Following Decision No. 19/2006/QĐ-BCN (Part II)

REGULATION ON ELECTRICAL INSTALLATIONS

PART II

ELECTRICAL WIRING SYSTEM

11TCN-19-2006

Installation of oil-filled cable equipment and oil pressure signal of pressure oil-filled cable line

II.3.50. Oil feeding system ensures safe operation for pressure oil-filled cable line in normal working condition and in overheated condition.

II.3.51. Oil amount in oil feeding system is determined taking into account oil consumption of that system. In addition, it is required to ensure oil reservation amount in emergency repair and sufficient oil feeding amount for the longest wire section.

II.3.52. Low-pressure oil tank should be stored in closed building. If quantity of oil tanks at outdoor oil feeding station is not over 6 tanks, they should be placed in chambers made of light metal, on shelves or columns.

Oil tank should be equipped with pressure gauge and protected from direct sunlight.

II.3.53. High-pressure oil feeders should be placed inside closed buildings in which temperature should not be less than + 10^{o}C and as near connection area (feeding area) into the cable as possible.

Connection of oil feeders into oil-filled cable is implemented via oil collector.

II.3.54. When installing high-pressure oil-filled cable lines in parallel with each other, oil feeding for each cable line should be proceeded by individual oil feeder; or by installing equipment for automatic changing oil feeder from this cable line to another cable line.

II.3.55. It is required to supply electricity for oil feeders from two separated sources and there should imperatively be a device for automatic switching on backup source.

Oil feeders should be isolated from each other by fire resistant separators with fire resistance level no less than 0.75 hour.

II.3.56. Each oil-filled cable line should have signal system for oil pressure, ensuring automatic recording and transmitting signals about decrease or increase in oil pressure over limited level to operation center.

II.3.57. At each section of low-pressure oil-filled cable, there should be at least two pressure sensors. For high-pressure oil-filled cable line, there should be pressure sensor at each oil feeder. Signal of emergency condition should be transmitted to the station with frequent watchman.

Signal system for oil pressure should be protected from electromagnetic influence of cable lines.

II.3.58. Oil feed stations for pressure oil-filled cable line should have telephone system for communication with regional network load dispatcher.

II.3.59. Chamber for electrical cubicles and automatic control equipments for oil feeder should not have vibration over allowable value of the equipment.

Installation of connection box and cable terminal

II.3.60. Installation of connection box and cable terminal should ensure to have structure in compliance with performance of cable and surrounding environment. Connection box and cable terminal should ensure not allow penetration of moisture and harmful objects into cable. They should be able to bear testing voltage as regulated.

II.3.61. Connection box and cable terminal should be used in compliance with technical standards of cable.

II.3.62. For connection box or locking box of low-pressure oil-filled cable, it is only allowed to use brass or copper connection box.

Length of sections and location of locking box of low-pressure oil-filled cable are determined taking into consideration of oil feeding for cable in normal condition and in temperature variation condition.

Locking box and semi-locking box of oil-filled cable line should be arranged in cable manhole. When cable is installed inside ground, cable box should be placed in manhole covered with fine soil or sand.

At electrification transport area (subway system, electrical train, railway system) or area having hazard to metal sheath of cable and cable box, cable box should be accessible for investigation.

II.3.63. On cable line using both oil-filled, paper-insulated cable and oil-filled cable, if oil-filled paper-insulated cable is installed higher than oil-filled cable, then it is required to use transitional locking box.

II.3.64. For cable lines with voltage over 1kV using rubber-insulated flexible cable and rubber-sheathed cable, when connecting, it is required to use hot curing method (baking) for rubber and to cover connection with a moisture resistant layer.

II.3.65. Number of connection boxes in a kilometer of cable line which is newly built should not exceed:

4 boxes for three-core cable with voltage of 1-10kV and cross section up to 3x95 mm^2

5 boxes for three-core cable with voltage of 1-10kV and cross section 3x120mm^2 – 3x240 mm^2

6 boxes for three-phase cable with voltage of 15-22-35 kV

2 boxes for single-core cable.

For cable line with voltage 110-220kV, quantity of boxes is stated by design.

It is not allowed to use short cable sections installed in cable constructions with great length.

II.3.66. Manufacture and installation of cable terminal box, connection box should be implemented in compliance with regulations and specific technical guidelines.

Earth connection

II.3.67. Metal-sheathed cable lines and structure for cable installation should be earthed or neutral connected as in Chapter I.7- Part I.

II.3.68. In earth connection or neutral connection, metal sheath and steel ring of pressure cable should be connected to each other and connected to connection box by soft copper wire. In all cases, earthed wire should have section no less than 6mm^2.

Cross section of earthed wire of pilot cable should be selected in compliance with requirements in Chapter I.7- Part I.

If there are connection box and lightning resistant equipment on the pole, ring and metal sheath and box cover should be connected to earthed equipment of lightning resistant component. It is not allowed to use metal sheath of cable to be earthed wire.

II.3.69. For low-pressure oil-filled cable line, it is required to connect cable terminal box, connection box and locking box. For oil feeder, it should be connected to copper-sheathed cable line via insulated pipe. Sheath of cable terminal box should be isolated from aluminum sheath. This requirement is not applied for cable line directly connected to transformer. When using low-pressure oil-filled cable line having steel ring, at each cable manhole, connection boxes should be welded at both ends and earthed.

For high-pressure oil-filled cable line installed inside ground, steel pipe should be earthed at each manhole and at both terminals of the cable. If oil-filled cable is installed inside cable construction, in addition to above earth points, there should be intermediate earth points as regulated in design.

When required to protect steel pipe against corrosion, earth connection of the pipe should be implemented in compliance with requirements of that protection method, but should still ensure ability for investigation of resistance of anti-corrosion covering layer.

II.3.70. When connecting cable line into overhead power transmission line at pole where there is no earth connection, it is able to use cable sheath as earthed wire for cable terminal box. If this box is at other side of the cable line which has been earthed, earth resistance of cable sheath should be in compliance with requirement in Chapter I.7- Part I.

Special requirements for cable in power plants,

electrical substation and power distribution equipment

II.3.71. Requirements in Article II.3.72 and 77 are applied for assembly of cable line of power plant with output from 25MW and above, distribution equipment and substation with voltage of 220-500kV as well as for distribution equipment and substation having special mission.

II.3.72. Main wiring diagram, auxiliary diagram and control diagram, equipments and cable assembly of power plant or substation should be installed so that when there is fire inside or outside cable assembly, some mechanical assemblies of the plant still work normally, not interrupting backup connection of distribution equipments and substation as well as alarming system and fire fighting system.

II.3.73. For major cable group of the power plant, there should be cable structures (cable layers, cable tunnel, cable manhole…) isolated from technological equipments. It is not allowed to let unprofessional people to access this area.

When installing cable group at power plant, selection of cable line should take into account:

- Heating cable due to heat from technological equipments.
- Breaking, deforming cable (due to fire, explosion), polluting cable due to dirt penetrated via de-duster system.

It is not allowed to install transitional cable in technical tunnel, ventilation shaft, water treating area by chemical as well as in area of corrosive chemical pipeline system.

II.3.74. Mutual backup branching cable (pressure cable, operation cable, control cable, signal cable, fire fighting cable…) should be installed so that when there is fire, they will not be damaged at the same time. To do that, cable assemblies should be divided into sub-groups and isolated from each other. Division into sub-groups depends on condition at the site.

II.3.75. In area of electrical generator assembly, allow to build cable structure with fire resistance level of 0.25 hour. In this case, technological equipments which can be inflammation source (oil tank, oil station…) should be separated by bulkheads with fire resistance level of 0.75 hour and above.

In area of generator assembly, allow to install cable outside specialized cable construction, provided that cable is surely not be damaged due to mechanical impact, dust, sparks when repairing other technological equipments and it is required to ensure convenient operation of the cable.

To access cable line at a height over 5m, it is required to build paths with rest points.

For single-core cable and small cable groups (up to 20 wires), it is not necessarily to build rest points but they should be able for quick replacement and repair during operation procedure.

When installing cable in area of a generator assembly outside specialized cable construction, it is required to ensure ability of dividing cable into sub-groups in different lines.

II.3.76. Cable layers, tunnels for installing cables of different machine assemblies, including cable layers and tunnel under control cabinet of machine assemblies should be divided in compliance with each machine assembly and separating different chambers from cable layer, cable tunnel, manhole, box, stray and positions where cable runs by bulkheads, covers with fire resistance level of over 0.75 hour.

At area where cable runs via bulkhead or cover, it is required to consider usage of incombustible material which is easy for drilling and has fire resistance level over 0.75 hour, convenient for replacement and addition of cable.

At cable construction with great length of power plant, it is required to consider building of exits at distances of not greater than 50m.

Cable assembly of power plants should be separated from tunnel of cable network exiting from the plant and from bus-bar by fire resistant bulkhead with fire resistance level over 0.75 hour.

II.3.77. Area where cable runs into closed chamber of distribution equipment, area of control cabinet, open distribution equipment…, there should be bulkhead with fire resistance level of over 0.75 hour.

Area where cable runs into control cabinet of generator assembly, it is required to cover by slabs of material with fire resistance level greater than 0.75 hour.

Cable manhole should be isolated from cable tunnel, cable layer and other cable construction by bulkhead with fire resistance level over 0.75 hour and should be totally covered at both the top and bottom.

Long cable manhole when running via the cover should be separated into chambers with length not greater than 20m by incombustible bulkhead with fire resistance level over 0.75 hour.

Transitional cable manhole should have exit and entrance and ladder or hook for travel.

Installation of cable inside ground

II.3.78. When installing cable inside ground, it should be placed in cable tunnel. There should be a fine sand layer under cable and cable should be covered with a fine soil layer without any gravel, stone, slag or garbage.

Along cable line, there should be protective solution against mechanical impact, such as:

- For cable with voltage 35kV and above, cable tunnel should be covered with concrete slabs with thickness no less than 50mm.
- For cable with voltage less than 35kV, cable tunnel should be covered with concrete slabs or brick panels horizontally with cable line or covered with solid material along cable line (silica brick, perforated brick or hollow brick is not allowed).

When installing cable with voltage up to 22kV under ground at a depth of 1m or greater, it is not required to have protective method against mechanical impact; except for the case of cable for urban power network, cable via railway, tramway and roadway)

For cable with voltage less than 1kV, protection is only required at sections where there is ability of mechanical impact.

Above regulations are not applied for cable construction method by underground drilling (digging by robot).

II.3.79. Depth for cable installation from planning standard elevation is at least:

- 0.7m for cable with voltage up to 22kV
- 1.0m for cable with voltage of 35kV
- 1.5m for cable with voltage 110-220kV

Depth can be reduced to 0.5m at cable section with length less than 5m, at entry area toward building or at intersection area with underground structures, but cable should be protected against mechanical impact.

II.3.80. Distance from cable line (at all voltage levels when installing inside ground) to foundation of building or constructional structure should not be less than 0.6m.

It is prohibited to install cable directly under foundation of building or constructional structure. When installing cable via buried storey, technical basement, it is required to follow regulations issued by the State.

II.3.81. When cables are installed in parallel with each other, if there is no guideline of manufacturer, distance between cables should be at least:

a. 100mm: between pressure cables with voltage up to 10kV or between this type of cable and pilot cable.

b. 250mm: between pressure cables with voltage 22kV or 35kV or between these types of cable and other pressure cable with lower voltage.

c. 500mm: between cables of different organs or between pressure cable and communication cable.

d. 500mm: between pressure oil-filled cable with voltage 110kV-220kV or between pressure oil-filled cable and other cable, of which low-pressure oil-filled cables should be isolated from each other and from other cables by concrete slabs. In addition, it is required to take into consideration electromagnetic influence of cables on communication cable.

e. Distance between pilot cables is not stated.

In necessary case, if agreed by operation management organ and allowed by practical condition, it is able to reduce distance value in "b" and "c" to 100mm; for distance between pressure cable with voltage 10kV and communication cable (excluding high frequency cable), this value is reduced to 250mm provided that cable will be protected if there is short circuit.

II.3.82. When installing cable via forest or green zone, minimum distance from cable to tree stump is 2m. If agreed by responsible organs of the region, this distance can be reduced to 0.75m.

II.3.83. Distance from cable with voltage up to 35kV, pressure oil-filled cable in parallel to pipeline (water pipe, water channel), low-pressure gas pipe from 0.0049MPa to 0.588MPa should not be less than 1m; to pipeline having pressure over 0.588MPa to 1.176MPa should not be less than 2m.

In narrow condition, above distance of cable line with voltage of 35kV (excluding distance to liquid fuel pipe or gas pipeline) can be reduced to 0.5m; this value can be still reduced to 0.25m for cable installed in pipe along that length.

For cable with voltage 110-220kV, at sections not greater than 50m which require to be placed near each other, horizontal distance to the pipe (excluding liquid fuel pipe and gas pipe) can be reduced to 0.5m, provided that there should be isolated wall between cable and pipeline to avoid damage of cable due to mechanical impact.

Prohibit to install cable in parallel with pipeline in form of overlapping.

II.3.84. When installing cable line in parallel with heat pipe, distance between cable and the pipe should not be less than 2m. At area where cable is compulsory to be near heat pipe, along the section near the cable, heat pipe should be covered with a heat insulation to avoid increasing temperature of soil surrounding cable line, in all conditions in the year over 10^{o}C for cable line with voltage up to 10kV and 5^{o}C for cable line with voltage from 22kV to 220kV.

II.3.85. When cable line is in parallel with railway, it should be installed outside boundary of railway. In special case, if agreed by railway management organization, cable line can be installed inside area of railway but should be far from center of railway no less than 3.25m; far from electrification railway no less than 10.75m. At narrow area, this distance can be reduced but cable should be placed in pipe or block for the whole length via that area.

When cable line is near electrification railway which uses direct electric current, cable pipe and cable block should be insulated (asbestine, bituminous or insulated plastic).

II.3.86. When cable line is in parallel with tramway, distance from cable line to the nearest rail should not be less than 2.75m. At narrow area, this distance can be reduced provided that for the whole length of cable, cable should be placed in insulated pipe, block as stated in II.3.85.

II.3.87. When cable line is in parallel with roadway class I or class II, cable line should be installed outside drainage or toe of road embankment no less than 0.7m. This distance can be reduced if agreed by transport management authority.

II.3.88. Distance from cable line to earth equipment of pole of overhead transmission line with voltage over 1kV to 35kV should not be less than 5m; for overhead transmission line with voltage of 110kV and above, this distance should not be less than 10m. At narrow area, this distance can be 2m and above.

Distance from cable line to toe of pole of overhead transmission line less than 1kV should not be less than 1m. At narrow area, cable installation should be implemented by running via insulated pipe and the distance to toe of the pole will be reduced to 0.5m.

At power plant and substation, allow to install cable far from foundation of pole of overhead transmission line over 1kV no less than 0.5m if earth equipment of that pole is connected to earth network of the station.

II.3.89. At crossing point between pressure cable line and other cable, there should be a soil layer of no less than 0.5m thick for isolation. For cable with voltage up to 35kV, if using pipe or concrete slab for isolating the crossing point 1m to each side, isolating distance can be reduced to 0.15m. Pilot cable and communication cable should be placed on pressure cable.

II.3.90. When cable line crosses with pipeline system, including oil pipeline and gas pipeline, minimum distance between cable and pipe should be 0.5m. If cable is placed inside cable pipe on the whole crossing length added with 2m at each side, the distance can be reduced to 0.25m.

When pressure oil-filled cable line crosses with pipeline, distance between them should not be less than 1m. At narrow area, the distance can be 0.25m provided that cable is placed in pipe or concrete gutter having cover.

II.3.91. When cable line with voltage up to 35kV crosses with heat pipeline, distance from cable to heat insulation sheath of the pipe should not be less than 0.5m. Then heat pipe along the crossing section added 2 more meters at each side should have thermal insulation coating so that temperature of soil surrounding cable will not increase 10^{o}C compared with maximum temperature in summer and 15^{o}C compared with minimum temperature in winter.

In case above conditions can not be met, one of following method should be implemented:

a. To install cable at a depth up to 0.5m instead of 0.7m (as in article II.3.79)

b. To use cable with greater cross section

c. To place cable inside a pipe, running under heat pipe and far from heat pipe no less than 0.5m provided that the pipe is installed in such a way that cable replacement is easy.

When cable crosses with heat pipeline, distance from pressure oil-filled cable to thermal insulation sheath of the pipe should not be less than 1m; at narrow area, this distance should not be less than 0.5m, then heat pipe on the whole crossing length added with 3 more meters at each side should be coated with thermal insulation material so that temperature of soil surrounding cable will not increase 5^oC in any seasons in the year.

II.3.92. When crossing with railway and roadway, cable should be placed in tunnel, in block or pipe on the whole horizontal length of the road added 0.5m more from road's edge. Burying depth of cable is at least 1m from road pavement and lower than bottom of drainage gutter at two sides of the road at least 0.5m.

When crossing with electrification railway using direct current, cable block or cable line should be insulated (refer to article II.3.85); crossing area should be far from switching area and far from connection area of electrical wire (negative wire) into railway no less than 10m. Installation of cable crossing with electrification railway should have crossing angle from $75^o \div 90^o$.

Hole of cable block should be sealed by bituminous hemp mixed with clay soil and depth into the pipe should not be less than 30cm.

When crossing with dead end, local path, specialized path with few vehicles, cable can be placed directly inside ground.

When crossing with non-electrification railway which has been newly built or newly built roadway, it is not necessarily to re-install current cable line. At crossing area, there should be backup pipes or pipe blocks for repair of cable line. Backup pipes or pipe block should be sealed at two ends.

II.3.93. When crossing with tramway, cable should be placed in insulated block or pipe(see II.3.85). Crossing area should be far from switching position or connection area of electrical wire (negative wire) into the rail no less than 3m.

II3.94. When crossing with area of automobiles, garage…, cable should be placed inside pipe.

When running via spring, water gutter and via alluvial deposit, cable should also be placed inside pipe.

II.3.95. When installing cable connection box, distance from connection box to the nearest other cable is not less than 250mm.

When requirement for this distance value can not be met, there should be protection method for cable near the connection box (such as using brick or concrete slab to isolate with connection box).

Do not place connection box of pressure oil-filled cable or oil paper-insulated cable at incline area. If this is irresistible, surface under the connection box should have a small un-inclined area.

To ensure replacement of cable connection box, there should be backup length at both end of the box.

II.3.96. When there is stray current at cable line with dangerous value, implement following methods:

- To change cable line direction out of that dangerous area.
- If it is not able to change cable line direction, there should be method to minimize the stray current or we should use cable with high corrosion resistance (i.e. dry cable…).

Installation of cable in cable block and cable tray

II.3.97. Cable line, cable block can be made of steel, cast iron, concrete, ceramic, synthetic resin or similar materials. When selecting material for cable pipe or block, attention should be drawn to underground water level, erosion of water as well as stray current at installation area.

Single-phase cable is only placed inside pipe made of nonmagnetic material. Each phase of cable line should be placed in individual pipe.

II.3.98. Quantity of chambers in cable block, distance between chambers and dimension of chambers should be selected in exothermal condition.

II.3.99. Each cable block should have 15% backup chamber but not less than one chamber.

II.3.100. Depth for cable pipe and block inside ground should be in compliance with practical condition, but no less than values stated in II.3.79, from the cable to the top.

Depth for cable pipe and block at closed space or under ground of production house.

II.3.101. Cable block and cable pipe when installing should have inclination toward cable manhole at least 0.2%.

II.3.102. For cable pipes installed directly inside ground, minimum gap between them, between pipe with cable or with other structures should be the same as gap for cable without pipe (see II.3.81).

When installing cable under floor of workshops, distance between cables is the same with installation of cable inside ground.

II.3.103. Cable inside cable block, at turning point of cable lie and at area where cable block runs into ground should have manhole to ensure convenience for cable construction. At straight line, cable manhole is also required, distance from cable manholes is determined by allowable limited length of cable.

When quantity of cable is up to 10 and cable has voltage up to 35kV, allow cable to run from cable block into ground without cable manhole. In that case, there should be method to prevent water penetration into the block.

II.3.104. Cable from cable pipe or block running into building, cellar or basement… can be implemented by on of following methods:

a. Directly running into the house

b. Building cable manhole inside the house or adjacent to outside wall of the house

There should be method to prevent water or creatures (rat, snake..) from going into the house via cable line.

II.3.105. At exit area from cable pipe or chamber of the block or manhole as well as at area of pipe connection, internal side of the pipe, of the block and the gutter should be flat and smooth to prevent damaging external sheath when drawing cable.

