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VENTILATION - AIR-CONDITIONING

DESIGN STANDARDS

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CONTENT

Foreword

TCVN 5687:2010 replaces TCVN 5687:1992.

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Ventilation – air conditioning – Design standards

1. Scope

1.1 This standard applies to the design and installation of ventilation - air conditioning systems for residential buildings, public buildings and industrial buildings.

1.2 This standard does not apply to the following types of work and system:

- Ventilation - air conditioning systems for shelters; for works containing and using radioactive, combustible materials, with ion emitters; for mines;

- Systems specialized for heating, cooling and dust disposing, technology device and electrical equipment systems, compressed air transportation systems;

- Central heating system using steam or hot water.

NOTE: For special cases that require heating, the air conditioning system shall undertake this function by method of hot air heating or local heating using gas heating panels, electric heating panels, underfloor heating grid, etc, and shall comply with the requirements specified in relevant standards.

1.3 When designing and installing the systems mentioned above, it is also necessary to ensure the requirements of other current standards related.

2. Normative references

The following normative references are of great importance when applying this standard. For document with year of publication, apply the stated edition. For document without year of publication, the latest edition, include its amendment (if have), shall be applied

TCVN 2622:1995 *Fire protection of buildings. Design requirements.*

TCVN 3254:1989, *Fire protection. General safety requirements*

TCVN 3288:1979, *Ventilation systems. General safety requirements.*

TCVN 5279:1990, *Fire and explosion safety. Combustible dusts. General requirements*

TCVN 5937:2005, *Air quality. Ambient air quality standards*

TCVN 5938:2005, *Air quality. Maximum allowable concentration of hazardous substances in ambient air.*

TCVN 5939:2005, *Air quality. Industrial emission standards. Inorganic substances and dusts*

TCVN 5940:2005, *Air quality. Industrial emission standards. Organic substances*

TCXDVN 175:2005[*)], *Maximum permitted noise levels for public buildings. Design standard*

TCXD 232:1999[*)], *Ventilating, air-conditioning and cooling system. Manufacture, installation and acceptance*

QCXDVN 02:2008/BXD, *Vietnam Building Code. Natural Physical & Climatic Data for Construction. Part 1.*

QCXDVN 05:2008/BXD, *Vietnam Building Code. Dwellings and Public Buildings. Occupational Health and Safety.*

QCXDVN 09:2005, Energy Efficiency Building Code

Labour sanitary standard on permitted concentration limit of hazardous substannces in working air of production workshops – published by Ministry of Health in 2002.

3. General regulations

3.1 When designing ventilating, air-conditioning systems should consider the application of technological solutions and architecture structural solutions to ensure:

a) Microclimate conditions and the cleanlines of the standard working environment of rooms in residential buildings, public buildings and administrative-activity rooms in industrial buildings (hereinafter referred to as the administrative-activity buildings) – according to Annex A, Annex F, Annex G and TCVN 5937:2005

b) Microclimate conditions and the cleanlines of the standard working environment of industrial buildings, laboratories, storage spaces in all types of buildings mentioned above – according to Annex A, Annex D and Annex G

c) Standard noise and vibration from ventilating-air conditioning equipments and systems, except for emergency ventilation system and smoke exhaust systems – according to TCXD 175:2005;

d) Conditions for approaching to repair ventilating – air conditioning systems;

[*)] These standards shall be transferred into TCVN or QCVN

e) Fire safety and explosion safety of ventilation – air conditioning systems – according to TCVN 3254:1989 and TCVN 5279-90;

f) Energy savings during employing and operating processes – according to QCXDVN 09:2005.

Number of staff in charge of operating the ventilation – air conditioning systems must be specifed in the designing plan.

3.2 When designing the refurbishment and the equipment reinstallation for industrial buildings, public buildings and administrative-activity buildings, it is necessary to ultilize the ventilation - air conditioning systems that are already available on economic-technical ground if they meet the standard's requirements.

3.3 Ventilation-air conditioning equipments, duct lines installed in rooms with corrosive environment, or used for transportation of corrosive agents shall be made of anti-corrosion materials or shall be coated with antirust paint.

3.4 In order to avoid the ignition of air, gas, aerosol, dust that may exist in the room, there shall be heat insulation layers on hot surfaces of ventilation-airconditioning equipments. The temperature of the heat insulation layers' outer surfaces shall be 20% lower than the ignition temperature of the gas, air…mentioned above.

Note: Do not install the equipment in room containing combustible gas if it is impossible to cool down the outer surface of its heat insulation layer to the required level mentioned above.

3.5 Construction of the thermal isolation of cooling gas ducts and cold/hot water ducts must be designed and installed in accordance with 8.2 ad 8.3 of TCXD 232:1999.

3.6 For non-standard ventilating-air conditioning equipments, air duct and thermal isolation material must be manufactured from materials that are permitted to be used in construction.

4. Calculation Conditions

4.1 Calculation parameters of indoor air

4.1.1 When designing air conditioning system aim at maintaining thermally comfortable conditions for human body, calculation parameters of indoor air shall be in accordance with annex A depending on the working state (static rest, light work, medium work or heavy work)

4.1.2 For natural and mechanical ventilation, in summer, calculation temperature of indoor air should not be higher than the outdoor mean highest temperature of the hottest month in the year by more than 3^oC. In winter, calculation temperature of indoor air can be taken according to Annex A.

4.1.3 In the case of natural or mechanical ventilation, where it is impossible to ensure the thermally comfortable conditions in accordance with annex A, movement speed of the air shall be increased in order to compensate for the increase in environmental temperature to keep thermal sensation norm within permitted range. Every increase of 1^oC in temperature requires an increase of 0.5-1m/s in wind speed, but the total increase should not exceed 1.5 m/s for civil houses and 2.5 m/s for industrial houses.

4.1.4 Temperature, relative humidity, wind speed and cleaniness of the atmosphrere in breeding facilities and agricultural works as well as in preservation warehouses of agricultural products shall be taken according to the technological and constructional design standards for the types of construction mentioned above.

4.2 Calculation parameters of outdoor air

4.2.1 Calculation parameters of outdoor air (hereinafter referred to as outdoor calculation parameters) used for designing natural and mechanical ventilation is the medium of the highest temperatures of the hottest month (for summer) or the medium of the lowest temperatures of the coldest month (for winter) in a year (see QCXDVN 02:2008/BXD, Annex to Chapter 2, Table 2.3 and Table 2.4)

4.2.2 Outdoor calculation parameters for designing air conditioning must be chosen according to the number of hour m, measured in hours per year, the non-assurance of indoor hydrothermal conditions is allowed or the assurance coefficient K_{bd} shall be used.

Calculation parameters for designing air conditioning are classified into three grades: I, II and III.

-Grade I with number of hour allowing the non-assurance of indoor hydrothermal conditions is m = 35 h/year, corresponding to assurance coefficient K_{bd} = 0.996 – used for air conditioning systems in constructions of special important functions;

- Grade II with number of hour allowing the non-assurance of indoor hydrothermal conditions is m = 150 ÷ 200 h/year , corresponding to assurance coefficient K_{bd} = 0.983 ÷ 0.977 – used for air conditioning systems in charge of ensuring thermal confortable conditions and technological conditions in constructions of regular functions such as offices, stores, industrial buildings, art-recreation centres.

- Grade III with number of hour allowing the non-assurance of indoor hydrothermal conditions is m = 350 ÷ 400 h/year , corresponding to assurance coefficient K_{bd} = 0.960 ÷ 0.954 – used for air conditioning systems in industrial constructions that do not have high requirements on hydrothermal conditions and when the indoor calculation parameters can not be assured by regular mechanical or natural ventilation without hydrothermal treatment.

Outdoor calculation parameters used for designing iar conditioning according to the number of hour that allow the non-assurance of indoor hydrothermal conditions (m) – see Annex B or can refer to the method for determining outdoor calculation parameters according to excess levels of wet-bulb temperature and dry-bulb temperature that is applied by American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE).

Datas on excess level MV% of wet-bulb temperature and dry-bulb temperature of some regions in Vietnam – see Annex C.

4.2.3 For particular case where there is reasonable economical-tecnichal conditions, outdoor air calculation parameters can be decided according to any value of number of hour allowing the non-assurance of indoor hydrothermal conditions (m), but the value chosen should not be lower than that of the Grade III mentioned above.

Note: Excess level MV% of wet/dry-bulb temperature means the proportion of time in a year with temperature of equal or higher value incomparison with the chosen temperature value. According to ASHRAE regulations, in summer – require cooling- there are three excess levels which should be used for determining calculation parameters for air conditioning : 0.4 % (corresponding to excess hour of 35h/year); 1% (corresponding to excess hour of 88h/year)and 2% (corresponding to excess hour of 175h/year); in winter – require heating – there are two excess levels which are 99.6% (corresponding to excess hour of 8725h/year) and 99% (corresponding to excess hour of 8672 h/year). Converting excess level MV into assurance coefficient $K_{bđ}$ *, in turnly, we will have: in summer, corresponding to the three values of assurance coefficient are:* K_{bd}*= 0.996; 0.990 and 0.980. In winter:* K_{bd}*= 0.996 and 0.990.*

2) Due to objective conditions, Annex B and C currently contain datas of only 15 regions representing for 7 climatic zones (according to climate classification of QCXDVN 02:2008/BXD). Other regions can be added in the future. For the time being, regions that are not included in Annex B and Annex C can refer to the datas provied for their adjacent regions; interpolate according to distance between the two regions adjacent to the two sides or take according to climate zone;

3) Southern regions with average annual temperature of over 25 °C (from Dong Ha southward, except for Tay Nguyen provinces) are considerred regions without cold winter. Winter in these regions is just a season with cooler climate in comparison with summer and it is necessary to know the calculation parameters for checking whether the air conditioning process in this season requires cold supplying or not, or it only requires adiabatic cooling of mixed air, and after that should or should not add heat before supplying into room, or even can use solely outdoor air to supply for rooms. Hence, Annex B and Annex C contain calculation parameters of both summer and winter for all regions mentioned in the Annexes.

4.3 Cleaniness of ambient and indoor air

4.3.1 Concentration of hazardous gases and dust in ambient air must be in accordance with TCVN 5937:2005 and TCVN 5938:2005

4.3.2 Concentration of hazardous gases and dust in working environment of production plants shall be in accordance with Annex D (published by Ministry of Health, in 2002)

4.3.3 Concentration of hazardous substances in air supplied into house at diffuser grilles shall not exceed 30% of permitted limit concentration for indoor environment as specified in 4.3.2 for production plants and shall be equal to the permitted concentration specified for ambient air as in 4.3.1 for residential and public buildings

4.3.4 Limit concentration for fire and explosion safety of indoor gases must be referred to outdoor calculation parameter conditions for designing ventilation-air conditioning and must be in accordance with TCVN 3254:1989 and TCVN 5279:1990

5. Ventilation – Air conditioning

5.1 General instructions

5.1.1 In summer, it is necessary to ultilize natural ventilation, cross ventilation for industrial buildings, public buildings and residential buildings. In winter, care has to be taken to avoid cold draught.

5.1.2 For multi-storey buildings (with or without air-conditioning systems), it is necessary to design vertical exhaust pipes with mechanical suction (exhaust fans) for kitchens and bathrooms. For buildings of less than 5 stories, the application of natural exhaust systems by thermal pressure or wind pressure is acceptable (natural exhaust hood). Where it is impossible to let exhaust from verticle pipe to escape from the roof, regulation specified in 5.6.2 shall apply

5.1.3 Natural ventilation in industrial buildings with excessive heat (hot workshop) should be calculated according to thermal pressure corresponding to difference in temperature between indoor and outdoor air as regulated in 4.1.2 and 4.2.1, taking in to account the increase in temperature according to the height of the workshop.

Impact of mechanical ventilation (if have) should be taken into account when designing natural ventilation.

5.1.4 Natural ventilation in industrial buildings without excessive heat (cold workshop) need to be calculated according to the wind's impact. Calculated wind speed shall be taken according to the medium wind speed of typical month in summer or winter given in QCXDVN 02:2008/BXD

5.1.5 Mechanical ventilation shall be applied when:

a) Microclimatic conditions and cleanliness of indoor air can not be guaranteed by means of natural ventilating;

b) Rooms or architechtural spaces at hiden locations, include types of basement, do not allow arrangement of natural ventilation.

Combined ventilation which use a part of natural ventilating for discharging or supplying air could be used.

5.1.6 Mechanical ventilation without cooling or with cooling but only by simple method such as: the use of underground water or adiabatic cooling (recirculated spraying) should be applied for crane cabs in production plants with excessive heat of more than 25 W/m^2 or where the rate of thermal radiation exceeds 140 W/m^2 .

Ventilation by outdoor air (fresh air) shall be used where concentration of hazardous gases in the ambient air of crane cabs exceeds the permissible limits.

5.1.7 Anterooms of production buildings of explosion hazard level A and B (see TCVN 2622:1995 – Annex B) that produces hazardous gases as well as rooms that produce hazardouss gases of type 1 and type 2 (see Annex E) must be supplied with fresh air.

5.1.8 Mechanical supply-exhaust ventilation or mechanical exhaust ventilation shall be applied for excavations of at least 0.5m depth as well as for inspection trenches that are used everyday in production rooms of explosion hazard level A and B or in rooms producing hazardous gas, steam, aerosol that is heavier than air.

5.1.9 Ceiling fans and stand fans are used as a supplement for air supply ventilation system to boost the moving speed of air during hot season at working places or in rooms of:

a)Public buildings, administrative-activity buildings;

b) Production plants with thermal radiation rate of over 140 W/m^2 .

5.1.10 Fresh air (outdoor air) diffusers at stationary workingplaces should be used for the following cases:

a) Thermal radiation rate of over 140 W/m^2

b) For open technological processes that produce hazardous gases and that do not allow the arrangement of local exhaust ventilation or partition. Along with this, must use measures to prevent hazardous gases from spreading to other working areas in the workshops.

In metal-smelting/casting/rolling workshops with natural ventilation system, lotus diffusers using indoor air (cooled or not cooled by recirculated water) can be used.

5.2 Types of ventilating-air conditioning system (VAS)

5.2.1 Local air conditioning system is mainly used for apartment in residential building, hotel room or individual working room of administrative-activity building where the coefficient of stimulatenous use is relatively low.

Central water air conditioning system is encouraged to be used for barrack, administrative-activity building or hotel with usable area of at least 2000 m^2 in order to minimize the installation of outdoor unit so as not to affect the external aesthetics of the building. In this case, the system must be equipped with means for flexibly opening and closing sub-loads and water meter for measuring the amount of cold/hot water consumed by each consuming family.

When designing Variable Refrigeration Flow air conditioning system for multi-story barrack or room that can accommodate a great numbers of people, special attention should be paid for the safety conditions relating to provisions in 7.4.c) as well as the usable functions of the system.

5.2.2 Central air conditioning system with temperature and humidity air handling unit shall be used for rooms that can accommodate a great number of people such as meeting rooms, audience rooms of theatres, cinemas, etc.

5.2.3 Central air-conditioning systems that are responsible for maintaining parameters of indoor microclimate all day, all night and all year long should be designed with at least 02 air-conditioners. When an air-conditioner is broken down, the other one must still be in capable of ensuring the indoor microclimate conditions and no less than 50% of air exchange flow rate.

5.2.4 General ventilating and air conditioning system with capability to automatically adjust the flow rate according to changes in excessive heat, excessive humudity and hazardous gases content should be designed on reasonable economic-technical basement.

5.2.5 Where rooms of different fire danger levels are located on the same fire protection area, ventilating-air conditioning systems should be designed individually for each room group.

Rooms of the same fire danger levels that are not separated by fire resistant partitions, or are separated by fire resistant partitions but still have connecting holes with total area of over 1 m^2 shall be considerred as a single room.

5.2.6 General ventilating-air conditioning system can be desinged for the following room groups:

a) Residential rooms;

b) Rooms used for public activities, administrative-activity buildings and industrial buildings of explosion and fire hazard level E;

c) Production rooms of explosion and fire hazard level A or B located on no more than 3 contiguous floors;

d) Production rooms of the same explosion and fire hazard level C, D or E;

e) Storage rooms of the same explosion and fire hazard level A, B or C located on no more than 3 contiguous floors;

5.2.7 General ventilating-air conditioning system can be designed for the following combination of some rooms of different functions when joining rooms of other group with area of no greater than 200 m^2:

a) Residential rooms and administrative-activity rooms or production rooms with the conditions that the manifolds distributing air to rooms of different functions are equipped with fire preventing valves;

b) Production rooms of explosion and fire hazard level D or E with administrative-activity rooms (except for crowded rooms);

c) Production rooms of explosion and fire hazard level A, B or C with production rooms of any other explosion and fire hazard level, including storage rooms (except for crowded rooms) with the conditions that the manifolds distributing air to rooms of different functions are equipped with fire preventing valves

5.2.8 A separate ventilating-air conditioning system shall be designed for a room if the economic-technical foundation allows.

5.2.9 Local exhaust system shall be so designed as to the concentration of explosive substances in exhausted air does not exceed the lower limit of ignition concentration at the temperature of the exhausted air by more than 50%

5.2.10 Mechanical supplying ventilation for industrial buildings that operate for over 8 hours per day in areas with cold winter should be designed in combination with warm air heating.

5.2.11 General ventilating systems in industrial buildings, administrative-activity buildings, especially in basements, where the application of natural ventilation is not practical should be designed with at least 2 supply fans and/or 2 exhaust fans, providing that the flow rate of each fan is not less than 50% of the ventilating flow rate.

The designing of 01 supply system and 01 exhaust system is acceptable where there is spare fan.

5.2.12 Local systems for exhausting hazardous gases class 1 and 2 must be equiped with a spare fan for each system or for every group of two systems where the fan stops without stopping technological equipments may result in the increase in the concentration of indoor hazardous gases and this concentration could exceed the permitted level during working shift.

If the automatic operated emergency ventilation can help to decrease the concentration of hazardous gases to below the permitted level, the installation of spare fan shall not be necessary. – see 9.13.f).

5.2.13 General mechanical exhaust ventilation in rooms of explosion and fire danger level A and B must be designed with a spare fan (for each system or for several systems) with flow rate in capable of maintaining the concentration of hazardous gases and dust in the room at no more than 10% of their lower ignition concentration limit.

Spare fan is not required in the following cases:

a) if it is possible to stop the related technological equipments and terminate the source that generates hazardous gases and dust when the general system stops.

b) if the room is equipped with emergency ventilation system whose capacity is in capable of maintaining the concentration of explosive steam, gas, dust at no more than 10% of their lower ignition concentration limit.

5.2.14 Local exhaust system in charge of discharging hazardous gases and explosive compounds must be separated from general ventilation system, as specified in 5.2.9.

Hazardous gas local exhaust system can be mounted with general exhaust ventilation system that works continuously day-night if spare fan is available and air is not required to be treated before being discharged into the atmosphere.

5.2.15 General exhaust ventilation system in rooms of explosion and fire danger level C,D,E in charge of exhausting air within the range of 5m surrounding equipments containing explosive material, where explosive mixtures can be formed, must be separated from other ventilation systems of those rooms.

5.2.16 Supply diffuser system supplying air for working areas with thermal radiation must be separated from other ventilation system.

5.2.17 System in charge of supplying outdoor air (fresh air) to one or more buffering compartments of production rooms of explosion and fire danger level A and B must be separated from other ventilation systems and must be equipped with spare fan.

Fresh air can be supplied for buffering compartment of one or a group of production rooms or buffering compartment of ventilation machinery room of explosion and fire danger A and B from supply ventilation system (noncirculate) of those production rooms (A and B) or from supply ventilation system (noncirculate) of production rooms of explosion and fire danger level C,D and E with the condition that the rooms mentioned above are equipped with automatic valves which would lock the access ducts of the rooms in case of fire, and there is spare fan to ensure adequate air exchange rate.

5.2.18 Local exhaust system must be separately designed for each hazardous substance or group of substances emitted from technological equipments as the combination of these substances would form an explosive compound or a compound with higher hazardousity. which, if combines with each other would form. In technological designing part must clearly note the possibility to connect the local exhaust systems to exhaust explosive or hazardous substances to the same system.

5.2.19 General exhaust ventilation in storage rooms that emitted hazardous gases must be designed with mechanical exhaust power (exhaust fan). If hazardous gases belong to class 3 or 4 (little dangerous) and are lighter than air, natural ventilation or emergency mechanical ventilation with capacity in capable of ensuring required air exchange multiple and in-place controlling board located right at the access door.

5.2.20 Local exhaust system for combustible substances which can create deposit or condensation on air duct as well as on ventilation equipment must be designed separately for each room or each equipment unit.

5.2.21 General mechanical supply and exhaust ventilation system of a room can be in charge of ventilating for deep excavation or inspection trench located in that room (see 5.1.8).

5.3 Location of outdoor air (fresh air) intake opening

5.3.1 Outdoor air intake openings of mechanical ventilation system as well as windows or open vents used for natural ventilation must be located in areas that are free from air pollution, especially odor pollution.

Concentration of pollutants (includes base concentration) in outdoor air at the locations mentioned above must not exceed:

+ 0.3 times of the concentration permitted for working areas of industrial buildings or administrative-activity buildings.

+ Permitted concentration for ambient air of residential buildings and public constructions.

5.3.2 The lower edge of outdoor air intake opening of mechanical ventilation system or air conditioning system must be located over 2m above the ground. For areas with strong dusty wind, the lower edge of outdoor air intake opening must be located over 3m above the ground, and behind the outdoor air intake opening, there should be a dust-settling chamber.

5.3.3 Outdoor air intake openings must be equipped with grilles, rat screens and louvers

5.3.4 Outdoor air intake opening or tower may be located on exterior walls, roof or garden yard and must be located a minimum of 5m horizontally from any exhaust opening of neibouring houses, kitchens, toilet rooms, garages, cooling towers, machinery compartments.

5.3.5 Should not design a general outdoor air intake opening for supplying systems if they are not allowed to be arranged in one room.

5.4 Flow rate of outdoor air (fresh air) according to sanitary requirements, supply air flow rate in general and recirculated air (return air)

5.4.1 Outdoor air flow rate according to sanitary requirements for rooms with comfort air conditioners must be calculated to be able to dilute noxious matters and odor from human body and from objects, equipments in the rooms. Where there is not enough evidence for calculating, the amount of outdoor air can be taken according to the standard amount per person or according to the floor area as specified in Annex F.

5.4.2 For rooms with mechanical ventilation (not air conditioning), outdoor air flow rate is also calculated to ensure the permitted concentration of indoor noxious substances, taking into account the requirements to compensate for the amount of discharge air of local exhaust system aims to create favourable pressure differentials in the room. Where there is not enough evidence for calculating, the outdoor flow rate shall be taken according to the air exchange multiple specified in Annex G

5.4.3 Flow rate of supply air (outdoor air or combination of outdoor air and circulating air – combined air) must be calculated as specified in Annex H. The value taken shall be the greatest number in order to ensure the requirements on sanitary and fire and explosion safety.

5.4.4 Flow rate of air supplied for buffering compartments as specified in 5.1.7 and 5.2.7 must be calculated in order to ensure the excessive pressure of 20Pa in the buffering compartments (when closing) in comparison with the room pressure and shall not be less than 250 m^3/h

Flow rate air (outdoor air or combined air) supplied for elevator equipment room of production plant of explosion and fire danger level A and B must be calculated to create an excessive pressure of 20 Pa in comparison with the pressure in the adjacent elevator compartment. Pressure difference between buffering compartment of elevator equipment room and its adjacent rooms must not exceed 50 Pa

5.4.5 The taking of circulated air (return air) is not allowed in the following cases:

a) From rooms where the maximum outdoor air flow rate was calculated coming from the amount producing hazardous gases type 1 and 2;

b) From rooms with bacterial, pathogenic fungi that exceed the permitted standards of the Ministry of Health, or rooms that have an unpleasant smell;

c) From rooms where there is possibility of producing hazardous substances when air contacts with hot surfaces of ventilation equipments such as air heater if there is no air filter in front of those equipments.

d) From production rooms of explosion and fire danger level A and B (except for hot-cold air curtain at the doors)

e) From areas within the range of 5m surrounding the equipments in production rooms of explosion and fire danger level C,D and E if within these areas, the combination of steam, gas, dust emitted from the equipments and the air could form explosive compounds.

f) From local exhaust system used for exhausting hazardous gases and explosive compounds;

g) From buffering rooms.

