remain in place until filling is completed and all dome covers have been closed and secured, unless one of the conditions of 66.28.3.1 exists. [**30:**28.11.1.2]

See Exhibit 66.65 for a bonding connection being made to a tank vehicle.

66.28.11.1.3 When transferring Class I liquids, or Class II or Class III liquids at temperatures at or above their flash points, engines of tank vehicles or motors of auxiliary or portable pumps shall be shut down during the making and breaking of hose connections. [**30:**28.11.1.3]

Exhibit 66.65

Bonding cable attached to a tank vehicle prior to loading cargo. (Courtesy of Newson Gale Inc.)

Any engine represents a potential ignition source. Making and breaking hose connections usually results in the release of a small quantity of liquid or vapor. The intent here is to control the ignition source, given the inevitable presence of small liquid or vapor releases.

66.28.11.1.4 If loading or unloading is done without requiring the use of the motor of the tank vehicle, the motor shall be shut down throughout any transfer operations involving Class I liquids. [**30:**28.11.1.4]

66.28.11.1.5* Filling through open domes into tank vehicles that contain vapor–air mixtures within the flammable range or where the liquid being filled can form such a mixture shall be by means of a downspout that extends to within 6 in. (150 mm) of the bottom of the tank unless the liquid is not an accumulator of static electric charges. [**30:**28.11.1.5]

Δ **A.66.28.11.1.5** NFPA 77 provides additional information on static electricity protection. [**30:**A.28.11.1.5]

66.28.11.1.6 When top loading a tank vehicle with Class I or Class II liquids without a vapor control system, valves used for the final control of flow shall be of the self-closing type and shall be manually held open except where automatic means are provided for shutting off the flow when the vehicle is full. [**30:**28.11.1.6]

66.28.11.1.6.1 Automatic shutoff systems shall be provided with a manual shutoff valve located at a safe distance from the loading nozzle to stop the flow if the automatic system fails. [**30:**28.11.1.6.1]

66.28.11.1.6.2 When top loading a tank vehicle with vapor control, flow control shall be in accordance with 66.28.11.1.8 and 66.28.11.1.9. [**30:**28.11.1.6.2]

66.28.11.1.7 When bottom loading a tank vehicle, a positive means shall be provided for loading a predetermined quantity of liquid, together with a secondary automatic shutoff control to prevent overfill. [**30:**28.11.1.7]

66.28.11.1.7.1 The connecting components between the loading rack and the tank vehicle that are required to operate the secondary control shall be functionally compatible. [**30:**28.11.1.7.1]

66.28.11.1.7.2 The connection between the liquid loading hose or pipe and the tank vehicle piping shall be by means of a dry disconnect coupling. [**30:**28.11.1.7.2]

The requirements in 66.28.11.1.7 and its subparagraphs are intended to provide safeguards against overfilling of tank vehicles. When the practice of top loading prevailed and an operator was required to be on the top of the tank to observe the fill mark, a manually operated valve was an acceptable safeguard. With the advent of bottom-loading practices, it became unnecessary for the operator to be on the top of the tank, but other safeguards were required. The usual solution has been to employ a preset delivery meter that automatically stops the flow of liquid when a preset quantity has been delivered to the tank. Because this meter is not completely adequate, the additional requirement for a second automatic shutoff device (electrical or otherwise) to stop the flow of liquid when the tank is full has been deemed necessary. Such dual shutoff systems are considered adequate where vapor recovery is employed, so that it is unnecessary to open the top openings of the tank during filling.

The purpose of a dry disconnect coupling as required in 66.28.11.1.7.2 is to eliminate spills when the fill hose is disconnected from the vehicle.

66.28.11.1.8 When bottom loading a tank vehicle that is equipped for vapor control, but when vapor control is not used, the tank shall be vented to the atmosphere, at a height not lower than the top of the cargo tank of the vehicle, to prevent pressurization of the tank. [**30:**28.11.1.8]

The intent of this requirement is that vapor be released only where there is a reasonable chance for dissipation. Vapor return connections are frequently at about the same level as liquid connections. If vapor return is not being used, means must be provided to limit vapor release near ground level and to release the vapor at least as high as the top of the tank or to pipe the vapor to a safe remote location.

66.28.11.1.8.1 Connections to the facility's vapor control system shall be designed to prevent the escape of vapor to the atmosphere when the system is not connected to a tank vehicle. [**30:**28.11.1.8.1]

66.28.11.1.9 When bottom loading is used, reduced flow rates (until the fill opening is submerged), splash deflectors, or other devices shall be used to prevent splashing and to minimize turbulence. [**30:**28.11.1.9]

This requirement is intended to minimize the development of static electric charges that can be generated by splash filling. Such charges can reside in the bulk of the liquid or can be present in the liquid droplets in the vapor space.

66.28.11.1.10 Metal or conductive objects, such as gauge tapes, sample containers, and thermometers, shall not be lowered into or suspended in a compartment while the compartment is being filled or immediately after cessation of pumping, in order to permit the relaxation of charge. [**30:**28.11.1.10]

Any ungrounded conductive object that is lowered into the cargo tank will accumulate a static electric charge by inductance, if the charge in the liquid is not allowed to relax or to bleed off to ground. As the object is withdrawn from the cargo tank, the accumulated charge might discharge to ground via proximity to or contact with the dome — therefore, the requirement for the relaxation period exists. Even after the relaxation period, any conductive object lowered into the cargo tank should be bonded to the tank itself.

66.28.11.1.11 Hose materials used for transfer shall be compatible with the liquids being handled. [**30:**28.11.1.11]

66.28.11.2 Loading and Unloading of Tank Cars.

66.28.11.2.1 Liquids shall be loaded only into tank cars whose material of construction is compatible with the chemical characteristics of the liquid. The liquid being loaded shall also be chemically compatible with the liquid hauled on the previous load unless the tank car has been cleaned. [**30:**28.11.2.1]

66.28.11.2.2* Filling through open domes into tank cars that contain vapor–air mixtures within the flammable range, or where the liquid being filled can form such a mixture, shall be by means of a downspout that extends to within 6 in. (150 mm) of the bottom of the tank unless the liquid is not an accumulator of static electric charges. [**30:**28.11.2.2]

A.66.28.11.2.2 NFPA 77 provides additional information on static electricity protection. [**30:**A.28.11.2.2]

66.28.11.2.3 When bottom loading is used, reduced flow rates (until the fill opening is submerged), splash deflectors, or other devices shall be used to prevent splashing and to minimize turbulence. [**30:**28.11.2.3]

66.28.11.2.4 Metal or conductive objects, such as gauge tapes, sample containers, and thermometers, shall not be lowered into or suspended in a compartment while the compartment is being filled or immediately after cessation of pumping, in order to permit the relaxation of charge. [**30:**28.11.2.4]

66.28.11.2.5 Hose materials used for transfer shall be compatible with the liquids being handled. [**30:**28.11.2.5]

66.28.11.3* Switch Loading. To prevent hazards due to a change in flash point of liquids, any tank car or tank vehicle that has previously contained a Class I liquid shall not be loaded with a Class II or Class III liquid unless proper precautions are taken. [**30:**28.11.3]

Δ **A.66.28.11.3** The term *switch loading* describes a situation that warrants special consideration. [**30:**A.28.11.3]

When a tank is emptied of a cargo of Class I liquid, a mixture of vapor and air is left, which can be, and often is, within the flammable range. When such a tank is refilled with a Class I liquid, any charge that reaches the tank shell will be bled off by the required bond wire. Also, there will be no flammable mixture at the surface of the rising oil level because the Class I liquid produces at its surface a mixture too rich to be ignitible. This is the situation commonly existing in tank vehicles in gasoline service. If, as occasionally happens, a static charge does accumulate on the surface sufficient to produce a spark, it occurs in a too-rich, nonignitible atmosphere and thus causes no harm. [**30:**A.28.11.3]

A very different situation arises if the liquid is "switch loaded," that is, when a Class II or Class III liquid is loaded into a tank vehicle that previously contained a Class I liquid. [**30:**A.28.11.3]

Class II or Class III liquids are not necessarily more potent static generators than the Class I liquid previously loaded, but the atmosphere in contact with the rising oil surface is not enriched to bring it out of the flammable range. If circumstances are such that a spark should occur either across the oil surface or from the oil surface to some other object, the spark occurs in a mixture that can be within the flammable range, and an explosion can result. [**30:**A.28.11.3]

It is emphasized that bonding the tank to the fill stem is not sufficient; a majority of the recorded explosions have occurred when it was believed the tank had been adequately bonded. The electrostatic potential that is responsible for the spark exists inside the tank on the surface of the liquid and cannot be removed by bonding. Measures to reduce the chance of such internal static ignition can be one or more of the following:

(1) Avoid spark promoters. Conductive objects floating on the oil surface increase the charge of sparking to the tank wall. Metal gauge rods or other objects projecting into the vapor space can create a spark gap as the rising liquid level approaches the projection. A common precaution is to require that fill pipes (downspouts) reach as close to the bottom of the tank as practicable. Any operation such as sampling, taking oil temperature, or gauging that involves lowering a conductive object through an opening into the vapor space on the oil should be deferred until at least 1 minute after flow has ceased. This will permit any surface charge to relax.
(2) Reduce the static generation by one or more of the following:
    (a) Avoid splash filling and upward spraying of oil where bottom filling is used.
    (b) Employ reduced fill rates at the start of filling through downspouts, until the end of the spout is submerged. Some consider 3 ft/sec (0.9 m/sec) to be a suitable precaution.
    (c) Where filters are employed, provide relaxation time in the piping downstream from the filters. A relation time of 30 seconds is considered by some to be a suitable precaution.
(3) Eliminate the flammable mixture before switch loadings by gas freeing or inerting.

[**30:**A.28.11.3]

See NFPA 77 and NFPA 385 for further information. [**30:**A.28.11.3]

66.28.11.4 The person responsible for loading or unloading shall remain in attendance during the operation or be able to locally or remotely monitor and control the operation for the duration of the operation. [**30:**28.11.4]

Exception: A responsible person shall not be required where a hazards analysis shows that the loading or unloading operation can be safely shut down in an emergency. [30:28.11.4]

66.28.11.4.1* The responsible person shall be trained to recognize unsafe conditions and take appropriate actions. [**30:**28.11.4.1]

A.66.28.11.4.1 Emergency and safety procedures include, but are not limited to, the following:

(1) Procedures for bonding and grounding the tank vehicle
(2) Proper use of portable extinguishers
(3) Procedures for recognizing and eliminating sources of ignition
(4) Procedures for recognizing and understanding contingency plans for handling a spill or leak
(5) Procedures for notifying the appropriate agencies in an emergency

[**30:**A.28.11.4.1]

66.29 Wharves

66.29.1 Scope.

66.29.1.1 This section shall apply to all wharves, as defined in 3.3.288, whose primary purpose is the bulk transfer of liquids. [**30:**29.1.1]

Δ **66.29.1.2** This section shall not apply to the following:

(1) Marine service stations, as covered in Chapter 30 and NFPA 30A
(2) Marinas and boatyards, as covered in Chapter 28 and NFPA 303
(3) Wharves that handle liquefied petroleum gas, as covered in Chapter 69 and NFPA 58, *Liquefied Petroleum Gas Code*, or liquefied natural gas, as covered in NFPA 59A

[**30:**29.1.2]

66.29.2 Reserved.

66.29.3 General Requirements.

Δ **66.29.3.1** General-purpose wharves that handle bulk transfer of liquids and other commodities shall meet the requirements of Section 28.2 and NFPA 307. [**30:**29.3.1]

By "general-purpose wharves," the *Code* means wharves or piers that handle commodities other than flammable and combustible liquids, as opposed to those that handle liquids only.

66.29.3.2 Incidental handling of packaged cargo of liquids and loading or unloading of general cargo, such as ships' stores, during transfer of liquids shall be conducted only when approved by the wharf supervisor and the senior officer of the vessel. [**30:**29.3.2]

The handling of packaged cargo and stores during transfer of liquid cargo does not constitute an unreasonable risk, if the activity is confined to areas remote from the liquids loading connection. It is the joint responsibility of the ship's officers and the wharf representatives to prescribe times and places for such transfers to be safely carried out.

66.29.3.3 Wharves at which liquid cargoes are to be transferred in bulk to or from tank vessels shall be at least 100 ft (30 m) from any bridge over a navigable waterway or from any entrance to or superstructure of a vehicular or railroad tunnel under a waterway. [**30:**29.3.3]

This provision recognizes the possibility that a spill or other accident during the loading or unloading of liquid cargoes would represent a potentially severe threat to a bridge or the entrance to or superstructure of a tunnel. The exposure to fire of the structure of a tunnel beneath the waterway, although addressed, would be greatly reduced.

66.29.3.4 The termination of the loading or unloading fixed piping shall be at least 200 ft (60 m) from any bridge or from any entrance to or superstructure of a tunnel. [**30:**29.3.4]

66.29.3.5 The substructure and deck of the wharf shall be designed for the use intended. [**30:**29.3.5]

66.29.3.6 The deck of the wharf shall be permitted to be of any material that will afford the desired combination of flexibility, resistance to shock, durability, strength, and fire resistance. [**30:**29.3.6]

66.29.3.7 Heavy timber construction shall be permitted. [**30:**29.3.7]

66.29.3.8 Tanks used exclusively for ballast water or Class II or Class III liquids stored at temperatures below their flash points shall be permitted to be installed on a wharf designed to support the weight of the tank and its contents. [**30:**29.3.8]

The installation of tanks for Class II and Class III liquids stored at temperatures below their flash points is permitted on structurally sound wharves because of the reduced fire risk with these liquids. Ballast water tanks can be installed on the wharves for the same reason, although it is obvious that the problem of supporting large tanks will usually dictate that they be installed on shore.

66.29.3.9 Loading pumps capable of building up pressures that exceed the safe working pressure of cargo hose or loading arms shall be provided with bypasses, relief valves, or other arrangements to protect the loading facilities against excessive pressure. [**30:**29.3.9]

66.29.3.9.1 Relief devices shall be tested at least annually to determine that they function satisfactorily at their set pressure. [**30:**29.3.9.1]

66.29.3.10 All pressure hose and couplings shall be inspected at intervals recommended by the manufacturer for the service in which they are used. [**30:**29.3.10]

66.29.3.10.1 With the hose extended, the hose and couplings shall be tested using the in-service maximum operating pressure. [**30:**29.3.10.1]

66.29.3.10.2 Any hose showing material deterioration, signs of leakage, or weakness in its carcass or at the couplings shall be withdrawn from service and repaired or discarded. [**30:**29.3.10.2]

66.29.3.10.3 The hose materials used for transfer shall be compatible with the liquids being handled. [**30:**29.3.10.3]

66.29.3.11 Piping, valves, and fittings shall meet applicable requirements of Section 66.27 and shall also meet the following requirements:

(1) Flexibility of piping shall be assured by layout and arrangement of piping supports so that motion of the wharf structure resulting from wave action, currents, tides, or the mooring of vessels will not subject the piping to excessive strain.

Ensuring an appropriate degree of flexibility in piping systems on wharves is important because a wharf structure might be subject to movement from the impact of vessels during mooring and from the action of wind, waves, and tides. Failure of piping under those circumstances could release liquid that, if ignited, might result in a serious fire. The spread of burning liquid on water is likely to endanger all the piping, because much of the piping is frequently installed beneath the wharf surface to provide clear space for handling of dry cargo. In addition, the wharf structure will not be able to withstand the effects of a prolonged fire in most instances.

(2) Pipe joints that depend on the friction characteristics of combustible materials or on the grooving of pipe ends for mechanical continuity of piping shall not be permitted.
(3) Swivel joints shall be permitted to be used in piping to which hose are connected and for articulated swivel-joint transfer systems, provided the design is such that the mechanical strength of the joint will not be impaired if the packing materials should fail, for example, by exposure to fire.
(4) Each line conveying Class I or Class II liquids leading to a wharf shall be provided with a readily accessible block valve located on shore near the approach to the wharf and outside of any diked area. Where more than one line is involved, the valves shall be identified as to their specific lines and grouped in one location.

The intent here is that pipelines leading to the wharf be equipped with block valves located on shore, so they are accessible for operation even if fire results in burning liquid floating on the water, making it impossible to reach valves located on the wharf itself. In some places, it might be desirable to install additional block valves at points where a group of loading positions are served, as on a T-headed wharf.

(5) Means shall be provided for easy access to any cargo line valves that are located below the wharf deck.

[**30:**29.3.11]

The intent of this requirement is to make it easy to operate valves located below the wharf deck by means of trap doors or similar arrangements, while keeping the wharf surface unobstructed for the passage of motor vehicles. Such trap doors are usually conspicuously painted, and the parking of vehicles or staging of dry cargo over them is forbidden.

66.29.3.12 Pipelines on wharves that handle Class I or Class II liquids, or Class III liquids at temperatures at or above their flash points, shall be bonded and grounded. [**30:**29.3.12]

Wharf pipelines usually have screwed or welded flange connections and are thus electrically continuous, eliminating the need for any special bonding. However, if for any reason nonconductive connections are installed, a survey should be made to determine the desirability of placing electrical bonds around them.

66.29.3.12.1 Insulating flanges or joints shall be installed for protection against stray currents. [**30:**29.3.12.1]

Insulating connections for cargo hose are intended to isolate the vessel from possible stray currents originating on shore. Therefore, bonds around them are obviously undesirable. If the presence of continuous or intermittent stray currents in shore piping is revealed by test, all wharf piping should be electrically isolated from the shore piping with insulating connections.

66.29.3.12.2 Bonding and grounding connections on all pipelines shall be located on the wharf side of insulating flanges, if used, and shall be accessible for inspection. [**30:**29.3.12.2]

66.29.3.12.3 Bonding between the wharf and the vessel shall not be required. [**30:**29.3.12.3]

66.29.3.13 Hose or articulated swivel-joint pipe connections used for cargo transfer shall be capable of accommodating the combined effects of change in draft and change in tide. Hose shall be supported to avoid kinking and damage from chafing. [**30:**29.3.13]

66.29.3.14 Mooring lines shall be kept adjusted to prevent surge of the vessel from placing stress on the cargo transfer system. [**30:**29.3.14]

66.29.3.15 Material shall not be placed on wharves in such a manner as to obstruct access to fire-fighting equipment or important pipeline control valves. [**30:**29.3.15]

66.29.3.16 Where the wharf is accessible to vehicle traffic, an unobstructed roadway to the shore end of the wharf shall be maintained for access of fire-fighting apparatus. [**30:**29.3.16]

66.29.3.17 Loading or unloading shall not commence until the wharf supervisor and the person in charge of the tank vessel agree that the tank vessel is properly moored and all connections are properly made. [**30:**29.3.17]

66.29.3.18 Mechanical work shall not be performed on the wharf during cargo transfer, except under special authorization based on a review of the area involved, methods to be employed, and precautions necessary. [**30:**29.3.18]

66.29.3.19 Sources of ignition shall be controlled during transfer of liquids. [**30:**29.3.19]

66.29.3.20 Vehicular traffic and mechanical work including, but not limited to, welding, grinding, and other hot work, shall not be performed during cargo transfer except as authorized by the wharf supervisor and the senior officer on the vessel. [**30:**29.3.20]

66.29.3.21 Smoking shall be prohibited at all times on the wharf during cargo transfer operations. [**30:**29.3.21]

66.29.3.22 For marine terminals handling flammable liquids and combustible liquids at temperatures at or above their flash points, Figure 66.29.3.22 shall be used to determine the extent of classified areas for the purpose of installation of electrical equipment. [**30:**29.3.22]

66.29.3.23 Where a flammable atmosphere can exist in the vessel cargo compartment, cargo transfer systems shall be designed to limit the velocity of the incoming liquid stream to 3 ft (0.9 m) per second until the compartment inlet opening is sufficiently submerged to prevent splashing. [**30:**29.3.23]

66.29.3.24 Filters, pumps, wire screens, and other devices that can produce static electric charges through turbulence shall be so located to allow a minimum of 30 seconds of relaxation time prior to discharging cargo into the compartment. [**30:**29.3.24]

66.29.3.25* Spill collection shall be provided around manifold areas to prevent spread of liquids to other areas of the wharf or under the wharf. [**30:**29.3.25]

A.66.29.3.25 Where practical, the collection basin should be drained to a remote location. [**30:**A.29.3.25]

66.29.3.26 Vapor seals shall be provided on all drain lines leaving the wharf. [**30:**29.3.26]

66.29.3.27 Where required, wharves shall have a system to isolate and shut down the loading operation in the event of failure of a hose, loading arm, or manifold valve. This system shall meet all of the following requirements:

(1) If the protective system closes a valve on a gravity-fed or pipeline-fed loading system, it shall be designed to ensure the line is not subjected to damage from pressure surges.
(2) Emergency shutdown systems shall be permitted to be automatically or manually activated.

[**30:**29.3.27]

66.29.3.27.1 Manually activated device(s) shall be identified and accessible during an emergency. [**30:**29.3.27.1]

66.29.3.28* Fire protection and emergency response equipment for wharves shall be related to the products being handled, emergency response capability, size, location, frequency of use, and adjacent exposures. [**30:**29.3.28]

A.66.29.3.28 Because of the many variables involved, exact requirements cannot be provided. However, Table A.66.29.3.28 provides guidance on the level of fire protection typically provided at wharves and marine terminals handling flammable liquids. [**30:**A.29.3.28]

66.29.3.28.1 Where a fire water main is provided, the main shall be permitted to be wet or dry. In all cases, isolation valves and fire department connections shall be provided at the wharf-to-shore connection. [**30:**29.3.28.1]

66.29.3.28.2 Where a fire water main is provided, hydrants and monitors shall also be provided so that effective fire water streams

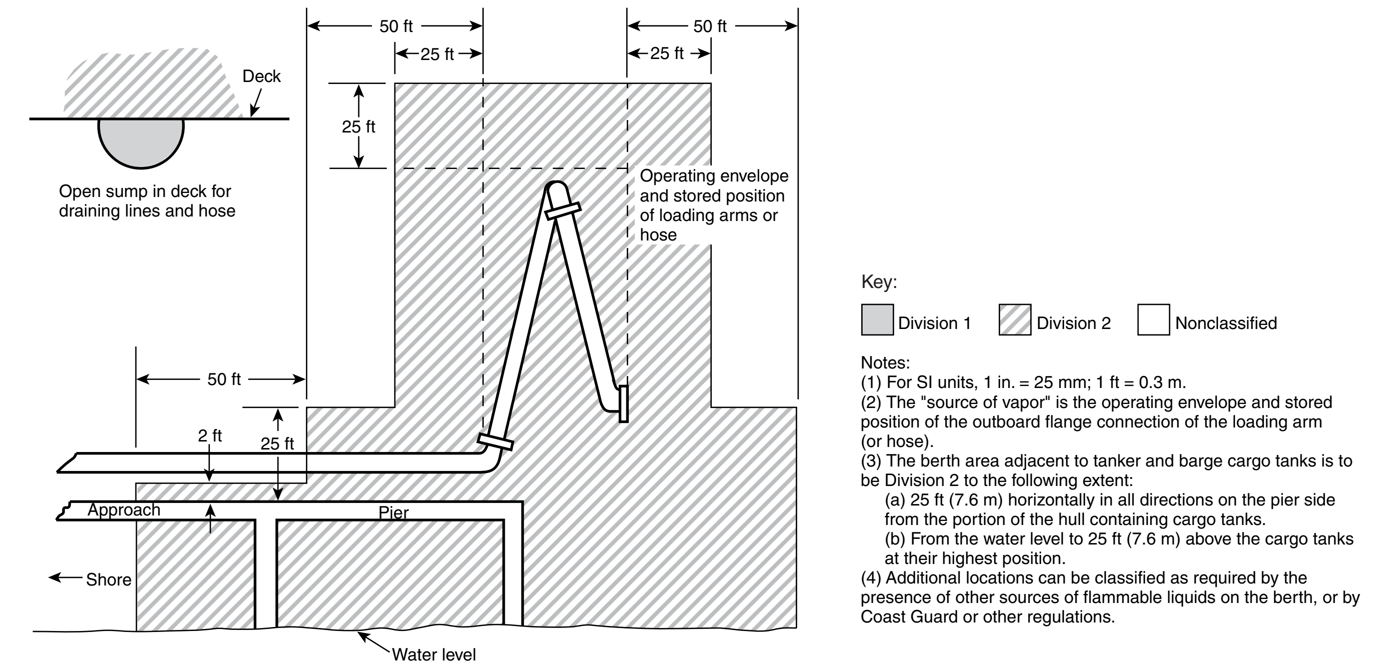


FIGURE 66.29.3.22 *Area Classification for a Marine Terminal Handling Flammable Liquids. [**30:** Figure 29.3.22]*

Δ *TABLE A.66.29.3.28 Typical Fire Protection for Wharves and Marine Terminals*

Locations	Water Demand (gpm)	Hydrant Monitors[a] (gpm)	Hose Reels	Fire Extinguisher Dry Chemical 120-B:C	Fire Extinguisher Dry Chemical 240-B:C Wheeled	International Shore Connection	Emergency Equipment Lockers	Monitors and Hose Foam Concentrate Required (gal)	Fire Boat Connection
Barge terminals	500–1000	Two 500	Two 1¼	2	NR	NR	1	100[b]	NR
Tankers 20,000 DWT and under	1000–2000	Two 500	Two 1¼	2	1	1	1	300[b]	2
20,001–70,000 DWT	2000	Two 1000	Four 1¼[c]	2	2[d]	2	1	2000	2
70,001 DWT and over	2000[e]	Two 1000	Four 1¼[c]	3	2[d]	2	1	2000[f]	2
Sea islands	2000–4000[e]	Three 1000	Four 1¼[c]	4	2	3	2	3000	2

For SI units, 1 gpm = 3.8 L/min; 1 gal = 3.8 L; 1 lb = 0.45 kg.

NR: Not required.

[a]A minimum of two 1½ in. (38 mm) hydrant outlets should be provided at each monitor riser.

[b]This can be provided by onshore mobile equipment.

[c]One hose reel at each berth should have foam capability.

[d]The proximity of adjacent berths can reduce total required.

[e]Under-dock systems are optional. Add water for under-dock system (0.16 × area).

[f]Under-dock systems are optional. Add foam for under-dock system (0.16 × 0.3 × 30 × area). [**30:** Table A.29.3.28]

can be applied to any berth or loading manifold from two directions. [**30:**29.3.28.2]

Δ **66.29.3.28.3** Fire water pumps, fire hose, fire water mains, foam systems, and other fire suppression equipment shall be maintained and tested in accordance with NFPA 25. [**30:**29.3.28.3]

66.29.3.28.4 Where no fire water main is provided, at least two 150 lb (68 kg) dry chemical extinguishers shall be provided. The extinguishers shall be located within 50 ft (15 m) of pump or manifold areas and shall be easily reached along emergency access paths. [**30:**29.3.28.4]

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NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*, 2015 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 2016 edition.

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Flammable Solids

67

Flammable solid is defined in 3.3.248.2 as a solid substance, other than a substance defined as a blasting agent or explosive, that is liable to cause fire resulting from friction or retained heat from manufacture, that has an ignition temperature below 212°F (100°C), or that burns so vigorously or persistently when ignited that it creates a serious hazard. For requirements pertaining to the storage, use, and handling of flammable solids, users are directed to Chapter 60 on hazardous materials. Chapter 60 also contains provisions that must be followed when the storage, use, or handling of a hazardous material exceeds the maximum allowable quantity (MAQ) per control area as set forth in that chapter.

In addition to complying with Chapter 60, flammable solids exceeding the MAQ must also comply with any additional provisions set forth in NFPA 400, *Hazardous Materials Code.* The first edition of NFPA 400 was published in 2010, and the 2016 edition of the document is referenced throughout this edition of the *Code*. NFPA 400 combined NFPA hazardous materials documents into a single code. Rather than repeating the provisions, many of the chapters of this *Code* related to hazardous materials now reference NFPA 400.

67.1 General

67.1.1 The storage, use, and handling of flammable solids shall comply with the requirements of Chapter 60.

Δ **67.1.2** The storage, use, and handling of flammable solids in amounts exceeding the maximum allowable quantity permitted in control areas as set forth in Chapter 60 shall also comply with the requirements of NFPA 400.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 400, *Hazardous Materials Code,* 2016 edition.

68 Highly Toxic and Toxic Solids and Liquids

Toxic material is defined in 3.3.180.14 as a material that produces a lethal dose or lethal concentration that falls within any of the following categories:

1. A chemical or substance that has a median lethal does (LD_{50}) of more than 50 mg/kg but not more than 500 mg/kg of body weight when administered orally to albino rats weighing between 200 g and 300 g each
2. A chemical or substance that has a median lethal dose (LD_{50}) of more than 200 mg/kg but not more than 1000 mg/kg of body weight when administered by continuous contact for 24 hours, or less if death occurs within 24 hours, with the bare skin of albino rabbits weighing between 2 kg and 3 kg each
3. A chemical or substance that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2000 parts per million by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L of mist, fume, or dust, when administered by continuous inhalation for 1 hour, or less if death occurs within 1 hour, to albino rats weighing between 200 g and 300 g each

A highly toxic material is defined in 3.3.180.7 as a material that produces a lethal dose or lethal concentration that falls within any of the following categories:

1. A chemical that has a median lethal dose (LD_{50}) of 50 mg/kg or less of body weight when administered orally to albino rats weighing between 200 g and 300 g each
2. A chemical that has a median lethal dose (LD_{50}) of 200 mg/kg or less of body weight when administered by continuous contact for 24 hours, or less if death occurs within 24 hours, with the bare skin of albino rabbits weighing between 2 kg and 3 kg each or albino rats weighing 200 g to 300 g each
3. A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 mg/L or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour, or less if death occurs within 1 hour, to albino rats weighing between 200 g and 300 g each

For requirements pertaining to the storage, use, and handling of highly toxic solids and liquids, users are directed to Chapter 60 on hazardous materials. Chapter 60 also contains provisions that must be followed when the storage, use, or handling of a hazardous material exceeds the maximum allowable quantity (MAQ) per control area as set forth in that chapter.

In addition to complying with Chapter 60, highly toxic solids and liquids exceeding the MAQ must also comply with any additional provisions set forth in NFPA 400, *Hazardous Materials Code*. The first edition of NFPA 400 was published in 2010, and the 2016 edition of the document is referenced throughout this edition the *Code*. NFPA 400 combined NFPA hazardous materials documents into a single code. Rather than repeating the provisions, many of the chapters of this *Code* related to hazardous materials now reference NFPA 400.

68.1 General

68.1.1 The storage, use, and handling of highly toxic and toxic solids and liquids shall comply with Chapter 60.

Δ **68.1.2** The storage, use, and handling of highly toxic and toxic solids and liquids in amounts exceeding the maximum allowable quantity permitted in control areas as set forth in Chapter 60 shall also comply with the requirements of NFPA 400.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 400, *Hazardous Materials Code,* 2016 edition.

Liquefied Petroleum Gases and Liquefied Natural Gases

69

Chapter 69 is based on text extracted from the 2017 edition of NFPA 58, *Liquefied Petroleum Gas Code*. NFPA 58 applies to the storage, handling, transportation, and use of liquefied petroleum gas (LP-Gas). NFPA 58 addresses virtually every aspect of LP-Gas distribution and use, but it does not cover the production of the gas itself.

69.1 General Provisions

69.1.1* Application.

A.69.1.1 See A.1.3.2.

Δ **69.1.1.1** The storage, use, and handling of liquefied petroleum gases (LP-Gas) shall comply with the requirements of this chapter; NFPA 58 and Sections 60.1 through 60.4 of this *Code*.

69.1.1.2 Where the provisions of Chapter 69 or NFPA 58 conflict with the provisions of Chapter 60, the provisions of this chapter and NFPA 58 shall apply.

69.1.1.3 Stationary Installations. Plans for stationary installations utilizing storage containers with aggregate water capacity exceeding 4000 gal (15.2 m^3), and all rooftop installations of ASME containers shall be submitted to the AHJ before the installation is started by the person or company that either installs or contracts to have the containers installed. *[See also 6.22.11.1(F) of NFPA 58.]* [**58:**4.3.1]

Plans should be submitted to the authority having jurisdiction (AHJ), which is usually a fire department or state fire marshal. In the absence of specific requirements from the AHJ, plans should include a site plan showing key distances and references to the *Code*, along with information regarding key equipment (e.g., container specifications, investigation of reused equipment). Subsection 6.29.3 of NFPA 58 requires a written fire safety analysis to be submitted for installations that have an aggregate water capacity of more than 4000 gal (15.2 m^3) subject to exposure from a single fire in heavily populated or congested areas. (See Supplement 1 of *NFPA 58: LP-Gas Code Handbook*, "Guidelines for Conducting a Fire Safety Analysis," and the *Fire Safety Analysis Manual for LP-Gas Storage Facilities* for more information.)

Note that 69.1.1.3 requires only that plans be submitted to, but not necessarily approved by, the AHJ. There are many differences in how the AHJ's office is organized in each state or locality, and it was decided that approval from the AHJ would not be a code requirement because of the difficulty some propane companies have experienced in receiving acknowledgment from the AHJ that plans were even received. It is left up to each state or locality to determine how to implement the requirements of this paragraph.

Because they are relatively simple and standard installation procedures are used, installations smaller than 4000 gal (15.2 m^3) do not require that plans be submitted. Smaller installations include most one- and two-family homes and typical smaller commercial services that use U.S. Department of Transportation (DOT) cylinders and/or ASME 500 gal (1.9 m^3) or 1000 gal (3.8 m^3) capacity containers. Some authorities, however, require approval of these small installations in heavily populated or congested areas. In such instances, the authorities will either amend 69.1.1.3 or adopt specific wording in the document that requires approval.

Some local authorities need to know of small tank installations for specific reasons. One reason that some localities require notification about or even permits for these small tanks is to verify that tanks installed in flood-prone areas are properly anchored to prevent flotation in accordance with 69.3.8.1.6. Some coastal communities inspect tanks for nothing other than proper anchoring in areas they consider to be flood prone.

69.1.2 Permits. Permits, where required, shall comply with Section 1.12.

Table 1.12.8(a) enables the AHJ to issue a permit for the storage, use, handling, or dispensing of LP-Gas in excess of 125 gal (0.5 m^3) water capacity; for an amount shown in Table 1.12.8(b); or for the installation or modification of LP-Gas systems.

69.2 LP-Gas Equipment and Appliances

Section 69.2 provides design, manufacture, marking, and performance requirements for individual LP-Gas components or complete systems, with the exception of the following:

1. Cargo tank vehicles (See Chapter 9 of NFPA 58.)
2. Engine fuel systems (excluding over-the-road vehicles) (See Chapter 11 of NFPA 58.)
3. Engine fuel systems for over-the-road vehicles (See Chapter 12 of NFPA 58.)

The sections in Chapter 5 of NFPA 58 include detailed information and requirements on the following topics:

- Containers, including cylinders and ASME containers
- Container appurtenances, including pressure relief devices, regulators, pressure regulators, overfilling prevention devices (OPDs), container connections, and various gauges
- Regulators and regulator vents
- Piping, including hose; fittings; and valves
- Valves other than container valves
- Hydrostatic relief valves
- Equipment, including pumps, compressors, meters, engines, and sight flow indicators
- Appliances
- Vaporizers, tank heaters, vaporizing burners, and gas-air mixers
- Vehicle fuel dispensers

69.2.1 Containers.

69.2.1.1 General.

69.2.1.1.1* Containers shall be designed, fabricated, tested, and marked (or stamped) in accordance with the regulations of the U.S. Department of Transportation (DOT 49 CFR); Federal Aviation Administration (FAA 14 CFR) the ASME *Boiler and Pressure Vessel Code*, Section VIII, "Rules for the Construction of Unfired Pressure Vessels"; or the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*, except for UG-125 through UG-136. [**58:**5.2.1.1]

The DOT has approved the use of composite cylinders only if they are fabricated under a DOT special permit. Composite cylinders have a 15-year service life and must be requalified every 5 years. These cylinders can be used for all applications not prohibited by NFPA 58, such as outdoor gas grills, industrial trucks, and other applications not located in buildings.

The Federal Aviation Administration (FAA) has been added to the list of construction regulations, coinciding with the changes in the scope of NFPA 58, to cover the use of containers in hot air balloons. The FAA has several regulations, referred to as airworthiness directives (AD), regarding the construction and appurtenance requirements of such containers.

A.69.2.1.1.1 Prior to April 1, 1967, regulations of the U.S. Department of Transportation were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply and are available from the Canadian Transport Commission, Union Station, Ottawa, Canada. [**58:**A.5.2.1.1]

Construction of containers to the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases* has not been authorized after July 1, 1961. [**58:**A.5.2.1.1]

The requirements for the construction of pressure vessels used to store LP-Gases are referenced in A.69.2.1.1.1 (requirements for nonpressurized refrigerated containers are located in Chapter 12 of NFPA 58). The referenced codes provide a level of safety such that the development of independent requirements in NFPA 58 for the construction of pressure vessels for LP-Gas is not necessary. In referencing the ASME *Boiler and Pressure Vessel Code*, the Technical Committee has made an exception to sections UG-125 through UG-136, which cover pressure relief devices. The requirements for pressure relief devices in the ASME *Boiler and Pressure Vessel Code* differ from those in UL 132, *Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, which require larger pressure relief valves.

Pressurized LP-Gas containers in the United States, Canada, and other countries served by marketers based in the United States and Canada comply with 69.2.1.1.1. Many other countries that use NFPA 58 have their own container requirements. In the event that a container constructed to a different standard is to be filled in a jurisdiction that enforces NFPA 58, approval to fill that container must be obtained from the AHJ. For cylinders, the AHJ is the DOT. Given the relatively low cost of cylinders, it is easier to purchase a new cylinder than to petition the DOT for a variance. Cylinders manufactured to other than DOT specifications can be used in the United States but cannot be refilled.

The treatment of cylinders built to non-U.S. specifications is addressed in the preceding paragraphs. Because most states adopt and enforce the ASME *Boiler and Pressure Vessel Code*, the state boiler agency must be contacted. For example, when packaged propane equipment is imported with propane tanks, the AHJ should be contacted to determine how to proceed.

Intermodal containers, as shown in Exhibit 69.1, are shipping containers larger than cylinders that are mounted within a frame for shipment on railcars, trucks, and ships. The containers are similar to dry shipping containers. The United Nations (UN) accepts intermodal containers for international shipping. These containers must meet DOT specifications and ASME Code requirements. LP-Gas is shipped via intermodal containers to islands and inland areas that are accessible only by rivers or other bodies of water.

69.2.1.1.1.1 Used containers constructed to specifications of the Association of American Railroads shall not be installed. [**58:**5.2.1.1(A)]

Railcar tanks are not constructed to the ASME *Boiler and Pressure Vessel Code*; rather, they are constructed to the *Manual of Standards and Recommended Practices*, published by the Association

Exhibit 69.1

Intermodal container. (Courtesy of Permagas)

of American Railroads (AAR). The AAR code is concerned with the forces that a tank car will experience over its lifespan. Tank cars must be removed from service at the end of their prescribed 40-year service life.

69.2.1.1.1.2 Adherence to applicable ASME Code case interpretations and addenda that have been adopted and published by ASME 180 calendar days prior to the effective date of NFPA 58 shall be considered as compliant with the ASME Code. [**58:**5.2.1.1(B)]

69.2.1.1.1.3 Where containers fabricated to earlier editions of regulations, rules, or codes listed in 69.2.1.1.1, and of the Interstate Commerce Commission (ICC) *Rules for Construction of Unfired Pressure Vessels*, prior to April 1, 1967, are used, the requirements of Section 1.4 of NFPA 58 shall apply. [**58:**5.2.1.1(C)]

The intent and application of 69.2.1.1.1.3 is often misinterpreted with regard to containers that were built to the API-ASME code *Unfired Pressure Vessels for Petroleum Liquids and Gases* (specifications U-200 and U-201) and pre-1949 editions of the ASME *Boiler and Pressure Vessel Code* (specifications U-68 and U-69). Because these ASME containers have a very long service life when properly maintained, many remain in use and are sometimes relocated and reinstalled. However, not all containers built to the older editions of the ASME *Boiler and Pressure Vessel Code* can remain in use or be relocated and reinstalled, regardless of their condition. According to 69.4.2.2, a container must be found suitable for continued use before it is filled. In Section 1.4 of NFPA 58, the AHJ has the authority to make any code requirement retroactive where a "distinct hazard to life and property" exists. The reinstallation of containers built to older editions of the code must be reviewed by the AHJ to determine if any current requirements meet the threshold for retroactivity.

69.2.1.1.2 Containers that have been involved in a fire and show no distortion shall be requalified for continued service before being used or reinstalled. [**58:**5.2.1.2]

69.2.1.1.2.1 Cylinders shall be requalified by a manufacturer of that type of cylinder or by a repair facility approved by DOT. [**58:**5.2.1.2(A)]

If a cylinder has been subjected to fire, the shell — which is usually steel, aluminum, or fiberglass — can be weakened, and the cylinder must be requalified by a properly qualified repair facility authorized by the U.S. DOT or by Transport Canada. Paragraph 69.2.1.1.2.1, however, imposes additional restrictions for aluminum and composite cylinders exposed to fire.

69.2.1.1.2.2 ASME or API-ASME containers shall be retested using the hydrostatic test procedure applicable at the time of the original fabrication. [**58:**5.2.1.2(B)]

When an ASME container has been subjected to fire, it must be retested using the hydrostatic test procedure applicable at the time the container was originally made. The testing is required because the heat of the fire can alter the properties of the steel and reduce its ability to contain pressure. Based on equivalency, the AHJ can consider other nondestructive test methods as alternatives to the hydrostatic test. The following methods are listed in the ASME *Boiler and Pressure Vessel Code* and may be useful for finding flaws in a container that would prevent it from being placed back into service after a fire:

- Radiography
- Ultrasonic
- Magnetic particle
- Liquid penetrants
- Visual inspection
- Leak testing
- Electromagnetic testing
- Acoustic emission

It is important to remember that the ASME *Boiler and Pressure Vessel Code* is a construction code, not a maintenance or an inspection code, and other codes (e.g., 49 CFR, "Transportation"; *National Board Inspection Code* (NBIC); or NFPA 58) may allow or require hydrostatic pressure testing as a nondestructive test when needed. While a hydrostatic pressure test is considered nondestructive, it can result in damage to the pressure vessel if a significant flaw is detected. The person performing such tests must be familiar with both the code requirements used to construct the container and the test methods used to test the container.

69.2.1.1.2.3 All container appurtenances shall be replaced. [**58:**5.2.1.2(C)]

69.2.1.1.2.4 DOT 4E specification (aluminum) cylinders and composite cylinders involved in a fire shall be permanently removed from service. [**58:**5.2.1.2(D)]

DOT 4E aluminum cylinders must not be returned to service after a fire because exposure to even moderately high temperatures can affect the structural properties of aluminum and severely decrease its tensile strength. Composite cylinders exposed to fire can also be weakened, and the manufacturer should be consulted for guidance.

69.2.1.1.3 ASME paragraph U-68 or U-69 containers shall be permitted to be continued in use, installed, reinstalled, or placed back into service. Installation of containers shall be in accordance with all provisions listed in NFPA 58. *(See Section 5.2, Table 5.4.4.2, Table 5.9.2.5(A), and Annex D of NFPA 58.)* [**58:**5.2.1.3]

The requirement in 69.2.1.1.3 specifically states that ASME paragraph U-68 or U-69 containers can be continued in service and reinstalled.

69.2.1.1.4 Containers that show excessive denting, bulging, gouging, or corrosion shall be removed from service. [**58:**5.2.1.4]

All containers that show excessive dents, bulges, gouges, or corrosion must be removed from service because such defects can reduce the pressure capability of the container. Once removed from service, the container can be scrapped or repaired using methods that are in accordance with the code of manufacture.

69.2.1.1.5 Except for containers used in cargo tank vehicle service, ASME containers of 3000 gal (11.4 m^3) water capacity or less used to store anhydrous ammonia shall not be converted to LP-Gas fuel service. [**58:**5.2.1.5]

Paragraph 69.2.1.1.5 addresses problems that have occurred with portable pressure vessels of 3000 gal (11.4 m^3) or less that are mounted on wheels and used at farms for both propane and ammonia at different times. These containers are sometimes called "nurse tanks." Three fatal accidents were reported involving propane tanks that had formerly been in ammonia service. Larger containers are also used for both ammonia and propane, but because there have been no incidents reported with larger containers, the restriction applies only to containers of 3000 gal (11.4 m^3) or less.

The following safety hazards are associated with converting tanks from propane to ammonia use and vice versa:

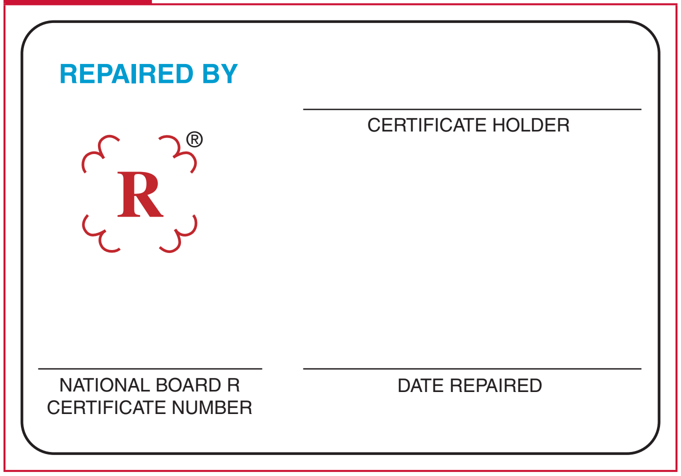
1. Potential overfilling of the container due to inappropriate dip tube length
2. Container failure from stress caused by corrosion cracking due to prior ammonia service
3. Improper sizing or material of relief valves (propane containers can use steel or brass valves, while ammonia tanks can only use steel valves because ammonia corrodes brass)
4. Accumulation of rust, which can form if the container is left open during a changeover and can lead to odor fade

69.2.1.1.6 Repairs or alteration of a container shall comply with the regulations, rules, or code under which the container was fabricated. Repairs or alteration to ASME containers shall be in accordance with the ANSI/NB23 *National Board Inspection Code*. [**58:**5.2.1.6]

69.2.1.1.7 Field welding shall be permitted only on saddle plates, lugs, pads, or brackets that are attached to the container by the container manufacturer. [**58:**5.2.1.7]

The heat of welding directly to the container can affect the strength of the material and change its characteristics so that it may no longer meet the requirements of the ASME *Boiler and Pressure Vessel Code*. Such heating can set up localized stresses that can reduce the strength of the material or container. Repairs to pressure vessels must meet the requirements of the NBIC and must be performed by a repair organization accredited by the National Board and authorized to utilize the "R" code symbol stamp. Following a repair and final inspection by a National Board–commissioned inspector, the repair organization will affix to the pressure vessel a "Repair" nameplate that is similar to the ASME nameplate (the ASME nameplate is not to be removed or altered). The requirements in the NBIC were developed to maintain the integrity of the pressure vessel after it has been placed in service (see Exhibit 69.2).

Exhibit 69.2



National Board "R" stamp. (Reprinted with permission of the National Board of Boiler and Pressure Vessel Inspectors)

69.2.1.1.8 Containers for general use shall not have individual water capacities greater than 120,000 gal (454 m^3). [**58:**5.2.1.8]

Containers installed for general use and in dispensing stations are limited in size per 69.2.1.1.8. However, the number of containers in general use is not limited. The term *general use*, which is not defined in the *Code*, refers to installations where LP-Gas is being stored for an end-use application, such as fuel. Thus, an LP-Gas bulk plant where most employees can be expected to be aware of the proper procedures for handling LP-Gas is not considered to be general use.

69.2.1.1.9 Dispensing systems not located in LP-Gas bulk plants, industrial plants, or industrial applications shall have an aggregate water capacity not greater than 30,000 gal (114 m^3). [**58:**5.2.1.9]

69.2.1.1.10 Heating or cooling coils shall not be installed inside storage containers. [**58:**5.2.1.10]

Internal container components such as heating and cooling coils can be inspected only when the container is emptied, purged, and declared safe for entry. It is possible that a container's components might not be inspected during the container's normal life of service. If not inspected, corrosion or other container component failure will not be observed and thus can never be repaired or taken out of service. If heating or cooling coils installed inside the storage container leak, the gas could enter the piping of the heating or cooling system because the LP-Gas pressure is normally higher than the pressure in the internal coil. Leakage into the heating or cooling system could result in a pressure that ruptures or creates leaks in the heating or cooling piping. Even if a break does not occur, a flammable product will be present in the heating or cooling system that could escape near an ignition source.

69.2.1.1.11 ASME containers installed underground, partially underground, or as mounded installations shall incorporate provisions for cathodic protection and shall be coated with a material recommended for the service that is applied in accordance with the coating manufacturer's instructions. [**58:**5.2.1.11]

This requirement for underground containers recognizes a long-standing practice to provide corrosion protection in addition to a corrosion-resistant coating. The method used is called *cathodic protection*, which commonly utilizes a metal that is more electrochemically reactive than steel so that it "sacrificially corrodes" instead of the steel tank. Typically, magnesium is used with underground containers of all types.

69.2.1.2 Portable Container Appurtenance Physical Damage Protection.

69.2.1.2.1 Cylinders shall incorporate protection against physical damage to cylinder appurtenances and immediate connections to such appurtenances when not in use by any of the following means:

(1) A ventilated cap
(2) A ventilated collar

The cap or collar described in 69.2.1.2.1 and shown in Exhibit 69.3 is required to provide physical protection for the valves and any other appurtenances connected to the cylinder.

Cylinders are portable and normally are transported from their regular use point to a filling point; there are inevitable occurrences in which the cylinder becomes involved in a transportation incident, falls over, or is dropped. If a removable cap is used, it must be in place prior to moving the cylinder. The cap also provides a lifting point for the cylinder. The valve must never be used for lifting a cylinder. Ventilation openings are required to permit discharge from the pressure relief valve to dissipate.

(3) A cylinder valve providing inherent protection as defined by DOT in 49 CFR 173.301(h)(3)

[**58:**5.2.6.1]

69.2.1.2.2 Protection of appurtenances of portable containers, skid tanks, and tanks for use as cargo tanks of more than 1000 lb (454 kg) water capacity [nominal 420 lb (191 kg) propane capacity] shall comply with 69.2.1.2.2.1 through 69.2.1.2.2.3. [**58:**5.2.6.2]

69.2.1.2.2.1 Appurtenance protection from physical damage shall be provided by recessing, by protective housings, or by location on the vehicle. [**58:**5.2.6.2(A)]

Exhibit 69.3

Cylinder collars. (Courtesy of Manchester Tank)

69.2.1.2.2.2 Appurtenance protection shall comply with the provisions under which the containers are fabricated. [**58:**5.2.6.2(B)]

69.2.1.2.2.3 Appurtenance protection shall be secured to the container in accordance with the ASME code under which the container was designed and built. [**58:**5.2.6.2(C)]

Paragraph 69.2.1.2.2.3 refers to the code under which the container was built, instead of specifying the safety factors to be used. Since the appurtenance protection is usually installed by the container manufacturer or assembler of a portable tank unit, it is reasonable to assume that the fabricator has access to the container construction code. This provision allows protection that was built to older editions of the construction code to continue in service.

• N **69.2.1.3 Portable Storage Containers.**

N **69.2.1.3.1** The legs or supports, or the lugs for the attachment of legs or supports, shall be secured to the container in accordance with the ASME code under which the container was designed and built. [**58:**5.2.7.1]

N **69.2.1.3.2** The attachment of a container to either a trailer or semitrailer running gear, or the attachments to the container to make it a vehicle, so that the unit can be moved by a conventional over-the-road tractor, shall comply with the DOT requirements for cargo tank service. [**58:**5.2.7.2]

N **69.2.1.3.3** Portable tank design and construction of a full framework, skids, or lugs for the attachment of skids, and protection of fittings shall be in accordance with DOT portable tank specifications. The bottom of the skids shall be not less than 2 in. (51 mm) or more than 12 in. (300 mm) below the outside bottom of the tank shell. [**58:**5.2.7.3]

69.2.1.4 Container Marking.

69.2.1.4.1 Cylinders shall be marked as provided in the regulations, rules, or code under which they are fabricated. [**58:**5.2.8.1]

69.2.1.4.1.1 Where LP-Gas and one or more other compressed gases are to be stored or used in the same area, the cylinders shall be marked "Flammable" and either "LP-Gas," "Propane," or "Butane," or shall be marked in accordance with the requirements of 49 CFR, "Transportation." [**58:**5.2.8.1(A)]

69.2.1.4.1.2 When being transported, cylinders shall be marked and labeled in accordance with 49 CFR, "Transportation." [**58:**5.2.8.1(B)]

Hazardous materials labels are normally printed on or affixed to cylinders containing such materials. They are color- and symbol-coded to afford easy and immediate recognition of the existing hazards. Cylinders containing propane require the label to appear as a diamond with a red background and to be at least 3.9 in.^{2} (2516 mm^2), unless the neck ring (as shown in Exhibit 69.4) listed in CGA C-7, *Guide to Classification and Labeling of Compressed Gases*, is used. The "2" represents the hazard class, which is compressed gas. Sometimes the number "2.1" will appear instead, which represents the hazard class division and denotes flammable gas.

Markings are printed on or affixed to packages of hazardous materials such as propane cylinders to convey additional information about the hazardous material being transported. Cylinders that contain hazardous materials must be marked with the proper name of the material (either "Liquefied Petroleum Gas" or "Propane") and the shipping identification number (usually "1075," but may also be "1978").

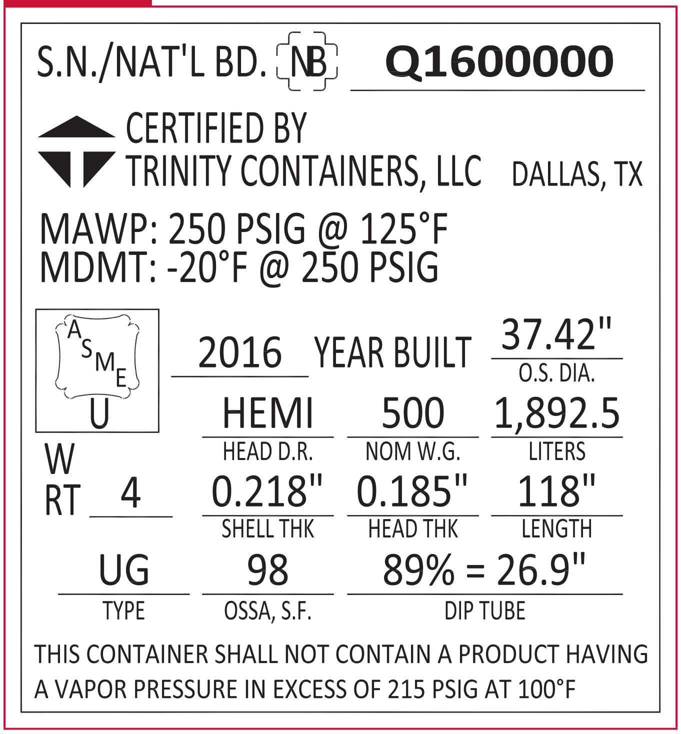
69.2.1.4.2* Cylinders shall be marked with the following information:

(1) Water capacity of the cylinder in pounds
(2) Tare weight of the cylinder in pounds, fitted for service [**58:**5.2.8.2]

Exhibit 69.4

Neck ring and DOT flammable gas label (red). (Courtesy of Labelmaster®)

Exhibit 69.5



Optional container listing on container nameplate. (Courtesy of Trinity Containers)

A.69.2.1.4.2 The tare weight is the cylinder weight plus the weight of all permanently attached valves and other fittings but does not include the weight of protecting devices that are removed in order to load the cylinder. [**58:**A.5.2.8.2]

69.2.1.4.3* The markings specified for ASME containers shall be on a stainless steel metal nameplate attached to the container, located to remain visible after the container is installed. [**58:**5.2.8.3]

A.69.2.1.4.3 Head design refers to the shape of the head. Shapes include hemispherical, semi-ellipsoidal, and others. *(Refer to the API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases for more information.)* [**58:**A.5.2.8.3]

The container nameplate, as shown in Exhibit 69.5, must be stainless steel and attached to the container in a manner that eliminates the possibility of corrosion to the nameplate, fasteners, or the container. Container corrosion can occur if water is trapped between the nameplate and the container. The nameplate is usually attached to the container using a continuous stainless steel weld around the nameplate to comply with the requirement in 69.2.1.4.3.1 that the attachment not contribute to corrosion of the container. This provision is not in conflict with the ASME Code, but it is important to be aware of the provision if ordering a propane container from a fabricator that does not normally fabricate propane containers.

Paragraph 69.4.2.2.8 states that "containers shall be filled only after determination that they comply with the design, fabrication, inspection, marking, and requalification provisions of NFPA 58." Without a nameplate, a container does not comply with the marking requirements of NFPA 58. In addition, nameplates provide the operating parameters used in the design of the container and information on the materials used. If the nameplate is missing, it cannot be immediately determined whether the container complies with the design and fabrication requirements of NFPA 58. A frequent saying in the industry is, "If you don't have a nameplate, you don't have a tank," since filling of the tank is impossible without a nameplate.

If the manufacturer is still in business, and records of the container construction are available, it is relatively easy to obtain a replacement nameplate. The container may be filled once the replacement nameplate has been attached to the container, bringing it back into compliance with the marking requirements of the code.

Some states have their own rules for attaching a replacement nameplate; however, those nameplates might not be recognized outside the state that approved the replacement.

The rules of the National Board of Boiler and Pressure Vessel Inspectors (NBBI) restrict who may attach a replacement nameplate. The AHJ not only must be involved but also must approve and possibly witness the attachment.

The requirement for a nameplate in the ASME Code is of great importance, and removal of a nameplate for any reason is not permitted. When repainting ASME containers, the nameplate should be taped over to prevent obscuring the markings on the nameplate. If the nameplate is to be removed temporarily for container painting, the NBBI must be contacted to determine if removal is allowed and, if so, how. The instructions and documentation are included on form NB-136, which can be found on the NBBI website at www.nationalboard.org. It is important to have the documentation of a replaced nameplate when the tank is inspected.

The provisions for buried or mounded tanks in 69.2.1.4.3.2 require that duplicate nameplate information be provided in a visible location if the original nameplate is obscured. This additional marking permits verification of the container nameplate information without digging up an underground container, which could damage the container, the protective coating, or a cathodic protection system if one is used.

The information required by 69.2.1.4.3.3(12) through 69.2.1.4.3.3(14) was inserted to make the requirements of NFPA 58 consistent with the manufacturers' requirements in the ASME *Boiler and Pressure Vessel Code*. Containers manufactured prior to the 2004 edition of NFPA 58 are not required to display this new information on the nameplate.

69.2.1.4.3.1 The nameplate shall be attached in such a way as to minimize corrosion of the nameplate or its fastening means and not contribute to corrosion of the container. [**58:**5.2.8.3(A)]

69.2.1.4.3.2 Where the container is buried, mounded, insulated, or otherwise covered so the nameplate is obscured, the information contained on the nameplate shall be duplicated and installed on adjacent piping or on a structure in a clearly visible location. [**58:**5.2.8.3(B)]

69.2.1.4.3.3 Stationary ASME containers shall be marked with the following information:

(1) Service for which the container is designed (e.g., underground, aboveground, or both)
(2) Name and address of container supplier or trade name of container
(3) Water capacity of container in pounds or U.S. gallons
(4) MAWP in pounds per square inch
(5) Wording that reads "This container shall not contain a product that has a vapor pressure in excess of ___ psig at 100°F" *(see Table 5.2.4.2 of NFPA 58)*
(6) Outside surface area in square feet
(7) Year of manufacture
(8) Shell thickness and head thickness
(9) OL (overall length), OD (outside diameter), and HD (head design)
(10) Manufacturer's serial number
(11) ASME Code symbol
(12) Minimum design metal temperature ___°F at MAWP ____ psi
(13) Type of construction "W"
(14) Degree of radiography "RT-___"

[**58:**5.2.8.3(C)]

69.2.1.4.3.4 In addition to the markings required by this Code, nameplates on cargo tanks shall include the markings required by the ASME *Boiler and Pressure Vessel Code* and the DOT. [**58:**5.2.8.3(D)]

Note that 49 CFR 178.345-14 contains additional marking requirements for cargo tank motor vehicles that transport propane. In addition to the ASME nameplate provided with the tank, a specification plate must be permanently attached to the cargo tank by brazing or welding on the left side near the front, so that it is accessible for inspection. All plates must be maintained in a legible condition. The specification plate must have the following information stamped, embossed, or otherwise marked into the metal of the plate in characters at least 3/16 in. (4.8 mm) high:

1. Cargo tank motor vehicle manufacturer — "CTMV mfr."
2. Cargo tank motor vehicle certification date — "CTMV cert. date"
3. Cargo tank manufacturer — "CT mfr."
4. Cargo tank date of manufacture, including month and year — "CT date of mfr."
5. Maximum weight of lading, in pounds — "Max. Payload"
6. Lining materials, if applicable — "Lining"
7. Heating system design pressure, in psig, if applicable — "Heating sys. press."
8. Heating system design temperature, in degrees Fahrenheit, if applicable — "Heating sys. temp."
9. Cargo tank serial number, assigned by cargo tank manufacturer, if applicable — "CT serial"

69.2.1.4.4 Warning labels shall meet the following requirements:

(1) Warning labels shall be applied to all cylinders of 100 lb (45.4 kg) propane capacity or less that are not filled on site.
(2) Warning labels shall include information on the potential hazards of LP-Gas.