II.3.106. For outdoor distribution station at area with high underground water level, use installation method of surface cable (inside tray or box). Cable tray and its cable should be built of reinforcement concrete. Cable trays should be placed on concrete supports with inclination of at least 0.2% for easy drainage. If there are drain mouths on surface cable line, inclination is not required.

When installing cable tray, it is required to ensure not obstructing transport and affecting maintenance and repair of other equipments.

Exit terminal of cable from tray and control cabinet should be placed inside pipe. Allow locating cable supports in cable tunnel within area of the same open chamber of outdoor distribution station; then cable toward control cabinet and protection is not required to be placed in pipe but should have protective method against mechanical damage.

Installation of cable in cable constructions

II.3.107. Installation of cable should take into account ability of laying more 15% of cable in design (replacing cable in installation procedure, additional laying…).

II.3.108. Cable layers, tunnel, cable corridor, router and cable manhole should be isolated from other spaces and nearby cable constructions by fire-resistant separator with fire resistance level no less than 0.75 hour. Separator with long cable tunnel should be divided into sections, with entrance and exit not

far from each other over 150m for installation of pressure cable and pilot cable; not over 100 m for installation of pressure oil-filled cable. Area of a tunnel section with double floor should not be greater than 600m^2.

Entrance and exit into cable construction and separator of electrical equipments in II.3.71 should have fire resistance level of 0.75hour and 0.6 hour in remained electrical equipments.

Exit from cable construction should be arrange toward outside or toward workshop room with high safety in fire prevention and protection. Quantity and position of exits (exit door) from cable construction is determined at the site but at least 2. If length of cable construction is not over 25m, allow to have only one exit.

Entrance into cable construction should be automatic gate and have gasket. Exits should be reversed and have lock which can be unlocked from inside without key. Doors among chambers, tunnel sections open toward the nearest exit and self-closing.

Cable router, cable jacks having technical framework should have ladder entrance. Distance between entrances not greater than 150m. Distance from ladder flight, cable support toward the entrance should not be greater than 25m.

Entrance should have door to prevent free access from outsider. Doors should have locks for unlocked from inside without using key.

Distance between entrances into cable corridor with cable voltage up to 35kV should not be greater than 150m; for pressure oil-filled cable, this distance not greater than 120m.

Outdoor cable layers, cable corridor should be placed in load-bearing reinforced concrete structures (pillar, overhanging beam) with fire resistance level no less than 0.75 hour or by steel panels with fire resistance level no less than 0.25 hour.

Load bearing structure of building, construction can be hazardously deformed or reduced mechanical strength when there is fire at cable groups (or cable assembly); cable router or cable corridor at that position should be protected with fire resistance level no less than 0.75 hour.

Cable corridor should also be divided into chambers by fire resistant bulkheads with fire resistance level no less than 0.75 hour. If cable has voltage up to 35kV, length of each chamber of the corridor should not be greater than 150m and not greater than 120 for pressure oil-filled cable. Outdoor cable corridor has covered sections will not follow this regulation.

II.3.109. In cable tunnel and cable stray, there should be method to prevent industrial waste water or oil from penetrating into and there should be method for draining water contaminated with sand and soil to outside area. Inclination of draining bottom of tunnel and stray should not be less than 0.5% toward

collecting pit or drainage gutter. Travel from chamber to chamber when they are at different height should be performed on slope with inclination not greater than 15^{o}. Prohibit to use step ladder between chambers of the cable tunnel.

In outdoor cable tunnel and cable stray higher than underground water level, allow to build their bottoms by compacted soil and covered with gravel layer of 10÷15 cm thick.

In the cable tunnel, there should be automatic pump for water drainage depending on water level. Operation control device and electrical engine should have structure meeting requirement for application at especially wet area.

When traveling via support and corridor at different heights, there should be slope with inclination not greater than 15^{o}. In special case, allow to build step with inclination of 1:1.

II.3.110. Cable stray and double floor in distribution station and in chamber should be covered by removable slabs made of fire resistant material. In chamber of rotating machine and similar spaces, ribbed steel panel should be used. When covering cable stray and double floor, it is required to consider ability of transporting equipments on that cover.

II.3.111. Weight of the cover for lifting up should not be greater than 50kg. Each cover panel should have hook for lifting when required.

II.3.112. Prohibit to build cable stray at area where there is ability of fused metal, high-temperature liquid running into the area or there is substance damaging metal sheath of the cable. At that area, it is also not allowed to build entrance door into cable chamber, cable stray.

II.3.113. Underground cable tunnel at outside of building should be covered with soil layer of 0.5m on its surface.

II.3.114. When installing cable at same area with heat pipeline in the building, temperature rise of the air at cable laying area due to the heat pipe should not exceed $5^{o}C$ in the whole year. To do that, it is required to consider ventilation and improvement of heat insulation for heat pipes.

II.3.115. In the cable construction, it is suggested to use all manufactured length of the cable. Cable laying should be in compliance with following requirements:

1. Pilot cable and communication cable are above or beneath pressure cable but should be isolated. At crossing or branching point, allow not to have isolator.
2. Pilot cable is allowed to be laid near pressure cable with voltage up to 1kV.
3. Pressure cable with voltage up to 1kV should be placed above cable with higher voltage and there should be isolator between them.

4. Different cable groups: operating cable, backup cable higher than 1kV of electrical generator, transformer… of load of type I should have low and high level and separated by bulkheads.
5. Bulkheads mentioned in 1, 3, 4 should be made of fire resistant material with fire resistance level no less than 0.25 hour.

When using automatic fire fighting system with foam or water jet, bulkheads in 1, 3 and 4 are not required.

Outdoor cable stray, partially covered cable corridor will not required bulkheads in 1, 3 and 4. Then, backup pressure cable line (excluding cable line for load of type I) should be far from each other no less than 600mm. At the cable bridge, cable is placed at two sides of horizontal support of the main structure (beam, hook); at cable corridor, cable is place at two sides of the path

II.3.116. Pressure oil-filled cable should be placed in individual construction. Allow to place pressure oil-filled cable at the same area with other cables. Then, it will be located at the lowest area and isolated from other cables by horizontal supports with fire resistance level no less than 0.75 hour. Pressure oil-filled cables should also be isolated from each other by the same method.

II.3.117. Requirement for installing and for quantity of equipments automatically alarming and fighting against fire in cable construction should be determined basing on approved guidelines.

There should be fire hose reels near the exit and ventilation well (within radius not greater than 25m). For support bridge, cable corridor should be calculated so that all points will not have distance over 100m to the nearest fire hose reel.

II.3.118. For cable construction having pilot cable and steel-ring pressure cable with cross section equal to or greater than 25mm^2, lead-sheath cable without steel-ring should be placed on support bracket. Un-armored pilot cable, lead sheath pressure cable without steel-ring and pressure cable of other sheathes with cross section less than 16mm^2 should be placed in stray or isolated shelves (by enclosed bulkhead or sparse type)

Allow to lay cable directly on bottom of cable stray when that stray has a depth not greater than 0.9m; then distance between pressure cable groups with voltage over 1kV and pilot cable groups should not be less than 100mm or they will be isolated by bulkhead with maximum fire resistance level not less than 0.25 hour.

Minimum distance between cables is stated in Table II.3.1.

II.3.119. At narrow area of underground constructions, allow to use cable tunnel with height less than values in table II.3.1 but not less than 1.5m and in compliance with requirements: voltage of cable line is

not greater than 10kV, length of cable tunnel is not over 100m, remain distances are in compliance with table II.3.2 and there should be exit at the end of cable tunnel.

Table II.3.1: Minimum distance between cables in cable construction

Distance	Minimum size in installation (mm)	
	In cable tunnel, cable corridor, support bridge	**In cable stray and double floor**
Height of the construction	1800	Not limited but not greater than 1200mm
Horizontal distance between supports when installing at both sides (passage width)	1000	300 for depth of 0.6m 450 for depth of 0.6-0.9 m 600 for depth greater than 0.9m
Horizontal distance from support to wall when installing at one side (passage width)	900	As above
Vertical distance between horizontal supports (*) - up to 10kV - 22-35kV - 110 kV and greater	 200 250 300(**)	 150 200 250
For pilot cable, communication cable and pressure with cross section of 3 x 25 mm^2	100	
Distance between support (bracket) by length of construction	800-1000	
Vertical distance and horizontal distance of pressure cable with voltage up to 35kV (***)	Not smaller than cable diameter	
Horizontal distance between pilot cable and communication cable (***)	Not specified	
Horizontal distance between cable with voltage 110kV and greater	100	Not smaller than cable diameter

Note:

(*) Effective length of support should not be greater than 500mm at straight section

(**) If cable is laid in triangle form, the value is 250mm

(***) Including cable inside cable manhole.

Table II.3.2 – Minimum distance from cable support, cable corridor to building or constructional structure

Constructional works	Arrangement	Minimum size, m
When running horizontally, in parallel		
Building and constructions having enclosed wall	From cable bridge and cable corridor to wall of building and construction	Not specified
Building and constructions having perforated wall	As above	2
Un-electrification railway in area of factory	From cable bridge and cable corridor to the nearest external of construction	* 1 m for corridor and bridge for traveling * 3m for corridor and bridge not for traveling
Roadway in factory area and fire rescue path	From cable bridge and corridor to road verge at outside of bottom of drainage of the road.	2
Cable road	From cable bridge and corridor to external edge of moving part	1
Surfaced pipeline	From cable bridge and corridor to the nearest portion of conduit	0.5
Overhead transmission line	From cable bridge and corridor to conductor wires	See II.5.116
When crossing vertically		
Un-electrification railway in area of factory	From the lowest point of support bridge and cable corridor to rail surface	5.6
Electrification railway in area of factory	From the lowest point of the support bridge and cable corridor: - To rail surface - To the highest cable wire or steel cable of contact network	7.1 3

Internal road of factory (fire rescue path)	From the lowest point of support bridge and cable corridor to road pavement (surface of fire rescue path)	4.5
Ground-based pipeline	From structure of support bridge and cable corridor to the nearest pipe	0.5
Overhead transmission line	From structure of support bridge and cable corridor to the wire	See II.5.124
Telecommunication and broadcasting line	As above	1.5

II.3.120. Low pressure oil-filled cable and single phase cable should be fixed on the support so that there will not be closed magnetic circuit. Distance between fixed points will not exceed 1m.

Steel pipe of high pressure oil-filled cable line can be placed on poles or hung by hanger; Distance between poles or hangers is determined by design. In addition, cable pipe should be fixed into the pole to prevent deformation of pipe due to heat influence. Pole foundation will be calculated to bear weight of cable pipe. Quantity and position of pole is in compliance with design.

Pole and fixing points of bifurcating equipment of high pressure oil-filled cable line should be able to eliminate vibration of the pipe, annul closed magnetic circuit surrounding them. There should be insulation for fixing points or junction to the pole.

II.3.121. Height of cable manhole should not be less than 1.8m; height of cable chamber is not specified. Types of cable manholes used for placing connection box, lock connection box or semi-lock connection box should have sufficient size for installation without requiring widening work.

Onshore cable manhole where cable lines are turned to be installed in water should have sufficient size for accommodating backup cable and oil feeder.

At bottom of manhole, there should be collector pit for rainwater, underground water and pumping equipment to pump out water as in II.3.109. Cable manholes should have metallic ladder. Cable and connection box inside cable manhole should be placed on support, stray or bulkhead.

II.3.122. Entrance into cable manhole and cable tunnel should have diameter no less than 650mm and covered by metallic material. Entrance door can be unlocked from beneath without using key. Covers should have handles for opening.

II.3.123. Connection box of pressure cable from 6-35kV in cable tunnel, cable layer and cable stray should have protection sheath against explosion and fire in cable box.

II.3.124. Cable terminal box of high pressure oil-filled cable should be placed in rooms with automatic dryer when ambient temperature decreases to less than 5^oC.

II.3.125. When laying pressure oil-filled cable in cable corridor, it is required to take into account heating the corridor in accordance with equivalent technical regulation of oil-filled cable.

Room for oil feeder for high pressure oil-filled cable should have natural ventilation. Allow installing underground oil feeder together with cable manhole, at that situation, cable manhole should have water pump as in II.3.109.

II.3.126. Cable constructions, except for cable layer, cable pit used for installing connection box, cable stray and cable room should be equipped with natural or artificial ventilation systems and these systems should be independent from each other.

Calculation for ventilation for cable construction bases on difference in temperature between input and output air not greater than 10^oC. In that condition, it is required to limit ability of creating hot air stream at narrow place, turning point…

Ventilating equipment should have chokes (choke valve) to obstruct air in fire or extreme cooling air stream in winter. Structure of ventilating equipment should automatically obstruct air from outside in fire.

When installing cable in room, it is required to prevent overheat of cable due to ambient temperature and influence of technical equipments.

Cable construction, except for cable manhole used for connection box, cable tunnel, cable room and outdoor cable supports should have lighting system and electrical circuit used for hand-held lamp and device.

Installation of cable in production space

II.3.127. When installing cable in production factory, it is required to meet following requirements:

1. Cables are accessible for repair or cables are at open space for easy observation all types of cable (including armored cable); cable at areas where there is transportation of machine, equipment, goods and vehicles… should be protected against damage as in II.3.14.
2. Distance between cables should be in compliance with data in Table II.3.1.
3. Distance between pressure cable in parallel with any type of pipe should not be less than 0.5m; for cable in parallel with gas pipe and fluid fuel pipe, this distance will not be less than 1m. If the

distance is temporarily close or in case of crossing with each other, cable should be protected against mechanical damage (by steel pipe, by additional sheaths..) on that closed section and adding 0.5m more at each end. If necessary, there should be overhead protection method for cable.

At area where cable crosses with passage, cable should be placed at a height no less than 1.8m from the floor.

It is not allowed to lay cable in parallel above or under oil pipe and fluid liquid fuel pipe by vertical plane.

II.3.128. Installation of cable under foundation or among floors should have stray or pipe but cable should not be compacted. Area where cable runs out of floor and wall can be installed with pipe or pits for cable. After cable installation, gaps of pipe or pits should be sealed by fire resistant material.

Prohibit laying cable in ventilation shaft. Allow running individual cable in steel pipe crossing via ventilation shafts.

Prohibit installing open cable in staircase.

Installation of cable in water

II.3.129. When running cable via river, channel…, cable should be installed at the section where river bed and bank are rarely eroded (crossing section of river, spring – see II.3.42). Installation of cable at river of which water flow is changeable and banks are flooded frequently, submerged installation of cable at the river bed should base on specific condition. Depth of cable installation is determined by design. Do not lay cable at harbor area, boat stand, dock, float bridge and frequent boat stations.

II.3.130. When installing cable under the sea, attention should be drawn to depth, speed and water back pressure and wind pressure at the area where cable starts to be moved from seashore into the sea. Attention should also be drawn to chemical composition of terrain of seabed, chemical composition of water.

II.3.131. Cable installation at the bottom is implemented so that at uneven area, cable will not be sagged due to its weight. Sharp edge should be evened. Avoid installing cable at area of reef, abyss and obstacle under water; otherwise, it is required to place cable inside cable tunnel, cable gutter.

II.3.132. When installing cable at river, channel, cable depth for installation should not be less than 1m at area near river bank and at shallow water, at passage path of boat and vessels; for pressure oil-filled cable, this depth is not less than 2m.

At dam, water reservoir where there is periodically suction dredging of the bottom, installation depth of cable is under agreement of authoritative organs.

Pressure oil-filled cable 110-220kV running via river, channel which is waterway transport line should be placed in cable tunnel and covered with sand to protect against mechanical damage.

II.3.133. Distance between cables under bed of river, channel with width up to 100m should not be less than 0.25m. Hidden cable line should be far from available cable line no less than 1.25 times of depth at area for cable installation, in relation to mean annual water level.

When installing low pressure oil-filled cable under water at a depth of 5÷15m and water flow rate is not greater than 1m/s, distance between individual phases (without special clamp between phases) should not be less than 0.5m, distance between outmost cables of the cable line running in parallel with each other should not be less than 5m.

When installing cable at a depth of over 15m, flow rate over 1m/s, distance between individual phases and cable lines is stated by specific design.

When installing pressure oil-filled cable in parallel with cable with voltage up to 35kV under water, horizontal distance between them should not be less than 1.25 times of average annual depth of the river at the position of cable, but not be less than 20m.

Horizontal distance of cable line buried at the bed of river, channel or water reservoir to pipeline (gas pipeline, oil pipeline…) is determined by design depending on specific work volume at the bed of river, channel for installation of pipeline and cable, but not be less than 50m. Allow reducing that horizontal distance to 15m if agreed by management authority of that cable line and pipeline.

II.3.134. At the bank without complete embankment, area where cable is run into water should have backup length of cable no less than 10m for river and 30m for the sea. At the bank with complete embankment, cable portion onshore should be placed inside cable pipe. At area where cable starts to be run into water, there is generally cable manhole. Cable pipeline at inclined position toward onshore manhole, lower end should be at a depth no less than 1m compared with the lowest water level. Cable pipeline at the bank location should be reinforced.

II.3.135. At area where water flow and bank do not have clear boundary, bank is eroded affecting cable, there should be protection method against erosion and flooding due to floods by reinforcing that bank area (building embankment, piling, building dyke…)

II.3.136. Prohibit installing cables crossing with each other underwater

II.3.137. At the area where cable runs via river, channel, there should be warning board on the riverside as regulated by current law of waterway and sea transport.

II.3.138. When installing in water 3 and above cable lines of voltage up to 35kV, there should be one backup cable for each group of 3 cables. When installing in water, pressure oil-filled cable line of each phase should have backup: for one line – backup one phase; for two lines: backup 2 phases; for 3 and

above lines: backup as in specific design but no less than 2 phases. Phases for backup should be installed so that when required, it is able to replace any phase in working phases.

Installation of cable in special construction

II.3.139. For installation of cable for stone bridge, concrete reinforcement bridge and iron bridge, cable should be run at walkway of that bridge and should be placed inside cable stray or fir-proof pipe for each individual cable. Pay attention to a method to reduce ability of rainwater running directly on that pipe.

All cable lines when running by stone bridge, concrete reinforcement bridge should be insulated from iron part of the bridge.

II.3.140. Installation of cable for wooden constructions (bridge, dock…) should be performed by placing cable in steel pipe or fir-proof pipe.

II.3.141. At the area where cable runs via dilatation joint of the bridge, via gap between structure and bridge abutment, there should be a method to prevent cable from mechanical damage.

II.3.142. Installation of cable for water dam, dyke, dock, vessel stand, directly inside soil trench… should be implemented by covering on the cable line a soil layer of no less than 1m thick.

II.3.143. Prohibit installing types of oil-filled cable along bridge.

Chapter II.4

OVERHEAD TRANSMISSION LINE WITH VOLTAGE UP TO 1KV

Scope and definition

II.4.1. This chapter is applied to overhead transmission line with voltage up to 1kV using bare wire, insulated wire and low-voltage aerial bundled cable. This chapter is not applicable to overhead transmission line specialized for tram and trolleybus. Cable section inserted into overhead transmission line and the section bifurcated from overhead transmission line should meet requirement in chapter II.3.

II.4.2. Overhead transmission line is the construction for transmitting and distributing electric power by conductor wire, installed in the open air and mounted on insulator and accessories, installed on poles or structure of other constructions.

In this regulation, overhead transmission line includes bifurcated sections from main wire line to entrance terminal into houses.

II.4.3. In physio-mechanical consideration, normal condition of overhead transmission line is considered to be working condition when conductor wire is not broken. Emergency condition of overhead transmission line is the working condition when conductor wire is broken.

General requirement

II.4.4. Physio-mechanical calculation for conductor wire of overhead transmission line should be implemented by allowable stress method. Standard load is determined as in Chapter II.5.

For insulator and accessory, calculation is performed in relation to breaking load.

For pole and foundation, calculation is in relation to limited state method.

Results should be in compliance with current standard and regulation on construction.

II.4.5. Overhead transmission line should be arranged so that poles will not obstruct entrance into houses and not block passage of people and vehicles. At area where there is ability of dangerous accident due to collision of vehicles, electric poles should have protection method.

II.4.6. On the pole of overhead transmission line, at a height of 2.0-2.5m from ground surface, it is required to note down information of pole sequence and year of its erection.

II.4.7. Metallic structure of overhead transmission line should be protected against corrosion, the best way is to be galvanized.

Climate condition

II.4.8. Climate condition for calculating overhead transmission line up to 1kV is in compliance with Chapter II.5.