For local dust exhaust system (except for dust that can form explosive compound when combining with air), after being dust filtered, the air can be returned into the room as long as it meets the requirements in 5.7.2

Requirements for air circulated from laboratories must comply with regulations on ventilation for laboratory – see Annex I

5.4.6 Air circulation (return air) is only allowed to perform within the range of:

a) An apartment, a hotel suite (with multiple rooms) or a building of a family;

b) One or several rooms that emit same group of hazardous steam, gas, dust class 1 or 2, except for rooms listed in 5.4.5 a)

5.4.7 Recirculating air system (recirculated air intake opening) must be located in working areas or service areas

5.5 Organization of ventilation – air exchanging

5.5.1 Distribution of supply air and air exhaust from rooms of public buildings , administrative buildings and industrial buildings must be suitable with the functions of the rooms in a day, a year, taking into account the changes in the sources of heat, humidity and hazardous substances.

5.5.2 In principle, supply ventilation must be applied directly with rooms that are often in used by human.

5.5.3 Air supplied for corridors or subrooms that are adjacent to main rooms must not exceed 50% air supplied for the main rooms

5.5.4 Production rooms of explosion and fire danger level A and B as well as production rooms that emits hazardous or smelling gas must be ventilated with negative excessive pressure, except clean rooms in where excessive pressure must be positive.

For air conditioned rooms, excessive pressure must be positive when the rooms are free from hazardous gas or bad smell source.

5.5.5 Air flow rate required for creating positive excessive pressure in rooms without buffering compartment shall be so determined as to achive excessive pressure of no less than 10 Pa (when doors are closed) , and no less than 100 m^3/h for each access door. Where there is buffering compartment, the air flow required for creating excessive pressure shall be equal to the air flow supplied for the buffering compartment.

Note: Air flow for creating excessive pressure is added to regular ventilating air flow

5.5.6 Air supplied for room(s) must not go from a highly polluted area to a less polluted one and affect the operating conditions of local exhaust openings.

5.5.7 In production workshops, air is supplied to working areas via air supply openings with air flow moving: horizontally through or above working areas; diagonally from over 2m above the floor; vertically from at least 4m above the floor.

For production workshops that rarely produce heat, air supply openings can be located at high positions to produce vertical, downward diagonal or horizontal air flow.

5.5.8 In rooms where the humidity emitted level is high or the ratio between excessive heat and excessive humidity is less than 4000 kJ/kg, a part of air supplied to room must be blowed to the area that tends to be the dew-point on inner surface of outer door.

In rooms with dust emission, air supply openings must be located at high positions and the air flow shall be downward.

In rooms with different functions and without dust emission, air supply openings can be located in service areas or working areas and the air flow shall be upward.

5.5.9 Outdoor air need to be supplied to workers' fixed working positions if those positions are located near hazardous-producing sources where do not allow the installation of local exhaust hoods.

5.6 Air discharge (discharged wind)

5.6.1 Air conditioned rooms must be equipped with a system in charge of exhausting polluting air when necessary in order to enhance the quality of indoor environment.

5.6.2 Air exhaust opening must be located at least 5m away from outdoor air intake opening of air supply system.

5.6.3 Process of exhausting air from room to outdoor using exhaust ventilation system must start from the most polluting area as well as areas of the highest temperature or enthalpy. For rooms that produce dust, air exhausted by general ventilation system must be exhausted from the lower area. Polluted air flow must not be directed to working places.

5.6.4 In production plants that produce hazardous or explosive gases, air must be exhausted from the upper area and for no less than one air change (1 time the volume of the plant per 1 hour). For plants of over 6m height, the rate of air change would be no less than $6m^3$/h per $1m^2$ of floor area.

5.6.5 Highly located exhaust openings of general exhaust ventilation system must be installed as follow:

- below the ceiling or the roof; the distance from the floor to the lower edge of the exhaust opening shall be no less than 2m when exhausting excessive heat, excessive humidity or hazardous gas;

- distance from the ceiling or the roof to the upper edge of the exhaust opening shall not be less than 0.4 m when discharging explosive gas mixture or aerosol (except for the combination of hydro and air);

- distance from the roof or the ceiling to the upper edge of the exhaust opening shall be no less than 0.1m for room of less than 4m height or no less than 0.025 times the room’s height (and no more than 0.4 m) for room of over 4m height when exhausting the mixture of hydro and air

5.6.6 For exhaust opening of general exhaust ventilation system which is located at a low position, the distance between the floor and the lower edge of the exhaust opening must be less than 0.3 m.

Air flow rate exhausted from local exhaust openings which are located at low positions within working area shall be considered as air discharging from that area.

5.7 Air dust filtering

5.7.1 Outdoor air and circulated air in air conditioned rooms must be filtered to be free from dust.

5.7.2 Supply air of mechanical ventilating and air conditioning systems must be dust filtered in order to ensure that the concentration of dust after filtering would not exceed:

a) Permitted concentration according to TCVN 5937:2005 for residential buildings and public buildings;

b) 30% permitted concentration for working areas of industrial buildings and administrative-activity buildings;

c) 30% permitted concentration for working areas with dust size of no greater than 10 μm when supplying air to crane cabs, control rooms, workers' breathing zones as well as for air diffuser systems;

d) Permitted concentration according to technical requirements for ventilating equipments.

5.7.3 Air filtering grilles shall be so installed as to be able to prevent unfiltered air from bypassing the filtering grilles.

5.7.4 Air filter must be accessible whenever necessary to check its condition and air resistance.

5.8 Air curtain (Wind screen)

5.8.1 Air curtain is used in the following cases:

a) Used for doors and technological doors in industrial buildings in order to prevent air from moving between rooms when necessary.

b) For doors of public and industrial buildings with air conditioners, when the number of people that go in and out usually exceeds 300 turn/h, in order to avoid cool loss in summer or heat loss in winter, the following options should be considered:

- Air curtain;
- Doors through buffering room, rotary doors, etc.
- Create positive pressure in the lobby to reduce wind loss due to the opening of door

5.8.2 Air supplying for anti-cold air curtain installed at door must has temperature of maximum 50°C and velocity of maximum 8 m/s

5.8.3 Air curtain used for door of cold storage or special technological room must follow professional guidelines of respective technical sector.

5.9 Emergency ventilation

5.9.1 Emergency ventilation system should be set up in production room with possibility of emitting a great amount of hazardous gas or explosive substance in accordance with requirements of technology part in the design. The non-simultaneity of break-down that may occur to technological equipments and ventilating equipments is taken into account.

5.9.2 Flow rate of emergency ventilation system must be determined according to technological requirements.

5.9.3 Emergency ventilation system for production rooms of explosion and fire danger level A and B must be mechanical ventilation system. For production rooms of explosion and fire danger level C,D, and E, emergency ventilation using natural exhausting force is acceptable with the condition that the ventilating flow rate is ensured under any weather condition.

5.9.4 If properties of air environment (temperature, type of combustible gas, steam, dust) in room that is in need of emergency ventilation exceed the permitted limits of anti-combustion fan, the emergency ventilation system must be constructed with ejector fan.

5.9.5 Launching emergency ventilation allows the use of:

a) General exhaust ventilation systems and local exhaust systems if they can afford the flow rate for emergency ventilation.

b) The systems mentioned in a) and emergency ventilation system to make up for the deficiency of the flow.

c) Emergency ventilation system shall be used only when the use of systems mentioned in a) for emergency ventilating is inappropriate or impossible.

5.9.6 Hazardous gas exhaust duct and exhaust opening of emergency ventilation system must be arranged according to requirements specified in 5.6.5 and 5.6.6 at the following areas:

a) Working areas if the unit mass of hazardous gas produced is heavier than that of the air in workplace.

b) Upper areas if the unit mass of hazardous gas produced is lighter than that of the air in workplace.

5.9.7 Air making up using supplying system is not necessary when operating emergency ventilation.

5.10 Ventilating-air conditioning equipments and installation

5.10.1 Ventilation fan, air conditioner, air supply chamber, air processing chamber air heating equipment, equipment for reusing excess heat, dust filter of all types, flow control valve, silencing coil, etc (hereinafter referred to as equipments) must be chosen on the basement of the air flow that passes by, taking into account the flow loss due to equipments' gap (according to manufacturer's instructions); for the case of air duct, instructions mentioned in 5.12.9 shall apply (except for air duct parts that are located right in the rooms to be served). Rate of air leaking through gaps of fire and smoke prevention valves must be in accordance with requirements specified in 6.5.

5.10.2 Equipments with explosion protection characteristic shall be used in the following cases:

a) If the equipments are located in production rooms of fire and explosion danger level A and B or are located in the air ductworks that serve these rooms;

b) Equipments used for ventilating-air conditioning systems, smoke exhausting systems (include excess heat reusing systems) that serve production rooms of fire and explosion danger level A and B;

c) Equipments that are used for air exhausting system – see 5.2.15;

d) Equipments that are used for local exhaust system with function of discharging explosive compounds.

Equipments of regular type can be used in local exhaust systems in production rooms of fire and explosion danger level C, D and E with the function of discharging mixture of steam, gas-air where, according to technological design standard, when the system operates normally or when there is problem with technological device, all possibilities of forming mixture with explosive concentration are eliminated

Ejector exhaust system shall be used if temperature of the environment of transporting air, or group of gas, steam, aerosol, dust mixture, etc and air belonging to explosive type is not consistent with the technical conditions of explosion-proof fan. In these systems, fans, air compressors, air blowers, etc of regular types can be used if these equipments work with outdoor air.

5.10.3 For equipments of air supply ventilating and air conditioning systems serving production rooms of fire danger level A and B, or for cases where heat used for excess heat reusing systems of these areas is taken from production rooms of other fire danger levels that are located in the same area for installing ventilation equipments, equipments of regular types can be used with the condition that explosion proof check valves are arranged on the air ductwork as specified in 5.10.15.

5.10.4 Where fan is not connected to air ductwork, its exhaust opening and supply opening must be equipped with protective net.

5.10.5 For filtering explosive dusts in exhaust air, dust filter to be installed must meet the following requirements:

a) for dry filtering – use explosion proof filter with continuous dust discharging mechanism.

b) for wet filtering (include foam filtering) – explosion proof filter is commonly used; however, where there is technical substantiation, the use of regular filter shall be acceptable.

5.10.6 In production compartments containing gas equipments, air exhaust system must be equipped with airflow control valve which has mechanism for preventing the fully close of valve.

Supply openings of air diffuser system in working place must be designed with mechanism in capable of rotating 180^0 horizontally and flow-directing wings for regulating the supply flow with an angle of 30° vertically.

5.10.7 Excess heat reusing equipments and silencing equipments must be made from fire proof materials; the inner surface of excess heat using equipments can be made from hard-to-burn materials.

5.10.8 Except for equipments in charge of supplying air for air curtain or air curtain using circulated air, ventilation equipments are not allowed to be located within the areas that they are supposed to serve for the following constructions:

a) Storage rooms of fire danger level A,B and C;

b) Residential buildings, administrative – public buildings, except for equipments with airflow rate of under 10000 m^3/h

Emergency ventilation equipment and local exhaust system are allowed to be installed in the production room which is under its charge.

5.10.9 Equipments of supply ventilation system and air conditioning system must not be located in areas where the use of circulated air is not permitted.

5.10.10 Equipments of ventilating system for rooms of level A and B as well as equipments of local exhaust system for exhausting explosive gas mixture should not be located in the basement.

5.10.11 Primary dust filter on air supply line must be arranged before heating coil; additional filter (secondary filter) shall locate before the point where the supplying air enters the room.

5.10.12 When arrange dry filter devices and explosive dust filter at the outside of the houses and construction works, need place them at the distance not smaller than 10m apart from the wall at the outside or in the one separated house. House for placing ventilating equipment with the above dry filter allows arranging next to dust filter placing bare at the outside

Dry filter and dry filter for discharging dust on cycle if air amount through filter not over 15,000 m^3/hr and accumulated dust amount in container not over 60 kg, can place in workshop served by these systems at separated compartment (except for basement) apart from other ventilating equipments

5.10.13 Dry filter for filtering explosive mixture of dust and gas must be located:

a) Outside building of fire resistant rate I and II (see TCVN 2622-1995, Table 2) adjacent to its walls, if on the wall over the entire height of the building with width of no less than 2m horizontally each side measured from edge of dust filter there is no building's window; if there is window(s), it must be fixed door, has twin frame with steel fibre reinforced glass, or backed up with glass block; if there is window that can be opened normally, the filter must be placed at least 10m away from the wall of the building.

b) Outside the buildings of fire resistant grade III, IV and V, and no less than 10m away from the walls of the buildings.;

c) Inside the buildings, in dedicated machinery compartments for ventilating equipments along with fans and other filters used for filtering explosive gas-dust mixtures: installation of this type of filter in the basements is acceptable with the condition that the filter is in capable of continuously discharging combustible dust; for the case of manual dust discharging system, the mass of dust accumulates in dust container, closed containers in the basement must not exceed 200 kg; this type of filter can also be placed in production rooms (except for production rooms of fire danger level A and B) if the flow rate of filtered air does not exceed 15 000 m^3/h and the filter is uninterruptedly mounted with technological devices.

In production compartments, installation of combustible dust filters shall be allowed if the dust concentration in filtered air which would be supplied back to the production compartments, where the filters are located, does not exceed 30% allowable limit of dust concentration in working areas.

5.10.14 Dust settling chamber must not be used for combustible and explosive dust.

5.10.15 Equipments of supply ventilation system, air conditioning system (hereinafter referred to as air supply system) serving production compartments of fire danger level A and B must not be located in the same machinery compartment with exhaust ventilation equipments, as well as with exhaust-supply system using circulated air or using excess-heat-reusing equipments with air-to-air heat transferring mechanism.

Air supply duct for production compartments of fire danger level A and B, which include administrative working rooms, breakrooms for employees, must be equipped with anti-explosion check valves at positions where the air duct goes through the enclosure walls of ventilation equipment rooms.

5.10.16 Equipments of supply ventilation system with circulating mechanism serving production compartments of fire danger level C must not be arranged in the same machinery compartment with ventilation equipments used for other fire danger levels.

5.10.17 Equipments of supply ventilation system which is in charge of supplying air for habitable rooms must not be arranged in the same machinery compartment with equipments of air supply system for public service rooms, as well as with equipments of air exhaust systems.

5.10.18 Ventilation equipments in charge of exhausting bad smelling gases (for example: systems for exhausting from toilet areas, from smoking rooms, etc) must not be arranged in ventilating machinery compartments that are in charge of supplying air for other spaces.

5.10.19 Equipments of general exhaust ventilation system serving production compartments of fire danger level A and B must not be placed in the same machinery compartments with equipments of other ventilation system.

Equipments of general exhaust ventilation system serving production compartments of fire danger level A and B can be located in the same compartment with local exhaust ventilation equipments specially used for exhausting explosive mixture with or without wet filter, if there is measure for eliminating the accumulation of explosive substances in air duct. Exhaust ventilation equipment for production compartments of fire danger level C must not be installed in the same compartment with exhaust ventilation system used for production compartments of fire danger level D.

5.10.20 Local ventilation equipment used for discharging explosive gas mixture must not be arranged in the same equipment room with group of equipments of other ventilation systems, except for cases mentioned in 5.10.19

5.10.21 Exhaust ventilation system with heat recycling mechanism using air-to-air heat exchanger, as well as air circulating equipment must be arranged according to requirements specified in 5.10.18 and 5.10.19.

Air-to-air heat recycling equipment must be arranged in equipment compartment of air supply system.

5.11 Ventilation-air conditioning machinery compartments

5.11.1 Machinery compartment for locating equipments of exhaust system must be designed with the same fire danger in comparison with that of the production compartment served by this system.

Machinery compartment for fans, air compressors supplying outdoor air for ejector pumps located outside the production compartments must be designed with fire danger level E. Where air supplied for ejector is taken from production rooms, ventilation machinery compartment must be designed with the same fire danger as that of the production room.

Fire danger level of equipment compartment of local exhaust system which is in charge of exhausting explosive mixture from technological devices, located in production rooms of fire danger level C, D and E or in compartments of public, administrative-activity blocks, as well as equipments of general exhaust ventilation system stated in 5.2.15 must meet the requirements on fire danger A or B.

Machinery compartment for local exhaust equipment, that is used for discharging explosive dust-gas mixture and is equipped with wet filter placed in front of the fan, can be considered as of fire danger level E if there is enough evidences.

Machinery compartment for general exhaust ventilation equipments of habitable room, public room, or administrative-activity room shall be classified as of fire danger level E.

Machinery compartment for exhaust ventilation equipments that serve production rooms of different fire danger levels must be treated according to the highest danger level.

5.11.2 Machinery compartment for ventilation equipments of supply ventilation system must be designed according to:

a) Grade C: if there are dust filter sets which use oil for filtering and each filter set contains over 70 litres of oil (over 60 kg of oil)

b) Grade C: If the system circulates air taken from production room of fire danger level C, except for cases where the circulated air is taken from production rooms that do not produce combustible dust or gases, or where air is filtered by wet filters or foam filters.

c) The same grade with production compartment: if excess heat of air environment shall be use by air-to-air excess-heat-reusing equipment

d) Grade E for all other cases. In the case of machinery rooms for air supply equipments that serve production rooms of different fire danger level, the highest fire danger level shall be used.

5.11.3 In machinery compartments for equipments of exhaust ventilation system that serves production room of fire danger level A and B and systems mentioned in 5.2.15, or in machinery compartments for local explosive gas mixture exhaust system must not arrange modals of heat supply system, pumping system, or arrange spaces for machine repairing, spaces for oil reclaiming or for other purposes.

5.11.4 Machinery compartment for ventilation equipment must be located within fire prevention areas, where there are production rooms served by this system. This equipment room can be arranged outside fire prevention walls of fire prevention areas or within a fire prevention area in buildings of fire resistant rate I, II, III. In these cases, machinery compartment must be adjacent to fire prevention wall; in machinery compartment, there must not be ventilation equipments that serve production compartments located on different sides of fire prevention wall; air duct that goes through fire prevention wall must be equipped with fire prevention valve.

5.11.5 Room for installation of dry filter specialized for filtering explosive mixture must not be located below crowded areas.

5.11.6 Height of machinery compartment for ventilation equipment must be at least 0.8 m higher than the equipment’s height, and must not be less than 1.8m measured from the floor to the lowest support of ceiling structure or floor of the upper storey. Conditions for movements of lifting devices inside the machinery compartment (if have) shall be taken into account.

Within the space where the machine is located as well as on operating floor, width of aisle lying between structural elements of the machine as well as between machinery and cladding structure shall not be less than 0.7m, taking into account the need for machine repairing, assembling and constructing.

5.11.7 In machinery compartment for equipments of exhaust system, exhaust ventilation should be organized with air exchange multiple of no less than 1 time/h.

5.11.8 In machinery compartment for equipments of air supply system (except air supply system for creating smoke preventing pressure), supply ventilation should be organized with air exchange multiple of no less than 2 time/h. Both the use of this air supply system or a specific air supply system are accepted.

5.11.9 Ductwork used for the transmission of flammable fluid or gas or fuel gas must not go through spaces where ventilation equipments are installed.

Sewage pipes must not go through spaces used for installation of ventilation equipments, except for rain water pipes or technological water pipe of ventilation equipments located in upper machinery compartments.

5.11.10 If weight of a structural unit or a part of structural member exceeds 50kg while the use of lifting devices of production line is not available, it is necessary to prepare a separating lifting device specially used for the purposes of repairing ventilation equipments (fan, motor, etc)

5.12 Air duct (wind duct)

5.12.1 On the air duct of general ventilation system, air conditioning duct system, for preventing product of fire (smoke) from spreading into rooms in case of fire, installation of the following devices is required:

a) Fire damper: on collecting pipe of each floor at points for connecting with vertical or horizontal manifold in public house, administrative-service building or production plant of fire danger level D;

b) Smoke damper: on collecting pipe at points for connecting with vertical or horizontal manifold for habitable room, public room, administrative-activity room (except for toilet area, bath room, wash room) in multi-floor building, as well as production plant of fire danger level D. Each horizontal manifold must not be connected with more than five collecting pipes from adjacent floor, providing that each collecting pipe serve one floor.

c) Fire damper: on air ducts that serve production rooms of fire danger level A, B or C and at points where the air ducts go through fire preventing walls or floors.

d) Fire damper: on each air manifold lying through rooms (at a distance of no more than 1m away from the nearest turn that lead to fan) which serves a group of rooms of a production group of fire danger level A, B or C (except for storage compartment) with general area of no more than 300 m^2 within the range of a floor with door opening to public corridor;

e) Check valve: on branch pipe for each production room of level A, B or C at points for connecting with collecting pipe or manifold.

Note:

1) Fire damper mentioned in 5.12.1 a) and 5.12.1 c) must be located on partition, directly adjacent to partition at any side of the partition or apart from the partition, but fire strength of air duct from the partition to the damper must be ensured to be equal to that of the partition.

2) If the designing of fire damper or smoke damper is impractical due to technical conditions or some other reasons, the air ducts should not be mounted to a system; in this case, separate ventilation system should be designed for each space, this would eliminates the need for installing fire damper or smoke damper.

3) Local exhaust duct system specialized for discharging explosive gas mixture must be designed in accordance with the requirements specified in 6.12.1 c) and 5.12.1 e)

4) Connecting of air ducts of general exhaust ventilation system of residential building, public building or administrative-activity building is permitted in roof floor, except for air ducts in treatment-medical building

5.12.2 Air duct must be equipped with check valve in order to preventing the spreading from room to room of hazardous gas type 1 and 2 (when ventilation system does not work) in cases where rooms are located on different floors and if the flow rate of outdoor air supplied to rooms is calculated according to the conditions for diluting hazardous.

On fire preventing walls or fire preventing partitions separating public spaces, administrative-activity spaces, or production spaces of fire danger level D and E or separating with corridor, designing of opening for air to pass by is permitted with the condition that this opening is protected by fire damper.

5.12.3 Air duct must be made from regulated materials – see Annex J.

Air duct with fire-resistant rating of equal to or lower than fire-resistant rating of building structure is allowed to be used for transporting air which is free from condensable gases; in this case, the tightness of the duct, the smoothness of the inner duct surface (coated, glued by smooth materials, etc) and the ability to clean the air duct must be ensured.

5.12.4 Duct with round section should be preferred; where there is economical-technical substantiation, air duct with rectangular section or other geometrical section can be used. Dimension of duct's section shall be in accordance with Annex K.

5.12.5 Air duct made from non-combustible materials shall be used for:

a) Local exhaust systems that are in charge of exhausting explosive mixtures, emergency ventilation system, systems that are in charge of transporting air with temperature of above 80°C over the entire length of the duct lines.

b) Duct lines that go through or manifold of ventilation-air conditioning system in residential building, public building, administrative-activity building and production plant.

c) Air ducts that go through machinery compartment for installation of ventilation equipments, as well as technical floors, basements, and mezzanine floors.