[**58:**5.2.8.4]

The requirements in 69.2.1.4.4 recognize the need to warn users who are not familiar with the properties and potential hazards of propane. Exhibits 69.6 and 69.7 show examples of different types of warning labels. Note that the cylinder sizes are based on propane capacity because propane and butane — both LP-Gases — have different densities and therefore different weights for a full cylinder of the same volume.

The term *filled on site* means that the cylinder was filled at the usage site and typically applies to cylinders permanently installed at buildings that are filled by a propane delivery truck (bobtail). Cylinders that are filled on site do not require a warning label because the consumer does not handle or install the cylinder.

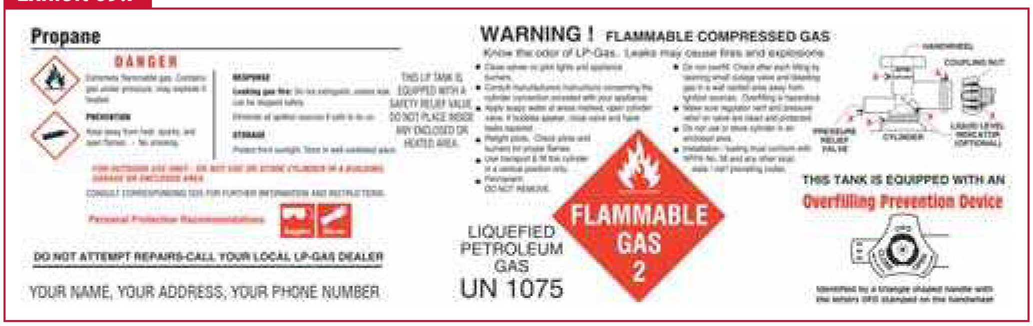
Warning labels are required only on portable cylinders of 100 lb (45.4 kg) propane capacity or less because these containers are most likely to be used by consumers of gas who may not be familiar with the hazards associated with LP-Gas. Larger cylinders are assumed to be handled only by propane companies, although this may not be the case universally.

The *Code* does not specify the text of a label, but it must include information on the potential hazards of LP-Gas as well as other information. Many labels include a warning that the cylinder must not be brought into buildings. This is true for most cylinders, but not all. In accordance with Section 6.20 of NFPA 58, certain cylinders may be brought into buildings. A warning stating that the cylinder may not be brought into buildings should not be placed on such cylinders. Although this may seem obvious, problems have arisen when inspectors have found cylinders that are permitted by Section 6.20 of NFPA 58 to be used in buildings with labels stating the opposite. This situation occurs because the most common size of propane cylinders is 20 lb (9.1 kg), and their most common use is with gas grills. Cylinder

Exhibit 69.6

Sample warning label intended for gas grill cylinders. (Courtesy of Screen Graphics of Florida)

Exhibit 69.7



Sample warning label intended for use on cylinders in commercial or industrial service. (Courtesy of Screen Graphics of Florida) manufacturers usually provide a warning label that anticipates use of the cylinder with gas grills unless otherwise specified.

The code does not specify the form of the label, only that it be applied to the cylinder. Because the term *apply* means "to put on," the label can be glued to the container or attached by a mechanical means such as a plastic strip. If the label is not on the cylinder but rather on an enclosure holding the cylinder or on a cylinder cover or other container, it has not been applied to the cylinder and does not meet the requirement of 69.2.1.4.4. If a decorative cover or plastic sleeve is used to cover a cylinder, the required label must be on the decorative cover in addition to the label on the cylinder because the warning must be visible to anyone using the cylinder.

69.2.1.4.5 All containers that contain unodorized LP-Gas products shall be marked "NOT ODORIZED." [**58:**5.2.8.5].

69.2.1.4.5.1 The marking shall have a contrasting background surrounded by a rectangular red border and with red letters in the sizes shown in Table 69.2.1.4.5.1. [**58:**5.2.8.5(A)]

***TABLE 69.2.1.4.5.1** "NOT ODORIZED" Label Size*

Water Capacity		Letter Height		Border Width	
gal	m³	in.	cm	in.	cm
≥499	≥1.89	4	10.0	½	1.3
49–498	0.19–1.88	1½	3.7	5/16	0.8
2.6–48	0.01–0.18	¾	1.8	¼	0.6
1–2.5	0.004–0.009	3/8	1.0	1/16	0.2

[**58:** Table 5.2.8.5(A)]

The marking "NOT ODORIZED" on ASME containers of unodorized propane provides important information to emergency responders (see Exhibit 69.8). The lack of odorant in a storage container adds to the potential hazard that both users and emergency responders face. By providing a visible marking, everyone working around stationary containers that hold unodorized LP-Gas is made aware of the absence of odorant and that alternative sensing devices must be used to locate suspected leaks.

Propane is permitted to be shipped and used without an odorant where the odorant would be harmful to a process or would serve no useful purpose, such as where propane is used as a chemical feedstock and the odorant could poison a catalyst, or where butane or propane is used as a propellant in aerosol cans. The application of butane or propane as an aerosol is not covered by NFPA 58 because this application is using LP-Gas as a delivery device rather than consuming it.

69.2.1.4.5.2 The markings shall be on both ends or on both sides of a container or on both sides and the rear of cargo tanks. [**58:**5.2.8.5(B)]

N **69.2.2 Reserved. [58:5.2]**

Exhibit 69.8

ASME container marked "NOT ODORIZED." (Courtesy of National Propane Gas Association)

N **69.2.3 Reserved. [58:5.3]**

N **69.2.4 Reserved. [58:5.4]**

N **69.2.5 Reserved. [58:5.5]**

N **69.2.6 Containers with Attached Supports.**

N **69.2.6.1 Vertical ASME Containers.** Vertical ASME containers of over 125 gal (0.5 m³) water capacity for use in permanent installations in stationary service shall be designed with steel supports that allow the container to be mounted on and fastened to concrete foundations or supports. [**58:**5.6.1]

N **69.2.6.1.1** Steel supports shall be designed to make the container self-supporting without guy wires and to withstand the wind and seismic (earthquake) forces anticipated at the site. [**58:**5.6.1.1]

N **69.2.6.1.2** Steel supports shall be protected against fire exposure with a material having a fire resistance rating of at least 2 hours. [**58:**5.6.1.2]

N **69.2.6.1.3** Continuous steel skirts having only one opening of 18 in. (460 mm) or less in diameter shall have 2-hour fire protection applied to the outside of the skirt. [**58:**5.6.1.3]

Vertical containers such as the one shown in Exhibit 69.9 are used where space is not available for horizontal containers. Because

Exhibit 69.9

Vertical container. (Courtesy of LP Gas magazine)

the failure of a vertical tank's structural supports can result in severe damage to the container when it falls, there are special fire protection requirements for the supports. The 2-hour fire resistance rating can be obtained by using a protective material that may have been tested to the requirements of ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, a standard used to determine the fire resistance rating of structural elements. Vertical tanks are most often located at propane vehicle refueling stations, where space is usually at a premium. Larger vertical tanks have also been installed where land cost is very high, such as near New York City.

Paragraph 69.2.6.1.3 addresses vertical tanks equipped with continuous steel skirts, which are not normally found at propane dispensing locations but are more common in refineries. Their use is permitted where the skirt is protected with fire resistance–rated insulation on its exterior.

N **69.2.6.2 Skid Tanks.** Skid tanks shall have a secure steel frame to allow transportation of the skid tank when not filled with LP-Gas. [**58:**5.6.2]

N **69.2.6.3 Porta-Pacs.**

N **69.2.6.3.1** The legs or supports, or the lugs for the attachment of legs or supports, shall be secured to the container in accordance with the ASME code under which the container was designed and built. [**58:**5.6.3.1]

N **69.2.6.3.2** The ASME container shall be attached to either:

(1) A trailer or semitrailer running gear, or the attachments to the container to make it a vehicle, so that the unit can be moved by a conventional over-the-road tractor.
(2) A metal frame such that the container can be moved as a trailer if wheels are added, which shall be approved for stationary use, or on a flat rail car.
(3) Protection of appurtenances shall be in accordance with 69.2.1.2.
(4) Movable fuel storage tenders shall be secured to the trailer support structure for the service involved.

[**58:**5.6.3.2]

N **69.2.7 Reserved.**

N **69.2.8 Reserved.**

69.2.9 Container Appurtenances.

N **69.2.9.1 Materials.**

N **69.2.9.1.1** Container appurtenances and regulators shall be fabricated of materials that are compatible with LP-Gas, shall be resistant to the action of LP-Gas under service conditions.

N **(A)** The following materials shall not be used:

(1) Gray cast iron
(2) Nonmetallic materials for bonnets or bodies of valves or regulators

[**58:**5.9.1.1]

Gray cast iron is prohibited because it can be subject to cracking and failing due to mechanical shock or severe thermal shock under fire conditions. The requirement for using metallic materials for the bodies of valves and regulators ensures that, when exposed to the elements, fire, or mechanical abuse, the device can be reasonably expected to function without creating a safety hazard. Although there have been considerable improvements in the temperature and pressure capabilities of plastic materials, they still do not approach the melting or softening points of metals.

N **69.2.9.1.2*** Pressure-containing metal parts of appurtenances shall have a minimum melting point of 1500°F (816°C), except for the following:

(1) Fusible elements
(2) Approved or listed variable liquid level gauges used in containers of 3500 gal (13.2 m^3) water capacity or less

[**58:**5.9.1.2]

N **A.69.2.9.1.2** Materials with melting points exceeding 1500°F (816°C) include steel, ductile (nodular) iron, malleable iron, or brass, as follows:

(1) Ductile iron should meet the requirements of ASTM A395/A395M, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, or equivalent and malleable iron should meet the requirements

of ASTM A47/A47M, *Standard Specification for Ferritic Malleable Iron Castings,* or equivalent.

(2) Approved or listed variable liquid level gauges used in containers of 3500 gal (13.2 m³) water capacity or less are exempt from the minimum melting point requirement.

(3) Cast-iron should not be used.

(4) Nonmetallic materials should not be used for bonnets or bodies of valves or regulators.

[**58:**A.5.9.1.2]

The melting point criteria for metal parts of appurtenances in 69.2.9.1.2 are intended to provide a degree of structural integrity in the event of exposure to fire and the application of water for fire control. However, appurtenance configuration, mass, and location on the container affect the degree of hazard to the appurtenance. Item (2) of 69.2.9.1.2 for liquid level gauges on smaller containers reflects this consideration.

Note that metal used for pressure-containing parts is required to have a melting point of at least 1500°F (816°C). Most metals and alloys become structurally unusable at temperatures approaching one-third to one-half their melting points, making materials with melting points below 1500°F (816°C) a potential safety concern in the event of fire exposure.

N **69.2.9.1.3** Container appurtenances shall have a service pressure of at least 250 psig (1.7 MPag). [**58:**5.9.1.3]

N **69.2.9.1.4** Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas. [**58:**5.9.1.4]

N **69.2.9.1.4.1** Gaskets shall be made of metal or other material confined in metal having a melting point over 1500°F (816°C) or shall be protected against fire exposure. [**58:**5.9.1.4(A)]

N **69.2.9.1.4.2** When a flange is opened, the gasket shall be replaced. [**58:**5.9.1.4(B)]

N **69.2.9.1.4.3** Aluminum O-rings and spiral-wound metal gaskets shall be permitted. [**58:**5.9.1.4(C)]

N **69.2.9.1.4.4** Gaskets for use with approved or listed liquid level gauges for installation on a container of 3500 gal (13.2 m³) water capacity or less shall be exempt from the minimum melting point requirement. [**58:**5.9.1.4(D)]

LP-Gas systems must be able to maintain their integrity when subjected to fire. Therefore, the requirement in 69.2.9.1.4 that gaskets maintain their integrity when subjected to a temperature of 1500°F (816°C) limits their use to those materials that have the best chance of maintaining their integrity in a fire. Other gasket materials, such as Teflon® and rubber, are permitted only where the flange containing the gasket is protected against fire exposure. This protection, although not specified, must safeguard the gasket from temperatures that would degrade it in a reasonably expected fire condition. A thermal insulating material that would not be degraded in a fire situation can be used.

When a flange is opened, the gasket can be damaged, and the damage may not be visible to the person opening the flange. Therefore, gasket replacement is required.

Aluminum O-rings and spiral-wound metal gaskets are permitted because they have been listed for many years and have a long, successful track record. The manufacturer's instructions concerning reuse of these gaskets should be followed. Because these types of gaskets are designed to deform when tightened to seal, it is good practice to replace them when a flange is opened, as the gasket manufacturer may recommend.

69.2.10 Piping (Including Hose), Fittings, and Valves. Piping (including hose), fittings, and valves shall comply with Section 5.9 of NFPA 58.

69.3 Installation of LP-Gas Systems

Section 69.3 includes information needed for the installation of the most commonly encountered LP-Gas systems and individual components. Note that systems that are installed on vehicles, that are highly specialized, or that are not as common have been separated into three chapters in NFPA 58: Chapter 9, Vehicular Transportation of LP-Gas; Chapter 11, Engine Fuel Systems; and Chapter 13, Refrigerated Containers.

Δ **69.3.1* Application.** Section 69.3 shall apply to the following:

(1) Location and field installation of LP-Gas systems that use components, subassemblies, container assemblies, and container systems that are fabricated in accordance with Chapter 5 of NFPA 58

(2) Location of containers and liquid transfer systems

(3) Installation of container appurtenances and regulators

(4) Installation of piping (including flexible connectors and hose), hydrostatic relief valves, and piping service limitations

(5) Installation of equipment

(6) Testing of piping systems

(7) Location of containers not connected for use

[**58:**6.1.1]

A.69.3.1 Section 6.5 of NFPA 58 includes general provisions that are applicable to most stationary systems. Sections 6.7 through 6.15 of NFPA 58 extend and modify Section 6.5 of NFPA 58 for systems installed for specific purposes. [**58:**A.6.1.1]

N **69.3.2 Nonapplication.** This chapter does not apply to the following:

(1) Refrigerated containers

(2) Installation of systems used in the highway transportation of LP-Gas

[**58:**6.1.2]

69.3.3 Location of Containers.

69.3.3.1 LP-Gas containers shall be located outside of buildings unless they are specifically allowed to be located inside of buildings. [**58:**6.2.1]

Δ **69.3.3.2** LP-Gas containers shall be allowed in buildings only for the following applications:

(1) Cylinders as specifically provided for in Section 6.22 of NFPA 58
(2) Containers of less than 125 gal (0.5 m^3) water capacity for the purposes of being filled in buildings or structures complying with Chapter 10 of NFPA 58
(3) Containers on LP-Gas vehicles complying with, and parked or garaged in accordance with, Chapter 9 of NFPA 58
(4) Containers used with LP-Gas portable engine fuel systems complying with 11.15.1 of NFPA 58
(5) Containers used with LP-Gas stationary engine fuel systems complying with Section 6.28 of NFPA 58
(6) Containers used with LP-Gas–fueled industrial trucks complying with 11.13.4 of NFPA 58
(7) Containers on LP-Gas–fueled vehicles garaged in accordance with Section 11.16 of NFPA 58
(8) Cylinders awaiting use, resale, or exchange when stored in accordance with Section 69.5.2 and 69.5.3

[**58:**6.2.2]

Because propane is a flammable gas, NFPA 58 has always required that LP-Gas containers be located outdoors, with the stated exceptions in 69.3.3.2. A flammable gas leak outdoors dissipates much more quickly and with less chance of reaching a source of ignition than a leak occurring indoors.

The code recognizes that there are a limited number of necessary uses of propane cylinders in buildings and structures, and those uses are listed in 69.3.3.2. Permitted uses are based on safeguards that minimize the possibility of a release of LP-Gas that could lead to ignition. Safeguards include limiting the size of the container, controlling the presence of ignition sources, and even designing the room or building to minimize the consequences of an explosion or fire.

In some European countries, LP-Gas is used in a totally different manner than it is in the United States. In those countries, it is standard practice for LP-Gas containers to be located not only within buildings, but within multistory apartment buildings, providing fuel for cooking and other applications where central heating systems are not utilized. The LP-Gas distribution system in those countries also has some differences in the manner in which LP-Gas is delivered, because most residences use LP-Gas cylinders that are exchanged rather than filled on site. Note that there may be significant differences in building construction, cylinder refilling, and cylinder filling practices between the United States and Canada and other countries that allow different uses of cylinders.

In addition to the general prohibition of using cylinders indoors, it is also prohibited to store cylinders, whether empty or full, inside a residential building. Requirements for storage of cylinders awaiting use or sale and exceptions for necessary uses are located in Chapter 8 of NFPA 58.

N **69.3.4 Location of Containers Not Connected for Use.**

The requirements in 69.3.4, which were newly added in the 2018 edition of the *Code*, address those containers that are removed from service yet remain on site.

Before this revision, there were no requirements concerning the safe placement of ASME tanks, whether empty or full, when they were not attached in a system. Several AHJs found that new supplying companies would disconnect the competitor's tank and then set the old tank aside, sometimes in an unsafe location or condition. Previously, NFPA 58 did not address placement after disconnection.

In previous editions of NFPA 58, a full 1000 gal (3.8 m^3) tank, for example, could be set right beside a residence if it was not connected for use. The requirement that it had to be at least 10 ft (3 m) from the building applied in previous editions of the code only if it was connected to a system, according to the scope statement of Chapter 6 of NFPA 58. If that tank rolled over and the pressure relief valve no longer communicated with the vapor space that also would not violate the requirements in previous versions of the code. This new subsection was written to recognize that a prohibition of these and other hazards had to be addressed.

N **69.3.4.1** Cylinders awaiting use, resale, or exchange shall be stored in accordance with Chapter 8. [**58:**6.3.1]

Paragraph 69.3.4.1 is a reminder that cylinders [containers complying with DOT specifications] not in use have requirements in Chapter 8 of NFPA 58.

N **69.3.4.2** ASME containers of 4,000 gal (15.2 m^3) or less that have been removed from service but that contain LP-Gas shall be stored outside of buildings in accordance with either 69.3.4.2(1) or 69.3.4.2(2):

(1) Containers shall be located either at a bulk plant or in an approved area.

The Technical Committee recognizes that storing containers at a bulk plant or in an area acceptable to the AHJ is considered to be storage in a controlled area.

The requirements in 69.3.4.2 were written to allow an exception for those containers stored outside a bulk plant, since employees who work in bulk plants are more familiar with the hazards of a container containing a highly flammable substance.

(2) Containers not complying with 69.3.4.2(1) shall comply with the following:
  (a) Containers shall be located in a manner that will minimize exposure to physical damage.

Item (2)(a) allows a newly disconnected tank to be placed near a roadway or other traveled location (so the tank owner has easier access for removal) as long as it is located in such a way that minimizes the possibility of vehicular impact. If it is located at a construction site, the possibility that something may run into or fall on the tank must be considered.

  (b) Containers shall be oriented so that the pressure relief valve remains in communication with the vapor space.

Item (2)(b) requires that the tank be set so that the relief valve communicates with the vapor space and will continue to do so for reasons explained in 69.3.8.1.1. Preventing the tank from

Exhibit 69.10

Disconnected ASME tank set in an unsafe manner. (Courtesy of Randy Renfrow, North Carolina Department of Agriculture and Consumer Services)

rolling over protects children who may be playing on or around the tank while it is still at their house. Exhibit 69.10 shows a disconnected tank set in a questionable manner. Some questions to consider are as follows: Would the blocks keeping it from rolling over? If a child removed the blocks, would the tank roll over?

(c) Containers shall not be located on roofs of buildings.
(d) Valve outlets on ASME containers shall be plugged or capped.
(e) Where screw-on-type caps or collars are utilized on ASME containers, they shall be in place whenever this type of container is stored regardless of the fill level of the container.

Items (2)(d) and (2)(e) require further protection against accidental release of product. Plugging or capping the outlet makes it less likely that a person unfamiliar with the risks of opening the valves on tanks will release the product. Ensuring that a cap or a collar is in place for older ASME containers further guards against accidental release of product.

(f) The location of ASME containers shall comply with the "Aboveground Containers" column and the "Between Containers" column of Table 69.3.5.1.1 with respect to important buildings and lines of adjoining property that can be built upon.
(g) Where the provisions of 69.3.4.2(2)(f) are impractical, alternative storage locations for containers shall be approved by the authority having jurisdiction.

[**58:**6.3.2]

Item (2)(f) recognizes that the separation requirements for attached tanks also serve well for tanks that are not attached. It also requires that underground tanks meet the separation requirements for aboveground tanks when they are placed above ground and are awaiting removal.

Item (2)(g) recognizes that there may be special situations where the requirements of (2)(f) are impractical and gives direction to the AHJ to determine alternative storage locations for these situations.

69.3.5 Container Separation Distances.

69.3.5.1 Aboveground Containers. [58:6.4.1]

69.3.5.1.1* Containers installed outside of buildings, whether of the portable type replaced on a cylinder exchange basis or permanently installed and refilled at the installation, shall be located with respect to the adjacent containers, important building, group of buildings, or line of adjoining property that can be built upon, in accordance with Table 69.3.5.1.1, Table 69.3.6.1.2, 69.3.5.1.2 through 69.3.5.1.3, 69.3.5.3, 69.3.5.4.1 through 69.3.5.4.4, and 69.3.6.3.6 through 69.3.6.3.11. [**58:**6.4.1.1]

The requirement in 69.3.5.1.1 has been in NFPA 58 since at least the 1967 version of that code. It is a critical part of the code and the most widely used.

The requirements in 69.3.5 through 69.3.7 and Section 6.29 of NFPA 58 provide location and point-of-transfer requirements for containers. These requirements are critical to understanding the application of Table 6.4.1.1.

The siting criteria in 69.3.5.1.1 require that a container be located a specified distance from other containers, an important building or group of buildings, or a line of adjoining property that can be built upon. These separation distances are intended to reflect the container's relative exposure hazard due to the presence of the items cited and vice versa.

The distances are based on a combination of the following factors:

- Potential hazard of LP-Gas
- Size and type of equipment used to contain the gas
- Possibility of leaks (which can ignite)
- Need for fuel in buildings

The distances are not based on a worst-case scenario in which the LP-Gas container fails catastrophically, releasing its contents in a few seconds. During the approximately 80-year history of NFPA 58, experience with LP-Gas containers located near buildings has not identified that such incidents occur.

Research has been conducted to evaluate the effects of radiant heat from fires to LP-Gas containers. Raj, in the article "Exposure of a Liquefied Gas Container to an External Fire," discussed this evaluation, the associated mathematical model, and detailed results with and without the effects of wind in the peer-reviewed *Journal of Hazardous Materials*.

The maximum steel container surface temperatures where in contact with vapor are presented in Commentary Table 69.1. Several different container sizes are provided.

The temperature at which the yield strength of a propane tank's steel begins to decrease is close to 800°F (427°C). Based on that temperature, there is no threat of propane tank failure from radiant heat due to an external fire occurring at the minimum separation distances specified in Table 69.3.5.1.1.

In general, two phrases that appear in the text of 69.3.5.1.1 continue to cause confusion among users and enforcers: "important building" and "line of adjoining property that can be built upon."

TABLE 69.3.5.1.1 Separation Distances Between Containers, Important Buildings, and Line of Adjoining Property That Can Be Built Upon

Water Capacity per Container		Minimum Distances					
		Mounded or Underground Containers[a]		Aboveground Containers		Between Containers[b]	
gal	m³	ft	m	ft	m	ft	m
<25[c]	<0.5[c]	10	3	0[d]	0[d]	0	0
125–250	0.5–1.0	10	3	10	3	0	0
251–500	>1.0–1.9	10	3	10	3	3	1
501–2,000	>1.9–7.6	10	3	25[e]	7.6	3	1
2,001–30,000	>7.6–114	50	15	50	15	5	1.5
30,001–70,000	>114–265	50	15	75	23	¼ of sum of diameters of adjacent containers	
70,001–90,000	>265–341	50	15	100	30		
90,001–120,000	>341–454	50	15	125	38		
120,001–200,000	>454–757	50	15	200	61		
200,001–1,000,000	>757–3785	50	15	300	91		
>1,000,000	>3785	50	15	400	122		

[a]See 69.3.5.2.1.
[b]See 69.3.5.4.5.
[c]See 69.3.5.4.4.
[d]See 69.3.5.4.1, 69.3.5.4.2, 69.3.5.4.3, 69.3.5.4.4.
[e]See 69.3.5.1.3.
[**58:**Table 6.4.1.1]

COMMENTARY TABLE 69.1 *Maximum Steel Container Surface Temperatures in Contact with Vapor Space Where Exposed to Fire*

Container Size (w.c.)		Maximum Temperature Attained (30-minute Exposure)	
gal	m³	°F	°C
1,000	3.8	660	349
2,000	7.6	648	342
4,000	15.2	507	264
12,000	45.4	507	264
18,000	68.1	437	225
30,000	114.0	384	195
60,000	227.0	340	171

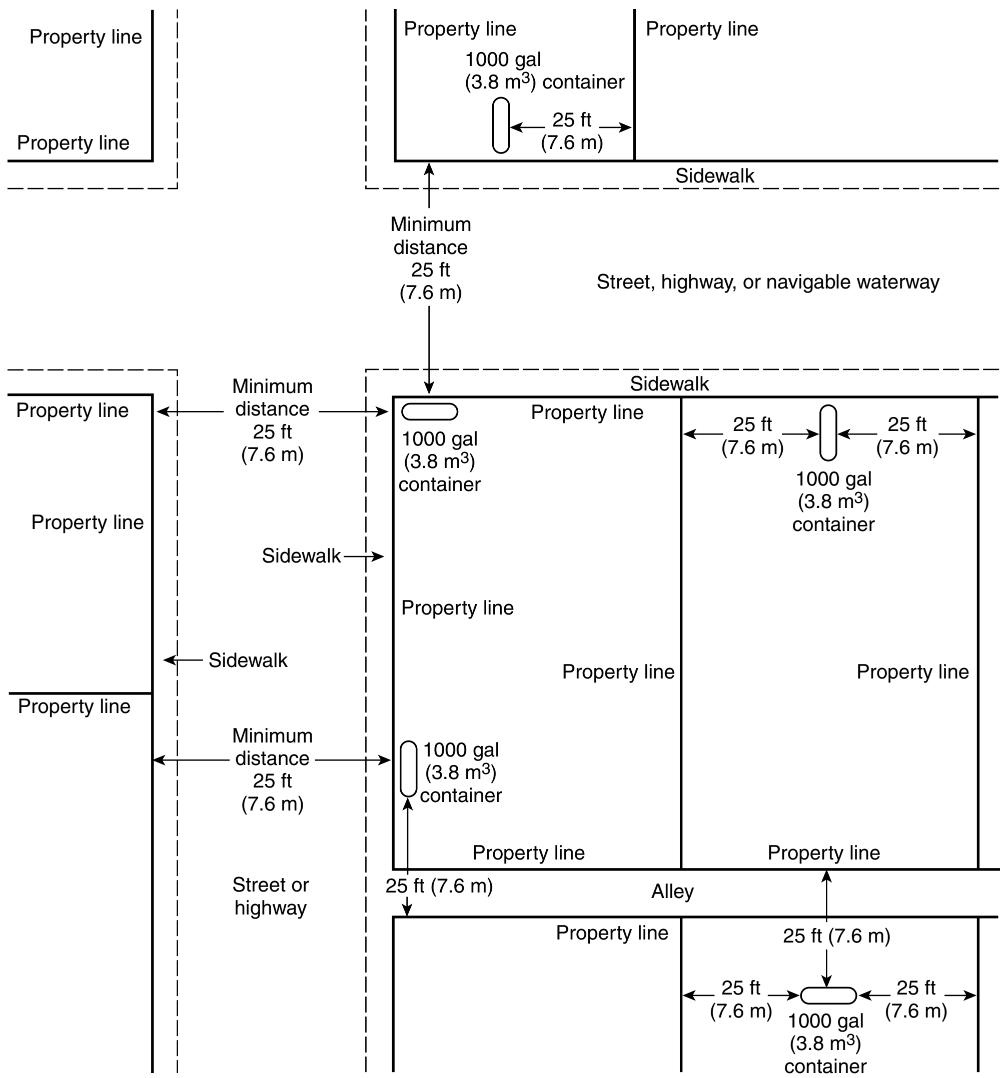
A.69.3.5.1.1 When applying Table 69.3.5.1.1 to cylinders, which have their capacities expressed in pounds, the first table entry, <125 gal (<0.5 m³), includes all cylinders. Cylinders have a maximum capacity of 1000 lb or 119 gal (454 kg or 3.8 m³) (water capacity). [**58:**A.6.4.1.1]

The "Line of Adjoining Property that can be built upon" refers to the property boundaries of the plot adjacent to the one upon which the tank is located. This is illustrated in Figure A.69.3.5.1.1 taking into consideration a condition that involves property on the other side of a street, highway, navigable waterway, or other right of way. The minimum distance limitation is from the tank to the property line where that property line is common to plots of ground of different ownership and would also apply between the tank and the property line of the far side of a street or other public right of way. [**58:**A.6.4.1.1]

69.3.5.1.2 When the provisions of 6.30.3 through 6.30.5 of NFPA 58 are met, the minimum distance from an ASME container to a building shall be reduced by one-half for ASME containers of 2001 gal through 30,000 gal (7.6 m³ through 114 m³) water capacity. [**58:**6.4.1.2]

Paragraph 69.3.5.1.2 recognizes the alternative installation requirements of 6.30.4 and 6.30.5 of NFPA 58 for redundant fail-safe product control methods and low emission transfer, respectively. In accordance with those subsections in NFPA 58, the separation distance can be reduced.

69.3.5.1.3 The 25 ft (7.6 m) minimum distance from aboveground ASME containers of 501 gal through 2000 gal (1.9 m³ through 7.6 m³) water capacity to buildings, a group of buildings, or the



△ ***FIGURE A.69.3.5.1.1*** *Illustration of Separation Distances from Containers to the Line of Adjoining Property that can be Built Upon. [**58:**Figure A.6.4.1.1]*

line of adjoining property that can be built upon shall be reduced to 10 ft (3 m) for a single ASME container of 1200 gal (4.5 m³) or less water capacity where such container is at least 25 ft (7.6 m) from any other LP-Gas container of more than 125 gal (0.5 m³) water capacity. [**58:**6.4.1.3]

Paragraph 69.3.5.1.3, often called the "restaurant exemption," provides a special case that allows the installation of one LP-Gas container of 1200 gal (4.5 m³) or less 10 ft (3 m) from a building rather than the 25 ft (7.6 m) required in Table 69.3.5.1.1. The 10 ft (3 m) spacing of one container with 1200 gal (4.5 m³) or less water capacity is allowed only if one such container is installed and there are no other LP-Gas containers of more than 125 gal (0.5 m³) water capacity within 25 ft (7.6 m). The provision was created because of the limited space often found in commercial areas, and it has continued to be used because fire records do not indicate a problem with the reduced distance.

Note that the 25 ft (7.6 m) separation distance to other LP-Gas containers is applicable in all cases, even if two different users would like to install containers less than 25 ft (7.6 m) apart.

69.3.5.2 Underground or Mounded ASME Containers.

69.3.5.2.1 Minimum distances for underground or mounded ASME containers of 2001 gal through 30,000 gal (7.6 m³ through 114 m³) water capacity, incorporating all the provisions of Section 6.30 of NFPA 58, shall be reduced to 10 ft (3 m). [**58:**6.4.2.1]

The reduced distances for underground or mounded containers reflect the fact that they are not subject to boiling liquid expanding vapor explosions (BLEVEs) from fire exposure, and the features provided in Section 6.30 of NFPA 58 reduce the potential for uncontrolled release of product that could result in an explosion hazard.

Paragraphs 69.3.5.2.2 69.3.5.2.3 provide important information in measuring the distances required in 69.3.5.2.1. Although they may appear redundant to one another, 69.3.5.2.2 and 69.3.5.2.3 do not address the same issues. Paragraph 69.3.5.2.2 addresses the clearances for fire safety purposes, while 69.3.5.2.3 addresses spacing requirements to allow heavy equipment to have access to the containers as well as to create an access easement for utilities.

69.3.5.2.2 Distances for all underground and mounded ASME containers shall be measured from the container surface. [**58:**6.4.2.2]

Note that 69.3.5.2.2 requires that the measurement of separation distances from an underground or mounded ASME container be taken from the nearest surface of the container rather than the pressure relief valve discharge, which is used in 69.3.5.4.

69.3.5.2.3 No part of an underground or mounded ASME container shall be less than 10 ft (3 m) from a building or line of adjoining property that can be built upon. [**58:**6.4.2.3]

It is stated in this *Code* that no part of an underground tank is permitted be within 10 ft (3 m) of a building. However, there may be situations where there is a property line that may be built upon, but an underground tank may be desired less than 10 ft (3 m) from that line (e.g., a coastal or remote area with limited space). If such an installation is requested and there is guaranteed assurance that no building will be located within 10 ft (3 m) horizontally from any surface of the tank, even across the property line, then the intent to keep the tank away from buildings is met. This type of situation is allowed by the *Code* via the equivalency provisions in Section 1.4.

69.3.5.3 Minimum Separation Distances for ASME Containers.

69.3.5.3.1 The minimum separation distances specified in Table 69.3.5.1.1 between containers and buildings of noncombustible construction devoted exclusively to gas manufacturing and distribution operations shall be reduced to 10 ft (3 m). [**58:**6.4.3.1]

Paragraph 69.3.5.3.1 allows a reduction of the separation distances [from 50 ft (15 m) to 10 ft (3 m)] of containers to buildings used only for gas manufacturing and distribution because workers in a building covered by this provision are employed in the transfer of liquid LP-Gas and have had initial and refresher training in its hazards. In addition, because the building is constructed of noncombustible materials, the potential exposure to the container from a building fire is greatly reduced. The separation distance from containers to other buildings on the site and to buildings on adjacent sites cannot be reduced.

69.3.5.3.2 If the aggregate water capacity of a multicontainer installation is 501 gal (1.9 m³) or more and the installation is comprised of individual containers, each with a water capacity of less than 125 gal (0.5 m³), the minimum distance shall comply with Table 69.3.5.1.1 and 69.3.5.3.2.1 through 69.3.5.3.2.3. [**58:**6.4.3.2]

69.3.5.3.2.1 The aggregate capacity shall be used rather than the capacity per container. [**58:**6.4.3.2(A)]

69.3.5.3.2.2 If more than one such installation is made, each installation shall be separated from any other installation by at least 25 ft (7.6 m). [**58:**6.4.3.2(B)]

69.3.5.3.2.3 The minimum distances between containers shall not be applied to installations covered by 69.3.5.3.2. [**58:**6.4.3.2(C)]

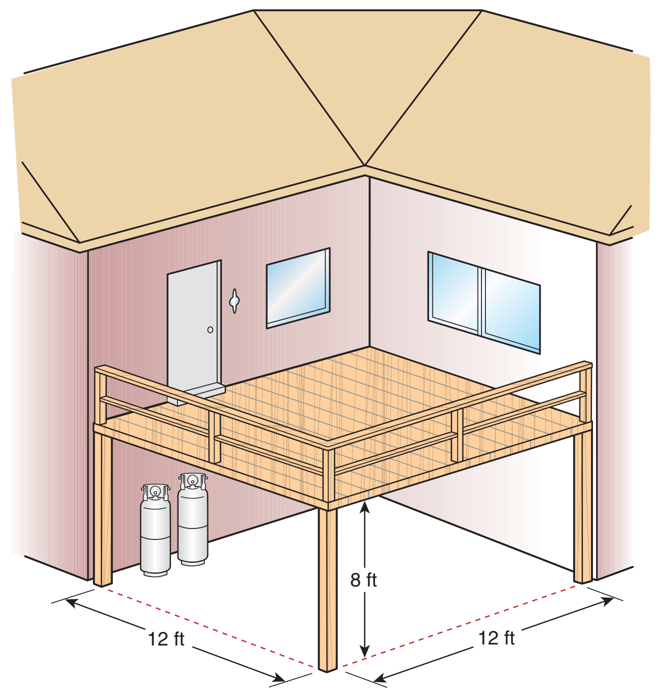
69.3.5.4 Separation Distance Between Container Pressure Relief Valve and Building Openings.

69.3.5.4.1 Cylinders shall not be located and installed underneath any building sunless the space is open to the atmosphere for 50 percent of its perimeter or more. [**58:**6.4.4.1]

Paragraph 69.3.5.4.1 provides guidance to *Code* users who install cylinders outdoors that are protected from the weather. It establishes that a minimum of 50 percent of the perimeter of an enclosed area be open to the atmosphere. See Exhibit 69.11, which shows a deck with two sides completely open. Cylinders can be installed under a deck like the one in the exhibit.

Although NFPA 58 is not a building code, it does provide safety requirements for the installation of propane containers that help achieve the safe occupancy and use of buildings. Note that NFPA *101*®, *Life Safety Code*®, prohibits LP-Gas containers

Exhibit 69.11



Total wall enclosure area = (12 ft × 8 ft) × 4 = 384 ft²
Minimum required open area = 384 ft² × 50% = 192 ft²

Illustration of 50 percent open perimeter of the space below a deck.

from being located under egress paths from upper-level rooms. This would preclude locating containers under a stairway or ramp that is the best practical way to evacuate — for example, a second-floor apartment or an elevated beach house.

69.3.5.4.2 ASME containers of less than 125 gal (0.5 m^3) water capacity shall be located and installed so that the discharge from pressure relief devices shall not terminate in or beneath any building. [**58:**6.4.4.2]

69.3.5.4.3* The distance measured horizontally from the point of discharge of a container pressure relief valve to any building opening below the level of such discharge shall be in accordance with Table 69.3.5.4.3. [**58:**6.4.4.3]

TABLE 69.3.5.4.3 *Separation Distance Between Container Pressure Relief Valve and Building Openings*

Container Type	Exchange or Filled on Site at the Point of Use	Distance Horizontally from Relief Valve Discharge to Opening Below Discharge		Discharge from Relief Valve, Vent Discharge, and Filling Connection to Exterior Source of Ignition, Openings into Direct-Vent Appliances, and Mechanical Ventilation Air Intakes	
		ft	m	ft	m
Cylinder	Exchange	3	0.9	5	1.5
Cylinder	Filled on site at the point of use	3	0.9	10	3.0
ASME	Filled on site at the point of use	5	1.5	10	3.0

[**58:**Table 6.4.4.3]

A.69.3.5.4.3 Building openings in the context of 69.3.5.4.3 are any opening that communicates air from the exterior to the interior of the building, including windows, doors, or dryer vent terminations below the level of the relief valve discharge. [**58:**A.6.4.4.3]

Table 69.3.5.4.3 highlights the differences in location requirements between cylinders and ASME containers. The table also highlights the different requirements between cylinders filled on site and cylinders that are exchanged. An exchanged cylinder is one that is transported full to the consumer site to be exchanged with an empty cylinder. Note that the distance is greater for containers (both cylinders and ASME tanks) filled at the point of use because the fixed maximum liquid level gauge (referred to as "Vent Discharge" in the table) is usually open and discharges propane into the air while the cylinder is being filled. There is also a small discharge of propane when the hose assembly is disconnected from the container filler valve. Both of these releases are a possible ignition hazard and warrant the extra separation distance.

Table 69.3.5.4.3 applies to cylinders installed alongside a building. The requirements are intended to achieve the following:

- Minimize the possibility of LP-Gas escaping through the cylinder pressure relief valve and entering a building. Pressure relief valve operation is most likely to occur if the container has been overfilled or the container is heated due to exposure to intense sunlight or another source of heat.
- Minimize the possibility of any LP-Gas released through the relief valve providing fuel for a fire or igniting.

Note that the required distance to a pressure relief valve on a cylinder from a building opening is 3 ft (1 m), and the required distance for a pressure relief valve on an ASME container is 5 ft (1.5 m). This difference recognizes the following:

1. The start-to-discharge setting for a relief valve on a cylinder is higher than that for an ASME container [nominally 375 psig (2.6 MPag) and 250 psig (1.7 MPag), respectively], resulting in a lower probability of a discharge of LP-Gas occurring from a DOT cylinder than from an ASME container.
2. The cylinder relief valve is smaller than the relief valves used on large ASME containers. The discharge flow is correspondingly less.

The "building opening" cited in 69.3.5.4.3 is normally a door or a window, which can be either closed or open. When open, doors and windows can have air flow through them in either direction due to natural breezes.

Building openings also include crawl space vents. Recent construction trends have resulted in these vents on residences being spaced 6 ft (1.8 m) on center. As such, a container may not be placed between them and next to the building and still have the required separation from the opening. Sealing the vent could be an option if it does not violate the venting requirements of the crawl space; however, doing so may result in inadequate ventilation of the space.

Where the airflow is caused by a mechanical air movement system, such as a direct-vent appliance or a mechanical ventilation air intake, a 5 ft (1.5 m) distance for exchanged cylinders or a 10 ft (3 m) distance for cylinders or ASME containers filled at the point of use is specified. The reason for this requirement is because the directed airflow into the building could pick up LP-Gas.

Although direct-vent appliances do not represent a pathway for LP-Gas into the building, they do draw in outside air for combustion. If this air contains LP-Gas in ignitible proportions, the appliance ignition or burner flame can be an ignition source, and because of the small volume within which the flammable mixture is contained, an overpressure event may be possible.

Mechanical ventilation system air intakes are an obvious pathway for LP-Gas into a building interior. A mechanical ventilation system air outlet — for example, a kitchen exhaust fan — is considered to be a building opening, much like a door or window, and may actually draw air into the building when it is not operating. While the fan may incorporate a damper to minimize reverse flow, such dampers rarely seal tightly and are known to deform and allow reverse flow after some time in use.

See Exhibit 69.12 for an illustration of the requirements in Table 69.3.5.1.1 and Table 69.3.5.4.3.

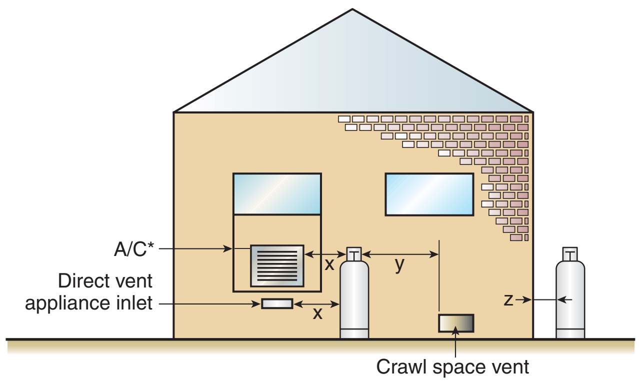
69.3.5.4.4 The distance measured in any direction from the point of discharge of a container pressure relief valve, vent of a fixed maximum liquid level gauge on a container, and the container filling connection to exterior sources of ignition, openings into direct-vent (sealed combustion system) appliances, and mechanical ventilation air intakes shall be in accordance with Table 69.3.5.4.3. [**58:**6.4.4.4]

Work on the dispersion of flammable gases from relief valves has been conducted by the Battelle Memorial Institute and is reported in the paper by Hoehne, Luce, and Miga titled "The Effect of Velocity, Temperature, and Gas Molecular Weight on Flammability Limits in Wind-Blown Jets of Hydrocarbon Gases." That report forms a basis for API STD 521, *Pressure-Relieving and Depressuring Systems*.

The results of one test on dispersion of flammable gases from relief valves are shown in Exhibit 69.13. While this reports just one test, which was not intended to be a thorough study, it is the only data available. Discharge of liquid from a fixed maximum liquid level gauge for as long as 3 minutes is an abnormal condition because, normally, the gauge discharge valve is closed by the person filling the container when liquid first appears. A lack of wind is conducive to the formation of high concentrations of LP-Gas, but it is a rare occurrence. In spite of the severity of the test conditions as compared to field experience, the concentration of LP-Gas at 10 ft (3 m) did not exceed 20 percent of the lower flammable limit (LFL), or a safety factor of 5.

The required separation for containers filled on site also reflects the small but distinct possibility that the filler valve may

Exhibit 69.12



Distance to outdoor sources of ignition and building openings (source: Table 69.3.5.4.3)

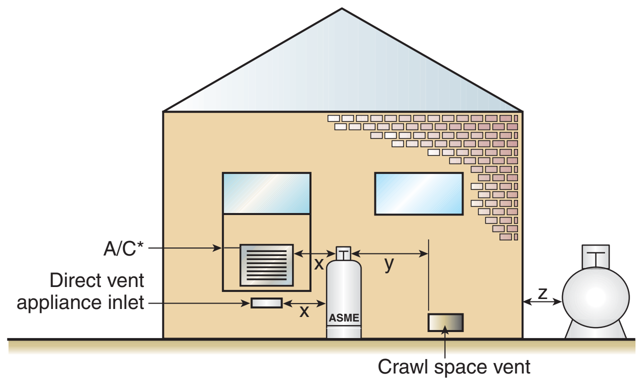
Filling method	Distance X	Distance Y
Filled by exchange	5 ft	3 ft
Filled at the point of use	10 ft	5 ft

* or other exterior source of ignition

Distance to building, cylinders - Z (source: Table 69.3.5.1.1)

One container 125 gal or less	0 ft
Multiple containers, 125 gal or less with aggregate < 501 gal	0 ft
Multiple containers, 125 gal or less with aggregate > 501 gal	Per Table 69.3.5.1.1 (using aggregate water capacity)

(a) Location of Cylinders



Distance to outdoor sources of ignition and building openings (source: Table 69.3.5.4.3)

Filling method	Distance X	Distance Y
Filled by exchange	5 ft	5 ft
Filled at the point of use	10 ft	5 ft

* or other exterior source of ignition

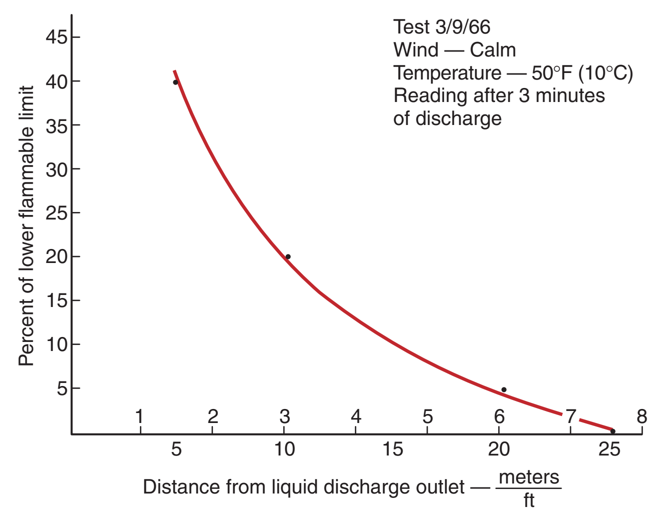
Distance to building - Z, ASME containers up to 2000 gal (source: Table 69.3.5.1.1)

One container 125 gal or less	0 ft
126–500 gal	10 ft
One container, 501–1200 gal	10 ft (see 69.3.5.1.3)
501–1200 gal	25 ft

(b) Location of ASME Containers

Locations of cylinders and ASME containers.

Exhibit 69.13



Concentration of propane-air mixture resulting from discharge of liquid propane from a fixed liquid level gauge on a cylinder. (Courtesy of Wilbur Walls)

not close properly after the container is filled. If the filler valve fails to close when the fill nozzle is removed, gas will be released through the valve and can result in fire and injury to transfer personnel.

69.3.5.4.5 Access at the ends or sides of individual underground containers having a water capacity of 125 gal (0.5 m^3) or more shall be provided in multicontainer installations to facilitate working with cranes or hoists. [**58:**6.4.4.5]

Paragraph 69.3.5.4.5 requires that access to an underground container installation be provided to allow cranes and hoists to service or remove the containers. Minimum clearance around the container installation is not required because many cranes can extend to allow access to the containers from a single point.

69.3.6 Other Container Location Requirements.

69.3.6.1 ASME Multi-Container Requirements.

69.3.6.1.1 Where storage containers having an aggregate water capacity of more than 4000 gal (15.2 m^3) are located in heavily populated or congested areas, the siting provisions of 69.3.5.1.1 and Table 69.3.5.1.1 shall be permitted to be modified as indicated by the fire safety analysis described in 6.29.3 of NFPA 58. [**58:**6.5.1.1]

The text in 69.3.6.1.1 establishes an additional requirement for larger installations in populated and congested areas, allowing the AHJ to require an analysis of local conditions.

In the United States and Canada, LP-Gas installations are usually found in rural and suburban areas or in commercial and industrial areas, where the hazards are commensurate with other operations and exposure to the public has been limited accordingly. Inevitably, exceptions to these locations occur and the versatility of LP-Gas has increased the number of LP-Gas installations. Installations are common in towns and cities not supplied by a utility gas system. In other countries, propane installations can be found in similar locations or throughout the country, depending on the availability of other fuels.

Paragraph 69.3.6.1.1 recognizes that larger installations in populated or congested areas may warrant further attention to the general siting criteria in 69.3.5.1.1. Some *Code* users misinterpret 69.3.6.1.1 to mean that, where storage exceeds 4000 gal (15.2 m^3), the separation distances of Table 69.3.5.1.1 should be increased. This is not necessarily the case. In addition, attempts have been made to force propane facilities to be relocated if buildings have been allowed to be constructed closer than the spacing requirements of Table 69.3.5.1.1 after the propane facility has been installed.

Increasing the distances may be impossible in a heavily populated or congested area. What 69.3.6.1.1 does state is that the distances provided in 69.3.5.1.1 and Table 69.3.5.1.1 can be modified based on the results of a fire safety analysis. The requirements for the fire safety analysis are provided in 6.29.3 of NFPA 58.

The phrase "heavily populated or congested areas" is not defined. The phrase is subject to interpretation by the AHJ; often, zoning criteria will come into play. For example, an area including buildings that house an institutional occupancy — such as a prison or a hospital — in which the occupants are incarcerated or nonambulatory and unable to respond to an emergency without assistance may be considered congested or heavily populated.

69.3.6.1.2 Aboveground multicontainer installations comprised of ASME containers having an individual water capacity of 12,000 gal (45 m^3) or more and installed for use in a single location shall be limited to the number of containers in one group, with each group separated from the next group in accordance with the degree of fire protection provided in Table 69.3.6.1.2. [**58:**6.5.1.2]

69.3.6.1.3 Where the provisions of 6.30.3 and 6.30.4 of NFPA 58 are met, the minimum separation distance between groups of ASME containers protected by hose stream only shall be one-half the distances required in Table 69.3.6.1.2. [**58:**6.5.1.3]

This reduced spacing is allowed because the provisions of 6.30.3 and 6.30.4 of NFPA 58 enhance the product control performance of the containment system. For example, 6.30.3 requires internal valves to be installed having both remote and automatic (thermally activated) shutoff capability, as well as positive shutoff valves. In addition, 6.30.4 of NFPA 58 requires ESVs with remote and thermal activation.

69.3.6.2 Underground and Mounded ASME Containers.

69.3.6.2.1 Underground or mounded ASME containers shall be located in accordance with 69.3.6.2.2 and 69.3.6.2.3. [**58:**6.5.2.1]

69.3.6.2.2 Underground or mounded containers shall be located outside of any buildings. [**58:**6.5.2.2]

Δ *TABLE 69.3.6.1.2 Maximum Number of Containers in a Group and Their Separation Distances*

Fire Protection Provided by	Maximum Number of Containers in One Group	Minimum Separation Between Groups	
		ft	m
Hose streams only *(see 6.5.1.2 and 6.29.3.1 of NFPA 58)*	6	50	15
Fixed monitor nozzles per 6.29.6.3 of NFPA 58	6	25	7.6
Fixed water spray per 6.29.6.1 of NFPA 58	9	25	7.6
Insulation per 6.29.5.1 of NFPA 58	9	25	7.6

[**58:** Table 6.5.1.2]

69.3.6.2.3 Buildings shall not be constructed over any underground or mounded containers. [**58:**6.5.2.3]

The requirement that underground and mounded containers be installed outdoors (and not beneath buildings) is consistent with the requirements for aboveground containers.

N **69.3.6.2.4** The sides of adjacent containers shall be separated in accordance with Table 69.3.5.1.1 but shall not be separated by less than 3 ft (1 m). [**58:**6.4.2.4]

N **69.3.6.2.5** Where containers are installed parallel with ends in line, the number of containers in one group shall not be limited. [**58:**6.4.2.5]

N **69.3.6.2.6** Where more than one row of containers is installed, the adjacent ends of the containers in each row shall be separated by not less than 10 ft (3 m). [**58:**6.4.2.6]

A minimum separation distance of 3 ft (1 m) for underground and mounded containers is required in 69.3.6.2.4 to allow for movement that cannot be observed. This minimum separation is also required between rows of containers to allow heavy equipment access, if needed (see Exhibit 69.14).

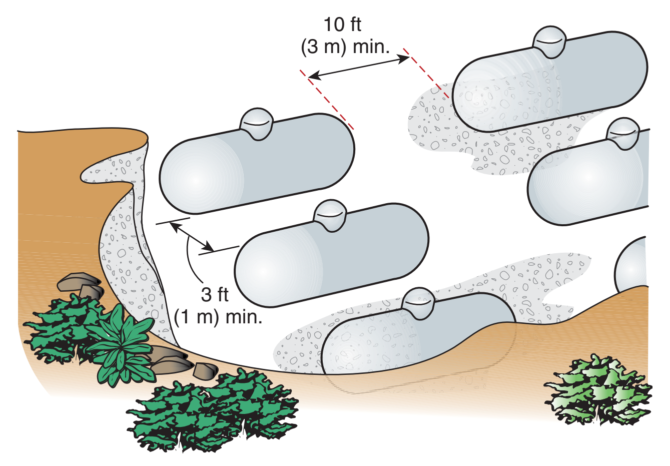
69.3.6.3 Additional Container Installation Requirements.

69.3.6.3.1 Additional container installation requirements shall comply with 69.3.6.3.2 through 69.3.6.3.13 and 69.3.6.4. [**58:**6.5.3.1]

69.3.6.3.2 Containers shall not be stacked one above the other. [**58:**6.5.3.2]

The purpose of the requirement in 69.3.6.3.2 is to avoid incidents where a gas release from one container can cause fire impingement on a container installed above it.

Exhibit 69.14



Separation of mounded or underground containers.

A literal reading of the words indicates that such an installation is prohibited. However, the intent of 69.3.6.3.2 is to prevent interaction between containers in a fire situation. One of two scenarios would have to occur for a negative impact from this type of scenario:

1. An underground container catches fire and affects the aboveground container.
2. An aboveground container on fire affects an underground container installed beneath it.

One of the concerns for such an installation would be the location of the relief valve discharge of the underground container. Depending on the installation, it may be prudent to pipe the relief valve discharge of the underground container to a point where it is higher than the top of, or cannot impinge on, an aboveground container installed above it. In such cases, care must be taken to ensure that the relief valve discharge piping cannot affect the operation of the relief valve.

It should be noted that there are other reasons not related to safety that make such an installation preferable. One reason in particular would be that maintenance of either container will become more difficult, especially that of the underground container.

69.3.6.3.3* Combustible materials shall not accumulate or be stored within 10 ft (3 m) of a container. [**58:**6.5.3.3]

Δ **A.69.3.6.3.3** Clearance is required between combustible materials and propane containers in order to minimize the effects of fires on the container. The requirement to maintain separation between the container and stored combustible materials is needed so that an accumulation of materials that may represent a hazard to the container does not occur. The term "stored" is intended to denote materials that are purposely placed. Vegetation of any type located near or under the container is not considered to be a hazard. [**58:**]

69.3.6.3.4* The area under containers shall be graded or shall have dikes or curbs installed so that the flow or accumulation of flammable liquids with flash points below 200°F (93.4°C) is prevented. [**58:**6.5.3.4]

A.69.3.6.3.4 For information on flash point see NFPA 30 [**58:**A.6.5.3.4]

The requirement in 69.3.6.3.4 is intended to be applied where LP-Gas containers are installed in close proximity to other flammable liquid storage containers. Paragraph 69.3.6.3.5 indicates the required separation from containers used to store flammable or combustible liquids that have a wall or dike constructed between them and the LP-Gas container.

Flash point is the temperature at which a flammable liquid can vaporize in sufficient quantity to form a flammable mixture of vapor and air. A liquid's flash point is determined by a test in which a sample of the liquid in an open cup is heated until its vapors can be ignited. Gases, such as propane and butane, do not have a flash point because they cannot be contained in an open cup at room temperature, although it is possible to measure a flash point by refrigerating propane or butane and using a refrigerated cup.

Propane will remain a liquid below –40°F (–40°C) but, even at such low temperatures, a flash point provides no useful information because the presence of flammable gas is assumed in the event of leakage. Flash point has value in dealing with flammable liquids because it advises when to be concerned about ignition of vapors (e.g., gasoline) and when not to be concerned (e.g., motor oil).

Liquids with flash points below 100°F (37.8°C) are classified as Class I (flammable) liquids in NFPA 30, *Flammable and Combustible Liquids Code*. Examples of Class I (flammable) liquids are gasoline and many alcohols. Liquids with a flash point between 100°F and 140°F (37.8°C and 60.0°C) are classified as Class II (combustible) liquids. Examples of Class II (combustible) liquids include diesel fuel and kerosene.

69.3.6.3.5 LP-Gas containers shall be located at least 10 ft (3 m) from the centerline of the wall of diked areas containing flammable or Class II combustible liquids. [**58:**6.5.3.5]

69.3.6.3.6 The minimum horizontal separation between aboveground LP-Gas containers and aboveground tanks containing liquids having flash points below 200°F (93.4°C) shall be 20 ft (6 m). [**58:**6.5.3.6]

Paragraphs 69.3.6.3.5 and 69.3.6.3.6 are intended to keep flammable or combustible liquids from accumulating under or around LP-Gas containers. Paragraph 69.3.6.3.6 addresses the mutual exposure between flammable liquids tanks and LP-Gas containers. This requirement was derived through a cooperative effort between the NFPA technical committees responsible for NFPA 30 and NFPA 58. The minimum separation distance of 20 ft (6 m) facilitates cooling and fire-extinguishing activities by fire departments. Paragraphs 69.3.6.3.7 and 69.3.6.3.8 point out exceptions to this distance where mitigation measures are utilized.

69.3.6.3.7 The requirements of 69.3.6.3.6 shall not apply where LP-Gas containers of 125 gal (0.5 m^3) or less water capacity are installed adjacent to fuel oil supply tanks of 660 gal (2.5 m^3) or less capacity. [**58:**6.5.3.7]

The requirement in 69.3.6.3.7 recognizes the reduced hazard that smaller storage containers present and the fact that many installations are limited in space, making it impractical to comply with the 20 ft (6 m) separation distance. Industry experience has shown that these installations are not a safety problem. The interpretation is that the maximum capacity of both containers must be met for the exception to apply.

69.3.6.3.8 No horizontal separation shall be required between aboveground LP-Gas containers and underground tanks containing flammable or combustible liquids installed in accordance with NFPA 30. [**58:**6.5.3.8]

Δ **69.3.6.3.9*** The minimum separation between LP-Gas containers and oxygen or gaseous hydrogen containers shall be in accordance with NFPA 55. [**58:**6.5.3.9]

A.69.3.6.3.9 Also see NFPA 51 for oxygen systems. [**58:**A.6.5.3.9]

69.3.6.3.10 Where protective structures having a minimum fire resistance rating of 2 hours interrupt the line of sight between uninsulated portions of the oxygen or hydrogen containers and the LP-Gas containers, no minimum distance shall apply. [**58:**6.5.3.10]

Δ **69.3.6.3.11** The minimum separation between LP-Gas containers and liquefied hydrogen containers shall be in accordance with NFPA 55. [**58:**6.5.3.11]

The separation requirements between oxygen, gaseous hydrogen, and liquefied hydrogen containers and systems should be obtained from NFPA 55, *Compressed Gases and Cryogenic Fluids Code*. Rather than recreating those portions of NFPA 55, users are referred to NFPA 55 for complete coverage.

Paragraph 69.3.6.3.10 is an exception to 69.3.6.3.9 and permits an elimination of separation where the required 2-hour fire resistance–rated assembly is installed. This assembly is considered sufficient to protect the container from fire impingement.

69.3.6.3.12 Where LP-Gas cylinders are to be stored or used in the same area with other compressed gases, the cylinders shall be marked to identify their content in accordance with ANSI/CGA C-7, *Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers*. [**58:**6.5.3.12]

69.3.6.3.13 An aboveground LP-Gas container and any of its parts shall not be located within 6 ft (1.8 m) of a vertical plane beneath overhead electric power lines that are over 600 volts, nominal. [**58:**6.5.3.13]

The requirement in 69.3.6.3.13 reflects the possibility of an accident occurring should a power line break and lead to container failure through arc penetration or ignition of the pressure relief valve discharge.

69.3.6.4* Structure Requirements.