II.4.9. When calculating overhead transmission line, it is required to use climate combination condition as follows:

a. Maximum temperature T_{max}, wind pressure q = 0

b. Minimum temperature T_{min}; wind pressure q = 0

c. Average annual temperature T_{tb}; wind pressure q =0

d. Maximum wind pressure q_{max}, temperature T = 25^{o}C

II.4.10. Distance of conductor wire closed to building and constructions as well as architectural structures should be checked taking consideration the condition: stated pressure wind and maximum air temperature.

Conductor wire and accessories

II.4.11. Overhead transmission line can use conductor wire of single core or bundled core. Prohibit using single-core conductor core which is taken from bundled core wire. By physio-mechanical strength condition, overhead transmission line can use conductor wire with cross section no less than:

- Multi-core aluminum wire: 16mm^2
- Steel-cored aluminum wire and aluminum alloy wire: 10 mm^2
- Multi-core copper wire: 4 mm^2
- Single-core copper wire: 3mm (diameter)

For bifurcated wire from the main wire line to entrance terminal into houses, it is normally to use insulated multi-core copper wire with cross section depending on load and length of conductor wire but minimum value will be 4mm^2 for bifurcated wire up to 10m; 6mm^2 for bifurcated wire over 10m to 25m.

Refer to Chapter II.5 for mechanical characteristics of conductor wire.

II.4.12. Calculation of conductor wire by strength should be in compliance with Chapter II.5.

II.4.13. Connection of conductor wire is performed by compressing, by welding or clamping.

Single-core wire should be twisted before welding. Not allow stitching.

II.4.14. Connection joint bearing tension force should have mechanical strength no less than 90% breaking tension of the wire.

II.4.15. Connection of conductor wires of different metals or different cross sections should be implemented at the tack. These connection joints should not bear any load and not be electromechanically corroded.

II.4.16. Connecting conductor wire into post insulator should be performed by special ties or lock.

Conductor wire of bifurcated section should be fixedly mounted on the pole or structure of building.

II.4.17. Physio-mechanical safety factor of insulator pedestal or hanger should not be less than 2.

Arrangement of conductor wire on the pole

II.4.18. Arrangement of conductor wire on the pole of overhead transmission line can be in any forms not depending on climate condition.

When arranging conductor wire at different heights, in general, neutral wire is placed beneath phase wire of overhead transmission line. Wire of outdoor lighting circuit mounted on the same pole of overhead transmission line can be placed beneath neutral wire.

II.4.19. Fuse, sectional switch… one the pole should be arranged lower than conductor wire.

II.4.20. Distance between bare wires should not be less than 20cm when pole span is up to 30m and no less than 30cm when pole span is greater than 30m.

Horizontal distance between bare wires connecting among struts on the pole should not be less than 15cm.

Distance from bare wire to the pole, strut or other element of the pole should not be less than 5cm.

II.4.21. For overhead transmission line using insulated wire, distances in II.4.20 are multiplied by 0.5 factor.

Insulator

II.4.22. Mechanical safety factor of insulator is ratio between mechanical breaking load and maximum standard load acting on the insulator. This factor should not be less than 2.5.

II.4.23. At bifurcating area and crossing area of conductor wires of overhead transmission line, when requiring to hang various conductor wires on the same insulator, it is required to use multi-layer insulator or special insulator.

Neutral wire should be mounted on insulator.

Over-voltage protection and earth connection are required.

II.4.24. For overhead transmission line up to 1kV, only use method of earthed neutral wire. In earth neutral network, insulator pedestal or hanger of phase wire and reinforcement of concrete pole should be

connected to neutral wire. Neutral wire should have multiple earth connection. Distance to multiple earth connection points is 200 to 250m.

Ground wire on the pole should have diameter no less than 6mm. Earth resistance is not greater than 50Ω

II.4.25. To prevent over-voltage due to lightning at residential area having one-storey or two-stories houses where overhead transmission line is not covered by trees, tall buildings or industrial chimneys…, overhead transmission line should be earthed and distance between them should not be greater than:

- 200 m for area with hours of thunderstorm in one year less than 40 hours.
- 100 m for area with hours of thunderstorm in one year over 40 hours.

Earth resistance should not be greater than 30Ω.

In addition, earth connection is required for:

a. At bifurcated pole into houses where there are many people (school, kindergarten, hospital…) or area of great economic value (livestock shed, warehouse, factory…)

b. At end pole of transmission line where wire is bifurcated into houses, distance from earth connection of the end pole to adjacent earth connection not greater than 100m for area with hours of thunderstorm in one year from 10÷40 and not greater than 50m for area with hours of thunderstorm in one year over 40.

Earth connection points for preventing over-voltage due to lightning as mentioned above are also used as multiple earth connection points of neutral wire.

In addition, there should be low-voltage lightning protection at poles stated in a and b.

Power pole

II.4.26. Overhead transmission line up to 1kV voltage can use following poles

a. Support pole: is the pole installed between two anchoring poles. In normal working condition of overhead transmission line, this pole does not bear any longitudinal force.

b. Straight anchoring pole: is the pole installed at anchoring position on straight alignment of the line and at crossing position with other construction. This pole should be solid structure, in normal working condition of overhead transmission line, it will bear difference in force of conductor wire along the alignment (if any).

c. Angle pole (supporting or anchoring): is the pole installed at position where alignment of overhead transmission line turns direction. This pole in normal working condition of the overhead transmission line will bear combination tension force of conductor wire at adjacent pole spans, acting on bisector of the overhead transmission line.

d. Terminal pole: is the pole installed at the beginning or end of overhead transmission line. This pole is type of anchoring pole which in normal working condition of overhead transmission line should be able to bear tension force of conductor wire toward one direction.

e. Bifurcating pole is the pole at which there is bifurcation of overhead transmission line.

f. Crossing pole is the pole at which there is crossing of overhead transmission line from two different directions.

Bifurcating pole and crossing pole can be all types of pole stated above.

II.4.27. All types of pole can use supporting strut or anchoring wire to increase load bearing ability. Anchoring wire should not obstruct passage of people and means.

Anchoring wire of the pole can be mounted on anchoring foundation buried inside ground or mounted on building or construction by brick, stone or concrete reinforcement.

Steel anchoring wire should be selected basing on calculation and its cross section should not be les than $25mm^2$.

II.4.28. Anchoring wire of overhead transmission line should be connected to earth equipment, earth resistance as in II.4.25 or it should be insulated by anchoring type by voltage of overhead transmission line and be installed at a height no less than 2.5m from ground surface.

II.4.29. All types of pole are calculated in relation with mechanical load corresponding with normal working condition of overhead transmission line (conductor wire is not broken) in two cases: maximum wind pressure and lowest temperature.

In calculation, allow to calculate only main loads as follows:

- For support pole: load due to wind acts on horizontal direction perpendicularly to conductor wire line and pole structure.
- For straight anchoring pole: wind load acts on horizontal direction perpendicularly to conductor wire line and pole structure; longitudinal load of conductor wire due to difference in tension force of conductor wire at adjacent pole spans.
- For angle pole: horizontal load due to tension force of conductor wires (toward axial line of the beam), horizontal force due to wind acting on conductor wire and pole structure.
- For end pole: horizontal load acting along overhead transmission line due to tension force toward one direction of wire and wind.

II.4.30. Overhead transmission line can use steel pole, concrete reinforcement pole.

II.4.31. Determination of size for pole burying should base on pole height, quantity of conductor wires on the pole, constructional condition as well as constructional method.

II.4.32. When installing pole at flooded area where soil can be eroded, there should be method against erosion.

Crossing or running closely

II.4.33. When overhead transmission lines cross with each other, cross with construction, street, square…, crossing angle is not stated.

II.4.34. Distance from conductor wire (bare or insulation sheathed) at the maximum sag, to ground surface should not be less than 6m for populous area (*) and 5m for sparse area (**).

At bifurcated section where overhead transmission line runs into the house, vertical distance from conductor wire to pavement surface and walkway can be reduced to 3.5m.

Note:

(*) Populous area is cities, towns, factory, station, harbor, automobile stop, school, market, beach, village…where there is great population or will develop in the next 5 years as in approved planning.

(**) Sparse population area is area where there is no dwellings even though there is frequent visit of people and means as well as transporting vehicles. This place can be field, hurst, garden…where there is a few dwellings and temporary constructional work…

II.4.35. When determining distance from overhead transmission line to ground surface, water surface or construction, it is required to take into account the maximum sag of wire, not considering heating due to electric current in case of maximum air temperature and dead calm.

II.4.36. Horizontal distance from outmost bare conductor wire of overhead transmission line when deflected by wind to the maximum toward building or building's structure should not be less than:

- 1.5m from balcony, terrace and window
- 1.0m from enclosed wall.
- For overhead transmission line using insulated conductor wire, above distances will be multiplied by factor of 0.5.

Not allow that overhead transmission line running on the roof, except for bifurcations of overhead transmission line toward entrance of the house (see II.1.78).

II.4.37. Distance from external edge of pole foundation of overhead transmission line to buried cable line, underground pipeline and specialized surfaced pole should not be less than values in following table:

Name	Minimum distance (m)
Water pipeline, gas pipeline, vapor pipeline, heat pipeline, drainage pipe	1
Water post for fire fighting, channel, water well	2
Petroleum feeder	10
Underground cable (except for communication cable, signal cable)	1
Buried cable inside the pipe	0.5

II.4.38. Overhead transmission line up to 1kV should not cross over navigable river; otherwise, it is required to follow requirements in Chapter II.5.

When crossing with small river, channel without travel of boat and vessel, distance from conductor wire of overhead transmission line to the maximum water level should not be less than 2m; distance from pole of overhead transmission line to edge of water horizontally should not be less than height of the pole.

II.4.39. When overhead transmission line up to 1kV crosses over forest or green area, it is not compulsory to cut down the trees but vertical distance from the bottom wire and horizontal distance from outmost wire at the maximum sang and deflection toward tree's top or toward outmost portion of the tree should not be less than 1m for bare wire; 0.5m for insulated wire.

II.4.40. When overhead transmission line up to 1kV crosses with overhead transmission line over 1kV, requirements in II.5.114 to II.5.119 should be met. When they run in parallel with each other, follow requirements in II.5.120. Overhead transmission line up to 1kV and overhead transmission line over 1kV mounted on the same pole or crossing with each other on the same pole should meet requirements in II.5.48.

For overhead transmission lines up to 1kV mounted on the same pole, vertical distance among these lines using bare conductor wire should not be less than 40cm; for horizontal arrangement, horizontal distance among lines using bare conductor wire should not be less than 20cm.

If overhead transmission line uses insulated wire, above distance will be multiplied by a factor as in following principle:

- Overhead transmission line of bare conductor wire running together with overhead transmission line of insulated wire: factor of 1.

- Overhead transmission line of insulated wire running together with overhead transmission line of bare wire: factor of 0.5.

II.4.41. Overhead transmission lines up to 1kV crossing with each other should be performed on crossing pole. Allow them to cross with each other in pole span, then vertical distance between the nearest wires of crossing line at maximum air temperature and in dead calm condition should not be less than 1m for the line using bare wires; if both lines use insulated wire, this distance will not be less than 0.5m. At the area where overhead transmission line crosses with each other, it is able to use anchoring pole or support pole.

When crossing within pole span, crossing area should be selected to be near pole of upper overhead transmission line. Then horizontal distance between poles and bare wire crossing with each other will not be less than 2m.

II.4.42. When overhead transmission line crosses with overhead communication line and overhead signal line, it is required to meet following requirements:

a. Crossing only happens within pole span of the line, then overhead communication line and/or overhead signal line can use bare wire or cable. Allow overhead transmission line with voltage not over 380/220V crosses with broadcasting wire on the same pole, but it is required to meet requirements in II.4.48.

b. Conductor wire of overhead transmission line above wire of overhead communication line and overhead signal line should be double mounted; wire of overhead transmission line should be multi-cored type with cross section no less than $35mm^2$ for aluminum wire, $16mm^2$ for steel-cored aluminum wire or copper wire. In crossing pole span, not allow any joints on wire of overhead transmission line.

c. Vertical distance from overhead transmission line at maximum sag (corresponding with maximum air temperature) to communication wire or signal wire at the crossing point should not be less than 1.25m.

Distance from crossing point to the nearest pole of overhead transmission line should not be less than 2m.

d. Wire of communication line can be arrange above wire of overhead transmission line with voltage not greater than 380/220V if meeting following requirements:

- Vertical distance to the top wire of overhead transmission line is not less than 1.25m.
- Bare wire of communication line at the most disadvantageous climate condition should have physio-mechanical safety factor no less than 2.2.

- Insulated wire of overhead communication line should bear breakdown voltage no less than 2 times of working voltage of crossed overhead transmission line and physio-mechanical safety factor corresponding with the most disadvantageous climate condition is not less than 1.5.
- In populous area, allow bifurcation from overhead transmission line with voltage not greater than 380/220V into the house under overhead communication line using insulated wire.

e. Pole of overhead transmission line when crossing with overhead communication line of class I should be anchoring pole while pole when crossing with overhead communication line of other classes should be support pole.

II.4.43. When overhead transmission line crosses with communication cable line or signal line one the pole, follow requirements in II.4.49.

II.4.44. When overhead transmission line crosses with underground communication cable line or signal line, it is required to meet following requirements:

a. Horizontal distance from post foundation of cable line or signal line to vertical plane of the nearest conductor wire should not be less than 5m.

b. Distance from communication cable or signal line to earth components of the nearest overhead transmission line is not less than 3m; at narrow site condition, this distance should not be less than 1m provided that communication cable line has screen.

c. When selecting communication cable line or signal cable line, if allowed, it is suggested to select far from pole of overhead transmission line.

II.4.45. When overhead transmission line runs closely to overhead communication line and/or overhead signal line, horizontal distance between outmost wire of the overhead transmission line to overhead communication line or overhead signal line should not be less than 2m. At narrow site condition, this distance should not be less than 1.5m.

II.4.46. When overhead transmission line with voltage up to 1kV runs closely to antennas of electrical sending and receiving stations, local radio terminals, distance between them is not specified.

II.4.47. Distance between wire of bifurcated section of overhead transmission line and broadcasting wire at bifurcating point into the house should not be less than 0.6m vertically when arranging overhead transmission line and broadcasting wire vertically. Wire of overhead transmission line should be arranged above broadcasting wire.

II.4.48. Allow mounting wire of overhead transmission line with voltage not greater than 380/220V on the same pole with broadcasting wire of which voltage between broadcasting wires is not greater than 360V in following cases:

a. Distance from bottom wire of broadcasting line to ground surface, distance between bifurcated broadcasting circuits and between their wires should be in compliance with regulations on construction and repair of overhead communication line and broadcasting line stated by Ministry of Post and Telecommunication.

b. Wire of overhead transmission line should be placed above broadcasting line with vertical distance on the pole from the bottom wire of overhead transmission line to the top wire of broadcasting line should not be less than 1.5m and within pole span no less than 1m. When installing wire of broadcasting line on support, this distance is measured from the bottom wire of overhead transmission line on the same direction with wire of broadcasting line.

c. When working on overhead transmission line sharing the same pole with wire of broadcasting line, follow regulations on safety engineering stated by the Ministry of Post and Telecommunication and safety regulation of Ministry of Industry.

II.4.49. Allow to mount wire of overhead transmission line with voltage up to 1kV on the same pole with wire of communication cable line or signal cable line when meeting following requirements:

a. Cable line is mounted beneath overhead transmission line.

b. Distance on the pole from bottom wire of overhead transmission line to cable of communication line/signal line should not be less than 1.5m

c. Metal sheath of cable should be earthed with each earth connection for each 250m long of cable.

II.4.50. Allow to mount wire of overhead transmission line voltage not greater than 380/220V on the same pole with wire of remote control system if meeting all requirements in II.4.48.

II.4.51. When overhead transmission line crosses or runs in parallel with railway or roadway of class I, II, it is required to meet equivalent requirements in Chapter II.5.

Crossing point can use input cable section into overhead transmission line. Selection of crossing method should base on technical and economical calculation.

When overhead transmission line crosses with roadway of class III÷V, distance from wire to pavement surface at maximum sag should not be less than 6m.

II.4.52. When overhead transmission line crosses or runs closely with roadway, wire of overhead transmission line should be above traffic signs as well as above wire for hanging those signs at a distance no less than 1m. This wire hanger should be earthed with earth resistance not greater than 10 Ω.

II.4.53. When overhead transmission line crosses or runs closely with contact wire and hanging wire of tramway and trolleybus way, it is required to meet following requirements:

a. Overhead transmission line should be installed outside area of contact network, including poles of that network.

b. When overhead transmission line crosses with contact network, it is required to arrange overhead transmission line above hanging wire of the contact network; wire should be multi-cored type with cross section no less than 35mm^2 for aluminum wire; 16mm^2 for steel-cored aluminum wire or copper wire.

Not allow connecting wire in crossing area.

c. Distance from wire of overhead transmission line at the maximum sag to surface of the rail should not be less than 8m if crossing with tramway; 9m to pavement surface if crossing with trolleybus way. In all cases, distance from wire of overhead transmission line to hanging wire or conductor wire of contact network should not be less than 1.5m.

d. Conductor wire of overhead transmission line should be mounted on double insulator.

e. Pole of overhead transmission line should be checked if there is one wire being broken.

f. Overhead transmission line is not allowed to crosses at position of beam hanging contact wire of tramway and trolleybus way.

II.4.54. When overhead transmission line crosses or runs closely with overhead carrying cable line and surfaced metallic pipeline, it is required to meet following requirements:

a. Overhead transmission line is placed beneath overhead carrying cable line.

b. Overhead carrying cable line has protective bridge or net for conductor wire of overhead transmission line or uses buried cable connected into overhead transmission line.

c. When overhead transmission line crosses with overhead carrying cable line or surfaced pipeline, distance of wire of overhead transmission line in all cases to components of overhead carrying cable line and pipeline should not be less than 1m.

d. When overhead transmission line runs in parallel with overhead carrying cable line or surfaced pipeline, distance between wire of overhead transmission line to those lines should not be less than pole height; on narrow line, when wire of overhead transmission line is deflected maximum, that distance should not be less than 1m.

e. When crossing with overhead transmission line, surfaced pipeline and metallic components of overhead carrying cable line should be earthed; earth resistance should not be greater than 10 Ω.

II.4.55. When overhead transmission line runs closely to combustible construction or airport, it is required to meet accurately requirements in Chapter II.5.

Overhead transmission line using low voltage aerial bundled cable

II.4.56. In addition to meeting general requirements for pole, earth connection, crossing or running closely…, overhead transmission line using low voltage aerial bundled cable has several specific regulations.

II.4.57. Low voltage aerial bundled cable is not burred underground.

II.4.58. Accessories of cable should be uniform and in compliance with requirements for applied cable type. In installation, use tools and devices in compliance with guidelines of supplier.

II.4.59. When low voltage aerial bundled cable runs on the same pole with other overhead transmission line up to 1kV, as standard, consider this cable line as line of insulated wire and follow regulations in II.4.40.

II.4.60. Distance of low voltage aerial bundled cable line:

- To ground surface: as regulated in II.4.34 and II.4.51.
- To architectural structures at all directions: at least a + 0.1 (m)

In which a (in meters) is the maximum deflection of cable by wind action, depending on wire cross section, pole span, pole tension force, sag and wire temperature (refer to tables in Annex II.4.1)

II.4.61. When installing aerial bundled cable line into building wall or architectural structures, distance to the wall or that structure should not be less than 5cm.

II.4.62. Technical specifications of low voltage aerial bundled cable base on data of manufacturer; otherwise, refer to Annex II.4.2 and II.4.3.

Chapter II.5

Overhead transmission line with voltage over 1kV up to 500kV

Scope and definition

II.5.1. This chapter is applied to overhead transmission line with voltage over 1kV up to 500kV using bare wire.

This chapter is not applied to overhead transmission line with special characteristics such as electric network of electrification railway, tramway, trolleybus way…

Input cable terminal into overhead transmission line with voltage up to 220kV should meet requirements in Chapter II.3 and Article II.5.67.

II.5.2. Overhead transmission line is the construction for transmitting and distributing electric power, arranged in the open air, mounted on insulator and accessories, placed on pole or structure of other constructions (bridge, dam…). Overhead transmission line is considered from mounting position on the beam of gantry pole or other structure of power station.

II.5.3. In physio-mechanical calculation:

- Normal condition of overhead transmission line is working condition when conductor wire or ground wire is not broken.
- Emergency condition of overhead transmission line is the working condition when one or several conductor wires or ground wire s are broken.
- Installation condition of overhead transmission line is the state of the line during erection of pole, installation of conductor wire or ground wire .