5.12.6 Air ducts made from hard-to-burn materials can be used in single-storey buildings which are residential buildings, public buildings, administrative-activity buildings and production plants of fire danger level E, except for systems mentioned in 5.12.5 a), as well as in crowed rooms.

5.12.7 Air ducts made from flammable materials can be used within the areas served by this system, except for cases stated in 5.12.5. Soft ducts or turning chutes made from flammable materials can be used in systems that serve or go through buildings of level E if their length does not exceed 10% the length of hard-to-burn air duct or does not exceed 5% the length of non-flammable air duct. Soft duct that is connected to fan can be made from flammable materials, except for systems stated in 5.12.5 a).

5.12.8 For protecting air duct from rust, flammable paint coat or film coat with thickness of no more than 0.5 mm can be used.

5.12.9 Regulation on the tightness of air duct

a) Grade K (tight) – apply specially to passing by duct in general ventilation system, when static pressure at fan is greater than 1400 Pa, or to all local exhaust systems and air-conditioning systems;

b) Grade BT (Normal) – for all others cases.

The amount of air loss due to leaking or penetrating into the duct through gaps on duct line must not exceed the values given in Table 1.

5.12.10 Air duct that goes through the room and manifold of ventilation system can be me of:

a) Flammable and hard-to-burn materials with the condition that the duct is placed in channel, in box or in separate cover with fire resistant rate of 0.5h;

b) Non-flammable materials with fire resistant rate of lower than regulated, but no less than 0.25h when the duct is placed in a channel, shaft or other cladding structure made of non-flammable materials with fire resistant rate of 0.5h

5.12.11 Fire resistant rate of air duct and manifold placed in machinery compartment for ventilation equipments or placed outside the building, except for air duct or manifold that goes through ventilation equipment machinery room.

5.12.12 Air duct that traverses buffering compartment of rooms of fire danger level A and B, as well as local exhaust system for discharging explosive gas mixture must be constructed with fire resistant rate of 0.5 h

5.12.13 Fire dampers installed on openings or on air ducts that intersect floors or fire preventing walls must have fire resistant rate of:

1h – when standard fire resistant rate of floor or fire preventing structure is at least 1h;

0.5 h - when standard fire resistant rate of floor or fire preventing structure is 0.75h

0.25 h - when standard fire resistant rate of floor or fire preventing structure is 0.25h

For other cases, fire dampers to be installed must have fire resistant rate of not lower than fire resistant rate of air ducts on where they are installed, and must not be less than 0.25h.

5.12.14 Air ducts must not traverse stair frame (except for the case of air supply system with mechanism of increasing pressure for smoke prevention) and refuges.

5.12.15 Air duct systems that start from production compartments of fire danger level A or B or pipelines of local exhaust systems that are in charge of exhausting explosive mixtures must not be placed in basements or underground channels.

5.12.16 Holes for air ducts to go through walls, partitions or floors of the construction (include shaft walls and enclosures of duct box) must be tamped with materials that are non-flammable and in capable of ensuring fire-resistant rate of the partition walls gone through by the ducts.

5.12.17 Air duct transporting explosive gases can be crossed by heat-carrying pipe if the maximum heat of this pipe (measured in °C) is lower by at least 20% in comparison with the ignition temperature of gas, dust or aerosol mixtures carried by the duct.

5.12.18 Air duct of local exhaust system transporting explosive gas mixture, the parts with positive pressure, as well as parts of air duct system in charge of transporting hazardous gases type 1 and 2 must not be placed through other spaces. Air ducts of this type can be processed by welding method according to tightness grade K and without detach-attach mechanism.

5.12.19 Duct for transporting gas and other flammable substances, electric cables, pipes for discharging waste water must not be installed inside air ducts or at 50 mm away from the duct surfaces; the technical systems mentioned above must not traverse air ducts.

5.12.20 Air ducts of general exhaust systems, local exhaust systems in charge of exhausting explosive gas mixtures that are lighter than air must be designed with incline of no less than 0.5% upward the direction of moving air flow.

5.12.21 Air ducts, in where there may be deposit or condensation of moisture or fluid of any type, must be constructed with incline of no less than 0.5% following the direction of air flow, and constructed with pipes for discharging condensed fluid

5.12.22 Difference in balanced pressure loss on duct branches must not exceed 10%.

6. Smoke protection in case of fire

6.1 Emergency ventilation system for discharging smoke in case of fire (hereinafter referred to as smoke exhaust ventilation) must be so designed as to ensure the safety for human to escape from the building at the early stage when the fire starts from a room of the building.

6.2 Smoke exhaustion must be designed:

a) From corridor or lobby of residential building, public building, administrative-activity building;

b) From corridor of over 15m length without natural lighting via garret windows on outside walls (hereinafter referred to as natural lighting) in production plants of fire danger level A,B and C which have at least 2 stories.

c) From each production plant or storage compartment whose regular workplaces are without natural lighting, or with natural lighting but without mechanism for opening lighting windows at the height of at least 2.2 m from the floor (in both cases, the area of the openings must be sufficient for natural smoke discharging in case of fire), if production is of fire danger level A,B and C; or level D or E in buildings of fire resistant grade IV;

d) For public buildings, administrative-activity buildings, from each room without natural lighting, if rooms are used for the purpose of gathering a large amount of people:

- From each storage compartments with area of over 55 m^2 if there are flammable materials and/or regular working spaces in the storage compartments;

- From cloakroom with area of over 200 m^2

Smoke exhaustion from production plant of fire danger level C with area of under 200 m^2 can be organized from corridor that is asymptotic with this production plant.

6.3 Requirements set out in 6.2 shall not apply to:

a) Areas where time for smoke flooding as regulated in 6.9 is greater than time required for human to escape from here (except for production compartments of fire danger level A and B);

b) Areas of less than 200 m^2 equipped with automatic fire fighting system using water or foam, except for production rooms of fire danger level A and B;

c) Areas that are equipped with gas automatic fire fighting system;

d) Laboratories that are mentioned in Annex I;

e) Corridors, lobbies, if direct smoke exhaust is organized from adjacent areas which have doors open to these spaces.

Note:

If in a large space where smoke exhaust is organized there are many small compartments with area of under 50 m^2 for each, it is not required to organize smoke exhaust separately for each compartment if mass of smoke exhausted generally for the overall large space already includes that.

6.4 Smoke flow rate, measured in kg/h, exhausted from corridor or lobby must be determined according to the calculation or according to Annex L, providing that unit weight of smoke is 6 N/m^3 , temperature of smoke is 300°C and air is taken via doors opening to stair frame or outdoor.

For double-winged door, calculated door area shall be taken as the area when the larger wing is opened.

6.5 Smoke discharge must be in charge by a separate mechanical exhaust system. Determination of the amount of exhaust smoke should take into account:

Mass of air that penetrate into the pipelines, canal, smoke transporting channel, duct, etc made of tole according to instructions mentioned in 5.12.9; for cases where ducts are made of other type of materials, determine according to calculation or regulations specified in 5.12.9;

b) Mass of penetrated air, G_v ,measured in kg/h, via smoke exhaust valve in closed state must be determined in accordance with manufacturer's instruction, but should not exceed the index number determined according to the following formula:

$$G_v = 40.3(A_v \Delta P)^{0.5} n$$

Where:

A_v is section area of valve, measured in square meter (m^2);

ΔP is difference in pressure between two sides of valve, measured in Pascal (Pa);

n is the number of closed valve in smoke exhaust system in case of fire.

6.6 Smoke exhaust opening (exhaust opening) must be arranged above smoke exhaust shaft, below the ceiling of corridor or lobby. Smoke exhaust opening is allowed to be mounted with smoke exhaust shaft via a exhaust branch duct. Length of corridor served by a smoke exhaust opening is often no greater than 30m.

On smoke exhaust branch of corridor or lobby, allow the mounting of no more than two smoke exhaust openings of the same floor.

6.7 Flow rate of smoke directly exhausted from the room's space as specified in 6.2 c) and 6.2 d) must be determined according to calculation or according to Annex L:

a) According to fire zone perimeter G, kg/h

b) According to requirements on protecting emergency exits from being overflowed by smoke G_1, kg/h

Note:

1) when determining exhaust smoke flow rate as specified in 6.7b), mean wind speed of hot season or cold season, whichever is greater, shall be taken; and the value taken should not exceed 5 m/s.

2) For isolated spaces, where smoke discharging through corridor as specified in 6.2 d) is permitted, number for calculation shall be the greater smoke amount determined according to 6.4 or 6.7

6.8 Space with area of over 1600 m^2 needed to be divided into multi smoke exhaust areas for taking into account the possibility that the fire may happen in a single area. These areas must be separated by leakless stand partitions made of non-flammable materials, hanged from the ceiling till the height of no less than 2.5m above the floor in order to form a "smoke tank".

Smoke release areas, separated or not, must be calculated for the possibility of generating a fire inside there.

Area of each smoke release area must not exceed 1600 m^2

6.9 Time required for smoke to overflow room area or smoke tank X, measured in seconds (s), must be determined according to the following formula:

$$\tau = 6.39A(Y^{0.5} - H)^{0.5}) / P_f \qquad (3)$$

Where:

A is room area or the area of smoke tank, measured in square meter (m^2);

Y is height of the peripheral below the smoke layer, take Y = 2.5 m, for smoke tank, take the height measured from the lower peripheral of smoke partition to the room's floor as the value of Y, measured in meter (m);

H is height of the room, measured in meter (m);

P_f is perimeter of fire zone, determined according to calculation or according to Annex L, measured in meter (m)

6.10 Moving speed of smoke, measured in m/s, in valve, in duct line, in smoke release tank must be taken according to calculation.

Mean unit weight y, measured in N/m^3, smoke temperature °C, in cases where smoke is discharged from space with area of less than 10 000 m^3, shall be taken as follow:

γ = 4 N/m^3, t = 600 °C – when combustible substance is gas or fluid;

γ = 5 N/m^3, t = 450 °C – when combustible substance is solid subject;

γ = 6 N/m^3, t = 300 °C – when combustible substance is fiber and smoke is discharged from corridor or lobby.

Mean unit weight, γ_m, of smoke discharged from space with area of over 10 000 m^3 shall be determined according to the following formula:

$$\gamma_m = \gamma + 0,05(V_p - 10) \quad (4)$$

where:

V_p is space volume, measured in cubic meter (m^3)

6.11 Direct smoke discharge from rooms in single storey building must be organized by natural exhaust system through smoke discharge tanks which are equipped with smoke valves or through ventilation skylights which do not attract wind.

In space range with width of equal or less than 15m adjacent to windows, smoke can be discharged through ventilation doors whose bottom fixtures are at least 2.2 m above the floor.

In multi-storey building, smoke discharge must be operated by mechanical exhaust system; each isolated space can be designed with separate natural smoke discharge tank.

In library, book/archive/paper storage room, require construction of natural exhaust system, take according to calculation data γ = 7 N/m^3 and temperature is 220 °C.

In mechanical smoke exhaust system, no more than 4 spaces or 4 smoke discharge areas of a single floor are allowed to be mounted to a single vertical manifold.

6.12 Smoke exhaust system must be equipped with:

a) Centrifugal exhaust fan coaxially mounted with motor (can use roof centrifugal fan) of the same safety level with the area under the system's charge, no hose fitting. Where required the use of hose fitting, hose fitting must be made of non-flammable materials. Can use centrifugal fan pulled by trapezoidal driving belt or mounted by coupling cooled by air.

b) Duct and exhaust tank made of non-flammable materials with fire resistant rate of no less than :

0.75 h – if smoke is discharged directly from room;

0.50 h – if smoke is discharged from corridor or lobby;

0.25 h – in case of air discharge after fire (see 6.14)

c) Smoke valve made of non-flammable materials which would automatically open in case of fire and has fire resistant rate of 0.5 h – for discharging smoke from corridor or lobby, and 0.25 h – for discharging smoke after fire (see 6.14). Smoke valve with non-standard fire resistant rate is permitted to be used in system that serves only one room.

Smoke collecting doors should be evenly arranged over the entire surface of the room, the smoke discharge area, or above smoke tank. Area under the charge of a smoke collecting door should not exceed 900 m^2 .

d) Opening discharging smoke to the outdoor locating at the height of no less than 2m from the roof surface made of flammable or hard-to-burn materials. Smoke discharging at the distance of less than 2m away from the roof surface shall be permitted if the roof surface is protected by a layer of non-flammable material within the range of no less than 2m from the boundary of the smoke discharge opening. Smoke discharge shaft of natural smoke exhaust system must be protected by ventilation hood. Discharge openings of mechanical smoke exhaust system must be left being uncovered, free from covering hood;

e) Installation of check valve is not required if the amount of excess heat inside production room served by the system exceeds 20 W/m^3.

Smoke from smoke discharge tank of lower stories, basement can be discharged into naturally ventilated area of steelworks, steel casting/rolling shop as well as other hot production workshops. In this case, smoke exhaust openings must be arranged at the height of no less than 6m above the floor of ventilated workshops; at no less than 3m vertical distance and 1m horizontal distance from building structures; in cases, where water spray system is installed above smoke exhausts opening, the distance between the opening and the floor must not be less than 3m. Smoke damper must not be installed on smoke exhaust shaft.

6.13 Smoke exhaust fan must be covered by fire resistant partition type 1.

Spaces for locating smoke protection equipments must be ventilated in order to maintain the environmental temperature at no greater than 60°C in hot season.

Allow the arrangement of smoke exhaust fan on roof surface and outside the building. Fans located outdoor (except for roof fan) must be equipped with protective grid for protecting it from people that are not in charge.

6.14 Discharging of smoke, gas, products of fir, etc after fire case from rooms equipped with gas fire fighting system must be operated by method of mechanical exhaust from the lower area of the room.

At points where air duct (except for air duct that traverses the room) goes through cladding structure of room equipped with gas fire fighting system, fire damper with fire resistant rate of no less than 0.25h must be installed.

6.15 In order to exhaust smoke in fire and gas of fire products after fire case, the use of emergency ventilation system and general ventilation system shall be permitted if all requirements set out in sections from 6.4 to 6.14 are satisfied.

6.16 Supplying of outdoor air for smoke protection area (exit area) aiming at creating positive pressure in case of fire must be operated as follow:

a) Supply to local emergency stair frame;

b) Supply to elevator shaft, if there is no buffering compartment on the exit of the elevator;

c) Supply to buffering compartment in front of elevator in the basement of public building, administrative-activity building, and production building;

d) Supply to buffering compartment in front of stair frame in the basement with production compartments of fire danger level C.

Note: In steelworks, steel casting/rolling mill and other hot workshops, supplying air can be taken from other ventilated apertures of the buildings.

e) Supply to machinery compartments of elevators in production buildings of fire danger level A and B, where need to maintain positive pressure in comparison with the outside.

6.17 Flow rate of outdoor air supplied to emergency areas for the purpose of protecting against smoke must be calculated to ensure that positive pressure would not be less than 20Pa:

a) at the lower part of elevator shaft when elevator doors at all stories (except for the lowest stories) are closed.

b) at the lower part of each stair division while opening doors on exit ways from corridors or lobbies of the floor that is in fire to stairway or outdoor with the condition that doors for exiting from corridors or lobbies on all other stories are closed.

Flow rate of air supplied to buffering compartment operating in case of fire with a door opening to corridor, lobby or basement must be determined by calculating or taking 1.3 m/s as the wind speed on the door frame.

6.18 Number of air distribution point for creating positive pressure in stair frame must be adequate to ensure the uniformity of the pressure field. In air supply system for stair frame of a five-floor building or of a higher one, distance between air supplying points must not exceed 2 floors.

6.19 Calculation against smoke requires:

a) Temperature and speed of outdoor air in cold season. If speed of outdoor air in hot season is higher than that in cold season, the calculation must be rechecked according to the hot season parameter. Wind speed whether in hot season or cold season must not exceed 5 m/s;

b) Emergency exits must be located toward the effect direction of the wind to the facade of the buildings;

c) Excessive pressure in elevator shaft, in stair frame, a well as in buffering compartment shall be taken in relationship with wind pressure on building's face at wind direction;

d) Pressure on tightly closed doors on emergency exit way shall be no greater than 150 Pa;

e) For double winged door, only the area of the larger wing is taken.

Elevator cab must be located downstairs, and doors open to elevator shaft at this floor must be opened.

6.20 Protecting against smoke requires execution of the following regulations:

a) Air supply system in charge of creating pressure must be so designed and installed as to ensure the reliability and persistency of the air supply line from outdoor air opening to air distribution points in stair frame in case of fire;

b) Air supply system in charge of creating pressure must be automatically activated according to fire alarming order.

Beside that, fan's switch and indicator lamp must be so organized that fire fighting staff can activate the fan from fire protection commanding centre, where there is not such centre these shall be located on the main fire alarming board.;

c) Centrifugal fan or axial fan should be installed in their own room, separated from fans used for other purposes by fire resistant partition level I (corresponding to fire danger level A). Fans can be installed outdoor or on the roof of the building, equipped with protective fence for protecting from people that are not in charge.

d) Air duct must be manufactured from non-flammable material its fire resistant rate of 0.5 h;

e) Fan shall be equipped with check valve. The installation of check valve on fan can be omitted if the amount of excessive heat in production room, where this fire protection system is installed exceed $20W/m^3$;

f) Outdoor air openings must be at least 5m away from smoke exhaust openings.

7. Cold supply

7.1 Cold supply system using natural or artificial cold source must be desinged where microclimate parameter according to standard cannot be ensured by methods of direct or indirect eveporative cooling. The choosing of cold source must be made with consideration of economical-technical conditions.

7.2 Cold supply system is often comprised of two or more machine assemblies or cooling systems; a cooling machine or a cooling system with ability to adjust cooling capacity can be designed; air conditioning system level 1 operating all day and night should be equipped with a spare cooling machine.

The number of cooling machine used for air conditioning in production buildings must be determined from the fluctuation condition of outdoor climate and conditions for ensuring technological requirements of production line when a cooling machine of the greatest capacity breaks down and stops working.

7.3 Cooling losses on equipments and duct of cold supply system must be determined by calculation (thermal insulation calculation), however, the value must not exceed 10% cooling capacity of cooling system.

7.4 Direct evaporative cooling coil (refrigerant evaporating coil) can be applied:

a) For rooms that are free from uncovered fire;

b) If evaporating coil is connected to the separate refrigerant circulation loop of a cooling machine;

c) If the amount of refrigerant when operating emergency discharge from the circulation loop into the room of the smallest bulk does not exceed the permitted emergency concentration specified in Table 2

Table 2 – Permitted emergency concentration

Type of refrigerant	**R22**	**R123**	**R134 A**	**R407 A**	**R410 A**	**R500 Composition according to mass: 73.8%R12 + 26.2%R152a**	**R502 Composition according to mass: 48.8%R22 + 51.2%R115**
Permitted emergency concentration, g/m^3	360	360	360	360	410	410	460

For cooling coil that serves a group of room, concentration of refrigerant q, measured in g/m^3 in any room must be determined according to the following formula:

$$q = \frac{mL_N}{V_p \sum L_N} \qquad (5)$$

Where:

m is mass of refrigerant in cooling circulation loop, measured in gram (g);

L_N is flow rate of outdoor air supplied to the room, measured by cubic meter per hour (m^3/h);

V_p is volume of the room, measured by cubic meter (m^3);

$\sum L_N$ is total amount of air supplied to all rooms; measured by cubic meter per hour (m^3/h).

7.5 In order to regulate the cooling capacity for enhancing full load factor and utilizing low-load power, cold supply system using water (and salted water) must be designed with cold storage tank.

7.6 Boiling temperature of refrigerant in evaporating coil of tube type (where refrigerant boils in the area between tubes) in charge of cooling water should be no less than (+2 °C); for evaporating coil of other types, the temperature taken should not be less than (-2 °C).

7.7 A system of compressor-type cooling machines which contains more than 250kg lubricant in any of its machines must not be located in production compartments, public buildings, administrative-service buildings, if above the ceiling or below the floor of this cooling machine compartment is a temporary or regularly crowed area.

7.8 Cooling system that uses ammoniac can be used for supplying cold for production plants, if the machine is located in a separate building, in lean-to or in a separate room of a single-storey workshop. Condensing coil and evaporating coil can be arranged outdoor at the distance of at least 2m away from the walls of the building.

Direct evaporating cooling coil which uses ammoniac as the refrigerant must not be used for cooling air supposed to be supplied for rooms.

7.9 Vapour absorption cooling machine using ejector pump and Br-Li absorption cooling machine must be located outdoor or in a separate machinery compartment of production workshop.

7.10 Machinery compartment for installation of Br-Li cooling machine and vapour ejector cooling machine or cooling machine with heat pump mechanism must be classified as of fire danger level E, and ammoniac cooling machine shall be of fire danger level B. Cooling machine oil must be stored in a separate compartment.

7.11 Opening for exhausting refrigerant from safety valve must be at least 2m above the window, the door and the air taking openings, and at least 5m above the ground. Discharging flow must be directly skyward. Ammoniac refrigerant exhaust opening must be at least 3m above the roof of the building.

7.12 Machinery compartment for installation of cooling machine must be generally ventilated in order to eliminate excessive heat by mechanical exhaust system designed to be in capable of:

a) discharging air with air exchanging multiple is 3; in emergency cases, air exchanging multiple must be ensured to be 5 for types of refrigerant mentioned in Table 2;

b) discharging air with air exchanging multiple is 4; in emergency cases, air exchanging multiple shall be 11 for ammoniac refrigerant.

8. Using of secondary thermal energy source

8.1 Ventilation-air conditioning system should be designed with ability to utilize secondary thermal energy source (SES):

a) Recaptured from discharged air of general ventilation systems and local exhaust ventilation systems;

b) Recaptured from technological devices under the form of cold energy and heat energy can be used for purposes of ventilation – air-conditioning.

The possibility to recapture heat from natural ventilation system may not need to be mentioned.

8.2 Effectiveness of using SES for ventilating-air conditioning purposes, choosing heat (cold) usage map, choosing heat equipments and heat pump, etc must ha enough economic-technical substantiation taking into account the stability of SES as well as of the need to use this energy source in technical system.

Where design solutions bring about same economic values (within the range of ± 5% according to recovery cost), solution that help to save more fuel shall be chosen.

8.3 Concentration of hazardous substances in air when using thermal (cold) SES must not exceed the values mentioned in 4.3.3.

8.4 In equipments that recycle excessive heat according to air-air and gas-air map, at air duct connecting points, pressure of air supplied to construction must be ensured to be higher than pressure of discharged gas or air. Maximum difference in pressure must not exceed the value permitted according to technical documents of excess heat recycle equipment.

In heat recycle equipment of air-to-air type or gas-to-air type, the possibility of hazardous gas spreading due to technical characteristics of the equipment need to be considered.

8.5 Air to air heat recycle equipment (as well as heat recycle equipment using heat tube principle) must not be used for heating (cooling) air supplied to building, if it utilizes the energy of:

a) air taken from production compartments of fire danger level A and B; air taken from production compartments of fire danger level A and B can be used for cooling (heating) these compartment themselves if the equipments used is of anti-explosion level;

b) Air taken from local exhaust system exhausting explosive mixture or mixture that contains hazardous substance type 1. Air taken from local exhaust system exhausting mixture with non-explosive dust can be used if it has been dust filtered;

c) Air with deposited matters or condensed matters sticking on heat exchanging surface of hazardous type 1 and 2, or with annoying smell used in heat recycle equipment according to heat resumption diagram, or in heat recycle equipments operated according to heat tube principle;

d) Air that contains pathogenic virus, bacteria, fungus at dangerous concentration according to regulations of authorized sanitary and epidemic organization.