A.69.3.6.4 The presence of such structures can create significant hazards, such as the following:

(1) Pocketing of escaping gas
(2) Interference with application of cooling water by fire departments
(3) Redirection of flames against containers
(4) Impeding the egress of personnel in an emergency
[**58:**A.6.5.4]

69.3.6.4.1 Structures such as fire walls, fences, earth or concrete barriers, and other similar structures shall not be permitted around or over installed nonrefrigerated containers unless specifically allowed. [**58:**6.5.4.1]

69.3.6.4.2 Structures partially enclosing containers shall be permitted if designed in accordance with a sound fire protection analysis. [**58:**6.5.4.2]

69.3.6.4.3 Structures used to prevent flammable or combustible liquid accumulation or flow shall be permitted in accordance with 69.3.6.3.4. [**58:**6.5.4.3]

69.3.6.4.4 Structures between LP-Gas containers and gaseous hydrogen containers shall be permitted in accordance with 69.3.6.3.10. [**58:**6.5.4.4]

69.3.6.4.5 Structures such as fences shall be permitted in accordance with 6.21.4 of NFPA 58. [**58:**6.5.4.5]

69.3.7 Location of Transfer Operations.

Subsection 69.3.7 deals with the filling of portable containers and with the filling of stationary containers when not filled at the container (i.e., via fixed piping to a point remote from the container where the filling hose is connected). It does not apply to the filling of stationary containers where the point of transfer is located at the container. Subsection 69.3.7 is not in conflict with Subsection 69.3.5, as is sometimes thought. Subsection 69.3.5 applies to the location of containers, while Subsection 69.3.7 applies to points of transfer, that is, a location where the filling hose connection is made and broken to fill various containers.

Paragraph 69.3.7.1.6 permits a container in a stationary installation to be filled at the container itself as long as it is in compliance with 69.3.5. Where the filling point is piped to another location (not at the container), 69.3.7.2.1 becomes applicable.

The location of portable cylinders being filled is not covered in 69.3.5. The applicable subsection is 69.3.5, with the pertinent requirements found in 69.3.7.2.2. Note that the storage of cylinders awaiting sale or use is covered in Chapter 8 of NFPA 58.

69.3.7.1 Transfer of Liquids.

69.3.7.1.1* Liquid shall be transferred into containers, including containers mounted on vehicles, only outdoors or in structures specially designed for such purpose. [**58:**6.7.1.1]

A.69.3.7.1.1 It is the intent to allow transfer of liquid into containers in open areas under canopies or roofs where 50 percent or more of the perimeter is not enclosed. [**58:**A.6.7.1.1]

The location of portable containers being filled is of concern. If filling is to be done in a building, the building must meet the requirements of Chapter 10 of NFPA 58. It is the intent of those requirements that if filling occurs in a structure open to the outdoors and at least 50 percent of its perimeter is not enclosed, it is considered outdoors.

69.3.7.1.2 The transfer of liquid into containers mounted on vehicles shall not take place within a building but shall be permitted to take place under a weather shelter or canopy. *(See 6.27.3.3 of NFPA 58.)* [**58:**6.7.1.2]

The reference to 6.27.3.3 of NFPA 58 guides the user to more information on the limits of a weather shelter. For example, that referenced paragraph requires that a minimum of 50 percent of the perimeter under a weather shelter or canopy not be enclosed.

69.3.7.1.3 Structures housing transfer operations or converted for such use after December 31, 1972, shall comply with Chapter 10 of NFPA 58. [**58:**6.7.1.3]

69.3.7.1.4 The transfer of liquid into containers on the roofs of structures shall be permitted, provided that the installation conforms to the requirements specified in 6.8.7 and 6.22.11 of NFPA 58. [**58:**6.7.1.4]

69.3.7.1.5 The transfer hose shall not be routed in or through any building except those specified in 69.3.7.1.3. [**58:**6.7.1.5]

The prohibition of routing delivery hoses through buildings resulted from reports in at least one area where row houses are common and where there is no street access for the bobtail to the containers. The shortest route for the hose was into the building through the front door and out the back door to the cylinder. The practice of routing the hose through a building increased the possibility of hose damage and the potential for subsequent leakage in an enclosed area.

69.3.7.1.6 Filling of containers located outdoors in stationary installations in accordance with 69.3.5 shall be permitted to be filled at that location. [**58:**6.7.1.6]

This *Code* requirement, which is often misunderstood, simply states that if the hose end valve of a delivery vehicle is connected to a fill valve that is attached directly to the container, the provisions of 69.3.7 do not apply as long as the container itself has been installed in accordance with the spacing requirements of 69.3.5.

69.3.7.2 Container Point of Transfer Location Requirements.

Δ **69.3.7.2.1** If the point of transfer of containers located outdoors in stationary installations is not located at the container, it shall be located in accordance with Table 69.3.7.2.1. [**58:**6.7.2.1]

Where a portable container is filled, or where the filling connection of a stationary container is located remote from the container, hazards exist that are not addressed by the spacing distances in 69.3.5. These hazards are addressed in Table 69.3.7.2.1, including not only the hazards to the surroundings from the filling process but to the LP-Gas installation from the surroundings as well.

Δ ***TABLE 69.3.7.2.1*** *Distance Between Point of Transfer and Exposures*

Part	Exposure	Minimum Horizontal Distance ft	m
A	Buildings,[a] mobile homes, recreational vehicles, and modular homes with at least 1-hour fire-rated walls[b]	10[c]	3.1
B	Buildings[a] with other than at least 1-hour fire-rated walls[b]	25[c]	7.6[c]
C	Building wall openings or pits at or below the level of the point of transfer	25[c]	7.6[c]
D	Line of adjoining property that can be built upon	25[c]	7.6[c]
E	Outdoor places of public assembly, including schoolyards, athletic fields, and playgrounds	50[c]	15[c]
F	Public ways, including public streets, highways, thoroughfares, and sidewalks		
	(1) From points of transfer for LP-Gas dispensing systems	10	3.1
	(2) From other points of transfer	25[c]	7.6[c]
G	Driveways[d]	5	1.5
H	Mainline railroad track centerlines	25	7.6
I	Containers[e] other than those being filled	10	3.1
J	Flammable and Class II combustible liquid[f] dispensers and the fill connections of containers	10[c]	3.1[c]
K	Flammable and Class II combustible liquid aboveground containers, and filling connections of underground containers	20	6.1
L	Stored or accumulated combustible materials	10	3.1

[a]For the purpose of the table, buildings also include structures such as tents and box trailers at construction sites.

[b]See ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or UL 263, *Standard for Fire Tests for Building Construction and Materials*.

[c]See 69.3.7.3.4.

[d]Not applicable to driveways and points of transfer at vehicle fuel dispensers.

[e]Not applicable to filling connections at the storage container or to dispensing vehicle fuel dispenser units of 4000 gal (15.2 m^3) water capacity or less when used for filling containers not mounted on vehicles.

[f]NFPA 30 defines these as follows: Class I flammable liquids include those having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psia (276 kPa) at 100°F (37.8°C). Class II combustible liquids include those having a flash point at or above 100°F (37.8°C) and below 140°F (60°C).

[**58:** Table 6.7.2.1]

Part A of Table 69.3.7.2.1 includes mobile homes, recreational vehicles (RVs), and modular homes. Part J identifies a safe spacing from points of LP-Gas transfer to flammable liquids, Class II combustible liquids dispensers, and the fill connections of aboveground and underground containers.

Refer to NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, when installing propane-dispensing facilities at service stations that also dispense other vehicle fuels such as gasoline, diesel fuel, compressed natural gas (CNG), and hydrogen.

69.3.7.2.2 Containers not located in stationary installations shall be filled at a location determined by the point of transfer in accordance with Table 69.3.7.2.1. [**58:**6.7.2.2]

69.3.7.3 Separation Distance from Point of Transfer.

69.3.7.3.1 If the point of transfer is a component of a system covered by Section 6.26 or Chapter 11 of NFPA 58, the requirements of parts A, B, and C of Table 69.3.7.2.1 shall not apply to the structure containing the point of transfer. [**58:**6.7.3.1]

69.3.7.3.2 If LP-Gas is vented to the atmosphere under the conditions stipulated in 7.3.1(5) of NFPA 58, the distances in Table 69.3.7.2.1 shall be doubled. [**58:**6.7.3.2]

69.3.7.3.3 If the point of transfer is housed in a structure complying with Chapter 10 of NFPA 58, and the common walls comply with 10.2.1 of NFPA 58, separation distances in Table 69.3.7.2.1 shall not be required where the common walls comply with 10.3.1.3 of NFPA 58. [**58:**6.7.3.3]

The requirements of Chapter 10 of NFPA 58 pertain to buildings or structures housing LP-Gas facilities. Paragraph 10.3.1.3 of NFPA 58 requires a fire resistance rating of at least 1 hour for the common walls that separate the portion of the structure housing the LP-Gas facility from the rest of the structure, with openings protected by a fire door with a rating of at least 1½ hours. In addition, the wall must be designed to withstand a static pressure of 100 lb/ft^2 (4.8 kPa). Under these conditions, the distances in Table 69.3.7.2.1 can be reduced and, because no lower limit is provided, the distances can be reduced to zero. Consultation with the AHJ may be appropriate regarding distance reductions.

69.3.7.3.4 The distances in Table 69.3.7.2.1, parts B, C, D, E, F(2), and J, shall be reduced by one-half where the system incorporates the provisions of low emission transfer as provided in 6.30.5 of NFPA 58. [**58:**6.7.3.4]

69.3.8 Installation of Containers.

69.3.8.1 General Requirements.

69.3.8.1.1 Containers shall be positioned so that the pressure relief valve is in direct communication with the vapor space of the container. [**58:**6.8.1.1]

Positioning the container so that the pressure relief valve is in direct communication with the vapor space is important for several reasons, including minimal release of LP-Gas and cooling by the liquid phase change.

Tilting, inverting, or laying a cylinder on its side so that liquid LP-Gas can be withdrawn is not permitted, in part because liquid in the container comes into contact with the pressure relief device. Liquid withdrawal fittings are available that allow the proper position of the relief valve to be maintained.

Because cylinders do not normally have liquid withdrawal valves, it is common practice when emptying a cylinder at a bulk plant to temporarily orient the container in a way that allows the withdrawal of liquid from the service (vapor) valve. While the container is tilted or otherwise positioned to put the liquid in contact with the service valve, the liquid is also in communication with the pressure relief valve. This action is not a violation of 69.3.8.1.1 because the text addresses containers that are installed. Additionally, when cylinders are inverted to remove liquid, a transfer is occurring and will be attended (see 69.4.2.1.2). Those in attendance will observe any abnormal situations and correct them, something that probably would not be done for an installed container.

Δ **69.3.8.1.2** LP-Gas containers or systems that are installed within 10 ft (3 m) of public vehicular thoroughfares shall be provided with a means of vehicular barrier protection. [**58:**6.8.1.2]

Paragraph 69.3.8.1.2 is intentionally written as a performance requirement and is not meant to provide specific guidelines as to when protection is needed or the nature of the protection. Any potential threat to containers and the means of mitigation of those threats are to be determined by and are the responsibility of the *Code* user or the AHJ.

Discussions about the intent of this paragraph and others dealing with protection are widespread. As a result, a number of different devices and concepts have been proposed. Many of these are included in the annex material associated with the definition for *vehicular barrier protection (VBP)* (see A.3.3.88 of NFPA 58).

The local AHJ should be contacted to determine the expected level of protection and acceptable types of barriers.

69.3.8.1.3 Field welding on containers shall be limited to nonpressure parts such as saddle plates, wear plates, or brackets installed by the container manufacturer. [**58:**6.8.1.3]

Field welding on pressure vessels can be done only by persons qualified in accordance with the relevant pressure vessel code requirements. Heating a pressure vessel can affect the properties of the steel and must not be done unless the individual has the proper knowledge of those effects. Therefore, unless the person possesses the proper qualifications, only those parts of the system that do not affect the pressure vessel itself are permitted to be welded in the field.

Welding on an ASME pressure vessel can be performed only by welders who have received an "R" stamp certification from the NBBI. This certification permits them to repair pressure vessels such as LP-Gas containers. After the weld is complete, the NBBI "R" will be stamped on the vessel near the weld. Exhibit 69.2 shows an "R" stamp certificate.

Paragraph 69.3.8.1.3 does permit welding to take place on parts that are not part of the pressure vessel container, such as saddle plates, wear plates, and brackets.

69.3.8.1.4* Aboveground containers shall be painted. [**58:**6.8.1.4]

A.69.3.8.1.4 Generally, a light-reflecting color paint is preferred unless the system is installed in an extremely cold climate. [**58:**A.6.8.1.4]

Steel LP-Gas cylinders and ASME containers are painted for corrosion protection. Although NFPA 58 does not stipulate paint colors, color does affect the rate of heat absorption from solar radiation and the consequent pressure in the container. This heat absorption can result in operation of a pressure relief device in very warm climates. In very cold climates, a dark color may be appropriate to enhance propane vaporization in the container. Vaporization will not occur below about −40°F (−40°C).

White paint with a titanium oxide pigment is able to reflect 90 to 95 percent of solar light. Yellow paint made with a medium yellow chrome pigment reflects about 80 percent of light. Aluminum reflects about 70 percent. Other colors reflect less than 15 percent, and black reflects no solar radiation.

69.3.8.1.5 Containers shall be installed so that all container operating appurtenances are accessible. [**58:**6.8.1.5]

This requirement prevents containers from being installed with valves, gauges, or controls that are inaccessible. Occasionally a storage container must be evacuated before it is moved or for other reasons. Fittings for container evacuation eliminate the need to roll a container on its side to pump it out. Many other installation situations in which the container appurtenances may not be accessible will occur unless attention is given to the container position before installation.

69.3.8.1.6 Where necessary to prevent flotation due to possible high flood waters around aboveground or mounded containers, or high water table for those underground and partially underground, containers shall be securely anchored. [**58:**6.8.1.6]

Anchorage of ASME containers usually consists of strapping or bolting the container to concrete pads or foundations or by using mobile home–type helix anchors. The design of an anchorage system can be complicated and may require a civil engineer to determine an appropriate method, based on the soil conditions and anticipated flood levels. However, some jurisdictions may have published approved methods for use based on the type of flooding that may occur.

Anchorage of larger cylinders can be accomplished by strapping or chaining through the foot-ring or by strapping over the cylinder. Chaining or strapping the cylinder to a building or other support can anchor smaller cylinders. When using chains to anchor a cylinder, care should be taken not to damage cylinder paint. Anchors are available for securing manufactured housing, and these have been used for propane containers.

In practice, ASME containers are more likely to be anchored than are cylinders. Cylinders, which are usually smaller than ASME containers, might not be anchored because of their smaller size, unless required by local ordinance. Therefore, smaller cylinders can be separated from their connections and be carried away in a flood. Even with their valves open, these cylinders generally do not significantly contribute to overall flood damage, but they can complicate the recovery effort, especially if houses moved by flooding are on top of containers. There are also concerns related to the loss of property (i.e., the containers) and hazards to navigation.

The anchoring system should be designed in such a way as to keep the container from inverting. Anchoring the container by passing cables through only the lifting lugs will rarely prevent the container from inverting, likely causing the container to float upside down and the connecting piping to break and release liquid propane.

69.3.8.2 Installation of Cylinders.

69.3.8.2.1 Cylinders shall be installed only aboveground and shall be set upon a firm foundation or otherwise be firmly secured. *(See 69.3.8.2.2.)* [**58:**6.8.2.1]

Cylinders are designed primarily for transportation purposes with the understanding that they are used as storage for fuel. Cylinders are allowed to be installed below grade, but not buried in the ground. In an earlier edition of NFPA 58, it was written that cylinders could be installed in the niche of a slope or terrace wall as long as the container and regulator did not contact the ground and the compartment or recess was ventilated and drained.

Although traditional materials such as concrete blocks and treated wood may be used, the term "firm foundation" is used in 69.3.8.2.1 to provide a performance criterion that would avoid unnecessary restrictions on the use of innovative materials such as plastics and composite materials. Wood can be used as a foundation for cylinders, but it must be monitored. If the wood rots, it no longer provides a firm foundation and could allow the cylinder to come in contact with the soil; corrosion of the cylinder could then occur.

69.3.8.2.2 The cylinder shall not be in contact with the soil. [**58:**6.8.2.2]

69.3.8.2.3 Flexibility shall be provided in the connecting piping. *(See 69.3.8.2.4.)* [**58:**6.8.2.3]

Flexibility in the connecting piping is generally obtained by the use of a "pigtail," which is a short length of copper tubing with connectors on both ends. Pigtails are available from suppliers in a variety of lengths and are shipped without bends. They are bent into a circular shape when installed. Pigtails connect the cylinder service valve to the regulator that is attached to the piping system downstream. Copper is a good material for this use because it allows small amounts of vibration and movement due to settling without fracturing the connector. However, significant vibration and repeated movement can cause copper to become brittle and fail. If that occurs, a pigtail with a larger diameter may be successful; otherwise, an alternative means must be provided.

69.3.8.2.4 Where flexible connectors are used, they shall comply with 6.11.6 of NFPA 58. [**58:**6.8.2.4]

69.3.9 Internal Valves.

69.3.9.1 The requirements of 69.3.9.2 through 69.3.9.5 shall be required for internal valves in liquid service that are installed in containers of over 4000 gal (15.2 m^3) water capacity by July 1, 2003. [**58:**6.13.1]

69.3.9.2 Internal valves shall be installed in accordance with 5.9.4.2 and Table 5.9.4.2 of NFPA 58 on containers of over 4000 gal (15.2 m^3) water capacity. [**58:**6.13.2]

69.3.9.3 Thermal Activation.

69.3.9.3.1 Automatic shutdown of internal valves in liquid service shall be provided using thermal (fire) actuation. [**58:**6.13.3.1]

69.3.9.3.2 The thermal sensing element of the internal valve shall be within 5 ft (1.5 m) of the internal valve. [**58:**6.13.3.2]

69.3.9.4 Remote Shutdown Station.

69.3.9.4.1 At least one remote shutdown station for internal valves in liquid service shall be installed in accordance with the following:

(1) Not less than 25 ft (7.6 m) or more than 100 ft (30 m) from the liquid transfer point
(2) Not less than 25 ft (7.6 m) from the internal valves that are being controlled
(3) Along a path of egress from the liquid transfer point

[**58:**6.13.4.1]

69.3.9.4.2 This requirement shall be retroactive to all internal valves required by NFPA 58. [**58:**6.13.4.2]

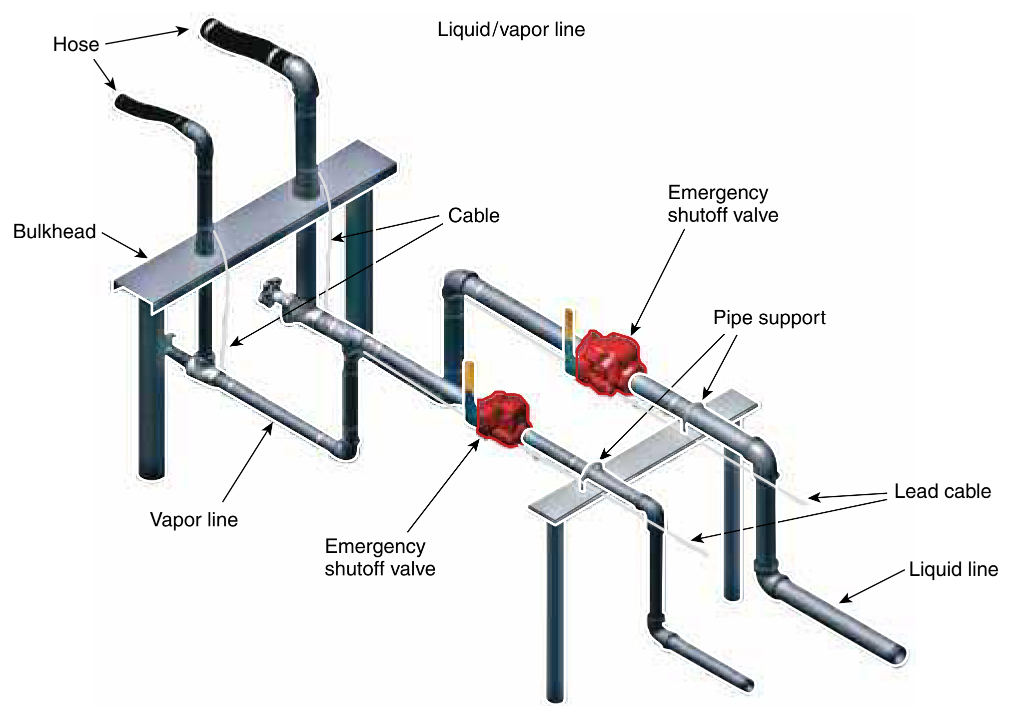
69.3.9.5 Emergency remote shutdown stations shall be identified by a sign, visible from the point of transfer, incorporating the words "Propane — Container Liquid Valve Emergency Shutoff" in block letters of not less than 2 in. (51 mm) in height on a background of contrasting colors to the letters. [**58:**6.13.5]

69.3.10 Emergency Shutoff Valves.

Subsection 69.3.10 requires both an automatic and a manual means of stopping the escape of LP-Gas, other than by an excess-flow check valve, from the storage container downstream of the emergency shutoff valve (ESV). There are installations in which the container capacity exceeds 4000 gal (15.2 m^3) — which would require an ESV — but the size of the hoses or swivel-type piping for handling liquid and vapor is smaller than 1½ in. (39 mm) and 1¼ in. (32 mm), respectively, so an ESV is not required.

Exhibit 69.15 shows how ESVs are installed. Two ESVs are shown in the drawing, one for liquid and one for vapor, as is commonly used for transfers to and from bobtails, transports, and railcars. Pull-away protection is accomplished by the bulkhead, which anchors the plant-side piping if the hose is pulled away by the vehicle. This installation uses a mechanically operated

Exhibit 69.15



Installation of emergency shutoff valves at unloading station. (Courtesy of RegO® Products)

ESV. Note the lead cables leading away from the hoses. These are connected to the shutoff point required in 69.3.10.12.1 and close the ESV when pulled. The cable on the vehicle side of the ESV demonstrates a way to shut off the valve if a pull-away occurs, in which case the cable will be pulled by the hose or dislocated piping, closing the valve. This method is not specifically required by NFPA 58, but it is an inexpensive way to provide a quicker closing of an ESV in a pull-away incident.

69.3.10.1 On new installations and on existing installations, stationary container storage systems with an aggregate water capacity of more than 4000 gal (15.2 m^3) utilizing a liquid transfer line that is 1½ in. (39 mm) or larger, and a pressure equalizing vapor line that is 1¼ in. (32 mm) or larger, shall be equipped with emergency shutoff valves. [**58:**6.14.1]

69.3.10.2 An emergency shutoff valve shall be installed in the transfer lines of the fixed piping transfer system within 20 ft (6 m) of lineal pipe from the nearest end of the hose or swivel-type piping connections. [**58:**6.14.2]

69.3.10.3 When the flow is only into the container, a backflow check valve shall be permitted to be used in lieu of an emergency shutoff valve if installed in the piping transfer system downstream of the hose or swivel-type piping connections. [**58:**6.14.3]

69.3.10.4 The backflow check valve shall have a metal-to-metal seat or a primary resilient seat with metal back-up, not hinged with combustible material, and shall be designed for this specific application. [**58:**6.14.4]

69.3.10.5 Where there are two or more liquid or vapor lines with hoses or swivel-type piping connected of the sizes designated, an emergency shutoff valve or a backflow check valve, where allowed, shall be installed in each leg of the piping. [**58:**6.14.5]

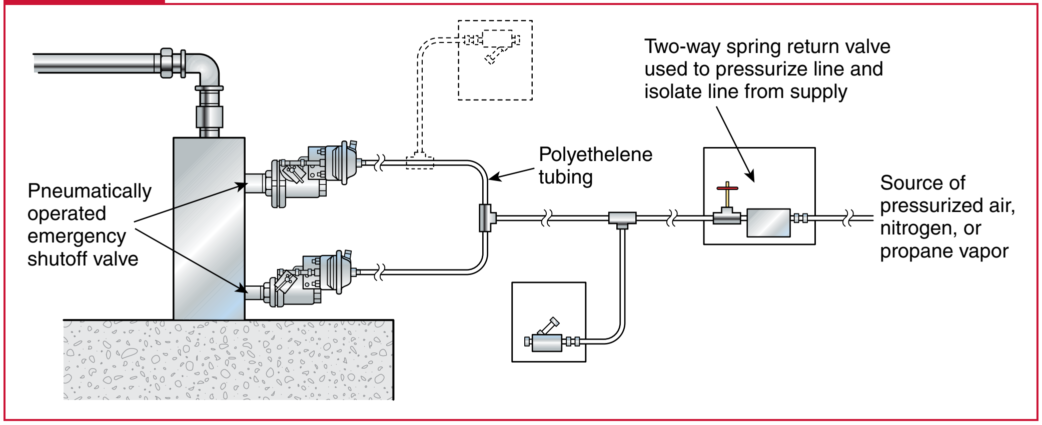
Where flow is in two directions, an ESV is required in each leg. Listing of ESVs is not required, but most manufacturers elect to list the valves because listing assists in the approval process. Where flow is only into the container, a check valve can be used, provided it is "designed for the specific application." Although that particular phrase is not defined in NFPA 58, it is intended to indicate a check valve that will be able to withstand the forces and flows of the fluid on the valve and its moving parts over an extended time where it is used.

Exhibit 69.16 illustrates a pneumatically operated ESV (See Exhibit 69.15 for a mechanically operated ESV).

69.3.10.6 Emergency shutoff valves shall be installed so that the temperature-sensitive element in the valve, or a supplemental temperature-sensitive element that operates at a maximum temperature of 250°F (121°C) that is connected to actuate the valve, is not more than 5 ft (1.5 m) from the nearest end of the hose or swivel-type piping connected to the line in which the valve is installed. [**58:**6.14.6]

Automatic actuation of an ESV occurs when the element that is part of or attached to the valve reacts to the heat from a fire. The element could be the pressurized plastic tubing that carries the compressed air, nitrogen, or LP-Gas vapor (see Section 6.12

Exhibit 69.16



Installation of pneumatically operated emergency shutoff valve. (Courtesy of National Propane Gas Association)

of NFPA 58) used to operate the ESV. The loss of pressure in the plastic tubing causes the reaction of the ESV. If the tubing is installed along the piping system, it will react before the LP-Gas in the piping would react.

Paragraph 69.3.10.6 states that a supplemental element within 5 ft (1.5 m) of the ESV can be installed in lieu of incorporating the temperature-sensitive element in the ESV. Some installations utilize additional elements to shut the valve in the event of fire in a location remote from the ESV.

69.3.10.7 Temperature-sensitive elements of emergency shutoff valves shall not be painted, nor shall they have any ornamental finishes applied after manufacture. [**58:**6.14.7]

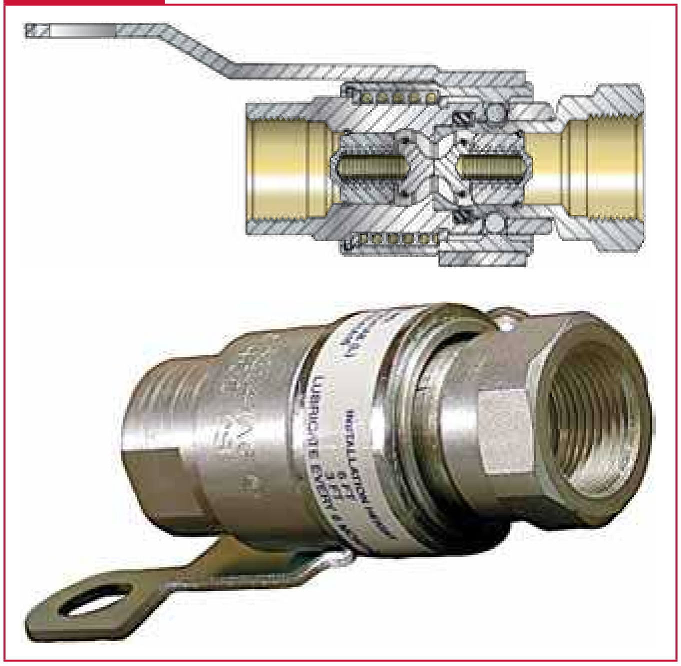
69.3.10.8* The emergency shutoff valves or backflow check valves shall be installed in the fixed piping so that any break resulting from a pull will occur on the hose or swivel-type piping side of the connection while retaining intact the valves and piping on the plant side of the connection. [**58:**6.14.8]

A.69.3.10.8 Anchorage can be accomplished by the use of concrete bulkheads or equivalent anchorage or by the use of a weakness or shear fitting. [**58:**A.6.14.8]

The feature described in 69.3.10.8 is commonly referred to as "pull-away protection." The valve or the piping system is designed so that if the vehicle moves away without disconnecting from the system, the piping system breaks in such a way that the vehicle side fails instead of the plant side. This ensures a smaller quantity of product is released than if the plant side of the system were to fail. Exhibit 69.15 shows one common way to accomplish "pull-away protection." Exhibit 69.17 illustrates a pull-away valve. This provision also applies to transfer from railroad tank cars directly into tank trucks with no intermediate storage. The code requires the same safety and pull-away protection for trackside transfer as for fixed installations.

69.3.10.9 Where emergency shutoff valves are required to be installed in accordance with 69.3.10.2, a means shall be incorporated to actuate the emergency shutoff valves in the event of a break of the fixed piping resulting from a pull on the hose. [**58:**6.14.9]

Exhibit 69.17



Pull-away valve. (Courtesy of RegO® Products)

69.3.10.10 Emergency shutoff valves required by NFPA 58 shall be tested annually for the functions required by 5.13.2.3(2) and (3) of NFPA 58, and the results of the test shall be documented. [**58:**6.14.10]

This requirement references 5.13.2.3 of NFPA 58 and includes testing for activation of the ESV by manual shutoff at the installed location and by manual shutoff from the remote location.

The test method for ESVs is not specified in NFPA 58; the valves can be tested in place by releasing propane from a storage tank into the atmosphere or into an empty bobtail for transport. The valves can also be removed and tested in a test facility.

Documentation of these tests is important so the AHJ can verify that the tests were done. Without documentation, many AHJs view the testing as not having occurred, spurring the common phrase, "Document it or it did not happen." In some areas, the AHJ requests permission to observe the tests. In locations where the AHJ performs an inspection that includes testing the ESVs, and a written record of the test exists, that test and record meet the requirements of 6.13.10 of NFPA 58.

69.3.10.11 Backflow check valves installed in lieu of emergency shutoff valves shall be checked annually for proper operation, and the results of the test shall be documented. [**58:**6.14.11]

69.3.10.12 All new and existing emergency shutoff valves shall comply with 69.3.10.12.1 through 69.3.10.12.3. [**58:**6.14.12]

69.3.10.12.1 Each emergency shutoff valve shall have at least one clearly identified and easily accessible manually operated remote emergency shutoff device. [**58:**6.14.12.1]

69.3.10.12.2 The shutoff device shall be located not less than 25 ft (7.6 m) or more than 100 ft (30 m) in the path of egress from the emergency shutoff valve. [**58:**6.14.12.2]

69.3.10.12.3 Where an emergency shutoff valve is used in lieu of an internal valve in compliance with 5.9.4.2(D)(2) of NFPA 58, the remote shutoff device shall be installed in accordance with 69.3.9.4 and 69.3.9.5. [**58:**6.14.12.3]

Note that the phrase "new and existing" in 69.3.10.12 makes the requirements in 69.3.10.12.1 through 69.3.10.12.3 retroactive to all installations.

In addition to automatic actuation, an ESV must be installed so that it can be operated manually both from a remote location and from its installed location. The term *remote* describes the ability to activate the ESV from a location far enough from the point of transfer to be considered safe. Here, in the installation chapter, *remote* has been mandated to be between 25 ft and 100 ft (7.6 m and 30 m) from the valve and in the path of egress from where the ESV is installed.

In some locations, strict compliance with the distance requirement can present problems. For instance, if the section of a yard from 20 ft to 110 ft (6 m to 33.5 m) from the valve is where trucks travel, putting the remote location at exactly 100 ft (30 m) may mean it is likely to be destroyed by a passing truck. In that case, the AHJ could approve a location at 115 ft (35 m) in accordance with Section 1.4. The intent of having the remote location in the path of egress recognizes that the transfer employee will be better able to actuate the remote closure device while utilizing this path. It will also keep from drawing the transfer employee further into the site, possibly into a more dangerous location. The path of egress is generally considered to be along the same path used to enter the facility, especially when the site is fenced.

69.3.10.13 Emergency shutoff valves for railroad tank car transfer systems shall be in accordance with 6.21.2.6, 6.30.4, 7.2.3.7, and 7.2.3.8 of NFPA 58. [**58:**6.14.13]

69.3.11* Installation in Areas of Heavy Snowfall.

A.69.3.11 Gas leaks have resulted from snow or ice accumulations on gas systems, and snow or ice shedding from roofs onto gas systems. In these incidents, external fires have occurred and in some cases gas has migrated into or under buildings, resulting in interior fires or explosions. Selection of appropriate methods of protection should be based upon the installation and anticipated snow and or ice loading. Possible methods of protection include the following:

(1) Minimizing the extent of above-ground piping.
(2) Locating above-ground piping, regulators, and meters above anticipated snow accumulations.
(3) Locating above-ground piping, regulators and meters on the gable end of buildings, rather than under eaves, to prevent damage from snow or ice shedding off of roofs.
(4) Protecting above-ground piping, regulators, and meters with extended roof overhangs or dedicated covers.
(5) Adding additional support above-ground piping, regulators and meters to withstand anticipated snow or ice loading.

[**58:**A.6.18]

N **69.3.11.1** In areas where the ground snow load is equal to or exceeds 100 psf (488 kg/m^2), piping, regulators, meters, and other equipment installed in the piping system shall be protected from the forces of accumulated snow. [**58:**6.18.1]

The application of this requirement has been expanded in the 2017 edition of NFPA 58 to include any locations that exceed 100 psf (488 kgf/m^2). The definition of *ground snow load* was changed in the 2017 edition of NFPA 58; it now includes reference to ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, and the 50-year ground snow load.

The force of accumulated snow can damage piping, meters, and regulators outside of buildings. Exhibit 69.18 shows a method of meter protection that can be used in areas prone to heavy snowfall. Specific protection requirements are not mandated because it is difficult to make one rule that covers all potential snowfalls. Several municipalities in the area of the Sierra Nevada Mountains have enacted specific rules on the subject of heavy snowfall that can be used as a potential model for installation requirements.

69.3.12 LP-Gas Systems in Buildings or on Building Roofs or Exterior Balconies.

69.3.12.1 Application.

Δ **69.3.12.1.1** Subsection 69.3.12 shall apply to the installation of the following LP-Gas systems in buildings or structures:

(1) Cylinders inside of buildings or on the roofs or exterior balconies of buildings
(2) Systems in which the liquid is piped from outside containers into buildings or onto the roof

[**58:**6.22.1.1]

Exhibit 69.18

A method of meter protection in heavy snow areas. (Courtesy of Dead River Company)

69.3.12.1.2 The phrase *cylinders in use* shall mean connected for use. [**58:**6.22.1.2]

69.3.12.1.2.1 The use of cylinders indoors shall be only for the purposes specified in 6.22.4 through 6.22.10 of NFPA 58. [**58:**6.22.1.2(A)]

69.3.12.1.2.2 The use of cylinders indoors shall be limited to those conditions where operational requirements make the indoor use of cylinders necessary and location outside is impractical. [**58:**6.22.1.2(B)]

The use of cylinders indoors, as well as on balconies and roofs of buildings, is permitted only for the purposes specified in 6.22.4 through 6.22.10 of NFPA 58. All other uses, including normal, routine comfort heating, are prohibited. Cylinder systems having capacities larger than 1 lb (0.45 kg) of LP-Gas and the associated storage of such cylinders indoors are limited to the following uses:

- Construction and renovation of buildings
- Industrial applications
- Education
- Research
- Training
- Temporary heating in cases of emergency

These limited applications acknowledge the good experience and presence of trained personnel in industrial uses and the temporary nature and lack of alternative fuel sources for certain appliances needed at certain times in buildings.

Where the indoor use of LP-Gas cylinders is permitted, the user or installer must first attempt to locate the cylinders outdoors. Only if it is impractical to locate the cylinders outdoors is the installer permitted to locate the cylinders indoors. In determining whether an outdoor location is impractical, consultation with the AHJ may be required.

69.3.12.1.2.3 The use of cylinders on roofs shall be limited to those conditions where operational requirements make the use of cylinders necessary and location other than on roofs of buildings or structures is impractical. [**58:**6.22.1.2(C)]

Provisions for the installation of cylinders on roofs were originally incorporated into the *Code* to provide fuel for emergency generators and microwave relay stations. The provisions also have been applied where providing cylinders on roofs that serve penthouses and in hospitals. Again, such systems are permitted only where the use of cylinders is necessary and other outdoor locations are impractical.

69.3.12.1.2.4 Liquid LP-Gas shall be piped into buildings or structures only for the purposes specified in 6.11.1.1(D) of NFPA 58. [**58:**6.22.1.2(D)]

Although LP-Gas vapor at pressures up to and including 20 psig (138 kPag) can be piped into buildings, there are certain limitations for piping liquid LP-Gas at pressures exceeding 20 psig (138 kPag) into buildings. These limitations are covered in 6.11.1.1 and 6.11.1.3 of NFPA 58. Liquid LP-Gas piping into buildings or structures is also limited due to the hazards of a release. After reaching atmospheric pressure, liquid LP-Gas will instantly change states to a vapor, and the flow rate of fuel through a leak would be much higher than if it were vapor piping.

69.3.12.1.3 Storage of cylinders awaiting use shall be in accordance with Chapter 8 of NFPA 58. [**58:**6.22.1.3]

69.3.12.1.4 Transportation of cylinders within a building shall be in accordance with 6.22.3.6 of NFPA 58. [**58:**6.22.1.4]

Δ **69.3.12.1.5** The following provisions shall be required in addition to those specified in Sections 6.2 and 6.4 of NFPA 58:

(1) Liquid transfer systems shall be in accordance with Chapter 7 of NFPA 58.
(2) Engine fuel systems used inside buildings shall be in accordance with Chapter 11 of NFPA 58.
(3) LP-Gas transport or cargo tank vehicles stored, serviced, or repaired in buildings shall be in accordance with Chapter 9 of NFPA 58.

[**58:**6.22.1.5]

69.3.12.2 Additional Equipment Requirements for Cylinders, Equipment, Piping, and Appliances Used in Buildings, Building Roofs, and Exterior Balconies.

69.3.12.2.1 Cylinders shall be in accordance with the following:

(1) Cylinders shall not exceed 245 lb (111 kg) water capacity [nominal 100 lb (45 kg) propane capacity] each.

Basic considerations are given in 69.3.12.2.1 regarding the type of cylinder to be used. The cylinder must have a maximum

LP-Gas capacity of 100 lb (45 kg). This size is the largest size that can be easily moved by personnel from a practical standpoint. There have been some 500 gal (1.9 m^3) ASME tanks used at different floor levels on large construction sites. Such use was, and continues to be, prohibited by the *Code*. The NFPA 58 approach to the use of ASME bulk tanks is to locate them at ground level on the outside or on the roof (with approval of the AHJ) and pipe the LP-Gas into the building.

(2) Cylinders shall comply with other applicable provisions of Section 5.2 of NFPA 58, and they shall be equipped as provided in Section 5.9 of NFPA 58.
(3) Cylinders shall be marked in accordance with 5.2.8.1 and 5.2.8.2 of NFPA 58.
(4) Cylinders with propane capacities greater than 2 lb (0.9 kg) shall be equipped as provided in Table 5.9.4.1(B) of NFPA 58, and an excess-flow valve shall be provided for vapor service when used indoors.

The requirements in items (2) through (4) refer the code user to Table 5.9.4.1(B) of NFPA 58 for the proper appurtenances to be installed on the cylinder. This table has two separate columns for cylinders, and the requirements differ based on the type of service.

In addition to the requirements of Table 5.9.4.1(B) of NFPA 58, cylinders in vapor service used indoors must have an excess-flow valve installed per 69.3.12.2.1(4). This provides a higher level of safety by providing excess-flow protection in the event of a pipe or hose failure inside a building; therefore, standard vapor service cylinders — including those used for gas grills — cannot be used in buildings unless they are fitted with an excess-flow valve. The excess-flow valve must be selected for proper closing flow, and sizing can be difficult for those used on portable cylinders because the flow can vary with tank pressure (and temperature) and with the length of the discharge hose or piping.

(5) Cylinder valves shall be protected in accordance with 5.2.6.1 of NFPA 58.

Item (5) refers to 5.2.6.1 of NFPA 58, which requires that all cylinder valves be protected against physical damage by a ventilated cap or collar. Recessing the valve into the container is also permitted by DOT cylinder regulations, but this procedure is rarely used for LP-Gas cylinders. Note that when a removable cap is used, it must be in place when the container is not in use.

(6) Cylinders having water capacities greater than 2.7 lb (1.2 kg) and connected for use shall stand on a firm and substantially level surface.

The term *firm (surface)* is used here, but it is not defined in the *Code*. It is intended to mean a level surface on which the cylinder will not sink or tip due to its weight. Concrete and masonry surfaces can be used, but they are not required for cylinders in buildings.

(7) Cylinders shall be secured in an upright position if necessary.

The requirement in item (7) emphasizes the importance of maintaining the cylinder in the proper orientation so that the following occurs:

- The pressure relief device is in communication with the vapor space in the cylinder (see commentary following 69.5.2.1.2 for more information on why a vapor discharge is favorable over a liquid discharge on a cylinder).
- Stress is not placed on piping attached to the cylinder, which could cause a break or leakage.
- The cylinder is not subject to impact if there is traffic nearby.

(8) Cylinders and the valve-protecting devices used with them shall be oriented to minimize the possibility of impingement of the pressure relief device discharge on the cylinder and adjacent cylinders.

[**58:**6.22.2.1]

As required in 69.3.12.2.1(8), it is important that the cylinder pressure relief discharge be directed through a hole in the cap or collar. In positioning a group of cylinders, attention should be given to ensure that pressure relief valves are not directed at adjacent cylinders.

69.3.12.2.2 Manifolds and fittings connecting cylinders to pressure regulator inlets shall be designed for at least 250 psig (1.7 MPag) service pressure. [**58:**6.22.2.2]

Because the manifold will be carrying gas at the same pressure as the gas in the cylinder, it must be designed with a pressure rating of at least 250 psig (1.7 MPag).

69.3.12.2.3 Piping shall comply with Section 5.11 of NFPA 58 and shall have a pressure rating of 250 psig (1.7 MPag). [**58:**6.22.2.3]

69.3.12.2.4 Liquid piping and vapor piping at pressures above 125 psig (0.9 MPag) shall be installed in accordance with 6.11.3 of NFPA 58. [**58:**6.22.2.4]

Δ **69.3.12.2.5** Hose, hose connections, and flexible connectors shall comply with the following:

(1) Hose used at pressures above 5 psig (34 kPag) shall be designed for a pressure of at least 350 psig (2.4 MPag).
(2) Hose used at a pressure of 5 psig (34 kPag) or less and used in agricultural buildings not normally occupied by the public shall be designed for the operating pressure of the hose.

The allowance in item (2) provides an alternative to the hose designed for a pressure of 350 psig (2.4 MPag) if the hose is to be used at low pressures of 5 psig (34 kPag) in agricultural buildings not normally occupied by the public. This alternative came about because LP-Gas installations are frequently located in buildings used for poultry breeding, and the 350 psig (2.4 MPag) hose was a problem due to its stiffness and resulted in kinking where bends were needed. The paramount life safety concerns in 69.3.12 are relaxed for poultry breeding and similar agricultural buildings, which are infrequently occupied by people.

(3) Hose shall comply with 5.10.6 of NFPA 58.
(4) Hose shall be installed in accordance with 6.23.4 of NFPA 58.
(5) Hose shall be as short as practical, without kinking or straining the hose or causing it to be close enough to a burner to be damaged by heat.
(6) Hoses greater than 10 ft (3 m) in length shall be protected from damage.

[**58:**6.22.2.5]

Although basic provisions for hose are given by reference to 5.10.6 of NFPA 58 in (3) (note: The *Code* contains an error and section 69.3.12.2.5(3) should reference 5.11.6 of NFPA 58), the following two important exceptions are taken:

1. Hose used in buildings must be designed for a 350 psig (2.4 MPag) working pressure. This requirement is intended not only to account for the pressures involved, but to ensure that a stronger type of hose is used in this service. This is particularly a concern at construction sites where abrasions and damage due to rough usage can be encountered. [Note that this hose is required in 5.11.6.4 of NFPA 58 only for pressures over 5 psig (34 kPag) used in all other applications.]
2. The length of hose is not restricted to a specific length for connecting to appliances [see 6.23.4.2(1) of NFPA 58], although it must be kept as short as is practical. In addition, if the length of hose exceeds 10 ft (3 m), either it must be installed in a manner that protects it from damage or additional external protective devices, such as conduit, must be used.

Δ **69.3.12.2.6*** Portable heaters, including salamanders, shall comply with the following:

(1) Portable heaters shall be equipped with an approved automatic device to shut off the flow of gas to the main burner and to the pilot, if used, in the event of flame extinguishment or combustion failure.
(2) Portable heaters shall be self-supporting unless designed for cylinder mounting.
(3) Portable heaters shall not be installed utilizing cylinder valves, connectors, regulators, manifolds, piping, or tubing as structural supports.
(4) Portable heaters having an input of more than 50,000 Btu/hr (53 MJ/hr) shall be equipped with either a pilot that must be lighted and proved before the main burner can be turned on or an approved electric ignition system.

[**58:**6.22.2.6]

A.69.3.12.2.6 The requirement for a pilot or an electronic ignition system became effective for heaters with inputs over 50,000 Btu/hr manufactured on or after May 17, 1967. [**58:**A.6.22.2.6]

Paragraph 69.3.12.2.6 is intended to provide basic requirements for AHJs to use in approving portable heaters. Although standards exist for the listing of portable heaters, not all heaters are tested and listed.

Δ **69.3.12.2.7** The provisions of 69.3.12.2.6 shall not be applicable to the following:

(1) Tar kettle burners, hand torches, or melting pots
(2) Portable heaters with less than 7500 Btu/hr (8 MJ/hr) input if used with cylinders having a maximum water capacity of 2.7 lb (1.2 kg) and filled with not more than 16.8 oz (0.522 kg) of LP-Gas

[**58:**6.22.2.7]

All portable heaters used indoors must have flame failure protection except for the following:

- Attended appliances, such as tar kettle burners, hand torches, or melting pots
- Smaller heaters of less than 7500 Btu (8 MJ/hr) capacity connected to a 1 lb (0.45 kg) LP-Gas cylinder

Flame failure protection is provided by an approved automatic device that shuts off the flow of gas to the main burner and the pilot (where a pilot is used) if the flame is not sensed. Additionally, these small portable heaters designed for cylinder mounting must not use valves, piping, regulators, or other equipment as structural supports for the heater.

If the provisions of 69.3.12.2.7 are not followed, the possibility of operators being burned during the ignition of heaters may exist when they use larger heaters designed to operate at higher inlet pressures. Unless a proven pilot light or electronic ignition is used, a large flame rollout can occur. Pilots on these larger heaters may experience premature thermocouple failure or outages due to wind or other factors. Another problem occurs if operators bypass these controls.

The intent of this system is to prevent the release of large amounts of unignited gas, which can result in an explosion/fire hazard.

69.3.12.3 Buildings Under Construction or Undergoing Major Renovation.

Δ **69.3.12.3.1** Where cylinders are used and transported in buildings or structures under construction or undergoing major renovation and such buildings are not occupied by the public, the requirements of 69.3.12.3.2 through 69.3.12.3.10 shall apply. [**58:**6.22.4.1]

69.3.12.3.2 The use and transportation of cylinders in the unoccupied portions of buildings or structures under construction or undergoing major renovation that are partially occupied by the public shall be approved by the AHJ. [**58:**6.22.4.2]

This requirement specifically extends coverage to the movement and use of cylinders in buildings that are under construction or undergoing major renovation. The term *major renovation* is not defined in NFPA 58, therefore the AHJ should be consulted before cylinders are used in a building being renovated. Buildings undergoing minor renovations are addressed in 69.3.12.4. Approval is required prior to the use or transport of cylinders in unoccupied portions of buildings that are partially occupied by the public.

69.3.12.3.3 Cylinders, equipment, piping, and appliances shall comply with 69.3.12.2. [**58:**6.22.4.3]

69.3.12.3.4 Heaters used for temporary heating shall be located at least 6 ft (1.8 m) from any cylinder. (*See 69.3.12.3.5 for an exception to this requirement.*) [**58:**6.22.4.4]

69.3.12.3.5 Integral heater-cylinder units specifically designed for the attachment of the heater to the cylinder, or to a supporting standard attached to the cylinder, and designed and installed to prevent direct or radiant heat application to the cylinder shall be exempt from the spacing requirement of 69.3.12.3.4. [**58:**6.22.4.5]

69.3.12.3.6 Blower-type and radiant-type units shall not be directed toward any cylinder within 20 ft (6.1 m). [**58:**6.22.4.6]

The concern behind 69.3.12.3.4 through 69.3.12.3.6 is the protection of cylinders used to fuel heating appliances from overheating from proximity to another heating appliance. Overheating can result in the release of propane through the pressure relief device. A minimum 6 ft (1.8 m) separation between heaters used for temporary heating and other LP-Gas cylinders is required under all circumstances. In addition, blower-type and radiant-type heaters cannot be directed toward any cylinder within a 20 ft (6.1 m) distance. The infrared or larger blower-type units have a more pronounced effect on heat transmission in the direction they are aimed; therefore, the greater separation distance to cylinders is required.

69.3.12.3.7 If two or more heater-cylinder units of either the integral or nonintegral type are located in an unpartitioned area on the same floor, the cylinder(s) of each such unit shall be separated from the cylinder(s) of any other such unit by at least 20 ft (6.1 m). [**58:**6.22.4.7]

69.3.12.3.8 If heaters are connected to cylinders manifolded together for use in an unpartitioned area on the same floor, the total water capacity of cylinders manifolded together serving any one heater shall not be greater than 735 lb (333 kg) [nominal 300 lb (136 kg) propane capacity]. If there is more than one such manifold, it shall be separated from any other by at least 20 ft (6.1 m). [**58:**6.22.4.8]

The LP-Gas maximum of 300 lb (136 kg) for manifolded systems has a long history in NFPA 58. A distance of 20 ft (6.1 m) is set out for the separation of different manifolded systems in the same unpartitioned floor area.

69.3.12.3.9 Where cylinders are manifolded together for connection to a heater(s) on another floor, the following shall apply.

(1) Heaters shall not be installed on the same floors with manifolded cylinders.
(2) The total water capacity of the cylinders connected to any one manifold shall not be greater than 2450 lb (1111 kg) [nominal 1000 lb (454 kg) propane capacity]
(3) Manifolds of more than 735 lb (333 kg) water capacity [nominal 300 lb (136 kg) propane capacity], if located in the same unpartitioned area, shall be separated from each other by at least 50 ft (15 m).

[**58:**6.22.4.9]

Where cylinders are installed on a floor level different from that where the heaters are located, the allowable quantities of propane gas are greater. This is due to the fact that the heaters represent a source of ignition and pose less of a threat when they are not on the same floor level as the cylinders.

69.3.12.3.10 Where compliance with the provisions of 69.3.12.3.6 through 69.3.12.3.9 is impractical, alternate installation provisions shall be allowed with the approval of the AHJ. [**58:**6.22.4.10]

69.3.12.4 Buildings Undergoing Minor Renovation When Frequented by the Public.

Δ **69.3.12.4.1** Cylinders used and transported for repair or minor renovation in buildings frequented by the public during the hours the public normally occupies the building shall comply with the following:

(1) The maximum water capacity of individual cylinders shall be 50 lb (23 kg) [nominal 20 lb (9.1 kg) propane capacity], and the number of cylinders in the building shall not exceed the number of workers assigned to the use of the propane.
(2) Cylinders having a water capacity greater than 2.7 lb (1.2 kg) shall not be left unattended.

[**58:**6.22.5.1]

69.3.12.4.2 During the hours the building is not open to the public, cylinders used and transported within the building for repair or minor renovation and with a water capacity greater than 2.7 lb (1.2 kg) shall not be left unattended. [**58:**6.22.5.2]

Building renovation during hours when the public is present requires special considerations. For example, the number of cylinders must not exceed the number of workers assigned to them, and the cylinders are not to be left unattended at any time.

When the building is not occupied by the general public, 69.3.12.4.2 lifts the restrictions on cylinder size and number of cylinders in the space.

69.3.12.5 Buildings Housing Industrial Occupancies.

69.3.12.5.1 Cylinders used in buildings housing industrial occupancies for processing, research, or experimental purposes shall comply with 69.3.12.5.1.1 and 69.3.12.5.1.2. [**58:**6.22.6.1]

69.3.12.5.1.1 If cylinders are manifolded together, the total water capacity of the connected cylinders shall be not more than 735 lb (333 kg) [nominal 300 lb (136 kg) propane capacity]. If there is more than one such manifold in a room, it shall be separated from any other by at least 20 ft (6.1 m). [**58:**6.22.6.1(A)]

69.3.12.5.1.2 The amount of LP-Gas in cylinders for research and experimental use in the building shall be limited to the smallest practical quantity. [**58:**6.22.6.1(B)]

69.3.12.5.2 The use of cylinders to supply fuel for temporary heating in buildings housing industrial occupancies with essentially noncombustible contents shall comply with the requirements in 69.3.12.3 for cylinders in buildings under construction. [**58:**6.22.6.2]

69.3.12.5.3 The use of fuel cylinders for temporary heating shall be permitted only where portable equipment for space heating is essential and a permanent heating installation is not practical. [**58:**6.22.6.3]

69.3.12.6 Buildings Housing Educational and Institutional Occupancies.

69.3.12.6.1 The use of cylinders in classrooms shall be prohibited unless they are used temporarily for classroom demonstrations in accordance with 69.3.12.8.1. [**58:**6.22.7.1]

Δ **69.3.12.6.2** Where cylinders are used in buildings housing educational and institutional laboratory occupancies for research and experimental purposes, the following shall apply:

(1) The maximum water capacity of individual cylinders used shall be 50 lb (23 kg) [nominal 20 lb (9.1 kg) propane capacity] if used in educational occupancies and 12 lb (5.4 kg) [nominal 5 lb (2 kg) propane capacity] if used in institutional occupancies.
(2) If more than one such cylinder is located in the same room, the cylinders shall be separated by at least 20 ft (6.1 m).
(3) Cylinders not connected for use shall be stored in accordance with Chapter 8 of NFPA 58.
(4) Cylinders shall not be stored in a laboratory room.

[**58:**6.22.7.2]

The maximum size cylinder for educational buildings is 20 lb (9.1 kg) of propane and 5 lb (2 kg) of propane for institutional occupancies, with a separation of 20 ft (6.1 m) if more than one container is located in the same room. Containers are not allowed in classrooms unless they are used in accordance with 69.3.12.8.1 for demonstration purposes. The storage of containers in educational and institutional occupancies must be in accordance with Chapter 8 of NFPA 58.

Note that the NFPA *101* definition of an educational occupancy covers through high school (grade 12). Educational facilities beyond grade 12 are generally considered to be the following occupancies:

- Instructional building: business occupancy
- Classrooms under 50 persons: business occupancy
- Classrooms 50 persons and over: assembly occupancy
- Laboratories, instructional: business occupancy
- Laboratories, noninstructional: industrial occupancy

For additional information, see NFPA *101* for proper occupancy classification of educational facilities beyond grade 12. Note that NFPA *101* classifications are for life safety purposes. The limits of propane cylinder size in NFPA 58 still apply. It would be a violation of that code to install a 20 lb (9.1 kg) LP-Gas tank in a high school chemistry laboratory to supply Bunsen burners on the student lab tables, connected by permanently installed piping.

The requirements of NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, apply to laboratories used for educational purposes beyond grade 12 and for other laboratories.

69.3.12.7 Temporary Heating and Food Service Appliances in Buildings in Emergencies.

Δ **69.3.12.7.1** Cylinders shall not be used in buildings for temporary emergency heating purposes except when all of the following conditions are met:

(1) The permanent heating system is temporarily out of service.
(2) Heat is necessary to prevent damage to the buildings or contents.
(3) The cylinders and heaters comply with, and are used and transported in accordance with, 69.3.12.2 and 69.3.12.3.
(4) The temporary heating equipment is not left unattended.
(5) Air for combustion and ventilation is provided in accordance with NFPA 54.

[**58:**6.22.8.1]

Cylinders used for temporary heating are strictly an emergency measure, to be used only if the permanent heating system is temporarily out of service. The requirement in 69.3.12.7.1 is not intended to apply to supplemental or zone heating. Emergency heating equipment must be attended at all times.

NFPA 54, *National Fuel Gas Code*, contains extensive requirements to ensure that gas-burning appliances have sufficient air for complete combustion and ventilation to ensure that no harmful products of combustion can accumulate in buildings. These requirements are located in Section 9.3 of NFPA 54 and should be reviewed prior to the installation of temporary heating equipment. This is especially important if the temporary heating equipment does not use the same venting provisions as the equipment it temporarily replaces.

69.3.12.7.2 When a public emergency has been declared and gas, fuel, or electrical service has been interrupted, portable listed LP-Gas commercial food service appliances meeting the requirements of 69.3.12.8.4 shall be permitted to be temporarily used inside affected buildings. [**58:**6.22.8.2]

69.3.12.7.3 The portable appliances used shall be discontinued and removed from the building at the time the permanently installed appliances are placed back in operation. [**58:**6.22.8.3]

These appliances are needed and commonly used in certain areas after natural disasters such as floods, ice storms, and hurricanes, where service from utilities supplying gas and electricity may be interrupted. Paragraph 69.3.12.7.3 mandates that the portable appliances and the cylinders used to fuel them must be removed from the building when permanent appliances are back in service.

69.3.12.8 Use in Buildings for Demonstrations or Training, and Use of Small Cylinders for Self-Contained Torch Assemblies and Food Service Appliances.

Δ **69.3.12.8.1** Cylinders used temporarily inside buildings for public exhibitions or demonstrations, including use in classroom demonstrations, shall be in accordance with the following:

(1) The maximum water capacity of a cylinder shall be 12 lb (5.4 kg) [nominal 5 lb (2 kg) propane capacity].
(2) If more than one such cylinder is located in a room, the cylinders shall be separated by at least 20 ft (6.1 m).

[**58:**6.22.9.1]

Cylinders up to 5 lb (2 kg) propane capacity may be used temporarily in buildings for exhibitions or demonstrations. The use of a 20 lb (9.1 kg) cylinder filled with 5 lb (2 kg) of propane is not permitted, however, because there is no easy way to verify that only 5 lb (2 kg) of propane is in the cylinder. This provision permits the demonstration of a portable cooking device with a 5 lb (2 kg) LP-Gas cylinder at an indoor trade show to demonstrate cooking equipment, but it does not permit an identical device to be used at the show to prepare food for sale. For cooking in restaurants and by caterers, 69.3.12.8.4 does permit the use of stoves fueled by 10 oz (0.28 kg) nonrefillable butane cylinders.

If the food preparation itself is primarily for demonstration, then the use is allowed. If the preparation is primarily for the sale of the prepared food, then 5 lb (2 kg) cylinders are prohibited. The reasoning behind this distinction is that a demonstration of cooking is not "rushed" and is being monitored closely by the cook and the audience. A commercial cooking operation, however, may be characterized by a lower level of supervision of the equipment and a much higher volume of food. Simply stated, if the food is given away, as would be done in a school or trade show, 5 lb (2 kg) cylinders are allowed. If the food is sold, the preparation method is considered normal use and not a demonstration, and 5 lb (2 kg) cylinders are not allowed.

Δ **69.3.12.8.2** Cylinders used temporarily in buildings for training purposes related to the installation and use of LP-Gas systems shall be in accordance with the following:

(1) The maximum water capacity of individual cylinders shall be 245 lb (111 kg) [nominal 100 lb (45 kg) propane capacity], but not more than 20 lb (9.1 kg) of propane shall be placed in a single cylinder.
(2) If more than one such cylinder is located in the same room, the cylinders shall be separated by at least 20 ft (6.1 m).
(3) The training location shall be acceptable to the AHJ.
(4) Cylinders shall be promptly removed from the building when the training class has terminated.

[**58:**6.22.9.2]

Where used for LP-Gas–related training in buildings, 100 lb (45 kg) propane cylinders are permitted to be used, but they may be filled with only 20 lb (9.1 kg) of propane and approval of the AHJ is required. Note that the requirement in 69.3.12.8.2 differs from 69.3.12.8.1, which covers public exhibitions or demonstrations where only small containers of 5 lb (2 kg) propane capacity maximum are permitted.

Δ **69.3.12.8.3*** Cylinders used in buildings as part of approved self-contained torch assemblies or similar appliances shall be in accordance with the following:

(1) Cylinders used in buildings shall comply with UL 147A, *Standard for Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies.*
(2) Cylinders shall have a maximum water capacity of 2.7 lb (1.2 kg).