II.5.4. Populous area is city, town, factory, station, harbor, bus stop, park, school, market, beach, stadium, village…

Sparse population area is area with a few dwellings even though people frequently visit and there is frequent transportation of machines and vehicles; fields, green hill, garden…or area with temporary dwellings or constructional structures. ..

Hard-for-travel area is the area where vehicles and mechanical means hardly go through.

Hard-for-access area is the area where pedestrians hardly visit.

Inaccessible area is the area where pedestrians can not access (cliff…)

II.5.5. Great span is the distance crossover river, lake, channel, bay where it is navigable for vessels, using crossing pole over 50m with crossover distance of 500m and above or from 700m and above with any height.

General requirement

II.5.6. When applying this regulation, if there are different requirements, it is required to use the highest requirement and the most disadvantageous condition for calculation.

II.5.7. In term of physio-mechanical requirement, conductor wire of overhead transmission line should be estimated by allowable stress method, insulator and accessory are calculated by breaking load method. Standard loads are determined as in this regulation.

Pole and foundation of overhead transmission line are calculated by limited state method.

II.5.8. It is required to reverse phase of wire of overhead transmission line to limit asymmetry of current and voltage. Overhead transmission line with voltage 110-500kV longer than 100km requires phase reversal in one complete period so that length of each step in one phase-reversal period is nearly equal to each other.

Phase reversal for overhead transmission line aiming to against influence of overhead transmission line on communication line should have specific calculation.

II.5.9. To manage operation of overhead transmission line, it is required to have station for operation control, solving emergency situation and repair:

a. To be installed at area of many lines.

b. To be convenient in term of traffic

c. Simple, compact, making use of available structures

d. To have communication system with local power network and line repairing team.

Installation of station is stated by design basing on requirements of power management authority and scope of power network as well as current regulations.

II.5.10. For managing operation of overhead transmission line with voltage of 110-220kV, there should be a path to access pole pedestal.

II.5.11. For managing operation of overhead transmission line of 500kV, there should be a path with minimum width of 2.5m far from the line not greater than 1km, ensuring access of mechanical means to adjacent area of overhead transmission line.

At area where mechanical means can not go through (swamp, flooded field, precious green…), it is required to build walkway, small bridge to the pole pedestal. Walkway should be build with width no less than 0.4m.

Except for specially difficult area, walkway should ensure transportation in flooding season.

II.5.12. Pole of overhead transmission line should be installed from riverside which is strongly eroded as far as possible, taking into consideration changes of riverbed and impact of floods. When arranging poles at lines crossing by area of river, lake, hill, mountain, basalt soil, especially primitive forest…, it is required to investigate and evaluate carefully erosion and settlement of the area. Flood frequency for overhead transmission line of 35kV and less is 5% (once in 20 years); for overhead transmission line of 110kV and 220kV is 2% (once in 50 years); for overhead transmission line of 500kV is 1% (once in 100 years).

Highest historic flood level will be used if there is no above data.

If it is required to install pole at above areas, there should be protection method for the pole (special foundation, building embankment, building drainage system, using reinforcement pole…)

Protection is required for pole installed in frequently flooded area.

Protection is also required for pole on hillside where it can be eroded by flood or water.

II.5.13. On the pole of overhead transmission line, there should be warning sign or permanent signal board for:

1. Sequence number on all poles, directing toward traffic road, at visible position.
2. Before being operated, number or symbol of wire line on all poles at the line having overhead transmission line running in parallel; on overhead transmission line with two circuits, there should be symbol for each circuit.
3. Warning board for danger is placed above ground surface from 2m to 2.5m on all poles in the line.

II.5.14. Metal pole, metal components of concrete pole which are open and all metal elements of concrete reinforcement pole should be antirust painted or coated as in current standard.

Pedestal of metal pole at frequently flooded area should have suitable protection method against corrosion.

II.5.15. When installing pole into concrete reinforcement foundation or pre-cast foundation, bolt for anchoring the pole should have stop nut. Threaded section of bolt should have a protruded length from stop nut about 5mm and above.

II.5.16. Pole of overhead transmission line with height of 80m and above should have warning paint color (warning for daytime) and indicating lamp (warning for nighttime) to ensure safety for airplane and vessel in compliance with current regulation.

II.5.17. There should be equipments for determining emergency situations on overhead transmission line of 110kV and above at power station.

II.5.18. When overhead transmission line goes through area of high wind, area of erosion, settlement, swamp, area of un-graded crushed stone…, it is required to consider solution to build roundabout route for overhead transmission line, avoiding above disadvantageous areas basing on technical and economical comparison.

Climate condition

II.5.19. Determination of climate condition for calculating and selecting structure of overhead transmission line should base on result of investigation datum in many years in term of wind speed and air temperature in the area of overhead transmission line estimated to build.

When processing investigation datum, it is required to consider characteristic of local climate condition such as wind pressure, natural conditions (ridged terrain, height from seawater level, nearby great water lake, wind blowing direction…) as well as considering available constructions or constructions being built in the area (water reservoir, water tower…).

II.5.20. Standard wind pressure, wind pressure by reasons, wind pressure increasing factor by height, wind pressure decreasing factor for overhead transmission line running in lee area should be in compliance with specific values and regulations in Standard for impact and load in TCVN 2737-1995. For overhead transmission line of 110kV and above, standard wind pressure should not be less than 60daN/m^2/

For overhead transmission lines, supposing that application time of the construction is 15 years for overhead transmission line of 35kV and less, 20 years for overhead transmission line of 110kV, 30 years for overhead transmission line of 220kV, 40 years for overhead transmission line 500kV, and great span.

II.5.21. Wind pressure acting on conductor wire of overhead transmission line is determined at height of converted center of all wires:

Converted center height of conductor wire (hqd) is determined by formula:

$$h_{qd} = h_{tb} - \frac{2}{3} f$$

Where:

h_{tb}- Average height for mounting conductor wire to insulator (m)

f- Sag of the wire, conventionally using maximum value (at maximum temperature) (m)

Wind pressure acting on ground wire is determined by height of arrangement centers of ground wire .

II.5.22. Wind pressure acting on conductor wire or ground wire in greater span should be determined as in II.5.20 and at the same time meet additional requirements as follows:

- For span only has one pole, converted center height of conductor wire or ground wire is determined by formula:

$$h_{qd} = \frac{h_1 + h_2}{2} - \frac{2}{3} f$$

Where: h_1 and h_2: Height of the point for mounting wire into the pole from normal water surface of river, lake, bay… (m)

f: Maximum sag of the conductor wire (m)

- For span having many pole spans, converted center height of conductor wire or ground wire is all-in determined for the whole span (limited by two anchoring poles) by formula:

$$h_{qd} = \frac{h_{qd1}.l_1 + h_{qd2}.l_2 + ... + h_{qdn}.l_n}{l_1 + l_2 + .. + l_n}$$

Where: h_{qd1}, h_{qd2}…h_{qdn} are converted center heights of pole span l_1, l_2…l_n forming that span. If the great span has several adjacent pole spans running over un-watered area, h_{qd} is determined from ground surface.

II.5.23. Wind pressure acting on structure of the pole is determined by their heights from ground surface. By pole's height, divided into sections not greater than 15m; in each section, wind pressure is equal and calculated with wind pressure value at average height of the section.

II.5.24. When determining wind influence on wire line and ground wire , angle of 90^o, 45^o and 0^o will be used with the wire line.

When calculating electrical pole, it is required to use wind direction in compliance with wire line angle of 90^o and 45^o.

II.5.25. Standard wind pressure acting on conductor wire or ground wire in daN is determined by formula:

$$P = a.C_x.K_1.q.F.\sin^2\varphi$$

Where:

a- Coefficient, taking into account unevenness of wind pressure in pole span, equal to:

1 when wind pressure is equal to 27daN/m^2

0.85 when wind pressure is equal to 40daN/m^2

0.75 when wind pressure is equal to 55daN/m^2

0.70 when wind pressure is equal to 76daN/m^2 and greater.

C_x – Aerodynamic coefficient, equal to 1.1 when diameter of conductor wire or ground wire from 20mm and above and equal to 1.2 when this diameter is less than 20mm.

K_1 – Conversion factor taking into account influence of length of the span on wind load, equal to 1.2 when pole span is up to 50m; equal to 1.1 when pole span is 150m; equal to 1 when pole span is 250m and greater (Values of K_1 for span with length within above values are determined by interpolation method).

q- Standard wind pressure by reason as regulated in TCVN 2737-1995 (taken into account coefficients stated in II.5.20).

F- Wind shielding section of conductor wire or ground wire , m^2

φ- Angle between wind direction and axle of wire line.

II.5.26. For overhead transmission line with voltage up to 22kV when mounting wire at a height less than 12m, standard wind pressure can be reduced 15% except when shielding factor has been used to reduce wind pressure in lee area.

For overhead transmission line in mountainous area, in terrain higher than surrounding area (mountain peak, mountain pass…) as well as at crossing section with valley, notch where there is high wind, the maximum wind pressure should be taken as in current standard if there is no investigation data.

II.5.27. When designing overhead transmission line, it is required to take into account following climate conditions:

a. Normal condition:

- Maximum temperature T_{max}, wind pressure q = 0
- Minimum temperature T_{min}; wind pressure q = 0
- Average annual temperature T_{tb}; wind pressure q =0
- Maximum wind pressure q_{max}, temperature T = 25^oC

b. Emergency condition:

- Minimum air temperature T_{min}, wind pressure q = 0
- Average annual temperature T_{tb}; wind pressure q =0
- Maximum wind pressure q_{max}, temperature T = 25°C

In emergency condition of overhead transmission line, maximum estimated wind pressure q_{max} is allowed to be in compliance with TCVN 2737-1995.

II.5.28. Check the pole of overhead transmission line in statute of installation in air temperature condition T =15°C and wind pressure q = 6.25 dNa/m^2.

II.5.29. When estimating and checking distance from alive components to pole structure of overhead transmission line or to construction, it is required to use climate condition as follows:

a. At working voltage: air temperature T= 25°C, wind pressure q = q_{max}

b. In atmospheric over-voltage and internal over-voltage, air temperature T= 20°C, wind pressure q = 0.1.q_{max} but not less than 6.25 daN/m^2.

Angle of deflection γ of vertically suspended insulator string (in comparison with vertical direction) under influence of wind is determined by formula:

$$tg\gamma = \frac{K.P_2}{G_d + 0.5G_c}$$

Where:

K – the factor taking into account vibration force of conductor wire. This K factor is corresponding with wind pressure in following table:

q (daN/m)	K
40	1
45	0.95
55	0.90
65	0.85
80	0.80
≥100	0.75

Intermediate values are determined by interpolation method.

P_2 – Wind pressure acting on conductor wire taking into account horizontal force combination of wire tension force in angle support, daN/m^2

G_d – Load due to weight of conductor wire acting on insulator string, daN

G_c – Weight of insulator string, daN.

Conductor wire or ground wire

II.5.30. Phases of overhead transmission line can be one phase wire or multiple phase wires. Determination of diameter, cross section, numbers of phase wires, distance between phase wires…should be by calculation.

II.5.31. By condition of mechanical condition, overhead transmission line should use multi-cored conductor wire or multi-cored ground wire with cross section no less than values in Table II.5.1.

When selecting wire for overhead transmission line to ensure loss due to corona effect, at a height up to 1000 m from seawater level, un-phased wire should have cross section no less than:

70mm^2 for overhead transmission line of 110kV

240mm^2 for overhead transmission line of 220kV

When selecting wire for overhead transmission line, in addition to loss due to corona effect, it is required to take into account high frequency interference, radio interference (for overhead transmission line of 110kV and above) and influence of electromagnetic field (for overhead transmission line of 220kV and above).

Table II.5.1 -Allowable minimum cross section of overhead transmission line by mechanical strength

Characteristic of overhead transmission line	**Wire cross section, mm^2**			
	Aluminum	**Steel-cored aluminum and aluminum alloy**	**Steel**	**Copper**
1. On normal pole spans of overhead transmission line	35	25	25	16
2. On pole spans crossing over navigable river, channel	75	35	25	
3. On pole spans of overhead transmission line crossing over construction of: - Communication line - Surfaced pipeline and transport cable line - Railway	70	35	25	

II.5.32. When selecting cross section for ground wire , in addition to calculating mechanical strength, it is required to check thermal stability when there is short circuit of one phase touching ground at the end pole of overhead transmission line (as in Annex I.3.2 – Part I). On the section of overhead transmission line mounting ground wire insulated from the ground, thermal stability is not required to be checked. Optical fiber ground wire (OPGW) is selected basing on mechanical strength and requires checking for thermal stability as for normal ground wire.

II.5.33. When calculating conductor wire or ground wire for overhead transmission line , it is required to base on mechanical characteristics stated by manufacturer or on current standard or reference.

II.5.34. Calculating conductor wire and ground wire by following conditions:

a. Maximum external load

b. Minimum temperature and without external load

c. Average annual temperature and without external load.

Maximum allowable stress of conductor wire or ground wire by conditions in Table II.5.2, except for regulation in II.5.35.

II.5.35. For overhead transmission line using aluminum wire, aluminum alloy wire and copper wire with cross section up to 95mm^2 in populous area and at crossing point with other construction, allowable stress is equal to 40% of breaking tensile stress of conductor wire. ‘

For overhead transmission line using steel-cored aluminum wire with cross section of 120mm^2 and greater, maximum stress is allowed to be 50% of breaking tensile stress when estimated wind pressure q $\geq$ 100 daN/m^2.

II.5.36. Stress arising at the highest mounting point of conductor wire on all poles of overhead transmission line , even at the great span, should not exceed 110% for steel-cored aluminum wire, 105% for other conductor wires from values in Table II.5.2.

II.5.37. When building overhead transmission line at areas where experience shows that steel-cored aluminum wire can be eroded (seashore, saline water area, chemical factory…), it is required to use type of conductor wire bearing erosion (anti-rust steel-cored aluminum wire or copper wire…).

If lacking data, safe distance against erosion should be 5km from seashore and 1.5km from chemical factory.

Table II.5.2. Allowable stress of conductor wire and ground wire by % of breaking tensile stress

Cross section of conductor wire and ground wire	Allowable stress in compliance with 5 of traction breaking stress of conductor wire and ground wire	
	At maximum external strain and minimum temperature	At annual average temperature
Aluminum wire, mm^2: 16-35 50 and 70 95 ≥ 120	 35 40 40 45	 25
Aluminum alloy wire, mm^2: 16-95 ≥ 120	 40 45	 30
Ground wire of steel material of all cross section, mm^2	50	30
Steel-cored aluminum wire and steel-cored aluminum alloy wire, mm^2: 16-25 35-95 ≥ 120 when A: C = 6.11÷6.25 ≥ 120 when A:C = 4.29÷4.39 ≥ 150	 35 40 40 45 45	 25
Copper wire, mm^2	50	30

II.5.38. Conductor wire or ground wire of overhead transmission line should be protected against vibration in following cases:

b. Pole span over 120m, at average annual temperature if stress inside conductor wire or ground wire is greater than:

4daN/mm^2 for aluminum wire

6 daN/mm^2 for steel-cored aluminum wire and aluminum alloy wire with cross section up to 95mm^2

5daN/mm^2 for steel-cored aluminum wire and aluminum alloy wire with cross section of 120mm^2 and above.

24daN/mm^2 for steel ground wire.

c. Crossing over great river, great lake, with span over 500m, not depending on stress inside conductor wire or ground wire.

For sections of overhead transmission line not being affected by wind horizontally (line along valley, line via forest…), vibration protection is not required.

For overhead transmission line with 3 phased wires and above, if stress of conductor wire at average annual temperature is not over 6.75daN/mm^2 and distance between batter board does not exceed 60m, vibration protection is not required, except for span greater than 500m.

II.5.39. On phased overhead transmission line , in pole span as well as at anchoring line on anchoring pole of conductor wire, it is required to install batter board. Distance among batter boards in pole span is not greater than 75m.

Arrangement of conductor wire, ground wire

II.5.40. For overhead transmission line , it is able to use any form of arrangement for conductor wire on the pole.

II.5.41. Distance between conductor wires of overhead transmission line should be selected basing on their working condition in the pole span, as well as on allowable insulation distance between conductor wire and components of the pole (article II.5.29 and II.5.69).

II.5.42. overhead transmission line with voltage of 35kV and above uses suspension insulator. Distance between conductor wires on horizontal plane in working condition of the wire in the pole span should not be less than value obtained from the formula:

$$D = \frac{U}{110} + 0.65\sqrt{f + \lambda}$$

Where:

D : Phase distance, m

U: Nominal voltage, kV

f – Estimated maximum sag, m

λ – Length of insulator string, m

When arranging conductor wire by vertical plane, that distance is determined by formula:

$$D = \frac{U}{110} + 0.42\sqrt{f}$$

When arranging conductor wires not on the same plane,

$D = \frac{U}{110} + 0.65\sqrt{f + \lambda}$ when difference in height on the wires $h < \frac{U}{110}$

II.5.43. Overhead transmission line voltage 35kV using post insulator and voltage up to 22kV using any types of insulator, distance between conductor wire in working condition of wire in the pole span will not be less than values determined by following formula:

$$D = \frac{U}{110} + 0.45\sqrt{f}$$

Where:

D: Phase distance, m

U: Nominal voltage, kV

f: Estimated maximum sag, m.

II.5.44. Distance between ground wire and conductor wire vertically is determined basing on working condition of conductor wire or ground wire in the pole span, in accordance with requirements in article II.5.63 and II.5.64.

II.5.45. For several separated pole spans, allow to remain distance between selected conductor wires if maximum sag does not exceed 2 times of estimated sag value.

II.5.46. On multi-circuit pole of overhead transmission line , distance between the nearest conductor wires of two adjacent circuits of the same voltage should not be less than:

2m for overhead transmission line of bare wire voltage up to 220kV with post insulator, 1m for overhead transmission line of insulated wire voltage up to 22kV with post insulator.

2.5m for overhead transmission line voltage 35kV with post insulator and 3m with suspension insulator.

4m for overhead transmission line voltage 110kV

6m for overhead transmission line voltage 220kV

8.5m for overhead transmission line voltage 500kV.

II.5.47. For overhead transmission line requiring repair in alive condition, to ensure safety for person climbing up the pole, distance from conductor wire and accessories for mounting conductor wire to earthed portion of overhead transmission line when conductor wire is not deflected will not be smaller than:

1.5m for overhead transmission line 35kV and 110kV

2.5m for overhead transmission line 220kV

4m for overhead transmission line 500kV

II.5.48. For conductor wires of overhead transmission line of different voltages, over 1kV to 500kV, the wire can be arranged on the same pole.

Distance between two adjacent circuits with different voltage as in requirement in article II.5.46, II.5.47 for circuit with greater voltage.

Allow to arrange conductor wires of overhead transmission line voltage up to 35kV and conductor wires of overhead transmission line voltage up to 1kV on the same pole provided that:

1. Overhead transmission line voltage up to 1kV should follow mechanical calculation condition as for overhead transmission line with greater voltage.
2. Conductor wire of overhead transmission line voltage up to 35kV should be arranged above conductor wire of overhead transmission line voltage up to 1kV, of which distance between conductor wire of 2 overhead transmission line s with different voltages at average annual temperature greater than 2m for bare wire, 1m for insulated wire.
3. Conductor wire of overhead transmission line of high voltage mounted on post insulator should be double (2 insulators at each position).

In the power network having neutral insulation or not directly earthed, with voltage up to 35kV and wire sections mounted on the same pole with overhead transmission line of higher voltage, electromagnetic induction and electrostatic of this overhead transmission line when power network is in normal working condition should not change neutral voltage over 15% of phase voltage of network having lower voltage.

Network having earthed neutral directly under influence of overhead transmission line with higher voltage does not have any special requirement for induction voltage.

Insulator

II.5.49. overhead transmission line voltage of 110kV and above only uses suspension insulator. At special positions (phase reversal, nearby ground wire, switchgear, switch..), allow to use suitable post insulator.

Pole having suitable composite insulated strut does not required insulator.

Overhead transmission line voltage 35kV and less can use both suspension insulator and post insulator.

II.5.50. Number of suspension insulators (with insulation distance of each insulator is not less than 250mm) in a string of overhead transmission line 6-35kV as follows: up to 10kV: 01 insulator; 15 and 22kV: 2 insulators; 35kV: 3 insulators.

Number of suspension insulators in a string and type of post insulator for overhead transmission line voltage up to 35kV is selected not depending on height from seawater level.

Requirement for insulation of overhead transmission line 15kV in the neutral system directly earthed is selected similarly to selection for overhead transmission line 10kV with separated neutral system.