8.6 In heat recycle equipments, heat energy of dangerous or hazardous gas, solution can be used for heating (cooling) air supplied to building under the role of intermediate heat carrying agent inside duct line or closed heat exchanging coil, providing that there is agreement of supervising authorities. If there is not such an agreement, supplemental heat circuit diagram should be used with heat carrying agent free from hazardous substance type 1,2 and 3; this diagram should also be used where there is possibility that the concentration of the hazardous substances mentioned above could exceeds the permitted concentration in case of emergency discharge into the building.

8.7 In heat recycle equipment of contact type (ejector chamber type) used for heating (cooling) air supplied to building, domestic water or hydro-solvent that is free from hazardous substances shall be used.

8.8 When using heat from ventilation system that contains dust or deposited aerosol, air must be filtered for achieving permitted dust concentration according to technical standard for heat recycle equipments, at the same time, heat exchanging surfaces must be periodically cleaned by suitable method.

8.9 In systems using SES, measures for preventing the frost of secondary heat carrying agent or for eliminating the forming of frost on the surfaces of heat recycle equipments must be considered.

8.10 Spare heat (cold) supply system accompanied with system recycling SES taken from ventilation system or technological system can be applied when economic-technical substantiation foundation is sufficient.

9. Power supplying and automatizing

9.1 Power source supplied for ventilation-air conditioning system must be classified into equal grade with the system supplying power for technological network and technical network of the construction.

Power supplied for emergency ventilation and smoke protection system, except for after fire smoke exhaust system (see 6.14), must be classified as grade 1. In cases where electric supplied for level 1 consumer could not be taken from two independent electric sources, it would be allowed to be taken from two different transformers of a electrical substation containing two transformers, or from two adjacent electrical substations – each substation contains a transformer. In this case, the substations must be mounted with two different electric supply lines, installed on different routes and must be equipped with spare automatic switching units, often at low voltage side.

9.2 Constructions and buildings with smoke exhaust protection system should be equipped with automatic fire alarm systems.

9.3 For constructions and buildings equipped with automatic fire fighting systems or automatic fire alarm systems, interlock (except power source for equipments mounted with single phase lighting system) must be designed for ventilation-air conditioning systems as well as smoke protection systems with these systems in order to:

a) Shutdown the power supplied for ventilation-air conditioning system in case of fire, except for system supplying air to buffering compartments of production rooms of fire danger level A and B;

b) Activate the emergency air supply system for preventing smoke (except for systems mentioned in 6.14);

c) Open smoke exhaust valves in the room or area where there is smoke, where is in fire, as well as in corridor of the in-fire storey and close the fire dampers (see 5.12.1).

Smoke dampers and fire dampers, ventilation openings, open-close mechanism on smoke exhaust shaft, windows, etc in charge of protecting against smoke must be equipped with mechanisms of automatic control, remote control and manual control (at the position of the equipment)

Note:

1) The need for shutting down the whole or a part of ventilation-air conditioning systems must be determined according to technological requirements;

2) Rooms that only have human-operated fire alarm system must be equipped with remote control equipments for stopping the ventilation-air conditioning systems that serve these areas, as well as activating the air supply system for smoke protection.

9.4 Rooms with automatic fire alarm systems must be equipped with remote controlled circuit breakers which are located outside the rooms served by these system.

Where there is need for shutting down at the same time all ventilation-air conditioning systems in production compartments of fire danger level A and B, remote control mechanism must be arranged outdoor.

For production compartments of fire danger level B, remote control system for shutting down ventilation-air conditioning system can be designed for each area of no less than 2500 m^2 .

9.5 Equipments, metal ducts and air ducts of ventilation-air conditioning systems in production compartments of fire danger level A and B, as well as local exhaust system discharging explosive mixture must be grounded in accordance with requirements on electrical installation.

9.6 Level of automatic control and restrain within the system must be so determined as to be economical reasonable and meet the technological requirements.

9.7 Parameters of heat (cold) carrying agents and air must be controlled in the following systems:

a) Local heat supply system: temperature and pressure of heat carrying agent on supply duct line and return duct line at machinery compartment for ventilation equipments; temperature and pressure on the outlet of heat exchanger;

b) Hot air heating and supply ventilation: temperature of supplied air and temperature of air in standard rooms (according to technological requirements);

c) Air diffuser: temperature of supplied air;

d) Air conditioning: temperature of outdoor air, circulated air, air supplied into the building, behind ejector chambers or behind cooling coils, air inside rooms, relative humidity of air (in case it is necessary to control this parameter);

e) Cold supply: temperature of cold carrying agents in front of and behind each heat exchanger or mechanism for mixing cold carrying agent, pressure of cold carrying agent in general duct line;

f) Ventilation – air conditioning includes filter set, static pressure chamber, heat recycle equipment: pressure and difference in pressure (according to requirements on technology, equipments as well as operation).

9.8 Remote measurement and inspection equipments must be used for measuring major parameters; remaining parameters should be measured by in-place measurement equipments (field assembled equipments or hand-held equipments).

Where a number of system is placed in a machinery compartment, a temperature and pressure measurement equipment should be arranged on general heat (cold) supply duct and at separate measurement points on the outlets of heat consumers.

9.9 Need to design signals on equipment operation states: “run”, “stop”, “break down”, etc of:

a) Ventilation-air conditioning systems serving rooms without natural ventilation of industrial buildings, administrative-activity buildings and public buildings;

b) Local exhaust system exhausting hazardous substances type 1 and 2 and explosive mixtures;

c) General exhaust ventilation system in production compartments of fire danger level A and B;

d) Exhaust ventilation system of storage compartments storing materials of fire danger level A and B, where the unreliability of microclimate parameters can cause breakdown.

Note: Requirements for areas without natural ventilation shall not apply to toilet rooms, smoking rooms, clothes storage rooms, etc and similar rooms.

9.10 Measuring, inspecting and remote controlling of major parameters in ventilation-air conditioning system must be carried out in accordance with technological requirements.

9.11 Automatic parameter controlling system must be used for:

a) Exhaust and supply ventilation systems operating with variable displacements or with variable mixing ratios between outdoor air and circulated air;

b) Supply ventilation system (if there is sufficient evidence);

c) Air conditioning system;

d) Cold supply system.

Note: Public building, administrative-activity building and production building should be equipped with programmed control systems in order to ensure the saving of heat and cold energy.

9.12 Environmental parameter measuring heads should be installed at points that show the characteristics of rooms or working places, at places where the measuring heads shall be free from the impacts of cold or hot surfaces or air flows. Measuring heads can be arranged in circulated or discharged air duct, if parameter of air inside there is not different from parameter of air inside the room or is different by a constant value.

9.13 Interlocking system must be designed for:

a) Closing or opening outdoor air damper when fans are turned on or off;

b) Closing or opening dampers of ventilation system which are connected to one another by air duct in order to replace a part of the system when another part technically breaks down;

c) Closing dampers on air duct (see 6.14) for rooms equipped with gas fire fighting system after the ventilation systems of these rooms are turned off;

d) Starting spare equipments when the mains equipments encounter problems;

e) Opening and closing sources that supply heat carrying agents when air processing equipments are started or turned off;

f) Activating emergency ventilation system whenever there is hazardous substance with concentration exceeding permitted concentration in working places, or when concentration of combustible substance in the space exceeds 10% lower ignition limit of gas, dust, air mixtures.

9.14 Automatic interlocking systems of air fans of local exhaust and general exhaust ventilation systems mentioned in 5.2.12 and 5.2.13, where spare fans are not installed, connected with technological devices must be able to stop the devices when the fans break down and stop working, if the systems are incapable of stopping the technological devices, they must be able to send out alarm signal.

9.15 Systems with variable circulated air and outdoor air mixing flow rate must be equipped with interlocks in order to ensure the minimum flow rate of outdoor air.

9.16 For exhaust ventilation system with mechanism of dust filtering using wet filters, fans must be interlocked with the system in charge of supplying water for wet filters in order to ensure that:

a) The water supply system would start when the fans start;

b) The fans would stop when the supplying of water stops or when the water levels in the filters decrease;

c) The fans would not be able to start when there is not any water or when the water level in the filter is lower than the regulated level.

9.17 The activation of air curtain must be interlocked with the opening-closing stage of gates, doors or openings of production line. The shutting down of air curtain must also be operated interlockedly when the gates, doors or openings of production line are closed and when the thermal condition inside the construction is recovered.

9.18 Management of ventilation-air conditioning systems in industrial and civil constructions, residential and administrative-activity buildings must be organized simultaneously with management of the buildings, which includes management systems, technological processes or technical devices.

9.19 Precision of microclimate maintenance inside a construction with air conditioning system (where there is not any special requirement) is regulated as follow:

a) For air conditioner of grade 1 and 2: ± 1 °C and ±7 % relative humidity;

b) For local air conditioner or additional micro-adjust air conditioning coils with separate sensing heads: ±2°C

10. Related architectural design solutions

10.1 Opening or window of industrial building which is used for natural ventilation during hot season must be located at the height of no greater than 1.8 m above the building's floor or working platform, measured to the bottom frame of the opening. For area with cold season, it is necessary to design measures for preventing the direct impact of cold wind on working positions that are near the doors when organizing natural ventilation.

In residential building, public building or administrative-activity building, openable door and windows should be designed for taking outdoor air for the constructions.

10.2 For openings, louvers and winged doors of industrial buildings, public buildings locating at the height of at least 2.2m, there must be manual opening-closing mechanism or remote opening-closing mechanism arranged within working area; for serving purposes of discharging smoke in case of fire, this mechanism must be located outdoor.

10.3 Working platform and fixed ladder used for installing, operating, repairing devices and mechanism of machines located at the height of at least 1.8 m above the floor or above the ground must be designed according to technical requirements for safety.

Duct appurtenances, air fans as well as local air conditioners can be repaired, mounted-demounted, or serviced from moving mechanisms with the condition that requirements of safety procedures are ensured.

10.4 For repairing and serving ventilation-air conditioning systems and cooling machines, architectural structure must allow installation of lifting device as specified in 5.11.10.

10.5 Cladding structure of ventilation machinery compartment located outside fire prevention wall (see 5.11.4) must be constructed with fire resistant rate of 0.75h, for structure of door – fire resistant rate of 0.6h.

10.6 For installing and mounting-demounting ventilation devices and cooling devices (or for replacing them where needed), distance for operation must be provided.

11 Water supply and drainage

11.1 Water supplying for injection chamber, sprayed coils, additional humidification and other air treating mechanism must meet the requirements of standards for potable water.

11.2 Water recirculated in injection chamber as well as in other equipments of ventilating-air conditioning system must be filtered out. Where there is higher requirement on sanitary, the water shall be bacteriological filtered.

11.3 Industrial water can be used for wet filter of dust collecting system (except for cases where filtered air shall be recirculated) or for cleaning wind-supplying equipment and heat-using equipment.

11.4 Duct line for discharging water from air processing device and for draining condensation water must be designed to discharge onto drainage system.

11. 5 Quality of water (hardness, pH level, sludge content…) used for cooling refrigerating device must be ensured according to technical condition for refrigerating machine.

Annex A

(normative)

Indoor air calculated parameters

used for designing air conditioning system ensuring thermal comfortable conditions

Table A.1

No.	Working status	Winter			Summer		
		Temperature t, °C	Relative humidity φ,%	Wind speed v, m/s	Temperature t, °C	Relative humidity φ, %	Wind speed v, m/s
1	Static rest	from 22 to 24	from 70 to 60	from 0.1 to 0.2	from 25 to 28	from 70 to 60	from 0.5 to 0.6
2	Light work	from 21 to 23	from 70 to 60	from 0.4 to 0.5	from 23 to 26	from 70 to 60	from 0.8 to 1.0
3	Medium work	from 20 to 22	from 70 to 60	from 0.8 to 1.0	from 22 to 25	from 70 to 60	from 1.2 to 1.5
4	Heavy work	from 18 to 20	from 70 to 60	from 1.2 to 1.5	from 20 to 23	from 70 to 60	from 2.0 to 2.5

Note:

1) Each working state corresponds to an amount of heat transforming inside human body – called thermal metabolism Q_M. According to many published documents over the world, thermal metabolism Q_M shall be as specified in table A.2

Table A.2

Working status	Metabolism value Q_M W	Average Q_m value W
Static rest	≤ 100	90
Light work	from 140 to 175	160
Medium work	from 175 to 300	240
Heavy work	> 300	350

2) With limits of microclimate parameters given in Table A.1 and metabolism Q_M values given in table A.2, if temperature of radiating surfaces (temperature of inner surfaces of wall, roof, etc) is 12°C in winter and 33°C in summer, the Belding-Hatch Heat Stress Index (HIS), as calculated, shall fluctuate with thin the range ≤10.

HSI values in the range 0÷10, for the body of Vietnamese people, in the condition of tropical climate with high temperature and humidity, can be considered satisfactory. More specifically, HSI values in the above range shall provide normal thermesthesia with little or no heat stress.

When surface temperature decreases, wind speed can be reduced and vice versa, when surface temperature increases, wind speed should be increased, but should not exceed 2.5 m/s for residential building and 3.5m/s for industrial buildings (see 4.1.3)

Here are some specific calculated result:

Example 1: in the state of static resting (reading book, reading newspaper, etc) Q_M *= 86 kcal/h = 100W; in summer, if taking* t_K*= 28°C,* φ_K *= 60 % and V = 0.3 m/s, we will have HSI = 18.33 - unsatisfactory, pretty hot. If the wind speed increases to v = 0.5 m / s, then the HSI = 9.81 <10 - good.*

Example 2: In the state of heavy working Q_M *= 300 kcal/h ≈ 350 W, also in summer if* t_K*=* ***28°C****,* φ_K *= 60 % and v = 1.5 m / s, HSI shall be 13.57 – there is heat stress which means a little hot. When the wind speed increases to v = 2 m / s, the HSI = 9.2 <10 - good.*

In both example, radiation surface temperature t_R *= 28°C.*

3) When there is no special requirement, precision for maintaining comfortable microclimate condition must ensure the temperature tolerance to be Δt = ±1 °C and the relative humidity tolerance to be Δφ = ± 7%

4) Precision for maintaining comfortable temperature, when local air conditioner or local mixer with direct temperature sensing head is used, is allowed to be ± 2 °C

For some constructions of special functions, as well as technological processes that need to be operated in a environment of specific temperature and humidity level, data mentioned in Table A.3 shall be referred.

Table A.3 – Reasonable calculated parameters of indoor air serving occupational and technological requirements.

No.	Technology or construction type	Temperature t, °C	Relative humidity φ,%	Wind speed v, m/s
1	Operating room in hospital	from 20 to 25	from 50 to 60	from 1 to 1.3
2	Library, book storage room	from 20 to 28	from 50 to 60	
3	Museum show room (objects made from wood, paper, leather, glued objects)	from 20 to 26	from 50 to 60	
4	Printing factory - Multi color printing - Regular printing	 from 24 to 26 from 24 to 26	 from 50 to 55 from 55 to 60	
5	Photographic and film technology - develop film - air dry film - Photopaper and developer storage room	 from 20 to 24 from 22 to 26 from 20 to 27	 60 ±5 60 ± 5 from 40 to 50	
6	Textile factory - Yarn combing workshop - Yarn spinning workshop - Weaving workshop	 from 22 to 28 from 24 to 28 from 22 to 28	 from 55 to 50 from 60 to 50 from 75 to 70	
7	Rayon industry - Spinning workshop - Packaging workshop - Weaving workshop - Laboratory for testing physico-mechanical characteristics of fibre and cloth	 from 24 to 26 from 18 to 20 from 24 to 26 from 20 to 2	 60 ±5 50 ±3 55 ±5 55 ±5	
8	Tobacco factory - Tobacco storage room - Tobacco fibre workshop - Tobacco wrapping workshop - Tobacco milding chamber	 from 20 to 26 from 20 to 26 from 20 to 26 from 24 to 1	 from 75 to 80 from 70 to 75 from 65 to 70 from 75 to 5	
9	Black tea factory -Tea rolling compartment - Fermenting compartment - Screening and packaging compartment	 from 20 to 28 from 20 to 26 from 20 to 28	 from 90 to 95 from 95 to 98 from 55 to 65	

No.	Technology or construction type	Temperature t, °C	Relative humidity φ,%	Wind speed v, m/s
10	Precision mechanic - Thermostat room - Optical glass melting workshop - Refractor polishing workshop - Workshop for manufacturing electric measuring instrument - Computer room	 from 18 to 20 24+1 24 ± 0.5 from 22 to 26 from 20 to 28	 40 ±5 45 ±5 80 ± 5 from 50 to 55 from 50 to 70	

Annex B

(normative)

Outdoor calculation parameters for air conditioning according to hours of non-assurance, m (h/year) or assurance coefficient K_{bd}

Region: Ha Giang

According to meteorological data of 24 measurements per day; 19 years includes of 2 periods: year 1981 and from year 1983 to 2000

Summer

m, h/year	K_{bd}	I, kJ/kg /kcal/kg	t, °C	φ, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	110.00/26.27	38.0	64.3	31.6	991.5 (743.2)
35	0.996	94.76 / 22.63	37.0	55.1	28.8	
50	0.994	93.70/22.38	36.8	55.0	28.5	
100	0.989	91.64/21.89	36.0	56.1	28.1	
150	0.983	90.25/21.55	35.8	55.5	27.8	
200	0.977	89.31 /21.33	35.6	55.3	27.6	
250	0.971	88.46/21.13	35.4	55.1	27.5	
300	0.966	87.74/20.95	35.3	54.9	27.3	
350	0.960	87.16/20.82	35.2	54.9	27.2	
400	0.954	86.59 / 20.68	35.1	54.8	27.1	
450	0.949	86.03 / 20.55	34.9	54.7	26.9	
500	0.943	85.62/20.45	34.8	54.7	26.9	

Winter

m, h/year	K_{bd}	I, kJ/kg /kcal/kg	t, °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	14.00/ 3.34	3.0	92.0	2.5	996.4 (746.8)
35	0.996	23.54/ 5.62	8.0	91.4	7.3	
50	0.994	24.36/ 5.82	8.5	89.3	7.7	
100	0.989	26.59/ 6.35	9.6	89.3	8.7	
150	0.983	28.11 / 6.71	10.3	89.5	9.4	
200	0.977	29.36/ 7.01	10.8	90.0	9.9	
250	0.971	30.38/ 7.26	11.2	90.4	10.3	
300	0.966	31.17/ 7.44	11.5	90.3	10.7	
350	0.960	31.99/ 7.64	11.9	90.7	11.0	
400	0.954	32.62/ 7.79	12.2	90.3	11.3	
450	0.949	33.16/ 7.92	12.4	89.8	11.5	
500	0.943	33.74/ 8.06	12.7	89.8	11.7	

Region: Sapa

According to meteorological data of 24 measurements per day; 17 years: from 1988 to 2004

Summer

m, h/year	**K_{bd}**	**I,** kJ/kg /kcal/kg	**t,** °C	, %	**t_u,** °C	**P_{kq},** mbar (mmHg)
0	1.000	82.00/ 19.58	29.0	67.5	23.9	839.5 (629.2)
35	0.996	72.24/ 17.25	27.4	62.9	21.7	
50	0.994	71.33/17.04	27.3	62.4	21.5	
100	0.989	69.33/ 16.56	26.9	61.5	21.0	
150	0.983	67.99/ 16.24	26.7	60.7	20.7	
200	0.977	67.19/16.05	26.5	60.6	20.5	
250	0.971	66.36/ 15.85	26.4	60.0	20.3	
300	0.966	65.71 / 15.69	26.2	59.7	20.1	
350	0.960	65.19/15.57	26.1	59.7	20.0	
400	0.954	64.68/ 15.45	26.0	59.5	19.8	
450	0.949	64.17/15.33	25.9	59.2	19.7	
500	0.943	63.79 / 15.23	25.8	59.0	19.6	

Winter

m, h/year	**K_{bd}**	**I,** kJ/kg /kcal/kg	**t,** °C	, %	**t_u,** °C	**P_{kq},** mbar (mmHg)
0	1.000	6.00/ 1.43	-2.0	81.5	-3.1	838.4 (628.4)
35	0.996	11.96/ 2.86	1.2	86.0	0.3	
50	0.994	12.19/ 2.91	1.7	81.4	0.4	
100	0.989	14.39/ 3.44	2.7	84.5	1.6	
150	0.983	15.75/ 3.76	3.3	85.6	2.3	
200	0.977	16.85/ 4.03	3.8	86.7	2.8	
250	0.971	18.23/ 4.35	4.2	90.9	3.5	
300	0.966	18.50/ 4.42	4.5	88.2	3.6	
350	0.960	19.33/ 4.62	4.8	89.4	4.0	
400	0.954	20.21 / 4.83	5.1	91.1	4.4	
450	0.949	20.69/ 4.94	5.4	90.3	4.7	
500	0.943	21.30/ 5.09	5.7	90.3	4.9	

Region: Lai Chau

According to meteorological data of 24 measurements per day; 20 years: from 1983 to 2002

Summer

m, h/year	**$K_{bđ}$**	**I,** kJ/kg /kcal/kg	**t,** °C	, %	**t_u,** °C	**P_{kq},** mbar (mmHg)
0	1.000	102.00/24.36	40.0	49.3	30.0	
35	0.996	90.97/21.73	38.1	46.9	27.8	
50	0.994	89.93/21.48	37.9	46.8	27.6	
100	0.989	88.00/21.02	37.4	46.8	27.2	
150	0.983	86.86/20.75	37.0	46.9	26.9	
200	0.977	85.85/20.50	36.8	46.8	26.7	978.2
250	0.971	85.20 / 20.35	36.6	47.0	26.6	(733.2)
300	0.966	84.53/20.19	36.4	47.0	26.4	
350	0.960	83.89/20.04	36.2	47.0	26.3	
400	0.954	83.42/ 19.92	36.1	47.1	26.2	
450	0.949	82.96/ 19.81	35.9	47.1	26.1	
500	0.943	82.49/ 19.70	35.8	47.1	26.0	

Winter

m, h/year	**$K_{bđ}$**	**I,** kJ/kg /kcal/kg	**t,** °C	, %	**t_u,** °C	**P_{kq},** mbar (mmHg)
0	1.000	16.00/ 3.82	4.0	92.7	3.5	
35	0.996	26.67/ 6.37	9.4	91.5	8.7	
50	0.994	27.98/ 6.68	9.9	92.3	9.2	
100	0.989	30.36/ 7.25	11.0	92.2	10.3	
150	0.983	31.63/ 7.55	11.6	90.9	10.8	
200	0.977	32.83/ 7.84	12.1	91.5	11.3	988.5
250	0.971	33.52/ 8.01	12.5	90.2	11.6	(740.9)
300	0.966	34.39/ 8.21	12.8	90.6	11.9	
350	0.960	35.10/ 8.38	13.1	90.4	12.2	
400	0.954	35.62/ 8.51	13.4	89.8	12.4	
450	0.949	36.29/ 8.67	13.6	90.4	12.6	
500	0.943	36.88/ 8.81	13.8	90.7	12.9	

Region: Lang Son

According to meteorological data of 24 measurements per day; 20 years: from 1985 to 2004

Summer

m, h/year	**K_{bd}**	**I,** kJ/kg /kcal/kg	**t,** °C	, %	**t_u,** °C	**P_{kq},** mbar (mmHg)
0	1.000	100.00/23.88	37.0	58.8	29.6	
35	0.996	89.92/21.48	35.4	55.8	27.6	
50	0.994	88.74/21.19	35.3	55.2	27.3	
100	0.989	86.56 / 20.67	34.9	54.5	26.9	
150	0.983	85.43 / 20.40	34.7	54.2	26.6	
200	0.977	84.58 / 20.20	34.5	54.2	26.4	976.2
250	0.971	83.83/20.02	34.3	54.0	26.3	(731.7)
300	0.966	83.32/ 19.90	34.2	54.0	26.1	
350	0.960	82.81 / 19.78	34.1	54.1	26.0	
400	0.954	82.30/ 19.66	33.9	54.0	25.9	
450	0.949	81.86/19.55	33.8	54.0	25.8	
500	0.943	81.52/19.47	33.7	54.1	25.7	