[**58:**6.22.9.3]

A.69.3.12.8.3 The weight of the cylinders will be affected by the specific gravity of the LP-Gas. Weights varying from 16.0 oz to 16.8 oz (454 g to 476 g) are recognized as being within the range of what is nominal. [**58:**A.6.22.9.3]

A cylinder of 2.7 lb (1.2 kg) water capacity will hold about 1.09 lb (0.49 kg) of propane [2.7 lb (1.2 kg) water capacity × 0.504 specific gravity (lb propane/lb water) × 80 percent (fill level)]. The cylinders are sometimes called "1 pound cylinders" and are usually sold with a net weight as required by consumer protection laws. These small cylinders are usually filled by automatic filling machinery, and some weight variation is normal and expected. Therefore, a filling target of over 1 lb (0.45 kg) is set so that, at the lowest filling level, 1 lb (0.45 kg) will be provided. The normal weight ranges for these 1 lb (0.45 kg) cylinders are provided in A.6.69.3.12.8.3. The vast majority of the 1 lb (0.45 kg) cylinders are disposable — these disposable cylinders are prohibited by DOT regulations and 69.4.2.2.8 from being refilled — and must be disposed of or recycled after use. Refillable 1 lb (0.45 kg) cylinders are available, and only this type can be refilled.

Paragraph 69.3.12.8.3 relates to, and limits the use of, LP-Gas cylinders with a propane capacity of up to 1 lb (0.45 kg). The provision permits the use of portable appliances that are fueled by butane and propane, such as curling irons and cigarette lighters, and the cylinders used to refill them. The requirement that 1 lb (0.45 kg) cylinders comply with UL 147A, *Standard for Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies*, establishes minimum safety standards for these cylinders above those required by the DOT.

Note that the use of cylinders of this size with portable cooking appliances is not mentioned and is therefore prohibited in buildings, except as permitted in restaurants and attended commercial food catering by 69.3.12.8.4 and in emergency cooking as permitted by 69.3.12.7.2.

Δ **69.3.12.8.4** Cylinders used with commercial food service appliances shall be used inside restaurants and in attended commercial food catering operations in accordance with the following:

(1) Cylinders and appliances shall be listed.
(2) Commercial food service appliances shall not have more than two 10 oz (296 ml) nonrefillable butane gas cylinders, each having a maximum capacity of 1.08 lb (0.490 kg).

(3) Cylinders shall comply with UL 147B, *Standard for Nonrefillable (Disposable) Type Metal Container Assemblies for Butane*.
(4) Cylinders shall be connected directly to the appliance and shall not be manifolded.
(5) Cylinders shall be an integral part of the listed, approved, commercial food service device and shall be connected without the use of a rubber hose.
(6) Storage of cylinders shall be in accordance with 8.3.1 of NFPA 58.

[**58:**6.22.9.4]

Direct connection enhances safety because hoses are inherently subject to wear and abuse. The number of cylinders connected at one time is limited to two, and the containers cannot be manifolded. This arrangement permits a two-burner stove to have each burner fed from a separate cylinder and limits the amount of leakage in the event of a problem. See Exhibit 69.19 for an example of a butane-fueled portable cooking appliance.

Note that only certain small cylinders with strict limitations are allowed. Cylinders must be nonrefillable, must be listed to UL 147B, *Standard for Nonrefillable (Disposable) Type Metal Container Assemblies for Butane*, and cannot contain more than 10 oz (0.28 kg) of butane.

Exhibit 69.20 shows a listed butane cylinder for use with portable cooking appliances. Note the indentations on the upper rim seal of the cylinder. These indentations are known as "rim relief," which is a designed weak point that fails upon overpressure to ensure that "rocketing" of the cylinder is minimized. The cutaway section shows the internal vapor tube that is in the top of the cylinder when the cylinder is properly placed in its area of the stove. A notch in the flange at the top of the cylinder ensures proper orientation.

69.3.12.9 Cylinders on Roofs or Exterior Balconies.

69.3.12.9.1 Where cylinders are installed permanently on roofs of buildings, the buildings shall be of fire-resistant construction or noncombustible construction having essentially noncombustible contents, or of other construction or contents that are protected with automatic sprinklers. [**58:**6.22.11.1]

Exhibit 69.19

Butane-fueled portable cooking appliance. (Courtesy of ChefMaster)

Exhibit 69.20

Listed butane cylinder for portable cooking appliance. (Courtesy of ChefMaster)

69.3.12.9.1.1 The total water capacity of cylinders connected to any one manifold shall be not greater than 980 lb (445 kg) [nominal 400 lb (181 kg) propane capacity]. If more than one manifold is located on the roof, it shall be separated from any other by at least 50 ft (15 m). [**58:**6.22.11.1(A)]

69.3.12.9.1.2 Cylinders shall be located in areas where there is free air circulation, at least 10 ft (3 m) from building openings (such as windows and doors), and at least 20 ft (6.1 m) from air intakes of air-conditioning and ventilating systems. [**58:**6.22.11.1(B)]

The requirement for separating cylinders from air intakes into buildings relates to the release of gas that may occur and the need to prevent that gas from being brought into the building and potentially ignited.

69.3.12.9.1.3 Cylinders shall not be located on roofs that are entirely enclosed by parapets more than 18 in. (460 mm) high unless the parapets are breached with low-level ventilation openings not more than 20 ft (6.1 m) apart, or unless all openings communicating with the interior of the building are at or above the top of the parapets. [**58:**6.22.11.1(C)]

69.3.12.9.1.4 Piping shall be in accordance with 69.3.12.2.3 through 69.3.12.2.5. [**58:**6.22.11.1(D)]

69.3.12.9.1.5 Hose shall not be used for connection to cylinders. [**58:**6.22.11.1(E)]

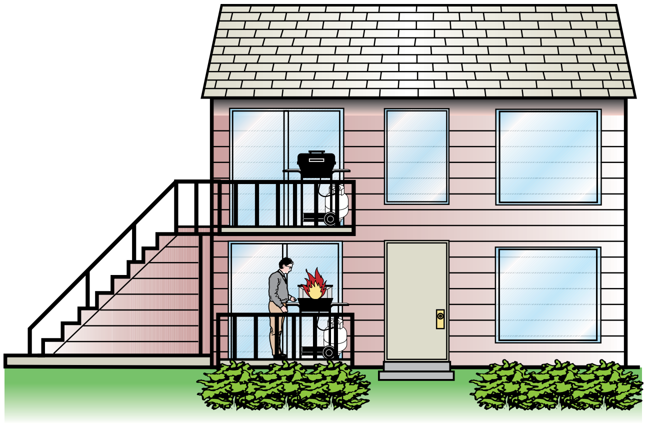
69.3.12.9.1.6 The fire department shall be advised of each installation. [**58:**6.22.11.1(F)]

69.3.12.9.2 Cylinders having water capacities greater than 2.7 lb (1 kg) [nominal 1 lb (0.5 kg) LP-Gas capacity] shall not be located

Exhibit 69.21

Prohibited Locations of Grills with Cylinders on Balconies. (Courtesy of Richard Fredenburg, North Carolina Department of Agriculture and Consumer Services)

Exhibit 69.22



Permitted location of cylinders on balconies located one above the other in a two-unit dwelling.

on decks or balconies of dwellings of two or more living units above the first floor unless they are served by exterior stairways. [**58:**6.22.11.2]

Exhibit 69.21 shows an example of how consumers might violate this prohibition. The balconies in this exhibit are part of an eight-unit condominium, and five of the units had grills with 20 lb (9.1 kg) cylinders on their balconies and no exterior stairways. In some instances, consumers might respond to a removal request by storing the cylinders in even more dangerous locations, such as inside the residence or garage. One secure solution for this location could be a community "exchange cabinet" in a safe, unobtrusive location.

The prohibition of cylinders above the first floor in multiple family dwellings of two or more living units reflects concerns for storage and transportation within these buildings, including elevators, egress of occupants from the upper floors in the event of an emergency, and the exposure to surrounding living units in the event of a leak or fire on a balcony. Note that a living unit may have more than one floor.

In multiple-family dwellings of two living units located one above the other, gas grill cylinders are permitted on balconies that are accessed from exterior stairways to each balcony, as shown in Exhibit 69.22.

69.3.13 Installation of Appliances.

69.3.13.1 Installation of Patio Heaters.

69.3.13.1.1 Patio heaters utilizing an integral LP-Gas container greater than 1.08 lb (0.49 kg) propane capacity shall comply with 69.3.13.1.2 and 69.3.13.1.3. [**58:**6.23.2.1]

69.3.13.1.2 Patio heaters shall be listed and used in accordance with their listing and the manufacturer's instructions. [**58:**6.23.2.2]

The requirement addressing patio heaters in 69.3.13.1.1 recognizes the growing use of portable outdoor appliances to heat areas where the climate is too cool to sit or stand outside comfortably. They are generally used in restaurants with outdoor seating areas to enable the areas to be used for longer periods. They are also sometimes used where attendants, such as those working for a valet parking service, wait outside. (See Exhibit 69.23.)

69.3.13.1.3 Patio heaters shall not be located within 5 ft (1.5 m) of exits from an assembly occupancy. [**58:**6.23.2.3]

69.3.13.2 Hose for Portable Appliances.

69.3.13.2.1 The requirements of 69.3.13 shall apply to hoses used on the low-pressure side of regulators to connect portable appliances. [**58:**6.23.3.1]

Δ **69.3.13.2.2** Where used inside buildings, the following shall apply:

(1) The hose shall be the minimum practical length and shall be in accordance with 69.3.12.2.5.
(2) The hose shall not extend from one room to another or pass through any partitions, walls, ceilings, or floors except as provided by 69.3.12.3.9.
(3) The hose shall not be concealed from view or used in concealed locations.

[**58:**6.23.3.2]

It is important for the hose to be visible so that any wear or damage it sustains can be readily detected. Hose that is longer than needed can be looped under equipment and be partially hidden. Hose hidden in walls, partitions, ceilings, and floors cannot be inspected for wear or damage.

69.3.13.2.3 Where installed outside of buildings, the hose length shall be permitted to exceed 10 ft (3.3 m) but shall be as short as practical. [**58:**6.23.3.3]

Exhibit 69.23

Patio heaters. (Courtesy of Richard Fredenburg, North Carolina Department of Agriculture and Consumer Services)

69.3.13.2.4 Hose shall be securely connected to the appliance. [**58:**6.23.3.4]

69.3.13.2.5 The use of rubber slip ends shall not be permitted. [**58:**6.23.3.5]

69.3.13.2.6 A shutoff valve shall be provided in the piping immediately upstream of the inlet connection of the hose. [**58:**6.23.3.6]

A shutoff valve is required at the point where the hose connects to the piping system to permit the appliance to be isolated from the piping system should it be necessary to conduct maintenance or repairs on the hose or appliance.

69.3.13.2.7 Where more than one such appliance shutoff is located near another, the valves shall be marked to indicate which appliance is connected to each valve. [**58:**6.23.3.7]

69.3.13.2.8 Hose shall be protected against physical damage. [**58:**6.23.3.8]

Because hose is vulnerable to mechanical and thermal damage and has a limited service life, hose should be used only where necessary and where it can be readily inspected and maintained. The requirements for hose and hose connectors are located in 5.11.6 of NFPA 58.

69.3.14 LP-Gas Systems on Vehicles (Other Than Engine Fuel Systems).

Δ **69.3.14.1* Application.** Subsection 69.3.14 shall apply to the following:

(1) Nonengine fuel systems on all vehicles
(2) Installations served by exchangeable (removable) cylinder systems and by permanently mounted containers

[**58:**6.26.1]

A.69.3.14.1 Typical non-engine fuel systems include those on commercial, industrial, construction, and public service vehicles such as trucks, semitrailers, trailers, portable tar kettles, road surface heating equipment, mobile laboratories, clinics, and mobile cooking units (such as catering and canteen vehicles). [**58:**A.6.26.1]

A variety of LP-Gas systems are installed on vehicles where the gas is not used as a vehicle engine fuel. Examples of this include the following:

- Vehicles (usually trailers) with mounted tar kettles used in the construction industry for heating tar for roofing
- Food-warming delivery vehicles, such as pretzel or hot dog carts and larger hot dog or lunch wagons
- Service vehicles that need a source of heated water, such as those used by carpet cleaning services
- Food trucks where the propane is used to prepare food

Δ **69.3.14.2 Nonapplication.** Subsection 69.3.14 shall not apply to the following:

(1) Systems installed on mobile homes
(2) Systems installed on recreational vehicles
(3) Cargo tank vehicles, cargo tank vehicles (trailers and semitrailers), and similar units used to transport LP-Gas as cargo, which are covered by Chapter 9 of NFPA 58
(4) LP-Gas engine fuel systems on the vehicles, which are covered by Chapter 11 of NFPA 58

[**58:**6.26.2]

69.3.14.3 Container Installation Requirements.

69.3.14.3.1 Containers shall comply with 69.3.14.3.1.1 through 69.3.14.3.1.5. [**58:**6.26.3.1]

69.3.14.3.1.1 ASME mobile containers shall in accordance with one of the following:

(1) A MAWP of 312 psig (2.2 MPag) or higher where installed in enclosed spaces of vehicles
(2) A MAWP of 312 psig (2.2 MPag) or higher where installed on passenger vehicles
(3) A MAWP of 250 psig (1.7 MPag) or higher for containers where installed on the exterior of nonpassenger vehicles

[**58:**6.26.3.1(A)]

69.3.14.3.1.2 LP-Gas fuel containers used on passenger-carrying vehicles shall not exceed 200 gal (0.8 m^3) aggregate water capacity. [**58:**6.26.3.1(B)]

69.3.14.3.1.3 The capacity of individual LP-Gas containers on highway nonpassenger vehicles shall be 1000 gal (3.8 m^3) or in accordance with U.S. Department of Transportation regulations. [**58:**6.26.3.1(C)]

Prior to the 2018 edition of the *Code*, there was a table summarizing the various maximum water capacities for containers on highway nonpassenger vehicles. This table has been removed and replaced with a single requirement summarizing the previous information and referencing DOT regulations.

N **69.3.14.3.1.4** The capacity of cargo tank motor vehicles shall not be limited by NFPA 58. [**58:**6.26.3.1(D)]

69.3.14.3.1.5 Containers designed for stationary service only and not in compliance with the container appurtenance protection requirements of 5.2.6 of NFPA 58 shall not be used. [**58:**6.26.3.1(E)]

69.3.14.3.2 ASME containers and cylinders utilized for the purposes covered by 69.3.14 shall not be installed, transported, or stored (even temporarily) inside any vehicle covered by 69.3.14, except for ASME containers installed in accordance with 69.3.14.3.4.9, Chapter 9 of NFPA 58, or DOT regulations. [**58:**6.26.3.2]

69.3.14.3.3 The LP-Gas supply system, including the containers, shall be installed either on the outside of the vehicle or in a recess or cabinet vaportight to the inside of the vehicle but accessible from and vented to the outside, with the vents located near the top and bottom of the enclosure and 3 ft (1 m) horizontally away from any opening into the vehicle below the level of the vents. [**58:**6.26.3.3]

69.3.14.3.4 Containers shall be mounted securely on the vehicle or within the enclosing recess or cabinet. [**58:**6.26.3.4]

69.3.14.3.4.1 Containers shall be installed with road clearance in accordance with 11.8.3 of NFPA 58. [**58:**6.26.3.4(A)]

69.3.14.3.4.2 Fuel containers shall be mounted to prevent jarring loose and slipping or rotating, and the fastenings shall be designed and constructed to withstand, without permanent visible deformation, static loading in any direction equal to four times the weight of the container filled with fuel. [**58:**6.26.3.4(B)]

69.3.14.3.4.3 Where containers are mounted within a vehicle housing, the securing of the housing to the vehicle shall comply with this provision. Any removable portions of the housing or cabinet shall be secured while in transit. [**58:**6.26.3.4(C)]

69.3.14.3.4.4 Field welding on containers shall be limited to attachments to nonpressure parts such as saddle plates, wear plates, or brackets applied by the container manufacturer. [**58:**6.26.3.4(D)]

69.3.14.3.4.5 All container valves, appurtenances, and connections shall be protected to prevent damage from accidental contacts with stationary objects; from loose objects, stones, mud, or ice thrown up from the ground or floor; and from damage due to overturn or similar vehicular accident. [**58:**6.26.3.4(E)]

As with vehicle propulsion engine fuel containers, exterior containers and appurtenances must be protected against material thrown up from the road, as set forth in 69.3.14.3.4.5. Slush and other hazards thrown up from the road must not block the regulator vent, and splashguards or the practice of locating the regulator in a compartment can protect from these hazards. A blocked vent can lead to higher than normal pressures in the utilization system and can lead to pilot failure and improper appliance operation. Appurtenances on a container, particularly on those mounted below the vehicle, should be installed so that they are accessible for maintenance and readily accessible if needed for normal operations such as operation of the fixed maximum liquid level gauge during filling.

69.3.14.3.4.6 Permanently mounted ASME containers shall be located on the vehicle to provide the protection specified in 69.3.14.3.4.5. [**58:**6.26.3.4(F)]

69.3.14.3.4.7 Cylinders shall have permanent protection for cylinder valves and connections. [**58:**6.26.3.4(G)]

69.3.14.3.4.8 Where cylinders are located on the outside of a vehicle, weather protection shall be provided. [**58:**6.26.3.4(H)]

69.3.14.3.4.9 Containers mounted on the interior of passenger-carrying vehicles shall be installed in compliance with Section 11.9 of NFPA 58. Pressure relief valve installations for such containers shall comply with 11.8.5 of NFPA 58. [**58:**6.26.3.4(I)]

The container mounting arrangement must be strong enough to remain intact and to protect the container and its appurtenances and connections from damage caused by collisions, road debris, and weather. These provisions do not apply to engine fuel containers, as stated by the reference in 69.3.14.3.4.9 to Chapter 11 of NFPA 58.

Δ **69.3.14.3.5** Cylinders installed on portable tar kettles alongside the kettle, on the vehicle frame, or on road surface heating equipment shall be protected from radiant or convected heat from open flame or other burners by the use of a heat shield or by the location of the cylinder(s) on the vehicle. In addition, the following shall apply:

(1) Cylinder valves shall be closed when burners are not in use.
(2) Cylinders shall not be refilled while burners are in use as provided in 7.2.3.2(B) of NFPA 58.

[**58:**6.26.3.5]

Cylinders should be mounted so that no wear takes place; for example, chains can cut grooves in cylinders due to vehicular motion. Most tar kettles use liquid burners, so the right type of cylinder and appurtenances must be used. The word "liquid" is stamped on the cylinder next to the liquid withdrawal connection. A metal barrier or some other physical protection is required between the tar kettle and the cylinder to protect the cylinder from becoming overheated due to its proximity to the tar kettle.

69.3.14.4 Installation of Container Appurtenances.

Δ **69.3.14.4.1** Container appurtenances shall be installed in accordance with the following:

(1) Pressure relief valve installation on ASME containers installed in the interior of vehicles complying with Section 11.9 of NFPA 58 shall comply with 11.8.5 of NFPA 58.
(2) Pressure relief valve installations on ASME containers installed on the outside of vehicles shall comply with 11.8.5 of NFPA 58 and 69.3.14.3.3.
(3) Main shutoff valves on containers for liquid and vapor shall be readily accessible.
(4) Cylinders shall be designed to be filled in either the vertical or horizontal position, or if they are the universal type, they are permitted to be filled in either position.
(5) All container inlets, outlets, or valves installed in container inlets or outlets, except pressure relief devices and gauging devices, shall be labeled to designate whether they communicate with the vapor or liquid space.
(6) Containers from which only vapor is to be withdrawn shall be installed and equipped with connections to minimize the possibility of the accidental withdrawal of liquid.

[**58:**6.26.4.1]

The three following types of fuel container installations affect how the pressure relief valve is installed and located:

1. Cylinders in a cabinet or recess in accordance with 69.3.14.3.3, for which the pressure relief valve is not required to be piped away
2. Containers installed in the interior of passenger-carrying vehicles, which are permitted in Section 11.9, with relief valve piped away in accordance with 11.8.5.2 of NFPA 58
3. Containers mounted on the exterior of vehicles, which is allowed per 69.3.14.3.3

Paragraph 11.8.5.2(F) of NFPA 58 provides specific requirements for the pressure relief valve pipeaway system, if used. Also refer to 11.8.5.2(F) of NFPA 58 for requirements for protecting the pressure relief valve outlet (valve or discharge piping) from being plugged with dirt, asphalt, or water.

69.3.14.4.2 Regulators shall be installed in accordance with 6.10.2 of NFPA 58 and 69.3.14.4.2.1 through 69.3.14.4.2.5. [**58:**6.26.4.2]

69.3.14.4.2.1 Regulators shall be installed with the pressure relief vent opening pointing vertically downward to allow for drainage of moisture collected on the diaphragm of the regulator. [**58:**6.26.4.2(A)]

69.3.14.4.2.2 Regulators not installed in compartments shall be equipped with a durable cover designed to protect the regulator vent opening from sleet, snow, freezing rain, ice, mud, and wheel spray. [**58:**6.26.4.2(B)]

69.3.14.4.2.3 If vehicle-mounted regulators are installed at or below the floor level, they shall be installed in a compartment that provides protection against the weather and wheel spray. [**58:**6.26.4.2(C)]

Δ **69.3.14.4.2.4** Regulator compartments shall comply with the following:

(1) The compartment shall be of sufficient size to allow tool operation for connection to and replacement of the regulator(s).
(2) The compartment shall be vaportight to the interior of the vehicle.
(3) The compartment shall have a 1 in.^{2} (650 mm^2) minimum vent opening to the exterior located within 1 in. (25 mm) of the bottom of the compartment.
(4) The compartment shall not contain flame or spark-producing equipment.

[**58:**6.26.4.2(D)]

69.3.14.4.2.5 A regulator vent outlet shall be at least 2 in. (51 mm) above the compartment vent opening. [**58:**6.26.4.2(E)]

Two-stage pressure regulation must be used in all systems covered in 69.3.14. Multiple regulators provide several safety features, which are described in the commentary following 6.10.2.3 in NFPA 58: *LP-Gas Code Handbook*.

Regulators (and cylinders) used on vehicles are usually installed in a compartment for security and to comply with the requirement for protection of regulators from sleet, snow, freezing rain, and so forth. The enclosure cannot contain electrical devices that are a source of ignition and must be ventilated to allow any released propane to disperse. Louvers in the compartment or its door are typically used to provide this required ventilation. Louvers must communicate with the outdoors and not to the interior of the vehicle.

69.3.14.5 Piping.

69.3.14.5.1 Piping shall be installed in accordance with 6.11.3 of NFPA 58 and 69.3.14.5.1.1 through 69.3.14.5.1.13. [**58:**6.26.5.1]

The main lines and branch connections must be kept outside the vehicle so that, if leakage occurs, gas will not accumulate in the vehicle. To avoid compounding problems in the event of collisions, overturns, and disconnection of vehicles, fuel lines cannot be connected between two vehicular units. These types of risks are regarded as greater than the corresponding risks in a system located completely on one vehicle.

69.3.14.5.1.1 Steel tubing shall have a minimum wall thickness of 0.049 in. (1.2 mm). [**58:**6.26.5.1(A)]

Steel tubing in vehicular installations has been specified as having a minimum 0.049 in. (1.2 mm) wall thickness to provide strength against vibration and to provide an additional tolerance for corrosion.

69.3.14.5.1.2 A flexible connector shall be installed between the regulator outlet and the fixed piping system to protect against expansion, contraction, jarring, and vibration strains. [**58:**6.26.5.1(B)]

69.3.14.5.1.3 Flexibility shall be provided in the piping between a cylinder and the gas piping system or regulator. [**58:**6.26.5.1(C)]

69.3.14.5.1.4 Flexible connectors shall be installed in accordance with 6.11.6 of NFPA 58. [**58:**6.26.5.1(D)]

69.3.14.5.1.5 Flexible connectors longer than the length allowed in the *Code*, or fuel lines qthat incorporate hose, shall be used only where approved. [**58:**6.26.5.1(E)]

69.3.14.5.1.6 The piping system shall be designed, installed, supported, and secured to minimize the possibility of damage due to vibration, strains, or wear and to preclude any loosening while in transit. [**58:**6.26.5.1(F)]

69.3.14.5.1.7 Piping shall be installed in a protected location. [**58:**6.26.5.1(G)]

Δ **69.3.14.5.1.8** Where piping is installed outside the vehicle, it shall be installed as follows:

(1) Piping shall be under the vehicle and below any insulation or false bottom.
(2) Fastening or other protection shall be installed to prevent damage due to vibration or abrasion.
(3) At each point where piping passes through sheet metal or a structural member, a rubber grommet or equivalent protection shall be installed to prevent chafing.

[**58:**6.26.5.1(H)]

69.3.14.5.1.9 Gas piping shall be installed to enter the vehicle through the floor directly beneath or adjacent to the appliance served. [**58:**6.26.5.1(I)]

69.3.14.5.1.10 If a branch line is installed, the tee connection shall be located in the main gas line under the floor and outside the vehicle. [**58:**6.26.5.1(J)]

69.3.14.5.1.11 Exposed parts of the fixed piping system either shall be of corrosion-resistant material or shall be coated or protected to minimize exterior corrosion. [**58:**6.26.5.1(K)]

69.3.14.5.1.12 Hydrostatic relief valves shall be installed in isolated sections of liquid piping as provided in Section 6.15 of NFPA 58. [**58:**6.26.5.1(L)]

Δ **69.3.14.5.1.13** Piping systems, including hose, shall be proven free of leaks in accordance with Section 6.16 of NFPA 58. [**58:**6.26.5.1(M)]

69.3.14.5.2 There shall be no fuel connection between a tractor and trailer or other vehicle units. [**58:**6.26.5.2]

69.3.14.6 Equipment Installation. Equipment shall be installed in accordance with Section 6.20 of NFPA 58 and 69.3.14.6.1 and 69.3.14.6.2. [**58:**6.26.6]

69.3.14.6.1 Installation shall be made in accordance with the manufacturer's recommendations and, in the case of approved equipment, as provided in the approval. [**58:**6.26.6.1]

69.3.14.6.2 Equipment installed on vehicles shall be protected against vehicular damage as provided for container appurtenances and connections in 69.3.14.3.4.5. [**58:**6.26.6.2]

69.3.14.7 Appliance Installation on Vehicles.

69.3.14.7.1 Paragraph 69.3.14.7 shall apply to the installation of all appliances on vehicles. It shall not apply to engines. [**58:**6.26.7.1]

69.3.14.7.2 All appliances covered by 69.3.14.7 installed on vehicles shall be approved. [**58:**6.26.7.2]

69.3.14.7.3 Where the device or appliance, such as a cargo heater or cooler, is designed to be in operation while the vehicle is in transit, means, such as an excess flow valve to stop the flow of gas in the event of a line break, shall be installed. [**58:**6.26.7.3]

Appliances used in vehicles and the vibration that occurs while vehicles are in transit can result in fittings loosening or becoming disconnected. This requirement recognizes that possibility and requires a positive means of stopping the flow if fittings are disconnected. Even though excess-flow valves are given as an example of protection, other types of protection can be used. Excess-flow valves will close only when the design flow is reached, and they might not operate in the event of a partial separation of a fitting. If the vehicle comes under DOT regulations, reference should be made to the DOT requirements that may apply.

69.3.14.7.4 Gas-fired heating appliances shall be equipped with shutoffs in accordance with 5.23.7(A) of NFPA 58 except for portable heaters used with cylinders having a maximum water capacity of 2.7 lb (1.2 kg), portable torches, melting pots, and tar kettles. [**58:**6.26.7.4]

69.3.14.7.5 Gas-fired heating appliances, other than ranges and illuminating appliances installed on vehicles intended for human occupancy, shall be designed or installed to provide for a complete separation of the combustion system from the atmosphere inside the vehicle. [**58:**6.26.7.5]

The concept of isolating the combustion system of appliances — except ranges in vehicle interiors where passengers might be — is consistent with all other vehicle standards on this subject, including the standards for RVs. No portable or conventional room heaters should be used inside such vehicles. Isolation may be accomplished through the use of direct-vent type heaters and water heaters or through separation by installing the appliance in a compartment with provisions for outside air. The range is an attended appliance and need not be isolated, but it should never be used for comfort heating.

Although extensive requirements for the installation of appliances fueled by LP-Gas are included in NFPA 54, that code is limited to appliances that are connected to a fixed building piping system. The appliances covered under NFPA 58 are those not normally connected to a fixed building piping system.

69.3.14.7.6* Where unvented-type heaters that are designed to protect cargo are used on vehicles not intended for human occupancy, provisions shall be made to provide air from the outside for combustion and dispose of the products of combustion to the outside. [**58:**6.26.7.6]

A.69.3.14.7.6 Requirements for the design of containers are located in Section 5.2 of NFPA 58. Requirements for container appurtenances are located in Section 5.3 of NFPA 58. [**58:**A.6.26.7.6]

69.3.14.7.7 Appliances installed in the cargo space of a vehicle shall be readily accessible whether the vehicle is loaded or empty. [**58:**6.26.7.7]

69.3.14.7.8 Appliances shall be constructed or otherwise protected to minimize possible damage or impaired operation due to cargo shifting or handling. [**58:**6.26.7.8]

69.3.14.7.9 Appliances shall be located so that a fire at any appliance will not block egress of persons from the vehicle. [**58:**6.26.7.9]

Δ **69.3.14.7.10** A permanent caution plate shall be affixed to either the appliance or the vehicle outside of any enclosure, shall be adjacent to the container(s), and shall include the following instructions:

CAUTION:

(1) Be sure all appliance valves are closed before opening container valve.
(2) Connections at the appliances, regulators, and containers shall be checked periodically for leaks with soapy water or its equivalent.
(3) Never use a match or flame to check for leaks.
(4) Container valves shall be closed when equipment is not in use.

[**58:**6.26.7.10]

69.3.14.7.11 Gas-fired heating appliances and water heaters shall be equipped with automatic devices designed to shut off the flow of gas to the main burner and the pilot in the event the pilot flame is extinguished. [**58:**6.26.7.11]

• **69.3.14.8 Parking, Servicing, and Repair.**

69.3.14.8.1 Where vehicles with LP-Gas fuel systems used for purposes other than propulsion are parked, serviced, or repaired inside buildings, the requirements of 69.3.14.8.2 through 69.3.14.8.4 shall apply. [**58:**6.26.8.1]

69.3.14.8.2 The fuel system shall be leak-free, and the container(s) shall not be filled beyond the limits specified in Chapter 7 of NFPA 58. [**58:**6.26.8.2]

Specific requirements for the parking, servicing, and repair of vehicles that have non–engine fuel LP-Gas systems are provided in 69.3.14.8.1. RVs are not addressed because they are covered by NFPA 1192, *Standard on Recreational Vehicles*. Subsection 6.26.8 of NFPA 58 also does not address manufactured housing, which is covered under federal regulations, or vehicles used to transport LP-Gas as cargo, which are covered under Chapter 9 of NFPA 58.

The requirements in 69.3.14.8 are similar to those for vehicles using LP-Gas as an engine fuel. Vehicles having a total LP-Gas capacity of more than 300 lb (136 kg) are required to follow the more detailed requirements of Section 9.7 of NFPA 58.

69.3.14.8.3 The container shutoff valve shall be closed, except that the container shutoff valve shall not be required to be closed when fuel is required for test or repair. [**58:**6.26.8.3]

69.3.14.8.4 The vehicle shall not be parked near sources of heat, open flames, or similar sources of ignition, or near unventilated pits. [**58:**6.26.8.4]

69.3.14.8.5 Vehicles having containers with water capacities larger than 300 gal (1.1 m^3) shall comply with the requirements of Section 9.7 of NFPA 58. [**58:**6.26.8.5]

69.3.15 Vehicle Fuel Dispenser and Dispensing Systems.

Section 69.3.15 provides requirements in one place for vehicle fuel dispensers and dispensing stations or propane vehicle fueling stations, as shown in Exhibit 69.24. Refer to NFPA 30A, which includes a separate chapter — Chapter 12 — to address the requirements for installing propane dispensers at service stations.

Propane and CNG have been identified as alternative fuels to gasoline for powering motor vehicles. The use of propane or CNG can result in a reduction in engine emissions such as carbon monoxide and unburned hydrocarbons.

Governments all over the world are working with industry and environmental groups to promote the use of alternative vehicle fuels — including propane, CNG, electricity and hydrogen — in fleet operations and in privately owned personal vehicles. The selection of fuels usually is based on a combination of perceived safety, cost, and local availability. Promotion of the use of alternative fuels has led to a need to promote these fuels beyond the typical private fleet dispensing operations and to make them available at existing commercial gasoline automotive service stations.

Table 6.7.2.1 of NFPA 58 specifies distances from points of transfer and exposures. This table applies to the location of the filling of cylinders that are not installed, which includes all cylinders brought to a dispensing station for filling. The table provides separation distances from points of transfer, such as the hose end, to several exposures. Possible exposures include public

Exhibit 69.24

Dispensing station for propane vehicles. (Courtesy of CleanFuel USA)

ways, buildings with and without fire-resistive walls, mainline railroad track centerlines, outdoor places of public assembly, and flammable liquids dispensers.

69.3.15.1 Application.

69.3.15.1.1 Subsection 69.3.15 includes the location, installation, and operation of vehicle fuel dispensers and dispensing systems. [**58:**6.27.1.1]

69.3.15.1.2 The provisions of 69.3.3 and 69.3.5, as modified by 69.3.15, shall apply. [**58:**6.27.1.2]

69.3.15.2 Location.

69.3.15.2.1 Location of vehicle fuel dispensers and dispensing systems shall be in accordance with Table 69.3.7.2.1. [**58:**6.27.2.1]

69.3.15.2.2 Vehicle fuel dispensers and dispensing systems shall be located away from pits in accordance with Table 69.3.7.2.1, with no drains or blow-offs from the unit directed toward or within 15 ft (4.6 m) of a sewer system's opening. [**58:**6.27.2.2]

69.3.15.3 General Installation Provisions.

69.3.15.3.1 Vehicle fuel dispensers and dispensing systems shall be installed in accordance with the manufacturer's installation instructions. [**58:**6.27.3.1]

Vehicle fuel dispensers and dispensing stations are typically manufactured as complete units for installation in the field. Some of these units are listed, but even if they are not, the manufacturer's installation instructions must be followed.

Questions concerning the safety of installing dispensing stations have been raised for locations where local ordinances prohibit aboveground tanks from being in front of buildings. Generally, resorting to the use of an underground tank is the solution, though there are some design considerations that must be resolved before this is done.

Propane is stored as a liquefied gas under pressure. Dispenser pumps are normally at the low point of the piping between the tank and the meter to have as much net positive suction head (NPSH) as possible available at the pump. This positive pressure is to keep the propane from boiling and introducing vapor into the metering system or causing cavitation in the pump. Both of these situations are undesirable, because vapor in the meter affects accuracy and cavitation is detrimental to pump life. If the pump for an underground tank is located at ground level, it likely will not have sufficient NPSH.

If the pump is placed underground at the bottom of the tank, there are concerns for maintenance accessibility. If it is accessible, there may be a violation for having a pit too close to the point of transfer. It also may violate the manufacturer's installation instructions.

69.3.15.3.2 Vehicle fuel dispensers and dispensing systems shall not be located within a building or structure, unless they comply with Chapter 10 of NFPA 58. [**58:**6.27.3.2]

This requirement is another example of the restriction against piping liquid LP-Gas into a building or structure that is not specifically designed in accordance with Chapter 10 of NFPA 58.

69.3.15.3.3 Where a vehicle fuel dispenser or dispensing system is installed under a weather shelter or canopy, the area shall be ventilated and shall not be enclosed for more than 50 percent of its perimeter. [**58:**6.27.3.3]

These requirements are concerned with the need to disperse any vapors that may be released during the fueling process to avoid the formation of a flammable propane–air mixture. The requirement also provides guidance on how much of a weather shelter can be installed without the area being considered an indoor location. If an installation is considered to be an indoor type, compliance with Chapter 10 of NFPA 58 is mandated.

69.3.15.3.4 Control for the pump used to transfer LP-Gas through the unit into containers shall be provided at the device in order to minimize the possibility of leakage or accidental discharge. [**58:**6.27.3.4]

This requirement does not necessarily reduce the possibility of a leak occurring, but it can reduce the impact of the leak by allowing the operator to quickly stop the flow of product from the pump.

69.3.15.3.5 A device that shuts off the flow of gas when flow exceeds the predetermined flow rate shall be installed as close as practical to the point where the dispenser hose connects to the liquid piping. [**58:**6.27.3.5]

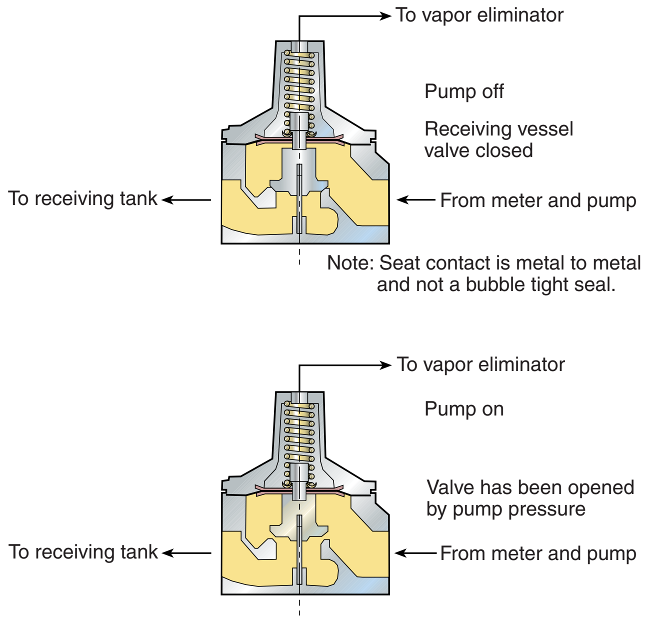
This requirement has been revised in the 2018 edition of the *Code* to permit the use of systems other than excess-flow check valves. Specifying only an excess-flow check valve prevents the use of other valves that incorporate the same function. It is with this knowledge in mind that, instead of referring to specific devices, the requirement was revised in NFPA 58 to refer to devices in general.

A differential back pressure valve is used with an LP-Gas meter measuring liquid. The purpose of the differential back pressure valve is to ensure that vapor is not introduced into the metering system. Vapor passing through a meter designed for liquid would cause an inaccurate delivery. The differential back pressure valve works in conjunction with the vapor eliminator (located upstream of the meter) to stop flow through the meter when vapor is detected in the piping upstream of the meter. See Exhibit 69.25 for a graphical explanation of the operation of a differential back pressure valve.

A valve working in conjunction with an electronic register as part of the dispenser can be set to close when the register detects a predetermined flow rate. Additionally, excess-flow and differential back pressure valves serve separate purposes. A differential back pressure valve is part of the metering system and is designed to prevent vapor from entering the meter by closing itself when vapor is detected in the vapor eliminator. The valve is closed when the pump is off, which prevents release of LP-Gas if there is a leak downstream of the valve. When the pump is on and the product is flowing, the differential back pressure valve may not close if there is a rupture downstream of the valve.

Paragraph 69.3.15.3.5 requires either an excess-flow valve or a differential pressure or meter assembly to be installed at the point that the dispenser hose connects to the liquid piping in the dispenser unit.

Exhibit 69.25



Operation of differential back pressure valve. (Courtesy of Liquid Controls, Inc.)

69.3.15.3.6 Piping and the dispensing hose shall be provided with hydrostatic relief valves in accordance with Section 6.15 of NFPA 58. [**58:**6.27.3.6]

69.3.15.3.7 Protection against trespassing and tampering shall be in accordance with 6.21.4 of NFPA 58. [**58:**6.27.3.7]

Security at dispensing stations is important, both for filling cylinders and for buildings. Access to the dispenser and its controls must be limited to trained operators, and the equipment must be secured to prevent tampering when not attended. Options in 6.21.4 of NFPA 58 include fences and locking the equipment.

Δ **69.3.15.3.8** The container liquid withdrawal opening used with vehicle fuel dispensers and dispensing stations shall be equipped with one of the following:

(1) An internal valve fitted for remote closure and automatic shutoff using thermal (fire) actuation
(2) A positive shutoff valve that is located as close to the container as practical in combination with an excess-flow valve installed in the container, plus an emergency shutoff valve that is fitted for remote closure and installed downstream in the line as close as practical to the positive shutoff valve

[**58:**6.27.3.8]

69.3.15.3.9 An identified and accessible remote emergency shutoff device for either the internal valve or the emergency shutoff valve required by 69.3.15.3.8(1) or 69.3.15.3.8(2) shall be installed not less than 3 ft (1 m) or more than 100 ft (30 m) from the liquid transfer point. [**58:**6.27.3.9]

69.3.15.3.10 Emergency shutoff valves and internal valves that are fitted for remote closure as required in this section shall be tested annually for proper operation. [**58:**6.27.3.10]

Paragraphs 69.3.15.3.8 through 69.3.15.3.10 recognize that remote closures with thermal actuation are important devices for providing a safe way to shut off product releases in the event of an emergency. Generally, dispensers are located in public areas. Equipping dispenser stations with remote shutoffs fitted with thermal actuation will provide an additional level of safety for dispensers. Testing is also required to verify that the shutoff devices remain in good operating condition.

69.3.15.3.11 A manual shutoff valve and an excess-flow check valve shall be located in the liquid line between the pump and the dispenser inlet where the dispensing device is installed at a remote location and is not part of a complete storage and dispensing unit mounted on a common base. [**58:**6.27.3.11]

69.3.15.3.12 All dispensers shall be installed either on a concrete foundation or shall be part of a complete storage and dispensing unit mounted on a common base and installed in accordance with 6.8.3.1(F) of NFPA 58. [**58:**6.27.3.12]

Anchorage of a dispenser helps to ensure that the breakaway device mandated in 69.3.15.4.2 operates properly. Physical protection is also required and is often needed in areas where vehicular traffic is normal.

69.3.15.3.13 Vehicle barrier protection (VBP) shall be provided for containers serving liquid dispensers where those containers are located within 10 ft of a vehicle thoroughfare or parking location. Such protection shall be either 69.3.15.3.13.1 or 69.3.15.3.13.2. [**58:**6.27.3.13]

69.3.15.3.13.1 Concrete filled guard posts constructed of steel not less than 4 in. (102 mm) in diameter, with the following characteristics:

(1) Spaced not more than 4 ft (1219 mm) between posts on center
(2) Set not less than 3 ft (900 mm) deep in a concrete footing of not less than 15 in. (380 mm) diameter
(3) Set with the top of the posts not less than 3 ft (900 mm) above ground
(4) Located not less than 3 ft (900 mm) from the protected installation

[**58:**6.27.3.13(A)]

69.3.15.3.13.2 Equivalent protection in lieu of guard posts shall be a minimum of 3 ft (900 mm) in height and shall resist a force of 6000 lb (26,690 N) applied 3 ft (900 mm) above the adjacent ground surface. [**58:**6.27.3.13(B)]

In the 2017 edition of NFPA 58, the 12,000 lb (53,380 N) requirement was revised to 6,000 lb (26,690 N) after a research paper prepared for the National Propane Gas Association, "Evaluation of Collision Protection Provided by Vehicle Impact Bollards and Propane Cylinder Exchange Cabinets," was presented to the Technical Committee on Liquefied Petroleum Gases that stated the previous requirements did not originate from DOT regulations and were unnecessary as stated.

Previously, the lack of specificity in the *Code* led to a wide range of interpretations by AHJs, resulting in confusion. The *Code* now provides a clear set of requirements for consistent enforcement.

69.3.15.3.14 Where the dispenser is not mounted on a common base with its storage container and the dispensing unit is located within 10 ft of a vehicle thoroughfare, parking location, or a engine fuel filling station, the dispenser shall be provided with VBP. [**58:**6.27.3.14]

69.3.15.3.15 Dispensers shall be protected from physical damage. [**58:**6.27.3.15]

69.3.15.3.16 A listed quick-acting shutoff valve shall be installed at the discharge end of the transfer hose. [**58:**6.27.3.16]

A listed quick-acting shutoff valve must be installed at the end of the transfer hose, which helps the operator of the dispenser quickly shut off the flow of liquid when the vehicle fuel tank or the cylinder reaches its maximum capacity. A gate valve or globe valve does not meet this requirement because it can take a few seconds to screw the valves closed, time during which the container can become significantly overfilled. By using a listed quick-acting shutoff valve, flow can be stopped quickly.

69.3.15.3.17 An identified and accessible switch or circuit breaker shall be installed outside at a location not less than 20 ft (6.1 m) or more than 100 ft (30.5 m) from the dispenser to shut off the power in the event of a fire, an accident, or other emergency. [**58:**6.27.3.17]

Paragraph 69.3.15.3.17 provides specific minimum and maximum distances from a shutoff switch to the dispenser. The outside location is required because enforcers were finding that, where it was indoors, such equipment was being made inaccessible by the storage or display of items being sold at the same location. A sign or other marking (see 69.3.15.3.18) must identify the location of the switch so that the dispenser can be shut off either from the vicinity of the dispenser or from a remote location.

There are places where limiting the switch location to the specified distance can result in an installation that fails to meet the intent of the requirement, such as a lot where the specified distance range is in an area where vehicles are moving about. In such a location, the AHJ may allow the distance to be slightly extended in order to provide a safe and useful installation. Reducing the distance may make it inaccessible in the event of a release, especially if it results in a fire, so it should not be considered. In all such instances, the AHJ should be consulted prior to the installation.

69.3.15.3.18 The markings for the switches or breakers shall be visible at the point of liquid transfer. [**58:**6.27.3.18]

It is important that the markings locating the switches or breakers be legible from the transfer point and that obstructions and signs not be placed in such a way that the markings are hidden.

69.3.15.4 Installation of Vehicle Fuel Dispensers.

Δ **69.3.15.4.1** Hose shall comply with the following:

(1) Hose length shall not exceed 18 ft (5.5 m) unless approved by the AHJ.
(2) All hose shall be listed.
(3) When not in use, the hose shall be secured to protect the hose from damage.

[**58:**6.27.4.1]

This provision is modeled after 12.2.4 of NFPA 30A. The 18 ft (5.5 m) limit on hose length comes from the U.S. Bureau of Weights and Measures. The normal maximum hose length may be exceeded when necessary, with the approval of the AHJ.

The AHJ must consider whether the excess-flow valve at the hose or piping interface will still function if the hose fails near the delivery end. A long hose can restrict flow enough so that the excess-flow valve will fail to close.

Δ **69.3.15.4.2** A listed emergency breakaway device shall be installed and shall comply with UL 567, *Standard for Emergency Breakaway Fittings, Swivel Connectors, and Pipe-Connection Fittings for Petroleum Products and LP-Gas,* and be designed to retain liquid on both sides of the breakaway point, or other devices affording equivalent protection approved by the AHJ. [**58:**6.27.4.2]

Pull-away incidents have occurred with gasoline, diesel, and propane fuel dispensers. Anchorage of the breakaway device in accordance with the manufacturer's instructions is required to ensure that the dispenser operates properly. If the dispenser does not provide anchorage, a separate post or other means of anchorage may be necessary.

69.3.15.4.3 Vehicle fuel dispensers shall be located as follows:

(1) Conventional systems shall be at least 10 ft (3.0 m) from any dispensing device for Class I or Class II liquids.
(2) Low-emission transfer systems in accordance with Section 6.30.5 of NFPA 58 shall be at least 5 ft (2 m) from any dispensing device for Class I or Class II liquids.

[**58:**6.27.4.3]

See NFPA 30 for information on classification of liquids. Gasoline, for example, is a Class I liquid.

69.4 LP-Gas Liquid Transfer

The transfer of liquid LP-Gas to or from stationary storage containers, transportation vehicles (highway and rail), and portable containers requires connections and disconnections of couplings by transfer personnel. The likelihood of releasing LP-Gas into the atmosphere is greatest during these operations. Section 69.4 provides safety requirements for when liquid LP-Gas is transferred from one container to another and for when liquid or vapor LP-Gas is vented and purged to the atmosphere.

Section 69.4 addresses the following important aspects related to liquid transfer of LP-Gas:

- Operational safety of transfer operations (including training and qualification requirements, operational requirements, controlling sources of ignition, filling/evacuating containers, and hose inspection)
- Venting LP-Gas to atmosphere (including the acceptable conditions)
- Quantity of LP-Gas in containers (including the maximum allowable quantity)

69.4.1* Scope.

A.69.4.1 Ignition source control at transfer locations is covered in Section 6.25 of NFPA 58. Fire protection is covered in Section 6.29 of NFPA 58. [**58:**A.7.1]

69.4.1.1 Section 69.4 applies to transfers of liquid LP-Gas from one container to another wherever this transfer involves connections and disconnections in the transfer system or the venting of LP-Gas to the atmosphere. [**58:**7.1.1]

69.4.1.2 Section 69.4 also applies to operational safety and methods for determining the quantity of LP-Gas permitted in containers. [**58:**7.1.2]

The probability of the release of LP-Gas, especially liquid LP-Gas, is greatest during liquid transfer operations. While release is an operational necessity, it can and should be minimized. Accurate container filling is necessary to avoid release through pressure relief devices after the container has been filled. Therefore, the *Code* has always thoroughly addressed these operations. Exhibit 69.26 is an example of a transfer operation showing the filling of cargo tank vehicles at a pipeline terminal.

69.4.2 Operational Safety.

69.4.2.1 Transfer Personnel.

69.4.2.1.1 Transfer operations shall be conducted by qualified personnel meeting the provisions of Section 4.4 of NFPA 58. [**58:**7.2.1.1]

Exhibit 69.26

Transport trailers loading at a pipeline terminal.

69.4.2.1.2 At least one qualified person shall remain in attendance at the transfer operation from the time connections are made until the transfer is completed, shutoff valves are closed, and lines are disconnected. [**58:**7.2.1.2]

Liquid transfer operation is considered to have the greatest risk of discharge of flammable gas into the atmosphere. The individual performing the transfer must be fully qualified in such work and sufficiently familiar with the operation of equipment to stop the transfer operation and minimize the loss of product should an emergency arise.

The term *in attendance* in 69.4.2.1.2 clarifies the intent of the requirement, which is that the qualified person must view the transfer operation and be able to take action if needed at any time. The entire transfer operation may not be viewable from one location. For example, if an operator is filling a tank at a building, the tank may not be visible from where the bobtail is parked. In this example, the operator must choose the best location to ensure that the tank is not overfilled. During the time the bobtail cannot be seen, the operator must use all his or her senses (e.g., listening to the truck engine for speed changes that could indicate releases, listening for the escape of hissing gas, looking for vapor clouds) to monitor the transfer process. If the operator needs to leave the location, the transfer operation must be stopped during that absence according to DOT regulations in 49 CFR 177.834(i)(1), "Loading," and (2), "Unloading."

A qualified operator is considered to be in attendance when he or she is standing at the cargo tank vehicle, sitting in the cab of the vehicle, or sitting in a booth or guardhouse with the cargo tank vehicle in clear sight. The qualified operator must be awake and aware of the transfer during the operation. If the complete transfer system is not visible from one location and the transfer is lengthy — for example, during the unloading of a transport — it is prudent for the operator to check the entire system for leakage during the transfer.

69.4.2.1.3 Transfer personnel shall exercise caution to ensure that the LP-Gases transferred are those for which the transfer system and the containers to be filled are designed. [**58:**7.2.1.3]

Accidents can occur if propane or a mixture of propane and butane is placed in containers suitable only for butane. The pressure relief device is set to a lower pressure for butane and can result in a release of flammable gas during its operation if a different LP-Gas is transferred into the container. The ASME container nameplate and the cylinder collar or body are marked with the design pressure of the container.

69.4.2.2 Filling and Evacuating of Containers.

69.4.2.2.1 Transfer of LP-Gas to and from a container shall be accomplished only by qualified individuals trained in proper handling and operating procedures meeting the requirements of Section 4.4 of NFPA 58 and in emergency response procedures. [**58:**7.2.2.1]

Training in emergency response procedures is required so that, in the event of an incident, personnel are prepared and able to take prompt action to minimize the extent of loss, damage, or fire. The transfer personnel filling the containers may be the only individuals who regularly view or inspect some containers.

Employee turnover at dispensing sites such as hardware stores, gas stations, and convenience stores may be high and could provide an extra challenge in ensuring all operators are properly trained. It is critical that both initial training and refresher training be provided.

69.4.2.2.2 When noncompliance with Section 5.2 and Section 5.9 of NFPA 58 is found, the container owner and user shall be notified in writing. [**58:**7.2.2.2]

When it is determined that a container does not comply with Section 5.2 or Section 5.9 of NFPA 58, the owner or operator of the container must be notified in writing. This important requirement relies on 69.4.2.2.1, which mandates that personnel who transfer LP-Gas are qualified. Paragraph 69.4.2.2.1 is especially important given the trend in some areas toward greater numbers of fixed containers owned by users who may not be aware of the requirements of Sections 5.2 and 5.9 of NFPA 58.

Paragraph 69.4.2.2.2 does not specify who must provide the notification, and there has been some confusion over who can notify the owner or operator of a container. Clearly, the qualified operator must make the determination that the container is not suitable to be filled, but the container filler is not required to notify the owner or operator. The filler can provide written notification at the container location, or it can be provided by other employees of the propane company. The requirement states that there must be written notification. The point at which an individual determines that there is a problem with the container is the essential first step for initiating the written notification. If this individual fails to either present the notice or inform the next individual involved in the process, there is no possibility for the notification required by 69.4.2.2.2 to occur.

69.4.2.2.3 Injection of compressed air, oxygen, or any oxidizing gas into containers to transfer LP-Gas liquid shall be prohibited. [**58:**7.2.2.3]

The use of compressed air, oxygen, or other oxidizing gases to transfer LP-Gas is extremely dangerous because it can create a flammable gas mixture within the container. A flammable gas mixture being fed into an appliance can ignite and the flame can travel back to the container, which can result in an explosion. Special care should be taken where propane cylinders are sold to customers using the propane as a cutting fuel in conjunction with oxygen. NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes*, provides the necessary safety requirements to prevent oxygen and fuel gases from mixing. The use of LP-Gas with oxygen is not covered under this *Code*.

This requirement does not prohibit injecting an inert gas into a container. Hot air balloon pilots regularly add nitrogen to their propane containers to increase the pressure and ensure that there will be sufficient flow of liquid propane to the burners, since operating at a higher altitude can lead to lowered fuel temperature or pressure. Nitrogen is not an oxidizing gas.

69.4.2.2.4 When evacuating a container owned by others, the qualified person(s) performing the transfer shall not inject any material other than LP-Gas into the container. [**58:**7.2.2.4]

69.4.2.2.5* Valve outlets on refillable cylinders of 108 lb (49 kg) water capacity [nominal 45 lb (20 kg) propane capacity] or less shall be equipped with a redundant pressure-tight seal or one of the following listed connections: CGA 790, CGA 791, or CGA 810, as described in CGA V-1, *Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections*. [**58:**7.2.2.5]

The CGA 790 connection is a left-handed, threaded connection that was widely used for gas grill connections until the recent introduction of couplings that do not require tools. The CGA 791 is a newer threaded connection incorporating a square thread that is found on the majority of gas grills today. The CGA 810 is a "quick connect" fitting offered on some gas grills today. Both the CGA 791 and CGA 810 connections incorporate a redundant seal, which allows flow only when the cylinder is properly connected for use.

Paragraph 5.9.3.4 of NFPA 58 requires these portable cylinders to be equipped with the CGA 791 or CGA 810 connection, which are described in the commentary following 5.9.3.4 of NFPA 58: *LP-Gas Code Handbook*.

It is not the intent of 69.4.2.2.5 to require a cap or plug to be installed on a cylinder using a CGA 791 connection or a CGA 810 connection, because those connections will allow gas to be removed from the cylinder only when the connection is made. This stipulation was needed because many enforcers saw the plastic plugs as proof of redundant sealing and were requiring them for the CGA 791 and CGA 810 connections. However, no plug was produced for those connections, so a separate plug is not needed. If a plug is put into a CGA 791 or CGA 810 connection, it will defeat the redundant seal. However, a damaged O-ring on the plug would then allow the cylinder to leak.

A.69.4.2.2.5 Examples of an effective seal are a POL plug or cap. Listed quick-closing couplings with CGA V-1 connection numbers 790 (fork lift ACME connection), 791 (portable cylinder ACME/POL connection), and 810 (socket/plug quick connection) have secondary seals. Therefore, plugs or caps for these connections are not required or recommended. [**58:**A.7.2.2.5]

69.4.2.2.6 Where redundant pressure seals are used, they shall be in place whenever the cylinder is not connected for use. [**58:**7.2.2.6]

69.4.2.2.7 Nonrefillable (disposable) and new unused cylinders shall not be required to be equipped with valve outlet seals. [**58:**7.2.2.7]

While it may appear that 69.4.2.2.7 is in conflict with 69.4.2.2.5, note that 69.4.2.2.5 applies to cylinders of 45 lb (20 kg) propane capacity and less, while 69.4.2.2.7 applies to nonrefillable (disposable) cylinders that usually have a capacity of 1 lb (0.45 kg) or less. The largest possible disposable cylinder for flammable gases is about 1.1 lb (0.50 kg) propane capacity. A conflict between 69.4.2.2.7 and 69.4.2.2.5 does not exist where cylinders follow the DOT requirements.

69.4.2.2.8 Containers shall be filled only after determination that they comply with the design, fabrication, inspection, marking, and requalification provisions of NFPA 58. [**58:**7.2.2.8]

There are several reasons that NFPA 58 does not hold a specific individual responsible for determining whether a container complies with the requirements of the applicable pressure vessel code. One reason worth noting is that, in most cases, the individual filling a container is more qualified than the owner to determine that the container is code compliant. The provision in 69.4.2.2.8 places a great deal of responsibility on the filler, who is required by this *Code* to be properly trained on filling the container. If at any point the filler does not follow the training, it is considered a violation of this *Code*.

To fulfill this requirement, the filler must be familiar with marking and inspection requirements, which requires considerable training. There are millions of 20 lb (9.1 kg) cylinders owned by the public, and owners of portable cylinders often are not aware of the requalification that is necessary 12 years after the date of manufacture and every 5 to 12 years thereafter (see 5.2.2 and Annex C of NFPA 58).

When filling cylinders, the filler must be careful to verify that the cylinder requalification period has not been exceeded. If a cylinder is out of date, it cannot be filled, and the owner should be notified of his or her responsibility to have the cylinder requalified prior to filling. The filler should check for corrosion on easily visible surfaces and in the area within the foot ring at the bottom of portable cylinders. Many propane companies establish policies to guide cylinder fillers in this determination.

Exhibit 69.27 shows a container being filled. Note the bobtail remote shutoff in the operator's left hand, which meets the

Exhibit 69.27

Filling a storage container. (Courtesy of Richard Fredenburg and Tart Propane)

DOT requirement for a remote shutdown system. The operator can stop the truck pump and close the tank valve by pressing the button on the remote.

Newer composite cylinders also must be requalified. The methods used for metal cylinders cannot be used for composite cylinders. The filler should refer to the information provided by the cylinder manufacturer for the frequency and method of requalification. If such information is not readily available, the U.S. DOT can provide the frequency and the procedures that must be used.

Subsection 5.9.3 of NFPA 58 for overfilling prevention device (OPD) valves on most cylinders of 4 lb to 40 lb (1.8 kg to 18 kg) propane capacity requires an OPD device to be in place on every cylinder before it is filled. This requirement applies to all new cylinders manufactured after the September 30, 1998, retrofit requirement became effective on April 1, 2002, for all cylinders (see 5.9.3.2 of NFPA 58).

The filler must check cylinders for the OPD valve before filling (see 69.4.2.2.16). It should be noted that in the United States, some states have not adopted editions of NFPA 58 that require an OPD, and other states have adopted editions of NFPA 58 that require an OPD but have not adopted the OPD requirements specifically. The OPD requirements cannot be enforced for refilling cylinders in those states, but many propane marketers make the NFPA 58 OPD requirements their company policy. Because all cylinders of 4 lb to 40 lb (1.8 kg to 18 kg) propane capacity manufactured after September 1998 have an OPD, the number of non-OPD cylinders is diminishing and will continue to diminish.

Fillers of ASME tanks must check the condition of the tank before starting to fill (see 69.4.2.2.16). The filler is not, however, expected to discover difficult-to-determine conditions such as internal corrosion, worn valve seats, or other conditions that are not reasonably apparent. The filler should be alert to visible corrosion, indications of leakage, missing piping components, and the absence of a nameplate. If any of these conditions is present, the filler should report it to the owner (see 69.4.2.2.2).

Exhibit 69.28 shows a cylinder filling facility. When the cylinder (not shown) is filled to its correct filling weight, the automatic shutoff valve on the hose inlet will activate and automatically stop the flow.

69.4.2.2.9 Prior to refilling a cylinder that has a cylinder sleeve, the cylinder sleeve shall be removed to facilitate the visual inspection of the cylinder. [**58:**7.2.2.9]

This requirement was added to solve a problem created by the use of plastic sleeves by cylinder exchange companies. The sleeves contain product information and the necessary consumer warning information. It was discovered that many of the sleeves were being left on during the refilling process, making it impossible to see if the cylinder was corroding under the sleeve, as shown in Exhibit 69.29. The sleeve can allow water to collect between it and the cylinder, causing corrosion. Requiring the sleeve to be removed prior to filling is a simple way to identify any corrosion.