Number of suspension insulators in a string for overhead transmission line 110-500kV with a height up to 1000m from seawater level is selected basing on formula:

$$n = \frac{dxU_{max}}{D}$$

Where:

n: Number of insulators in one string.

d: standard selected insulation distance, equal to 16mm/kV for normal environment, 20mm/kV for lightly polluted environment; 25mm/kV for polluted environment; 31mm/kV for seriously polluted environment or area near the sea about 5km.

U_{max} is maximum working line voltage of wire line, kV

D: length of insulation distance, selected by manufacturer, mm.

After determining n, its value is rounded to maximum integer.

When selecting type of suspension insulator for each string with insulation distance greater then 2.3 times of structural length of the insulator string in working voltage condition, it is required to re-check with condition of make-and-break over-voltage. Estimated value of make-and-break over-voltage is $312kV_{max}$ for overhead transmission line 110kV and 620kVmax for overhead transmission line of 220kV; 1175kVmax for overhead transmission line 500kV.

II.5.51. When selecting number of insulators in one string, it is required to meet following requirements:

a. Number of insulators (all types of insulator) in an anchoring string of overhead transmission line voltage up to 110kV should be increased one insulator in comparison with support string. For overhead transmission line voltage 220kV, number of insulators in anchoring string and support

string is the same. For overhead transmission line voltage 500kV, add one more insulator for the whole line.

b. For pole over 40m high, number of insulators in one string should be increased in comparison with insulators on other pole of that overhead transmission line.

- One insulator when crossover span has lightning protection equipment.
- One insulator when pole has ground wire for each additional height of 10m for the pole from the height of 40m.

c. overhead transmission line voltage up to 110kV running via area with height of over 1000m to 2500m from seawater level as well as overhead transmission line voltage 220kV running through area with height over 1000m to 2000m from seawater level should be added one more insulator from value in "a" and "b" in this article.

Overhead transmission line running through seriously polluted area (near industrial factories, seashore…) will have suitable number and type of insulator depending on specific condition.

II.5.52. Safety factor of insulator is ratio between breaking load (post insulator) or electromechanical strength (for suspension insulator) with maximum load acting on the insulator when overhead transmission line works in normal condition. This factor is not less than 2.7; at condition of average annual temperature, without wind, this factor is not less than 5.0.

In emergency condition of overhead transmission line, safety factor of suspension insulator is not less than 1.8 for overhead transmission line of and less than 120kV, and no less than 2 for overhead transmission line of 500kV voltage.

Force acting on suspension insulator in emergency condition of overhead transmission line is determined as in II.5.83 and II.5.84.

Crossing point with roadway of class III and above, roadway in urban area, public railway, navigable waterway.. should use double insulator.

Line's accessories

II.5.53. Mounting wire into suspension insulator by support or anchor.

Mounting wire into post insulator by tightening wire or specialized clamp.

II.5.54. Support can be fixed support or sliding support. To ensure safety, fixed support is recommended. At great span, conductor wire or ground wire can be hung on pulley or special rack.

II.5.55. For conductor wire of different phases on the same pole as well as wires of the same phase on different poles, it is able to use different supports (fixed or sliding support).

II.5.56. Mounting ground wire into support pole should be performed by fixed support; into anchoring pole, use anchor support.

II.5.57. Not allow to connect conductor wire or ground wire of overhead transmission line 110kV and above by bolt but by specialized connector. In one pole span of overhead transmission line, each conductor wire or ground wire should have one connection joint and should meet requirements in II.5.101, II.5.106, 117, 141, 145, 151 and 162.

II.5.58. Mechanical safety factor of accessories for mounting wire is ratio between breaking mechanical load with maximum load acting on the accessories, at normal working condition of overhead transmission line and this factor is not less than 2.5; not less than 1.7 in emergency condition.

Safety factor of foot of post insulator when overhead transmission line is in normal working condition is not less than 2; and not less than 1.3 when overhead transmission line is in emergency condition.

Force acting on accessories in emergency condition is determined as in II.5.83 and II.5.84.

Over-voltage protection, earth connection

II.5.59. Overhead transmission line voltage 110kV and above should be protected against direct lightning strike by ground wire on the whole length of the line, except for several special sections where ground wire can not be arranged. This section should have other lightning protection method.

II.5.60. Overhead transmission line voltage from 22kV and less does not required protection method against lightning strike by ground line on its whole length. Its poles should be earthed as in II.5.71 and II.5.77.

II.5.61. Overhead transmission line voltage of 35kV does not required protection by ground wire but its poles should be earthed as in II.5.71 and II.5.77 and section of overhead transmission line into station should meet requirement in II.5.62.

II.5.62. Section where overhead transmission line runs into substation should be protected against atmospheric over-voltage in compliance with requirement of the substation.

II.5.63. When using ground wire for protecting overhead transmission line, it is required to meet following requirements:

a. Single-tower metallic poles and concrete reinforcement poles are mounted with one ground wire, protection angle not greater than 30^{o}.
b. On the metallic pole with horizontal conductor wire, mount 2 ground wires, with protection angle for the outmost wire not greater than 20^{o}.
c. For gantry concrete reinforcement pole, allow increasing protection angle for the outmost wire up to 30^{o}.

d. When overhead transmission line is mounted with two ground wires, distance between these wires at the capital of the pole should not exceed 5 times of vertical distance between ground wire and conductor wire.

e. Required protection angle of each design project is smaller than above value, depending on thunder days and terrain of the area through which overhead transmission line runs; depending on pole height and importance of the overhead transmission line.

II.5.64. Vertical distance between ground wire and conductor wire at middle of pole span of overhead transmission line, not taking into account deflection of the wire due to wind, by protection condition in atmospheric over-voltage, should not be less than values in following table:

Length of pole span, m	Distance, m	Length of pole span, m	Distance, m
100	2.0	700	11.5
150	3.2	800	13.0
200	4.0	900	14.5
300	5.5	100	16.0
400	7.0	1200	18.0
500	8.5	1500	21.0
600	10.0	-	-

Intermediate value of length of pole span is obtained by interpolation method. On the pole span of overhead transmission line mounted with ground wire, sag of ground wire is not greater than sag of conductor wire.

II.5.65. Ground wire without optical fiber core on all poles of overhead transmission line of 220kV and above should be mounted via insulator in parallel with spark-gap of 40mm. In each anchoring length up to 10km, ground wire is earthed at an anchoring point. For greater anchoring length, number of earth connection points in that length should be selected so that value of maximum vertical electromotive force generated inside ground wire in short-circuit condition on the pole will not disrupt spark-gap.

At the section into substation of overhead transmission line 220kV with length from 2 to 3km, if ground wire is not used to take electricity by capacitance method or by communication, it is required to have earth connection for each pole.

At the section into substation of overhead transmission line 500kV with length less than 5km, ground wire should be earthed at each pole. On overhead transmission line 500kV using ground wire as high frequency communication wire, ground wire should be insulated at least by two insulators on the whole length of overhead transmission line and it is required to transpose the wire (via consideration) so that longitudinal induced electromotive force on the ground wire should not exceed allowable value

determined in design in both normal working condition and in short-circuit condition on overhead transmission line 500kV.

When using optical fiber cored ground wire running in parallel with ground wire without optical fiber core, all above ground wires should be earthed at the poles.

II.5.66. When using steel ground wire with cross section less than 50mm^2 at overhead transmission line having short-circuit current greater than 15kA, it is required to earth that ground wire by a wire in parallel with the lock.

II.5.67. Cable sections mounted to overhead transmission line should be protected against atmospheric over-voltage by lightning protection equipments at cable terminal; earth electrode of ground wire should be connected to metallic sheath of cable by the shortest connection.

II.5.68. overhead transmission line crossing over great river, abyss with pole higher than 40m on which there is no ground wire should be equipped with lightning protection equipment.

II.5.69. For overhead transmission line running via area with height up to 1000m from seawater level, insulation distance between conductor wire and alive wire accessory to earthed component, pole should not be less than values in Table II.5.3.

When overhead transmission line runs via area higher than 1000m from seawater level, minimum insulation distance by maximum working voltage should be increased in comparison with value in table II.5.3, at each added 100m high from seawater level, the value will be increased 1.4%.

II.5.70. Minimum insulation distance between phases of overhead transmission line at transposition pole, at bifurcation position and change in wire arrangement should not be less than value in Table II.5.4.

Table II.5.3: Minimum insulation distance at the pole between live part and earthed part of the line

Estimated condition when selecting insulation distance	**Minimum insulation distance (cm) at the pole by voltage of overhead transmission line, kV**					
	Up to 10	**15÷22**	**35**	**110**	**220**	**500**
a. Atmospheric over-voltage						
- Post insulator	15	25	35			
- Suspension insulator	20	35	40	100	180	320
b. Internal over-voltage	10	15	30	80	160	300
c. Maximum working voltage		7	10	25	55	115

Table II.5.4: Minimum insulation distance between phases at the pole of overhead transmission line

Estimated condition	Minimum insulation distance between phases (cm) by voltage of overhead transmission line, kV					
	Up to 10	**15÷22**	**35**	**110**	**220**	**500**
- In atmospheric over-voltage	20	45	50	135	250	400
- In internal over-voltage	22	33	44	100	200	420
- In working voltage	-	15	20	145	95	200

II.5.71. Earth connection is required:

a. Steel pole and concrete reinforcement pole of:

- Overhead transmission line voltage of 110kV and above

- Overhead transmission line voltage up to 35kV not having quick-break ground protection or running via sparse area, earth ground is required for poles (2 to 3 spans) and earth connection is required at pole crossing with traffic line.

b. Steel pole and concrete reinforcement pole with all voltage grades which are mounted with ground wire or have lightning protection equipment as well as all pole where there are main transformer or measuring device, disconnector, fuse or other electrical devices.

II.5.72. Earth resistance of pole of overhead transmission line:

a. Having ground wire or lightning protection equipment and other equipments should not be greater than values in table II.5.5

b. Earth resistance of overhead transmission line voltage 6-22kV in populous area and overhead transmission line 35kV is also taken in table II.5.5.

c. Earth resistance of overhead transmission line voltage 6-22kV in sparse area: when resistivity of ground is up to 100Ωm, the resistance value is not greater than 30Ω.

When resistivity of ground is over 100Ωm, the resistance value is not greater than 0.3Ω

d. For overhead transmission line pole having equipments such as main transformer, measuring transformer, disconnector, fuse or other devices, earth resistance will be:

- Overhead transmission line 6-35kV with great ground current and overhead transmission line 110kV and above should follow table II.5.5.

- Overhead transmission line 6-35kV with small ground current, follow article I.7.35 and 36- Part I.

e. At the pole of overhead transmission line higher than 40m and having ground wire, earth resistance should be less than 2 times of value in table II.5.5.

For overhead transmission line protected by ground wire, earth resistance value in table II.5.5 is measured when removing ground wire.

II.5.73. Overhead transmission line which runs via area having resistivity $\rho \leq 500\Omega m$ and not having corrosive water should make use of steel reinforcement of concrete reinforcement foundation to be natural earth connection or to combine with artificial earth connection.

At area where there is greater resistivity, it is not allowed to consider natural earth connection by steel reinforcement of the pole foundation. Value of earth resistance required in table II.5.5 should be ensure to be equal to artificial earth connection.

Table II.5.5 – Earth resistance of overhead transmission line

Resistivity of the earth, ρ, Ωm	Earth resistance, Ω
Up to 100	Up to 10
Over 100 to 500	15
Over 500 to 1000	20
Over 1000 to 5000	30
Over 5000	6.10^{-3} ρ

II.5.74. For concrete reinforcement foundation when being used as natural earth connection (except for article II.5.140):

- Not to coat bitumen on the foundation.
- There should be metallic connection between anchoring bolt and foundation frame. Conductivity of concrete reinforcement foundation should be measured after the foundation is installed for two and more months.

II.5.75. Recommend to make use of longitudinal steel bars of concrete reinforcement (connected by metal wire with each other and with earthed object) to be ground wire.

Ground wire and components mounting insulator into the strut should be connected by metal with earth wire or earthed reinforcement of the concrete reinforcement pole.

II.5.76. Cross section of ground wire on the pole of overhead transmission line is not smaller than $35mm^2$, for single-cored wire, diameter should not be less than 10mm; allow to use single-cored galvanized steel wire with diameter no less than 6mm to be ground wire on the pole. On concrete

reinforcement pole and metallic pole, it is required to connect ground wire by welding or by bolt, but there is at least one place near the ground is bolted.

II.5.77. Earthed connection structure of overhead transmission line should be buried at a minimum depth of 0.5m, at cultivated soil area, this depth is at least 1ml; at stony area, allow to place ground wire directly under stone layer with a thickness of covering layer no less than 0.1m. When thickness of the covering layer does not meet above requirement, it is able to place ground wire right on the stone layer and covered by concrete mortar.

Pole

II.5.78. Overhead transmission line can use following types of pole:

- Support pole, anchoring pole, angle pole, transposition pole, stop pole and special pole. Poles can be type of single circuit, multiple circuits, one voltage grade or various voltage grades.
- Support pole can have solid or soft structure while anchoring pole and stop pole should have solid structure.
- Angle pole can be support or anchoring.

Depending on position location, all types of poles can use anchoring wire or without anchoring wire. Positions above paths should not use anchoring wire.

It is not allowed to use wooden pole for all overhead transmission line.

II.5.79. Position of anchoring pole is determined by working condition and installation condition of overhead transmission line.

Anchoring pole can be placed at steering angle of overhead transmission line and at crossing position with other constructions.

II.5.80. Overhead transmission line having conductor wire with cross section up to 185mm^2 mounted by permanent lock and sliding lock on the same pole, anchoring length should not be greater than 5km. For overhead transmission line having conductor wire with cross section greater than 185mm^2, anchoring length should not be greater than 10km.

When mounting conductor wire into permanent lock or on post insulator, anchoring length depends on condition of overhead transmission line.

II.5.81. Pole of overhead transmission line is calculated with loads when the line works in normal condition and emergency condition.

- Anchoring pole: It is required to check difference in stretching force of conductor wire or ground wire which generates due to difference between two representative pole span toward side of two poles.
- Dual-circuit pole: it is required to check at condition only mounting wire of one circuit in all conditions. Pole of overhead transmission line also requires checking in term of erection condition as well as condition when mounting conductor wire or ground wire.

II.5.82. In normal condition of overhead transmission line, poles are calculated by following conditions:

- Conductor wire or ground wire is not broken, maximum wind pressure (q_{max}). Angle pole is calculated with minimum temperature (T_{min}) when representative pole span is smaller than ultimate pole span.
- Stop pole is calculated in stretching condition of all wires or ground wires toward one side. At the side of substation or adjacent area to the great span, it is considered not to mount conductor wire or ground wire.

II.5.83. In emergency condition of overhead transmission line, support pole for mounting suspension insulator should take into account the force due to breaking of conductor wire or ground wire generating maximum bending moment or torque moment on the pole by following conditions:

1. One or more conductor wires of one phase is broken (at any wires on the pole), but ground wire is not broken.
2. One ground wire is broken, conductor wire is not broken.
3. When calculating the pole, allow to take in to account influence of conductor wires or ground wire not being broken..
4. Standard stretching force of un-phased overhead transmission line which has wire mounted by permanent lock when breaking one conductor wire is equal to following conventional value:

a. For solid structure pole (free metallic pole, concrete reinforcement pole having anchoring wire and other solid structure poles):

- Conductor wire with cross section up to 185mm^2: $0.5T_{max}$
- Conductor wire with cross section from 240mm^2 and above: $0.4T_{max}$

b. For free concrete reinforcement pole:

- Conductor wire with cross section up to 185mm^2: $0.3T_{max}$
- Conductor wire with cross section from 240mm^2 and above: $0.25T_{max}$

Where T_{max} is the maximum stretching force of one conductor wire in emergency condition .

c. For other types of pole (pole of new material, metallic soft structure pole), standard stretching force calculated with the factor depends on bend of the pole within scope specified in "a" and "b".

In calculation for support of overhead transmission line 220kV and less which is phased when wire is broken, standard stretching force of the wire on permanent lock of phased overhead transmission line is determined similarly to calculation for un-phased overhead transmission line but will be multiplied by number of wires in one phase and multiplied by factor:

0.8 when one phase is divided into two wires

0.7 when one phase is divided into three wires

0.6 when one phase is divided into four wires.

Standard stretching force of ground wire is equal to $0.5T_{max}$.

Where T_{max} is maximum stretching force of ground wire in emergency condition.

For soft structure pole (concrete reinforcement pole without anchoring wire), allow to determine standard stretching force when breaking ground wire, taking into consideration blend of the pole.

II.5.84. In emergency condition of overhead transmission line, anchoring pole and stop pole should take into account the force when conductor wire and ground wire are broken, causing maximum blending moment or torque moment on the pole by following condition:

a. Breaking conductor wire of one phase in a pole span when at any number of circuits on the pole; ground wire is not broken.

b. Breaking one ground wire in a pole span; conductor wire is not broken.

II.5.85. In calculating emergency condition for support pole overhead transmission line 500kV which is phased, when wire is broken, conventionally standard load at wire hanging point of one phase is specified to be equal to $0.15T_{max}$ but not less than 1800daN.

II.5.86. Anchoring pole should be checked with installation condition as follows:

a. One of pole spans with number of conductor wires on any pole which only has conductor wire of one circuit, not having ground wire.

b. One of pole spans where there is ground wire, not having conductor wire. When checking, use climate condition as in II.5.31.

In installation condition (erection of the pole, mounting conductor wire or ground wire…), when necessary, it is able to increase firmness (temporarily) of each component of the pole and to install temporary anchoring wire.

II.5.87. In emergency condition of the support pole at great span, with un-phased conductor wire mounted by permanent lock, estimated force when conductor wire is broken is equal to overall residual force of the conductor wire in climate condition stated in II.5.28.

When hanging conductor wire or ground wire on pulleys, in emergency condition, force acting longitudinally on overhead transmission line is equal to 2000 daN for phase of single wire; 3500daN for phase having two conductor wires and 5000 daN for phase having 3 conductor wires.

Support pole of one circuit is calculated in case when conductor wire of one phase is broken and pole of two circuits is calculated in case when conductor wire of two phases is broken, ground wire is not broken.

Standard force of ground wire mounted by permanent lock, when being broken and acting on crossover support pole will be equal to maximum overall stretching force of ground wire, conductor wire not being broken.

Single-circuit anchoring pole of a great span in emergency condition should be calculated taking into account condition of breaking wire of one phase; multiple-circuit anchoring pole is calculated with case of breaking conductor wire of two phases, ground wire not being broken.

Standard force of ground wire when being broken on the crossover anchoring pole in emergency condition is equal to maximum overall stretching fore of ground wire, conductor wire is not broken.

II.5.88. Anchoring pole of cc 500Kv should be checked with installation condition as follows:

a. At a pole span where all conductor wires or ground wires have been mounted and at other pole span, conductor wires or ground wires are not mounted.

   Stretching force of conductor wire or ground wire which has been mounted is stated to be 2/3 of maximum value, climate condition is air temperature T=15^{o}C and wind pressure Q= 7daN/m^{2}. In case when pole and all components are tightened to foundation, they should have standard strength when not using temporary anchoring wire.

b. In a pole span with any number of conductor wires on the pole, conductor wires of one circuit is mounted in any sequence and steps; ground wire has not been installed.

c. In a pole span with any number of conductor wires on the pole, ground wires are mounted in any sequence and steps, conductor wire has not been installed.

In installation condition (erection of the pole, mounting conductor wire or ground wire…), when necessary, it is able to increase temporary firmness of every pole component and to install temporary anchoring wire.

II.5.89. Strut and support of conductor wire, ground wire of all poles should be checked with corresponding load by installation method stated in design, taking into account component of stretching force of anchoring wire; weight of conductor wire, ground wire and insulator as well as weight of accessories and equipped worker in the installation process. These loads are on position of insulator.

Standard load of accessories and equipped worker as follows:

100daN: for pole using post insulator

150daN: support pole, using suspension insulator up to 220kV

200daN: anchoring wire using suspension insulator up to 220kV

250daN: pole 500kV

II.5.90. For overhead transmission line voltage 110kV and above, if it is the only power supply source, pole structure should meet II.5.47 to be repaired without breaking electricity.

II.5.91. Stress in anchoring wire when breaking conductor wire or ground wire should not be greater than 70% breaking tension force of material made of anchoring wire.

II.5.92. Structure of metallic pole, concrete reinforcement pole of overhead transmission line should ensure that workers can climb up the pole easily.

For metallic pole, oblique angle of girder in comparison with horizontal plane should be less than 30^{o}; if the oblique angle is greater, it is required to build steps. Centrifugal concrete reinforcement pole should have hole for mounting steps.