Winter

m, h/year	**K_{bd}**	**I,** kJ/kg /kcal/kg	**t,** °C	, %	**t_u,** °C	**P_{kq},** mbar (mmHg)
0	1.000	10.00/ 2.39	0.0	100.0	0.0	
35	0.996	16.37/ 3.91	4.5	88.2	3.6	
50	0.994	17.32/ 4.14	5.0	88.3	4.1	
100	0.989	19.34/ 4.62	6.1	87.1	5.2	
150	0.983	20.81 / 4.97	6.8	88.1	5.9	
200	0.977	21.80/ 5.21	7.3	87.5	6.4	980.5
250	0.971	22.61 / 5.40	7.7	87.8	6.7	(734.9)
300	0.966	23.28/ 5.56	8.1	87.3	7.1	
350	0.960	23.85/ 5.70	8.4	86.9	7.3	
400	0.954	24.44/ 5.84	8.7	87.1	7.6	
450	0.949	24.96/ 5.96	8.9	86.8	7.8	
500	0.943	25.42/ 6.07	9.2	86.2	8.0	

Region: Yen Bai

According to meteorological data of 24 measurements per day; 20 years: from 1985 to 2004

Summer

m, h/year	K_{bd}	I, kJ/kg /kcal/kg	t, °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	106.00/25.32	39.0	57.3	31.0	999.3 (749.0)
35	0.996	95.60 / 22.83	37.1	55.8	29.0	
50	0.994	94.72/22.62	36.9	55.7	28.8	
100	0.989	92.99/ 22.21	36.2	56.9	28.5	
150	0.983	91.78/21.92	35.8	57.4	28.3	
200	0.977	90.92/21.72	35.6	57.5	28.1	
250	0.971	90.06/21.51	35.4	57.3	27.9	
300	0.966	89.46/21.37	35.3	57.2	27.8	
350	0.960	88.88/ 21.23	35.2	57.2	27.7	
400	0.954	88.29/21.09	35.0	57.2	27.5	
450	0.949	87.80/ 20.97	34.8	57.4	27.4	
500	0.943	87.40/20.87	34.6	57.9	27.3	

Winter

m, h/year	K_{bd}	I, kJ/kg /kcal/kg	t, °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	18.00/ 4.30	5.0	95.0	4.6	1004.6 (753.0)
35	0.996	25.75/ 6.15	9.0	92.8	8.4	
50	0.994	26.39/ 6.30	9.4	91.4	8.7	
100	0.989	28.39/ 6.78	10.3	91.7	9.6	
150	0.983	29.85/ 7.13	10.8	92.4	10.2	
200	0.977	30.71 / 7.33	11.3	91.6	10.5	
250	0.971	31.57/ 7.54	11.7	91.5	10.9	
300	0.966	32.40/ 7.74	12.0	91.9	11.2	
350	0.960	32.87/ 7.85	12.3	90.5	11.4	
400	0.954	33.49/ 8.00	12.6	90.5	11.7	
450	0.949	34.11 / 8.15	12.8	90.7	11.9	
500	0.943	34.69/ 8.28	13.0	90.7	12.2	

Region: Quang Ninh

According to meteorological data of 24 measurements per day; 20 years: from 1982 to 2001

Summer

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	108.00/ 25.79	36.0	72.5	31.4	1001.3 (750.5)
35	0.996	93.71 /22.38	34.6	65.0	28.7	
50	0.994	92.97/ 22.20	34.4	64.8	28.5	
100	0.989	91.29/21.80	34.2	64.3	28.2	
150	0.983	90.15/21.53	34.0	64.1	27.9	
200	0.977	89.51 /21.38	33.7	64.6	27.8	
250	0.971	88.94/21.24	33.4	65.2	27.7	
300	0.966	88.35/21.10	33.2	65.9	27.6	
350	0.960	87.85/20.98	33.0	66.1	27.5	
400	0.954	87.50/20.90	32.9	66.0	27.4	
450	0.949	87.14/20.81	32.9	65.9	27.3	
500	0.943	86.78 / 20.73	32.8	65.8	27.2	

Winter

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	16.00/ 3.82	6.0	68.9	3.7	1015.0 (760.8)
35	0.996	22.72/ 5.43	8.4	83.0	7.1	
50	0.994	23.69/ 5.66	8.9	83.1	7.5	
100	0.989	25.41 / 6.07	9.8	82.2	8.3	
150	0.983	26.84/ 6.41	10.2	85.4	9.0	
200	0.977	27.95/ 6.67	10.7	85.5	9.4	
250	0.971	28.86/ 6.89	11.1	85.9	9.8	
300	0.966	29.59/ 7.07	11.5	85.6	10.2	
350	0.960	30.32/ 7.24	11.8	85.7	10.5	
400	0.954	31.00/ 7.40	12.0	85.9	10.8	
450	0.949	31.60/ 7.55	12.3	85.8	11.0	
500	0.943	32.21 / 7.69	12.6	85.8	11.3	

Region: Hanoi

According to meteorological data of 24 measurements per day; 20 years: from 1971 to 1990

Summer

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	112.00/26.75	40.0	58.4	32.1	
35	0.996	95.53/22.82	37.8	53.4	29.1	
50	0.994	94.53 / 22.58	37.5	5á.4	28.9	
100	0.989	92.73/22.15	36.7	54.8	28.5	
150	0.983	91.53/21.86	36.4	55.2	28.3	
200	0.977	90.63/21.64	36.1	55.1	28.1	1004.2
250	0.971	89.86/21.46	35.9	55.4	27.9	(752.7)
300	0.966	89.38/21.35	35.6	56.0	27.8	
350	0.960	88.89/21.23	35.4	56.6	27.7	
400	0.954	88.39/21.11	35.1	57.2	27.6	
450	0.949	87.92/21.00	34.9	57.4	27.5	
500	0.943	87.58 / 20.92	34.8	57.5	27.4	

Winter

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	18.00/ 4.30	5.0	96.3	4.7	
35	0.996	23.02/ 5.50	8.6	83.4	7.2	
50	0.994	24.00/ 5.73	9.0	84.6	7.7	
100	0.989	25.66/ 6.13	9.6	85.8	8.5	
150	0.983	26.79/ 6.40	10.2	85.7	9.0	
200	0.977	27.74 / 6.63	10.6	85.5	9.4	1018.9
250	0.971	28.57/ 6.82	11.0	85.5	9.7	(763.7)
300	0.966	29.28/ 6.99	11.4	85.4	10.1	
350	0.960	29.98/ 7.16	11.7	85.5	10.4	
400	0.954	30.67/ 7.32	12.0	85.6	10.6	
450	0.949	31.27/ 7.47	12.2	85.5	10.9	
500	0.943	31.87/ 7.61	12.5	85.5	11.1	

Region: Nghe An (Vinh)

According to meteorological data of 24 measurements per day;

20 years, divided into 02 periods: from 1979 to 1985 and from 1989 to 2001

Summer

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	112.00/26.75	40.0	58.4	32.1	
35	0.996	94.55 / 22.58	38.4	50.3	28.9	
50	0.994	92.90/22.19	38.2	49.5	28.6	
100	0.989	90.46/21.61	37.3	50.7	28.1	
150	0.983	89.05/21.27	36.9	50.6	27.8	
200	0.977	87.96/21.01	36.7	50.4	27.5	1004.6
250	0.971	87.37 / 20.87	36.5	50.7	27.4	(753.0)
300	0.966	86.76/20.72	36.3	50.7	27.3	
350	0.960	86.14/20.57	36.1	50.7	27.1	
400	0.954	85.74 / 20.48	36.0	51.0	27.1	
450	0.949	85.41 /20.40	35.9	51.1	27.0	
500	0.943	85.08/20.32	35.7	51.3	26.9	

Winter

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	20.00/ 4.78	7.0	83.6	5.8	
35	0.996	27.76/ 6.63	10.1	91.5	9.4	
50	0.994	28.49/ 6.81	10.5	90.6	9.7	
100	0.989	30.53/ 7.29	11.4	90.3	10.6	
150	0.983	32.14/ 7.68	12.1	91.2	11.3	
200	0.977	33.15/ 7.92	12.6	90.3	11.7	1018.1
250	0.971	34.32/ 8.20	13.0	91.3	12.1	(763.1)
300	0.966	35.00/ 8.36	13.3	90.2	12.4	
350	0.960	35.78/ 8.55	13.6	90.4	12.7	
400	0.954	36.57/ 8.73	13.9	90.8	13.0	
450	0.949	37.20/ 8.88	14.2	90.5	13.3	
500	0.943	37.82/ 9.03	14.4	90.4	13.5	

Region: Da Nang

According to meteorological data of 24 measurements per day; 20 years: from 1985 to 2004

Summer

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	102.00/24.36	39.0	54.3	30.3	1005.0 (753.3)
35	0.996	91.51 /21.86	37.6	50.5	28.3	
50	0.994	90.63/21.65	37.4	50.3	28.1	
100	0.989	89.05/21.27	37.0	50.4	27.8	
150	0.983	87.96/21.01	36.8	50.2	27.5	
200	0.977	87.43 / 20.88	36.5	50.6	27.4	
250	0.971	86.88/20.75	36.4	50.7	27.3	
300	0.966	86.32/ 20.62	36.2	50.7	27.2	
350	0.960	85.87/20.51	36.0	51.1	27.1	
400	0.954	85.58 / 20.44	35.8	51.6	27.0	
450	0.949	85.27 / 20.37	35.6	52.0	27.0	
500	0.943	84.97/20.29	35.4	52.4	26.9	

Winter

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	30.00/ 7.17	10.0	100.0	10.0	1007.7 (755.3)
35	0.996	41.39/ 9.89	15.6	91.1	14.7	
50	0.994	42.36/ 10.12	16.1	90.1	15.1	
100	0.989	44.56/ 10.64	16.8	90.9	15.9	
150	0.983	46.02/ 10.99	17.3	91.0	16.4	
200	0.977	47.17/11.27	17.7	91.4	16.7	
250	0.971	48.18/ 11.51	18.0	91.4	17.1	
300	0.966	48.74/ 11.64	18.3	90.1	17.3	
350	0.960	49.37/ 11.79	18.6	89.4	17.5	
400	0.954	50.12/ 11.97	18.7	90.6	17.7	
450	0.949	50.82/ 12.14	18.9	91.6	17.9	
500	0.943	51.38/ 12.27	19.1	91.6	18.1	

Region: Buon Ma Thuot

According to meteorological data of 24 measurements per day; 20 years: from 1981 to 2000

Summer

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	98.00/23.41	37.0	55.8	28.9	955.8 (716.4)
35	0.996	79.99/19.10	35.7	44.0	25.1	
50	0.994	79.68/19.03	35.5	44.4	25.1	
100	0.989	78.54/18.76	35.1	44.5	24.8	
150	0.983	77.80/18.58	34.8	44.8	24.6	
200	0.977	77.39/18.48	34.6	45.4	24.5	
250	0.971	76.96/18.38	34.4	45.7	24.4	
300	0.966	76.52/18.28	34.2	45.9	24.3	
350	0.960	76.09/18.17	34.0	46.1	24.2	
400	0.954	75.83/18.11	33.9	46.3	24.2	
450	0.949	75.61/18.06	33.7	46.5	24.1	
500	0.943	75.39/18.01	33.6	46.7	24.1	

Winter

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	32.00/7.64	11.0	95.8	10.6	953.5 (714.7)
35	0.996	40.54/9.68	14.7	92.1	13.9	
50	0.994	41.66/9.95	15.1	92.2	14.3	
100	0.989	43.85/10.47	15.8	92.7	15.1	
150	0.983	44.96/10.74	16.3	91.7	15.4	
200	0.977	45.86/10.95	16.7	91.3	15.7	
250	0.971	46.67/11.15	16.8	92.2	16.0	
300	0.966	47.29/11.29	17.1	91.7	16.2	
350	0.960	47.82/11.42	17.3	91.5	16.4	
400	0.954	48.37/11.55	17.5	91.6	16.6	
450	0.949	48.91/11.68	17.6	91.7	16.7	
500	0.943	49.42/11.80	17.8	91.7	16.9	

Region: Nha Trang

According to meteorological data of 24 measurements per day;

19 years include of 02 periods: from 1981 to 1987 and from 1989 to 2000

Summer

m, h/year	**$K_{bđ}$**	**I,** kJ/kg /kcal/kg	**t,** °C	**,** %	**t_u,** °C	**P_{kq},** mbar (mmHg)
0	1.000	96.00/22.93	37.0	56.9	29.2	
35	0.996	89.27 /21.32	35.2	57.8	27.8	
50	0.994	88.47/21.13	35.0	57.7	27.7	
100	0.989	87.14/20.81	34.9	57.1	27.4	
150	0.983	86.09 / 20.56	34.7	56.6	27.2	
200	0.977	85.53 / 20.43	34.6	56.6	27.0	1006.4
250	0.971	85.01 /20.30	34.5	56.5	26.9	(754.3)
300	0.966	84.48/20.18	34.4	56.2	26.8	
350	0.960	83.98 / 20.06	34.3	56.0	26.7	
400	0.954	83.70/19.99	34.2	55.9	26.6	
450	0.949	83.42/ 19.92	34.2	55.9	26.6	
500	0.943	83.14/19.86	34.1	55.9	26.5	

Winter

m, h/year	**$K_{bđ}$**	**I,** kJ/kg /kcal/kg	**t,** °C	**,** %	**t_u,** °C	**P_{kq},** mbar (mmHg)
0	1.000	40.00/ 9.55	16.0	82.9	14.2	
35	0.996	47.74/ 11.40	18.7	84.3	16.9	
50	0.994	48.84/ 11.66	18.9	85.8	17.3	
100	0.989	50.86/ 12.15	19.5	86.3	17.9	
150	0.983	52.29/ 12.49	20.0	86.3	18.4	
200	0.977	53.28/ 12.73	20.1	87.7	18.7	1006.2
250	0.971	54.13/12.93	20.3	88.0	19.0	(754.2)
300	0.966	54.82/ 13.09	20.7	87.2	19.2	
350	0.960	55.49/ 13.25	21.0	86.5	19.4	
400	0.954	56.13/13.41	21.1	87.1	19.6	
450	0.949	56.61 / 13.52	21.2	87.7	19.7	
500	0.943	57.09/ 13.63	21.2	88.4	19.8	

Region: Da Lat

According to meteorological data of 24 measurements per day; 20 years: from 1985 to 2004

Summer

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	78.00/ 18.63	29.0	63.3	23.2	849.6 (636.8)
35	0.996	66.88 / 15.97	27.5	56.0	20.5	
50	0.994	65.85/ 15.73	27.4	55.1	20.3	
100	0.989	64.30/ 15.36	27.0	54.5	19.9	
150	0.983	63.52/15.17	26.9	54.0	19.7	
200	0.977	62.92/ 15.03	26.7	53.8	19.5	
250	0.971	62.32/ 14.88	26.6	53.5	19.4	
300	0.966	61.87/14.78	26.5	53.4	19.2	
350	0.960	61.58/14.71	26.4	53.4	19.2	
400	0.954	61.30/14.64	26.3	53.3	19.1	
450	0.949	61.01 / 14.57	26.3	53.2	19.0	
500	0.943	60.73/ 14.50	26.2	53.1	18.9	

Winter

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	20.00/ 4.78	6.0	80.3	4.4	846.5 (634.5)
35	0.996	28.04/ 6.70	8.9	89.9	8.0	
50	0.994	28.69/ 6.85	9.3	88.4	8.2	
100	0.989	30.94/ 7.39	10.1	89.9	9.2	
150	0.983	32.31 / 7.72	10.6	90.2	9.7	
200	0.977	33.64/ 8.03	11.0	91.4	10.2	
250	0.971	34.37/ 8.21	11.4	90.9	10.5	
300	0.966	35.18/ 8.40	11.6	91.5	10.8	
350	0.960	35.95/ 8.59	11.8	92.1	11.1	
400	0.954	36.53/ 8.72	12.1	92.1	11.3	
450	0.949	36.92/ 8.82	12.3	91.5	11.4	
500	0.943	37.33/ 8.92	12.5	91.1	11.6	

Region: Hochiminh City

According to meteorological data of 24 measurements per day; 20 years: from 1983 to 2002

Summer

m, h/year	**$K_{bđ}$**	**I,** kJ/kg /kcal/kg	**t,** °C	, %	**t_u,** °C	**P_{kq},** mbar (mmHg)
0	1.000	112.00/ 26.75	38.0	67.0	32.2	
35	0.996	94.05 / 22.46	36.8	56.0	28.8	
50	0.994	91.43/21.84	36.6	54.2	28.3	
100	0.989	86.80/ 20.73	36.3	50.8	27.3	
150	0.983	85.38 / 20.39	36.1	50.1	27.0	
200	0.977	84.50/ 20.18	36.0	49.9	26.8	1006.4
250	0.971	83.86 / 20.03	35.9	49.6	26.7	(754.3)
300	0.966	83.54/ 19.95	35.8	49.6	26.6	
350	0.960	83.22/ 19.88	35.7	49.7	26.5	
400	0.954	82.90/ 19.80	35.6	49.7	26.5	
450	0.949	82.57/ 19.72	35.5	49.7	26.4	
500	0.943	82.24 / 19.64	35.4	49.6	26.3	

Winter

m, h/year	**$K_{bđ}$**	**I,** kJ/kg /kcal/kg	**t,** °C	, %	**t_u,** °C	**P_{kq},** mbar (mmHg)
0	1.000	40.00/ 9.55	17.0	74.8	14.2	
35	0.996	50.98/ 12.18	19.6	86.1	18.0	
50	0.994	52.15/12.46	20.0	85.9	18.4	
100	0.989	54.54/ 13.03	20.5	88.4	19.1	
150	0.983	56.19/13.42	21.0	88.6	19.6	
200	0.977	57.25/ 13.67	21.3	88.5	19.9	1009.9
250	0.971	57.89/ 13.83	21.6	88.0	20.1	(756.9)
300	0.966	58.01 / 13.86	21.6	87.6	20.2	
350	0.960	58.03/ 13.86	21.7	87.1	20.2	
400	0.954	58.04/ 13.86	21.8	86.5	20.2	
450	0.949	58.05/ 13.86	21.9	86.0	20.2	
500	0.943	58.06/ 13.87	21.9	85.4	20.2	

Region: Can Tho

According to meteorological data of 24 measurements per day;

14 years: from 1986 to 1997 and from 1999 to 2000

Summer

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	110.00/26.27	36.0	75.0	31.8	
35	0.996	91.88/21.94	34.9	62.2	28.4	
50	0.994	90.21 /21.54	34.8	-60.8	28.1	
100	0.989	87.73 / 20.95	34.5	59.4	27.5	
150	0.983	86.56/20.67	34.4	58.7	27.3	
200	0.977	85.74 / 20.48	34.2	58.4	27.1	1008.2
250	0.971	85.26/20.36	34.1	58.4	27.0	(755.7)
300	0.966	84.78 / 20.25	34.0	58.4	26.9	
350	0.960	84.32/20.14	33.9	58.1	26.8	
400	0.954	83.93/20.05	33.9	58.0	26.7	
450	0.949	83.72/ 19.99	33.8	58.0	26.7	
500	0.943	83.50/ 19.94	33.7	58.1	26.6	

Winter

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	42.00 /10.03	17.0	80.8	14.9	
35	0.996	54.16 /12.94	19.9	91.9	19.0	
50	0.994	55.04/ 13.15	20.2	91.4	19.2	
100	0.989	57.40/ 13.71	20.8	92.1	19.9	
150	0.983	58.01 / 13.85	21.1	91.6	20.1	
200	0.977	58.02/ 13.86	21.2	90.7	20.1	1005.2
250	0.971	58.03/ 13.86	21.3	89.8	20.1	(753.4)
300	0.966	58.04/ 13.86	21.4	88.9	20.1	
350	0.960	58.05/ 13.86	21.5	88.1	20.1	
400	0.954	58.06/ 13.87	21.6	87.7	20.1	
450	0.949	58.07/ 13.87	21.6	87.4	20.1	
500	0.943	58.08/ 13.87	21.7	87.1	20.1	

Region: Ca Mau

According to meteorological data of 24 measurements per day; 20 years: from 1985 to 2004

Summer

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	102.00/24.36	37.0	62.7	30.4	
35	0.996	88.79/21.21	35.1	57.7	27.8	
50	0.994	87.85/20.98	35.0	57.4	27.6	
100	0.989	86.50/20.66	34.8	56.8	27.3	
150	0.983	85.74 / 20.48	34.6	56.8	27.1	
200	0.977	85.31 /20.38	34.5	57.0	27.0	1009.0
250	0.971	84.87 / 20.27	34.4	'56.9	26.9	(756.3)
300	0.966	84.42/20.16	34.3	56.8	26.8	
350	0.960	83.99 / 20.06	34.2	56.8	26.7	
400	0.954	83.81 /20.02	34.1	57.0	26.7	
450	0.949	83.63/ 19.97	34.0	57.1	26.6	
500	0.943	83.46/ 19.93	33.9	57.2	26.6	

Winter

m, h/year	K_{bd}	**I,** kJ/kg /kcal/kg	**t,** °C	, %	t_u, °C	P_{kq}, mbar (mmHg)
0	1.000	46.00/ 10.99	18.0	84.8	16.3	
35	0.996	56.94/ 13.60	20.7	92.2	19.8	
50	0.994	57.95/ 13.84	20.9	93.2	20.1	
100	0.989	58.01 /13.85	21.1	91.1	20.1	
150	0.983	58.02/ 13.86	21.3	89.9	20.1	
200	0.977	58.03/ 13.86	21.5	88.7	20.1	1004.8
250	0.971	58.04/ 13.86	21.6	87.8	20.1	(753.1)
300	0.966	58.05/ 13.86	21.6	87.3	20.1	
350	0.960	58.06/ 13.87	21.7	86.9	20.1	
400	0.954	58.07/ 13.87	21.7	86.5	20.1	
450	0.949	58.09/ 13.87	21.8	86.1	20.1	
500	0.943	58.10/13.88	21.9	85.7	20.1	

Annex C

(normative)

Outdoor calculation parameters according to excess level, % of dry-blub and wet-bulb temperature used for designing air conditioning according to ASHRAE

Outdoor calculation parameters for air conditioning

according to different excess levels of Ha Giang

Excess level MV, %		Assurance coefficient K_{bd}	Summer			Winter		
Summer	Winter		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	34.9	28.7	27.1	8.5	7.7	8.2
1.0	99.0	0.990	34.1	28.1	27.0	10.1	8.9	9.3
1.5	98.5	0.985	33.7	27.9	26.8	10.7	9.5	9.8
2.0	98.0	0.980	33.3	27.7	26.9	11.2	10.0	10.3
2.5	97.5	0.975	33.1	27.5	26.6	11.6	10.4	10.5
3.0	97.0	0.970	32.8	27.4	26.5	12.0	10.7	10.9
3.5	96.5	0.965	32.5	27.2	26.5	12.3	11.0	11.3
4.0	96.0	0.960	32.3	27.1	26.4	12.6	11.3	11.5
4.5	95.5	0.955	32.1	27.0	26.2	12.8	11.5	11.8
5.0	95.0	0.950	31.9	26.9	26.3	13.1	11.8	11.9

Outdoor calculation parameters for air conditioning according to different excess levels of Sapa