N **69.4.2.2.10 Reserved.**

N **69.4.2.2.11 Reserved.**

Exhibit 69.28

Cylinder filling room with automatic cylinder filling scales. (Courtesy of Propane Education and Research Council)

Exhibit 69.29

Cylinder showing corrosion under a sleeve (sleeve removed). (Courtesy of Richard Fredenburg, North Carolina Department of Agriculture and Consumer Services)

69.4.2.2.12 "Single trip," "nonrefillable," or "disposable" cylinders shall not be refilled with LP-Gas. [**58:**7.2.2.12]

Single-trip, nonrefillable, or disposable cylinders are not designed for extended service. Their small size increases the chance that they will be overfilled when commonly available filling equipment and procedures are used. The cylinders are designed for filling by weight and are equipped with connections that will not fit correctly with common filling equipment. However, adapters for refilling such cylinders are widely available because refillable cylinders come in the same sizes as nonrefillable cylinders. There are various resources for showing the public how to fill nonrefillable cylinders against the design of the cylinder; following such instructions should be actively discouraged.

Δ **69.4.2.2.13** Containers shall comply with the following with regard to service or design pressure requirements:

(1) The service pressure marked on the cylinder shall be not less than 80 percent of the vapor pressure of the LP-Gas for which the cylinder is designed at 130°F (54.4°C).
(2) The maximum allowable working pressure (MAWP) for ASME containers shall be in accordance with Table 5.2.4.2 of NFPA 58.

[**58:**7.2.2.13]

Table 5.2.4.2 of NFPA 58 establishes a requirement that ASME pressure vessels for propane service have a design pressure of 250 psig (1.7 MPag). If used in the interior of vehicles or as engine fuel containers (if built after April 1, 2001), the design pressure is increased to 312 psig (2.2 MPag). See 5.2.4.4 and 5.2.4.5 of NFPA 58 for more information on the maximum allowable working pressure (MAWP) of engine fuel containers.

N **69.4.2.2.14** Universal cylinders shall be permitted to be filled when in the vertical position or in the horizontal position when the positioning slot is in the correct orientation. [**58:**7.2.2.14]

The requirement in 69.4.2.2.14 was added in the 2018 edition of the *Code* to clarify that universal cylinders are designed and permitted to be filled in either orientation. The location of openings and the internal arrangement of the piping for fill valves, relief valves, and fixed liquid level devices are such that safe filling and determination of proper filling can be made either when the cylinder is vertical or when it is horizontal and the positioning slot is at the bottom. Orientations other than vertical and horizontal (slot down) are not allowed.

Note that it is not a requirement that the positioning slot be in the correct orientation and engaged during filling. Depending on the device and the requirements of that device, including relevant safety standards, the cylinder may be filled whether or not it is installed on the device it fuels. Also note that, if it is installed on the device, it must be the required distance from a source of ignition (e.g., hot exhaust pipes, active electrical equipment).

69.4.2.2.15 Transfer of refrigerated product shall be made only into systems that are designed to accept refrigerated product. [**58:**7.2.2.15]

69.4.2.2.16 A container shall not be filled if the container assembly does not meet the requirements for continued service. [**58:**7.2.2.16]

The term *container assembly* is defined in NFPA 58 as "an assembly consisting of the container and fittings for all container openings such as shutoff valves, excess-flow valves, liquid level gauging devices, pressure relief devices, and protective housings."

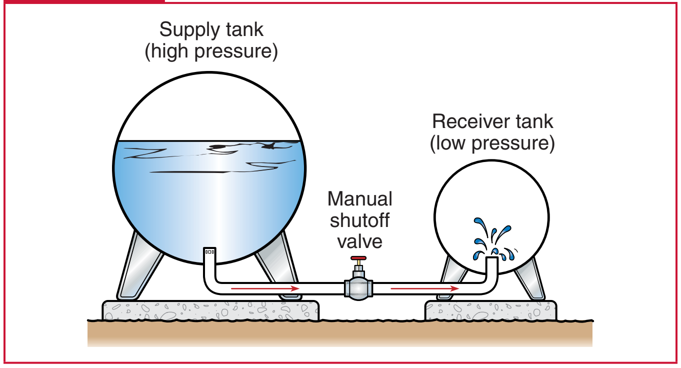
There are several reported cases where a fill valve adapter has been left attached to a fill valve because the fill valve failed to seat properly after filling. Such adapters are temporary and are intended to prevent release of the product until the fill valve can be replaced or repaired. A container assembly with an adapter does not meet the requirements for continued service because the internal back-flow check devices of the fill valve are disabled. The external back-flow check device in the adapter provides temporary safety, but it should not be relied on for continued protection. This paragraph requires that the container not be filled until the fill valve correction is made.

69.4.2.2.17 Transfer hoses larger than ½ in. (12 mm) internal diameter shall not be used for making connections to individual cylinders being filled indoors. [**58:**7.2.2.17]

69.4.2.3 Arrangement and Operation of Transfer Systems.

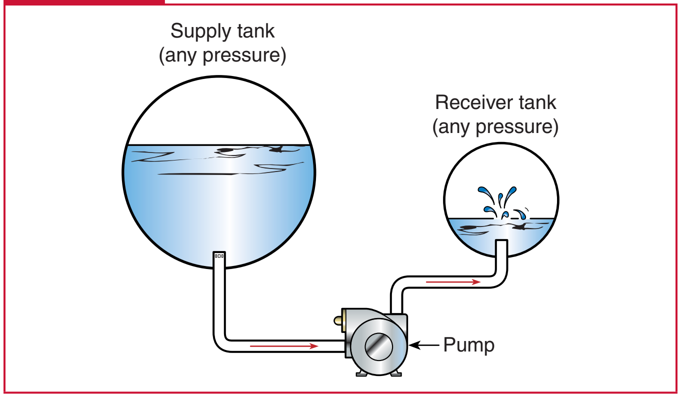
LP-Gas can be transferred by pressure differential using gravity (as shown in Exhibit 69.30), pumps (as shown in Exhibit 69.31), or compressors to provide the force necessary for transfer. Transfer by gravity is not common, but it is sometimes used to transfer LP-Gas into forklift cylinders at the customer's location.

Exhibit 69.30



Liquid transfer by pressure differential or gravity. (Courtesy of National Propane Gas Association)

Exhibit 69.31



Liquid transfer by pump. (Courtesy of National Propane Gas Association)

The pressure differential method of transferring LP-Gas works when the pressure in the container to be filled is lower than that in the supply container. Liquid will flow until the pressures in the containers are equal. To fill a container, it will probably be necessary to reduce the pressure inside it by opening the valve to the atmosphere prior to transferring product. This procedure is often viewed as unreliable and can cause atmospheric contamination of the receiving container.

Compressors are used to unload railroad tank cars and some transport trucks. A compressor takes vapor from the container that will be receiving the product and transfers the vapor to the container from which the liquid is being unloaded. This vapor transfer creates a higher pressure in the container being unloaded than in the receiving container, causing the liquid to flow into the receiving container. When all the liquid has been transferred, the residual vapors in the unloading railroad tank car or transport vehicle can be recovered and placed into the receiving vessel by reversing the flow through the compressor piping.

It is advantageous to have vapor enter at the bottom of the receiving container so that it will pass through the cooler liquid, making it easier to condense. If the vapor enters at the top of the receiving container, the heat of compression will warm the vapor and increase pressure in the receiving container, slowing the transfer operation. Care must be taken when opening valves, because doing so rapidly can result in the closing (also known as "slugging") of any excess-flow check valves that have been installed.

Pumping is the usual liquid transfer method for operations such as delivery to a fixed container, transfer from bulk storage into bobtail delivery trucks, and unloading of transport vehicles. With both pump and compressor transfer methods, it is important to have proper correlation between the design size of both the piping and the excess-flow check valve so that the valve does not close prematurely. Proper excess-flow valve sizing is also important from a safety standpoint because the size of the line must permit sufficient flow to allow the valve to operate if there is a break or rupture in the line.

69.4.2.3.1 Public access to areas where LP-Gas is stored and transferred shall be prohibited, except where necessary for the conduct of normal business activities. [**58:**7.2.3.1]

Areas where LP-Gas is stored or handled present hazards that are not apparent to those who are untrained in the properties of LP-Gas and the equipment used at the site. Therefore, the public is normally excluded from these areas. Many bulk plants invite their customers to bring cylinders to a drop-off point or a refilling point; these areas are normally open to the public, and this practice is permitted.

69.4.2.3.2 Sources of ignition shall be turned off during transfer operations, while connections or disconnections are made, or while LP-Gas is being vented to the atmosphere. [**58:**7.2.3.2]

Δ **69.4.2.3.2.1** Internal combustion engines within 15 ft (4.6 m) of a point of transfer shall be shut down while such transfer operations are in progress, with the exception of the following:

(1) Engines of LP-Gas cargo tank vehicles, constructed and operated in compliance with Chapter 9 of NFPA 58, while such engines are driving transfer pumps or compressors on these vehicles to load containers in accordance with 6.6.2.2 of NFPA 58
(2) Portable engines with shielded ignition systems and exhaust system spark-arresters located at least 10 ft (3 m) from a point of transfer while such engines are driving transfer pumps or compressors
(3) Engines for industrial (and forklift) trucks powered by LP-Gas used in buildings as provided in Section 11.13 of NFPA 58

[**58:**7.2.3.2(A)]

Item 2 was added in the 2018 edition of the *Code* to coincide with the separation requirements in 69.4.2.3.3 and the shielded ignition and exhaust system spark arrester requirements in 6.20.3.3 of NFPA 58. This allows an exception for safety devices and practices that mitigate possible source of ignition hazards.

Vehicle engines must be allowed to operate when the engine drives a pump or a compressor used to transfer LP-Gas and when the truck is entering or leaving filling stations. An operating gasoline-fueled internal combustion engine normally does not create sparks or have surfaces hot enough to ignite propane and will stall in a propane-rich environment due to lack of air for proper combustion. Similarly, a diesel engine may not ignite released LP-Gas, but damage can occur if gas is sucked into the air intake and causes the engine to accelerate uncontrollably. This is one reason for the operator to be in attendance and carefully monitoring the transfer process.

69.4.2.3.2.2 Smoking, open flame, portable electrical tools, and extension lights capable of igniting LP-Gas shall not be permitted within 25 ft (7.6 m) of a point of transfer while filling operations are in progress. [**58:**7.2.3.2(B)]

The spacing of sources of ignition and LP-Gas transfer operations is consistent with DOT regulations for separation distances for smoking. Note that this requirement applies only to portable sources of ignition and not to fixed electrical sources of ignition, which are covered in Section 6.25 of NFPA 58.

69.4.2.3.2.3 Metal cutting, grinding, oxygen–fuel gas cutting, brazing, soldering, or welding shall not be permitted within 35 ft (10.7 m) of a point of transfer while filling operations are in progress. [**58:**7.2.3.2(C)]

The 35 ft (10.7 m) separation distance between points of transfer and sources of ignition correlates with the requirements of NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*. The 35 ft (10.7 m) distance is necessary because slag or sparks created during hot work have been shown to travel some distance horizontally and, at this time, there has been no indication to the committee that such a distance is insufficient in length.

69.4.2.3.2.4 Materials that have been heated above the ignition temperature of LP-Gas shall be cooled before LP-Gas transfer is started. [**58:**7.2.3.2(D)]

69.4.2.3.2.5 Sources of ignition shall be turned off during the filling of any LP-Gas container on the vehicle. [**58:**7.2.3.2(E)]

Ignition sources on vehicles being fueled and those waiting to be fueled must be controlled. Special care should be taken when containers on recreational vehicles (RVs) are filled, because several fires have been reported where containers were being filled without the extinguishment of pilot flames or other sources of ignition during refueling. Some RVs have appliances such as furnaces and ranges with sources of ignition that operate automatically, and it may be appropriate to turn all circuit breakers to the "off" position to prevent them from operating.

69.4.2.3.3 Cargo tank vehicles unloading into storage containers shall be at least 10 ft (3.0 m) from the container and so positioned that the shutoff valves on both the truck and the container are readily accessible. [**58:**7.2.3.3]

69.4.2.3.4 The cargo tank vehicle shall not transfer LP-Gas into dispensing station system while parked on a public way. [**58:**7.2.3.4]

Operations involving the unloading of cargo tank vehicles are required to have a minimum separation of 10 ft (3 m) from the cargo tank vehicle to the container receiving the product. It is important to have the cargo tank vehicle located such that the operating controls on both the truck and the tank being filled are accessible in an emergency.

The prohibition of street parking is intended to avoid risks associated with accidental vehicle collisions during a transfer operation. Traffic in the area is expected while vehicles arrive with engine fuel containers to be filled or empty cylinders to be turned in. This prohibition does not apply to cargo tank vehicles transferring into containers at other locations.

The station shown in Exhibit 69.32 shows the vapor and liquid connections of a truck unloading station.

69.4.2.3.5 Transfers to containers serving agricultural or industrial equipment requiring refueling in the field shall comply with 69.4.2.3.5.1 and 69.4.2.3.5.2. [**58:**7.2.3.5]

69.4.2.3.5.1* Where the intake of air-moving equipment is less than 50 ft (15 m) from a point of transfer, it shall be shut down while containers are being refilled. [**58:**7.2.3.5(A)]

A.69.4.2.3.5.1 Air-moving equipment includes large blowers on crop dryers, space heaters, and some central heating equipment. Equipment employing open flames includes flame cultivators, weed burners, and tar kettles. [**58:**A.7.2.3.5(A)]

Exhibit 69.32

Truck unloading station. (Courtesy of Richard Fredenburg, North Carolina Department of Agriculture and Consumer Services)

69.4.2.3.5.2 Equipment employing open flames or equipment with integral containers shall be shut down while refueling. [**58:**7.2.3.5(B)]

Agricultural and industrial installations present hazards different from those presented by residential fuel applications because they generally use more LP-Gas. The safety precautions required in 69.4.2.3.5 recognize common sources of ignition that can contribute to accidents during transfer. Open flames may be used in weed burners, flame cultivation, vaporizing burners, industrial heaters, and various other applications.

Δ **69.4.2.3.6** During the time railroad tank cars are on sidings for loading or unloading, the following shall apply:

(1) A caution sign, with wording such as "STOP. TANK CAR CONNECTED," shall be placed at the active end(s) of the siding while the car is connected, as required by DOT regulations.

Exhibit 69.33 shows a "Stop, Car Connected" warning sign on the track leading to a transfer station. Note that a derailer has been placed on the track with a sign. The derailer will cause a car passing over it to derail, and the train's engineer will be aware of the derailing and stop the train.

(2) Wheel chocks shall be placed to prevent movement of the car in either direction.

[**58:**7.2.3.6]

This requirement reiterates an important DOT regulation. Accidents have occurred in cases where railroad tank cars have been moved with the unloading hose or connections still in place. In one reported situation, a tank car was partially unloaded and the hoses disconnected when the workers incorrectly assumed that

Exhibit 69.33

"Stop" and "Derail" signs on a track. (Courtesy of Eastern Propane Corp.)

the container was empty and moved the tank car. To prevent such incidents from occurring, the wheel stops (also known as chock blocks) and the warning sign should always be in place until the tank car has been completely unloaded and the railroad personnel have been advised to move the tank car.

Exhibits 69.34 and 69.35 show tank car loading and unloading installations. Note the small plastic tubing strapped to the hoses in Exhibit 69.34. This tubing carries pressurized gas, which opens the emergency shutoff valves used to connect to the tank car. In case of fire, the tubing will fail and the emergency shutoff valves will close.

Δ **69.4.2.3.7** Where a hose or swivel-type piping is used for loading or unloading railroad tank cars, it shall be protected as follows:

(1) An emergency shutoff valve shall be installed at the railroad tank car end of the hose or swivel-type piping where flow into or out of the railroad tank car is possible.
(2) An emergency shutoff valve or a backflow check valve shall be installed on the railroad tank car end of the hose or swivel piping where flow is only into the railroad tank car.

[**58:**7.2.3.7]

Exhibit 69.36 shows a railroad tank car–unloading tower. Note the platform access to tank car domes. The emergency shutoff valve or check valve is located at the end of the swivel piping shown above the platform.

69.4.2.3.8 Where cargo tank vehicles are filled directly from railroad tank cars on a private track with nonstationary storage tanks involved, the following requirements shall be met:

(1) Transfer protection shall be provided in accordance with 69.3.10.
(2) Ignition source control shall be in accordance with Section 6.25 of NFPA 58.
(3) Control of ignition sources during transfer shall be provided in accordance with 69.4.2.3.2.
(4) Fire extinguishers shall be provided in accordance with 9.4.7 of NFPA 58.
(5) Transfer personnel shall meet the provisions of 69.4.2.1.
(6) Cargo tank vehicles shall meet the requirements of 69.4.2.3.
(7) The points of transfer shall be located in accordance with 69.3.7.2.1 with respect to exposures.
(8) Provision for anchorage and breakaway shall be provided on the cargo tank vehicle side for transfer from a railroad tank car directly into a cargo tank vehicle.
(9) The provisions of Chapter 15 of NFPA 58 shall apply to all LP-Gas transfers performed in accordance with 69.4.2.3.8.

[**58:**7.2.3.8]

Exhibit 69.34

Tank car loading/unloading facility. Note the swing arms connected to the tank car dome. (Courtesy of Eastern Propane Corp.)

Exhibit 69.35

Close-up of tank car dome. (Courtesy of Eastern Propane Corp.)

Exhibit 69.36

Railcar unloading tower. (Courtesy of Eastern Propane Gas Inc.)

The requirements 69.4.2.3.8 are needed to permit the unloading of railcars where they cannot be unloaded directly into storage tanks. For example, this type of transfer is allowed when sections of rail mainlines are abandoned, when rail service to an area is discontinued, or when railcars cannot reach their normal unloading location due to emergency situations. Requiring that safety features equivalent to those of fixed transfer facilities be installed is intended to prevent the tank truck from moving and breaking a hose or piping system.

Δ **69.4.2.3.9** Where cargo tank vehicles are filled from other cargo tank vehicles or cargo tanks, the following requirements shall apply:

(1) Transfer between cargo tanks or cargo tank vehicles where one is used as a bulk plant shall be temporary installations that comply with 4.3.2, 6.21.1, 6.21.2, 6.21.4 through 6.21.6 of NFPA 58, and 69.4.2.3.1.

Both cargo tank vehicles and cargo tanks are used as alternatives to fixed storage, normally found at bulk and industrial plants. Product is transferred from one cargo tank vehicle or cargo tank to another cargo tank vehicle. Typically, transfer of product takes place from a cargo tank transport vehicle [9000 gal to 11,000 gal (34 m^3 to 42 m^3) water capacity] into a bobtail [typically 2500 gal to 5000 gal (9.5 m^3 to 19 m^3) water capacity].

The requirements in 69.4.2.3.9 are similar to those in 69.4.2.3.8 for transfer from railcars directly to cargo tank vehicles.

(2) Arrangements and operations of the transfer system shall be in accordance with the following:
   (a) The point of transfer shall be in accordance with Table 69.3.7.2.1.
   (b) Sources of ignition within the transfer area shall be controlled during the transfer operation as specified in 69.4.2.3.2.
   (c) Fire extinguishers shall be provided in accordance with 9.4.7 of NFPA 58.

(3) Cargo tanks shall comply with the requirements of 69.4.2.2.8.

(4) Provisions designed either to prevent a pull-away during a transfer operation or to stop the flow of products from both cargo tank vehicles or cargo tanks in the event of a pull-away shall be incorporated.

The requirement in 69.4.2.3.9(4) does not specify a particular device, but it does require the use of a system that will achieve the desired performance of stopping product flow in case a pull-away occurs.

(5) Off-truck remote shutoff devices that meet 49 CFR 173.315(n) requirements and are installed on the cargo tank vehicle unloading the product shall satisfy the requirements of 69.4.2.3.9(4).

The requirement in item (5) specifically permits the use of an active shutdown device such as a radio-controlled device with an activator carried by the truck driver. The radio-controlled device, when activated by the driver, will stop the pump, shut off the engine, and close the primary internal valve on the cargo tank vehicle that is unloading product. Such devices are required by the DOT for all cargo tank vehicles of 3500 gal (13 m^3) or less. The device must be capable of performing at a distance of 150 ft (46 m) from the cargo tank vehicle. It must also be able to activate the shutdown system when tested at 300 ft (91 m) under optimum conditions.

Cargo tank vehicles of more than 3500 gal (13 m^3) in the United States are required by the DOT to have a passive shutoff device that will stop the flow of propane from the cargo tank vehicle upon hose separation. Products used to comply with this requirement include a special hose with an incorporated shutoff feature that activates if the hose coupling separates and a truck-mounted sensor that activates if pump discharge pressure increases. If a separation occurs with this system, the pump discharge pressure will increase due to the stoppage of flow.

Exhibit 69.37 shows a truck-mounted sensor on a larger cargo tank vehicle (transport), located at the discharge of the pump. It continually monitors the offloading process for changes that signify broken or damaged hoses, fittings, or piping. A leak is detected and stopped by the closure of the tank internal valves(s). The sensor also closes the internal valve if there is a loss of power or if the trailer parking brake is released (also known as a "fail close" or "fail safe" condition on the valve). Also shown is the control box, the vapor internal valve, the manual operators that open and close the internal valves, and the air operator. Note that vapor and liquid control handles and valve caps are color coded to indicate vapor and liquid piping.

(6) Cargo tank vehicle LP-Gas transfers that are for the sole purpose of testing, maintaining, or repairing the cargo tank vehicle shall be exempt from the requirements of 69.4.2.3.9(1).

[**58:**7.2.3.9]

The requirement in item (6) is intended to exempt vehicles that are undergoing testing, repair, or maintenance operations that routinely occur on cargo tank motor vehicles.

69.4.2.4 Hose Inspection.

69.4.2.4.1 Hose assemblies shall be observed for leakage or for damage that could impair their integrity before each use. [**58:**7.2.4.1]

69.4.2.4.2 The hose assemblies specified in 69.4.2.4.1 shall be inspected at least annually. [**58:**7.2.4.2]

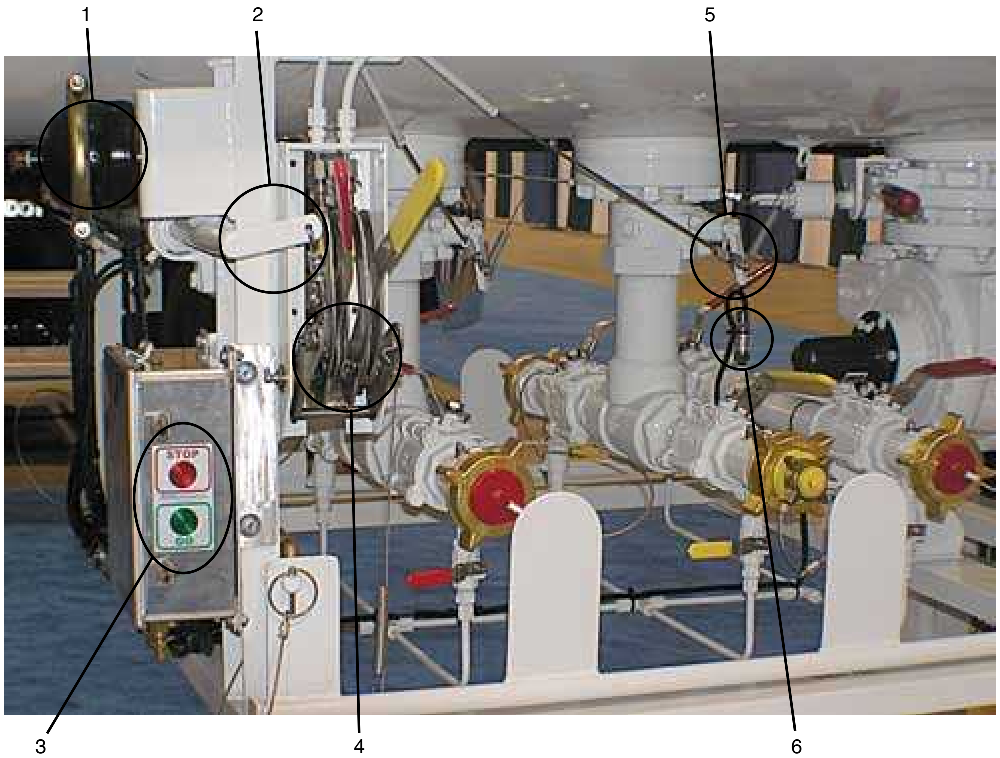
Δ **69.4.2.4.3** Inspection of pressurized hose assemblies shall include inspection for the following:

(1) Damage to outer cover that exposes reinforcement
(2) Kinked or flattened hose
(3) Soft spots or bulges in hose
(4) Couplings that have slipped on the hose, are damaged, have missing parts, or have loose bolts
(5) Leakage other than permeability leakage

[**58:**7.2.4.3]

69.4.2.4.4 Hose assemblies shall be replaced, repaired, or continued in service based on the results of the inspection. [**58:**7.2.4.4]

Exhibit 69.37



1. Air-operated shutdown actuator
2. Linkage/rod between spring chamber and valve operator
3. Passive shutdown controller
4. Manual operator to open/close vapor and liquid internal valves
5. Internal valve handle and cable linkage to valve operator with fusible link
6. Pressure sensor installed in pump discharge line, which sends signal to passive controller indicating that pump pressure is being maintained

Passive transport shutdown system. (Courtesy of Mississippi Tank Company)

69.4.2.4.5 Leaking or damaged hose shall be immediately repaired or removed from service. [**58:**7.2.4.5]

Hose assemblies are the weak link in liquid transfer operations. Hose is inherently weaker than pipe and has a much shorter lifespan, which can be further reduced by the effects of weather and physical damage (e.g., being dragged over earth, gravel, or barbed wire fences) and from other abrasive actions (e.g., pump-induced vibrations when in contact with gravel, concrete, or other rough surfaces). Bending hose beyond the maximum bending radius (kinking) can also cause damage. Hose ends can become loose and start leaking, or they can separate from couplers. Hose couplers can wear and not fit tightly, which may result in loosening caused by vibration.

Periodic inspection of hose assemblies is a requirement for safe transfer operations. However, disagreement remains over what should be included in the procedures. Some propane companies have established daily and periodic inspection procedures.

Pressure testing of hose assemblies is a subject that has been discussed often over the years by AHJs, cargo tank vehicle operators, and propane companies. Recent requirements by the DOT for cargo tank vehicle hose have mandated pressure testing of new and refitted hose assemblies in truck unloading services. Exhibit 69.38 shows a hose swivel end fitting, which can aid in kinking prevention.

69.4.3 Venting LP-Gas to the Atmosphere.

An increasing concern about venting LP-Gas to the atmosphere is the adverse environmental impact of the released propane. Unburned hydrocarbons in the air can combine with other chemicals to create smog or increased levels of ozone. The U.S. Environmental Protection Agency (EPA) has become more interested in recent years in any releases of unburned hydrocarbons (also known as “fugitive gas emissions”), which could result in more restrictions on venting LP-Gases.

Exhibit 69.38

Hose swivel end fitting. (Courtesy of Full Circle)

Δ **69.4.3.1 General.** LP-Gas in either liquid or vapor form shall not be vented to the atmosphere unless it is vented under the following conditions:

(1) Venting of LP-Gas shall be permitted where the maximum flow from fixed liquid level, rotary, or slip tube gauges does not exceed that from a No. 54 drill orifice.

It is necessary to vent both vapor and a small amount of liquid from fixed maximum liquid level, rotary, and slip tube gauges. Venting should be done with consideration for potential ignition hazards within the surroundings. To prevent LP-Gas from entering a building, it should not be discharged close to a window. A No. 54 drill size limits the vented LP-Gas to an amount that should dissipate rapidly.

(2) Venting of LP-Gas between shutoff valves before disconnecting the liquid transfer line from the container shall be permitted.
(3) Venting of LP-Gas, where necessary, shall be permitted to be performed by the use of bleeder valves.

If it is necessary to bleed off liquid from a pipe or a hose, the bleeding off must be done slowly and carefully. If bleeding off is not done correctly, a potential hazard to operating personnel created by the rapid discharge could result. The vapor ignition hazard area is also increased because of the conversion of liquid to vapor. Also, if the venting is too rapid, the cooled liquid remaining in the pipe or hose may slow or stop vaporizing and inhibit further release of liquid built up in the system. When the line is opened or the hose disconnected, a large release of the remaining product could then occur due to the leftover liquid.

(4) Venting of LP-Gas shall be permitted for the purposes described in 69.4.3.1(1) and 69.4.3.1(2) within structures designed for container filling in accordance with Chapter 10 of NFPA 58.

Buildings constructed to comply with Chapter 10 of NFPA 58 are built specifically to house LP-Gas transfer operations and have no open flames or electrical sources of ignition.

(5) Venting of LP-Gas listed liquid transfer pumps using such vapor as a source of energy shall be permitted where the rate of discharge does not exceed the discharge from a No. 31 drill size orifice.

This exception to the requirement on minimizing venting to the atmosphere has been in the *Code* for many years. It allows a piston pump powered by pressurized propane vapor to be used; however, piston pumps have not been available for many years.

(6) Venting of LP-Gas for purging in accordance with 7.3.2 of NFPA 58 shall be permitted.
(7) Venting of LP-Gas shall be permitted for emergencies.

The need for emergency venting is most common in cargo vehicle and railroad tank car accidents in which a tank is damaged and failure is considered possible. These situations often require the services of experts.

Teams of experts that specialize in response to railcar and truck accidents have been organized on a state or regional basis and are available to assist emergency responders in the event of a transportation emergency. One such group for chemical cargoes is the Chemical Transportation Emergency Center (CHEMTREC), which is operated by the American Chemistry Council (ACC). CHEMTREC provides a toll-free number (1-800-424-9300) for hazardous materials spills and incident emergencies. Frequently, local propane distributors assist in accidents involving propane cargoes through state or regional associations.

(8) Venting of LP-Gas vapor utilized as the pressure source in remote shutdown systems for internal valves and emergency shutoff valves shall be permitted.

[**58:**7.3.1]

Remote shutdown stations are often located at the gate or along the fence at a bulk plant. Consideration should be given to not placing ignition sources near these remote stations that utilize and could vent LP-Gas vapor.

69.5 Storage of Cylinders Awaiting Use, Resale, or Exchange

69.5.1 Scope.

Section 69.5 applies only to cylinders, which is defined as follows: “A portable container with a marked water capacity of 1000 lb (454 kg) or less that is designed to transport and store LP-Gas.”

The DOT specifications in 49 CFR 171.8 limit cylinders to 1000 lb (454 kg) water capacity, which is approximately 420 lb

(191 kg) propane capacity. DOT cylinders are portable storage containers that can be used in transportation, as well as installed and used in a stationary installation. The definition of *cylinder* does not include the following:

1. **ASME containers.** These are designed to be installed at one location and are not permitted to be transported when they contain more than 5 percent propane (with one exception covered in 9.6.2.2 of NFPA 58). Chapter 8 of NFPA 58 does not apply to ASME containers not connected for use, as they would be at a propane distribution facility.
2. **Cylinders made to specifications of other countries.** Under international treaties, the DOT permits these cylinders to be used, but not refilled, in the United States.

Δ **69.5.1.1** The provisions of Section 69.5 apply to the storage of cylinders of 1000 lb (454 kg) water capacity or less, whether filled, partially filled, or empty, as follows:

(1) At consumer sites or dispensing systems, where not connected for use
(2) In storage for resale or exchange by dealer or reseller

[**58:**8.1.1]

69.5.1.2 Section 69.5 does not apply to new or unused cylinders. [**58:**8.1.2]

69.5.1.3 Section 69.5 does not apply to cylinders stored at bulk plants. [**58:**8.1.3]

The current provisions of NFPA 58 do not differentiate between storage at a resale location or a user location, but they do stipulate what is to be done if portable cylinders are stored in conventional buildings (whether frequented by the public or not), outside of buildings, and in special buildings or rooms meeting the requirements of Chapter 10 of NFPA 58. The provisions of Chapter 8 of NFPA 58 apply only to the storage of cylinders on the premises of consumers, at dispensing stations, and at locations for resale or exchange by the cylinder dealer or reseller.

69.5.2 General Provisions.

69.5.2.1 General Location of Cylinders.

69.5.2.1.1 Cylinders in storage shall be located to minimize exposure to excessive temperature rises, physical damage, or tampering. [**58:**8.2.1.1]

Because of the smaller size of the cylinders covered in Chapter 8 of NFPA 58, the temperature of their contents tends to fluctuate more directly with ambient air temperatures or solar radiation than does the temperature of larger containers. These cylinders should not relieve LP-Gas through their pressure relief devices until the temperature of their contents exceeds 130°F (54°C), at which point the cylinder may become liquid full. These high temperatures could be reached in some extremely hot climates or in poorly located, poorly constructed, or unventilated storage locations.

In addition to temperature control, physical damage protection may be needed in storage locations. Certain facilities have considerable vehicular traffic — for example, forklift trucks — and require these precautions. Finally, tampering is a valid consideration. Although small portable cylinders, such as those used with grills, will not flow gas even if the valve is opened by hand, it is still important to provide protection from tampering, which could affect the safety devices.

69.5.2.1.2 Cylinders in storage having individual water capacity greater than 2.7 lb (1.1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] shall be positioned so that the pressure relief valve is in direct communication with the vapor space of the cylinder. [**58:**8.2.1.2]

The requirement that cylinders, other than very small cylinders, be stored so that the pressure relief valve is in the vapor space of the cylinder is an important safety concept that is repeated in several locations in the *Code*. The requirement is important because the capacity of pressure relief valves is based on gas flow, not liquid flow. If the pressure in a cylinder were sufficiently high to cause the pressure relief valve to operate, and the pressure relief valve were in communication with the liquid space of the cylinder, the following might occur:

- It might take more time to reduce the pressure in the container, since liquid is denser than gas and would therefore require a larger flow of liquid before resetting the valve.
- Liquid discharged from the cylinder would vaporize almost instantly, resulting in approximately 270 times as much vapor by volume as a gaseous release. If fire were the cause of the pressure relief valve operation, a liquid release would provide more fuel to the fire than a gaseous release.
- Liquid discharge would reduce the volume of liquid inside the container that would have contributed to the autorefrigeration reaction. Autorefrigeration occurs when the vapor pressure in the container decreases and causes the liquid to change phases. The liquid utilizes heat from the container as it changes phases, and the decrease in temperature of the container reduces the overall pressure in the container.

Cylinders less than 2.7 lb (1.1 kg) water capacity [about 1 lb (0.45 kg) of propane] are excluded from this requirement. Examples of such cylinders are those used for handheld soldering torches, portable stoves, camping equipment, and refillable portable appliances such as cigarette lighters (see Exhibit 69.39). These small cylinders are normally stored in cardboard shipping containers, and the proper storage orientation should be indicated on the shipping container.

69.5.2.1.3 Cylinders stored in buildings in accordance with 69.5.3 shall not be located near exits, near stairways, or in areas normally used, or intended to be used, for the safe egress of occupants. [**58:**8.2.1.3]

69.5.2.1.4 If empty cylinders that have been in LP-Gas service are stored indoors, they shall be considered as full cylinders for the

Exhibit 69.39

Cylinder used for portable appliance (camp stove).

purposes of determining the maximum quantities of LP-Gas permitted by 69.5.3.1, 69.5.3.2.1, and 69.5.3.3.1. [**58:**8.2.1.4]

Once filled, an LP-Gas cylinder seldom becomes completely empty. At the very least, the cylinder will usually be full of vapor and may contain some liquid or a residue that could contain the flammable odorant. If empty cylinders were not counted as full cylinders, it would be impossible for an enforcing authority to determine whether the storage limits were being exceeded without weighing all the cylinders.

69.5.2.1.5 Cylinders shall not be stored on roofs. [**58:**8.2.1.5]

Rooftops are largely out of sight and out of mind and are often places where combustible materials accumulate. Although the location of cylinders connected for use is permitted on rooftops, the storage of spare cylinders is not. Even an "empty" cylinder can complicate fire control activities. Rooftops are generally difficult locations to control, and adding a possible hazard to the area increases the difficulty for responding fire fighters should an emergency occur. In addition, the temperatures on roofs very often exceed ambient temperatures by several degrees.

69.5.2.2 Protection of Valves on Cylinders in Storage.

69.5.2.2.1 Cylinder valves shall be protected as required by 69.2.1.2.1 and 69.4.2.2.5. [**58:**8.2.2.1]

69.5.2.2.2 Screw-on-type caps or collars shall be in place on all cylinders stored, regardless of whether they are full, partially full, or empty, and cylinder outlet valves shall be closed. [**58:**8.2.2.2]

Protection for all cylinder valves is required by the DOT requirements for containers of hazardous materials. Smaller portable cylinders typically use a metal protective collar around the cylinder valve, while larger cylinders typically found in stationary service may have a screw-on cap or a dome cover.

69.5.2.2.3 Valve outlets on cylinders less than 108 lb (49 kg) water capacity [nominal 45 lb (20 kg) propane capacity] shall be plugged, capped, or sealed in accordance with 69.4.2.2.5. [**58:**8.2.2.3]

See the commentary following 69.4.2.2.5 for more details on cylinder plugs and caps, including important information about when plugs should not be used.

69.5.3 Storage Within Buildings.

Paragraph 69.5.3.3 covers cylinders in buildings not frequented by the public (e.g., industrial occupancies), such as repair shops that use LP-Gas containers for process or equipment operations and for forklift trucks. In buildings not frequented by the public, more LP-Gas can be stored because the general public will not be exposed to the hazards or be in the area of storage.

If highway vehicles carrying containers installed as service equipment are parked inside buildings or private garages, those containers are not considered part of the 735 lb (334 kg) total maximum water capacity allowed in the building. Paragraph 69.5.3.3.4 does not limit the number of these vehicles inside a private garage.

Special buildings or rooms must meet the requirements of Chapter 10 of NFPA 58, as discussed in 69.5.3.4. These special buildings or rooms cannot adjoin the line of property occupied by areas used for public gatherings such as schools, churches, hospitals, and athletic fields.

Residential buildings include one- and two-family dwellings, lodging or rooming houses, hotels and dormitories, and apartments, and include basements or any storage areas in a common basement of a multiple-family building and attached or detached garages, as noted in 69.5.3.5.

69.5.3.1 General. Storage of cylinders in buildings shall be in accordance with Table 69.5.3.1(a) or Table 69.5.3.1(b) or the requirements of 69.5.3. [**58:**8.3.1]

69.5.3.2 Storage Within Buildings Frequented by the Public.

69.5.3.2.1 The quantity of LP-Gas in cylinders stored or displayed shall not exceed 200 lb (91 kg) in one location, with additional storage separated by 50 ft (15 m). The maximum quantity to be stored in one building shall not exceed 1000 lb (454 kg). [**58:**8.3.2.1]

69.5.3.2.1.1 Where the total quantity stored in a building exceeds 200 lb (91 kg), an approved sprinkler system that, at a minimum, meets the requirement of Section 13.3 and NFPA 13 for Ordinary Hazard (Group 2) shall be installed. [**58:**8.3.2.1(A)]

69.5.3.2.1.2 The sprinkler density shall be 0.300 gpm (12.2 L/min) over the most remote 2000 ft^2 (18.6 m^2) area, and the hose stream allowance shall be 250 gpm (946 L/min). [**58:**8.3.2.1(B)]

Two requirements are provided for storing between 200 lb (91 kg) and 1000 lb (454 kg) in 1 lb (0.45 kg) or smaller cylinders:

1. The specified sprinkler system must be installed.
2. Additional storage of 200 lb (91 kg) must be separated by 50 ft (15 m).

***TABLE 69.5.3.1(a)** Maximum Allowable Storage Quantities of LP-Gas in Other Than Industrial, Storage, and Mercantile Occupancies*

Occupancy	Assembly	Educational	Day Care	Health Care	Ambulatory Health Care	Detention and Correctional	One- and Two-Family Dwellings	Lodging or Rooming House	Hotel and Dormitory	Apartment	Residential Board and Care	Business
Maximum Allowable Quantity (MAQ):												
Storage (state units: lb, gal, etc.)	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb
MAQ increases for:							Maximum 1 lb cylinders			1 lb cylinder		
Total (including cabinets)	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb
Total for suppression	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb
Total for both cabinets and suppression	0	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb	2 lb
Attended catered food service per NFPA 58 in 10 oz maximum cylinders	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb
			15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb
Additional 10 oz cylinders w/ 2-hr fire wall	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb	15 lb
Other												
Total (including threshold) for other	20 lb	20 lb	0	5 lb								
	Flame effects per NFPA 160. Additional 20 lb units with 20 ft (6 m) separation.	In labs, not in classrooms. Additional 20 lb units with 20 ft (6 m) separation.		In labs only. Additional 5 lb units with 20 ft separation						Amounts per dwelling		

[**58:** Table 8.3.1(a)]
For SI units, 1 lb = 0.45 kg, 1 oz = 0.028 kg.

The term *most remote*, as used in 69.5.3.2.1.2, refers to the concept that the flow of water from the sprinkler heads is not uniform across the entire sprinkler system. Sprinklers that have longer piping runs, especially of smaller diameter pipe, are more remote from the water supply and provide a lower flow of water than those closer to the supply and/or with larger diameter pipe. This is due to dynamic head losses as water is slowed by the friction of flow through a pipe. The system is designed so that the minimum required discharge density is provided at the most demanding area. Those areas closer to the water supply will then receive water flow that exceeds the minimum requirements. This concept is further explored in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

69.5.3.2.2 The cylinders shall not exceed a water capacity of 2.7 lb (1.1 kg) [nominal 1 lb (0.45 kg) LP-Gas]. [**58:**8.3.2.2]

69.5.3.2.3 In restaurants and at food service locations, storage of 10 oz (283 g) butane nonrefillable containers shall be limited to not more than 24 containers and 24 additional 10 oz (283 g) butane nonrefillable containers stored in another location within the building where constructed with at least 2-hour fire wall protection. [**58:**8.3.2.3]

Paragraph 69.5.3.2.3 permits the storage of up to forty-eight 10-oz (283 g) butane nonrefillable cylinders in restaurants and food service locations. The requirement covers fuel for the portable butane-fired cooking appliances allowed in 69.3.12.8.4,

TABLE 69.5.3.1(b) Maximum Allowable Storage Quantities of LP-Gas in Mercantile, Industrial, and Storage Occupancies

Occupancy	Mercantile	Industrial	Storage
Maximum Allowable Quantity (MAQ):			
Storage (state units: lb, gal, etc.)	200 lb (1 lb maximum/ cylinder)	300 lb	300 lb
MAQ increases for:			
Total (including threshold) for cabinets	200 lb	300 lb	300 lb
Total (including threshold) for suppression	200 lb	300 lb	300 lb
Total (including threshold) for both cabinets and suppression	200 lb	300 lb	300 lb
Total (including threshold) for other (describe)	1000 lb Separation of groups of 200 lb by 50 ft and a sprinkler density of 0.300 gpm (1.1 L/min) over the most remote 2000 ft^2 (18.6 m^2) area and 250 gpm (946 L/min) hose stream allowance	Additional 300 lb 300 ft separation	10,000 lb In special rooms or buildings per Chapter 10 of NFPA 58

[58: Table 8.3.1(b)]

For SI units, 1 lb = 0.45 kg; 1 gpm = 3.8 L/min; 1 ft = 0.3 m; 1 ft^2 = 0.09 m^2.

recognizing that spare cylinders must be on hand for these appliances and that a reasonable number of cylinders must be allowed. These cylinders are constructed to DOT specification 2P or 2Q per 49 CFR 178.33, "Specification 2Q; inner nonrefillable metal receptacles" and to UL 147A, *Standard for Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies*, or UL 147B. They are similar to aerosol containers.

69.5.3.3 Storage Within Buildings Not Frequented by the Public.

69.5.3.3.1 The maximum quantity of LP-Gas allowed in one storage location shall not exceed 735 lb (334 kg) water capacity [nominal 300 lb (136 kg) propane capacity]. [**58:**8.3.3.1]

69.5.3.3.2 Where additional storage locations are required on the same floor within the same building, they shall be separated by a minimum of 300 ft (91.4 m). [**58:**8.3.3.2]

69.5.3.3.3 Storage beyond the limitations described in 69.5.3.3.2 shall comply with 69.5.3.4. [**58:**8.3.3.3]

69.5.3.3.4 Cylinders carried as part of the service equipment on highway mobile vehicles shall not be part of the total storage capacity requirements of 69.5.3.3.1, where such vehicles are stored in private garages and carry no more than three cylinders with a total aggregate capacity per vehicle not exceeding 100 lb (45.4 kg) of propane. [**58:**8.3.3.4]

The requirement in 69.5.3.3.4 addresses the quantity of propane being carried by a vehicle for other than engine fuel use. It was originally developed to recognize the carrying of portable cylinders on telephone and electric utility service vehicles and the garaging of such vehicles in buildings owned and occupied by such firms. The current limit of up to three cylinders on a vehicle while maintaining the total quantity of 100 lb (45.4 kg) of LP-Gas recognizes that many utility vehicles carry multiple cylinders to meet service requirements.

69.5.3.3.5 Cylinder valves shall be closed when not in use. [**58:**8.3.3.5]

69.5.3.4 Storage Within Special Buildings or Rooms.

69.5.3.4.1 The maximum quantity of LP-Gas stored in special buildings or rooms shall be 10,000 lb (4540 kg). [**58:**8.3.4.1]

69.5.3.4.2 Special buildings or rooms for storing LP-Gas cylinders shall not be located where the buildings or rooms adjoin the line of property occupied by schools, churches, hospitals, athletic fields, or other points of public gathering. [**58:**8.3.4.2]

Δ **69.5.3.4.3** The construction of all special buildings and rooms specified in 69.5.3.4.2 shall comply with Chapter 10 of NFPA 58 and the following:

(1) Vents to the outside only shall be provided at both the top and bottom of the building and shall be located at least 5 ft (1.5 m) from any building opening.
(2) The entire area shall be classified for purposes of ignition source control in accordance with Section 6.25 of NFPA 58.

[**58:**8.3.4.3]

The phrase "special buildings or rooms" refers to buildings and rooms used only to store LP-Gas. The construction of these special buildings and rooms must comply with Chapter 10 of NFPA 58 and the additional provisions of 69.5.3.4.

69.5.3.5 Storage Within Residential Buildings. Storage of cylinders within a residential building, including the basement or any storage area in a common basement of a multiple-family building and attached or detached garages, shall be limited to cylinders each with a maximum water capacity of 2.7 lb (1.2 kg) and shall not exceed 5.4 lb (2.4 kg) aggregate water capacity per each living space unit. [**58:**8.3.5]

69.5.4 Storage Outside of Buildings.

Subsection 69.5.4 applies to cylinders stored in outdoor areas and includes retail locations as part of a commercial cylinder exchange and industrial locations for cylinders used on site.

69.5.4.1* Location of Storage Outside of Buildings.

A.69.5.4.1 The filling process in 69.5.4.1.4 refers to the time period beginning when a cylinder or cylinders are brought to a dispensing station to be filled and ending when the last cylinder is filled and all the cylinders are removed from the filling area. This is meant to define a continuous process, with the cylinders being unattended for only brief periods, such as operator breaks or lunch. [**58:**A.8.4.1]

Δ **69.5.4.1.1** Storage outside of buildings for cylinders awaiting use or resale or that are part of a cylinder exchange point shall be located as follows:

(1) At least 5 ft (1.5 m) from any doorway or opening in a building frequented by the public where occupants have at least two means of egress as defined by 3.3.182 and NFPA *101*
(2) At least 10 ft (3 m) from any doorway or opening in a building or sections of a building that has only one means of egress

The separation distance between cylinder storage and a doorway or opening in a building is to ensure that anyone in the building is able to leave in the event of propane release or fire in the cylinder storage area. The mandated distance is 5 ft (1.5 m) if there are two or more means of egress from the building and 10 ft (3 m) if there is only one means of egress.

(3) At least 20 ft (6.1 m) from any automotive service station fuel dispenser

[**58:**8.4.1.1]

The requirement in 69.5.4.1.1(3) for a 20 ft (6.1 m) separation between cylinder storage and gasoline or diesel fuel dispensers at a gas station addresses concerns over possible vehicle impact with cylinders, which could cause cylinder failure or leakage that would affect safe means of egress from buildings. Exposure to fires during vehicle fueling operations is also a concern. Cylinder exchange cabinets are frequently located near the exits of convenience stores, gas stations, and similar locations (see Exhibit 69.40).

Note that this requirement is not in conflict with 1.3.2(11) of NFPA 58, which states that propane vehicle fuel dispensers in multiple fuel refueling stations are not covered by this *Code*. This distance is meant for the storage requirements of the cylinders at these locations.

Exhibit 69.40

Cylinder exchange cabinet at a retail location. (Courtesy of AmeriGas)

Δ *TABLE 69.5.4.1.2 Distances from Cylinders in Storage and Exposures*

Quantity of LP-Gas Stored		Horizontal Distance to . . .					
		(1) and (2)		(3) and (4)		(5)*	
lb	kg	ft	m	ft	m	ft	m
≤720	≤227	0	0	0	0	5	1.5
721–2,500	>227–1,134	0	0	10	3	10	3
2,501–6,000	>1,134–2,721	10	3	10	3	10	3
6,001–10,000	>2,721–4,540	20	6.1	20	6.1	20	6.1
>10,000	>4,540	25	7.6	25	7.6	25	7.6

*The minimum distance from a point of transfer associated with a dispensing system must comply with Table 69.3.5.2.1.

[**58:** Table 8.4.1.2]

69.5.4.1.2 Distances from cylinders in storage outside of buildings shall be in accordance with Table 69.5.4.1.2 with respect to the following:

(1) Nearest important building or group of buildings
(2) Line of adjoining property that can be built upon
(3) Busy thoroughfares or sidewalks on other than private property
(4) Line of adjoining property occupied by schools, churches, hospitals, athletic fields, or other points of public gathering
(5) Dispensing system

[**58:**8.4.1.2]

Column 5 in Table 69.5.4.1.2 covers the distance from a storage location to dispensing stations, recognizing the practice of offering filled cylinders to the public on an exchange basis rather than filling cylinders at a retail site. Column 5 requires a minimum spacing of 5 ft (1.5 m) from dispensing stations if on the same site.

Note also that 69.5.4.1.3 provides the option of using a noncombustible, 2-hour fire resistance–rated structure to provide a reduction in the separation distances specified in Table 69.5.4.1.2. The reason for this option is to bring NFPA 58 into agreement with common practices recognized for other compressed gas storage, based on alternatives that achieve the same level of fire protection.

69.5.4.1.3 Fire-Resistive Protective Structure.

69.5.4.1.3.1 The distances in Table 69.5.4.1.2 shall be reduced to 0 where a 2-hour fire-resistive protective structure made of noncombustible materials is provided that breaks the line of sight of the storage and the building. [**58:**8.4.1.3(A)]

69.5.4.1.3.2 For buildings with exterior walls rated 2-hour fire resistance and constructed of noncombustible materials not provided with eaves over the storage, the exterior wall shall be allowed in lieu of a protective structure to reduce the distance to 0. [**58:**8.4.1.3(B)]

69.5.4.1.4 Cylinders in the filling process shall not be considered to be in storage. [**58:**8.4.1.4]

Paragraph 69.5.4.1.4 clarifies that cylinders in the process of being filled are not covered by the 5 ft (1.5 m) spacing requirement from dispensing stations. The vague phrase "in the filling process" recognizes efficient filling practices in that it refers not only to the cylinder being filled but also to the group of cylinders being filled. Thus, a group of cylinders can be located within 5 ft (1.5 m) of a dispensing station, and all the cylinders in the group can be filled prior to any of them being moved to storage. No time limit is specified, but filling time is usually limited to the reasonable time it takes to perform the filling operation, allowing for brief periods for other activities such as lunches and breaks (see A.69.5.4.1).

69.5.4.2 Protection of Cylinders.

Δ **69.5.4.2.1*** Cylinders at a location open to the public shall be protected by either of the following:

(1) An enclosure in accordance with 6.21.4.2 of NFPA 58
(2) A lockable ventilated enclosure of metal exterior construction

[**58:**8.4.2.1]

The requirements that cabinets used for exchange cylinders must be ventilated and lockable are listed in 69.5.4.2.1 (see Exhibit 69.40). Ventilation is commonly accomplished by using expanded metal or screening for the sides of the locker. Requiring the cabinet to be locked prevents tampering with the cylinders in unattended locations. Note that storage would have to ensure that the pressure relief valve is in the vapor space of full containers, as required by 69.5.2.1.2. Note that 69.5.4.2.1(2) requires that the exterior construction of the cabinet be metal. The interior construction, however, can be of combustible components such as molded industrial fiberglass grates.

A.69.5.4.2.1 The shelves should be made of any material with a flame spread index, in accordance with ASTM E84, *Standard Test*

Method for Surface Burning Characteristics of Building Materials, or UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, of less than 25 and should be of sufficient strength to support the cylinders. [**58:**A.8.4.2.1]

69.5.4.2.2* Vehicular barrier protection (VBP) shall be provided where vehicle traffic is expected at the location, except where cylinders are protected in accordance with 69.5.4.2.1(2). [**58:**8.4.2.2]

A.69.5.4.2.2 Only minimal VBP, such as either parking bumpers (minimum of 6 inches above grade) or sidewalks (minimum of 6 inches above grade), may be needed for cylinder exchange cabinets. The storage cabinets associated with cylinder exchange may provide limited protection against physical damage to the stored cylinders. Examples of such protection include, but are not limited to:

(1) Guard rails
(2) Steel bollards
(3) Raised sidewalks (minimum of 6 in. in height)
(4) Fencing
(5) Ditches
(6) Berms (not to exceed 50% of the container perimeter)
(7) Jersey barriers
(8) Parking bumpers (minimum of 6 in. in height)
(9) Fencing/Gates
[**58:**A.8.4.2.2]

If vehicles are operated in areas where cylinders are stored, the cylinders must be protected from possible vehicle damage. In the 2017 edition of NFPA 58, this requirement was revised to no longer require VBP when the cylinders are protected by a lockable ventilated enclosure of metal exterior construction, as stated in 69.5.4.2.1(2).

69.5.4.3 Alternate Location and Protection of Storage. Where the provisions of 69.5.4.1 and 69.5.4.2.1 are impractical at construction sites or at buildings or structures undergoing major renovation or repairs, alternative storage of cylinders shall be acceptable to the AHJ. [**58:**8.4.3]

Where the provisions of 69.5.4.1 and 69.5.4.2.1 are impractical at construction sites or at buildings or structures undergoing major renovation or repairs, alternative storage of cylinders shall be acceptable to the AHJ.

69.5.5* Fire Protection and Electrical Area Classification.

Subsection 69.5.5 clarifies the application of the fire protection and electrical classification requirements to all locations that store more than 720 lb (327 kg) of LP-Gas. However, the requirements do not apply to cylinder storage at bulk plants because 69.5.1.3 exempts bulk plants from this chapter. Refer to Section 6.29 of NFPA 58 for the fire protection requirements for bulk plants.

A.69.5.5 See 6.29.4.3 of NFPA 58. [**58:**A.8.5]

Δ **69.5.5.1** Retail cylinder exchange locations shall be provided with at least one portable fire extinguisher in accordance with Section 4.7 of NFPA 58 having a minimum capacity of 10 lb (4.5 kg) dry chemical on the premises where retail cylinder exchange cabinets are storing more than 720 lb (327 kg) of propane. [**58:**8.5.1]

69.5.5.2 Storage locations, other than those complying with 69.5.5.1, where the aggregate quantity of propane stored is in excess of 720 lb (327 kg), shall be provided with at least one approved portable fire extinguisher in accordance with Section 4.7 of NFPA 58 having a minimum capacity of 18 lb (8.2 kg) dry chemical. [**58:**8.5.2]

69.5.5.3 The required fire extinguisher shall be located within 50 ft (15 m) travel distance of the propane storage location. [**58:**8.5.3]

• **69.5.5.4** The storage of cylinders awaiting resale shall be exempt from the electrical classification requirements of NFPA 58. [**58:**8.5.4]

Cylinder exchange locations are usually found at stores that may have ice machines, electrical switches, and electrical outlets near or next to the cylinder exchange cabinets. The area around cylinders awaiting resale is exempt from electrical area classification for the following two reasons:

1. The committee has received no reports on incidents involving exchange cabinets where an electrical ignition was a source of fire.
2. The DOT imposes no requirements for separation of cylinders in transportation from sources of ignition.

Therefore, such a restriction on cylinders awaiting sale was determined unnecessary and the exemption in 69.5.5.4 was written into the *Code*.

• 69.5.6 Automated Cylinder Exchange Stations.

As cylinder exchange becomes more popular, retailers have sought to provide their customers with this service outside of normal operating hours. There are several designs for automated cylinder exchange stations. Therefore, the minimum safety requirements reflect no specific design (see Exhibit 69.41).

69.5.6.1 Cylinder exchange cabinets that include an automated vending system for exchanging cylinders shall comply with the requirements in 69.5.6.2 through 69.5.6.6. [**58:**8.6.1]

Δ **69.5.6.2** Electrical equipment installed in cylinder storage compartments shall comply with the requirements for Class I, Division 2 equipment in accordance with *NFPA 70*. [**58:**8.6.2]

69.5.6.3 Cabinets shall be designed such that cylinders can be placed inside only in the upright position. [**58:**8.6.3]

69.5.6.4 Door releases for access to stored cylinders shall be permitted to be pneumatic, mechanical, or electrically powered. [**58:**8.6.4]

69.5.6.5 A manual override control shall be permitted for use by authorized personnel. [**58:**8.6.5]

69.5.6.6 The vending system shall not be capable of returning to automatic operation after a manual override until the system has been inspected and reset by authorized personnel. [**58:**8.6.6]

Exhibit 69.41

Two views of an automated vending propane station. (Courtesy of the Office of the State Fire Marshal of Illinois)

69.6 Vehicular Transportation of LP-Gas

69.6.1 Transportation in Portable Containers.

69.6.1.1 Transportation of Cylinders.

69.6.1.1.1 Cylinders having an individual water capacity not exceeding 1000 lb (454 kg) [nominal 420 lb (191 kg) propane capacity], when filled with LP-Gas, shall be transported in accordance with the requirements of 69.6.1. [**58:**9.3.2.1]

The maximum size of an individual cylinder permitted under DOT regulations is 1000 lb (454 kg) water capacity [nominal 420 lb (191 kg) of propane]. Portable ASME containers, which generally serve the same purpose as DOT cylinders, may be encountered and are also limited to this size for transportation. Exhibit 69.42 shows portable containers transported via open delivery truck.

69.6.1.1.2 Cylinders shall be constructed as provided in 69.2.1 and equipped in accordance with Section 5.9 of NFPA 58 for transportation as cylinders. [**58:**9.3.2.2]

Exhibit 69.42

Cylinders in an open portable container cargo vehicle (delivery truck). (Courtesy of Eastern Propane Corp.)

69.6.1.1.3 The quantity of LP-Gas in cylinders shall be in accordance with Chapter 7 of NFPA 58. [**58:**9.3.2.3]

All DOT cylinders are marked with the water capacity in pounds (kilograms). The water capacity is required because not all LP-Gases have the same specific gravity, therefore each has a different filling limit. Weight is used, not volume (as is done for ASME containers), because the cylinders are portable and can be placed on a scale. For propane, with a specific gravity between 0.504 and 0.510, the capacity of any cylinder (in pounds or kilograms) is obtained by multiplying the water capacity by 0.42. See Section 69.4 and Chapter 7 of NFPA 58 for a more detailed explanation.

Δ **69.6.1.1.4** Cylinder valves shall comply with the following:

(1) Valves of cylinders shall be protected in accordance with 69.2.1.2.1.
(2) Screw-on-type protecting caps or collars shall be secured in place.
(3) The provisions of 69.4.2.2.5 shall apply.

[**58:**9.3.2.4]

The requirements for cylinder valves are located in Chapter 5 of NFPA 58. Refer to commentary following 69.4.2.2.5 for the requirements referenced on cylinder valve plugs. The importance of providing protection for cylinder valves from damage cannot be overstated. A damaged or separated cylinder valve could result in an uncontrolled release of LP-Gas and perhaps even the propulsion of the cylinder itself.