Girder portions of the pole, except for rungs at connection terminal between two pole sections should be considered with human weight of 70kg.

Pole having position for mounting the top wire at a height over 70m should have stairs and landing protected by bars. Ladder or hook for climbing the pole should be far from ground surface 3m and above.

II.5.93. On body of steel pole and concrete reinforcement pole, there should be code for type of the pole by manufacturer or manufacturing place, which clearly states year of production. Overhead transmission line should runs via sparse population area.

II.5.94. Overhead transmission line running via sparse population, minimum cross section of conductor wire should be in compliance with II.5.31, wire connection as in II.5.57.

II.5.95. Vertical distance from the lowest point of conductor wire to natural ground surface, in normal working condition is not less than:

5.5 m for overhead transmission line voltage up to 35kV

6m for overhead transmission line voltage up to 110kV

7m for overhead transmission line voltage 220kV

At area difficult for accessing, above distance can be reduced 1m. At area very difficult for accessing (cliff…), the distance can be reduced 3m.

For overhead transmission line 500kV, the distance is stated as follows:

- At sparse area: 10m
- At area difficult for access: 8,
- At area very difficult for pedestrian to access (cliff..) 6m

Vertical distance determined by sag of conductor wire at maximum air temperature, windless and not taking into account heat generation due to electric current.

II.5.96. Horizontal distance from vertical plane of the outmost conductor wire of overhead transmission line at static state to the nearest protruded component of building or construction (protective corridor) should not be less than:

2m for overhead transmission line voltage up to 22kV

3m for overhead transmission line voltage 35kV

4m for overhead transmission line voltage 110kV

6m for overhead transmission line voltage 220kV

7 m for overhead transmission line voltage 500kV.

For armored cable up to 35kV, above distance is reduced 1/2.

II.5.97. Prohibit to water by spraying equipment at cultivated area in protection corridor of overhead transmission line 500kV.

II.5.98. Overhead transmission line running in forest or green area should ensure a minimum distance as in current regulation on protection of high voltage network.

Overhead transmission line running via water area

II.5.99. When overhead transmission line runs over water area (river, lake, channel, bay, harbor…), crossing angle is not specified.

II.5.100. For overhead transmission line running over river, channel, lake where there is navigable transport of vessels…, anchoring pole will be used.

For overhead transmission line having conductor wire with cross section of 120mm^2 and above which is mounted by permanent support lock and special lock, allow to use crossover support pole but the adjacent pole should be anchoring pole.

For great span, it is required to use anchoring pole for crossing over. If overhead transmission line has conductor wire with cross section of 120mm^2 and above and mounted by permanent lock or special lock, allow to use crossover anchoring pole but adjacent pole should be anchoring pole.

When using support pole in span of conductor wire or ground wire of overhead transmission line, it is required to use permanent lock or special lock for mounting.

II.5.101. Cross section of conductor wire or ground wire in crossing area of pole span, with condition that mechanical strength is not less than 35mm^2 for steel-cored aluminum wire, aluminum alloy wire and steel wire; not less than 70mm^2 for aluminum wire when crossing over navigable river and channel.

In crossing area of the pole, conductor wire or ground wire should not have connection joint, except for overhead transmission line having conductor wire section of 240mm^2 and above which can have one connection joint on each wire in a pole span.

II.5.102. Distance from the bottom conductor wire of overhead transmission line to water surface where vessel navigates should not be less than value in table II.5.6a.

Distance from conductor wire of overhead transmission line to in-navigable water is stated in table II.5.6b.

When the pole span is near a bridge which does not swing (or does not lift for navigation of vessel), it is able to base on height of the bridge to reduce distance value in above table, but should be agreed by waterway traffic management authority.

II.5.103. Area where overhead transmission line crosses with navigable channel, river…, it is required to have signal warning and symbol warning as regulated by the State.

Table II.5.6a – Minimum distance from conductor wire of overhead transmission line to water surface of inland waterway at crossing area

Technical level of inland waterway	Dimension of narrow passage, m					Vertical safe distance from lowest point of conductor wire to annual average highest water surface, m			
	Natural river		Canal		Curve radius	Up to 35kV	110 kV	220 Kv	500kV
	Water depth	Bed's width	Water depth	Bed's width					
I	>3.0	>90	>4.0	>50	>700	13.5	14	15	16
II	2-3	70-90	3-4	40-50	500-700	12.5	13	14	15
III	1.5-2	50-70	2.5-3	30-40	300-500	10.5	11	12	13
IV	1.2-1.5	30-50	2-2.5	20-30	300-500	9.5	10	11	12
V	1-1.2	20-30	1.2-2	10-20	100-200				
VI	<1	10-20	<1.2	10	60-150				

Table II.5.6b – Minimum distance from conductor wire of overhead transmission line to in-navigable water surface

Characteristics of crossing area	Minimum distance (m) by voltage of overhead transmission line, kV			
	Up to 35	**110**	**220**	**500**
To floodplain or yearly flooded area	5.5	6	7	8
To the highest water level of river, canal at maximum air temperature	2.5	3	4	5

Overhead transmission line running over populous area

II.5.104. overhead transmission line running over populous area, crossing angle with the street is not specified.

When overhead transmission line runs along the street, allow to arrange conductor wire above passage portion. Prohibit to use pole with anchoring wire on the street.

II.5.105. Pole at crossing area and turning area of the street should be protected from collision of vehicles.

II.5.106. Cross section of conductor wire or ground wire used for overhead transmission line in condition of mechanical strength should not be less than:

50mm^2 for aluminum wire

35mm^2 for steel-cored aluminum wire or aluminum alloy wire.

Bare conductor wire on the post insulator should be double mounted. Conductor wire on suspension insulator is mounted by permanent lock. Allow to use sliding lock for conductor wire with cross section from 300mm^2 and above.

In the pole span of overhead transmission line running over street, conductor wire or ground wire should not have connection joint. For conductor wire with cross section from 240mm^2 and above, allow to have one connection joint for each conductor wire in one pole span.

II.5.107. Vertical distance from the lowest point of conductor wire to the natural ground surface in normal working condition should not be less than:

7 m for overhead transmission line voltage up to 110kV

8m for overhead transmission line voltage 220kV

14m for overhead transmission line voltage 500kV.

When it is compulsory to build overhead transmission line running via constructions having great importance in fields of politics, economy, culture, national defense, communication information; areas where there are usually crowded in population area, historical and cultural monuments, famous landscapes…which have been ranked by the State, it is required to ensure following conditions:

a. Overhead transmission line running over above constructions and areas should be reinforced with protection method in term of construction and electricity safety.

b. Distance from the lowest point of conductor wire to natural ground should not be less than:

11m for overhead transmission line voltage 35Kv

12m for overhead transmission line with voltage up to 110kV

13m for overhead transmission line with voltage up to 220kV.

Above distance value is stated in normal working condition, the sag is calculated at maximum air temperature, windless and not taking into account heat generation influence due to electric current.

II.5.108. For overhead transmission line running over street, if conductor wire cross section is less than 185mm^2, distance from conductor wire to natural ground should be check under condition that one wire

is broken at adjacent pole span, with average annual temperature, and not taking into account heat generation due to electric current. This distance should not be les than:

4.5m for overhead transmission line voltage up to 110kV

5m for overhead transmission line voltage up to 220kV

II.5.109. Horizontal distance from outmost edge of pole foundation to edge of roadway (taking into account plan for widening) should not be less than 1.5m. In particular case for overhead transmission line voltage up to 35kV, above distance can be reduced to 0.5m.

II.5.110. Prohibit to run overhead transmission line above building and constructions, except for those which are allowed by the State under current regulations.

II.5.111. Horizontal distance from vertical plane of the outmost conductor wire of overhead transmission line at static state to the nearest protruded portion of building and construction (protection corridor) should be in compliance with article II.5.96.

II.5.112. Distance from earth component of overhead transmission line pole to pressure cable installed inside the ground should meet requirements in Chapter II.3.

II.5.113. In protection corridor of overhead transmission line 500kV, prohibit to build dwellings and other constructions. Available dwellings and constructional structures should be moved. In normal working condition of overhead transmission line, it is required to ensure electric field intensity to be less than 5kV/m for dwellings adjacent to the line corridor.

In protection corridor of overhead transmission line of 220kV and less, only allow to have dwellings or constructions which already exist before construction the overhead transmission line if they meet requirements in current regulations of the State.

Overhead transmission line crossing or running closely to each other

II.5.114. Crossing angle of overhead transmission line voltage over 1kV with each other and with overhead transmission line of voltage greater than 1kV is not specified.

Crossing position of overhead transmission line voltage up to 220kV should be selected to be near with pole of above line, but horizontal distance from this pole to conductor wire of beneath overhead transmission line at the maximum deflection of the wire should not be less than 6m while distance from pole top of the beneath overhead transmission line to conductor wire of above line should not be less than 5m.

For anchoring pole of overhead transmission line voltage 500kV, distance from crossing point to anchoring wire should not be less than 10m.

II.5.115. At the area where overhead transmission line crosses with each other, it is able to use anchoring pole or support pole.

II.5.116. Conductor wire of overhead transmission line of higher voltage is usually arrange above wire of overhead transmission line of lower voltage. In special case, allow to run overhead transmission line voltage 110kV and above of which conductor wire has cross section greater than 120mm^2 above wire of overhead transmission line voltage 220kV but double insulator should be used.

II.5.117. Cross section of conductor wire of overhead transmission lines crossing with each other should not be less than regulation in article II.5.106.

In crossing pole span, conductor wire or ground wire of upper overhead transmission line should not have connection joint. For conductor wire with cross section greater than 240mm^2, allow to have one joint on each wire, in each pole span.

II.5.118. In crossing pole span, if upper overhead transmission line uses support pole, conductor wire should be mounted by permanent lock. When cross section of conductor wire is 300mm^2 and above, allow to use sliding lock.

When using post insulator on upper overhead transmission line, insulator in crossing pole span should be double mounting.

II.5.119. Vertical distance between conductor wires or between the nearest conductor wire or ground wire of crossed overhead transmission lines at ambient temperature of 20^{o}C, in windless condition, should not be less than values in Table II.5.7.

In table II.5.7, intermediate values of length of pole span is determined by interpolation method.

When determining distance between conductor wires of crossed overhead transmission lines, it is required to consider ability of lightning strike into both lines and to use distance value in the more disadvantageous condition. If the upper overhead transmission line is protected by ground wire, consider ability of lightning strike on the lower overhead transmission line.

Allow to keep the pole of overhead transmission line voltage up to 110kV under conductor wire of upper overhead transmission line if vertical distance from conductor wire of this overhead transmission line to pole top of the lower overhead transmission line is taken correspondingly with values in table I.5.7 added with 2 more meters.

At the crossed area, if the upper overhead transmission line has ground wire, distance values stated in the table is used for the lower overhead transmission line.

Table II.5.7 – Minimum vertical distance between conductor wires or between conductor wire and earthed wire of crossed overhead transmission lines

Length of pole span, m	With minimum distance from crossing area to the nearest pole of overhead transmission line, m					
	30	50	70	100	120	150
When overhead transmission line 500kV crosses with each other and crosses with other overhead transmission line of lower voltage						
200	5	5	5	5.5	-	-
300	5	5	5.5	6	6.5	7
450	5	5.5	6	7	7.5	8
When overhead transmission line 220kV crosses with each other and crosses with other overhead transmission line of lower voltage						
Up to 200	4	4	4	4	-	-
300	4	4	5	4.5	5	5.5
450	4	4	4	4	6.5	7
When overhead transmission line 110-220kV crosses with each other and crosses with other overhead transmission line of lower voltage						
Up to 200	3	3	3	4	-	-
300	3	3	4	4.5	5.0	-
When overhead transmission line 6-10kV crosses with each other and crosses with other overhead transmission line of lower voltage						
Up to 100	2	2	-	-	-	-
150	2	2.5	2.5	-	-	-

II.5.120. When overhead transmission line runs closely to each other and in parallel with each other, distance from outmost conductor wire of overhead transmission line at static state should not be less than horizontal distance of protection corridor of overhead transmission line of higher voltage.

Overhead transmission line crossing with or running closely to overhead communication line or overhead signal line

II.5.121. Crossing angle of overhead transmission line with overhead communication line or overhead signal line of all grades is not specified. Conductor wire of overhead transmission line should be arrange above conductor wire of overhead communication line or overhead signal line.

Crossing position should be selected near pole of overhead transmission line.

Horizontal distance from overhead transmission line pole up to 220kV to conductor wire of overhead communication line or overhead transmission line is not less than 6m, from pole of overhead communication line and overhead signal line to conductor wire of overhead transmission line up to 220kV should not be less than 7m.

Allow to keep pole of overhead communication line or overhead signal line under the crossed overhead transmission line up to 220kV if distance from top of the pole of overhead communication line or overhead signal line to conductor wire of overhead transmission line is not less than:

6m for overhead transmission line 110kV

7 m for overhead transmission line 220kV

In crossing pole span between overhead transmission line voltage up to 35kV to 220kV with overhead communication line, if the overhead transmission line is used as high frequency communication line and remote control line on which there is communicating equipment having output of each circuit greater than 10W and overhead communication line has frequency band coincidence with frequency of high-frequency communication circuit, overhead communication line should be run by cable line buried underground.

II.5.122. Not allow to arrange pole of overhead communication line, overhead signal line under conductor wire of overhead transmission line 500kV.

Distance from cable pole top of overhead communication line, overhead signal line to the lowest conductor wire of overhead transmission line 500kV should not be less than 20m.

Distance from pole of overhead communication line, overhead signal line using bare conductor wire to vertical plane of the outmost conductor wire of overhead transmission line 500kV is taken in accordance with calculation factor for interference influence of overhead transmission line.

II.5.123. Overhead transmission line pole limiting crossing span with overhead communication line grade I (*), automatic line or semi-automatic line of railway, overhead communication line or overhead signal line of dispatching center station should be anchoring pole. For overhead transmission line voltage of 35kV and above, with wire cross section of 120mm^2 and above when crossing with overhead signal line will be able to use support pole.

Note (*): Basing on importance in politics, economy, national defense and international communication, long-distance bare communication line is classified into 3 classes:

- Class I: including communication lines between central and cities, towns, municipalities, industrial complexes, important harbors, international communication lines and important national defense lines.

- Class II: including provincial communication lines, connecting communication between cities, towns, municipalities and industrial complexes.
- Class III: including local communications lines, serving communication between provinces and districts, districts and districts, and towns or between factories, between post organs.

II.5.124. Cross section of conductor wire of overhead transmission line in crossing pole span with overhead communication line of all grades and with overhead signal line should not be less than 35mm^2 for steel-cored aluminum wire or aluminum alloy wire; 70mm^2 for aluminum wire.

In crossing pole span, conductor wire of overhead transmission line or ground wire should not connect joint. Conductor wire of overhead transmission line having cross section of 240mm^2 and above is allowed to have one joint on each wire, in one pole span.

II.5.125. Poles of overhead transmission line limiting crossing area with overhead communication line or overhead signal line or their adjacent pole spans at the road verge should be protected against collision with vehicles.

II.5.126. On the pole of overhead communication line or overhead signal line, at the crossing area, there should be also protective gap. Earth resistance should not be greater than 25Ω.

II.5.127. In crossing pole span with overhead communication line or overhead signal line, conductor wire of overhead transmission line when using suspension insulator should be mounted by permanent lock. When using post insulator, it is able to double mounting.

II.5.128. Vertical distance from conductor wire of overhead transmission line to conductor wire of overhead communication line or overhead signal line at crossing point in normal working condition of overhead transmission line and when one conductor wire is broken at the adjacent pole span should not be less than values in table II.5.8. For overhead transmission line using conductor wire with cross section of 185mm^2 and above, it is not required to check in condition of breaking conductor wire at the adjacent pole span.

Vertical distance in normal condition is determined by sag of the wire at maximum air temperature, not taking into account heat generation due to electric current; in emergency condition, this distance is calculated with average annual temperature, windless.

Table II.5.8 – Vertical minimum distance from conductor wire of overhead transmission line to conductor wire of overhead communication line or overhead signal line

Estimated condition	Distance (m) by voltage of overhead transmission line, kV				
	10	22	35	110	220
Normal condition	2	3	3	3	4
When wire is broken at adjacent pole span of overhead transmission line using suspension insulator	1	1	1	1	2

II.5.129. For overhead transmission line voltage up to 35kV crossing with broadcasting line, in the crossing area, broadcasting line should be run by buried cable.

II.5.130. When overhead transmission line crosses with buried cable line of overhead communication line or overhead signal line, it is required to meet following conditions:

a. When using overhead transmission line as high-frequency communication line with limitation of frequency from 30 to 150Hz, communicating equipment having output of each communication circuit greater than 10W, then overhead communication line or overhead signal line should be formed in connection with buried cable sections. Length of buried cable section for connection is determined via calculating interference of overhead transmission line on overhead communication line and at the same time, horizontal distance from cable terminal of overhead communication line or overhead signal line to projection on ground surface of the nearest conductor wire of overhead transmission line should not be less than 100m.

b. Distance from buried cable line of overhead communication line or overhead signal line to the nearest earthed component of the pole of overhead transmission line (if pole is not earthed, this is distance to the nearest component of the pole) should not be less than values in table II.5.9.

In case cable line of overhead communication line or overhead signal line is buried in protective steel pipe, forming an external screen or there is an U-shape iron liner outside cable line equal to distance between the two outmost conductor wires of overhead transmission line added with 10m more to each side, it is allowed that distance in the table equal to 5m. If using value smaller than 5m, calculation will be required.

When selecting overhead transmission line, distance from the line to cable of overhead communication line or overhead signal line to pole of overhead transmission line should be as far as possible, depending on each case.

Table II.5.9 – Minimum distance from underground cable of overhead communication line or overhead signal line to earthed part or the nearest portion of pole foundation of overhead transmission line

Resistivity of the earth, ρ, Ωm	Minimum distance (m) by voltage of overhead transmission line, kV	
	Up to 35	From 110 and above
	0.83 $\sqrt{\rho}$	
Up to 100		10
Over 100 to 500	10	25
Over 500 to 1000	11	35
Over 1000	0.35 $\sqrt{\rho}$	50

II.5.131. When overhead transmission line runs in parallel with overhead communication line or overhead signal line, horizontal distance between the nearest outmost conductor wires of these lines are based on calculation of influence of overhead transmission line on overhead communication line or overhead signal line, but should not be less than width of protection corridor of that overhead transmission line (see II.5.96).

Then pole of overhead communication line or overhead signal line should have support or double pole to prevent the case when overhead communication line or overhead signal line falls down, its conductor wire will not touch conductor wire of overhead transmission line.

Phase transposition step for conductor wire of overhead transmission line by influencing condition when lines are near each other is not specified.

II.5.132. At the angle pole of overhead transmission line mounting post insulator near overhead communication line or overhead signal line, distance between these lines should ensure safety as in II.5.96 when conductor wire at angle pole of overhead transmission line is broken and touch conductor wire of the nearest overhead communication line.

If it is not able to meet above requirements, insulator of overhead transmission line toward outside should be doubled.

II.5.133. Not allow to mount overhead communication line, overhead signal line (except for optical fiber cable) on the same pole with overhead transmission line voltage over 1kV.

II.5.134. When overhead transmission line runs closely to cable line of overhead communication line or overhead signal line which is buried in ground, it is required to meet requirements in II.5.130.

II.5.135. overhead transmission line running closely to radio broadcasting station, the minimum distance to antenna should be in accordance with Table II.5.10.

Table II.5.10 – Minimum distance from overhead transmission line to antenna pole of signal station

Signal antenna	Minimum distance (m) by voltage of overhead transmission line, kV	
	Up to 110	220 and 500
Medium and long wave	100	
Short wave by major radiation direction	200	300
Short wave by remained directions	50	
Short wave	150	200

Table II.5.11- Minimum distance from overhead transmission line to radio receiver center

Receiver center	Minimum distance (m) by voltage of overhead transmission line, kV		
	6-35	**110-220**	**500**
Main receiver center, regional and local	500	1000	2000
Isolated receiver center	400	700	1000
Local receiver center	200	300	400

II.5.136. Overhead transmission line running closely to radio receipt center is divided into various substations and local receiving station, distance of overhead transmission line to that center limitation will be equal to value in table II.5.11.

Allow the overhead transmission line to run closely to a distance of 50m provided that magnetic field interference does not exceed values stated by Ministry of Post and Telecommunication.

When designing overhead transmission line running over areas where there are receiving stations of great importance, it is required to follow all regulations stated by authoritative organs.