Excess level MV, %		Assurance coefficient K_{bd}	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	25.8	21.6	18.6	1.5	1.2	1.4
1.0	99.0	0.990	24.9	21.0	18.6	2.7	2.4	2.5
1.5	98.5	0.985	24.5	20.7	18.7	3.3	3.0	3.2
2.0	98.0	0.980	24.2	20.5	18.6	3.8	3.5	3.6
2.5	97.5	0.975	23.9	20.3	18.8	4.1	3.9	3.9
3.0	97.0	0.970	23.6	20.2	18.3	4.4	4.2	4.2
3.5	96.5	0.965	23.4	20.0	18.4	4.7	4.5	4.5
4.0	96.0	0.960	23.1	19.9	18.6	5.0	4.7	4.8
4.5	95.5	0.955	22.9	19.8	18.6	5.3	5.0	5.1
5.0	95.0	0.950	22.8	19.7	18.8	5.5	5.2	5.2

Outdoor calculation parameters for air conditioning

according to different excess levels of Lai Chau

Excess level MV, %		Assurance coefficient $K_{bđ}$	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	36.1	27.7	25.4	9.9	9.0	9.5
1.0	99.0	0.990	34.9	27.2	25.8	11.3	10.3	10.7
1.5	98.5	0.985	34.3	26.9	25.6	12.0	10.9	11.2
2.0	98.0	0.980	33.8	26.8	25.9	12.4	11.4	11.7
2.5	97.5	0.975	33.3	26.6	25.7	12.8	11.7	12.0
3.0	97.0	0.970	33.0	26.5	25.3	13.1	12.0	12.3
3.5	96.5	0.965	32.7	26.4	25.5	13.4	12.3	12.5
4.0	96.0	0.960	32.4	26.3	25.2	13.7	12.5	12.8
4.5	95.5	0.955	32.2	26.1	25.3	14.0	12.7	13.1
5.0	95.0	0.950	31.9	26.0	25.1	14.2	12.9	13.3

Outdoor calculation parameters for air conditioning

according to different excess levels of Lang Son

Excess level MV, %		Assurance coefficient $K_{bđ}$	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	33.8	27.6	26.5	5.1	4.0	4.3
1.0	99.0	0.990	33.0	26.9	25.8	6.5	5.3	5.6
1.5	98.5	0.985	32.5	26.7	25.7	7.3	6.0	6.3
2.0	98.0	0.980	32.2	26.5	25.7	7.8	6.5	6.8
2.5	97.5	0.975	31.9	26.3	25.5	8.3	6.8	7.0
3.0	97.0	0.970	31.6	26.2	25.5	8.6	7.2	7.4
3.5	96.5	0.965	31.3	26.1	25.3	8.9	7.4	7.9
4.0	96.0	0.960	31.1	26.0	25.2	9.2	7.7	8.0
4.5	95.5	0.955	30.9	25.9	25.1	9.5	7.9	8.2
5.0	95.0	0.950	30.7	25.8	25.0	9.7	8.1	8.4

Outdoor calculation parameters for air conditioning according to different excess levels of Yen Bai

Excess level MV, %		Assurance coefficient K_{bd}	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	35.2	28.9	27.9	9.5	8.6	8.9
1.0	99.0	0.990	34.2	28.5	27.6	10.6	9.7	9.9
1.5	98.5	0.985	33.7	28.3	27.6	11.2	10.3	10.4
2.0	98.0	0.980	33.3	28.1	27.3	11.6	10.7	10.9
2.5	97.5	0.975	33.0	27.9	27.2	12.0	11.0	11.2
3.0	97.0	0.970	32.8	27.8	27.1	12.3	11.3	11.5
3.5	96.5	0.965	32.5	27.7	27.0	12.6	11.6	11.8
4.0	96.0	0.960	32.3	27.6	27.0	12.9	11.8	12.0
4.5	95.5	0.955	32.1	27.5	26.8	13.1	12.1	12.3
5.0	95.0	0.950	31.8	27.4	26.7	13.4	12.3	12.4

Outdoor calculation parameters for air conditioning according to different excess levels of Quang Ninh

Excess level MV, %		Assurance coefficient K_{bd}	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	33.1	28.6	27.5	9.5	7.3	7.6
1.0	99.0	0.990	32.4	28.2	27.3	10.7	8.3	8.8
1.5	98.5	0.985	32.0	28.0	27.2	11.2	8.9	9.4
2.0	98.0	0.980	31.8	27.8	27.2	11.6	9.4	9.6
2.5	97.5	0.975	31.5	27.7	27.1	12.0	9.8	10.1
3.0	97.0	0.970	31.3	27.6	26.9	12.4	10.1	10.5
3.5	96.5	0.965	31.2	27.5	26.9	12.6	10.4	10.6
4.0	96.0	0.960	31.0	27.4	26.9	12.9	10.7	11.0
4.5	95.5	0.955	30.9	27.4	26.8	13.2	10.9	11.2
5.0	95.0	0.950	30.7	27.3	26.7	13.4	11.1	11.5

Outdoor calculation parameters for air conditioning according to different excess levels of Hanoi

Excess level MV, %		Assurance coefficient K_{bd}	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	35.4	29.0	28.0	9.6	7.5	8.4
1.0	99.0	0.990	34.4	28.5	27.9	10.6	8.5	9.1
1.5	98.5	0.985	33.8	28.3	27.6	11.1	9.1	9.5
2.0	98.0	0.980	33.4	28.1	27.5'	11.5	9.4	9.7
2.5	97.5	0.975	33.1	27.9	27.3	11.9	9.8	10.1
3.0	97.0	0.970	32.8	27.9	27.1	12.2	10.1	10.3
3.5	96.5	0.965	32.6	27.8	27.1	12.5	10.3	10.6
4.0	96.0	0.960	32.3	27.7	27.0	12.8	10.6	10.9
4.5	95.5	0.955	32.1	27.6	27.0	13.0	10.9	11.1
5.0	95.0	0.950	31.9	27.5	26.9	13.3	11.1	11.5

Outdoor calculation parameters for air conditioning

according to different excess levels of Nghe An (Vinh)

Excess level MV, %		Assurance coefficient K_{bd}	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	36.6	28.8	26.9	10.7	9.6	9.9
1.0	99.0	0.990	35.6	28.0	26.9	11.9	10.7	11.1
1.5	98.5	0.985	35.0	27.8	26.6	12.5	11.3	11.6
2.0	98.0	0.980	34.6	27.5	26.6	13.0	11.8	12.2
2.5	97.5	0.975	34.2	27.4	26.4	13.4	12.2	12.5
3.0	97.0	0.970	33.9	27.3	26.4	13.7	12.5	12.7
3.5	96.5	0.965	33.5	27.2	26.3	14.0	12.8	13.1
4.0	96.0	0.960	33.3	27.1	26.3	14.2	13.1	13.3
4.5	95.5	0.955	33.0	27.0	26.3	14.5	13.3	13.6
5.0	95.0	0.950	32.8	26.9	26.4	14.7	13.6	13.6

Outdoor calculation parameters for air conditioning

according to different excess levels of Da Nang

Excess level MV, %		Assurance coefficient K_{bd}	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	36.1	28.2	27.0	16.6	15.0	15.3
1.0	99.0	0.990	35.1	27.8	26.8	17.5	16.0	16.3
1.5	98.5	0.985	34.6	27.6	2ẹ.6	18.0	16.4	16.6
2.0	98.0	0.980	34.2	27.4	26.6	18.4	16.8	17.1
2.5	97.5	0.975	33.9	27.3	26.6	18.7	17.1	17.3
3.0	97.0	0.970	33.6	27.2	26.5	18.9	17.3	17.6
3.5	96.5	0.965	33.3	27.1	26.6	19.2	17.6	17.8
4.0	96.0	0.960	33.1	27.1	26.5	19.4	17.7	18.0
4.5	95.5	0.955	32.9	27.0	26.5	19.5	17.9	18.1
5.0	95.0	0.950	32.7	26.9	26.5	19.7	18.1	18.4

Outdoor calculation parameters for air conditioning

according to different excess levels of Buon Ma Thuot

Excess level MV, %		Assurance coefficient K_{bd}	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	34.3	25.1	22.0	15.5	14.1	14.4
1.0	99.0	0.990	33.4	24.8	22.5	16.4	15.1	15.2
1.5	98.5	0.985	32.8	24.6	22.3	16.9	15.5	15.7
2.0	98.0	0.980	32.4	24.5	22.4	17.2	15.8	16.0
2.5	97.5	0.975	31.9	24.4	22.7	17.5	16.0	16.2
3.0	97.0	0.970	31.6	24.3	22.7	17.8	16.2	16.5
3.5	96.5	0.965	31.3	24.3	22.7	18.0	16.4	16.7
4.0	96.0	0.960	31.0	24.2	22.9	18.1	16.6	16.8
4.5	95.5	0.955	30.7	24.1	22.9	18.3	16.7	17.0
5.0	. 95.0	0.950	30.5	24.1	23.0	18.5	16.9	17.2

Outdoor calculation parameters for air conditioning

according to different excess levels of Nha Trang

Excess level MV, %		Assurance coefficient K_{bd}	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	33.3	27.8	26.3	19.5	17.1	17.6
1.0	99.0	0.990	32.7	27.4	26.3	20.3	18.0	18.4
1.5	98.5	0.985	32.4	27.3	26.2	20.8	18.4	18.8
2.0	98.0	0.980	32.2	27.1	26.2	21.1	18.7	19.3
2.5	97.5	0.975	32.0	27.0	26.1	21.4	19.0	19.4
3.0	97.0	0.970	31.9	26.9	26.1	21.6	19.2	19.6
3.5	96.5	0.965	31.7	26.8	26.1	21.8	19.4	19.9
4.0	96.0	0.960	31.6	26.7	26.0	22.0	19.5	20.0
4.5	95.5	0.955	31.5	26.7	26.1	22.2	19.7	20.2
5.0	95.0	0.950	31.3	26.6	25.9	22.3	19.8	20.3

Outdoor calculation parameters for air conditioning

according to different excess levels of Da Lat

Excess level MV, %		Assurance coefficient K_{bd}	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	25.9	20.4	16.7	9.7	8.2	8.9
1.0	99.0	0.990	25.2	19.9	17.6	10.7	9.3	9.6
1.5	98.5	0.985	24.8	19.7	17.4	11.1	9.8	10.2
2.0	98.0	0.980	24.5	19.5	17.6	11.5	10.2	10.5
2.5	97.5	0.975	24.3	19.4	17.8	11.8	10.6	10.8
3.0	97.0	0.970	24.1	19.3	17.8	12.1	10.9	11.2
3.5	96.5	0.965	23.9	19.2	17.7	12.3	11.1	11.3
4.0	96.0	0.960	23.8	19.1	17.7	12.5	11.3	11.5
4.5	95.5	0.955	23.7	19.0	17.8	12.7	11.5	11.7
5.0	95.0	0.950	23.5	19.0	17.7	12.9	11.7	11.9

Outdoor calculation parameters for air conditioning

according to different excess levels of Hochiminh City

Excess level MV, %		Assurance coefficient $K_{bđ}$	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	35.4	28.6	25.7	20.7	18.1	18.7
1.0	99.0	0.990	34.7	27.4	25.7	21.6	19.1	19.7
1.5	98.5	0.985	34.3	27.0	25.6	22.1	19.5	20.1
2.0	98.0	0.980	34.0	26.9	25.5	22.5	19.9	20.5
2.5	97.5	0.975	33.8	26.7	25.5	22.8	20.1	20.7
3.0	97.0	0.970	33.6	26.6	25.4	23.0	20.4	21.1
3.5	96.5	0.965	33.5	26.5	25.4	23.2	20.6	21.3
4.0	96.0	0.960	33.3	26.5	25.3	23.4	20.7	21.5
4.5	95.5	0.955	33.2	26.4	25.3	23.5	20.9	21.7
5.0	95.0	0.950	33.0	26.4	25.3	23.6	21.0	21.9

Outdoor calculation parameters for air conditioning

according to different excess levels of Can Tho

Excess level MV, %		Assurance coefficient $K_{bđ}$	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	33.6	28.4	26.4	20.8	19.1	19.6
1.0	99.0	0.990	33.0	27.6	26.0	21.6	20.0	20.7
1.5	98.5	0.985	32.8	27.4	26.2	22.0	20.4	21.0
2.0	98.0	0.980	32.5	27.2	26.2	22.2	20.7	21.2
2.5	97.5	0.975	32.3	27.0	26.1	22.5	20.9	21.5
3.0	97.0	0.970	32.1	26.9	26.1	22.7	21.1	21.7
3.5	96.5	0.965	32.0	26.9	26.0	22.8	21.3	21.8
4.0	96.0	0.960	31.8	26.8	25.9	23.0	21.4	21.9
4.5	95.5	0.955	31.7	26.7	25.9	23.1	21.5	22.1
5.0	95.0	0.950	31.6	26.7	25.9	23.2	21.6	22.2

Outdoor calculation parameters for air conditioning according to different excess levels of Ca Mau

Excess level MV, %		Assurance coefficient $K_{bđ}$	Summer			Winter		
Summer	Summer		t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C	t_{dry} °C	t_{wet} °C	$t_{wet,coinc}$ °C
1	2	3	4	5	6	7	8	9
0.4	99.6	0.996	34.2	27.7	25.9	21.5	20.0	20.3
1.0	99.0	0.990	33.6	27.3	25.8	22.2	20.6	21.1
1.5	98.5	0.985	33.3	27.1	25.9	22.5	21.0	21.4
2.0	98.0	0.980	33.0	27.0	25.7	22.7	21.2	21.6
2.5	97.5	0.975	32.8	26.9	25.7	22.9	21.4	21.8
3.0	97.0	0.970	32.6	26.9	25.9	23.1	21.5	21.9
3.5	96.5	0.965	32.4	26.8	25.8	23.2	21.7	22.0
4.0	96.0	0.960	32.3	26.7	25.7	23.3	21.8	22.2
4.5	95.5	0.955	32.1	26.7	25.7	23.5	21.9	22.4
5.0	95.0	0.950	32.0	26.6	25.7	23.6	22.0	22.4

Note:

1) Calculated parameters for air conditioning taken according to excess level of dry bulb temperature and wet bulb temperature are proposed by ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) and is applied worldwide, especially in countries of English-American system.

2) Value of temperature taken according to excess level % is the value that frequency or duration of the appearance of temperature value equal or greater(in summer as well as in winter) than the taken value accounts for MV% of the total frequency or total duration in a year.

The relationship between excess level MV and assurance coefficient $K_{bđ}$ is shown in the following formula: $MV = (1 - K_{bđ})100\%$ - in summer, or $MV = K_{bđ} \times 100\%$ - in winter.

3) In summer, the higher the calculation temperature is, the smaller the value of MV% shall be; in contrast, in winter, the lower the calculation temperature is, the greater the value of MV% shall be. Hence, the two values of summer and winter excess level on the same line of the above table correspond to a same assuarance coefficient ***$K_{bđ}$***.

4) Excess level MV% shall be treated separately for dry-bulb temperature and wet-bulb temperature, these two parameters are considered to be independent with each other. However, for taking into account the simultaneity element of air parameters, ASHRAE introduces the term "The coincident wet-bulb temperature".

The coincident wet-bulb temperature listed with each design dry-bulb temperature is the mean of all wet-bulb temperatures occurring at the specific dry-bulb temperature.

5) According to regulations of ASHRAE, air conditioning system in summer calculated with excess level MV of wet-bulb temperature and dry-bulb temperature are: 0.4%; 1% and 2% (3 levels – considerred as 3 grades, correspond to the number of non-assuarance hours of: 35h/year; 88h/year and 175h/year or $K_{bđ}$ *of: 0.996; 0.990 and 0.980), in winter, MV of dry-bulb temperature used for calculation of heating shall be 99.6% and 99% (two levels – considerred as 2 grades, correspond to hours of non-assuarance of :35h/year and 88h/year or* $K_{bđ}$ *of 0.996 and 0.990).*

6) In the above tables, we have processed the climate datas in order to obtain the coincident wet-bulb temperature value $t_{wetcoinc}$ *in accordance with the definition of ASHRAE. According to actual datas, in summer,* $t_{wetcoinc}$ *(column 6) is lower than* t_{wet} *(independent – column 5), the contrary is witnessed in winter when* $t_{wetcoinc}$ *(column 9) is higher than* t_{wet} *(independent – column 8). This means the pair of values* t_{dry} *and* t_{wet} *in columns 4; 5 – summer and 7; 8 – winter provide a higher assurance in comparison with the pair of values* t_{dry} *and* $t_{wetcoinc}$ *in columns 4; 6 – summer and 7; 9 – winter. This result totally agrees with the result conducted by ASHRAE for a number of countries all over the world – see ASHRAE Handbook, Fundamentals Volume, 1997.*

7) Though there is not cold winter in South Central region and Sothern region of Vietnam, these regions are still provied with calculation parameters for both seasons. The winter in these regions is just a season with cooler climate in comparison with summer and it is necessary to know the calculation parameters for checking whether the air conditioning process in this season requires cold supplying or not, or it only requires adiabatic cooling of mixed air, and after that should or should not add heat before supplying into room, or even can use solely outdoor air to supply for rooms.

Annex D

(normative)

Permitted concentration limit of chemical and dust in working air

(According to Labour Sanitary Standard published by Ministry of Health in 2002)

D.1 Scope

This annex specified the maximum permitted concentration of some chemicals in working air.

This annex does not apply to residential air.

D.2 Definition

- TWA: average exposure value over a working shift (8 h).

- STEL: exposure value determined over a period of 15 minutes for each time and exposure for no more than 4 times per working shift (8 h)

D.3 Permitted concentration limit of chemical in working air

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
1.	Acrolein	CH_2CHCHO	0.25	0.50
2.	Acrylic amide	$CH_2CHCONH_2$	0.03	0.2
3.	Acrylonitrile	CH_2CHCN	0.5	2.5
4.	Allyl acetate	$C_5H_8O_3$	-	2
5.	Ammonia	NH_3	17	25
6.	Amyl acetate	$CH_3COOC_5H_{11}$	200	500
7.	Phthalic anhydride	$C_8H_4O_3$	2	3
8.	Aniline	$C_6H_5NH_2$	4	8
9.	Antimony	Sb	0.2	0.5
10.	ANTU	$C_{10}H_7NHC(NH_2)S$	0.3	1.5
11.	Arsenic and compounds	As	0.03	-
12.	Arsine	AsH_3	0.05	0.1
13.	Asphalt		5	10

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
14.	Acetone	$(CH_3)_2CO$	200	1000
15.	Acetone cyanohydrin	$CH_3C(OH)CNCH_3$	-	0.9
16.	Acetonitrile	CH_3CN	50	100
17.	Acetylene	C_2H_2	-	1000
18.	2,4-D (Dichlorophenoxyace-tic acid)	$Cl_2C_6H_3OCH_2COOCH$	5	10
19.	2, 4, 5-T (Trichlorophenoxyac-etic acid)	$C_6H_2CI_3OCH_2COOH$	5	10
20.	Acetic acid	CH_3COOH	25	35
21.	Boric acid and compounds	H_2BO_3	0.5	1
22.	Hydrochloric acid	HCl	5	7.5
23.	Formic acid	HCOOH	9	18
24.	Methacrylic acid	$C_4H_6O_2$	50	80
25.	Nitrous acid	HNO_2	45	90
26.	Nitric acid	HNO_3	5	10
27.	Oxalic acid	$(COOH)_2.2H_2O$	1	2
28.	Phosphoric acid	H_3PO_4	1	3
29.	Picric acid	$HOC_6H_2(NO_2)_3$	0.1	0.2
30.	Sulfuric acid	H_2SO_4	1	2
31.	Thioglycolic acid	$C_2H_4O_2S$	2	5
32.	Trichloroacetic acid	$C_2HCl_3O_2$	2	5
33.	Azinphos methyl	$C_{10}H_{12}O_3PS_2N_3$	0.02	0.06
34.	Aziridine	H_2CNHCH_2	0.02	-
35.	Silver	Ag	0.01	0.1
36.	Silver compounds	same Ag	0.01	0.03
37.	Barium oxide	BaO_2	0.6	6
38.	Benomyl	$C_{14}H_{18}N_4O_3$	5	10
39.	Benzene	C_6H_6	5	15
40.	Benzidine	$NH_2C_6H_4C_6H_4NH_2$	0.008	-
41.	Benzonitrile	C_7H_5N	-	1
42.	Benzopyrene	$C_{20}H_{12}$	0.0001	0.0003

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
43.	(o, p) Benzoquynone	$C_6H_4O_2$	0.4	1.0
44.	Benzotrichloride	$C_7H_5CL_3$	-	0.2
45.	Benzoyl peroxide	$C_{14}H_{10}O_4$	-	5
46.	Benzylchloride	$C_6H_5CH_2Cl$	-	0.5
47.	Beryllium and compounds	Be	-	0.001
48.	Polychlorinated biphenyls	$C_{12}H_{10-x}C_x$	0.01	0.02
49.	Boron trifluoride	BF_3	0.8	1
50.	Bromine	Br_2	0.5	1
51.	Bromodichloro-metan	$CHBrCl_2$		
52.	Bromoethane	C_2H_5Br	500	800
53.	Bromomethane	CH_3Br	20	40
54.	Bromine pentafluoride	BrF_5	0.5	1
55.	1,3-Butadiene	$CH_2CHCHCH_2$	20	40
56.	Butyl acetate	$CH_3COO[CH_2]_3CH_3$	500	700
57.	Butanols	$CH_3(CH_2)_3OH$	150	250
58.	Octa decanoic acid, cadmium	$C_{36}H_{72}O_4Cd$	0.04	0.1
59.	Cadmium and compounds	Cd	0.01	0.05
60.	Carbondioxide	CO_2	900	1800
61.	Carbon disulfide	CS_2	15	25
62.	Carbonmonoxide	CO	20	40
63.	Carbontetra-chloride	CCl_4	10	20
64.	Carbofuran	$C_{17}H_{15}O_3N$	0.1	-
65.	Carbonyl fluoride	COF_2	5	13
66.	Calcium carbonate	$CaCO_3$	10	-
67.	Calcium chromate	$CaCrO_4$	0.05	-
68.	Calcium hydroxyde	$Ca(OH)_2$	5	-
69.	Calcium oxide	CaO	2	4
70.	Calcium silicate	$CaSiO_3$	10	-

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
71.	Calcium sulfate dihydrate	$CaS0_4.2H_20$	6	-
72.	Calcium cyanamide	C_2CaN_2	0.5	1.0
73.	Caprolactam (dust)	$C_6H_{11}NO$	1	3
74.	Caprolactam (fume)	$C_6H_{11}NO$	20	-
75.	Captan	$C_9H_8CI_3N0_2S$,	5	-
76.	Carbaryl	$C_{10}H_7O$ O $CNHCH_3$	1	10
77.	Catechol	$C_{15}H_{14}O_6$	20	45
78.	Lead tetraethyl	$Pb(C_2H_5)_4$	0.005	0.01
79.	Lead and compounds	Pb	0.05	0.1
80.	Chlorine	Cl_2	1.5	3
81.	Chloroacetal-dehy.de	$ClCH_2CHO$	3	-
82.	Chlorine dioxide	ClO_2	0.3	0.6
83.	Chloroaceto-phenone	$C_6H_5COCH_2Cl$	0.3	-
84.	Chlorobenzene	C_6H_5Cl	100	200
85.	1 -Chloro-2,4-dinitro- benzene	$C_6H_3ClN_2O_4$	0.5	1
86.	Chloronitro-benzene	$C_6H_4ClNO_2$	1	2
87.	Chloroprene	$CH_2CClCHCH_2$	30	60
88.	1- Chloro 2- propanone	C_3H_5ClO	-	3
89.	Chloroform	$CHCl_3$	10	20
90.	Chloropicrin	CCl_3NO_2	0.7	1.4
91.	3- Chloropropene	C_2H_5Cl	1	2
92.	Chlorotrifluoro-ethylene	C_2ClF_3	-	5
93.	Cobalt and compounds	Co	0.05	0.1
94.	Cresol	C_7H_8O	5	10
95.	Chromium trioxide	CrO_3	0.05	0.1
96.	Chromium (III) compounds	Cr^{+3}	0.5	-