69.6.1.1.5 The cargo space of the vehicle shall be isolated from the driver's compartment, the engine, and the engine's exhaust system. [**58:**9.3.2.5]

69.6.1.1.5.1 Open-bodied vehicles shall be considered to be in compliance with 69.6.1.1.5.

69.6.1.1.5.2 Closed-bodied vehicles having separate cargo, driver, and engine compartments shall be considered to be in compliance with 69.6.1.1.5. [**58:**9.3.2.5(B)]

69.6.1.1.5.3 Closed-bodied vehicles, such as passenger cars, vans, and station wagons, shall not be used for transporting more than 215 lb (98 kg) water capacity [nominal 90 lb (41 kg) propane capacity], but not more than 108 lb (49 kg) water capacity [nominal 45 lb (20 kg) propane capacity] per cylinder, unless the driver and engine compartments are separated from the cargo space by a vaportight partition that contains no means of access to the cargo space. [**58:**9.3.2.5(C)]

The transportation of privately owned cylinders in passenger automobiles is a safety concern that is addressed based on the vehicle type. The transportation of LP-Gas by private parties, where the transportation is not considered to be "in commerce" as defined by the DOT, is not regulated by the DOT, and therefore only the provisions of NFPA 58 apply. The provisions of Section 69.6 are applied in the following situations:

1. **What are the provisions for a cylinder transported in an open-bodied vehicle (such as a pickup truck) or in a closed-bodied vehicle with a vaportight partition between the cargo space and the driver and engine compartments?**

   In both cases, up to 1000 lb (454 kg) of LP-Gas (total weight, including the weight of the LP-Gas and cylinders) can be transported in the vehicle as stated in 69.6.1.1.1. Where the LP-Gas exceeds 1000 lb (454 kg), the requirements of 69.6.1.1.10 and the DOT would apply to the vehicle.

2. **What are the provisions for a cylinder transported in a closed-body vehicle?**

   In this case, a maximum of 90 lb (41 kg) of propane can be transported in the passenger or cargo space of the vehicle. This requirement allows up to four typical grill cylinders [20 lb (9.1 kg) propane capacity], up to three 30 lb (13.6 kg) cylinders, or up to two 40 lb (18 kg) cylinders to be transported.

Note that the 90 lb (41 kg) limit in closed-body vehicles effectively prohibits the transportation of a 100 lb (45 kg) LP-Gas cylinder in passenger cars, vans, sport utility vehicles, and station wagons. Also, see 69.6.1.1.9 for requirements on cylinder orientation when being transported.

These rules apply to all transportation of cylinders, whether by propane company employees delivering cylinders to residences, by exchange cabinets, or by forklift operators or private citizens taking grill cylinders in for filling or exchange. These rules apply in much the same way as building codes apply to the modifications citizens make to their homes. In the case of building codes (and this varies with location), citizens are responsible for obtaining a building permit, for having construction done to meet the applicable code(s), and for getting an inspection by a building code official during construction and/or after the work is complete.

NFPA 58's requirements are less well known to consumers than building codes are, which is why some jurisdictions consider it the responsibility of the propane company employees to ensure that cylinders transported by customers are properly placed and secured in their vehicles when they leave the dispensing site.

69.6.1.1.6 Cylinders and their appurtenances shall be determined to be leak-free before being loaded into vehicles. [**58:**9.3.2.6]

69.6.1.1.7 Cylinders shall be loaded into vehicles with flat floors or equipped with racks for holding cylinders. [**58:**9.3.2.7]

69.6.1.1.8 Cylinders shall be fastened in position to minimize the possibility of movement, tipping, and physical damage. [**58:**9.3.2.8]

TABLE 69.6.1.1.9 Orientation of Cylinders on Vehicles

Propane Capacity of Cylinder		Open Vehicles	Enclosed Spaces of Vehicles
lb	kg		
≤45	≤20	Any position	
>45	>20	Relief valve in communication with the vapor space	
≤4.2	≤1.9		Any position
>4.2	>1.9		Relief valve in communication with the vapor space

[**58:**Table 9.3.2.9]

69.6.1.1.9 Cylinders being transported by vehicles shall be positioned in accordance with Table 69.6.1.1.9. [**58:**9.3.2.9]

Racks that hold cylinders in a horizontal position are commonly used for the delivery of industrial truck cylinders in open-body vehicles. The safety experience with this type of transportation has been good and is the reason that LP-Gas cylinders with a maximum propane capacity of 45 lb (20 kg) can be transported with the relief valve in contact with the liquid space of the container. That size is the maximum portable cylinder generally used in industrial trucks. Larger containers must be transported in a position such that the pressure relief valve is in communication with the vapor space of the container.

In closed-body vehicles, the requirements are much more stringent. Only cylinders less than or equal to 4.2 lb (0.016 m^3) propane capacity can be transported in any position, thereby resulting in the relief valve being in communication with liquid. As a result of this provision, nominal 20 lb (9.1 kg) cylinders (gas grill cylinders) cannot be transported on their sides inside a vehicle.

69.6.1.1.10 Vehicles transporting cylinders where the total weight is more than 1000 lb (454 kg), including the weight of the LP-Gas and the cylinders, shall be placarded as required by DOT regulations or state law. [**58:**9.3.2.10]

69.6.1.2 Fire Extinguishers.

Δ **69.6.1.2.1** Each truck or trailer transporting portable containers in accordance with 69.6.1.1 or 69.6.1.2 shall be equipped with at least one portable fire extinguisher in accordance with Section 4.7 of NFPA 58 having a minimum capacity of 18 lb (8.2 kg) dry chemical. [**58:**9.3.5.1]

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69.6.2 Parking and Garaging Vehicles Used to Carry LP-Gas Cargo.

The regulations for parking cargo tank vehicles and cylinder delivery trucks cover the following:

- Outdoor parking
- Parking in public buildings
- Parking in buildings owned by the vehicle's operator
- Parking in buildings used to repair vehicles

To facilitate easier understanding of 69.6.2, see the flow charts in Exhibit 69.43 and Exhibit 69.44.

69.6.2.1 Application. Subsection 69.6.2 applies to the parking and garaging of vehicles used for the transportation of LP-Gas. [**58:**9.7.1]

69.6.2.2 Parking Outdoors.

Δ **69.6.2.2.1** Vehicles shall not be left unattended on any street, highway, avenue, or alley, except for necessary absences from the vehicle associated with drivers' normal duties, including stops for meals and rest stops during the day or night, except as follows:

(1) This requirement shall not apply in an emergency.
(2) This requirement shall not apply to vehicles parked in accordance with 69.6.2.2.3 and 69.6.2.2.4.

[**58:**9.7.2.1]

69.6.2.2.2* Vehicles shall not be parked in congested areas. [**58:**9.7.2.2]

A.69.6.2.2.2 The term "congested area" is intended to describe situations where access to the vehicle during an emergency would be impeded or where moving the vehicle away from an emergency would be prevented. [**58:**A.9.7.2.2]

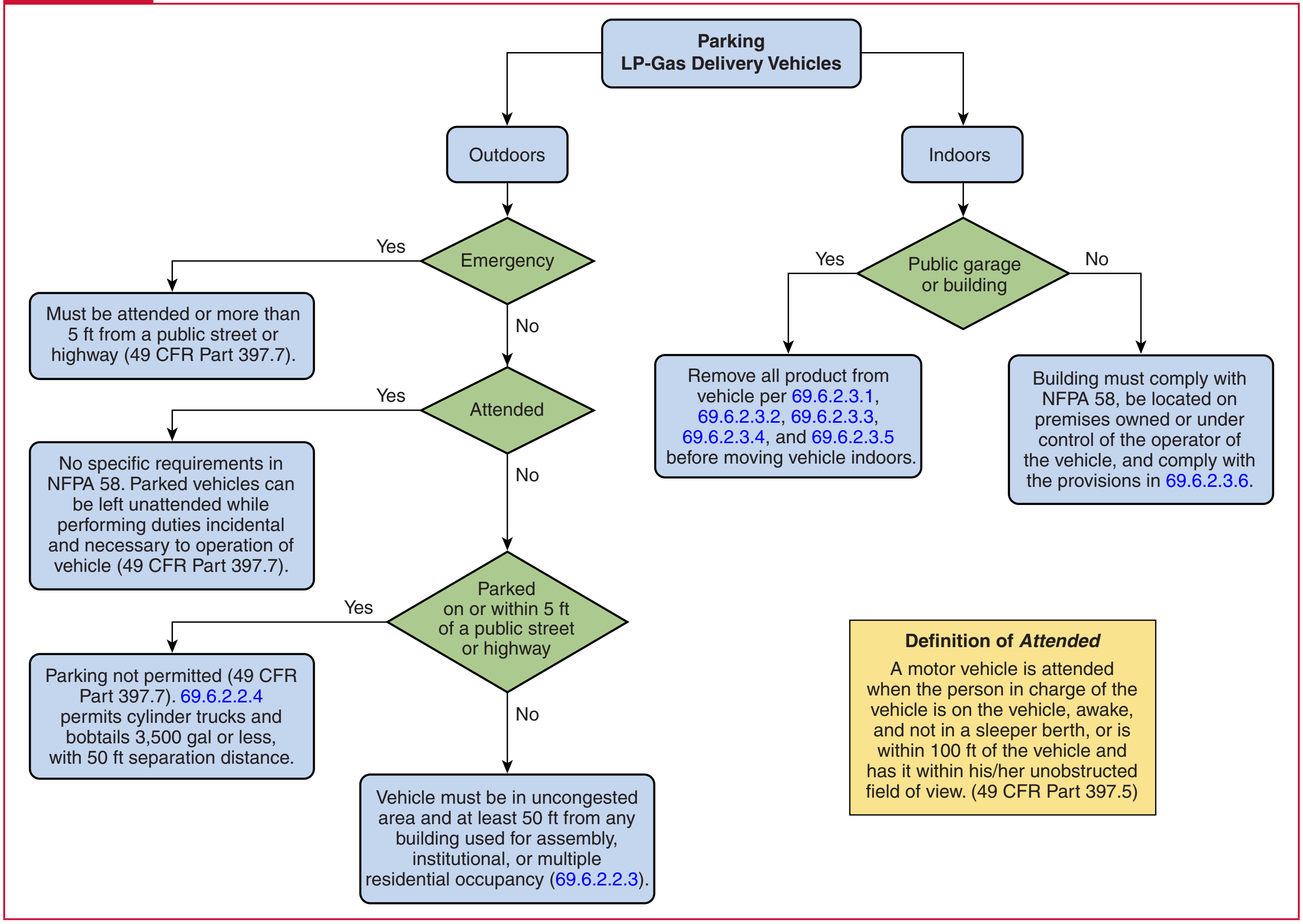
69.6.2.2.3 Where vehicles are parked off the street in uncongested areas, they shall be at least 50 ft (15 m) from any building used for assembly, institutional, or multiple residential occupancy. [**58:**9.7.2.3]

69.6.2.2.4 Where vehicles carrying portable containers or cargo tank vehicles of 3500 gal (13 m^3) water capacity or less are parked on streets adjacent to the driver's residence in uncongested residential areas, the parking locations shall be at least 50 ft (15 m) from a building used for assembly, institutional, or multiple residential occupancy. [**58:**9.7.2.4]

In remote areas, the driver's residence may be a considerable distance from bulk plant facilities, and customers may be located a considerable distance from the bulk plant yet near the driver's residence. In these cases, the retail bulk delivery tank truck or cylinder delivery truck is permitted to be parked near the driver's home.

Local regulations may prohibit parking commercial vehicles in residential neighborhoods; such regulations often supersede NFPA 58.

Exhibit 69.43



Parking of LP-Gas delivery vehicles flow chart. (Courtesy of National Propane Gas Association

69.6.2.3 Parking Indoors.

Δ **69.6.2.3.1** Cargo tank vehicles parked in any public garage or building shall have LP-Gas liquid removed from the following:

(1) Cargo tank
(2) Piping
(3) Pump
(4) Meter
(5) Hose
(6) Related equipment

[**58:**9.7.3.1]

69.6.2.3.2 Vehicles used to carry portable containers shall not be moved into any public garage or building for parking until all portable containers have been removed from the vehicle. [**58:**9.7.3.2]

69.6.2.3.3 The pressure in the delivery hose and related equipment shall be reduced to approximately atmospheric. [**58:**9.7.3.3]

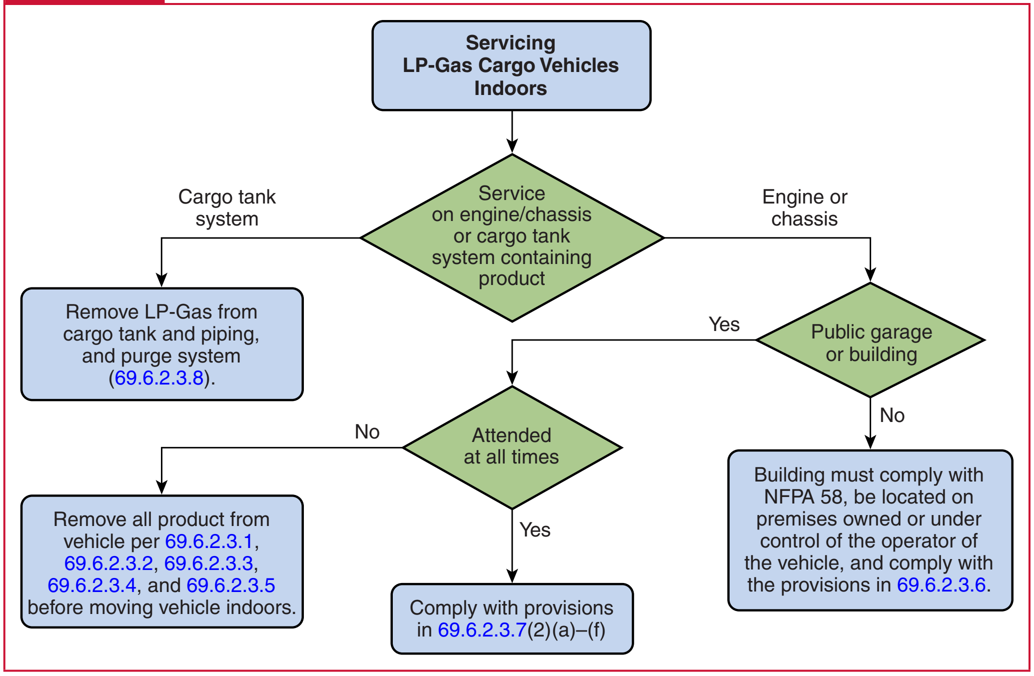
69.6.2.3.4 All valves shall be closed before the vehicle is moved indoors. [**58:**9.7.3.4]

69.6.2.3.5 Delivery hose or valve outlets shall be plugged or capped before the vehicle is moved indoors. [**58:**9.7.3.5]

69.6.2.3.6 Vehicles carrying or containing LP-Gas shall only be parked in buildings complying with Chapter 10 of NFPA 58 and located on premises owned or under the control of the operator of such vehicles where the following provisions are met:

(1) The public shall be excluded from such buildings.
(2) Floor level ventilation shall be provided in all parts of the building where such vehicles are parked.
(3) Leaks in the vehicle LP-Gas systems shall be repaired before the vehicle is moved indoors.
(4) Primary shutoff valves on cargo tanks and other LP-Gas containers on the vehicle (except propulsion engine fuel containers)

Exhibit 69.44



Servicing LP-Gas cargo vehicles indoors flow chart. (Courtesy of National Propane Gas Association)

shall be closed and delivery hose outlets plugged or capped to contain system pressure before the vehicle is moved indoors.

(5) Primary shutoff valves on LP-Gas propulsion engine fuel containers shall be closed while the vehicle is parked.

(6) No LP-Gas container shall be located near a source of heat or within the direct path of hot air being blown from a blower-type heater.

(7) LP-Gas containers shall be gauged or weighed to determine that they are not filled beyond the maximum filling limit according to Section 7.4 of NFPA 58.

[**58:**9.7.3.6]

If it is necessary to park cargo tank vehicles in public buildings, all liquid LP-Gas must be removed from the cargo tank. Cylinder trucks parked in public buildings must have all cylinders removed. In addition, the building in which the vehicle is parked must be constructed to comply with Chapter 10 of NFPA 58.

69.6.2.3.7 Where vehicles are serviced or repaired indoors, the following shall apply:

(1) When it is necessary to move a vehicle into any building located on premises owned or operated by the operator of such vehicle for service on engine or chassis, the provisions of 69.6.2.3.6 shall apply.

(2) When it is necessary to move a vehicle carrying or containing LP-Gas into any public garage or repair facility for service on the engine or chassis, the provisions of 69.6.2.3.1 shall apply, or the driver or a qualified representative of an LP-Gas operator shall be in attendance at all times while the vehicle is indoors, and the following shall apply:

(a) Leaks in the vehicle LP-Gas systems shall be repaired before the vehicle is moved indoors.

(b) Primary shutoff valves on cargo tanks, portable containers, and other LP-Gas containers installed on the vehicle (other than propulsion engine fuel containers) shall be closed.

(c) LP-Gas liquid shall be removed from the piping, pump, meter, delivery hose, and related equipment and the pressure therein reduced to approximately atmospheric before the vehicle is moved inside.

(d) Delivery hose or valve outlets shall be plugged or capped before the vehicle is moved indoors.

(e) No container shall be located near a source of heat or within the direct path of hot air blown from a blower or from a blower-type heater.

(f) LP-Gas containers shall be gauged or weighed to determine that they are not filled beyond the maximum filling capacity in accordance with Section 7.4 of NFPA 58.

[**58:**9.7.3.7]

If it is necessary to service cargo tank vehicles in garages, the following options are provided in 69.6.2.3.7:

1. If the garage is owned or operated by the vehicle operator, the requirements of 69.6.2.3.6 for parking of vehicles in public garages apply.

2. If the garage is a public garage, either the vehicle must be emptied of LP-Gas as required by 69.6.2.3.1 or the vehicle operator must be at the vehicle at all times it is in the garage, and the vehicle must meet the criteria in 69.6.2.3.7(2).

69.6.2.3.8 If repair work or servicing is to be performed on a cargo tank vehicle system, all LP-Gas shall be removed from the cargo tank and piping, and the system shall be thoroughly purged before the vehicle is moved indoors. [**58:**9.7.3.8]

It is extremely important to remove all LP-Gas from the cargo tank and piping and to purge any residual vapor from the system. Even though the repair work may not be intended to open the piping or tank, it may occur.

Δ 69.7 LP-Gases at Utility Plants

The design, construction, location, installation, and operation of refrigerated and nonrefrigerated liquefied petroleum gas systems at utility gas plants shall be in accordance with NFPA 59.

Δ 69.8 Liquefied Natural Gas (LNG) Facilities

The design, location, construction, and operation of liquified natural gas facilities shall be in accordance with NFPA 59A.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016.
NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.
NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2015 edition.
NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, 2011 edition.
NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes,* 2013 edition.
NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2014 edition.
NFPA 54, *National Fuel Gas Code*, 2015 edition.
NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2013 edition.
NFPA 58, *Liquefied Petroleum Gas Code*, 2014 edition.
NFPA *101*®, *Life Safety Code*®, 2015 edition.
NFPA 1192, *Standard on Recreational Vehicles,* 2015 edition.

Fire Safety Analysis Manual for LP-Gas Storage Facilities, 2014.

LP-Gas Code Handbook, Lemoff, T. C., ed., Ninth Edition, 2017.

American Petroleum Institute, Washington, DC.

API-ASME, *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases, pre–July 1, 1961.*
API RP 521, *Guide for Pressure-Relieving and Depressuring Systems*, 2014.

ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, American Society of Civil Engineers, Reston, VA, 2010.

ASME *Boiler and Pressure Vessel Code*, American Society of Mechanical Engineers, New York, NY, 2010.

ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, ASTM International, West Conshohocken, PA, 2012.

CGA C-7, *Guide to Classification and Labeling of Compressed Gases*, Compressed Gas Association, Chantilly, VA, 2014.
"Evaluation of Collision Protection Provided by Vehicle Impact Bollards and Propane Cylinder Exchange Cabinets," O. Harrison, Document No. 18.19083.01.107.FR1, prepared for the National Propane Gas Association. Southwest Research Institute, San Antonio, TX, December 2013.
Hoehne, V. O., Luce, R. G., and Miga, L. W., "The Effect of Velocity, Temperature, and Gas Molecular Weight on Flammability Limits in Wind-Blown Jets of Hydrocarbon Gases," Battelle Memorial Institute, Columbus, OH, 1970.
Manual of Standards and Recommended Practices, Association of American Railroads (AAR), Washington, DC.
National Board Inspection Code (NBIC), National Board of Boiler and Pressure Vessel Inspectors, Columbus, OH, 2011.
Raj, P. K., "Exposure of a Liquefied Gas Container to an External Fire," *Journal of Hazardous Materials* 122, 1–2 (June 2005): 37–49.

Underwriters Laboratories Inc., Northbrook, IL.

ANSI/UL 132, *Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, 2007, Revised 2010.
UL 147A, *Standard for Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies, 2005.*
ANSI/UL 147B, *Standard for Nonrefillable (Disposable) Type Metal Container Assemblies for Butane*, 2005, Revised 2008.

U.S. Government Publishing Office, Washington, DC.

Title 24, Code of Federal Regulations, Part 3280, "Mobile Home Construction and Safety Standard."
Title 49, Code of Federal Regulations, "Transportation."
Title 49, Code of Federal Regulations, Part 171.8, "Definitions and Abbreviations."
Title 49, Code of Federal Regulations, Parts 172.504 and 172.532.
Title 49, Code of Federal Regulations, Part 173.301(h)(3)
Title 49, Code of Federal Regulations, Part 177.834(i)(1), "Loading," and (2), "Unloading."
Title 49, Code of Federal Regulations, Part 177.834, Subpart B, "Hazardous Materials Regulations."

Title 49 Code of Federal Regulations, Part 178.33, "Specification 2Q; Inner Nonrefillable Metal Receptacles."
Title 49, Code of Federal Regulations, Part 178.50.
Title 49, Code of Federal Regulations, Part 178.68.
Title 49, Code of Federal Regulations, Part 178.133-17.
Title 49, Code of Federal Regulations, Part 178.345-14.
Title 49, Code of Federal Regulations, Part 393, "Motor Carrier Safety Regulations."
Title 49, Code of Federal Regulations, Part 397, "Transportation of Hazardous Materials; Driving and Parking Rules."

Underwriters Laboratories, Northbrook, IL.

ANSI/UL 132, *Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, 2007, Revised 2010.
ANSI/UL 147A, *Standard for Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies*, 2005.
ANSI/UL 147B, *Standard for Nonrefillable (Disposable) Type Metal Container Assemblies for Butane*, 2005, Revised 2008.

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Oxidizer Solids and Liquids

Oxidizer, as defined in 3.3.201 of this *Code*, is any solid or liquid material that readily yields oxygen or other oxidizing gas or that readily reacts to promote or initiate combustion of combustible materials and that can, under some circumstances, undergo a vigorous self-sustained decomposition due to contamination or heat exposure. Special precautions should be taken where oxidizers and organic peroxide formulations are present in retail outlets, since the potential for contact with incompatible materials is greater in such locations. For requirements pertaining to the storage, use, and handling of oxidizer solids and liquids, users are directed to Chapter 60 on hazardous materials. Chapter 60 also contains provisions that must be followed when the storage, use, or handling of a hazardous material exceeds the maximum allowable quantity (MAQ) per control area as set forth in that chapter.

In addition to complying with Chapter 60, oxidizer solids and liquids exceeding the MAQ must also comply with any additional provisions set forth in NFPA 400, *Hazardous Materials Code,* as well as the provisions for display and storage of Class 1 through Class 3 oxidizer solids and liquids in mercantile, storage, or industrial occupancies where the general public has access to the material for sale and the storage of these materials in those occupancies that are not accessible to the public. The first edition of NFPA 400 was published in 2010, and the 2016 edition of the document is referenced throughout this edition of the *Code*. NFPA 400 combined NFPA hazardous materials documents into a single code. Rather than repeating the provisions, many of the chapters of this *Code* related to hazardous materials now reference NFPA 400.

70.1 General

70.1.1 The storage, use, and handling of oxidizer solids and liquids shall comply with the requirements of Chapter 60.

Δ **70.1.2** The storage, use, and handling of oxidizer solids and liquids in amounts exceeding the maximum allowable quantity permitted in control areas as set forth in Chapter 60 shall also comply with the requirements of NFPA 400.

Δ **70.1.3** The display and storage of Class 1 through Class 3 oxidizer solids and liquids in mercantile, storage, or industrial occupancies where the general public has access to the material for sale, and to the storage of oxidizing solid and liquid materials in such occupancies in areas that are not accessible to the public, shall comply with the requirements of NFPA 400.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 400, *Hazardous Materials Code,* 2016 edition.

71 Pyrophoric Solids and Liquids

Pyrophoric material is defined in 3.3.180.13 as a chemical with an autoignition temperature in air at or below 130°F (54.4°C). For requirements pertaining to the storage, use, and handling of pyrophoric solids and liquids, users are directed to Chapter 60 on hazardous materials. Chapter 60 also contains provisions that must be followed when the storage, use, or handling of a hazardous material exceeds the maximum allowable quantity (MAQ) per control area as set forth in that chapter.

In addition to complying with Chapter 60, pyrophoric solids and liquids exceeding the MAQ must also comply with any additional provisions set forth in NFPA 400, *Hazardous Materials Code*. The first edition of NFPA 400 was published in 2010, and the 2016 edition of the document is referenced throughout this edition of the *Code*. NFPA 400 combined NFPA hazardous materials documents into a single code. Rather than repeating the provisions, many of the chapters of this *Code* related to hazardous materials now reference NFPA 400.

71.1 General

71.1.1 The storage, use, and handling of pyrophoric solids and liquids shall comply with the requirements of Chapter 60.

Δ **71.1.2** The storage, use, and handling of pyrophoric solids and liquids in amounts exceeding the maximum allowable quantity permitted in control areas as set forth in Chapter 60 shall also comply with the requirements of NFPA 400.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 400, *Hazardous Materials Code,* 2016 edition.

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Unstable (Reactive) Solids and Liquids

Unstable (reactive) material is defined in 3.3.180.15 as a material that, in the pure state or as commercially produced, will vigorously polymerize, decompose or condense, become self-reactive, or otherwise undergo a violent chemical change under conditions of shock, pressure, or temperature. For requirements pertaining to the storage, use, and handling of unstable (reactive) solids and liquids, users are directed to Chapter 60 on hazardous materials. Chapter 60 also contains provisions that must be followed when the storage, use, or handling of a hazardous material exceeds the maximum allowable quantity (MAQ) per control area as set forth in that chapter.

In addition to complying with Chapter 60, unstable (reactive) solids and liquids exceeding the MAQ must also comply with any additional provisions set forth in NFPA 400, *Hazardous Materials Code*. The first edition of NFPA 400 was published in 2010, and the 2016 edition of the document is referenced throughout this edition of the *Code*. NFPA 400 combined NFPA hazardous materials documents into a single code. Rather than repeating the provisions, many of the chapters of this *Code* related to hazardous materials now reference NFPA 400.

72.1 General

72.1.1 The storage, use, and handling of unstable (reactive) solids and liquids shall comply with the requirements of Chapter 60.

Δ **72.1.2** The storage, use, and handling of unstable (reactive) solids and liquids in amounts exceeding the maximum allowable quantity permitted in control areas as set forth in Chapter 60 shall also comply with the requirements of NFPA 400.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 400, *Hazardous Materials Code,* 2016 edition.

Water-Reactive Solids and Liquids

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Water-reactive material is defined in 3.3.180.16 as materials that explode; violently react; produce flammable, toxic, or other hazardous gases; or evolve enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture. For requirements pertaining to the storage, use, and handling of water-reactive solids and liquids, users are directed to Chapter 60 on hazardous materials. Chapter 60 also contains provisions that must be followed when the storage, use, or handling of a hazardous material exceeds the maximum allowable quantity (MAQ) per control area as set forth in that chapter.

In addition to complying with Chapter 60, water-reactive solids and liquids exceeding the MAQ must also comply with any additional provisions set forth in NFPA 400, *Hazardous Materials Code*. The first edition of NFPA 400 was published in 2010, and the 2013 edition of the document is referenced throughout this edition of NFPA 1, *Fire Code*. NFPA 400 combined NFPA hazardous materials documents into a single code. Rather than repeating the provisions, many of the chapters of this *Code* related to hazardous materials now reference NFPA 400.

73.1 General

73.1.1 The storage, use, and handling of water-reactive solids and liquids shall comply with the requirements of Chapter 60.

Δ **73.1.2** The storage, use, and handling of water-reactive solids and liquids in amounts exceeding the maximum allowable quantity permitted in control areas as set forth in Chapter 60 shall also comply with the requirements of NFPA 400.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 400, *Hazardous Materials Code,* 2016 edition.

74 Ammonium Nitrate

Like other inorganic nitrates, ammonium nitrate is an oxidizing agent and will increase the intensity of a fire. The oxidizing gas it gives off is nitrous oxide, rather than oxygen. Chemical- and fertilizer-grade ammonium nitrate must not be confused with certain ammonium nitrate combustible material mixtures used as explosives. All grades of ammonium nitrate can be detonated if they are in the proper crystalline form, if the initiating source is sufficiently large, or if heated under sufficient confinement (the purest material needing the greatest confinement). For requirements pertaining to the storage, use, and handling of ammonium nitrate, users are directed to Chapter 60 on hazardous materials. Chapter 60 also contains provisions that must be followed when the storage, use, or handling of a hazardous material exceeds the maximum allowable quantity (MAQ) per control area as set forth in that chapter.

In addition to complying with Chapter 60, the storage of ammonium nitrate in the form of crystals, flakes, grains, or prills, including fertilizer grade, dynamic grade, nitrous oxide grade, technical grade, and other mixtures containing 60 percent or more by weight of ammonium nitrate, must also comply with any additional provisions set forth in NFPA 400, *Hazardous Materials Code*. The first edition of NFPA 400 was published in 2010, and the 2016 edition of the document is referenced throughout this edition of the *Code*. NFPA 400 combined NFPA hazardous materials documents into a single code. Rather than repeating the provisions, many of the chapters of this *Code* related to hazardous materials now reference NFPA 400.

74.1 General

74.1.1 The storage, use, and handling of ammonium nitrate (solid oxidizer) shall comply with Chapter 60.

Δ **74.1.2** The storage of ammonium nitrate in the form of crystals, flakes, grains, or prills including fertilizer grade, dynamite grade, nitrous oxide grade, technical grade, and other mixtures containing 60 percent or more by weight of ammonium nitrate shall comply with NFPA 400.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 400, *Hazardous Materials Code,* 2016 edition.

Organic Peroxide Solids and Liquids

75

Organic peroxide is defined in 3.3.198 as any organic compound having a double oxygen or peroxy (-O-O-) group in its chemical structure. All organic peroxides are combustible, and many organic peroxides can be decomposed by heat, shock, or friction. Some organic peroxide materials may even be detonatable. Organic peroxides can be liquid or solid and are often dissolved in flammable or combustible solvents. The peroxides are often found wet with water or diluted with stable liquids. With solutions, sensitive crystals can be formed by freezing. For requirements pertaining to the storage, use, and handling of organic peroxide solids and liquids, users are directed to Chapter 60 on hazardous materials. Chapter 60 also contains provisions that must be followed when the storage, use, or handling of a hazardous material exceeds the maximum allowable quantity (MAQ) per control area as set forth in that chapter.

In addition to complying with Chapter 60, organic peroxide solids and liquids exceeding the MAQ must also comply with any additional provisions set forth in NFPA 400, *Hazardous Materials Code*. The first edition of NFPA 400 was published in 2010, and the 2016 edition of the document is referenced throughout this edition of the *Code*. NFPA 400 combined NFPA hazardous materials documents into a single code. Rather than repeating the provisions, many of the chapters of this *Code* related to hazardous materials now reference NFPA 400.

75.1 General

75.1.1 The storage, use, and handling of organic peroxide solids and liquids shall comply with the requirements of Chapter 60.

Δ **75.1.2** The storage, use, and handling of organic peroxide solids and liquids in amounts exceeding the maximum allowable quantity permitted in control areas as set forth in Chapter 60 shall also comply with the requirements of NFPA 400.

Reference Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 400, *Hazardous Materials Code,* 2016 edition.

Explanatory Material

A

The material contained in Annex A of the 2018 edition of NFPA 1, *Fire Code,* is not a part of the requirements of the *Code* but is included with the *Code* for informational purposes only. For the convenience of readers, in this handbook, the Annex A material follows the text to which it applies in Chapters 1 through 75 and, therefore, is not repeated here.

Hazardous Materials Classifications

B

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Scope

Annex B provides information, explanations, and examples to illustrate and clarify the hazard categories contained in Chapter 60. The hazard categories are based upon Title 29 of the Code of Federal Regulations. Where numerical classifications are included, they are in accordance with nationally recognized standards. Annex B should not be used as the sole means of hazardous materials classification.

B.2 Hazard Categories

B.2.1 Physical Hazards.

B.2.1.1 Explosives and Blasting Agents.

B.2.1.1.1 High Explosives. Can be detonated by means of blasting cap when unconfined. Examples: dynamite, TNT, nitroglycerine, C-3, and C-4.

B.2.1.1.2 Low Explosives. Can be deflagrated when confined. Examples: black powder, smokeless powder, propellant explosives, and display fireworks.

B.2.1.1.3 Blasting Agents. Oxidizer and liquid fuel slurry mixtures. Example: ammonium nitrate combined with fuel oil.

B.2.1.2 Compressed Gases.

B.2.1.2.1 Flammable. Examples: acetylene, carbon monoxide, ethane, ethylene, hydrogen, and methane.

B.2.1.2.2 Oxidizing. Examples: oxygen, ozone, oxides of nitrogen, chlorine, and fluorine. Chlorine and fluorine do not contain oxygen but reaction with flammables is similar to that of oxygen.

B.2.1.2.3 Corrosive. Examples: ammonia, hydrogen chloride, and fluorine.

B.2.1.2.4 Highly Toxic. Examples: arsine, cyanogen, fluorine, germane, hydrogen cyanide, hydrogen selenide, nitric oxide, phosphine, and stibene.

B.2.1.2.5 Toxic. Examples: chlorine, hydrogen fluoride, hydrogen sulfide, silicon tetrafluoride, and phosgene.

B.2.1.2.6 Inert (Chemically Unreactive). Examples: argon, helium, krypton, neon, nitrogen, and xenon.

B.2.1.2.7 Pyrophoric. Examples: diborane, dichloroborane, phosphine, and silane.

B.2.1.2.8 Unstable (Reactive). Examples: butadiene (unstabilized), ethylene oxide, and vinyl chloride.

B.2.1.3 Flammable and Combustible Liquids.

B.2.1.3.1 Flammable Liquids.

B.2.1.3.1.1 Class I-A liquids include those having flash points below 73°F (22.8°C) and having a boiling point below 100°F (37.8°C).

B.2.1.3.1.2 Class I-B liquids include those having flash points below 73°F (22.8°C) and having a boiling point at or above 100°F (37.8°C).

B.2.1.3.1.3 Class I-C liquids include those having flash points at or above 73°F (22.8°C) and below 100°F (37.8°C).

B.2.1.3.2 Combustible Liquids.

B.2.1.3.2.1 Class II liquids include those having flash points at or above 100°F (37.8°C) and below 140°F (60°C).

B.2.1.3.2.2 Class III-A liquids include those having flash points at or above 140°F (60°C) and below 200°F (93.3°C).

B.2.1.3.2.3 Class III-B liquids include those liquids having flash points at or above 200°F (93.3°C).

B.2.1.4 Flammable Solids.

B.2.1.4.1 Organic Solids. Examples: camphor, cellulose nitrate, and naphthalene.

B.2.1.4.2 Inorganic Solids. Examples: decaborane, lithium amide, phosphorous heptasulfide, phosphorous sesquisulfide, potassium sulfide, anhydrous sodium sulfide, and sulfur.

B.2.1.4.3 Combustible Metals (Except Dusts and Powders). Examples: cesium, magnesium, and zirconium.

B.2.1.4.4 Combustible Dusts and Powders (Including Metals). Examples: wood sawdust, plastics, coal, flour, and powdered metals (few exceptions).

B.2.1.5 Oxidizers.

B.2.1.5.1 Gases. Examples: oxygen, ozone, oxides of nitrogen, fluorine, and chlorine (reaction with flammables is similar to that of oxygen).

B.2.1.5.2 Liquids. Examples: bromine, hydrogen peroxide, nitric acid, perchloric acid, and sulfuric acid.

B.2.1.5.3 Solids. Examples: chlorates, chromates, chromic acid, iodine, nitrates, perchlorates, and peroxides.

B.2.1.5.4 Examples of Liquid and Solid Oxidizers According to Hazard.

B.2.1.5.4.1 Class 4. Examples: ammonium perchlorate (particle size greater than 15 microns), ammonium permanganate, guanidine nitrate, hydrogen peroxide solutions (greater than 91 percent), and tetranitromethane.

B.2.1.5.4.2 Class 3. Examples: ammonium dichromate, calcium hypochlorite (over 50 percent by weight), chloric acid (10 percent maximum concentration), hydrogen peroxide solutions (greater than 52 percent up to 91 percent), mono-(trichloro)-tetra-(monopotassium dichloro)-penta-s-triazinetrione, nitric acid, fuming (more than 86 percent concentration), perchloric acid solutions (60 percent to 72 percent by weight), potassium bromate, potassium chlorate, potassium dichloro-s-triazinetrione (potassium dichloroisocyanurate), sodium bromate, sodium chlorate, sodium chlorite (over 40 percent by weight), and sodium dichloro-s-triazinetrione (sodium dichloroisocyanurate).

B.2.1.5.4.3 Class 2. Examples: barium bromate, barium chlorate, barium hypochlorite, barium perchlorate, barium permanganate, 1-bromo-3-chloro-5, 5-dimethylhydantoin, calcium chlorate, calcium chlorite, calcium hypochlorite (50 percent or less by weight), calcium perchlorate, calcium permanganate, chromium trioxide (chromic acid), copper chlorate, halane (1,3-dichloro-5, 5-dimethylhydantoin), hydrogen peroxide (greater than 27.5 percent up to 52 percent), lead perchlorate, lithium chlorate, lithium hypochlorite (more than 39 percent available chlorine), lithium perchlorate, magnesium bromate, magnesium chlorate, magnesium perchlorate, mercurous chlorate, nitric acid (more than 40 percent but less than 86 percent), perchloric acid solutions (more than 50 percent but less than 60 percent), potassium perchlorate, potassium permanganate, potassium peroxide, potassium superoxide, silver peroxide, sodium chlorite (40 percent or less by weight), sodium perchlorate, sodium perchlorate monohydrate, sodium permanganate, sodium peroxide, strontium chlorate, strontium perchlorate, thallium chlorate, trichloro-s-triazinetrione (trichloroisocyanuric acid), urea hydrogen peroxide, zinc bromate, zinc chlorate, and zinc permanganate.

B.2.1.5.4.4 Class 1. Examples: all inorganic nitrates (unless otherwise classified), all inorganic nitrites (unless otherwise classified), ammonium persulfate, barium peroxide, calcium peroxide, hydrogen peroxide solutions (greater than 8 percent up to 27.5 percent), lead dioxide, lithium hypochlorite (39 percent or less available chlorine), lithium peroxide, magnesium peroxide, manganese dioxide, nitric acid (40 percent concentration or less), perchloric acid solutions (less than 50 percent by weight), potassium dichromate, potassium percarbonate, potassium persulfate, sodium carbonate peroxide, sodium dichloro-s-triazinetrione dihydrate, sodium dichromate, sodium perborate (anhydrous), sodium perborate monohydrate, sodium perborate tetrahydrate, sodium percarbonate, sodium persulfate, strontium peroxide, and zinc peroxide.

B.2.1.6 Organic Peroxides. Examples of organic peroxides according to hazard: Unclassified. Unclassified organic peroxides are capable of detonation and are regulated in accordance with Chapter 75.

B.2.1.6.1 Class I. Examples: acetyl cyclohexane sulfonyl 60-65 percent concentration by weight, fulfonyl peroxide, benzoyl peroxide over 98 percent concentration, *t*-butyl hydroperoxide 90 percent, *t*-butyl peroxyacetate 75 percent, *t*-butyl peroxyisopropylcarbonate 92 percent, diisopropyl peroxydicarbonate 100 percent, di-n-propyl peroxydicarbonate 98 percent, and di-n-propyl peroxydi-carbonate 85 percent.

B.2.1.6.2 Class II. Examples: acetyl peroxide 25 percent, *t*-butyl hydroperoxide 70 percent, *t*-butyl peroxybenzoate 98 percent, *t*-butyl peroxy-2-ethylhex-anoate 97 percent, *t*-butyl peroxyisobutyrate 75 percent, *t*-butyl peroxyisopropyl-carbonate 75 percent, *t*-butyl peroxypivalate 75 percent, dybenz-oyl peroxydicarbonate 85 percent, di-sec-butyl peroxydicarbonate 98 percent, di-sec-butyl peroxydicarbonate 75 percent, 1,1-di-(*t*-butylperoxy)-3,5,5-trimethyecyclohexane 95 percent, di-(2-ethythexyl) peroxydicarbonate 97 percent, 2,5-dymethyl-2-5 di (benzoylperoxy) hexane 92 percent, and peroxyacetic acid 43 percent.

B.2.1.6.3 Class III. Examples: acetyl cyclohexane sulfonal peroxide 29 percent, benzoyl peroxide 78 percent, benzoyl peroxide paste 55 percent, benzoyl peroxide paste 50 percent peroxide/50 percent butylbenzylphthalate diluent, cumene hydroperoxide 86 percent, di-(4-butylcyclohexyl) peroxydicarbonate 98 percent, *t*-butyl peroxy-2-ethytehexanoate 97 percent, *t*-butyl peroxyneodecanoate 75 percent, decanoyl peroxide 98.5 percent, di-*t*-butyl peroxide 99 percent, 1,1-di-(*t*-butylperoxy)-3,5,5-trimethylcyclohexane 75 percent, 2,4-dichlorobenzoyl peroxide 50 percent, diisopropyl peroxydi-carbonate 30 percent, 2,-5-dimethyl-2,5-di-(2-ethylhexanolyperoxy)-hexane 90 percent, 2,5-dimethyl-2,5-di-(*t*-butylperoxy) hexane 90 percent, and methyl ethyl ketone peroxide 9 percent active oxygen diluted in dimethyl phthalate.

B.2.1.6.4 Class IV. Examples: benzoyl peroxide 70 percent, benzoyl peroxide paste 50 percent peroxide/15 percent water/35 percent butylphthalate diluent, benzoyl peroxide slurry 40 percent, benzoyl peroxide powder 35 percent, *t*-butyl hydroperoxide 70 percent, *t*-butyl peroxy-2-ethylhexanoate 50 percent, decumyl peroxide 98 percent, di-(2-ethylhexal) peroxydicarbonate 40 percent, laurel peroxide 98 percent, p-methane hydroperoxide 52.5 percent, methyl ethyl ketone peroxide 5.5 percent active oxygen and methyl ethyl ketone peroxide 9 percent active oxygen diluted in water and glycols.

B.2.1.6.5 Class V. Examples: benzoyl peroxide 35 percent, 1,1-di-*t*-butyl peroxy 3,5,5-trimethylcyclohexane 40 percent, 2,5-di-(*t*-butyl peroxy) hexane 47 percent, and 2,4-pentanedione peroxide 4 percent active oxygen.

B.2.1.7 Pyrophoric Materials.

B.2.1.7.1 Gases. Examples: diborane, phosphine, and silane.

B.2.1.7.2 Liquids. Examples: diethyl aluminum chloride, diethyl beryllium, diethyl phosphine, diethyl zinc, dimethyl arsine, triethyl aluminum etherate, thriethyl bismuthine, thriethyl boron, trimethyl aluminum, and trimethyl gallium.

B.2.1.7.3 Solids. Examples: cesium, hafnium, lithium, white or yellow phosphorus, plutonium, potassium, rubidium, sodium, and thorium.

B.2.1.8 Examples of Unstable (Reactive) Materials According to Hazard. Classification by degree of hazard must be in accordance with Chapter 71.

B.2.1.8.1 Class 4. Examples: acetyl peroxide, dibutyl peroxide, dinitrobenzene, ethyl nitrate, peroxyacetic acid, and picric acid (dry) trinitrobenzene.

B.2.1.8.2 Class 3. Examples: hydrogen peroxide (greater than 52 percent), hydroxylamine, nitromethane, paranitroaniline, perchloric acid, and tetrafluoroethylene monomer.

B.2.1.8.3 Class 2. Examples: acrolein, acrylic acid, hydrazine, methacrylic acid, sodium perchlorate, styrene, and vinyl acetate.

B.2.1.8.4 Class 1. Examples: acetic acid, hydrogen peroxide 35 percent to 52 percent, paraldehyde, and tetrahydrofuran.

B.2.1.9 Examples of Water-Reactive Materials According to Hazard. Classification by degree of hazard must be in accordance with Chapter 73.

B.2.1.9.1 Class 3. Examples: aluminum alkyls such as triethylaluminum, isobutylaluminum, and trimethylaluminum; bromine pentafluoride, bromine trifluoride, chlorodiethylaluminium, and diethylzinc.

B.2.1.9.2 Class 2. Examples: calcium carbide, calcium metal, cyanogen bromide, lithium hydride, methyldichlorosilane, potassium metal, potassium peroxide, sodium metal, sodium peroxide, sulfuric acid, and trichlorosilane.

B.2.1.9.3 Class 1. Examples: acetic anhydride, sodium hydroxide, sulfur monochloride, and titanium tetrachloride.

B.2.1.10 Cryogenic Fluids. All of the cryogenics listed will exist as compressed gases when they are stored at ambient temperatures.

B.2.1.10.1 Flammable. Examples: carbon monoxide, deuterium (heavy hydrogen), ethylene, hydrogen, and methane.

B.2.1.10.2 Oxidizing. Examples: fluorine, nitric oxide, and oxygen.

B.2.1.10.3 Corrosive. Examples: fluorine and nitric oxide.

B.2.1.10.4 Inert (Chemically Unreactive). Examples: argon, helium, krypton, neon, nitrogen, and xenon.

B.2.1.10.5 Highly Toxic. Examples: fluorine and nitric oxide.

B.2.2 Health Hazards.

B.2.2.1 Highly Toxic and Toxic Materials.

B.2.2.1.1 Highly Toxic Materials.

B.2.2.1.1.1 Gases. Examples: arsine, chlorine trifluoride, cyanogen, diborane, fluorine, germane, hydrogen cyanide, nitric oxide, nitrogen dioxide, ozone, phosphine, hydrogen selenide, and stibene.

B.2.2.1.1.2 Liquids. Examples: acrolein, acrylic acid, 2-chloroethanol (ethylene chlorohydrin), hydazine, hydrocyanic acid, 2-methylaziridine (propylenimine), 2-methyllactonitrile (acetone cyanohydrin), methyl ester isocyanic acid (methyl isocyanate), nicotine, tetranitromethane, and tetraethylstannane (tetraethyl tin).

B.2.2.1.1.3 Solids. Examples: (acetato) phenylmercury (phenyl mercuric acetate), 4-aminopyridine, arsenic pentoxide, arsenic trioxide, calcium cyanide, 2-choloroacetophenone, aflatoxin B, decaborane (14), mercury (II) bromide (mercuric bromide), mercury (II) chloride (corrosive mercury chloride), pentachlorophenol, methyl parathion, phosphorus (white), and sodium azide.

B.2.2.1.2 Toxic Materials.

B.2.2.1.2.1 Gases. Examples: boron trichloride, boron trifluoride, chlorine, hydrogen fluoride, hydrogen sulfide, phosgene, and silicon tetrafluoride.

B.2.2.1.2.2 Liquids. Examples: acrylonitrile, allyl alcohol, alpha-chlorotoluene, aniline, 1-chloro-2, 3-epoxypropane, chloroformic acid (allyl ester), 3-chloropropene (allyl chloride), o-cresol, crotonaldehyde, dibromomethane, diisopropylamine, diethyl ester sulfuric acid, dimethyl ester sulfuric acid, 2-furaldehyde (furfural), furfuryl alcohol, phosphorus chloride, phosphoryl chloride (phosphorus oxychloride), and thionyl chloride.

B.2.2.1.2.3 Solids. Examples: acrylamide, barium chloride, barium (II) nitrate, benzidine, p-benzoquinone, beryllium chloride, cadmium chloride, cadmium oxide, chloroacetic acid, chlorophenylmercury (phenyl mercuric chloride), chromium (VI) oxide (chromic acid, solid), 2,4-dinitrotoluene, hydroquinone, mercury chloride (calomel), mercury (II) sulfate (mercuric sulfate), osmium tetroxide, oxalic acid, phenol, P-phenylenediamine, phenylhydrazine, 4-phenylmorpholine, phosphorus sulfide, potassium fluoride, potassium hydroxide, selenium (IV) disulfide, and sodium fluoride.

B.2.2.2 Radioactive Materials. (Reserved)

B.2.2.3 Corrosives.

B.2.2.3.1 Acids. Examples: chromic, formic, hydrochloric (muriatic greater than 15 percent), hydrofluoric, nitric (greater than 6 percent), perchloric, and sulfuric (4 percent or more).

B.2.2.3.2 Bases (Alkalis). Examples: hydroxides — ammonium (greater than 10 percent), calcium, potassium (greater than 1 percent), sodium (greater than 1 percent), and certain carbonates — potassium.

B.2.2.3.3 Other Corrosives. Examples: bromine, chlorine, fluorine, iodine, and ammonia.

Note: Corrosives that are oxidizers, e.g., nitric acid, chlorine, fluorine; or are compressed gases, e.g., ammonia, chlorine, fluorine; or are water-reactive, e.g., concentrated sulfuric acid, sodium hydroxide, are physical hazards in addition to being health hazards.

B.2.2.4 Carcinogens, Irritants, Sensitizers, and Other Health Hazard Materials. (Reserved)

B.3 Evaluation of Hazards

B.3.1 Degree of Hazard. The degree of hazard present depends upon many variables that should be considered individually and in combination. Some of the variables are as follows in B.3.1.1 through B.3.1.3.

B.3.1.1 Chemical Properties of the Material. Chemical properties of the material determine self-reactions and reactions that can occur with other materials. Generally, materials within subdivisions of hazard categories exhibit similar chemical properties. However, materials with similar chemical properties can present very different hazards. Each individual material should be researched to determine its hazardous properties and then considered in relation to other materials that it could contact and the surrounding environment.

B.3.1.2 Physical Properties of the Material. Physical properties, such as whether a material is a solid, liquid, or gas at ordinary temperatures and pressures, considered along with chemical properties determines requirements for containment of the material. Specific gravity (weight of a liquid compared to water) and vapor density (weight of a gas compared to air) are both physical properties that are important in evaluating the hazards of a material.

B.3.1.3 Amount and Concentration of the Material.

B.3.1.3.1 General. The amount of material present and its concentration must be considered along with physical and chemical properties to determine the magnitude of the hazard. Hydrogen peroxide, for example, is used as an antiseptic and a hair bleach in low concentrations (approximately 8 percent in water solution). Over 8 percent, hydrogen peroxide is classed as an oxidizer and is toxic. Above 90 percent, it is a Class 4 oxidizer "that can undergo an explosive reaction when catalyzed or exposed to heat, shock, or friction," a definition that incidentally also places hydrogen peroxide over 90 percent concentration in the unstable (reactive) category. Small amounts at high concentrations can present a greater hazard than large amounts at low concentrations.

B.3.1.3.2 Mixtures. Gases — toxic and highly toxic gases include those gases that have an LC_{50} of 2000 parts per million (ppm) or less when rats are exposed for a period of 1 hour or less. To maintain consistency with the definitions for these materials, exposure data for periods other than 1 hour must be normalized to 1 hour. To classify mixtures of compressed gases that contain one or more toxic or highly toxic components, the LC_{50} of the mixture must be determined. Mixtures that contain only two components are binary mixtures. Those that contain more than two components are multicomponent mixtures. When two or more hazardous substances (components) having an LC_{50} below 2000 ppm are present in a mixture, their combined effect, rather than that of the individual substances (components), must be considered. In the absence of information to the contrary, the effects of the hazards present must be considered as additive. Exceptions to the above rule can be made when there is a good reason to believe that the principal effects of the different harmful substances (components) are not additive.

For binary mixtures where the hazardous component is diluted with a nontoxic gas such as an inert gas, the LC_{50} of the mixture is estimated by use of the following formula:

$$LC_{50m} = \frac{1}{\left(\frac{C_i}{LC_{50i}}\right)} \quad \textbf{[B.3.1.3.2a]}$$

For multicomponent mixtures where more than one component has a listed LC_{50}, the LC_{50} of the mixture is estimated by use of the following formula:

$$LC_{50m} = \frac{1}{\left(\frac{C_{i1}}{LC_{50i1}}\right) + \left(\frac{C_{i2}}{LC_{50i2}}\right) + \left(\frac{C_{in}}{LC_{50\varepsilon}}\right)} \quad \textbf{[B.3.1.3.2b]}$$

where:

LC_{50m} = LC_{50} of the mixture in parts per million (ppm).

C = concentration of component (i) in decimal percent. The concentration of the individual components in a mixture of gases is to be expressed in terms of percent by volume.

LC_{50i} = LC_{50} of component (i). The LC_{50} of the component is based on a 1-hour exposure. LC_{50} data that are for other than 1-hour exposures must be normalized to 1 hour by multiplying the LC_{50} for the time determined by the factor indicated in Table B.3.1.3.2. The preferred mammalian species for LC_{50} data is the rat, as specified in the definitions of toxic and highly toxic in Chapter 3. If data for rats are unavailable, and in the absence of information to the contrary, data for other species can be utilized. The data must be taken in the following order of preference: rat, mouse, rabbit, guinea pig, cat, dog, and monkey.

i_n = component 1, component 2, and so on to the nth component.

Examples:

A. What is the LC_{50} of a mixture of 15 percent chlorine, 85 percent nitrogen? The 1-hour (rat) LC_{50} of pure chlorine is 293 ppm.

LC_{50m} = 1 / (0.15 / 293) or 1953 ppm. Therefore the mixture is toxic.

B. What is the LC_{50} of a mixture of 15 percent chlorine, 15 percent fluorine, and 70 percent nitrogen? The 1-hour (rat) LC_{50} of chlorine is 293 ppm. The 1-hour (rat) LC_{50} of fluorine is 185 ppm.

LC_{50m} = 1 / (0.15 / 293) + (0.15 / 185) or 755 ppm. Therefore the mixture is toxic.

TABLE B.3.1.3.2 Normalization Factor

Time (hours)	Multiply By
0.5	0.7
1.0	1.0
1.5	1.2
2.0	1.4
3.0	1.7
4.0	2.0
5.0	2.2
6.0	2.4
7.0	2.6
8.0	2.8

C. Is the mixture of 1 percent phosphine in argon toxic or highly toxic? The 4-hour (rat) LC_{50} is 11 ppm.

LC_{50m} = 1 / [0.01 / (11 × 2)] or 2200 ppm. Therefore the mixture is neither toxic nor highly toxic. Note that the 4-hour LC_{50} of 11 ppm was normalized to 1 hour by use of Table B.3.1.3.2.

B.3.1.3.3 Actual Use, Activity, or Process Involving the Material. The definition of handling, storage, and use in closed systems refers to materials in packages or containers. Dispensing and use in open containers or systems describes situations where a material is exposed to ambient conditions or vapors are liberated to the atmosphere. Dispensing and use in open systems, then, are generally more hazardous situations than handling, storage, or use in closed systems. The actual use or process can include heating, electric or other sparks, catalytic or reactive materials, and many other factors that could affect the hazard and must therefore be thoroughly analyzed.

B.3.1.3.4 Surrounding Conditions. Conditions such as other materials or processes in the area, type of construction of the structure, fire protection features (e.g., fire walls, sprinkler systems, alarms, etc.), occupancy (use) of adjoining areas, normal temperatures, exposure to weather, etc., must be taken into account in evaluating the hazard.

B.3.2 Evaluation Questions. The following are sample evaluation questions:

(1) What is the material? Correct identification is important; exact spelling is vital. Check labels, MSDS, ask responsible persons, etc.
(2) What are the concentration and strength?
(3) What is the physical form of the material? Liquids, gases, and finely divided solids have differing requirements for spill and leak control and containment.
(4) How much material is present? Consider in relation to permit amounts, exempt amounts (from Group H Occupancy requirements), amounts that require detached storage, and overall magnitude of the hazard.
(5) What other materials (including furniture, equipment, and building components) are close enough to interact with the material?
(6) What are the likely reactions?
(7) What is the activity involving the material?
(8) How does the activity impact the hazardous characteristics of the material? Consider vapors released or hazards otherwise exposed.
(9) What must the material be protected from? Consider other materials, temperature, shock, pressure, etc.
(10) What effects of the material must people and the environment be protected from?
(11) How can protection be accomplished? Consider the following:
  (a) Proper containers and equipment
  (b) Separation by distance or construction
  (c) Enclosure in cabinets or rooms
  (d) Spill control, drainage, and containment
  (e) Control systems — ventilation, special electrical, detection and alarm, extinguishment, explosion venting, limit controls, exhaust scrubbers, and excess flow control
  (f) Administrative (operational) controls — signs, ignition source control, security, personnel training, established procedures, storage plans, and emergency action plans

Evaluation of the hazard is a strongly subjective process; therefore, the person charged with this responsibility must gather as much relevant data as possible so that the decision is objective and within the limits prescribed in laws, policies, and standards.

It could be necessary to cause the responsible persons in charge to have tests made by qualified persons or testing laboratories to support contentions that a particular material or process is or is not hazardous. See 1.4.2.

B.4 Reference Publications

(Reserved)

B.5 Oxidizers and Organic Peroxides

B.5.1 General. This annex provides information, explanations, and examples to illustrate and clarify the hazard categories contained in Chapter 70 and Chapter 75 of this *Code*. The hazard categories are based on 29 CFR. Where numerical classifications are included, they are in accordance with nationally recognized standards.

B.5.2 Oxidizers.

B.5.2.1 General. The oxidizers on the following lists are typical for their class. Each oxidizer is undiluted unless a concentration is specified.

Unless concentration is specified, undiluted material is referenced. The following lists of oxidizers are provided to clarify how the NFPA Hazardous Chemicals Committee has classified typical oxidizers. The lists are not all-inclusive and are amended to reflect typical oxidizers used.

B.5.2.2 Class 1 Oxidizers. The following are typical Class 1 oxidizers:

(1) All inorganic nitrates (unless otherwise classified)
(2) All inorganic nitrites (unless otherwise classified)
(3) Ammonium persulfate
(4) Barium peroxide
(5) Calcium hypochlorite (nominal 80 percent, maximum 81 percent) blended with magnesium sulfate heptahydrate (nominal 20 percent, minimum 19 percent) having an available chlorine of less than or equal to 66 percent and a total water content of at least 17 percent.
(6) Calcium peroxide
(7) Hydrogen peroxide solutions (greater than 8 percent up to 27.5 percent)
(8) Lead dioxide
(9) Lithium hypochlorite (39 percent or less available chlorine)
(10) Lithium peroxide
(11) Magnesium peroxide
(12) Manganese dioxide
(13) Nitric acid (40 percent concentration or less)
(14) Perchloric acid solutions (less than 50 percent by weight)
(15) Potassium dichromate
(16) Potassium percarbonate
(17) Potassium persulfate
(18) Sodium carbonate peroxide
(19) Sodium dichloro-s-triazinetrione dihydrate (sodium dichloroisocyanurate dihydrate)
(20) Sodium dichromate
(21) Sodium perborate (anhydrous)
(22) Sodium perborate monohydrate
(23) Sodium perborate tetrahydrate
(24) Sodium percarbonate
(25) Sodium persulfate
(26) Strontium peroxide
(27) Trichloro-s-triazinetrione [trichloroisocyanuric acid (TCCA; trichlor), all physical forms]
(28) Zinc peroxide [**400:** G.3.2]

B.5.2.3 Class 2 Oxidizers. The following are typical Class 2 oxidizers:

(1) Barium bromate
(2) Barium chlorate
(3) Barium hypochlorite
(4) Barium perchlorate
(5) Barium permanganate
(6) 1-Bromo-3-chloro-5,5-dimethylhydantoin (BCDMH)
(7) Calcium chlorate
(8) Calcium chlorite
(9) Calcium hypochlorite (50 percent or less by weight unless covered by other formulations in Section G.3 of NFPA 400)
(10) Calcium perchlorate
(11) Calcium permanganate
(12) Chromium trioxide (chromic acid)
(13) Copper chlorate
(14) Halane (1,3-dichloro-5,5-dimethylhydantoin)
(15) Hydrogen peroxide (greater than 27.5 percent up to 52 percent)
(16) Lead perchlorate
(17) Lithium chlorate
(18) Lithium hypochlorite (more than 39 percent available chlorine)
(19) Lithium perchlorate
(20) Magnesium bromate
(21) Magnesium chlorate
(22) Magnesium perchlorate
(23) Mercurous chlorate
(24) Nitric acid (more than 40 percent but less than 86 percent)
(25) Nitrogen tetroxide
(26) Perchloric acid solutions (more than 50 percent but less than 60 percent)
(27) Potassium perchlorate
(28) Potassium permanganate
(29) Potassium peroxide
(30) Potassium superoxide
(31) Silver peroxide
(32) Sodium chlorite (40 percent or less by weight)
(33) Sodium perchlorate
(34) Sodium perchlorate monohydrate
(35) Sodium permanganate
(36) Sodium peroxide
(37) Strontium chlorate
(38) Strontium perchlorate
(39) Thallium chlorate
(40) Urea hydrogen peroxide
(41) Zinc bromate
(42) Zinc chlorate
(43) Zinc permanganate [**400:** G.3.3]

B.5.2.4 Class 3 Oxidizers. The following are typical Class 3 oxidizers:

(1) Ammonium dichromate
(2) Calcium hypochlorite (over 50 percent by weight unless covered in other formulations in B.5.2)
(3) Calcium hypochlorite (over 50 percent by weight)
(4) Chloric acid (10 percent maximum concentration)
(5) Hydrogen peroxide solutions (greater than 52 percent up to 91 percent)
(6) Mono-(trichloro)-tetra-(monopotassium dichloro)-penta-s-triazinetrione
(7) Nitric acid, fuming (more than 86 percent concentration)
(8) Perchloric acid solutions (60 percent to 72 percent by weight)
(9) Potassium bromate
(10) Potassium chlorate
(11) Potassium dichloro-s-triazinetrione (potassium dichloroisocyanurate)
(12) Sodium bromate
(13) Sodium chlorate
(14) Sodium chlorite (over 40 percent by weight)

[**400:** G.3.4]

B.5.2.5 Class 4 Oxidizers. The following are typical Class 4 oxidizers:

(1) Ammonium perchlorate (particle size greater than 15 microns)
(2) Ammonium permanganate
(3) Guanidine nitrate
(4) Hydrogen peroxide solutions (greater than 91 percent)
(5) Tetranitromethane

Ammonium perchlorate less than 15 microns is classified as an explosive and, as such, is not covered by NFPA 400. *(See NFPA 495.)* [**400:** G.3.5]

B.5.3 Typical Organic Peroxide Formulations.