In particular case, if it is not able to meet requirement for running closely, allow to reduce distance from overhead transmission line to receiving center if applying methods to ensure reduction in interference level to acceptable level.

Overhead transmission line crossing with or running closely to railway

II.5.137. Crossing angle between overhead transmission line and railway is not specified. For electrification railway, crossing angle is not less than 40^o. In all cases, if able, crossing angle should be approximately 90^o.

II.5.138. When overhead transmission line crosses with or runs closely to railway, distance from pole pedestal of overhead transmission line to corridor edge of the un-electrification railway or pole center of contact network of the electrification railway should not be less than height of the pole added with 3m.

In narrow site, allow to use distance value no less than:

3m for overhead transmission line voltage up to 22kV

6m for overhead transmission line voltage of 35kV up to 110kV

8 m for overhead transmission line voltage up to 220kV

10m for overhead transmission line voltage 500kV

At this site, not allow to install pole with anchoring wire.

Allow to keep pole of contact network of electrification railway under overhead transmission line if distance from conductor wire of overhead transmission line to top of the pole of contact network is not less than:

7m for voltage up to 110kV

8m for voltage up to 220kV

9m for 500kV

In particular case, on the narrow site, allow to mount conductor wire of overhead transmission line and conductor wire of contact network on the same pole. Technical condition for this mounting should be agreed by railway management authority.

II.5.139. When overhead transmission line crosses with or runs closely to railway, distance from conductor wire to railway surface or corridor edge of the railway should not be less than values in table II.5.12.

Maximum sag of conductor wire at crossed position with public railway and electrification railway is determined in normal condition, when air temperature is maximum, taking into account the wire heating

due to electric current. If there is no data on load of overhead transmission line, wire temperature is equal to 70°C.

In emergency condition, above distance is checked at average annual temperature and windless condition.

When overhead transmission line crosses or runs closely to railway, along the railway having overhead communication line or overhead signal line, in addition to table II.5.12, it is required to meet requirements in II.5.120 to II.5.131.

Table II.5.12 – Minimum distance when overhead transmission line crosses with railway or runs closely the railway

Crossing or running closely	Minimum distance (m) by voltage of overhead transmission line, Kv			
	Up to 22	35-110	220	500
1. When crossing, from conductor wire to railway surface in normal condition of overhead transmission line	7.5	7.5	8.5	12
2. When running closely, from conductor wire of overhead transmission line to constructional boundary of the railway when the wire is deflected by wind to maximum	1.5	2.5	2.5	4.5
3. When crossing with electrification railway and contact network in normal condition of overhead transmission line	The same as for overhead transmission lines crossing with each other, see Table II.5.7			
4. Similar to item 3, with situation of breaking one wire at adjacent pole span	1	1	2	3.5

II.5.140. When overhead transmission line crosses with public railway or electrification railway, pole should be anchoring type and insulator is double insulator.

When overhead transmission line crosses with many railways which do not have frequent trains, in the crossing area limited by anchoring poles, it is able to install support pole. Conductor wire at these poles should be mounted by permanent lock.

When crossing with specialized railway, allow to use support pole and conductor wire mounted by permanent lock

Prohibit to use steel structure of pole and concrete reinforcement of foundation at the crossover area as ground component.

II.5.141. Cross section of conductor wire when crossing with railway should not be less than:

35mm^2 for steel-cored aluminum wire and aluminum alloy wire

70mm^2 for aluminum wire.

Conductor wire or ground wire should not have any connection joint in crossing pole span.

II.5.142. When overhead transmission line crosses with railway which is protected by trees at two sides, it is required to meet requirements in II.5.98.

Overhead transmission line crossing with or running closely to roadway

II.5.143. Crossing angle between overhead transmission line and roadway is not specified.

II.5.144. When overhead transmission line crosses with roadway of class I, poles for limiting crossing area should be anchoring poles; insulator is mounted doubly; when overhead transmission line crosses with roadway from class II to class V (*), it is able to use support pole and conductor wire is mounted by permanent lock. If using post insulator, it should be mounted doubly.

Note (*): Basing on Standard for design of roadway in TCVN 4054-1985, technical classes of roadway and road line are divided into technical classes with main criteria stated in table II.5.13.

II.5.145. Cross section of conductor wire of overhead transmission line when crossing with roadway of class I, class II in condition of mechanical strength should not be less than 35mm^2 for steel-cored aluminum wire and aluminum alloy wire; 70mm^2 for aluminum wire.

Conductor wire or ground wire should not have any joint in crossing area between overhead transmission line and roadway of class I and class II.

For conductor wire with cross section of 240mm^2 and greater, allow to have one joint on each wire.

Table II.5.13 – Technical class of road way

Main criteria	**Technical class of roadway**						
	Terrain	**I**	**II**	**III**	**IV**	**V**	**VI**
Calculated speed, km/h	Plain	**120**	**100**	**80**	**60**	**40**	**25**
	Mountain	-	80	60	40	25	15
Number of traffic lanes	Plain	2-4	2-4	2	2	1	1
	Mountain	-	2	2	2	1	1
Width of road pavement, m	Plain	15.0	7.5	7.0	6.0	3.5	3.5
	Mountain	-	7.0	6.0	5.5	3.5	3.5
Width of embankment, m	Plain	26.0	13.5	12.0	9.0	6.5	6.0
	Mountain	-	13.0	9.0	7.5	6.5	6.0

II.5.146. Distance when overhead transmission line up to 220kV crosses or runs closely to roadway should not be less than value in table II.5.14.

Maximum sag of conductor wire is determined in normal condition of overhead transmission line when temperature is maximum and not taking into account heat generation due to electric current.

In emergency condition, above distance will be checked in average annual temperature and windless case.

II.5.147. Pole of overhead transmission line adjacent to roadway should be protected from collision of vehicles.

II.5.148. Distance when overhead transmission line 500kV crosses with or runs closely to roadway (including curve section of the roadway) should not be less than following values:

a. Vertical distance

   From conductor wire to road surface: 10m

   From conductor wire to vehicles: 5.5m.

b. Horizontal distance from any components of the pole to edge of road pavement when crossing or running in parallel: 10m.

Table II.5.14 – Minimum distance when overhead transmission up to 220kV crosses by or runs near roadway

Crossing or running near situation	Minimum distance (m) by voltage of overhead transmission line, kV		
	Up to 22	35-110	220
1. Vertical distance from conductor wire to the road surface: a. In normal condition b. When breaking one conductor core at the adjacent pole span (for wire less than 185 mm^2)	 7 5	 7 5	 8 5.5
2. Horizontal distance: From any component of the pole to the road verge: + When crossing with roadway of class I and II + When crossing with roadway of other class + When overhead transmission line runs in parallel with roadway, distance from outmost conductor wire to the road verge when the wire is at static state	 5 1.5 2	 5 2.5 4	 5 2.5 6

Overhead transmission line crossing with or running closely to tramway or trolleybus way

II.5.149. Crossing angle between overhead transmission line with tramway or trolleybus way is not specified.

II.5.150. When overhead transmission line crosses with tramway or trolleybus way, in the crossing pole span, it is required to use anchoring pole. For overhead transmission line with cross section of conductor wire of 120mm^2 and above, allow to use support pole.

II.5.151. Cross section of conductor wire of overhead transmission line crossing with tramway or trolleybus way should not be less than:

25mm^2 for steel-cored aluminum core, aluminum alloy wire

35mm^2 for aluminum wire.

Conductor wire or ground wire is not allowed to have connection joints in crossing area. Except for conductor wire with cross section of 240mm^2 and above which is allowed to have one joint for each wire.

II.5.152. In crossing area of overhead transmission line with tramway or trolleybus way, if suspension insulator is used on the pole of overhead transmission line for mounting single wire, it is only allowed to uses permanent lock. When overhead transmission line is phased from 3 wires and above, allowed to use sliding lock. Post insulator should be mounted doubly.

Table II.5.15 – Minimum distance when overhead transmission crosses with or runs near tramway or trolley bus-way

Crossing or running near situation	**Minimum distance (m) by voltage of overhead transmission line, kV**		
	Up to 110	**220**	**500**
1. Vertical distance from conductor wire to the road surface: a. When crossing with tramway (in normal condition) - To the rail surface - To conductor wire of contact network	 9.5 3	 10.5 4	 11.5 5
b. When breaking one conductor core at the adjacent pole span, to conductor wire of receipt network	1	2	-
c. When crossing with trolley bus-way (in normal condition): - To the highest point of traffic lane - To conductor wire of contact network	 11 3	 12 4	 13 5
2. Horizontal distance from conductor wire when being deflected by wind to maximum to the pole of contact network.	3	4	5

II.5.153. Distance when overhead transmission line crosses with or runs closely to tramway or trolleybus way when conductor wire has maximum sag should not be less than value in table II.5.15.

Maximum sag of conductor wire is determined in normal condition, by maximum air temperature and not taking into consideration heating of wire due to electric current.

In emergency condition, distance is checked with average annual temperature and windless case.

II.5.154. Allow to keep pole of contact network under conductor wire of overhead transmission line when vertical distance from conductor wire of the overhead transmission line to the pole top of contact network is not less than:

7m for overhead transmission line voltage up to 110kV

8m for overhead transmission line voltage of 220kV

9m for overhead transmission line voltage of 500kV.

Overhead transmission line running over bridge

II.5.155. Area where overhead transmission line runs over bridge or tilting section of the bridge should use anchoring pole or anchoring structure. All other support components on the bridge can be intermediate structures for mounting conductor wire by permanent lock; insulator is doubled mounted.

II.5.156. On metallic bridge used for railway which has under-bridge road, if on the whole length of the bridge has upper tightening component, allow to install conductor wire of overhead transmission line directly on the bridge span above or outside boundary of bridge frame.

It is not allowed to arrange conductor wire in corridor where there is contact power network of electrification railway.

On the bridge in city or roadway bridge, allow to install conductor wire of overhead transmission line outside bridge structure as well as within width of walkway and road for vehicles.

II.5.157. Minimum distance from conductor wire of overhead transmission line to bridge components should be taken under agreement with transport management authority. Wire sag is determined at maximum air temperature.

Overhead transmission line running over dam or dyke

II.5.158. When overhead transmission line runs over dam or dyke, distance from conductor wire at the maximum sag and maximum deflection toward component of the dam or dyke should not be less than values in table II.5.16.

When overhead transmission line runs over dam or dyke which is used as transport mean, it is required to meet requirements as stated for the case when overhead transmission line crosses with or runs closely to equivalent structures.

Maximum sag of the conductor wire is determined at maximum air temperature.

Minimum horizontal distance from pole foundation to dyke foot is in accordance with current State law on protection of dyke.

Table II.5.16 – Minimum distance from overhead transmission to elements of dyke, dam

Name of elements of dyke, dam	Minimum distance (m) by voltage of overhead transmission line, Kv		
	Up to 110	220	500
To dyke surface or protrusion portion of the dyke	6	7	10
To slope of the dyke	5	6	8
To overflow surface of the dam	4	5	7

II.5.159. When installing pole of overhead transmission line in protection corridor of the dyke and dam, there should be agreement between dyke and dam management authority and electric authority to ensure safety for dyke and dam and to be in compliance with technical and economical condition of overhead transmission line.

Overhead transmission line crossing with or running closely to surfaced pipeline or overhead carrying cable line

II.5.160. Crossing angle between overhead transmission line with surfaced pipeline or overhead carrying cable line is not specified.

II.5.161. When overhead transmission line crosses with surfaced pipeline or overhead carrying cable line, pole of overhead transmission line in the crossing area should be anchoring pole. For overhead transmission line with cross section of conductor wire is 120mm^2 and above, allow to use support pole.

Prohibit to hang protective mesh on the pole of overhead transmission line.

II.5.162. Conductor wire of overhead transmission line should be over pipeline or overhead carrying cable line. In particular case, allow overhead transmission line voltage up to 110kV runs beneath overhead carrying cable line but there should be bridge or mesh to protect conductor wire of overhead transmission line.

Cross section of conductor wire at crossing area should not be less than:

35mm^2 for steel-cored aluminum wire and aluminum alloy wire

70mm^2 for aluminum wire.

In the crossing pole span, conductor wire of overhead transmission line should not have any joints. Conductor wire of overhead transmission line with cross section over 240mm^2 is allowed to have joint on each wire, in a pole span.

II.5.163. On the pole of overhead transmission line, in crossing area, it is required to use suspension insulator; support will be permanent lock type. When using post insulator, double mounting is required.

II.5.164. In normal condition, horizontal distance from conductor wire at the maximum deflection and vertical distance at the maximum sag to any component of pipe or cable should not be less than:

3m for overhead transmission line voltage up to 22kV

4m for overhead transmission line voltage up to 35-110kV

5m for overhead transmission line voltage 220kV

II.5.165. At area where overhead transmission line 500kV crosses with surfaced gas-pipe, on the ground or overhead carrying cable line (except for pipeline buried inside ground), protection barrier is required. The barrier should be protruded at a distance of 6.5m from two sides, calculating from projection of the outmost conductor wire of overhead transmission line 500k at the maximum deflection.

II.5.166. Distance when overhead transmission line 500kV crossing or running closely or in parallel with surfaced pipeline should not be less than following values:

1. Vertical distance from conductor wire of overhead transmission line 500kV to any components of the pipe at normal condition: 6.5m
2. Horizontal distance

a. When running in parallel with each other:

- From outmost conductor wire to any component of pipeline (except for main oil pipe and oil product pipe) in normal condition: the distance is not less than height of the pole.
- From outmost conductor wire to any component of the main gas pipe in normal condition: no less than two times of the height of the pole.
- From outmost conductor wire to any component of the main oil pipe or oil product pipe in normal condition: 50m but not less than height of the pole.
- In narrow site, distance from outmost conductor wire to any component of the pipeline at maximum deflection of the wire: 6.5m.

b. When crossing with each other:

- From pole of overhead transmission line 500kV to any component of pipeline in normal condition: no less than height of the pole.
- In narrow site, distance from pole of overhead transmission line 500kV to any component of pipeline: 6.5m.

II.5.167. In crossing section with overhead transmission line, metallic pipeline, bridge, net, metallic barrier and overhead carrying cable line should be earthed by artificial connection system in compliance with regulation on earth connection. Earth resistance should not be greater than 10Ω.

Overhead transmission line crosses with or runs closely to pipeline buried in ground

II.5.168. Crossing angle between overhead transmission line with voltage up to 35kV and pipe buried in ground is not specified. Crossing angle between overhead transmission line with voltage of 110kV and above to main gas pipe, oil pipe and oil product pipe is not less than 60^o.

II.5.169. Main steam supply with pressure over 1.2MPa and main oil pipe (or oil product pipe) should be installed outside protection corridor of overhead transmission line.

In narrow condition, when overhead transmission line runs in parallel, as well as at position where overhead transmission line crosses with above pipes, allowable distance from edge of foundation or the nearest earth component of overhead transmission line to edge of the pipe is determined as follows:

5m for overhead transmission line voltage up to 35kV

10 m for overhead transmission line voltage 110-220kV

15 m for overhead transmission line voltage 500kV

II.5.170. When overhead transmission line crosses with or runs closely to steam supply with pressure less than 1.2MPa, or closely to oil pipe or oil product pipe and other pipes, distance from edge of foundation or earth components of overhead transmission line to edge of above pipes should not be less than:

5m for overhead transmission line voltage up to 35kV

10 m for overhead transmission line voltage 110kV and above.

At the section where pipe runs in protection corridor of overhead transmission line, it is required to check all welds of the main pipe with pressure equal to and less than 1.2 MPa by physical method.

II.5.171. Overhead transmission line 500kV should be built far from exhaust nozzle of 300m and above.

II.5.172. When overhead transmission line 550kV crosses with or runs closely to water pipe, drainage system (with open flow pressure), then vertical distance from the nearest earth component and the nearest pole foundation of overhead transmission line and pole foundation of overhead transmission line 500kV to the pipe should not be less than 3m.

Overhead transmission line runs closely to structure containing combustible and explosive substances

II.5.173. Overhead transmission line running closely to building or area containing combustible and explosive substances should meet requirements in current technical standard and regulations on explosion and fire protection and prevention.

For constructions not stated in current regulations, above distance should not be less than 60m.

Overhead transmission line runs closely to flame in burning oil and gas

II.5.174. When running closely to flame in fire of oil and gas, minimum distance from overhead transmission line to the flame is 60m.

Overhead transmission line runs closely to airport

II.5.175. Construction of overhead transmission line running closely to airport should be under agreement with aviation authority when:

- Distance from overhead transmission line to boundary of airport is up to 10km with pole of any height.
- Distance from overhead transmission line to boundary of airport is from 10km to 30km and absolute height of the pole is greater than absolute height of the airport of 50m and above
- Distance from overhead transmission line to boundary of airport is over 30km up to 75km and overhead transmission line has pole higher than 100m.

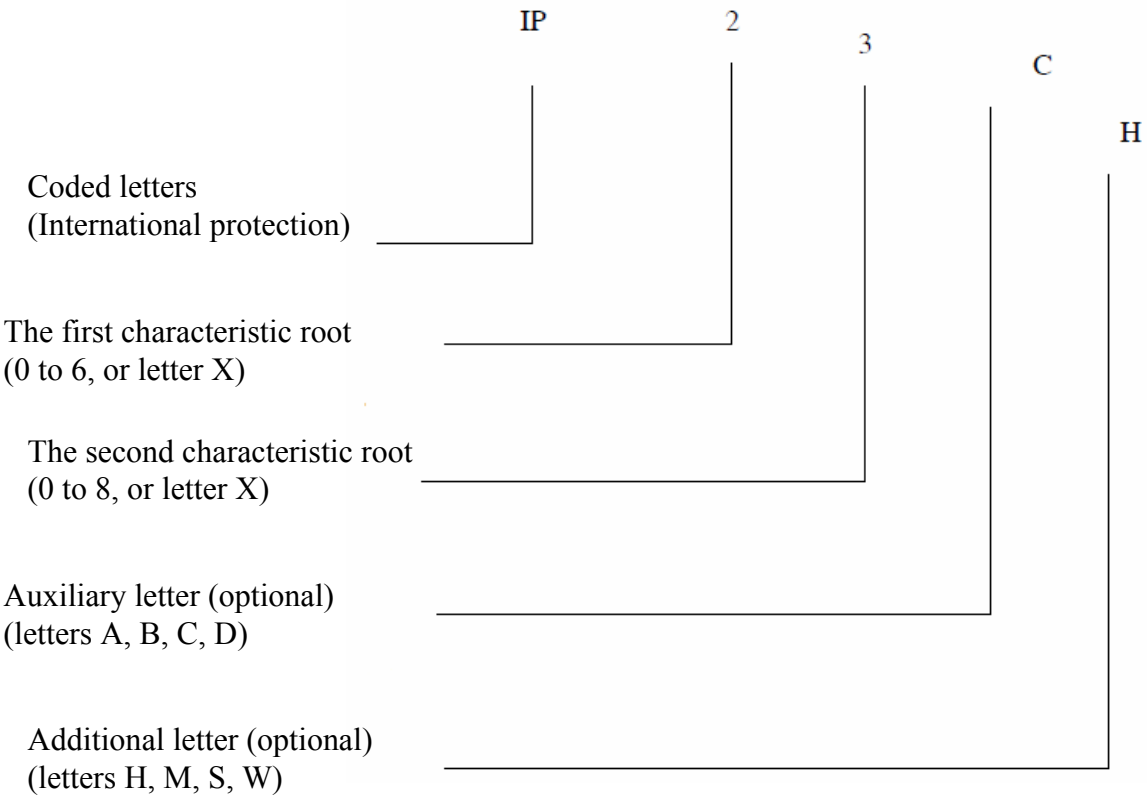
Annex II.1.

1. IP Code

Coding system is to indicate protection levels provided by a shielding component against contact with dangerous element, against penetration of solid, of water from outside into the element and to add related information to protection issue.

II. Arrangement of IP code

Example: IP23CH IP



* If it is not required to clarify characteristic root, this root number can be replaced by letter "X" (by "XX" if rejecting both two characteristic roots).

* Auxiliary letter or/and additional letter can be omitted without replacement.

* If using more than one additional letter, sequence of overhead transmission line will be used.

* If shielding element creates different protection levels for different estimated arrangements for installation, equivalent protection level should be assigned by manufacturer in related guidelines to each arrangement.