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
97.	Chromium (VI) compounds	Cr^{+4}	0.05	-
98.	Chrom (VI) compound (water soluble)	Cr^{+6}	0.01	-
99.	Crotonaldehyde	$CH_3CHCHCHO$	5	10
100.	Cumene	$C_6H_5CH(CCH_3\}_2$	80	100
101.	Cyanides (as CN)		0.3	0.6
102.	Mineral oil (mist)		5	10
103.	Petroleum distillates(napht)		1600	-
104.	Turpentine	$C_{10}H_{16}$	300	600
105.	Vegetable oil mist		10	-
106.	Diamino 4,4'-diphenyl methane	$NH_2C_6H_4C_6H_4NH_2$	-	0.8
107.	Dimethyl-1,2-dibromo-2,2-dichlorethyl phosphate-	$(CH_3O)_2POOCHBrCBrCl_2$	3	6
108.	Rubber solvent		1570	-
109.	Stoddard solvent (White spirit)		525	
110.	Soapston	$3MgO.4SiO_2.H_2O$	3	-
111.	Soapstone	$3MgO.4SiO_2.H_2O$	6	-
112.	Decalin	$C_{10}H_{18}$	100	200
113.	Demeton	$C_8H_{19}\ O_3PS_2$	0.1	0.3
114.	Diazinon	$C_{12}H_{21}N_2O_3PS$	0.1	0.2
115.	Diborane	B_2H_6	0.1	0.2
116.	Dibromo-chlorometan	$CHBr_2Cl$		
117.	1,2-Dibromo - 3chloro-propane	$C_3H_5Br_2Cl$	0.01	-
118.	Dibutyl phthalate	$C_6H_4(CO_2C_4H_9)_2$	2	4

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
119.	Dichloroacetylene	ClCCCl	0.4	1.2
120.	Dichlorobenzene	$C_6H_4Cl_2$	20	50
121.	Dichloroethane	CH_3CHCl_2	4	8
122.	1,1-Dichloroethylene	$C_2 H_2Cl_2$	8	16
123.	1,2-Dichloroethylene	$C_2 H_2Cl_2$	790	1000
124.	Cis- Dichloro ethylene	$C_2 H_2Cl_2$	790	1000
125.	Trans-Dichloroethylene	$C_2 H_2Cl_2$	790	1000
126.	Dichloromethane	$CH_2Cl_{2)}$	50	100
127.	1,2-Dichloropropan	$C_3H_6Cl_2$	50	100
128.	Dichloropropene	$C_3H_4 Cl_2$	5	-
129.	Dichlorostyrene	$C_8H_6 Cl_2$	50	-
130.	Dichlorvos	$(CH_3O)_2PO_2CHCCl_2$	1	3
131.	Dicrotophos	$C_8H_{16}NO_5P$	0.25	-
132.	Diglycidyl ether	$C_6H_{10} O_3$	0.5	1
133.	Dimethylamine	C_2H_7N	1	2
134.	Dimethyl formamide	$(CH_3)_2NCHO$	10	20
135.	1,1- Dimethyl hydrazine	$(CH_3)_2NNH_2$	0.2	0.5
136.	Dimethyl phenol	$C_8H_{10}O$	-	2
137.	Dimethyl sulfate	$(CH_3)_2SO_4$	0.05	0.1
138.	Dimethyl sulfoxide	C_2H_6OS	20	50
139.	Dinitrobenzene	$C_7H_6N_2O_4$	-	1
140.	Dinitrotoluene (DNT)	$C_6H_5CH_3(NO_2)_2$	1	2
141.	Dioxathion	$C_{12}H_{26}O_6P_2S_4$	0.2	-
142.	Diquat Dibromide	$C_{12}H_{12}N_2.2Br$	0.5	1
143.	1,4- Dioxane	$OCH_2CH_2OCH_2CH_2$	10	-
144.	Copper (dust)	Cu	0.5	1
145.	Copper (fume)	Cu	0.1	0.2
146.	Copper compounds	Cu	0.5	1
147.	Endosulfan	$C_9H_6Cl_6O_3S$	0.1	0.3

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
148.	2,3- Epoxy 1 - propanol	$C_3H_6O_2$	1	5
149.	EPN (o-ethyl-o-para nitrophenyl phenyl-phosphonothioate)	$C_{18}H_{14}NO_4PS$	0.5	“
150.	Ethanolamine	$NH_2C_2H_4OH$	8	15
151.	Diglycidyl ether	$C_6H_{10}O_3$	0.5	-
152.	Chloroethyl ether	$C_4H_8Cl_2O$	-	2
153.	Chloromethyl ether	$(CH_2Cl)_2O$	0.003	0.005
154.	Ethyl ether	$C_2H_5OC_2H_5$	1000	1500
155.	Isopropyl glycidyl ether	$(CH_3)_2CHOCH(CH_3)_2$	200	300
156.	Resorcinol monomethyl Ether	$C_7H_8O_2$	-	5
157.	Ethylamine	$CH_3CH_2NH_2$	18	30
158.	Ethylene	C_2H_4	1150	-
159.	Ethanethiol (Ethylmercaptan)	C_2H_5SH	1	3
160.	Ethylene dibromide	$BrCH_2CH_2Br$	1	-
161.	Ethylene glycol		10	20
162.	Ethylene glycol	$C_2H_6O_2$	60	125
163.	Ethylene glycol dinitrate	$C_2H_4(O_2N0)_2$	0.3	0.6
164.	Ethylene oxide	C_2H_4O	1	2
165.	Perchloroethylene	C_2Cl_4	70	170
166.	Ethylidene norbornene	C_9H_{12}	-	20
167.	Fensulfothion	$C_{11}H_{17}O_4PS_2$	0.1	-
168.	Fenthiol	$C_{10}H_{15}O_3PS_2$	0.1	-
169.	Fluorine	F_2	0.2	0.4
170.	Fluorides		1	2
171.	Formaldehyde	HCHO	0.5	1
172.	Formamide	$HCONH_2$	15	30
173.	Furfural	C_4H_3OCHO	10	20

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
174.	Furfuryl alcohol	$C_5H_6O_2$	20	40
175.	Coal Tar pitch volatiles		-	0.1
176.	Halothane	$C_2HBrClF_3$	8	24
177.	Merkuran (mixture of ethylmercuric chloride and lindane)	' ,	0.005	Ê̦
178.	Heptachlor (iso)	$C_{10}H_5Cl_7$	0.5	1.5
179.	Heptan	C_7H_{14}	800	1250
180.	Hexachloro-benzene	C_6Cl_6	0.5	0.9
181.	Hexachloro 1,3-butadiene	C_4Cl_6 .	-	0.005
182.	1,2,3,4,5,6-hexa-chloro-cyclohexane	$C_6H_6Cl_6$	0.5	-
183.	Hexachlorocy-clopentadiene	C_5Cl_6	0.01	0.1
184.	Hexafluoro-acetone	$(CF_3)_2CO$	0.5	0.7
185.	Hexafluoro-propene	C_6F_6	-	5
186.	n- Hexane	C_6H_6	90	180
187.	Hydrazine	H_4N_2	0.05	0.1
188.	Hydrocarbons (1-10 C)		-	300
189.	Hydrogen fluoride	HF	0.1	0.5
190.	Hydrogen hosphide	H_3P	0.1	0.2
191.	Hydrogene selenide	H_2Se	0.03	0.1
192.	Hydrogene sulfide	H_2S	10	15
193.	Hydrogen cyanide	HCN	0.3	0.6
194.	Hydroxydes (alkaline) (Alkali hydroxide)		0.5	1
195.	Hydroquynone (1,4-Dihydroxy- benzene)	$C_6H_6O_2$	0.5	1.5

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
196.	Iodomethane	CH_3I	1	2
197.	Iodoform	CHI_3	3	10
198.	Iodine	I_2	1	2
199.	Isopropyl glycidyl ether	$(CH_3)_2C_2H_2O(CH_3))_2$	240	360
200.	Isopropyl nitrate	$C_3H_7NO_2$	20	40
201.	Potassium cyanide	KCN	5	10
202.	Welding fumes		5	-
203.	Petroleum gas (liquefied)		1800	2250
204.	Zinc chloride	$ZnCl_2$	1	2
205.	Zinc Chromate	CrO_4Zn	0.01	0.03
206.	Zinc fluoride	F_2Zn	0.2	1
207.	Zinc oxide (dust, fume)	ZnO	5	10
208.	Zinc phosphide	P_2Zn_3	-	0.1
209.	Zinc stearate (inhalable dust)	$Zn(C_{18}H_{35}O_2)_2$	10	20
210.	Zinc stearate (respirable dust)	$Zn(C_{18}H_{35}O_2)_2$	5	-
211.	Zinc sulfide	ZnS	-	5
212.	Camphor	$C_{10}H_{16}O$	2	6
213.	Magnesium oxide	MgO	5	10
214.	Malathion	$C_{10}H_{19}O_6PS_2$	5	-
215.	Manganese and compounds	Mn	0.3	0.6
216.	Methallyl chloride	C_4H_7Cl	-	0.3
217.	Methane thiol	CH_4S	1	2
218.	Methoxychlor	$Cl_3CCH(C_6H_4OCH_3)_2$	10	20
219.	Methyl acrylate	$CH_2CHCOOCH_3$	20	40
220.	Methyl acrylonitrile	$CH_2C(CH_3)CN$	3	9
221.	2- Methyl aziridine	$C_8H_{16}N_2O_7$	5	-
222.	Methylamine	CH_5N	5	24
223.	Methyl acetate	CH_3COOCH_3	100	250
224.	Methyl ethyl keton	C_4H_8O	150	300

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
225.	2- Methyl furan	C_5H_6O	-	1
226.	Methyl hydrazine	CH_3NHNH_2	0.08	0.35
227.	Methyl mercaptan	CH_3SH	1	2
228.	Methyl methacrylate	$CH_2C(CH_3)COOCH_3$	50	150
229.	Methyl silicate	$C_4H_{12}O_4Si$	-	6
230.	Mevinphos	$C_7H_{13}O_6P$	0.1	0.3
231.	Monocrotophos	$C_7H_{14}NO_5P$	0.25	-
232.	Ferric salt (as Fe)		1	2
233.	Carbon black	C	3.5	7
234.	Naled	$(CH_3O)_2P(O)OCHBrCBrCl_2$	3	6
235.	Naphthalene	$C_{10}H_8$	40	75
236.	Chlorinated naphthalenes		0.2	0.6
237.	Sodium bisulfite	$NaHSO_3$	5	-
238.	Sodium borate	$Na_2B_4O_7$	1	-
239.	Sodium cyanide	NaCN	5	10
240.	Sodium fluoroacetate	FCH_2COONa	0.05	0.1
241.	Sodium metabisulfite (Disodium pyrosulfite)	$Na_2S_2O_5$	5	
242.	Sodium azide	NaN_3	0.2	0.3
243.	Neoprene	C_4H_5Cl	10	30
244.	Aluminum and compounds	Al	2	4
245.	Nicotine	$C_{10}H_{14}N_2$	0.5	1
246.	Nickel and compounds (soluble)	Ni	0.05	0.25
247.	Nickel monoxide	NiO, Ni_2O_3	0.1	-
248.	Nickel carbonyl	C_4NiO_4	0.01	0.02
249.	Nitrogen dioxide	NO_2 and N_2O_4	5	10
250.	Nitrogen monoxide	NO	10	20
251.	Nitrogene trifluoride	NF_3	30	45

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
252.	Nitrobenzene	$C_6H_5NO_2$	3	6
253.	1-Nitrobutane	$CH_3(CH_2)_3NO_2$	-	30
254.	Nitro ethane	C_2H_5NO	30	-
255.	Nitromethane	CH_3NO_2	30	-
256.	1-Nitropropane	$CH_3(CH_2)_2NO_2$	30	60
257.	Nitrotoluene	$CH_3C_6H_4NO_2$	11	22
258.	Glycerol trinitrate (Nitroglycerine)	$CH_2NO_3CHNO_3CH_2NO_3$ $[C_3H_5(NO_3)_3]$	0.5	1
259.	2-Nitropropane	$CH_3(CH_2)_2NO_2$	18	-
260.	Octane	$C_{10}H_{22}$	900	1400
261.	Osmium tetroxide	OsO_4	0.002	0.003
262.	Ozone	O_3	0.1	0.2
263.	Paraquat	$(CH_3(C_5H_4N)_2CH_3).2Cl$	0.1	0.3
264.	Parathion	$(C_2H_5O)_2PSOC_6H_4NO_2$	0.05	0.1
265.	Pentaborane	B_5H_9	0.01	0.02
266.	Pentachlorophenol	C_6Cl_5OH	0.2	0.4
267.	Perchloryl fluoride	ClO_3F	14	25
268.	Phenol	C_6H_5OH	4	8
269.	Phenyl hydrazine	$C_6H_5NHNH_2$	1	2
270.	Phenyl isocyanate	C_7H_5NO	0.02	0.05
271.	Phenylene diamine	$C_6H_8N_2$	0.1	0.2
272.	Phenyl phosphine	C_6H_7P	-	0.25
273.	Phorate	$(C_2H_5O)_2P(S)SCH_2S$-C_2H_5	0.05	0.2
274.	Phosgene	$COCl_2$	0.2	0.4
275.	Phosphine	PH_3	0.1	0.2
276.	Phosphorus (White, yellow)	P_4	0.03	0.1
277.	Phosphorous oxy chloride	$POCl_3$	0.6	1.2
278.	Phosphorus trichloride	$P\ Cl_3$	1	2
279.	Phosphorous pentachloride	PCl_5	1	2

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
280.	Picloram (iso)		10	20
281.	Propanol	$CH_3(CH_2)_2OH$	350	600
282.	P-Propiolactone	$C_3H_4O_2$	1	2
283.	Propoxur	$CH_3NHCOOC_6H_4OCH(CH_3)_2$	0.5	1.5 .
284.	n- Propylaxetat	$CH_3COOCH_2CH_2CH_3$	200	600
285.	Propylenimine	C_3H_7N	-	5
286.	Pyrethrin	$C_{21}H_{28}O_3$	5	10
287.	Pyridine	C_5H_5N	5	10
288.	Quynone	$C_6H_4O_2$	0.4	1.2'
289.	Resorcinol -1,3-Dihydroxybenzen	$C_6H_6O_2$	45	90
290.	Allyl alcohol	CH_2CHCH_2OH	3	6
291.	Ethanol	$CH_3(CH_2)OH$	1000	3000
292.	Furfuryl alcohol	$C_5H_6O_2$	20	40
293.	Methanol	CH_3OH	50	100
294.	n-Amyl alcohol	$CH_3(CH_2)_4OH$	100	200
295.	Propargyl alcohol	$HCCCH_2OH$	2	6
296.	Rotenone (Derris)	$C_{23}H_{22}O_6$	5	10
297.	Paraffin wax		1	6
298.	Ferric oxide (dust, fume)	Fe_2O_3	5	10
299.	Iron carbonyl	C_5FeO_5	0.08	0.1
300.	Selenium and compounds	Se	0.1	1
301.	Selenium dioxide	O_2Se	-	0.1
302.	Selenium hexafluoride	SeF_6	0.2	-
303.	Silane	H_2Si	0.7	1.5
304.	Stearates		10	-
305.	stibine	SbH_3	0.2	0.4
306.	Strychnine	$C_{21}H_{22}N_2O_2$	0.15	0.3
307.	Styrene	$C_6H_5CHCH_2$	85	420
308.	Sulfur chloride	S_2Cl_2	5	10

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
309.	Sulfur dioxide	SO_2	5	10
310.	Sulfuryl fluoride	F_2SO_2	20	40
311.	Sulfur tetrafluoride	SF_4	0.4	1
312.	Tellurium	Te	0.01	-
313.	Tellurium hexafluoride	F_6Te	0.1	-
314.	Tetrachloroethylene	C_2CL_4	60	-
315.	1,1,7,7 T etrachloroheptane	$C_7H_{12}CL_4$	-	1
316.	Tetraethyl pyrophosphate	$C_{18}H_{20}O_7P_2$	0.05	0.2
317.	Tetralin	$C_{10}H_{12}$	100	300
318.	Tetramethyl succinonitrile	$(CH_3)_2C_2(CN)_2(CH_3)_2$	3	6
319.	Tetranitrome thane	$CH_3(NO_2)_4$	8	24
320.	Tin (organic)	Sn	0.1	0.2
321.	Tin (inorganic)	Sn	1	2
322.	Tin oxide	SnO_2	2	-
323.	Thionyl Chloride	Cl_2OS	5	-
324.	Benzenethiol	C_6H_6S	2	-
325.	Thiram	$(CH_3)_2(SCSN)_2(CH_3)_2$	5	10
326.	Tobacco (dust)		2	5
327.	Mercury and compounds (inorganic)	Hg	0.02	0.04
328.	Mercury compounds (organic)	Hg	0.01	0.03
329.	Titanium	Ti	10	-
330.	Titanium dioxide (respirable dust)	TiO_2	5	-
331.	Titanium dioxide (inhalable dust)	$TìO_2$	6	10
332.	Toluene	$C_6H_5CH_3$	100	300
333.	Toluene diisocyanate	$C_9H_6N_2O_2$	0.04	0.07
334.	(m-, 0-, p-) Toluidine	$CH_3C_6H_4NH_2$	0.5	1
335.	Tribromometan	$CHBr_3$	5	15

No.	Chemical name	Chemical formula	Average per 8 hours (mg/m^3) (TWA)	Maximum per each time (mg/m^3) (STEL)
336.	Tributyl phosphate	$C_{12}H_{27}O_4P$	2.5	5
337.	Trichloroethane	$C_2H_3Cl_3$	10	20
338.	Trichloroethylene	C_2HCl_3	20	40
339.	Trinitrobenzene	$C_6H_3(NO_2)_3$	-	1.0
340.	Trichloro nitrobenzene	$C_6H_2Cl_3NO_2$	-	1.0
341.	2,4,6-Trinitrotoluene	$CH_3C_6H_2(NO_2)_3$	0.1	0.2
342.	Tritolyl phosphate	$C_{21}H_{21}O_4P$	0.1	0.2
343.	Uranium and compounds	U	0.2	-
344.	Vanadium	V	0.5	1.5
345.	Vanadium penta oxide	V_2O_5	0.05	0.1
346.	Vinyl acetate	$CH_2CHOOCCH_3$	10	30
347.	Vinyl bromide	CH_2CBr	20	40
348.	Vinyl chloride	C_2H_3Cl	1	5
349.	Vinyl cyclohexene dioxide (930)	$C_8H_{12}O_2$	60	120
350.	Warfarine	$C_{19}H_{16}O_4$	0.1	0.3
351.	Wofatox	$C_8H_{10}NO_5PS$	0.1	0.2
352.	Petrol (Petrol dis-tillates, gazoline)		300	-
353.	Cellulose (inhalable dust)		10	20
354.	Cellulose (respirable dust)		5	-
355.	Cesium hydroxide	CsOH	2	-
356.	Cyanogene	NCCN	4	20
357.	Cyanogene chloride	ClCN	0.3	0.6
358.	Cyanides	CN(K, Na)	0.3	0.6
359.	Cyclohexane	C_6H_{12}	500	1000
360.	Cychlohexanol	$C_6H_{11}OH$	100	200
361.	Xylene	$C_6H_4(CH_3)_2$	100	300
362.	Xylidine	$(CH_3)_2C_6H_3NH_2$	5	10

D.4 Allowable limits of dust concentration in working air

D.4.1 Maximum allowable concentration of dust free from silica

Type	**Substance**	**Total dust concentration,** mg/m^3	**Respiratory dust concentration,** mg/m^3
1	Activated charcoal , aluminum , bentonite , diatomite , graphite , kaolin , pyrite , talc	2	1
2	Bakelite , coal , iron oxide , zinc oxide , titanium dioxide , silica , apatite , Baril , phospholipide , limestone , perlite , marble , Portland cement	4	2
3	Herbal, animal, tea, tobacco dust, wooden dust, cereal dust	6	3
4	Organic and inorganic dust that is of neither type 1 nor type 2	8	4

D.4.2 Maximum allowable concentration of dust containing silica

Dust group	**Silica content, %**	**Total dust concentration,** particles/cm^3		**Respiratory dust concentration,** particles/cm^3	
		According to shift	**According to point of time**	**According to shift**	**According to point of time**
1	>50 100	200	600	100	300
2	>20 50	500	1 000	250	500
3	>5 0	1 000	2 000	500	1 000
4	[illegible]	1 500	3 000	800	1 500

D.4.3 Permissible occupational exposure limits for asbestos dust

No.	**Substance**	**8h as average,** fibres/ml	**1h as average,** fibres/ml
1	Serpentine (Chrysotile)	0.1	0.5
2	Amphibole	0	0

Annex E

(Informative)

E.1 Classification of hazardous substances according to hazardous level

This table for classification of toxic substances is compiled on the basement of reference made to Russian regulations OCT 12.1.007-76.

The classification table applies to toxic substances contained in ingredients, products, semi-finished productions and waste of manufacturing, using and preserving processes.

The classification table does not apply to toxic substances contained in radioactive substances, micro-organism (complex microorganism, bacteria, etc)

According to the level of their harm to human body, toxic matters are classified into 4 types with different dangerous levels as follow:

Type 1: Extremely dangerous substances;

Type 2: Substances of high dangerous level;

Type 3: Substances of medium dangerous level;

Type 4: Substances of low dangerous level.

Types of hazardous substance according to hazard level shall be determined according to concentration (mg/m^3) or content (mg/kg) depending on type of contact or exposure given in table E.1

Table E.1

Type of contact	Standard for classification of hazard			
	Type 1	**Type 2**	**Type 3**	**Type 4**
1. Permitted concentration limit of hazardous substances in working air, mg/m^3	Under 0.1	0.1 ÷ 1.0	1.1 ÷ 10.0	Over 10.0
2. Average dose in capable of causing death when infiltrating stomach, mg/kg	Under 15	15 ÷ 150	151 ÷ 5000	Over 5 000
3. Average dose in capable of causing death when infiltrating human body through skin, mg/kg	Under 100	100 ÷ 500	501 ÷ 2500	Over 2 500
4. Concentration in air that can cause death, mg/m^3	Under 500	500 ÷ 5 000	5001 ÷ 50000	Over 50 000

E.2 Requirements on safety when working with hazardous substances

E.2.1 Factories, workshops and production activities relating to hazardous substances must:

- Have standard-technical documents specified measures for labour safety when producing, recruiting or preserving hazardous substances.

- Have general measures on organization-techniques, labour sanitary and health-biochemistry.

E.2.2 Measures for labour safety in the case of contacting with hazardous substances must take into account:

- The ability of replacing hazardous substances with those that are less hazardous; replacing dry processing method with wet processing method when processing dust-producing-materials;

- Use gas fuel instead of solid, liquid or electric fuel during the process of material heating.