Δ **B.5.3.1 General.** The assignment of the organic peroxide formulation classifications shown in the tables in this annex are based on the container sizes shown. A change in the container size could affect the classification. The information in this annex was collected from the Organic Peroxides Producers (Society of the Plastics Industry-Organic Peroxide Producers Safety Division).

For an alphabetical listing of typical organic peroxide formulations, see Table B.5.3.1. [**400:** F.1]

Δ ***TABLE B.5.3.1*** *Organic Peroxide Formulations*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[b]					
				Control	Emergency						
Organic Peroxide Formulation	Concentration	Diluent[c]	Water	C/F	C/F	Health	Flammability	Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[d]
ACETYL ACETONE PEROXIDE	≤ 42	A ≥ 48%	≥ 8			2	1	3	II	16 gal (60 L)	2
ACETYL ACETONE PEROXIDE	≤ 32 as a paste					2	NE	3	III	110 lb (50 kg)	20
ACETYL CYCLOHEXANE-SULPHONYL PEROXIDE	≤ 82		≥ 12	–10/14	0/32	3	NE	4	I	55 lb (25 kg)**	3
ACETYL CYCLOHEXANE-SULPHONYL PEROXIDE	≤ 32	B ≥ 68		–10/14	0/32	3	4	3	III	16 gal (60 L)	
t-AMYL HYDROPEROXIDE	≤ 88	A ≥ 6	≥ 6			3	2	2	II	60 gal (225 L)	
t-AMYL PEROXYACETATE	≤ 62	A ≥ 38				3	2	3	II	16 gal (60 L)	
t-AMYL PEROXYBENZOATE	≤ 100					2	2	3	II	16 gal (60 L)	
t-AMYL PEROXY-2-ETHYL-HEXANOATE	≤ 100			20/68	25/77	2	2	3	II	16 gal (60 L)	
t-AMYL PEROXY-2-ETHYLHEXYL CARBONATE	≤ 100					1	2	3	II	16 gal (60 L)	
t-AMYL PEROXY ISOPROPYL CARBONATE	≤ 77	A ≥ 23				NE	2	3	I	16 gal (60 L)**	
t-AMYL PEROXYNEODECANOATE	≤ 77	B ≥ 23		0/32	10/50	1	2	3	II	16 gal (60 L)	
t-AMYL PEROXYNEODECANOATE	≤ 47	A ≥ 53		0/32	10/50	1	2	1	III	IBC tank	
t-AMYL PEROXYPIVALATE	≤ 77	B ≥ 23		10/50	15/59	2	2	3	II	16 gal (60 L)	
t-AMYLPEROXY-3,5,5-TRIMETH-YLHEXANOATE	≤ 100					2	2	4	I	16 gal (60 L)	
t-BUTYL CUMYL PEROXIDE	> 42–100					2	2	2	II	60 gal (225 L)	
t-BUTYL CUMYL PEROXIDE	≤ 52	Inert solid ≥ 48				2	NE	2	II	440 lb (200 kg)	
n-BUTYL-4,4-DI-(*t*-BUTYLPEROXY) VALERATE	> 52–100					1	2	3	II	16 gal (60 L)**	
n-BUTYL-4,4-DI-(*t*-BUTYLPEROXY) VALERATE	≤ 52	Inert solid ≥ 48				1	NE	2	III	440 lb (200 kg)	
t-BUTYL HYDROPEROXIDE[e]	> 79–90		≥ 10			3	3	3	I	16 gal (60 L)**	13
t-BUTYL HYDROPEROXIDE	≤ 80	A ≥ 20				3	NE	3	II	16 gal (60 L)	4, 13
t-BUTYL HYDROPEROXIDE[e]	≤ 79		> 14			3	NE	2	II	60 gal (225 L)	13, 23
t-BUTYL HYDROPEROXIDE[e]	≤ 72		≥ 28			3	2	1	III	IBC tank/tank truck	13, 32
t-BUTYL HYDROPEROXIDE + DI-*t*-BUTYLPEROXIDE	< 82 + >9		≥ 7			3	4	3	I	16 gal (60 L)**	13

(continues)

Δ *TABLE B.5.3.1 Continued*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[b]					
Organic Peroxide Formulation	Concentration	Diluent[c]	Water	Control C/F	Emergency C/F	Health	Flammability	Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[d]
t-BUTYL MONOPEROXYMALEATE	> 52–100					3	2	4	I	55 lb (25) kg**	3
t-BUTYL MONOPEROXYMALEATE	≤ 52	A ≥ 48				3	NE	3	II	16 gal (60 L)**	
t-BUTYL MONOPEROXYMALEATE	≤ 52	Inert solid ≥ 48				3	NE	2	II	440 lb (200 kg)	
t-BUTYL MONOPEROXYMALEATE	≤ 52 as a paste					3	2	2	II	440 lb (200 kg)	
t-BUTYL PEROXYACETATE	> 52–77	A ≥ 23				2	2	4	I	8 gal (30 L)**	3
t-BUTYL PEROXYACETATE	> 32–52	A ≥ 48				2	2	3	II	16 gal (60 L)**	
t-BUTYL PEROXYACETATE	≤ 32	B ≥ 68				2	2	1	III	IBC tank	
t-BUTYL PEROXYBENZOATE	> 77–100					2	1	3	II	16 gal (60 L)**	
t-BUTYL PEROXYBENZOATE	> 52–77	A ≥ 23				2	2	3	II	16 gal (60 L)	
t-BUTYL PEROXYBENZOATE	≤ 52	Inert solid ≥ 48				2	NE	3	II	110 lb (50 kg)	
t-BUTYL PEROXYBUTYL FUMARATE	≤ 52	A ≥ 48				NE	NE	3	II	16 gal (60 L)	
t-BUTYL PEROXYCROTONATE	≤ 77	A ≥ 23				2	2	3	II	16 gal (60 L)	
t-BUTYL PEROXYDIETHYLACETATE	≤ 100			20/68	25/77	3	2	3	I	16 gal (60 L)**	
t-BUTYL PEROXY-2-ETHYL-HEXANOATE	> 52–100			20/68	25/77	1	2	3	II	16 gal (60 L)**	
t-BUTYL PEROXY-2-ETHYL-HEXANOATE	> 32–52	B ≥ 48		30/86	35/95	1	2	2	II	60 gal (225 L)	
t-BUTYL PEROXY-2-ETHYL-HEXANOATE	≤ 52	Inert solid ≥ 48		20/68	25/77	1	NE	2	II	440 lb (200 kg)	
t-BUTYL PEROXY-2-ETHYL-HEXANOATE	≤ 32	B ≥ 68		40/104	45/113	1	2	1	III	IBC tank	
t-BUTYL PEROXY-2-ETHYL-HEXANOATE + 2,2-DI-(*t*-BUTYLPEROXY)BUTANE	≤ 12 + ≤ 14	A ≥ 14; Inert solid ≥ 60				1	NE	3	II	110 lb (50 kg)	
t-BUTYL PEROXY-2-ETHYL-HEXANOATE + 2,2-DI-(*t*-BUTYLPEROXY)BUTANE	≤ 31 + ≤ 36	B ≥ 33		35/95	40/104	1	NE	3	II	16 gal (60 L)	
t-BUTYL PEROXY-2-ETHYL-HEXYLCARBONATE	≤ 100					1	1	3	II	16 gal (60 L)	
t-BUTYL PEROXYISOBUTYRATE	> 52–77	B ≥ 23		15/59	20/68	1	2	4	I	8 gal (30 L)**	3
t-BUTYL PEROXYISOBUTYRATE	≤ 52	B ≥ 48		15/59	20/68	1	3	3	II	16 gal (60 L)	
t-BUTYLPEROXY ISOPROPYLCARBONATE	≤ 77	A ≥ 23				2	2	3	II	16 gal (60 L)**	
1-(2-*t*-BUTYLPEROXY ISOPROPYL)-3-ISOPROPENYLBENZENE	≤ 77	A ≥ 23				NE	NE	3	II	16 gal (60 L)	
1-(2-*t*-BUTYLPEROXY ISOPROPYL)-3-ISOPROPENYLBENZENE	≤ 42	Inert solid ≥ 58				NE	NE	2	II	440 lb (200 kg)	
t-BUTYL PEROXY-2-METHYLBENZOATE	≤ 100					3	4	3	I	16 gal (60 L)**	
t-BUTYL PEROXYNEODECANOATE	> 77–100			–5/23	5/41	2	3	3	II	16 gal (60 L)	
t-BUTYL PEROXYNEODECANOATE	≤ 77	B ≥ 23		0/32	10/50	2	2	3	II	16 gal (60 L)	

Δ ***TABLE B.5.3.1*** *Continued*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[b]					
Organic Peroxide Formulation	**Concen-tration**	**Diluent[c]**	**Water**	**Control C/F**	**Emer-gency C/F**	**Health**	**Flamma-bility**	**Insta-bility**	**Storage Class**	**Max Container Size**	**Subsidiary Risks and Remarks[d]**
t-BUTYL PEROXYNEODECANOATE	≤ 52 as a stable dispersion in water			0/32	10/50	2	NE	1	IV	IBC tank	
t-BUTYL PEROXYNEODECANOATE	≤ 42 as a stable dispersion in water			0/32	10/50	2	NE	2	IV	440 lb (200 kg)	
t-BUTYL PEROXYNEODECANOATE	≤ 32	A ≥ 68		0/32	10/50	2	NE	1	III	IBC tank	
t-BUTYL PEROXYNEOHEPTANOATE	≤ 77	A ≥ 23		0/32	10/50	1	2	3	II	16 gal (60 L)	
t-BUTYL PEROXYNEOHEPTANOATE	≤ 42 as a stable dispersion in≈water			0/32	10/50	1	NE	2	IV	60 gal (225 L)	
t-BUTYL PEROXYPIVALATE	> 67–77	A ≥ 23		0/32	10/50	2	2	3	II	16 gal (60 L)**	
t-BUTYL PEROXYPIVALATE	> 27–67	B ≥ 33		0/32	10/50	2	2	3	II	16 gal (60 L)	
t-BUTYL PEROXYPIVALATE	≤ 27	B ≥ 73		30/86	35/95	2	2	1	III	IBC tank	
t-BUTYLPEROXY STEARYL-CARBONATE	≤ 100					NE	NE	3	II	110 lb (50 kg)	
t-BUTYL PEROXY-3,5,5-TRIMETH-YLHEXANOATE	> 32–100					2	1	3	II	16 gal (60 L)	
t-BUTYL PEROXY-3,5,5-TRIMETH-YLHEXANOATE	≤ 42	Inert solid ≥ 58				1	2	1	II	110 lb (50 kg)	
t-BUTYL PEROXY-3,5,5-TRIMETH-YLHEXANOATE	≤ 32	B ≥ 68				2	2	1	III	IBC tank	
3-CHLOROPEROXYBENZOIC ACID	> 57–86	Inert solid ≥ 14				NE	NE	4	I	55 lb (25 kg)**	3
3-CHLOROPEROXYBENZOIC ACID	≤ 57	Inert solid ≥ 3	≥ 40			NE	NE	3	II	110 lb (50 kg)	
3-CHLOROPEROXYBENZOIC ACID	≤ 77	Inert solid ≥ 6	≥ 17			NE	NE	3	II	110 lb (50 kg)	
CUMYL HYDROPEROXIDE	> 90–98	A ≥ 10				3	1	2	III	60 gal (225 L)	13
CUMYL HYDROPEROXIDE	≤ 90	A ≥ 10				3	2	1	III	IBC tank	13, 18
CUMYL PEROXYNEODECANOATE	≤ 87	A ≥ 13		–10/14	0/32	1	3	3	I	16 gal (60 L)	
CUMYL PEROXYNEODECANOATE	≤ 77	B ≥ 23		–10/14	0/32	1	3	3	II	16 gal (60 L)	
CUMYL PEROXYNEODECANOATE	≤ 52 as a stable dispersion in water			–10/14	0/32	1	NE	1	III	IBC tank	
CUMYL PEROXYNEOHEPTANOATE	≤ 77	A ≥ 23		–10/14	0/32	1	3	3	II	16 gal (60 L)	
CUMYL PEROXYPIVALATE	≤ 77	B ≥ 23		–5/23	5/41	NE	3	3	II	16 gal (60 L)	
CYCLOHEXANONE PEROXIDE(S)	≤ 91		≥ 9			3	NE	3	I	110 lb (50 kg)**	13
CYCLOHEXANONE PEROXIDE(S)	≤ 72	A ≥ 28				3	NE	3	II	16 gal (60 L)	5
CYCLOHEXANONE PEROXIDE(S)	≤ 72 as a paste					3	NE	3	II	110 lb (50 kg)	5, 20
CYCLOHEXANONE PEROXIDE(S)	≤ 32	Inert solid ≥ 68				3	NE	0	V	Exempt	29

(continues)

Δ TABLE B.5.3.1 *Continued*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[b]					
				Control	Emergency						
Organic Peroxide Formulation	Concentration	Diluent[c]	Water	C/F	C/F	Health	Flammability	Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[d]
DIACETONE ALCOHOL PEROXIDES	≤ 57	B ≥ 26	≥ 8	40/104	45/113	NE	NE	3	II	16 gal (60 L)	6
DIACETYL PEROXIDE	≤ 27	B ≥ 73		20/68	25/77	1	2	3	II	16 gal (60 L)	7, 13
DI-*t*-AMYL PEROXIDE	≤ 100					2	4	2	II	60 gal (225 L)	
2,2-DI-(*t*-AMYLPEROXY)BUTANE	≤ 57	A ≥ 43				1	3	3	I	16 gal (60 L)	
1,1-DI-(*t*-AMYLPEROXY) CYCLOHEXANE	≤ 82	A ≥ 18				1	2	3	I	16 gal (60 L)**	
DIBENZOYL PEROXIDE	> 51–100	Inert solid ≤ 48				2	4	4	I	55 lb (25 kg)**	3
DIBENZOYL PEROXIDE	> 77–94		≥ 6			2	4	4	I	55 lb (25 kg)**	3
DIBENZOYL PEROXIDE	≤ 77		≥ 23			2	2	3	II	110 lb (50 kg)**	
DIBENZOYL PEROXIDE	≤ 62	Inert solid ≥ 28	≥ 10	T[f]		2	NE	3	II	110 lb (50 kg)	
DIBENZOYL PEROXIDE	> 52–62 as a paste			T[f]		2	2	3	II	110 lb (50 kg)	20
DIBENZOYL PEROXIDE	> 35–52	Inert solid ≥ 48				2	2	3	II	110 lb (50 kg)	
DIBENZOYL PEROXIDE	> 36–42	A ≥ 18	≤ 40	T[f]		2	2	2	II	60 gal (225 L)	
DIBENZOYL PEROXIDE	≤ 56.5 as a paste		≥ 15	T[f]		2	2	2	II	440 lb (200 kg)	
DIBENZOYL PEROXIDE	≤ 52 as a paste			T[f]		2	2	2	II	440 lb (200 kg)	20
DIBENZOYL PEROXIDE	≤ 42 as a stable dispersion in water					2	2	1	III	IBC tank	
DIBENZOYL PEROXIDE	≤ 35	Inert solid ≥ 65				2	2	0	V	Exempt	29
DI-(4-*t*-BUTYLCYCLOHEXYL) PEROXYDICARBONATE	≤ 100			30/86	35/95	1	2	3	I	110 lb (50 kg)**	
DI-(4-*t*-BUTYLCYCLOHEXYL) PEROXYDICARBONATE	≤ 42 as a stable dispersion in water			30/86	35/95	1	2	1	IV	IBC tank	
DI-*t*-BUTYL PEROXIDE[e]	> 52–100					1	4	2	II	60 gal (225 L)	
DI-*t*-BUTYL PEROXIDE	≤ 52	B ≥ 48				1	4	1	III	IBC tank	25
DI-*t*-BUTYL PEROXYAZELATE	≤ 52	A ≥ 48				NE	2	3	II	16 gal (60 L)	
2,2-DI-(*t*-BUTYLPEROXY) BUTANE	≤ 52	A ≥ 48				1	2	3	II	16 gal (60 L)	
1,6-DI-(*t*-BUTYLPEROXY CARBONYLOXY) HEXANE	≤ 72	A ≥ 28				NE	NE	3	I	16 gal (60 L)**	
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	> 80–100					1	2	4	I	8 gal (30 L)**	3
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	≤ 72	B ≥ 28				1	2	3	II	16 gal (60 L)**	30
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	> 52–80	A ≥ 20				1	2	3	II	16 gal (60 L)**	
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	> 42–52	A ≥ 48				1	2	3	II	16 gal (60 L)	
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	≤ 42	A ≥ 13	≥ 45			1	NE	3	III	110 lb (50 kg)	

Δ ***TABLE B.5.3.1*** *Continued*

Organic Peroxide Formulation	Concentration	Diluent[c]	Water	Recommended Maximum Temperatures[a] Control C/F	Recommended Maximum Temperatures[a] Emergency C/F	Hazard Identification NFPA 704 Ratings[b] Health	Hazard Identification NFPA 704 Ratings[b] Flammability	Hazard Identification NFPA 704 Ratings[b] Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[d]
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	≤ 42	A ≥ 58				1	2	1	III	IBC tank	
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	≤ 27	A ≥ 25				1	1	2	III	60 gal (225 L)	21
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	≤ 13	A ≥ 13; B ≥ 74				1	NE	1	III	IBC tank	
1,1-DI-(*t*-BUTYLPEROXY)-CYCLOHEXANE + *t*-BUTYL PEROXY-2-ETHYLHEXANOATE	≤ 43 + ≤ 16	A ≥ 41				1	2	3	II	16 gal (60 L)	
DI-*n*-BUTYL PEROXYDICARBONATE	> 27–52	B ≥ 48		–15/5	–5/23	1	NE	3	II	16 gal (60 L)	
DI-*n*-BUTYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water (frozen)			–15/5	–5/23	1	NE	2	IV	440 lb (200 kg)	
DI-*n*-BUTYL PEROXYDICARBONATE	≤ 27	B ≥ 73		–10/14	0/32	1	NE	2	III	60 gal (225 L)	
DI-*sec*-BUTYL PEROXYDICARBONATE	> 52–100			–20/–4	–10/14	1	4	3	I	16 gal (60 L)**	
DI-*sec*-BUTYL PEROXYDICARBONATE	≤ 52	B ≥ 48		–15/5	–5/23	1	4	3	II	16 gal (60 L)	
DI-(*t*-BUTYLPEROXYISO PROPYL) BENZENE(S)	> 42–100	Inert solid ≥ 57				1	1	3	II	110 lb (50 kg)	
DI-(*t*-BUTYLPEROXYISO PROPYL) BENZENE(S)	≤ 42	Inert solid ≥ 58				1	1	0	V	Exempt	29
DI-(*t*-BUTYLPEROXY) PHTHALATE	> 42–52	A ≥ 48				NE	2	3	II	16 gal (60 L)	
DI-(*t*-BUTYLPEROXY) PHTHALATE	≤ 52 as a paste					NE	NE	3	II	110 lb (50 kg)	20
DI-(*t*-BUTYLPEROXY) PHTHALATE	≤ 42	A ≥ 58				NE	1	2	II	60 gal (225 L)	
2,2-DI-(*t*-BUTYLPEROXY) PROPANE	≤ 52	A ≥ 48				NE	2	3	II	16 gal (60 L)	
2,2-DI-(*t*-BUTYLPEROXY) PROPANE	≤ 42	A ≥ 13; Inert solid ≥ 45				NE	NE	3	III	110 lb (50 kg)	
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	> 90–100					1	2	4	I	8 gal (30 L)**	3
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 90	B ≥ 10				1	2	4	I	16 gal (60 L)**	30
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	> 57–90	A ≥ 10				1	2	3	II	60 gal (225 L)**	
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 77	B ≥ 23				1	NE	3	II	16 gal (60 L)**	
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 57	Inert solid ≥ 43				1	2	1	III	IBC type	
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 57	A ≥ 43				1	NE	2	II	60 gal (225 L)	
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 32	A ≥ 26; B ≥ 42				1	4	2	II	60 gal (225 L)	
DICETYL PEROXYDICARBONATE	≤ 100			30/86	35/95	1	2	3	II	110 lb (50 kg)	
DICETYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water			30/86	35/95	1	2	1	IV	IBC tank	

(continues)

△ TABLE B.5.3.1 *Continued*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[b]					
				Control	Emergency						
Organic Peroxide Formulation	Concentration	Diluent[c]	Water	C/F	C/F	Health	Flammability	Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[d]
DI-4-CHLOROBENZOYL PEROXIDE	≤ 77		≥ 23			NE	NE	4	I	55 lb (25 kg)**	3
DI-4-CHLOROBENZOYL PEROXIDE	≤ 52 as a paste					NE	NE	3	II	110 lb (50 kg)	20
DI-4-CHLOROBENZOYL PEROXIDE	≤ 32	Inert solid ≥ 68				NE	NE	0	V	Exempt	29
DICUMYL PEROXIDE	> 52–100					1	1	1	III	IBC type	12
DICUMYL PEROXIDE	≤ 52	Inert solid ≥ 48				1	NE	0	V	Exempt	29
DICYCLOHEXYL PEROXYDICARBONATE	> 91–100			10/50	15/59	NE	NE	4	I	55 lb (25 kg)**	3
DICYCLOHEXYL PEROXYDICARBONATE	≤ 91		≥ 9	10/50	15/59	NE	NE	3	II	110 lb (50 kg)**	
DICYCLOHEXYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water			15/59	20/68	NE	NE	1	IV	IBC tank	
DIDECANOYL PEROXIDE	≤ 100			30/86	35/95	1	NE	3	II	110 lb (50 kg)**	
2,2-DI-(4,4-DI (*t*-BUTYLPEROXY) CYCLOHEXYL) PROPANE	≤ 42	Inert solid ≥ 58				1	NE	3	III	110 lb (50 kg)	
2,2-DI-(4,4-DI (*t*-BUTYLPEROXY) CYCLOHEXYL) PROPANE	≤ 22	B ≥ 78				1	NE	2	III	60 gal (225 L)	
DI-2,4-DICHLOROBENZOYL PEROXIDE	≤ 77		≥ 23			1	NE	4	I	55 lb (25 kg)**	3
DI-2,4-DICHLOROBENZOYL PEROXIDE	≤ 52 as a paste			20/68	25/77	1	2	2	II	440 lb (200 kg)	
DI-2,4-DICHLOROBENZOYL PEROXIDE	≤ 52 as a paste with silicon oil			T[f]		1	2	3	II	110 lb (50 kg)	
DI-(2-ETHOXYETHYL) PEROXYDICARBONATE	≤ 52	B ≥ 48		–10/14	0/32	NE	NE	3	I	16 gal (60 L)	
DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	> 77–100			–20/–4	–10/14	2	4	3	II	16 gal (60 L)**	
DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	≤ 77	B ≥ 23		–15/5	–5/23	2	4	3	II	16 gal (60 L)	
DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	≤ 62 as a stable dispersion in water			–15/5	–5/23	2	NE	2	III	IBC tank	
DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	≤ 52 as a stable dispersion in water (frozen)			–15/5	–5/23	2	NE	1	IV	IBC type	
2,2-DIHYDROPEROXYPROPANE	≤ 27	Inert solid ≥ 73				NE	NE	4	I	55 lb (25 kg)**	3

△ *TABLE B.5.3.1 Continued*

Organic Peroxide Formulation	Concentration	Diluent[c]	Water	Recommended Maximum Temperatures[a] Control C/F	Recommended Maximum Temperatures[a] Emergency C/F	Hazard Identification NFPA 704 Ratings[b] Health	Hazard Identification NFPA 704 Ratings[b] Flammability	Hazard Identification NFPA 704 Ratings[b] Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[d]
DI-(1-HYDROXYCYCLOHEXYL) PEROXIDE	≤ 100					NE	NE	3	II	110 lb (50 kg)	
DIISOBUTYRYL PEROXIDE	> 32–52	B ≥ 48		–20/–4	–10/14	3	4	4	I	8 gal (30 L)**	3
DIISOBUTYRYL PEROXIDE	≤ 32	B ≥ 68		–20/–4	–10/14	3	NE	3	II	16 gal (60 L)	
DIISOPROPYLBENZENE DIHYDROPEROXIDE	≤ 82	A ≥ 5	≥ 5			NE	NE	3	II	110 lb (50 kg)	24
DIISOPROPYL PEROXYDICARBONATE	> 52–100			–15/5	–5/23	3	4	4	I	55 lb (25 kg)**	3
DIISOPROPYL PEROXYDICARBONATE	≤ 52	B ≥ 48		–20/–4	–10/14	3	NE	3	II	16 gal (60 L)	
DIISOPROPYL PEROXYDICARBONATE	≤ 28	A ≥ 72		–15/5	–5/23	2	NE	3	II	16 gal (60 L)	
DILAUROYL PEROXIDE	≤ 100					1	2	3	II	110 lb (50 kg)	
DILAUROYL PEROXIDE	≤ 42 as a stable dispersion in water					1	NE	1	IV	IBC tank	
DI-(3-METHOXYBUTYL) PEROXYDICARBONATE	≤ 52	B ≥ 48		–5/23	5/41	NE	NE	3	I	16 gal (60 L)	
DI-(2-METHYLBENZOYL) PEROXIDE	≤ 87		≥ 13	30/86	35/95	3	NE	4	I	55 lb (25 kg)**	3
DI-(3-METHYLBENZOYL) PEROXIDE + BENZOYL (3-METHYLBENZOYL) PEROXIDE + DIBENZOYL PEROXIDE	≤ 20 + ≤ 18 + ≤ 4	B ≥ 58		35/95	40/104	NE	NE	3	II	16 gal (60 L)	
DI-(4-METHYLBENZOYL) PEROXIDE	≤ 52 as a paste with silicon oil					NE	NE	3	II	110 lb (50 kg)	
2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE	> 82–100					1	2	4	I	55 lb (25 kg)**	3
2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE	≤ 82	Inert solid ≥ 18				1	NE	3	II	110 lb (50 kg)	
2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE	≤ 82		≥ 18			1	NE	3	II	110 lb (50 kg)**	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXANE	> 90–100					2	2	3	II	16 gal (60 L)**	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXANE	> 52–90	A ≥ 10				2	2	3	II	16 gal (60 L)	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXANE	≤ 77	Inert solid ≥ 23				2	2	1	II	440 lb (200 kg)	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXANE	≤ 52	A ≥ 48				2	2	1	III	IBC tank	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXANE	≤ 47 as a paste					2	1	2	II	440 lb (200 kg)	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXYNE-3	> 86–100					1	2	4	I	8 gal (30 L)**	3

(continues)

Δ ***TABLE B.5.3.1*** *Continued*

Organic Peroxide Formulation	Concen-tration	Diluent[c]	Water	Recommended Maximum Temperatures[a] Control C/F	Emer-gency C/F	Hazard Identification NFPA 704 Ratings[b] Health	Flamma-bility	Insta-bility	Storage Class	Max Container Size	Subsidiary Risks and Remarks[d]
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXYNE-3	>52–86	A ≥ 14				1	2	3	II	16 gal (60 L)**	26
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXYNE-3	≤ 52	Inert solid ≥ 48				1	NE	3	III	110 lb (50 kg)	
2,5-DIMETHYL-2,5-DI-(2-ETHYL-HEXANOYLPEROXY) HEXANE	≤ 100			20/68	25/77	2	2	3	II	16 gal (60 L)**	
2,5-DIMETHYL-2,5-DIHYDROPEROXYHEXANE	≤ 82		≥ 18			3	2	3	II	110 lb (50 kg)**	
2,5-DIMETHYL-2,5-DI-(3,5,5-TRIMETHYLHEXANOYL-PEROXY)HEXANE	≤ 77	A ≥ 23				NE	NE	3	II	16 gal (60 L)	
1,1-DIMETHYL-3-HYDROXYBUTYL PEROXYNEOHEPTANOATE	≤ 52	A ≥ 48		0/32	10/50	NE	2	2	II	60 gal (225 L)	
DIMYRISTYL PEROXYDICARBONATE	≤ 100			20/68	25/77	1	NE	3	II	110 lb (50 kg)	
DIMYRISTYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water			20/68	25/77	1	NE	1	IV	IBC tank	
DI-(2-NEODECANOYL PEROXYISOPROPYL) BENZENE	≤ 52	A ≥ 48		–10/14	0/32	NE	NE	3	II	16 gal (60 L)	
DI-*n*-NONANOYL PEROXIDE	≤ 100			0/32	10/50	NE	NE	3	II	110 lb (50 kg)	
DI-*n*-OCTANOYL PEROXIDE	≤ 100			10/50	15/59	1	NE	3	II	110 lb (50 kg)**	
DI-(2-PHENOXYETHYL) PEROXYDICARBONATE	> 85–100					1	NE	4	I	55 lb (25 kg)**	3
DI-(2-PHENOXYETHYL) PEROXYDICARBONATE	≤ 85		≥ 15			1	NE	3	II	110 lb (50 kg)	
DIPROPIONYL PEROXIDE	≤ 27	B ≥ 73		15/59	20/68	NE	NE	2	III	60 gal (225 L)	
DI-*n*-PROPYL PEROXYDICARBONATE	≤ 100			–25/–13	–15/5	2	4	3	I	16 gal (60 L)**	
DI-*n*-PROPYL PEROXYDICARBONATE	≤ 77	B ≥ 23		–20/–4	–10/14	2	4	3	I	16 gal (60 L)**	
DISUCCINIC ACID PEROXIDE	> 72–100					3	NE	4	I	55 lb (25 kg)**	3, 17
DISUCCINIC ACID PEROXIDE	≤ 72		≥ 28	10/50	15/59	3	NE	3	II	110 lb (50 kg)	
DI-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE	> 38–82	A ≥ 18		0/32	10/50	2	2	3	II	16 gal (60 L)	
DI-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE	≤ 52 as a stable dispersion in water			10/50	15/59	2	2	1	III	IBC tank	
DI-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE	≤ 38	A ≥ 62		20/68	25/77	2	NE	1	III	IBC tank	
ETHYL 3,3-DI-(*t*-AMYLPEROXY) BUTYRATE	≤ 67	A ≥ 33				NE	2	3	II	16 gal (60 L)	
ETHYL 3,3-DI-(*t*-BUTYLPEROXY) BUTYRATE	> 77–100					1	1	3	II	16 gal (60 L)**	
ETHYL 3,3-DI-(*t*-BUTYLPEROXY) BUTYRATE	≤ 77	A ≥ 23				1	2	3	II	16 gal (60 L)	
ETHYL 3,3-DI-(*t*-BUTYLPEROXY) BUTYRATE	≤ 52	Inert solid ≥ 48				1	NE	3	II	110 lb (50 kg)	

Δ ***TABLE B.5.3.1*** *Continued*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[b]					
				Control	Emergency						
Organic Peroxide Formulation	**Concentration**	**Diluent[c]**	**Water**	**C/F**	**C/F**	**Health**	**Flammability**	**Instability**	**Storage Class**	**Max Container Size**	**Subsidiary Risks and Remarks[d]**
1-(2-ETHYLHEXANOYLPEROXY)-1,3-DIMETHYLBUTYL PEROXYPIVALATE	≤ 52	A ≥ 45; B ≥ 10		–20/–4	–10/14	2	NE	3	II	16 gal (60 L)	
t-HEXYL PEROXYNEODECANOATE	≤ 71	A ≥ 29		0/32	10/50	1	NE	3	II	16 gal (60 L)	
t-HEXYL PEROXYPIVALATE	≤ 72	B ≥ 28		10/50	15/59	NE	NE	3	II	16 gal (60 L)	
3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	≤ 77	A ≥ 23		–5/23	5/41	NE	3	3	II	16 gal (60 L)	
3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	≤ 52	A ≥ 48		–5/23	5/41	NE	3	2	II	60 gal (225 L)	
3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	≤ 52 as a stable dispersion in water			–5/23	5/41	NE	3	1	IV	IBC tank	
ISOPROPYL *sec*-BUTYL PEROXYDICARBONATE + DI-*sec*-BUTYL PEROXYDICARBONATE + DI-ISOPROPYL PEROXYDICARBONATE	≤ 32 + ≤ 15–18 ≤ 12–15	A ≥ 38		–20/–4	–10/14	2	NE	3	II	16 gal (60 L)	
ISOPROPYL *sec*-BUTYL PEROXYDICARBONATE + DI-*sec*-BUTYL PEROXYDICARBONATE + DI-ISOPROPYL PEROXYDICARBONATE	≤ 52 + ≤ 28 + ≤ 22			–20/–4	–10/14	2	4	4	I	8 gal (30 L)**	3
ISOPROPYLCUMYL HYDROPEROXIDE	≤ 72	A ≥ 28				3	2	1	III	IBC tank	13
p-MENTHYL HYDROPEROXIDE	> 72–100					3	2	3	II	16 gal (60 L)	13
p-MENTHYL HYDROPEROXIDE	≤ 72	A ≥ 28				3	2	1	III	IBC tank	27
METHYLCYCLOHEXANONE PEROXIDE(S)	≤ 67	B ≥ 33		35/95	40/104	NE	NE	3	II	16 gal (60 L)	
METHYL ETHYL KETONE PEROXIDE(S)	See remark 8)	A ≥ 48				3	NE	4	I	8 gal (30 L)**	3, 8, 13
METHYL ETHYL KETONE PEROXIDE(S)	See remark 9)	A ≥ 55				3	2	3	II	16 gal (60 L)	9
METHYL ETHYL KETONE PEROXIDE(S)	See remark 10)	A ≥ 60				3	2	2	II	60 gal (225 L)	10
METHYL ISOBUTYL KETONE PEROXIDE(S)	≤ 62	A ≥ 19				NE	2	3	II	16 gal (60 L)	22
METHYL ISOPROPYL KETONE PEROXIDE(S)	See remark 31)	A ≥ 70				NE	NE	1	III	IBC tank	31
ORGANIC PEROXIDE, LIQUID, SAMPLE						NE	NE	NE	II	16 gal (60 L)**	11
ORGANIC PEROXIDE, LIQUID, SAMPLE, TEMPERATURE CONTROLLED						NE	NE	NE	II	16 gal (60 L)**	11
ORGANIC PEROXIDE, SOLID, SAMPLE						NE	NE	NE	II	110 lb (50 kg)**	11
ORGANIC PEROXIDE, SOLID, SAMPLE, TEMPERATURE CONTROLLED						NE	NE	NE	II	110 lb (50 kg)**	11

(continues)

Δ TABLE B.5.3.1 *Continued*

Organic Peroxide Formulation	Concentration	Diluent[c]	Water	Recommended Maximum Temperatures[a] Control C/F	Recommended Maximum Temperatures[a] Emergency C/F	Hazard Identification NFPA 704 Ratings[b] Health	Hazard Identification NFPA 704 Ratings[b] Flammability	Hazard Identification NFPA 704 Ratings[b] Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[d]
3,3,5,7,7-PENTAMETHYL-1,2,4-TRIOXEPANE	≤ 100					2	2	2	II	60 gal (225 L)	
PEROXYACETIC ACID, TYPE D, stabilized	≤ 43					NE	NE	3	II	16 gal (60 L)	13, 14, 19
PEROXYACETIC ACID, TYPE E, stabilized	≤ 43					NE	NE	2	III	60 gal (225 L)	13, 15, 19
PEROXYACETIC ACID, TYPE F, stabilized	≤ 43					NE	NE	1	IV	IBC tank	13, 16, 19
PEROXYLAURIC ACID	≤ 100			35/95	40/104	NE	NE	2	II	440 lb (200 kg)	
PINANYL HYDROPEROXIDE	> 56–100					NE	NE	3	II	16 gal (60 L)	13
PINANYL HYDROPEROXIDE	≤ 56	A ≥ 44				NE	NE	1	III	IBC tank	
POLYETHER POLY-*t*-BUTYLPEROXYCARBONATE	≤ 52	B ≥ 48				NE	4	2	II	60 gal (225 L)	
1,1,3,3-TETRAMETHYLBUTYL HYDROPEROXIDE	≤ 100					3	2	3	II	16 gal (60 L)	
1,1,3,3-TETRAMETHYLBUTYL PEROXY-2 ETHYL-HEXANOATE	≤ 100			15/59	20/68	NE	3	3	II	16 gal (60 L)	
1,1,3,3-TETRAMETHYLBUTYL PEROXYNEODECANOATE	≤ 72	B ≥ 28		–5/23	5/41	1	3	3	II	16 gal (60 L)	
1,1,3,3-TETRAMETHYLBUTYL PEROXYNEODECANOATE	≤ 52 as a stable dispersion in water			–5/23	5/41	1	3	1	III	IBC tank	
1,1,3,3-TETRAMETHYLBUTYL PEROXYPIVALATE	≤ 77	A ≥ 23		0/32	10/50	2	4	3	II	16 gal (60 L)	
3,6,9-TRIETHYL-3,6,9-TRIMETHYL-1,4,7 TRIPEROXONANE	≤ 42	A ≥ 58				2	2	3	II	16 gal (60 L)	28

**Depending on package used for tests.

[a]These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. (See 49 CFR 173.225 for more information.)

[b]The column refers to NFPA 704 hazard ratings for health, flammability, and instability. *(See NFPA 704 for more information.)*

[c]Diluents Type A — are organic liquids which are compatible with the organic peroxide and which have a boiling point of not less than 150°C. Type A diluents may be used for desensitizing all organic peroxides.

Diluents Type B — are organic liquids which are compatible with the organic peroxide and which have a boiling point of less than 150°C but not less than 60°C and a flash point of not less than 5°C. Type B diluents may be used for desensitizing of all organic peroxides providing that the boiling point is at least 60°C higher than the SADT in a 50 kg package.

[d]See Table F.7 of NFPA 400.

[e]See NFPA 30 for additional storage requirements.

T[f] — Temperature control should be considered to reduce fire hazard depending on packaging size and recommendations in manufacturers' literature.

[**400:**Table F.1]

B.5.3.2 Class I Formulations.

B.5.3.2.1 Fire Hazard Characteristics. Class I formulations present a deflagration hazard through easily initiated, rapid explosive decomposition. Large-scale burn rates ≥300 kg/min can be expected. Class I includes some formulations that are relatively safe only under closely controlled temperatures. Either excessively high or low temperatures can increase the potential for severe explosive decomposition and/or rapid burning. [**400:** F.2.1]

B.5.3.2.2 Fire-Fighting Information. The immediate area should be evacuated and the fire should be fought from a remote location. Some damage to structures from overpressure can be expected should a deflagration occur. [**400:** F.2.2]

Δ **B.5.3.2.3 Typical Class I Formulations.** See Table B.5.3.2.3. [**400:** F.2.3]

Δ ***TABLE B.5.3.2.3*** *Typical Class I Formulations*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[b]					
Organic Peroxide Formulation	**Concentration**	**Diluent[c]**	**Water**	**Control C/F**	**Emergency C/F**	**Health**	**Flammability**	**Instability**	**Storage Class**	**Max Container Size**	**Subsidiary Risks and Remarks[d]**
ACETYL CYCLOHEXANE-SULPHONYL PEROXIDE	≤ 82		≥ 12	−10/14	0/32	3	NE	4	I	55 lb (25 kg)**	3
t-AMYL PEROXY ISOPROPYL CARBONATE	≤ 77	A ≥ 23				NE	2	3	I	16 gal (60 L)**	
t-AMYLPEROXY-3,5,5-TRIMETHYLHEXANOATE	≤ 100					2	2	4	I	16 gal (60 L)	
t-BUTYL HYDROPEROXIDE[d]	> 79–90		≥ 10			3	3	3	I	16 gal (60 L)	13
t-BUTYL HYDROPEROXIDE + DI-*t*-BUTYLPEROXIDE	< 82 + >9		≥ 7			3	4	3	I	16 gal (60 L)**	13
t-BUTYL MONOPEROXYMALEATE	> 52–100					3	2	4	I	55 lb (25 kg)**	3
t-BUTYL PEROXYACETATE	> 52–77	A ≥ 23				2	2	4	I	8 gal (30 L)**	3
t-BUTYL PEROXYDIETHYLACETATE	≤ 100			20/68	25/77	3	2	3	I	16 gal (60 L)**	
t-BUTYL PEROXYISOBUTYRATE	> 52–77	B ≥ 23		15/59	20/68	1	2	4	I	8 gal (30 L)**	3
t-BUTYL PEROXY-2-METHYLBENZOATE	≤ 100					3	4	3	I	16 gal (60 L)**	
3-CHLOROPEROXYBENZOIC ACID	> 57–86	Inert solid ≥ 14				NE	NE	4	I	55 lb (25 kg)**	3
CUMYL PEROXYNEODECANOATE	≤ 87	A ≥ 13		−10/14	0/32	1	3	3	I	16 gal (60 L)	
CYCLOHEXANONE PEROXIDE(S)	≤ 91		≥ 9			3	NE	3	I	110 lb (50 kg)**	13
2,2-DI-(*t*-AMYLPEROXY)BUTANE	≤ 57	A ≥ 43				1	3	3	I	16 gal (60 L)	
1,1-DI-(*t*-AMYLPEROXY) CYCLOHEXANE	≤ 82	A ≥ 18				1	2	3	I	16 gal (60 L)**	
DIBENZOYL PEROXIDE	> 51–100	Inert solid ≥ 48				2	4	4	I	55 lb (25 kg)**	3
DIBENZOYL PEROXIDE	> 77–94		≥ 6			2	4	4	I	55 lb (25 kg)**	3
DI-(4–*t*-BUTYLCYCLOHEXYL) PEROXYDICARBONATE	≤ 100			30/86	35/95	1	2	3	I	110 lb (50 kg)**	
1,6-DI-(*t*-BUTYLPEROXY CARBONYLOXY) HEXANE	≤ 72	A ≥ 28				NE	NE	3	I	16 gal (60 L)**	
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	> 80–100					1	2	4	I	8 gal (30 L)**	3
DI-*sec*-BUTYL PEROXYDICARBONATE	> 52–100			−20/−4	−10/14	1	4	3	I	16 gal (60 L)**	
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	> 90–100					1	2	4	I	8 gal (30 L)**	3
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 90	B ≥ 10				1	2	4	I	16 gal (60 L)**	30

(continues)

△ *TABLE B.5.3.2.3 Continued*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[b]					
				Control	Emergency						
Organic Peroxide Formulation	Concentration	Diluent[c]	Water	C/F	C/F	Health	Flammability	Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[d]
DI-4-CHLOROBENZOYL PEROXIDE	≤ 77		≥ 23			NE	NE	4	I	55 lb (25 kg)**	3
DICYCLOHEXYL PEROXY-DICARBONATE	> 91–100			10/50	15/59	NE	NE	4	I	55 lb (25 kg)**	3
DI-2,4-DICHLOROBENZOYL PEROXIDE	≤ 77		≥ 23			1	NE	4	I	55 lb (25 kg)**	3
DI-(2-ETHOXYETHYL) PEROXYDICARBONATE	≤ 52	B ≥ 48		−10/14	0/32	NE	NE	3	I	16 gal (60 L)	
2,2-DIHYDROPEROXYPROPANE	≤ 27	Inert solid ≥ 73				NE	NE	4	I	55 lb (25 kg)**	3
DIISOBUTYRYL PEROXIDE	> 32–52	B ≥ 48		−20/−4	−10/14	3	4	4	I	8 gal (30 L)**	3
DIISOPROPYL PEROXYDICARBONATE	> 52–100			−15/5	−5/23	3	4	4	I	55 lb (25 kg)**	3
DI-(3-METHOXYBUTYL) PEROXYDICARBONATE	≤ 52	B ≥ 48		−5/23	5/41	NE	NE	3	I	16 gal (60 L)	
DI-(2-METHYLBENZOYL) PEROXIDE	≤ 87		≥ 13	30/86	35/95	3	NE	4	I	55 lb (25 kg)**	3
2,5-DIMETHYL-2,5-DI-(BENZOYL-PEROXY)HEXANE	> 82–100					1	2	4	I	55 lb (25 kg)**	3
2,5-DIMETHYL-2,5-DI-(*t*-BUTYL-PEROXY) HEXYNE-3	> 86–100					1	2	4	I	8 gal (30 L)**	3
DI-(2-PHENOXYETHYL) PEROXY-DICARBONATE	> 85–100					1	NE	4	I	55 lb (25 kg)	3
DI-*n*-PROPYL PEROXY-DICARBONATE	≤ 100			−25/−13	−15/5	2	4	3	I	16 gal (60 L)**	
DI-*n*-PROPYL PEROXY-DICARBONATE	≤ 77	B ≥ 23		−20/−4	−10/14	2	4	3	I	16 gal (60 L)**	
DISUCCINIC ACID PEROXIDE	> 72–100					3	NE	4	I	55 lb (25 kg)**	3, 17
ISOPROPYL *sec*-BUTYL PEROXYDICARBONATE + DI-*sec*-BUTYL PEROXYDICARBONATE + DI-ISOPROPYL PEROXYDICARBONATE	≤ 52 + ≤ 28 + ≤ 22			−20/−4	−10/14	2	4	4	I	8 gal (30 L)**	3
METHYL ETHYL KETONE PEROXIDE(S)	See remark 8	A ≥ 48				3	NE	4	I	8 gal (30 L)**	3, 8, 13

** Depending on package used for tests.

[a]These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. *(See 49 CFR 173.225 for more information.)*

[b]The column refers to NFPA 704 hazard ratings for health, flammability, and instability. *(See NFPA 704 for more information.)*

[c]See Table F.7 of NFPA 400.

[d]See NFPA 30 for additional storage requirements.

[**400:**Table F.2.3]

B.5.3.3 Class II Formulations.

B.5.3.3.1 Fire Hazard Characteristics. Class II formulations present a severe fire hazard similar to Class I flammable liquids. The decomposition is not as rapid or violent as that produced by Class I organic peroxide formulations. As with Class I formulations, this class includes some formulations that are relatively safe when under controlled temperatures or when diluted. Many of the formulations in this class might require controlled temperature or might contain diluents to maintain their safety and stability. [**400:**F.3.1]

B.5.3.3.2 Fire-Fighting Information. Fires should be fought from a safe distance, because a hazard exists from rupturing containers. [**400:** F.3.2]

△ **B.5.3.3.3 Typical Class II Formulations.** See Table B.5.3.3.3. [**400:** F.3.3]

△ ***TABLE B.5.3.3.3*** *Typical Class II Formulations*

Organic Peroxide Formulation	Concentration	Diluent[c]	Water	Recommended Maximum Temperatures[a] Control C/F	Emergency C/F	Hazard Identification NFPA 704 Ratings[†b] Health	Flammability	Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[c]
ACETYL ACETONE PEROXIDE	≤ 42	A > 48%	≥8			2	1	3	II	16 gal (60 L)	2
t-AMYL HYDROPEROXIDE	≤ 88	A ≥ 6	≥ 6			3	2	2	II	60 gal (225 L)	
t-AMYL PEROXYACETATE	≤ 62	A ≥ 38				3	2	3	II	16 gal (60 L)	
t-AMYL PEROXYBENZOATE	≤ 100					2	2	3	II	16 gal (60 L)	
t-AMYL PEROXY-2-ETHYLHEXANOATE	≤ 100			20/68	25/77	2	2	3	II	16 gal (60 L)	
t-AMYL PEROXY-2-ETHYLHEXYL CARBONATE	≤ 100					1	2	3	II	16 gal (60 L)	
t-AMYL PEROXY-NEODECANOATE	≤ 77	B ≥ 23		0/32	10/50	1	2	3	II	16 gal (60 L)	
t-AMYL PEROXYPIVALATE	≤ 77	B ≥ 23		10/50	15/59	2	2	3	II	16 gal (60 L)**	
t-BUTYL CUMYL PEROXIDE	> 42–100					2	2	2	II	60 gal (225 L)	
t-BUTYL CUMYL PEROXIDE	≤ 52	Inert solid ≥ 48				2	NE	2	II	440 lb (200 kg)	
n-BUTYL-4,4-DI-(*t*-BUTYLPEROXY)VALERATE	> 52–100					1	2	3	II	16 gal (60 L)**	
t-BUTYL HYDROPEROXIDE	≤ 80	A ≥ 20				3	NE	3	II	16 gal (60 L)	4, 13
t-BUTYL HYDROPEROXIDE[d]	≤ 79		> 14			3	NE	2	II	60 gal (225 L)	13, 23
t-BUTYL MONOPEROXY-MALEATE	≤ 52	A ≥ 48				3	NE	3	II	16 gal (60 L)**	
t-BUTYL MONOPEROXY-MALEATE	≤ 52	Inert solid ≥ 48				3	NE	2	II	440 lb (200 kg)	
t-BUTYL MONOPEROXY-MALEATE	≤ 52 as a paste					3	2	2	II	440 lb (200 kg)	
t-BUTYL PEROXYACETATE	> 32–52	A ≥ 48				2	2	3	II	16 gal (60 L)**	
t-BUTYL PEROXYBENZOATE	> 77–100					2	1	3	II	16 gal (60 L)**	
t-BUTYL PEROXYBENZOATE	> 52–77	A ≥ 23				2	2	3	II	16 gal (60 L)	
t-BUTYL PEROXYBENZOATE	≤ 52	Inert solid ≥ 48				2	NE	3	II	110 lb (50 kg)	
t-BUTYL PEROXYBUTYL FUMARATE	≤ 52	A ≥ 48				NE	NE	3	II	16 gal (60 L)	
t-BUTYL PEROXYCROTONATE	≤ 77	A ≥ 23				2	2	3	II	16 gal (60 L)	
t-BUTYL PEROXY-2-ETHYLHEXANOATE	> 52–100			20/68	25/77	1	2	3	II	16 gal (60 L)**	
t-BUTYL PEROXY-2-ETHYLHEXANOATE	> 32–52	B ≥ 48		30/86	35/95	1	2	2	II	60 gal (225 L)	
t-BUTYL PEROXY-2-ETHYLHEXANOATE	≤ 52	Inert solid ≥ 48		20/68	25/77	1	NE	2	II	440 lb (200 kg)	
t-BUTYL PEROXY-2-ETHYLHEXANOATE + 2,2-DI-(*t*-BUTYLPEROXY) BUTANE	≤ 12 + ≤ 14	A ≥ 14; Inert solid ≥ 60				1	NE	3	II	110 lb (50 kg)	
t-BUTYL PEROXY-2-ETHYLHEXANOATE + 2,2-DI-(*t*-BUTYLPEROXY) BUTANE	≤ 31 + ≤ 36	B ≥ 33		35/95	40/104	1	NE	3	II	16 gal (60 L)	

(continues)

△ *TABLE B.5.3.3.3 Continued*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[†b]					
				Control	Emergency						
Organic Peroxide Formulation	Concentration	Diluent[c]	Water	C/F	C/F	Health	Flammability	Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[c]
t-BUTYL PEROXY-2-ETHYL-HEXYLCARBONATE	≤ 100					1	1	3	II	16 gal (60 L)	
t-BUTYL PEROXY-ISOBUTYRATE	≤ 52	B ≥ 48		15/59	20/68	1	3	3	II	16 gal (60 L)	
t-BUTYLPEROXY ISOPROPYL-CARBONATE	≤ 77	A ≥ 23				2	2	3	II	16 gal (60 L)**	
1-(2-*t*-BUTYLPEROXY ISOPROPYL)-3-ISOPROPENYLBENZENE	≤ 77	A ≥ 23				NE	NE	3	II	16 gal (60 L)	
1-(2-*t*-BUTYLPEROXY ISOPROPYL)-3-ISOPROPENYLBENZENE	≤ 42	Inert solid ≥ 58				NE	NE	2	II	440 lb (200 kg)	
t-BUTYL PEROXY-NEODECANOATE	> 77–100			–5/23	5/41	2	3	3	II	16 gal (60 L)	
t-BUTYL PEROXY-NEODECANOATE	≤ 77	B ≥ 23		0/32	10/50	2	2	3	II	16 gal (60 L)	
t-BUTYL PEROXY-NEOHEPTANOATE	≤ 77	A ≥ 23		0/32	10/50	1	2	3	II	16 gal (60 L)	
t-BUTYL PEROXYPIVALATE	> 67–77	A ≥ 23		0/32	10/50	2	2	3	II	16 gal (60 L)**	
t-BUTYL PEROXYPIVALATE	> 27–67	B • ≥ • 33		0/32	10/50	2	2	3	II	16 gal (60 L)	
t-BUTYLPEROXY STEARYLCARBONATE	≤ 100					NE	NE	3	II	110 lb (50 kg)	
t-BUTYL PEROXY-3,5,5-TRIMETHYLHEXANOATE	> 32–100					2	1	3	II	16 gal (60 L)	
t-BUTYL PEROXY-3,5,5-TRIMETHYLHEXANOATE	≤ 42	Inert solid ≥ 58				1	2	1	II	110 lb (50 kg)	
3-CHLOROPEROXYBENZOIC ACID	≤ 57	Inert solid ≥ 3	≥ 40			NE	NE	3	II	110 lb (50 kg)	
3-CHLOROPEROXYBENZOIC ACID	≤ 77	Inert solid ≥ 6	≥ 17			NE	NE	3	II	110 lb (50 kg)	
CUMYL PEROXY-NEODECANOATE	≤ 77	B ≥ 23		–10/14	0/32	1	3	3	II	16 gal (60 L)	
CUMYL PEROXY-NEOHEPTANOATE	≤ 77	A ≥ 23		–10/14	0/32	1	3	3	II	16 gal (60 L)	
CUMYL PEROXYPIVALATE	≤ 77	B ≥ 23		–5/23	5/41	NE	3	3	II	16 gal (60 L)	
CYCLOHEXANONE PEROXIDE(S)	≤ 72	A ≥ 28				3	NE	3	II	16 gal (60 L)	5
CYCLOHEXANONE PEROXIDE(S)	≤ 72 as a paste					3	NE	3	II	110 lb (50 kg)	5, 20
DIACETONE ALCOHOL PEROXIDES	≤ 57	B ≥ 26	≥ 8	40/104	45/113	NE	NE	3	II	16 gal (60 L)	6
DIACETYL PEROXIDE	≤ 27	B ≥ 73		20/68	25/77	1	2	3	II	16 gal (60 L)	7, 13
DI-*t*-AMYL PEROXIDE	≤ 100					2	4	2	II	60 gal (225 L)	
DIBENZOYL PEROXIDE	≤ 77		≥ 23			2	2	3	II	110 lb (50 kg)**	
DIBENZOYL PEROXIDE	≤ 62	Inert solid ≥ 28	≥ 10	T[e]		2	NE	3	II	110 lb (50 kg)	
DIBENZOYL PEROXIDE	> 52–62 as a paste			T[e]		2	2	3	II	110 lb (50 kg)	20
DIBENZOYL PEROXIDE	> 35–52	Inert solid ≥ 48				2	2	3	II	110 lb (50 kg)	
DIBENZOYL PEROXIDE	> 36–42	A ≥ 18	≥ 40	T[e]		2	2	2	II	60 gal (225 L)	
DIBENZOYL PEROXIDE	≤ 56.5 as a paste		≥ 15	T[e]		2	2	2	II	440 lb (200 kg)	
DIBENZOYL PEROXIDE	≤ 52 as a paste			T[e]		2	2	2	II	440 lb (200 kg)	20

Δ *TABLE B.5.3.3.3 Continued*

Organic Peroxide Formulation	Concentration	Diluent[c]	Water	Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[†b]			Storage Class	Max Container Size	Subsidiary Risks and Remarks[c]
				Control C/F	Emergency C/F	Health	Flammability	Instability			
DI-*t*-BUTYL PEROXIDE[d]	> 52–100					1	4	2	II	60 gal (225 L)	
DI-*t*-BUTYL PEROXYAZELATE	≤ 52	A ≥ 48				NE	2	3	II	16 gal (60 L)	
2,2-DI-(*t*-BUTYLPEROXY) BUTANE	≤ 52	A ≥ 48				1	2	3	II	16 gal (60 L)	
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	≤ 72	B ≥ 28				1	2	3	II	16 gal (60 L)**	30
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	> 52–80	A ≥ 20				1	2	3	II	16 gal (60 L)**	
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	> 42– 52	A ≥ 48				1	2	3	II	16 gal (60 L)	
1,1-DI-(*t*-BUTYLPEROXY)-CYCLOHEXANE + *t*-BUTYL PEROXY-2-ETHYL-HEXANOATE	≤ 43 + ≤ 16	A ≥ 41				1	2	3	II	16 gal (60 L)	
DI-*n*-BUTYL PEROXY-DICARBONATE	> 27–52	B ≥ 48		−15/5	−5/23	1	NE	3	II	16 gal (60 L)	
DI-*sec*-BUTYL PEROXY-DICARBONATE	≤ 52	B ≥ 48		−15/5	−5/23	1	4	3	II	16 gal (60 L)	
DI-(*t*-BUTYLPEROXY-ISOPROPYL) BENZENE(S)	> 42–100	Inert solid ≥ 57				1	1	3	II	110 lb (50 kg)	
DI-(*t*-BUTYLPEROXY) PHTHALATE	> 42–52	A ≥ 48				NE	2	3	II	16 gal (60 L)	
DI-(*t*-BUTYLPEROXY) PHTHALATE	≤ 52 as a paste					NE	NE	3	II	110 lb (50 kg)	20
DI-(*t*-BUTYLPEROXY) PHTHALATE	≤ 42	A ≥ 58				NE	1	2	II	60 gal (225 L)	
2,2-DI-(*t*-BUTYLPEROXY) PROPANE	≤ 52	A ≥ 48				NE	2	3	II	16 gal (60 L)	
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	> 57–90	A ≥ 10				1	2	3	II	16 gal (60 L)**	
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 77	B ≥ 23				1	NE	3	II	16 gal (60 L)**	
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 57	A ≥ 43				1	NE	2	II	60 gal (225 L)	
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 32	A ≥ 26; B ≥ 42				1	4	2	II	60 gal (225 L)	
DICETYL PEROXY-DICARBONATE	≤ 100			30/86	35/95	1	2	3	II	110 lb (50 kg)	
DI-4-CHLOROBENZOYL PEROXIDE	≤ 52 as a paste					NE	NE	3	II	110 lb (50 kg)	20
DICYCLOHEXYL PEROXY-DICARBONATE	≤ 91		≥ 9	10/50	15/59	NE	NE	3	II	110 lb (50 kg)**	
DIDECANOYL PEROXIDE	≤ 100			30/86	35/95	1	NE	3	II	110 lb (50 kg)**	
DI-2,4-DICHLOROBENZOYL PEROXIDE	≤ 52 as a paste			20/68	25/77	1	2	2	II	440 lb (200 kg)	
DI-2,4-DICHLOROBENZOYL PEROXIDE	≤ 52 as a paste with silicon oil			T[e]		1	2	3	II	110 lb (50 kg)	
DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	> 77–100			−20/−4	−10/14	2	4	3	II	16 gal (60 L)**	
DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	≤ 77	B ≥ 23		−15/5	−5/23	2	4	3	II	16 gal (60 L)	

(continues)

Δ ***TABLE B.5.3.3.3*** *Continued*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[†b]					
				Control	Emergency						
Organic Peroxide Formulation	**Concentration**	**Diluent[c]**	**Water**	**C/F**	**C/F**	**Health**	**Flammability**	**Instability**	**Storage Class**	**Max Container Size**	**Subsidiary Risks and Remarks[c]**
DI-(1-HYDROXYCYCLOHEXYL) PEROXIDE	≤ 100					NE	NE	3	II	110 lb (50 kg)	
DIISOBUTYRYL PEROXIDE	≤ 32	B ≥ 68		−20/−4	−10/14	3	NE	3	II	16 gal (60 L)	
DIISOPROPYLBENZENE DIHYDROPEROXIDE	≤ 82	A ≥ 5	≥ 5			NE	NE	3	II	110 lb (50 kg)	24
DIISOPROPYL PEROXY-DICARBONATE	≤ 52	B ≥ 48		−20/−4	−10/14	3	NE	3	II	16 gal (60 L)	
DIISOPROPYL PEROXY-DICARBONATE	≤ 28	A ≥ 72		−15/5	−5/23	2	NE	3	II	16 gal (60 L)	
DILAUROYL PEROXIDE	≤ 100					1	2	3	II	110 lb (50 kg)	
DI-(3-METHYLBENZOYL) PEROXIDE + BENZOYL (3-METHYLBENZOYL) PEROXIDE + DIBENZOYL PEROXIDE	≤ 20 + ≤ 18 + ≤ 4	B ≥ 58		35/95	40/104	NE	NE	3	II	16 gal (60 L)	
DI-(4-METHYLBENZOYL) PEROXIDE	≤ 52 as a paste with silicon oil					NE	NE	3	II	110 lb (50 kg)	
2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE	≤ 82	Inert solid ≥ 18				1	NE	3	II	110 lb (50 kg)	
2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE	≤ 82		≥ 18			1	NE	3	II	110 lb (50 kg)**	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXANE	> 90–100					2	2	3	II	16 gal (60 L)**	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXANE	> 52–90	A ≥ 10				2	2	3	II	16 gal (60 L)	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXANE	≤ 77	Inert solid ≥ 23				2	2	1	II	440 lb (200 kg)	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXANE	≤ 47 as a paste					2	1	2	II	440 lb (200 kg)	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXYNE-3	> 52–86	A ≥ 14				1	2	3	II	16 gal (60 L)**	26
2,5-DIMETHYL-2,5-DI-(2-ETHYLHEXANOYLPEROXY) HEXANE	≤ 100			20/68	25/77	2	2	3	II	16 gal (60 L)**	
2,5-DIMETHYL-2,5-DIHYDROPEROXYHEXANE	≤ 82		≥ 18			3	2	3	II	110 lb (50 kg)**	
2,5-DIMETHYL-2,5-DI-(3,5,5-TRIMETHYLHEXANOYL-PEROXY)HEXANE	≤ 77	A ≥ 23				NE	NE	3	II	16 gal (60 L)	
1,1-DIMETHYL-3-HYDROXYBUTYL PEROXYNEOHEPTANOATE	≤ 52	A ≥ 48		0/32	10/50	NE	2	2	II	60 gal (225 L)	
DIMYRISTYL PEROXY-DICARBONATE	≤ 100			20/68	25/77	1	NE	3	II	110 lb (50 kg)	
DI-(2-NEODECANOYLPEROXY ISOPROPYL) BENZENE	≤ 52	A ≥ 48		−10/14	0/32	NE	NE	3	II	16 gal (60 L)	
DI-n-NONANOYL PEROXIDE	≤ 100			0/32	10/50	NE	NE	3	II	110 lb (50 kg)	
DI-n-OCTANOYL PEROXIDE	≤ 100			10/50	15/59	1	NE	3	II	110 lb (50 kg)**	
DI-(2-PHENOXYETHYL) PEROXYDICARBONATE	≤ 85		≥ 15			1	NE	3	II	110 lb (50 kg)	
DISUCCINIC ACID PEROXIDE	≤ 72		≥ 28	10/50	15/59	3	NE	3	II	110 lb (50 kg)	

△ ***TABLE B.5.3.3.3*** *Continued*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[†b]					
				Control	Emer-gency						
Organic Peroxide Formulation	Concen-tration	Diluent[c]	Water	C/F	C/F	Health	Flamma-bility	Insta-bility	Storage Class	Max Container Size	Subsidiary Risks and Remarks[c]
DI-(3,5,5-TRIMETHYL-HEXANOYL) PEROXIDE	> 38-82	A ≥ 18		0/32	10/50	2	2	3	II	16 gal (60 L)	
ETHYL 3,3-DI-(*t*-AMYLPEROXY) BUTYRATE	≤ 67	A ≥ 33				NE	2	3	II	16 gal (60 L)	
ETHYL 3,3-DI-(*t*-BUTYLPEROXY) BUTYRATE	> 77–100					1	1	3	II	16 gal (60 L)**	
ETHYL 3,3-DI-(*t*-BUTYLPEROXY) BUTYRATE	≤ 77	A ≥ 23				1	2	3	II	16 gal (60 L)	
ETHYL 3,3-DI-(*t*-BUTYLPEROXY) BUTYRATE	≤ 52	Inert solid ≥ 48				1	NE	3	II	110 lb (50 kg)	
1-(2-ETHYLHEXANOYLPEROXY)-1,3-DIMETHYLBUTYL PEROXYPIVALATE	≤ 52	A ≥ 45; B ≥ 10		–20/–4	–10/14	2	NE	3	II	16 gal (60 L)	
t-HEXYL PEROXY-NEODECANOATE	≤ 71	A ≥ 29		0/32	10/50	1	NE	3	II	16 gal (60 L)	
t-HEXYL PEROXYPIVALATE	≤ 72	B ≥ 28		10/50	15/59	NE	NE	3	II	16 gal (60 L)	
3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	≤ 77	A ≥ 23		–5/23	5/41	NE	3	3	II	16 gal (60 L)	
3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	≤ 52	A ≥ 48		–5/23	5/41	NE	3	2	II	60 gal (225 L)	
ISOPROPYL *sec*-BUTYL PEROXYDICARBONATE + DI-*sec*-BUTYL PEROXY-DICARBONATE + DI-ISOPROPYL PEROXYDICARBONATE	≤ 32 + ≤ 15–18 ≤ 12–15	A ≥ 38		–20/–4	–10/14	2	NE	3	II	16 gal (60 L)	
p-MENTHYL HYDROPEROXIDE	> 72–100					3	2	3	II	16 gal (60 L)	13
METHYLCYCLOHEXANONE PEROXIDE(S)	≤ 67	B ≥ 33		35/95	40/104	NE	NE	3	II	16 gal (60 L)	
METHYL ETHYL KETONE PEROXIDE(S)	See remark 9	A ≥ 55				3	2	3	II	16 gal (60 L)	9
METHYL ETHYL KETONE PEROXIDE(S)	See remark 10	A ≥ 60				3	2	2	II	60 gal (225 L)	10
METHYL ISOBUTYL KETONE PEROXIDE(S)	≤ 62	A ≥ 19				NE	2	3	II	16 gal (60 L)	22
ORGANIC PEROXIDE, LIQUID, SAMPLE						NE	NE	NE	II	16 gal (60 L)**	11
ORGANIC PEROXIDE, LIQUID, SAMPLE, TEMPERATURE CONTROLLED						NE	NE	NE	II	16 gal (60 L)**	11
ORGANIC PEROXIDE, SOLID, SAMPLE,						NE	NE	NE	II	110 lb (50 kg)**	11
ORGANIC PEROXIDE, SOLID, SAMPLE, TEMPERATURE CONTROLLED						NE	NE	NE	II	110 lb (50 kg)**	11
3,3,5,7,7-PENTAMETHYL-1,2,4-TRIOXEPANE	≤ 100					2	2	2	II	60 gal (225 L)	
PEROXYACETIC ACID, TYPE D, stabilized	≤ 43					NE	NE	3	II	16 gal (60 L)	13, 14, 19
PEROXYLAURIC ACID	≤ 100			35/95	40/104	NE	NE	2	II	440 lb (200 kg)	
PINANYL HYDROPEROXIDE	> 56–100					NE	NE	3	II	16 gal (60 L)	13

(continues)

Δ *TABLE B.5.3.3.3 Continued*

Organic Peroxide Formulation	Concen-tration	Diluent[c]	Water	Recommended Maximum Temperatures[a] Control C/F	Emer-gency C/F	Hazard Identification NFPA 704 Ratings[†b] Health	Flamma-bility	Insta-bility	Storage Class	Max Container Size	Subsidiary Risks and Remarks[c]
POLYETHER POLY-*t*-BUTYLPEROXYCARBONATE	≤ 52	B ≥ 48				NE	4	2	II	60 gal (225 L)	
1,1,3,3-TETRAMETHYLBUTYL HYDROPEROXIDE	≤ 100					3	2	3	II	16 gal (60 L)	
1,1,3,3-TETRAMETHYLBUTYL PEROXY-2 ETHYL-HEXANOATE	≤ 100			15/59	20/68	NE	3	3	II	16 gal (60 L)	
1,1,3,3-TETRAMETHYLBUTYL PEROXYNEODECANOATE	≤ 72	B ≥ 28		–5/23	5/41	1	3	3	II	16 gal (60 L)	
1,1,3,3-TETRAMETHYLBUTYL PEROXYPIVALATE	≤ 77	A ≥ 23		0/32	10/50	2	4	3	II	16 gal (60 L)	
3,6,9-TRIETHYL-3,6,9-TRIMETHYL-1,4,7 TRIPEROXONANE	≤ 42	A ≥ 58				2	2	3	II	16 gal (60 L)	28

[a]These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. *(See 49 CFR 173.225 for more information.)*

[b]The column refers to NFPA 704 hazard ratings for health, flammability, and instability. *(See NFPA 704 for more information.)*

[c]See Table F.7 of NFPA 400.