- Restrain the composition of hazardous substances in in-put materials and in the final goods;

- Apply advanced technological processes (closed processes, mechanization, automatization, remote control, continuous production lines, automatic means for inspecting technological processes and opeartions)in order to isolating the workers from hazardous substances;

- Choose suitable technilogical devices and transporting equipments for preventing the emission of hazardous substances into working air causing their concentration to exceed the permitted limits when processing regular technological processes; beside that, it is necessary to properly and effectively exploit sanitary systems and technological equipments (ventilation, pumping and drainage);

- Reasonably arrange industry groups, workshops and production rooms;

- Apply the use of hazardous substance collecting and recycling system and discharged air filtering system; neutralize the production waste, equipment washing water and discharged water;

- Regularly check the concentration of hazardous substances in working air in accordance with E.3.1;

- Use personal protective devices and accessories;

- Train and educate about hazard protection and safety for staff;

- Carry out regular health check for staff and workers who have to contact with hazardous substances;

- Preparing medical measures for cases where require working with each kind of particular hazardous substances; provide instructions for timely in-place medical interference for person affected by hazardous substances.

E.3 Basic requirements on inspection of concentration of hazardous substances in working air

E.3.1 Inspection measurement of concentration of hazardous substances in working air must be carried out:

- Regularly with hazardous substances type 1;

- Periodically with hazardous substances type 2, 3and 4.

E.3.2 Continuous inspection of concentration of hazardous substances in working air must by carried out using autographic device or equipment with mechanism of alarming when the permitted limit is exceeded.

E.3.3 Inspection method must include:

- Instructions on sampling method and sample analyzing method for obtaining exact and reliable results;

- Researching on sampling in special production conditions, taking into account the major technolgical processes, hazardous substance producing sources, active technological devices and sanitary technical systems.

E.3.4 Sensitivity of the methos and measuring equipments must not be lower than 0.5 of permitted concentration limit; the tolerance must not exceed 25% of the value to be measured.

Annex F

(normative)

Outdoor air (fresh air) rate according to sanitary requirements set out for comfortably air conditioned rooms

No.	Room's name	Area, m^2/person	Required amount of outdoor air		Note
			m^3/h. person	$m^3/h.m^2$	
1	2	3	4	5	6
1	**Hotel, rest house**				
	Bed room	10	35		Not depend on room's area
	Living room	5	35		
	Corridor	3	25		
	Conference room	2	30		
	Hall	1	25		
	Working room	12-14	30		
	Lobby	1.5	25		
	Collective bed room	5	25		
	Bath room	-	-	40	Used when needed, not regularly
2	**Dry cleaning shop**	**3**	**40**		
3	**Restaurant**				
	Eating room	1.4	30		
	Fast food, coffee room	1	30		
	Bar, cocktail stand	1	35		Should be equipped with smoke exhaust system.
	Kitchen (cooking)	5	25		Must have smell exhaust system. Total amount of outdoor air and air penetrating from adjacent rooms must ensure the discharge flow rate of no less than $27m^3/h.m^2$.
4	**Theater, cinema**				
	Audience room	0.7	25		Require special ventilation for eliminating impact of staging process: i.e smoke, fire and foggy stages, etc.
	Corridor	0.7	20		
	Studio	1.5	25		
	Ticket room	1.6	30		

No.	Room's name	Area, m²/person	Required amount of outdoor air		Note
			m³/h. person	m³/h.m²	
5	**School, education establishments**				
	Studying room	2	25		
	Laboratory	3.3	35		See also regulations specified in documents of laboratories.
	Conference room, coaching room	3.3	30		
	Library	5	25		
	Hall	0.7	25		
	Music, singing practice room	2	25		
	Corridor	-	-	2	
	Storage room	-	-	9	Operated when needed only.
6	**Hospital, sanatorium**				
	Patient room	10	40		
	Exam room	5	25		
	Operation room	5	50		
	Room for examination of dead bodies	-	-	9	Must not use circulated air taken from here to supply for other rooms.
	Physiotherapy room	5	25		
	Dining room	1	25		
	Watch room	2.5	25		
7	**Gymnasium and recreation building**				
	Competition grandstand	0.7	25		
	Competition room	1.4	35		
	Indoor skating rink	-	-	9	
	Indoor swimming pool with audiences	-	-	9	Greater air flow rate may be required for controlling humidity.
	Dancing floor	1	40		
	Bowling room	1.4	40		
8	**Public spaces**				
	Corridor and storage room for household items	-	-	1	
	Shop chain	5	-	4	

No.	Room's name	Area, m²/person	Required amount of outdoor air		Note
			m³/h. person	m³/h. person	
	Shop	20	-	1	
	Room for resting	1.5	25		
	Smoke room	1,5	30		Require air discharge, circulation of exhaust air is not permitted.
9	**Shops of special types**				
	Hairdressing shop	4	25		
	Beauty salon	4	40		
	Clothes store, wooden shop	-	-	5	
	Flower shop	12	25		
	Supermarket	12	25		
10	**Car station, railway station**				
	Car/train waiting room	1	25		
	Platform (indoor)	1	25		
11	**Administrative building - office**				
	Working room	8-10	25		
	Conference room, board room	1	30		
	Waiting room	2	25		
12	**Residential building**				
	Bed room	8-10	35		
	Living room	8-10	30		
Note: Area m²/person in column 3 is actual area of space required for a person in the room.					

Annex G

(Normative)

Outdoor air (fresh air) flow rate for mechanical ventilated rooms

Type of room, construction	Number (multiple) of air exchange, times/h
Office	6
Residential building, bed room	2-3
Hotel dining room, canteen room	10
Shop, super market	6
Factory, industrial building	6
Studying room	8
Laboratory	10-12
Library	5-6
Hospital	6-8
Theater, cinema	8
Lobby, corridor, stair, exit **	4
Bath room, toilet	10
Kitchen (commercial building, domitory, factory)	20
Garage	6*
Fire fighting centre	6
Drainage pumping room	8

** Apply for room's height of 2.5 m. When room's height is above 2.5 m, must calculated according to the increasing ratio of the height;*

*** Lobby with area of under 10 m^2 does not require mechanical ventilation.*

For room in the basement, air exchange multiple can increase by 20% to 50%.

Annex H

(Normative)

Determintion of flow rate and temperature of air supplied into room

H.1 Flow rate L, m^3/h, of air supplied for ventilation and air conditioning system must be determined on the basis of calculation and the greatest flow rate value shall be chosen for ensuring:

a) Sanitary standard according to the following H.2;

b) Fire prevention standard according to requirements mentioned in H.3.

H.2 Air flow rate must be determined separately for the conditions of hot season and cold season when taking the greatest value determined according to formulas from H.1 to H.7 with specific density of air is 1.2 kg/m^3:

a) Calculate according to excess heat (sensible heat)

$$L = L_{h,cb} + \frac{3.6Q - cL_{h,cb}(t_{h,cb} - t_V)}{c(t_R - t_V)} \qquad \text{(H.1)}$$

Direct and scattered solar radiation heat entering the construction must be calculated when designing:

- Ventilation for construction during hot season, includes cooling ventilation using evaporating cooling method.

- Air conditioning: for hot and/or cold season;

b) Calculate according to the amount of hazardous or combustible substances produced:

$$L = L_{h,cb} + \frac{M_i - L_{h,cb}(C_{h,cb} - C_V)}{C_R - C_V} \qquad \text{(H.2)}$$

When some types of hazardous substance are emitted at the same time bringing about the collective effect, flow rate of air to be exchanged shall be determined as the total ventlation flow rate determined according to each hazardous substance.

c) According to excess humidity (steam)

$$L = L_{h,cb} + \frac{\mathrm{W} - 1.2(d_{h,cb} - d_V)}{1.2(d_R - d_V)} \qquad \text{(H.3)}$$

For rooms with excess humidity, it is necessary to check whether the air exchange flow rate is adequate to prevent the occurrence of dew point phenomenon on the inner surfaces of the exterior wall of the construction or not.

d) According to the total amount of excess heat (total heat):

$$L = L_{h,cb} + \frac{3.6Q_o - 1.2L_{h,cb}(I_{h,cb} - I_V)}{1.2(I_R - I_V)} \qquad (H.4)$$

e) According to the rate of air exchanging multiple:

$$L = mV_P \qquad (H.5)$$

f) According to the rate of specific flow of supply air:

$$L = SI_F \qquad (H.6)$$

$$L = NI_N \qquad (H.7)$$

In formulas (1) ÷ (7):

$L_{h,cb}$ is flow rate of air discharged from working areas or from servicing areas in the construction via local exhaust systems or flow rate of air used for technological requirements, measured in cubic meters per hour (m^3/h);

Q, Q_o is excess heat determined according to sensible heat and total heat inside the construction, measured in Watt (W);

C is specific heat capacity acorrding to air volume, taken as 1.2 kJ/$m^3.^0C$;

$t_{h,cb}$ is temperature of air in working areas or servicing areas discharged via local exhaust systems or used for technological purposes, measured in Celsius (^0C);

t_R is temperature of air discharged from areas ouside working areas or servicing areas, measured in Celsius (^0C);

t_V is temperature of air supplied to the building, measured in Celsius (^0C), taking in to account the requirement mentioned in H.5;

W is amount of excess moisture in the construction, measured by grams per hour (g/h);

$d_{h,\ cb}$ is moisture capacity of air discharged from working areas or servicing areas via local exhaust systems or used for technological purposes, measured in grams per kilogram (g/kg);

d_R is moisture capacity of air discharged from from areas ouside working areas or servicing areas, measured in grams per kilogram (g/kg);

d_V is moisture capacity of air supplied to the buidings, measured in grams per kilogram (g/kg);

$I_{h,\ cb}$ is enthalpy of air discharged from working areas or servicing areas via local exhaust systems or used for technological purposes, measured in kilojoules per kilogram (kJ/kg);

I_R is enthalpy of air discharged from from areas ouside working areas or servicing areas, measured in kilojoules per kilogram (kJ/kg);

I_V is enthalpy of air supplied for the construction, determined taking into account the increase in temperature according to H.5, measured in kilojoules per kilogram (kJ/kg);

M_i is the amount of each hazardous substance or explosive substance emitted in the construction, measured in milligrams per hour (mg/h);

$C_{h,cb}$, C_R is concentration of hazardous substances or explosive substance in air discharged from working area or servicing area, as well as outside the area mentioned above, measured in measured in milligrams per cubic meter (mg/m^3);

C_v is concentration of hazardous substances or explosive substance in air supplied for the construction, measured in milligrams per cubic meter (mg/m^3);

V_p is volume of room, m^3; for rooms of 6m height and above, V_p shall be considered to be 6 S;

S is area of room, measured in square meters (m^2);

N is number of people (number of audiences), number of working positions, number of equipment units;

m is air exchanging multiple according to standard , h^{-1};

I_F is standard air flow rate supplying for 1 m^2 of construction floor, measured in cubic meters per hour per square meter (m^3/(h.m^2);

I_N is flow rate of air supplied for the construction for one person, measured in cubic meter per hour (m^3/h), for 01 working position, for 01 audience or for 01 equipment unit.

Air parameters like $t_{h,cb}$, $d_{h,cb}$, $I_{h,cb}$ must be taken according to the values of calculation parameters in working area or servicing area of the construction specified in Article 4 “Calculation conditions” of this Standard; $C_{h,cb}$ shall be equal with the permitted concentration limit for working area of construction (see Annex D).

H.3. Air flow rate required for ensuring fire and explosion safety shall be determined by using formula (H.2) with $C_{h,cb}$ and C_R being replaced by 0.1 C_E, mg/m^3 (C_E is the lower explosive concentration limit of the mixture of gas, steam, dust and air)

H.4 Air flow rate L_{ck} of ventilation system which operates periodically with fan capacity of L_q m^3/h shall be determined from the minutes of continuous operation per hour z according to the following formula:

$$L_{ck} = L_q z / 60 \qquad \text{(H.8)}$$

H.5 Temperature of air supplied into rooms from mechanical ventilation and air conditioning system t_v must include the increase in temperature Δt, ^0C, when passing the fan:

$$\Delta t = 10^{-3} P \qquad \text{(H.9)}$$

Where:

P is total pressure of fan, measured in Pascal (Pa)

Annex I

(Normative)

Ventilation systems for laboratories

I.1 Ventilation systems for laboratories of production blocks and research institutes should be so designed as to meet the requirements set out for manufacturers with respect to levels of explosion hazard.

I.2 General supply ventilation system is suitable for a group of rooms located on no more than eleven floors (including the basement and technical floor) of the explosion hazard level C, D and E, and of administrative-activity building with maximum two storages of explosion hazard A (located on different floors), each storage has an area of maximum 36 m^2 and is used for storing everyday researching materials. Air ducts designed for these storages must be equiped with fire valves with fire resistance rating of 0.5 hour. For compartments of explosion hazard level C, air ducts shall be designed in accordance with 5.12.1c) or 5.12.1d).

I.3 General exhaust ventilation system connected to local exhaust system shall be designed for :

a) Storages of explosion hazard level A used for storing everyday materials;

b) For an laboratory compartment of explosion hazard level C, D and E, if the technological devices are equipped with local exhaust systems that do not form explosive mixtures.

I.4 Air recirculation is not allowed in science research laboratories where tests related to hazardous or explosive steam, gas, aerosol are conducted.

I.5 Laboratory of explosion hazard level C with an area of no more than 36m^2 does not require smoke exhaust system.

Annex J

(Normative)

Structural components and materials for air duct making

Characteristics of transported air environment	**Structural components and materials**
Temperature ≤ 80°C Relative humidity ≤ 60%	Concrete blocks, reinforced concrete; gypsum, board-gypsum, arbolit and gypsum concrete pipes; tole: galvanized tole, black iron plate, cold rolled sheet; glass cloth, paper and paperboard; other materials that meet the requirements of the environment mentioned above .
Temperature ≤ 80°C Relative humidity > 60%	Concrete blocks, reinforced concrete; tole: galvanized tole; aluminum foil; plastic tube and plastic sheet; glass cloth; impregnated paper and paperboard; other materials that meet the requirements of the environment transported.
Contains corrosive gases, active elements, dust, steam.	- Clay pipes and ferrocement pipe, plastic pipe; plastic concrete or acid resistant concrete blocks; glass cloth; plastic concrete; tole; coated or impregnated paper and paperboard which can against the impact of the transportation environment; other materials that meet the requirements of the environment transported.
Note: air duct must have protective layer that can resist the impacts of both ambient environment and transported environment.	

Annex K

(Normative)

Cross sectional external dimensions

of metal duct and required thickness of tole used for duct making

K.1 Outer diameter of circular duct

Outer diameter of metal duct should be in accordance with the following data, mm:

50	56	63	71	80	90	100	112	125
140	160	180	200	224	250	280	315	355
400	450	500	560	630	710	800	900	1000
1120	1250	1400	1600	1800	2000	2240	2500	2800
3150	3350	3550	4000	4500	5000	5600	6300	7100
8000	9000	10000						

K.2 External dimensions of rectangular duct

The ratio of rectangular duct's edges should not exceed 6.3. Duct's size can be adjusted with manufacturing units.

Table K.1 given the dimensions of rectangular duct that are commonly applied – according to TCXD 232:1999

Table K.1

Dimensions are measured in mm

External dimension of rectangular duct crosssection	External dimension of rectangular duct crosssection	External dimension of rectangular duct crosssection	External dimension of rectangular duct crosssection
125 × 125	315 × 315	600 × 500	1250 × 500
160 × 125	400 × 200	630 × 630	1250 × 630
160 × 160	400 × 250	800× 315	1250 × 800
200 × 125	400 × 315	800 × 400	1250 × 1000
200 × 160	400 × 400	800 × 500	1600 × 500
200 × 200	500 × 200	800 × 630	1600 × 630

External dimension of rectangular duct crosssection	External dimension of rectangular duct crosssection	External dimension of rectangular duct crosssection	External dimension of rectangular duct crosssection
250 × 150	500 × 250	800 × 800	1 600 × 800
250 × 160	500 × 315	1 000 × 315	1 600 × 1000
250 × 200	500 × 400	1 000 × 400	1 600 × 1250
250 × 250	500 × 500	1 000 × 500	2 000 × 800
315 × 150	630 × 250	1 000 × 630	2 000 × 1000
315×160	630 × 315	1 000 × 800	2 000 × 1250
315 × 200	630 × 400	1 000 × 1000	2 000 × 1500
315 × 250	630 × 450	1 250 × 400	2 000 × 2000

K.3 Thickness of tole sheet used for manufacturing air duct

K.3.1 For transporting air at below 80^{0}C, the tole thickness should be as follow:

a) For air duct with circular cross section

- Diameter : ≤200 mm — Tole thickness 0.5 mm
- Diameter : from 200 mm to 450 mm — Tole thickness 0.6 mm
- Diameter : from 500 mm to 800 mm — Tole thickness 0.7 mm
- Diameter : from 900 mm to 1200 mm — Tole thickness 1.0 mm
- Diameter : from 1400 mm to 1600 mm — Tole thickness 1.2 mm
- Diameter : from 1800 mm to 2000 mm — Tole thickness 1.4 mm

b) For air duct with rectangular cross section with the greater sides:

- Diameter : < 250 mm — Tole thickness 0.5 mm
- Diameter : from 300 mm to 1000 mm : — Tole thickness 0.7 mm
- Diameter : from 1250 mm to 2000 mm : — Tole thickness 0.9 mm
- Diameter : from 1800 mm to 2000 mm — Tole thickness 1.4 mm

c) For rectangular duct with a side greater than 2000mm or with cross section of 2000mm x 2000mm, thickness of tole sheet used for the manufacture of duct shall be determined by means of calculation.

K.3.2 For air duct processed by welding method, the tole thickness shall be determined according to the requirements of welding technology.

K.3.3 For duct used for the transportation of air at above 80^0C or air with contaminating dust or corrossive dust, the tole thickness shall be determined by means of calculation.

Annex L

(Normative)

Calculate the mass flow of exhaust smoke in case of fire

L.1 Mass flow of smoke G_1, kg/h, that need to be exhausted from halls or corridors in case of fire (see 5.7b) should be determined per the following formula:

a) For residential buildings:

$$G_1 = 3420\ BnH^{1.5} \qquad (L.1)$$

b) For Public buildings, administrative-activity buildings and production buildings:

$$G_1 = 4300\ BnH^{1.5}K_d \qquad (L.2)$$

in formula (1) and (2):

B: width of the greater door opening from corridor or hall to staircase or outside, measured in meter (m)

H: door height; where the height is greater than 2.5m, 2.5m shall be taken as the value of H;

K_d: coefficient of relatively stretched opening time of door from corridor to stairway or to outdoor during fire, K_d =1 if the number of people escaping through a single door is above 25 and K_d =0.8 if the number of people escaping through a single door is under 25;

n: coefficient depends on the total width of the large wings of doors opening from corridors to stairway or outdoor in case of fire, taken according to the following table L.1:

Table L.1

Construction type	Coefficient n corresponding to width B				
	0.6 m	0.9 m	1.2 m	1.3 m	2.4 m
Residential building	1.00	0.82	0.70	0.51	0.41
Public building, administrative-activity building	1.05	0.91	0.80	0.62	0.50

L.2 Flow rate G, kg/h, of smoke discharged from room space must be determined according to perimeter of fire zone (see 6.7 a)

Smoke flow rate for rooms with area of under 1600m^2 or for smoke tanks designed for rooms of greater area (see 6.8) must be determined according to the following formula:

$$G = 678.8 P_f y^{1.5} K_S \qquad \text{(L.3)}$$

Where:

P_f is perimeter of fire zone during the initial time, m, equal with the greatest value of the perimeter of unsealed fuel tank, or fuel container placed in a case made of flammable material.

For rooms eqipped with fire fighting sprinklers, P_f shall be 12m. Where it is impossible to determine the perimeter of fire zone, the following formula shall be used:

$$4 \le P_f = 0.38 A^{0.5} \le 12 \qquad \text{(L.4)}$$

Where:

A is area of room or smoke tank, measured in square meter (m^2);

y is distance, measured in m, from the lower edge of smoke zone to the floor, for the case of a room, this value shall be 2.5 m , or measured from the lower edge of dwaft partition forming a smoke tank to the floor;

K_s is coefficient, set K_s = 1.0; for system using natural smoke exhaust mechanism in combination with fire fighting sprinkler, K shall be 1.2

Note: Where fire zone value P_f >12m or distance y>4m, smoke flow rate shall be determined in accordance with part L.3 of this Annex.

L.3 Smoke flow rate G_1 measured in kg/h that need to be discharged from room space (taken according to requirements for protecting exit doors) must be determined according to formula (L.5) for cold season and rechecked for hot season, if wind speed in hot season is higher than that in cold season:

$$G_1 = 3584 \sum A_d \left[h_0 (\gamma_v - \gamma_{smoke}) \rho_v^2 + 0.7 v^{2\rho_v^2} \right]^{0.5} K_s \qquad \text{(L.5)}$$

Where:

$\sum A_d$ is corresponding area (with flow rate) of doors on escape way, measured in square meter (m^2);

h_0 is calculation height measured from the lower limit of smoke condensation zone to the door's centre, $h_0 = 0.5 H_{max} + 0.2$;

H_{max} is height of the tallest door on escape way, measured in meters (m);

γ_v is specific weight of outdoor air, measured in Newtons per cubic meter (N/m^3);

γ_{smoke} is specific weight of smoke, taken according to 6.10 and 6.11;

ρ_v is specific density of outdoor air, measured in kilograms per cubic meter (kg/m^3)

v is velocity of wind, m/s: when wind velocity is 1.0 m/s, set v=0; when wind velocity is greater than 1.0m/s, v shall be taken according to the value of outdoor climate parameter but should not exceed 5m/s.

Note: In area where there is many constructions, wind velocity can be taken according to investigation datas of local weather station; however, the value taken should not exceed 5m/s.

Corresponding area of doors A_d shall be determined by using the following formula:

$$\sum A_d = (\sum A_1 + K_1 \sum A_2 + K_2 \sum A_3) K_3 \qquad \text{(L.6)}$$

Where:

$\sum A_1$: total area of single doors opening to outdoor;

$\sum A_2$: total area of the first doors that need to be opened to escape from the rooms where require the opening of the seconds doors with total area of $\sum A'_2$, m^2, to escape to the outdoor, for example: doors of buffering compartments;

$\sum A_3$: total area of the first doors that need to be opened to escape from the rooms where require the opening of the seconds doors and third doors to escape to the outdoor; in this case, the total areas of th second doors and the third doors are $\sum A'_3$ and $\sum A''_3$;

K_1, K_2 are coefficients used for determining corresponding areas of successive open doors on escape way according to formulas:

$$K_1 = \left(1 + \frac{1}{c^2}\right)^{-0,5} \qquad \text{(L.7)}$$

$$K_2 = \left(1 + \frac{1}{c_1^2} + \frac{1}{c_2^2}\right)^{-0,5} \qquad \text{(L.8)}$$

Where:

$$c = \frac{\sum A_2'}{\sum A_2} \quad (L.9)$$

$$c_1 = \frac{\sum A_3'}{\sum A_3} \quad (L.10)$$

$$c_2 = \frac{\sum A_3''}{\sum A_3} \quad (L.11)$$

K_3 is coefficient of "relatively stretched opening time" of doors during the period when people escape from the rooms, determined according to the following formulas:

For single doors:

$$K_3 = 0.03N \le 1 \quad (L.12)$$

For double doors when escaping through buffering compartments:

$$K_3 = 0.05N \le 1 \quad (L.13)$$

Where:

N is average number of people escaping from the room through each door;

K_3 is no less than 0.8 for only one door; 0.7 for two doors; 0.6 for the case of three doors; 0.5 when there are four doors and 0.4 if there are at least five doors in the room;

Corresponding area $\sum A_d$ of ways for escaping from room shall be determined as follow for areas with calculation wind speed:

a) of 1m/s and below – equal with the total area of all escape ways.

b) of above 1m/s – calculate separatedly for doors for escaping from the main side (greatest coresponding area, taken as the sum of all escape ways on the side that has to face wind pressure) and calculate the sum value for all remaining escape doors.