[d]See NFPA 30 for additional storage requirements.

[e]T — Temperature control should be considered to reduce fire hazard depending on packaging size and recommendations in manufacturers' literature.

[**400:**Table F.3.3]

B.5.3.4 Class III Formulations.

B.5.3.4.1 Fire Hazard Characteristics. Class III formulations present a fire hazard similar to Class II combustible liquids. They are characterized by rapid burning and high heat liberation due to decomposition. Large-scale burn rates of <60 kg/min but ≥10 kg/min are expected for these organic peroxide formulations. These organic peroxides are typically less reactive or contain much higher levels of diluent than the Class I and Class II formulations. [**400:**F.4.1]

B.5.3.4.2 Fire-Fighting Information. Caution should be observed due to possible unexpected increases in fire intensity. [**400:** F.4.2]

Δ **B.5.3.4.3 Typical Class III Formulations.** See Table B.5.3.4.3. [**400:** F.4.3]

B.5.3.5 Class IV Formulations.

B.5.3.5.1 Fire Hazard Characteristics. Class IV formulations present fire hazards that are easily controlled. Reactivity has little effect on fire intensity. Large-scale burn rates of these organic peroxide formulations are <10 kg/min. [**400:** F.5.1]

B.5.3.5.2 Fire-Fighting Information. Normal fire-fighting procedures can be used. [**400:** F.5.2]

Δ **B.5.3.5.3 Typical Class IV Formulations.** See Table B.5.3.5.3. [**400:** F.5.3]

B.5.3.6 Class V Formulations.

B.5.3.6.1 Fire Hazard Characteristics. Class V formulations do not present severe fire hazards. Those that do burn do so with less intensity than ordinary combustibles. [**400:** F.6.1]

B.5.3.6.2 Fire-Fighting Information. Fire-fighting procedures need primarily consider the combustibility of containers. [**400:** F.6.2]

Δ **B.5.3.6.3 Typical Class V Formulations.** See Table B.5.3.6.3. [**400:** F.6.3]

△ ***TABLE B.5.3.4.3*** *Typical Class III Formulations*

Organic Peroxide Formulation	Concentration	Diluent[c]	Water	Recommended Maximum Temperatures[a] Control C/F	Recommended Maximum Temperatures[a] Emergency C/F	Hazard Identification NFPA 704 Ratings[b] Health	Hazard Identification NFPA 704 Ratings[b] Flammability	Hazard Identification NFPA 704 Ratings[b] Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[c]
ACETYL ACETONE PEROXIDE	≤ 32 as a paste					2	NE	3	III	110 lb (50 kg)	20
ACETYL CYCLOHEXANE-SULPHONYL PEROXIDE	≤ 32	B ≥ 68		−10/14	0/32	3	4	3	III	16 gal (60 L)	
t-AMYL PEROXYNEODECANOATE	≤ 47	A ≥ 53		0/32	10/50	1	2	1	III	IBC tank	
n-BUTYL-4,4-DI-(*t*-BUTYLPEROXY)VALERATE	≤ 52	Inert solid ≥ 48				1	NE	2	III	440 lb (200 kg)	
t-BUTYL HYDROPEROXIDE[d]	≤ 72		≥ 28			3	2	1	III	IBC type/tank truck	13, 32
t-BUTYL PEROXYACETATE	≤ 32	B ≥ 68				2	2	1	III	IBC tank	
t-BUTYL PEROXY-2-ETHYL-HEXANOATE	≤ 32	B ≥ 68		40/104	45/113	1	2	1	III	IBC tank	
t-BUTYL PEROXY-NEODECANOATE	≤ 32	A ≥ 68		0/32	10/50	2	NE	1	III	IBC tank	
t-BUTYL PEROXYPIVALATE	≤ 27	B ≥ 73		30/86	35/95	2	2	1	III	IBC tank	
t-BUTYL PEROXY-3,5,5-TRIMETHYLHEXANOATE	≤ 32	B ≥ 68				2	2	1	III	IBC tank	
CUMYL HYDROPEROXIDE	> 90–98	A ≥ 10				3	1	2	III	60 gal (225 L)	13
CUMYL HYDROPEROXIDE	≤ 90	A ≥ 10				3	2	1	III	IBC tank	13, 18
CUMYL PEROXY-NEODECANOATE	≤ 52 as a stable dispersion in≈water			−10/14	0/32	1	NE	1	III	IBC tank	
DIBENZOYL PEROXIDE	≤ 42 as a stable dispersion in water					2	2	1	III	IBC tank	
DI-*t*-BUTYL PEROXIDE	≤ 52	B ≥ 48				1	4	1	III	IBC tank	25
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	≤ 42	A ≥ 13	≥ 45			1	NE	3	III	110 lb (50 kg)	
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	≤ 42	A ≥ 58				1	2	1	III	IBC tank	
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	≤ 27	A ≥ 25				1	1	2	III	60 gal (225 L)	21
1,1-DI-(*t*-BUTYLPEROXY) CYCLOHEXANE	≤ 13	A ≥ 13; B ≥ 74				1	NE	1	III	IBC tank	
DI-n-BUTYL PEROXY-DICARBONATE	≤ 27	B ≥ 73		−10/14	0/32	1	NE	2	III	60 gal (225 L)	
2,2-DI-(*t*-BUTYLPEROXY) PROPANE	≤ 42	A ≥ 13; Inert solid ≥ 45				NE	NE	3	III	110 lb (50 kg)	
1,1-DI-(*t*-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 57	Inert solid ≥ 43				1	2	1	III	IBC tank	
DICUMYL PEROXIDE	> 52–100					1	1	1	III	IBC tank	12
2,2-DI-(4,4-DI (*t*-BUTYLPEROXY) CYCLOHEXYL) PROPANE	≤ 42	Inert solid ≥ 58				1	NE	3	III	110 lb (50 kg)	
2,2-DI-(4,4-DI (*t*-BUTYLPEROXY) CYCLOHEXYL) PROPANE	≤ 22	B ≥ 78				1	NE	2	III	60 gal (225 L)	

(continues)

△ *TABLE B.5.3.4.3 Continued*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[b]					
				Control	Emergency						
Organic Peroxide Formulation	Concentration	Diluent[c]	Water	C/F	C/F	Health	Flammability	Instability	Storage Class	Max Container Size	Subsidiary Risks and Remarks[c]
DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	≤ 62 as a stable dispersion in water			−15/5	−5/23	2	NE	2	III	IBC tank	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXANE	≤ 52	A ≥ 48				2	2	1	III	IBC tank	
2,5-DIMETHYL-2,5-DI-(*t*-BUTYLPEROXY)HEXYNE-3	≤ 52	Inert solid ≥ 48				1	NE	3	III	110 lb (50 kg)	
DIPROPIONYL PEROXIDE	≤ 27	B ≥ 73		15/59	20/68	NE	NE	2	III	60 gal (225 L)	
DI-(3,5,5-TRIMETHYL-HEXANOYL) PEROXIDE	≤ 52 as a stable dispersion in water			10/50	15/59	2	2	1	III	IBC tank	
DI-(3,5,5-TRIMETHYL-HEXANOYL) PEROXIDE	≤ 38	A ≥ 62		20/68	25/77	2	NE	1	III	IBC tank	
ISOPROPYLCUMYL HYDROPEROXIDE	≤ 72	A ≥ 28				3	2	1	III	IBC tank	13
p-MENTHYL HYDROPEROXIDE	≤ 72	A ≥ 28				3	2	1	III	IBC tank	27
METHYL ISOPROPYL KETONE PEROXIDE(S)	See remark 31	A ≥ 70				NE	NE	1	III	IBC tank	31
PEROXYACETIC ACID, TYPE E, STABILIZED	≤ 43					NE	NE	2	III	60 gal (225 L)	13, 15, 19
PINANYL HYDROPEROXIDE	≤ 56	A ≥ 44				NE	NE	1	III	IBC tank	
1,1,3,3-TETRAMETHYLBUTYL PEROXYNEODECANOATE	≤ 52 as a stable dispersion in water			−5/23	5/41	1	3	1	III	IBC tank	

[a]These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. *(See 49 CFR 173.225 for more information.)*

[b]The column refers to NFPA 704 hazard ratings for health, flammability, and instability. *(See NFPA 704 for more information.)*

[c]See Table F.7 of NFPA 400.

[d]See NFPA 30 for additional storage requirements.

[**400:**Table F.4.3]

Δ *TABLE B.5.3.5.3 Typical Class IV Formulations*

Organic Peroxide Formulation	Concen-tration	Diluent	Water	Recommended Maximum Temperatures[a] Control C/F	Emer-gency C/F	Hazard Identification NFPA 704 Ratings[b] Health	Flamma-bility	Insta-bility	Storage Class	Max Container Size	Subsidiary Risks and Remarks[c]
t-BUTYL PEROXYNEODECANOATE	≤ 52 as a stable dispersion in water			0/32	10/50	2	NE	1	IV	IBC tank	
t-BUTYL PEROXYNEODECANOATE	≤ 42 as a stable dispersion in water (frozen)			0/32	10/50	2	NE	2	IV	440 lb (200 kg)	
t-BUTYL PEROXYNEOHEPTANOATE	≤ 42 as a stable dispersion in water			0/32	10/50	1	NE	2	IV	60 gal (225 L)	
DI-(4-*t*-BUTYLCYCLOHEXYL) PEROXYDICARBONATE	≤ 42 as a stable dispersion in water			30/86	35/95	1	2	1	IV	IBC tank	
DI-*n*-BUTYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water (frozen)			−15/5	−5/23	1	NE	2	IV	440 lb (200 kg)	
DICETYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water			30/86	35/95	1	2	1	IV	IBC tank	
DICYCLOHEXYL PEROXY-DICARBONATE	≤ 42 as a stable dispersion in water			15/59	20/68	NE	NE	1	IV	IBC tank	
DI-(2-ETHYLHEXYL) PEROXY-DICARBONATE	≤ 52 as a stable dispersion in water (frozen)			−15/5	−5/23	2	NE	1	IV	IBC tank	
DILAUROYL PEROXIDE	≤ 42 as a stable dispersion in water					1	NE	1	IV	IBC tank	
DIMYRISTYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water			20/68	25/77	1	NE	1	IV	IBC tank	
3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	≤ 52 as a stable dispersion in water			−5/23	5/41	NE	3	1	IV	IBC tank	
PEROXYACETIC ACID, TYPE F, STABILIZED	≤ 43					NE	NE	1	IV	IBC tank	13, 16, 19

[a]These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. *(See 49 CFR 173.225 for more information.)*

[b]The column refers to NFPA 704 hazard ratings for health, flammability, and instability. *(See NFPA 704 for more information.)*

[c]See Table F.7 of NFPA 400.

[**400:**Table F.5.3]

△ ***TABLE B.5.3.6.3*** *Typical Class V Formulations*

				Recommended Maximum Temperatures[a]		Hazard Identification NFPA 704 Ratings[b]					
				Control	Emergency						
Organic Peroxide Formulation	**Concentration**	**Diluent**	**Water**	**C/F**	**C/F**	**Health**	**Flammability**	**Instability**	**Storage Class**	**Max Container Size**	**Subsidiary Risks and Remarks[c]**
CYCLOHEXANONE PEROXIDE(S)	≤ 32	Inert solid ≥ 68				3	NE	0	V	Exempt	29
DIBENZOYL PEROXIDE	≤ 35	Inert solid ≥ 65				2	2	0	V	Exempt	29
DI-(*t*-BUTYLPEROXYISOPROPYL) BENZENE(S)	≤ 42	Inert solid ≥ 58				1	1	0	V	Exempt	29
DI-4-CHLOROBENZOYL PEROXIDE	≤ 32	Inert solid ≥ 68				NE	NE	0	V	Exempt	29
DICUMYL PEROXIDE	≤ 52	Inert solid ≥ 48				1	NE	0	V	Exempt	29

[a]These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. *(See 49 CFR 173.225 for more information.)*

[b]The column refers to NFPA 704 hazard ratings for health, flammability, and instability. *(See NFPA 704 for more information.)*

[c]See Table F.7 of NFPA 400.

[**400:**Table F.6.3]

Sample Ordinance Adopting the NFPA 1, *Fire Code*

C

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1

The following sample ordinance is provided to assist a jurisdiction in the adoption of this *Code* and is not part of this *Code*.

ORDINANCE NO. ____________________

An ordinance of the *[jurisdiction]* adopting the *[year]* edition of NFPA 1, *Fire Code*, 2015 edition; and documents listed in Chapter 2 of that *Code*; prescribing regulations governing conditions hazardous to life and property from fire or explosion; providing for the issuance of permits and collection of fees; repealing Ordinance No. _______ of the [jurisdiction] and all other ordinances and parts of ordinances in conflict therewith; providing a penalty; providing a severability clause; and providing for publication; and providing an effective date.

BE IT ORDAINED BY THE *[governing body]* **OF THE** *[jurisdiction]*:

SECTION 1 That the NFPA 1, *Fire Code*, 2015 edition, and documents adopted by Chapter 2, three (3) copies of which are on file and are open to inspection by the public in the office of the *[jurisdiction's keeper of records]* of the *[jurisdiction]*, are hereby adopted and incorporated into this ordinance as fully as if set out at length herein, and from the date on which this ordinance shall take effect, the provisions thereof shall be controlling within the limits of the *[jurisdiction]*. The same are hereby adopted as the *Code* of the *[jurisdiction]* for the purpose of prescribing regulations governing conditions hazardous to life and property from fire or explosion and providing for issuance of permits and collection of fees.

SECTION 2 Any person who shall violate any provision of this code or standard hereby adopted or fail to comply therewith; or who shall violate or fail to comply with any order made thereunder; or who shall build in violation of any detailed statement of specifications or plans submitted and approved thereunder; or fail to operate in accordance with any certificate or permit issued thereunder; and from which no appeal has been taken; or who shall fail to comply with such an order as affirmed or modified by a court of competent jurisdiction, within the time fixed herein, shall severally for each and every such violation and noncompliance, respectively, be guilty of a misdemeanor, punishable by a fine of not less than $ _____ nor more than $_____ or by imprisonment for not less than ______ days nor more than ______ days or by both such fine and imprisonment. The imposition of one penalty for any violation shall not excuse the violation or permit it to continue; and all such persons shall be required to correct or remedy such violations or defects within a reasonable time; and when not otherwise specified the application of the above penalty shall not be held to prevent the enforced removal of prohibited conditions. Each day that prohibited conditions are maintained shall constitute a separate offense.

SECTION 3 Additions, insertions, and changes — that the [year] edition of NFPA 1, *Fire Code*, 2015 edition, is amended and changed in the following respects:

[List Amendments]

SECTION 4 That ordinance No. _________ of *[jurisdiction]* entitled *[fill in the title of the ordinance or ordinances in effect at the present time]* and all other ordinances or parts of ordinances in conflict herewith are hereby repealed.

SECTION 5 That if any section, subsection, sentence, clause, or phrase of this ordinance is, for any reason, held to be invalid or unconstitutional, such decision shall not affect the validity or constitutionality of the remaining portions of this ordinance. The *[governing body]* hereby declares that it would have passed this ordinance, and each section, subsection, clause, or phrase hereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses, and phrases be declared unconstitutional.

SECTION 6 That the *[jurisdiction's keeper of records]* is hereby ordered and directed to cause this ordinance to be published.

[NOTE: An additional provision may be required to direct the number of times the ordinance is to be published and to specify that it is to be in a newspaper in general circulation. Posting may also be required.]

SECTION 7 That this ordinance and the rules, regulations, provisions, requirements, orders, and matters established and adopted hereby shall take effect and be in full force and effect *[time period]* from and after the date of its final passage and adoption.

Hazardous Materials Management Plans and Hazardous Materials Inventory Statements

D

This annex is not a part of the requirements of this NFPA document unless specifically adopted by the AHJ.

D.1 Scope

Hazardous materials inventory statements (HMIS) and hazardous materials management plans (HMMP), which are required by the AHJ pursuant to Chapter 60, shall be provided for hazardous materials in accordance with Annex D.

Exception No. 1: Materials that have been satisfactorily demonstrated not to present a potential danger to public health, safety, or welfare, based upon the quantity or condition of storage, when approved.

Exception No. 2: Chromium, copper, lead, nickel, and silver need not be considered hazardous materials for the purposes of this annex unless they are stored in a friable, powdered, or finely divided state. Proprietary and trade secret information shall be protected under the laws of the state or AHJ.

A hazardous materials inventory statement (HMIS) and a hazardous materials management plan (HMMP) are optional tools for the authority having jurisdiction (AHJ). An operator or user of hazardous materials should contact the AHJ to determine whether and when an HMIS and an HMMP are needed. Requirements for the proper use of an HMMP and provisions that are found in a typical HMMP are located in 60.1.6 and Section 60.5. Annex D provides information and a number of sample forms for an HMMP of a typical facility.

Any modification to the forms, time frames, or thresholds found in this annex should be documented before the HMIS or HMMP is prepared. The AHJ should provide the needed information on how to submit the information, to whom it is to be submitted, and what approval form will be provided to the user to confirm that the HMIS or HMMP was accepted by the AHJ.

D.2 Hazardous Materials Inventory Statements (HMIS)

The purpose of an HMIS is to provide the AHJ with comprehensive documentation of the hazardous materials present in a facility. The HMIS allows emergency personnel to respond to an incident appropriately, based on the types and quantities of hazardous materials involved.

D.2.1 When Required. A separate HMIS shall be provided for each building, including its appurtenant structures, and each exterior facility in which hazardous materials are stored. The hazardous materials inventory statement shall list by hazard class all hazardous materials stored. The hazardous materials inventory statement shall include the following information for each hazardous material listed:

(1) Hazard class.
(2) Common or trade name.
(3) Chemical name, major constituents, and concentrations if a mixture. If a waste, the waste category.
(4) Chemical Abstract Service number (CAS number) found in 29 Code of Federal Regulations (CFR).
(5) Whether the material is pure or a mixture, and whether the material is a solid, liquid, or gas.
(6) Maximum aggregate quantity stored at any one time.
(7) Storage conditions related to the storage type, temperature, and pressure.

D.2.2 Changes to HMIS. An amended HMIS shall be provided within 30 days of the storage of any hazardous materials that changes or adds a hazard class or that is sufficient in quantity to cause an increase in the quantity that exceeds 5 percent for any hazard class.

If an HMIS has been developed, both the facility and the AHJ must be prepared to revisit and update the HMIS and HMMP whenever changes are identified that would impact either or both. The ongoing review should include the amount, type, use, or storage of hazardous materials, but the review is not limited simply to quantities for those purposes. If, for example, modifications in facility operating schedules have occurred, such as changing staffing at the facility from a 24-hour, 7-day operation to an 8 a.m. to 5 p.m. operation, 5 days a week, a different warning protection feature might be needed, and the plan would need to reflect other related items that might be affected.

D.3 Hazardous Materials Management Plan (HMMP)

The purpose of an HMMP is to provide specific information on hazardous materials and to specify uses and storage arrangements, as well as incident responses within the facility. The HMMP serves as a key component of the pre-plan for the site. When an HMMP is provided, it must be reviewed, and input should be provided from all impacted parties that would be requested to respond to an incident at the facility. The impacted parties should review their roles in responding to an incident. Training programs and site information should be reviewed and updated as modifications occur or if changes in key participants are modified.

The AHJ has the discretion to decide whether an HMMP is required. Many AHJs use the permit threshold to determine if an HMMP is required. See 1.12.8 for permit thresholds. Others might use an HMMP when the maximum allowable quantities (MAQs) are exceeded. Both of these conditions for imposing an HMMP are local issues and should be reviewed with an understanding of the capabilities of the local emergency responders and resources of the community. Some communities use the type of facility and not the amount of hazardous material (storage quantities only versus use and storage quantities) as a trigger for the HMMP. Annex D was designed to provide information on how to complete an HMMP, not when to invoke the requirement for an HMMP.

D.3.1 General. Applications for a permit to store hazardous materials shall include an HMMP standard form or short form in accordance with Section D.3 and shall provide a narrative description of the operations and processes taking place at the facility. *(See Figure D.3.1.)*

D.3.2 Information Required. The HMMP standard form shall include the information in D.3.2.1 through D.3.2.9.

D.3.2.1 General Information. General information, including business name and address, emergency contacts, business activity, business owner or operator, SIC code, number of employees and hours, Dunn and Bradstreet number, and signature of owner, operator, or designated representative.

D.3.2.2 General Site Plan. A general site plan drawn at a legible scale that shall include, but not be limited to, the location of buildings, exterior storage facilities, permanent access ways, evacuation routes, parking lots, internal roads, chemical loading areas, equipment cleaning areas, storm and sanitary sewer accesses, emergency equipment, and adjacent property uses. The exterior storage areas shall be identified with the hazard class and the maximum quantities per hazard class of hazardous materials stored. When required by the AHJ, information regarding the location of wells, flood plains, earthquake faults, surface water bodies, and general land uses within 1 mile (1.6 km) of the facility boundaries shall be included.

D.3.2.3 Building Floor Plan. A building floor plan drawn to a legible scale that shall include, but not be limited to, hazardous materials storage areas within the building and shall indicate rooms, doorways, corridors, means of egress, and evacuation routes. Each hazardous materials storage facility shall be identified by a map key that lists the individual hazardous materials, their hazard class, and quantity present for each area.

D.3.2.4 Hazardous Materials Handling. Information showing that activities involving the handling of hazardous materials between the storage areas and manufacturing processes on site are conducted in a manner to prevent the accidental release of such materials.

D.3.2.5 Chemical Compatibility and Separation. Information showing procedures, controls, signs, or other methods used to ensure separation and protection of stored materials from factors that could cause accidental ignition or reaction of ignitable, reactive, or incompatible materials in each area.

D.3.2.6 Monitoring Program. Information including, but not limited to, the location, type, manufacturer's specifications, if applicable, and suitability of monitoring methods for each storage facility when required.

D.3.2.7 Inspection and Record Keeping. Schedules and procedures for inspecting safety and monitoring and emergency equipment. The permittee shall develop and follow a written inspection procedure acceptable to the AHJ for inspecting the facility for events or practices that could lead to unauthorized discharges of hazardous materials. Inspections shall be conducted at a frequency appropriate to detect problems prior to a discharge. An inspection check sheet shall be developed to be used in conjunction with routine inspections. The check sheet shall provide for the date, time, and location of inspection; note problems and dates and times of corrective actions taken; and include the name of the inspector and the countersignature of the designated safety manager for the facility.

D.3.2.8 Employee Training. A training program appropriate to the types and quantities of materials stored or used shall be conducted to prepare employees to safely handle hazardous materials on a daily basis and during emergencies. The training program shall include the following:

(1) Instruction in safe storage and handling of hazardous materials, including maintenance of monitoring records
(2) Instruction in emergency procedures for leaks, spills, fires, or explosions, including shutdown of operations and evacuation procedures
(3) Record-keeping procedures for documenting training given to employees

D.3.2.9 Emergency Response. A description of facility emergency procedures is to be provided.

D.3.3 HMMP Short Form — Minimal Storage Site. A facility shall qualify as a minimal storage site if the quantity of each hazardous material stored in one or more facilities in an aggregate quantity for the facility is 500 lb (227 kg) or less for solids, 55 gal (208.2 L) or less for liquids, or 200 ft^3 (5.7 m^3) or less at NTP for

SAMPLE FORMAT
HAZARDOUS MATERIALS MANAGEMENT PLAN (HMMP) INSTRUCTIONS

SECTION I — FACILITY DESCRIPTION

1.1 Part A

1. Fill out Items 1 through 11 and sign the declaration.
2. Only Part A of this section is required to be updated and submitted annually, or within 30 days of a change.

1.2 Part B—General Facility Description (Site Plan)

1. Provide a site plan on 8½ in. by 11 in. (215 mm by 279 mm) paper, using letters on the top and bottom margins and numbers on the right and left side margins, showing the location of all buildings, structures, chemical loading areas, parking lots, internal roads, storm and sanitary sewers, wells, and adjacent property uses. Indicate the approximate scale, northern direction and date the drawing was completed.
2. List all special land uses within 1 mile (1.609 km).

1.3 Part C—Facility Storage Map (Confidential Information)

1. Provide a floor plan of each building on 8½ in. by 11 in. (215 mm by 279 mm) paper, using letters on the top and bottom margins and numbers on the right and left side margins, with approximate scale and northern direction, showing the location of each storage area. Mark map clearly "Confidential — Do Not Disclose" for trade-secret information as specified by federal, state, and local laws.
2. Identify each storage area with an identification number, letter, name, or symbol.
3. Show the following:
   - (a) Accesses to each storage area.
   - (b) Location of emergency equipment.
   - (c) The general purpose of other areas within the facility.
   - (d) Location of all aboveground and underground tanks to include sumps, vaults, belowgrade treatment systems, piping, etc.
4. **Map key.** Provide the following on the map or in a map key or legend for each storage area:
   - (a) A list of hazardous materials, including wastes.
   - (b) Hazard class of each hazardous waste.
   - (c) The maximum quantity for hazardous materials.
   - (d) Include the contents and capacity limit of all tanks at each area and indicate whether they are above or below ground.
   - (e) List separately any radioactives, cryogens, and compressed gases for each facility.
   - (f) Trade-secret information shall be listed as specified by federal, state, and local laws.

SECTION II — HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS)

2.1 Part A—Declaration

Fill out all appropriate information.

2.2 Part B—Inventory Statement

1. You must complete a separate inventory statement for all waste and nonwaste hazardous materials. List all hazardous materials in alphabetical order by hazard class.
2. Inventory Statement Instructions.

Column	Information Required
1	Provide hazard class for each material.
2	**Nonwaste.** Provide the common or trade name of the regulated material. **Waste.** In lieu of trade names, you may provide the waste category.
3	Provide the chemical name and major constituents and concentrations, if a mixture.
4	Enter the chemical abstract service number (CAS number) found in 29 CFR. For mixtures, enter the CAS number of the mixture as a whole if it has been assigned a number distinct from its constituents. For a mixture that has no CAS number, leave this item blank or report the CAS numbers of as many constituent chemicals as possible.
5	Enter the following descriptive codes as they apply to each material. You may list more than one code, if applicable. P = Pure M = Mixture S = Solid L = Liquid G = Gas
6	Provide the maximum aggregate quantity of each material handled at any one time by the business. For underground tanks, list the maximum volume [in gallons (liters)] of the tank. Enter the estimated average daily amount on site during the past year.
7	Enter the units used in Column 6 as: Lb = Pounds Ga = Gallons Cf = Cubic Feet
8	Enter the number of days that the material was present on site (during the last year).

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Δ ***FIGURE D.3.1*** *Sample Format of Hazardous Materials Management Plan (HMMP) Instructions.*

Column	Information Required
9	Enter the storage codes below for type, temperature, and pressure:

Type

A = Aboveground Tank
B = Belowground Tank
C = Tank Inside Building
D = Steel Drum
E = Plastic or Nonmetallic Drum
F = Can
G = Carboy
H = Silo
I = Fiber Drum
J = Bag
K = Box
L = Cylinder
M = Glass Bottle or Jug
N = Plastic Bottles or Jugs
O = Tote Bin
P = Tank Wagon
Q = Rail Car
R = Other

Temperature

4 = Ambient
5 = Greater than Ambient
6 = Less than Ambient, but not Cryogenic [less than –150°F (–101.1°C)]
7 = Cryogenic conditions [less than –150°F (–101.1°C)]

Pressure

1 = Ambient (Atmospheric)
2 = Greater than Ambient (Atmospheric)
3 = Less than Ambient (Atmospheric)

10 For each material listed, provide the SARA Title III hazard class as listed below. You may list more than one class. These categories are defined in 40 CFR 370.3.

Physical Hazard

F = Fire
P = Sudden Release of Pressure
R = Reactivity

Health Hazard

I = Immediate (Acute)
D = Delayed (Chronic)

11 **Waste Only.** For each waste, provide the total estimated amount of hazardous waste handled throughout the course of the year.

SECTION III — SEPARATION AND MONITORING

3.1 Part A — Aboveground

Fill out Items 1 through 6, or provide similar information for each storage area shown on the facility map. Use additional sheets as necessary.

3.2 Part B — Underground

1. Complete a separate page for each underground tank, sump, vault, belowgrade treatment system, etc.
2. Check the type of tank and method(s) that applies to your tank(s) and piping, and answer the appropriate questions. Provide any additional information in the space provided or on a separate sheet.

SECTION IV — WASTE DISPOSAL

Check all that apply and list the associated wastes for each method checked.

SECTION V — RECORD KEEPING

Include a brief description of your inspection procedures. You are also required to keep an inspection log and recordable discharge log, which are designed to be used in conjunction with routine inspections for all storage facilities or areas. Place a check in each box that describes your forms. If you do not use the sample forms, provide copies of your forms for review and approval.

SECTION VI — EMERGENCY RESPONSE PLAN

1. This plan should describe the personnel, procedures, and equipment available for responding to a release or threatened release of hazardous materials that are stored, handled, or used on site.
2. A check or a response under each item indicates that a specific procedure is followed at the facility, or that the equipment specified is maintained on site.
3. If the facility maintains a more detailed emergency response plan on site, indicate this in Item 5. This plan shall be made available for review by the inspecting jurisdiction.

SECTION VII — EMERGENCY RESPONSE TRAINING PLAN

1. This plan should describe the basic training plan used at the facility.
2. A check in the appropriate box indicates the training is provided or the records are maintained.
3. If the facility maintains a more detailed emergency response training plan, indicate this in Item 4. This plan shall be made available for review by the inspecting jurisdiction.

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Δ ***FIGURE D.3.1*** *Continued*

HAZARDOUS MATERIALS MANAGEMENT PLAN
SECTION I: FACILITY DESCRIPTION

Part A — General Information

1. Business Name: ______________________ Phone: ______________
   Address: ____
2. Person Responsible for the Business:

Name	Title	Phone

3. Emergency Contacts:

Name	Title	Home Number	Work Number

4. Person Responsible for the Application/Principal Contact:

Name	Title	Phone

5. Property Owner:

Name	Address	Phone

6. Principal Business Activity: ______________________
7. Number of Employees: ______________________
8. Number of Shifts: ______________________
9. Hours of Operation: ______________________
10. SIC Code: ______________________
11. Dunn and Bradstreet Number: ______________________
12. Declaration:
    I certify that the information above and on the following parts is true and correct to the best of my knowledge.

    Signature: ______________________ Date: ______________

    Print Name: ______________________ Title: ______________

    (Must be signed by owner/operator or designated representative)

Part B — General Facility Description/Site Plan

(Use grid format in Part C)

Special land uses within 1 mile (1.609 km): ______________________

____

____

____

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Δ ***FIGURE D.3.1*** *Continued*

SECTION I: FACILITY DESCRIPTION (Continued)

Part C — Facility Map

(Use grid format below)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	
1															1
2															2
3															3
4															4
5															5
6															6
7															7
8															8
9															9
10															10
11															11
12															12
13															13
14															14
15															15
16															16
17															17
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	

BUSINESS NAME		DATE
ADDRESS	CITY	PAGE ______ OF ______

SECTION II: HAZARDOUS MATERIALS INVENTORY STATEMENT

Part A — Declaration

1. Business Name: ______________________________
2. Address: ______________________________
3. Declaration:
   Under penalty of perjury, I declare the above and subsequent information, provided as part of the hazardous materials inventory statement, is true and correct.

   Signature: ______________________ Date: ______________________

   Print Name: ______________________ Title: ______________________

   (Must be signed by owner / operator or designated representative)

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Δ ***FIGURE D.3.1*** *Continued*

SECTION II: HAZARDOUS MATERIALS INVENTORY STATEMENT (Continued)

Part B — Hazardous Materials Inventory Statement

(1) Hazard Class	(2) Common/ Trade Name	(3) Chemical Name, Components, and Concentration	(4) Chemical Abstract Service No.	(5) Physical State

(6) Maximum Quantity on Hand at Any Time	(7) Units	(8) Days on Site	(9) Storage Code (Type, Pressure, Temperature)	(10) SARA Class	(11) Annual Waste Throughput

SECTION III: SEPARATION, SECONDARY CONTAINMENT, AND MONITORING

Part A — Aboveground Storage Areas

Storage Area Identification (as shown on facility map): ____________________

1. Storage Type:
   _____ Original Containers
   _____ Inside Machinery
   _____ 55 gal (208.2 L) Drums or Storage Shed
   _____ Pressurized Vessel
   _____ Safety Cans
   _____ Bulk Tanks
   _____ Outside Barrels
   _____ Other: ____________________

2. Storage Location:
   _____ Inside Building
   _____ Secured
   _____ Outside Building

3. Separation:
   _____ All Materials
   _____ Compatible
   _____ Separation by 20 ft (6.1 m)
   _____ One-Hour Separation Wall/Partition
   _____ Approved Cabinets
   _____ Other: ____________________

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Δ ***FIGURE D.3.1*** *Continued*

SECTION III: SEPARATION, SECONDARY CONTAINMENT, AND MONITORING *(Continued)*

4. Secondary Containment:
   _____ Approved Cabinet
   _____ Tray
   _____ Vaulted Tank
   _____ Double-Wall Tank
   _____ Secondary Drums
   _____ Bermed, Coated Floor
   _____ Other: ______________________________

5. Monitoring:
   _____ Visual
   _____ Continuous
   _____ Other: ______________________________
   Attach specifications if necessary

6. Monitoring Frequency:
   _____ Daily
   _____ Weekly
   _____ Other: ______________________________
   Attach additional sheets as necessary

Part B—Underground

Single-Wall Tanks and Piping

Tank Area Identification (as shown on facility map): ______________________________

1. _____ Backfill Vapor Wells
   Model and Manufacturer: ______________________________
   Continuous or Monthly Testing: ______________________________
2. _____ Groundwater Monitoring Wells
3. _____ Monthly Precision Tank Test
4. _____ Piping
   Monitoring Method: ______________________________
   Frequency: ______________________________
5. _____ Other: ______________________________

Double-Wall Tanks and Piping

Tank Area Identification (as shown on facility map): ______________________________

1. Method of monitoring the annular space: ______________________________
2. Frequency: ❑ Continuous ❑ Daily ❑ Weekly ❑ Other: ______________________________
3. List the type of secondary containment for piping: ______________________________
4. List method of monitoring the secondary containment for piping: ______________________________
5. Are there incompatible materials within the same vault? ❑ Yes ❑ No
   If yes, how is separate secondary containment provided? ______________________________

Note: If you have continuous monitoring equipment, you shall maintain copies of all service and maintenance work. Such reports shall be made available for review on site, and shall be submitted to the fire prevention bureau upon request.

Attach additional sheets as necessary.

SECTION IV: WASTE DISPOSAL

_____ Discharge to the Sanitary Sewer—
Wastes: ______________________________

_____ Pretreatment—
Wastes: ______________________________

_____ Licensed Waste Hauler—
Wastes: ______________________________

_____ Recycle—
Wastes: ______________________________

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Δ ***FIGURE D.3.1*** *Continued*

SECTION IV: WASTE DISPOSAL *(Continued)*

_____ Other—
Describe Method: ______________________________
Wastes: ______________________________

_____ No Waste

SECTION V: RECORD KEEPING

Description of our inspection program: ______________________________
____
____

_____ We will use the attached sample forms in our inspection program.
_____ We will not use the sample forms. We have attached a copy of our own forms.

SECTION VI: EMERGENCY RESPONSE PLAN

1. In the event of an emergency, the following shall be notified:
   A. On-Site Responders:

Name	Title	Phone

   B. Method of Notification to Responder:

_____ Automatic Alarm
_____ Manual Alarm
_____ Phone
_____ Verbal
_____ Other: ______________________________

   C. Agency and Phone Number: ______________________________
   Fire Department: ______________________________
   State Office of Emergency: ______________________________
   Services: ______________________________
   Other: ______________________________

2. Designated Local Emergency Medical Facility:

Name	Address	Phone (24 hours)

3. Mitigation Equipment:
   A. Monitoring Devices:
   _____ Toxic or Flammable Gas Detection
   _____ Fluid Detection
   _____ Other: ______________________________
   B. Spill Containment:
   _____ Absorbents
   _____ Other: ______________________________
   C. Spill Control and Treatment
   _____ Vapor Scrubber
   _____ Pumps/Vacuums
   _____ Neutralizer
   _____ Mechanical Ventilation
   _____ Secondary Containment
   _____ Other: ______________________________

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Δ ***FIGURE D.3.1*** *Continued*

SECTION VI: EMERGENCY RESPONSE PLAN *(Continued)*

4. Evacuation:
   ______ Immediate area evacuation routes posted
   ______ Entire building evacuation procedures developed
   ______ Assembly areas preplanned
   ______ Evacuation maps posted
   ______ Other: ______________________________

5. Supplemental hazardous materials emergency response plan on site.
   Location: ______________________________
   Responsible Person: ______________________________
   Phone: ______________________________

SECTION VII: EMERGENCY RESPONSE TRAINING PLAN

1. Person responsible for the emergency response training plan:

Name	Title	Phone
______________	______________	______________

2. Training Requirements:
   A. All employees trained in the following as indicated:
      ______ Procedures for internal alarm/notification
      ______ Procedures for notification of external emergency response organizations
      ______ Location and content of the emergency response plan
   B. Chemical handlers are trained in the following as indicated:
      ______ Safe methods for handling and storage of hazardous materials
      ______ Proper use of personal protective equipment
      ______ Locations and proper use of fire- and spill-control equipment
      ______ Specific hazards of each chemical to which they may be exposed
   C. Emergency response team members are trained in the following:
      ______ Procedures for shutdown of operations
      ______ Procedures for using, maintaining, and replacing facility emergency and monitoring equipment

3. The following records are maintained for all employees:
   ______ Verification that training was completed by the employee
   ______ Description of the type and amount of introductory and continuing training
   ______ Documentation on and description of emergency response drills conducted at the facility

4. A more comprehensive and detailed emergency response training plan is maintained on site.
   Location: ______________________________
   Responsible Person: ______________________________
   Phone: ______________________________

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Δ ***FIGURE D.3.1*** *Continued*

compressed gases and does not exceed the threshold planning quantity as listed in 40 CFR 355 Sections 302 and 304. The applicant for a permit for a facility that qualifies as a minimal storage site shall be permitted to file the short form HMMP. Such plan shall include the following components:

(1) General facility information
(2) A simple line drawing of the facility showing the location of storage facilities and indicating the hazard class or classes and physical state of the hazardous materials being stored
(3) Information describing that the hazardous materials will be stored and handled in a safe manner and will be appropriately contained, separated, and monitored
(4) Assurance that security precautions have been taken, employees have been appropriately trained to handle the hazardous materials and react to emergency situations, adequate labeling and warning signs are posted, adequate emergency equipment is maintained, and the disposal of hazardous materials will be in an appropriate manner

Subsection D.3.3 provides a short version of the HMMP so that if the local AHJ requires only limited information, this tool can be used without overburdening the facility. The thresholds listed are provided as guidelines for the use of the form but can be modified when adopted by the local AHJ.

D.4 Maintenance of Records

Hazardous materials inventory statements and hazardous materials management plans shall be maintained by the permittee for a period of not less than 3 years after submittal of updated or revised versions. Such records shall be made available to the AHJ upon request.

Fire Fighter Safety Building Marking System

E

This annex is not a part of the requirements of this NFPA document unless specifically adopted by the AHJ.

E.1 Fire Fighter Safety Building Marking System (FFSBMS)

The fire fighter safety building marking system (FFSBMS) was designed by fire service members as a tool to help responding fire fighters quickly determine certain information about a building and its occupants. Information about the building construction, sprinkler systems and standpipe systems, hazards of contents, occupants, and special hazards is placed on a single, easy-to-read sign. Note that this system does not take the place of fire department pre-fire planning.

To be adopted as part of a jurisdiction's fire code, Annex E must be specifically named in the adopting ordinance.

E.1.1 General.

E.1.1.1 The fire fighter safety building marking system provides basic building information for fire fighters responding to the building or structure.

E.1.1.2 Where required by the AHJ, buildings and structures shall have the fire fighter safety building marking system sign installed.

E.1.2 Sign.

E.1.2.1 The approved fire fighter safety building marking system sign shall be placed in a position to be plainly legible and visible from the street or road fronting the property or as approved by the fire department.

The FFSBMS sign must be placed in a location where responding fire fighters can easily see it. The authority having jurisdiction (AHJ) should consult with the fire department to determine where the sign is to be located. The fire department might require more than one sign based on its response plan for the location. At least one sign should be located near the access box to help ensure that fire fighters see it.

E.1.2.2 The fire fighter safety building marking system sign shall consist of the following:

(1) White reflective background with black letters
(2) Durable material
(3) Arabic numerals or alphabet letters
(4) Permanently affixed to the building or structure in an approved manner

The FFSBMS sign must be designed to be visible in all lighting conditions. The sign is to be permanently installed and affixed to the building. Paper or other nonpermanent signs should not be permitted.

E.1.2.3 The fire fighter safety building marking system shall be a Maltese cross as shown in Figure E.1.2.3.

E.1.2.4 The minimum size of the fire fighter safety building marking system sign and lettering shown in Figure E.1.2.4 shall

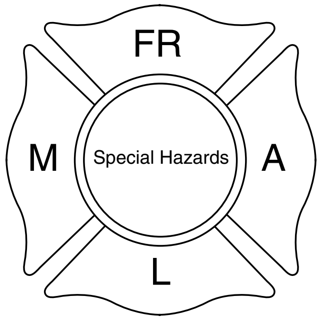

FIGURE E.1.2.3 *Sample Sign for Fire Fighter Safety Building Marking System.*

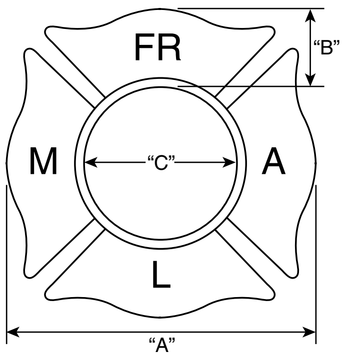

FIGURE E.1.2.4 *Dimensions for Fire Fighter Safety Building Marking System Signs.*

be in accordance with the following or as approved by the fire department:

(1) *A* shall be 5 in. × 5 in.
(2) *B* shall be 1¼ in.
(3) *C* shall be 2½ in.
(4) Letters shall be 1 in. height with a stroke of ¼ in.

The minimum sign size required by E.1.2.4 is 5 in. by 5 in. (127 mm by 127 mm). If the NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response,* marking system is to be included in the center of the sign, then the NFPA 704 sign must meet the size requirements outlined in NFPA 704. See the commentary following E.1.3.6.

E.1.3 Ratings.

E.1.3.1 Ratings shall be determined by the construction type, hazards of contents, automatic fire sprinkler systems and standpipe systems, occupancy/life safety, and special hazards in accordance with this section.

E.1.3.1.1 Where multiple ratings occur within a classification category, a determination shall be made by the AHJ of the rating that shall be based on the greatest potential risk for the specific category. *(See Note 1 in E.2.1.)*

Many buildings have numerous occupancies, construction types, or other ratings that could affect the FFSBMS. The AHJ should be consulted as to which rating to place in the appropriate hazard placeholder. An example of the greatest potential risk for construction type is where fire-resistive (FR) and noncombustible (NC) construction types are present. In that case, the suggested ranking for the FFSBMS is NC, because the risk of structural failure due to fire is greater with noncombustible construction compared to that associated with fire-resistive construction.

E.1.3.2 Construction Type. The construction type shall be designated by assigning the appropriate lettering to the top of the Maltese cross as follows:

(1) FR — Fire-resistive construction
(2) NC — Noncombustible construction
(3) ORD — Ordinary construction
(4) HT — Heavy timber construction
(5) C — Combustible construction

The construction types identified in E.1.3.2 are those used in fire fighter training programs. If the fire department prefers to use the construction types used by the building code adopted in its jurisdiction, it can easily change the designation. For a cross reference of building construction types, see Table A.12.2.

E.1.3.3 Hazards of Contents. The hazards of contents shall be rated by determining its hazard and assigning the appropriate rating to the left of the Maltese cross as follows *(see Note 2 in E.2.2)*:

L — Low hazard. Low hazard contents shall be classified as those of such low combustibility that no self-propagating fire therein can occur.

M — Moderate hazard. Moderate hazard contents shall be classified as those that are likely to burn with moderate rapidity or to give off a considerable volume of smoke.

H — High hazard. High hazard contents *(see Note 3 in E.2.3)* shall be classified as those that are likely to burn with extreme rapidity or from which explosions are likely.

The hazards of content ratings that are identified in E.1.3.3 are based on 6.2.2 NFPA *101*®, *Life Safety Code*®, as follows:

> **Low Hazard Contents.** Low hazard contents are classified as those of such low combustibility that no self-propagating fire therein can occur. Storage occupancies recognize storage of noncombustible materials as low hazard. In other occupancies, it is assumed that, even where the actual contents hazard is normally low, there is sufficient likelihood that some combustible materials or hazardous operations will be introduced in connection with building repair or maintenance, or some psychological factor might create conditions conducive to panic, so that the egress facilities cannot safely be reduced below those specified for ordinary hazard contents.
>
> **Ordinary Hazard Contents.** Ordinary hazard contents are classified as those that are likely to burn with moderate rapidity or to give off a considerable volume of smoke. Ordinary hazard classification represents the conditions found in most buildings and is the basis for the general requirements of this *Code*.
>
> The fear of poisonous fumes or explosions is necessarily a relative matter to be determined on a judgment basis. All smoke contains some toxic fire gases but, under conditions of ordinary hazard, there should be no unduly dangerous exposure during the period necessary to escape from the fire area, assuming there are proper exits.
>
> **High Hazard Contents.** High hazard contents are classified as those that are likely to burn with extreme rapidity or from which explosions are likely. High hazard contents include occupancies where flammable liquids are handled or used or are stored under conditions involving possible release of flammable vapors; where grain dust, wood flour or plastic dust, aluminum or magnesium dust, or other explosive dusts are produced; where hazardous chemicals or explosives are manufactured, stored, or handled; where materials are processed or handled under conditions producing flammable flyings; and other situations of similar hazard.

E.1.3.4 Automatic Fire Sprinkler and Standpipe System. The automatic fire sprinkler system and standpipe system shall be rated by determining its level of protection and assigning the appropriate rating to the right of the Maltese cross. If multiple systems are provided, all systems shall be included in the Maltese cross as follows:

(1) A — Automatic fire sprinkler system installed throughout
(2) P — Partial automatic fire sprinkler system or other suppression system installed
(3) S — Standpipe system installed
(4) N — None

E.1.3.5 Occupancy/Life Safety Issues. The occupancy/life safety type shall be rated by determining the level of difficulty in evacuating occupants from the building and the occupancy type by assigning the appropriate rating to the bottom of the Maltese cross as follows:

(1) L — Business, industrial, mercantile, residential, and storage occupancies
(2) M — Ambulatory health care, assembly, educational, and day care occupancies
(3) H — Detention and correction facilities, health care, and board and care occupancies

The occupancy ratings identified in E.1.3.5 are based on the number of occupants in a facility and whether the occupants are ambulatory or nonambulatory, or otherwise incapable of self-preservation, such as occupants in a detention and correctional occupancy. The rating will be higher where relatively large numbers of occupants, nonambulatory occupants, or occupants who are incapable of self-preservation are present.

E.1.3.6 Special Designations. The special hazards can be assigned to the center of the Maltese cross *(see Note 4 in E.2.4)*.

The center of the FFSBMS sign is left empty to provide space for additional information at the discretion of the local jurisdiction. The NFPA 704 marking system can be incorporated into the center of the FFSBMS sign if all the applicable provisions of NFPA 704 are met, such as lettering size.

E.1.4 Installation and Maintenance.

E.1.4.1 Fire departments that implement the fire fighter safety building marking system (FFSBMS) shall provide written instructions to the owner/operator of a facility equipped with a fire fighter safety building marking system sign regarding the information to be included on the sign, and the fire department shall perform annual inspections to verify continued compliance with the information shown on the sign *(see Note 5 in E.2.5)*.

The intent of E.1.4.1 is to verify on a regular basis that the information on the FFSBMS sign is correct. Fire departments responding to facilities equipped with an FFSBMS sign should verify signage and pre-plans annually. Other means of verifying the information on the sign could include mailings, use of outside consultants, and community service programs.

E.1.4.2 Installation and maintenance of the sign shall be the responsibility of the owner/operator.

E.1.4.3 The fire department shall enact procedures to identify changes of occupancy that could establish a need to update information on the sign and shall notify the owner/operator when changes are necessary.

The fire department should provide written procedures to building owners that establish when ratings on the FFSBMS need to be changed, such as in the case of a change of occupancy classification, which requires review by the AHJ in accordance with 1.7.12.5.

E.1.5 Training.

E.1.5.1 Training shall be provided to all fire department personnel responding to buildings using the FFSBMS sign.

E.2 Notes

The following notes are explanatory and are not part of the mandatory text for Annex E.

E.2.1 Note 1. An example of the greatest potential risk for construction type where an FR and an NC are present, the ranking on the FFSBMS sign would be NC.

E.2.2 Note 2. Hazard of contents are described as follows:

Low hazard recognizes storage of noncombustible materials as low hazard. In other occupancies it is assumed that, even where the actual contents hazard is normally low, there is sufficient likelihood that some combustible materials or hazardous operations will be introduced in connection with building repair or maintenance, or some psychological factor might create conditions conducive to panic, so that the egress facilities cannot safely be reduced below those specified for ordinary hazard contents.

Moderate hazard classification represents the conditions found in most buildings and is the basis for the general requirements of this *Code*.

The fear of poisonous fumes or explosions is necessarily a relative matter to be determined on a judgment basis. All smoke contains some toxic fire gases but, under conditions of moderate hazard, there should be no unduly dangerous exposure during the period necessary to escape from the fire area, assuming there are proper exits.

E.2.3 Note 3. High hazard contents include occupancies where flammable liquids are handled or used or are stored under conditions involving possible release of flammable vapors; where grain dust, wood flour or plastic dust, aluminum or magnesium dust, or other explosive dusts are produced; where hazardous chemicals or explosives are manufactured, stored, or handled; where cotton or other combustible fibers are processed or handled under conditions producing flammable flyings; and other situations of similar hazard.

E.2.4 Note 4. The center of the fire fighter safety building marking system sign has been left empty to permit the local jurisdiction space to provide for additional information that they may wish to add. The NFPA 704 marking system can be incorporated into the center of the fire fighter safety building marking system sign if all the applicable provisions of NFPA 704 are met including lettering size and so forth.

E.2.5 Note 5. The intent of this provision is to verify that the information on the FFSBMS sign is correct on a regular basis. Fire departments responding to facilities equipped with a FFSBMS sign should verify signage and preplans annually. Other means of verifying the information on the FFSBMS sign could include mailings, outside consultants, and community service programs.

References Cited in Commentary

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F

Fire Fighter Breathing-Air Replenishment Systems

N *This annex is not a part of the requirements of this NFPA document unless specifically adopted by the AHJ.*

N F.1 General

Where required by the AHJ, fire fighter breathing-air replenishment systems shall comply with Appendix F of the *Uniform Plumbing Code*.

Annex F is new to the 2018 edition of the *Code*. It provides the necessary guidance for those jurisdictions using fire fighter air replenishment systems. It should be noted that these systems are not mandated by the *Code* and that this annex is included solely to provide assistance to those authorities having jurisdiction (AHJs) that need to enforce fire fighter breathing-air replenishment system regulations in their jurisdictions.

G Informational References

△ G.1 Referenced Publications

The documents or portions thereof listed in this annex are referenced within the informational sections of this code and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

△ **G.1.1 NFPA Publications.** National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

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NFPA 52, *Vehicular Natural Gas Fuel Systems Code*, 2016 edition.
NFPA 54, *National Fuel Gas Code*, 2018 edition.
NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2016 edition.
NFPA 58, *Liquefied Petroleum Gas Code*, 2017 edition.
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NFPA 92, *Standard for Smoke Control Systems*, 2015 edition.
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G.2 References for Extracts

The following documents are listed here to provide reference information, including title and edition, for extracts given throughout the nonmandatory sections of this code as indicated by a reference in brackets [ ] following a section or paragraph. These documents are not a part of the requirements of this document unless also listed in Chapter 2 for other reasons.

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NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.
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NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildland Fire*, 2018 edition.
NFPA 1730, *Standard on Organization and Deployment of Fire Prevention Inspection and Code Enforcement, Plan Review, Investigation, and Public Education Operations*, 2016 edition.
NFPA 5000®, *Building Construction and Safety Code*®, 2018 edition.

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