III. Elements of IP code and meaning

Table II.1 describes briefly elements in IP code as follows: (for reference)

Annex II.4

Table 1: Sag and deflection due to wind of cable 4 x 95 mm^2 with pole traction force of 2.75kN

Pole span, m	Sag, m										Deflection due to wind, m
	Conductor wire temperature, ^{o}C										
	5	10	15	20	25	30	35	40	-5	80	
18	0.20	0.20	0.21	0.22	0.23	0.24	0.24	0.25	0.18	0.30	0.22
20	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.22	0.38	0.28
22	0.29	0.31	0.32	0.33	0.34	0.35	0.36	0.38	0.26	0.45	0.34
24	0.35	0.36	0.38	0.39	0.41	0.42	0.43	0.45	0.31	0.65	0.39
26	0.41	0.43	0.44	0.46	0.48	0.49	0.51	0.52	0.37	0.63	0.47
28	0.47	0.49	0.52	0.54	0.55	0.57	0.59	0.61	0.43	0.74	0.54
30	0.54	0.57	0.59	0.61	0.64	0.66	0.68	0.70	0.49	0.84	0.62
32	0.62	0.65	0.67	0.70	0.72	0.75	0.77	0.80	0.56	0.96	0.70
34	0.70	0.73	0.76	0.79	0.82	0.84	0.87	0.90	0.63	1.08	0.79
35	0.74	0.77	0.81	0.84	0.87	0.90	0.92	0.95	0.67	1.15	0.84
36	0.78	0.82	0.85	0.88	0.92	0.95	0.98	1.01	0.71	1.22	0.89
38	0.87	0.91	0.95	0.99	1.02	1.06	1.09	1.12	0.79	1.36	0.99
40	0.97	1.01	1.05	1.09	1.13	1.17	1.21	1.24	0.97	1.50	1.10
42	1.07	1.11	1.16	1.20	1.25	1.29	1.33	1.37	0.96	1.66	1.21
44	1.17	1.22	1.27	1.32	1.37	1.42	1.46	1.50	1.06	1.82	1.34
46	1.28	1.34	1.39	1.45	1.50	1.55	1.60	1.64	1.16	1.99	1.46
48	1.39	1.45	1.52	1.57	1.63	1.69	1.74	1.79	1.26	2.17	1.59
50	1.51	1.58	1.64	1.71	1.77	1.83	1.89	1.94	1.37	2.35	1.72
52	1.63	1.71	1.78	1.85	1.91	1.98	2.04	2.10	1.48	2.54	1.86
54	1.76	1.84	1.92	1.99	2.06	2.13	2.20	2.27	1.59	2.74	2.01
56	1.90	1.98	2.06	2.14	2.22	2.30	2.37	2.44	1.71	2.95	2.16
58	2.03	2.13	2.21	2.30	2.38	2.46	2.54	2.62	1.84	3.16	2.32
60	2.18	2.27	2.37	2.46	2.55	2.64	2.72	2.80	1.97	3.39	2.48
62	2.32	2.43	2.53	2.63	2.72	2.82	2.90	2.99	2.10	3.62	2.65
64	2.48	2.59	2.70	2.80	2.90	3.00	3.10	3.19	2.24	3.86	2.83
66	2.63	2.75	2.87	2.98	3.09	3.19	3.29	3.39	2.38	4.10	3.01
68	2.80	3.05	3.05	3.16	3.28	3.39	3.50	3.60	2.53	4.36	3.19
70	2.96	3.10	3.23	3.35	3.47	3.59	3.71	3.82	2.68	4.62	3.38

Table 2- Sag and deflection due to wind of cable 4 x 95 mm^2 with pole traction force of 4kN

Pole span, m	Sag, m										Deflection due to wind, m
	Conductor wire temperature, ^oC										
	5	10	15	20	25	30	35	40	-5	80	
26	0.28	0.30	0.31	0.33	0.34	0.36	0.37	0.38	0.25	0.47	0.34
28	0.33	0.35	0.36	0.38	0.40	0.41	0.43	0.44	0.29	0.55	0.39
30	0.38	0.40	0.42	0.44	0.46	0.47	0.49	0.51	0.34	0.63	0.45
32	0.43	0.45	0.48	0.50	0.52	0.54	0.56	0.58	0.38	0.71	0.52
34	0.49	0.51	0.54	0.56	0.59	0.61	0.63	0.65	0.43	0.80	0.58
36	0.55	0.57	0.60	0.63	0.66	0.68	0.71	0.73	0.48	0.90	0.65
38	0.61	0.64	0.67	0.70	0.73	0.76	0.79	0.81	0.54	1.00	0.73
40	0.67	0.71	0.74	0.78	0.81	0.84	0.87	0.90	0.60	1.11	0.80
42	0.74	0.78	0.82	0.86	0.89	0.93	0.96	0.99	0.66	1.23	0.88
44	0.52	0.86	0.90	0.94	0.98	1.02	1.06	1.09	0.72	1.35	0.98
45	0.85	0.90	0.94	0.99	1.03	1.07	1.10	1.14	0.76	1.41	1.02
46	0.89	0.94	0.99	1.03	1.07	1.11	1.15	1.19	0.79	1.47	1.07
48	0.97	1.02	1.07	1.12	1.17	1.21	1.26	1.30	0.86	1.60	1.16
50	1.05	1.11	1.16	1.22	1.27	1.32	1.36	1.41	0.93	1.74	1.25
52	1.14	1.20	1.26	1.32	1.37	1.42	1.48	1.53	1.01	1.88	1.36
54	1.23	1.29	1.36	1.42	1.48	1.54	1.59	1.64	1.09	2.02	1.47
56	1.32	1.39	1.46	1.53	1.59	1.65	1.71	1.77	1.17	2.18	1.59
58	1.42	1.50	1.57	1.64	1.71	1.77	1.84	1.90	1.26	2.34	1.70
60	1.52	1.60	1.68	1.75	1.83	1.90	1.97	2.03	1.35	2.51	1.81
62	1.62	1.71	1.79	1.87	1.95	2.03	2.10	2.17	1.44	2.68	1.93
64	1.73	1.82	1.91	2.00	2.08	2.16	2.24	2.31	1.53	2.86	2.06
66	1.84	1.94	2.03	2.12	2.21	2.30	2.38	2.46	1.63	3.04	2.20
68	1.95	2.06	2.16	2.25	2.35	2.44	2.53	2.61	1.73	3.23	2.33
70	2.07	2.18	2.29	2.39	2.49	2.59	2.68	2.77	1.83	3.42	2.47
72	2.19	2.31	2.42	2.53	2.63	2.74	2.83	2.93	1.94	3.62	2.61
74	2.31	2.44	2.56	2.67	2.78	2.89	2.99	3.10	2.05	3.82	2.76
76	2.44	2.57	2.70	2.82	2.93	3.05	3.16	3.27	2.16	4.03	2.91
78	2.57	2.71	2.84	2.97	3.09	3.21	3.33	3.44	2.28	4.24	3.07
80	2.96	2.85	2.90	3.12	3.25	3.38	3.5	3.62	2.39	4.47	3.24

Table 3- Sag and deflection due to wind of cable 4 x 95 mm^2 with pole traction force of 5kN

Pole span, m	Sag, m										Deflection due to wind, m
	Conductor wire temperature, ^{o}C										
	5	10	15	20	25	30	35	40	-5	80	
38	0.49	0.50	0.52	0.63	0.66	0.56	0.57	0.50	0.46	0.68	0.53
40	0.54	0.56	0.57	0.59	0.60	0.62	0.64	0.65	0.51	0.76	0.57
42	0.60	0.61	0.63	0.65	0.67	0.68	0.70	0.72	0.56	0.84	0.62
44	0.65	0.67	0.69	0.71	0.73	0.75	0.77	0.79	0.61	0.92	0.69
46	0.71	0.74	0.76	0.78	0.80	0.82	0.84	0.86	0.67	1.00	0.75
48	0.78	0.80	0.83	0.85	0.87	0.89	0.91	0.94	0.73	1.09	0.82
50	0.84	0.87	0.90	0.92	0.95	0.97	0.99	1.02	0.79	1.19	0.88
52	0.91	0.94	0.97	1.00	1.02	1.05	1.07	1.10	0.85	1.28	0.96
54	0.98	1.02	1.05	1.07	1.10	1.13	1.16	1.18	0.92	1.38	1.03
56	1.06	1.09	1.12	1.16	1.19	1.22	1.25	1.27	0.99	1.49	1.11
58	1.14	1.17	1.21	1.24	1.27	1.30	1.34	1.37	1.06	1.60	1.20
60	1.22	1.25	1.29	1.33	1.36	1.40	1.43	1.46	1.14	1.71	1.28
62	1.30	1.34	1.38	1.42	1.45	1.49	1.53	1.56	1.21	1.82	1.37
64	1.38	1.43	1.47	1.51	1.55	1.59	1.63	1.66	1.29	1.94	1.46
66	1.47	1.52	1.56	1.61	1.65	1.69	1.73	1.77	1.38	2.07	1.55
68	1.56	1.61	1.66	1.70	1.75	1.79	1.84	1.88	1.46	2.19	1.65
70	1.65	1.71	1.76	1.81	1.85	1.90	1.95	1.99	1.55	2.32	1.75
72	1.75	1.81	1.86	1.91	1.96	2.01	2.06	2.11	1.64	2.46	1.84
74	1.85	1.91	1.96	2.02	2.07	2.12	2.18	2.23	1.73	2.60	2.95
75	1.90	1.96	2.02	2.07	2.13	2.18	2.24	2.29	1.78	2.67	2.00
76	1.95	2.01	2.07	2.13	2.19	2.245	2.30	2.35	1.82	2.74	2.06
78	2.06	2.12	2.18	2.24	2.30	2.36	2.42	2.47	1.92	2.89	2.17
80	2.16	2.23	2.30	2.36	2.42	2.48	2.54	2.60	2.02	3.04	2.28
82	2.27	2.34	2.41	2.48	2.54	2.61	2.67	2.73	2.12	3.19	2.39
84	2.38	2.46	2.53	2.60	2.67	2.74	2.80	2.87	2.23	3.35	2.52
86	2.50	2.58	2.65	2.73	2.80	2.87	2.94	3.01	3.01	3.51	2.64
88	2.62	2.70	2.78	2.86	2.93	3.01	3.08	3.15	2.45	3.68	2.76

Table 3 (continued)

Pole span, m	Sag, m										Deflection due to wind, m
	Conductor wire temperature, °C										
	5	10	15	20	25	30	35	40	-5	80	
90	2.74	2.82	2.91	2.99	3.07	3.14	3.22	3.30	2.56	3.85	2.88
92	2.86	2.95	3.04	3.12	3.20	3.29	3.37	3.44	2.67	4.02	3.02
94	2.99	3.09	3.18	3.27	3.35	3.44	3.52	3.60	2.80	4.20	3.15
96	3.12	3.22	3.32	3.41	3.50	3.59	3.67	3.76	2.92	4.38	3.29
98	3.26	3.36	3.46	3.55	3.65	3.74	3.83	3.92	3.05	4.57	3.43
100	3.39	3.50	3.60	3.70	3.80	3.89	3.99	4.08	3.17	4.76	3.56
102	3.53	3.64	3.74	3.85	3.95	4.05	4.15	4.24	3.30	4.95	3.71
104	3.67	3.78	3.59	4.00	4.11	4.21	4.31	4.41	3.43	5.15	3.86
106	3.81	3.93	4.04	4.16	4.27	4.37	4.48	4.58	3.56	5.35	4.01
108	3.95	4.08	4.20	4.31	4.43	4.54	4.65	4.76	3.70	5.55	4.16
110	4.10	4.23	4.35	4.48	4.60	4.71	4.83	4.94	3.84	5.76	4.32
112	4.25	4.39	4.52	4.64	4.76	4.89	5.00	5.12	3.98	5.97	4.47
114	4.41	4.54	4.68	4.81	4.94	5.06	5.18	5.30	4.12	6.19	4.64
116	4.56	4.71	4.84	4.98	5.11	5.24	5.37	5.49	4.27	6.41	5.80
118	4.72	4.87	5.01	5.15	5.29	5.42	5.56	5.68	4.42	6.63	4.97
120	4.88	5.04	5.18	5.33	5.47	5.61	5.75	5.88	4.57	6.86	5.15
122	5.05	5.21	5.36	5.51	5.66	5.80	5.94	6.08	4.72	7.09	5.32
124	5.22	5.38	5.54	5.69	5.84	5.99	6.14	6.28	4.88	7.33	5.49
126	5.39	5.55	5.72	5.88	6.03	6.19	6.34	6.48	5.04	7.57	5.67
128	5.56	5.73	5.90	6.07	6.23	6.39	6.54	6.69	5.20	7.81	5.85
130	5.73	5.91	6.09	6.26	6.42	6.59	6.75	6.90	5.36	8.06	6.04
132	5.91	6.10	6.28	6.45	6.62	6.79	6.96	7.12	5.53	8.31	6.23
134	6.09	6.28	6.47	6.65	6.83	7.00	7.17	7.34	5.70	8.57	6.47
136	6.28	6.47	6.66	6.85	7.03	7.21	7.39	7.56	5.87	8.82	6.65
138	6.46	6.67	6.86	7.05	7.24	7.43	7.61	7.78	6.05	9.09	7.86
140	6.65	6.68	7.06	7.26	7.45	7.64	7.83	8.01	6.22	9.35	7.06

Annex II.4.2

Table 1. Technical parameters of aerial bundled cable with aluminum core bearing even force

Parameter	Unit	Nominal section of conduction core, mm							
		16	25	35	50	70	95	120	150
Number of conduction cores		2/4	2/3/4	2/3/4	2/3/4	4	2/4	4	4
Type of conduction core		Circular section, twisted and compressed							
Number of aluminum cores in a conduction core		7	7	7	7	(*) 19	(*) 19	(*) 19	(*) 19
Minimum conduction core diameter	mm	4.5	5.8	6.8	8.0	9.6	11.3	12.8	14.1
Maximum conduction core diameter	mm	4.8	6.1	7.2	8.4	10.1	11.9	13.5	14.9
Maximum direct resistance of conduction core at 20°C	Ω/km	1.910	1.200	0.868	0.641	0.443	0.320	0.253	0.206
Minimum traction breaking force of conduction core	kN	2.2	3.5	4.9	7.0	9.8	13.3	16.8	21.0
Minimum average thickness of insulator, not including ribs (not measuring at diaglyphic area or ribbed area)	nm	1.3	1.3	1.3	1.5	1.5	1.7	1.7	1.7
Minimum thickness of insulator at any position	mm	1.07	1.07	1.07	1.25	1.25	1.43	1.43	1.43
Maximum thickness of insulator at any position (not measuring at diaglyphic area or ribbed area)	mm	1.9	1.9	1.9	2.1	2.1	2.3	2.3	2.3
Maximum diameter of the core (not including ribs)	mm	7.9	9.2	10.3	11.9	13.6	15.9	17.5	18.9
Minimum load with insulation adhesion									
- X-90&X-FP-90	Kg	+	+	+	100	140	190	240	300
- With X-FP-90	Kg	+	+	+	+	+	110	+	+

Note: (*) allow to use tolerance of 1 aluminum core.

"+": Not defined

Table 2- Technical specifications of 2-core, 3-core cable, aluminum core

Parameter	Unit	Nominal section of conduction core, mm							
		16	25	35	50	70	95	120	150
Number of conduction cores		2	2	2	2	2	3	3	3
Maximum estimated external diameter of cable	mm	15.8	18.4	20.6	23.8	31.8	19.8	22.2	25.6
Cable's specific weight (approximately)	Kg/m	0.14	0.20	0.26	0.35	0.68	0.30	0.39	0.53
Maximum alternating resistance of conduction core at 80°C	Ω/km	2.37	1.49	1.08	0.796	0.398	1.49	1.08	0.796
Positive-sequence reactance (1) of cable at 50Hz	Ω/km	0.094	0.088	0.085	0.084	0.078	0.088	0.085	0.084
Maximum continuous working temperature	°C	80	80	80	80	80	80	80	80
Maximum continuous current	A	96	125	155	185	285	105	125	150
Minimum breaking load of the cable	kN	4.4	7.0	9.8	14.0	26.6	10.5	14.7	21.0
Elastic modulus	GPa	59	59	59	59	56	59	59	59
Elongation coefficient	10^{-6}/°C	23	23	23	23	23	23	23	23
Minimum curve radius of single core	mm	30	40	60	70	95	40	60	70
Minimum curve radius of cable	mm	95	110	125	145	285	120	135	155
Maximum value (2) of maximum working tension (28% LKD)	kN	1.23	1.96	2.74	3.92	7.45	2.94	4.12	5.88
Maximum value of normal tension (18% LKD)	kN	0.79	1.26	1.76	2.52	4.79	1.89	2.65	3.78

Note: (1) In most of cases, this value is used for zero-sequence reactance.

(2) At most of constructions, it is able to use lower values.

Table 3 – Parameters of 4-core cable, aluminum core

Parameter	Unit	Nominal section of conduction core, mm							
		16	25	35	50	70	95	120	150
Number of conduction cores		4	4	4	4	4	4	4	4
Maximum estimated external diameter of cable	mm	19.1	22.2	24.9	28.7	32.8	38.4	42.2	45.6
Cable's specific weight (approximately)	Kg/m	0.28	0.40	0.52	0.70	0.96	1.35	1.66	2.02
Maximum alternating resistance of conduction core at 80°C	Ω/km	2.37	1.49	1.08	0.796	0.551	0.398	0.315	0.257
Positive-sequence reactance (1) of cable at 50Hz	Ω/km	0.102	0.095	0.092	0.092	0.086	0.085	0.084	0.082
Maximum continuous working temperature	°C	80	80	80	80	80	80	80	80
Maximum continuous current	A	78	105	125	150	185	225	260	285
Minimum breaking load of the cable	kN	8.8	14.0	19.6	28.0	39.2	53.2	67.2	84.0
Elastic modulus	GPa	59	59	59	59	56	56	56	56
Elongation coefficient	10^{-6}/°C	23	23	23	23	23	23	23	23
Minimum curve radius of single core	mm	30	40	60	70	80	95	105	115
Minimum curve radius of cable	mm	115	135	150	160	285	345	380	410
Maximum value (2) of maximum working tension (28% LKD)	kN	2.46	3.92	5.49	7.84	11.0	14.9	18.8	23.5
Maximum value of normal tension (18% LKD)	kN	1.58	2.52	3.53	5.00	7.10	9.60	12.1	15.1

Note: (1) In most of cases, this value is used for zero-sequence reactance.

(2) At most of constructions, it is able to use lower values.

Table 4 - Main technical parameters of aluminum core aerial bundled neutral cable

Nominal section	Conduction core					Average thickness of insulation sheath	Core	
	Number of plies	Resistivity at 20°C	Core diameter		Minimum breaking tension		External diameter	
			Minimum	Maximum			Minimum	Maximum
mm²		Ω/km	mm	mm	daN	mm	mm	mm
1. Phase core								
25	7	1.200	5.8	6.3	300	1.4	8.6	9.4
35	7	0.868	6.8	7.3	420	1.6	10.0	10.9
50	7	0.641	7.9	8.4	600	1.6	11.1	12.0
70	12	0.443	9.7	10.2	840	1.8	13.3	14.2
95	19	0.320	11.0	12.2	1140	1.8	14.6	15.7
120	19	0.252	12.0	13.1	1440	1.8	15.6	16.7
150	19	0.206	13.9	15.0	1800	1.7	17.3	18.6
2. Load-bearing neutral core								
54.6	7	0.630	9.2	9.6	1660	1.6	12.3	13.0
70	7	0.500	10.0	10.2	2050	1.5	12.9	13.6
95	19	0.343	12.2	12.2	2750	1.6	15.3	16.3

Annex II.4.3

Table 1 – Stretch and sag of aerial bundled cable bearing even load, with aluminum core of 4x25m²

Pole span, m	Cable sag at environmental temperature, cm			
	0°C	20°C	30°C	40°C
Tensile stress 30N/mm²				
20	16	29	34	38
30	35	50	57	63
40	68	84	92	99
50	110	127	135	144
60	163	180	188	196
Tensile stress 40N/mm²				
20	11	24	30	35
30	23	40	48	54
40	42	63	72	80

50	73	95	105	114
60	112	135	145	155
Tensile stress 60N/mm^2				
20	6	15	21	27
30	13	27	35	43
40	22	41	51	61
50	34	56	69	80
60	54	81	94	107

Note: It is able to use interpolation method for intermediate values not stated in the table

Table 2- Stretch and sag of aerial bundled cable bearing even load, with aluminum core of 4x35m^2

Pole span, m	**Cable sag at environmental temperature, cm**			
	0^{o}C	**20^{o}C**	**30^{o}C**	**40^{o}C**
Tensile stress 30N/mm^2				
20	16	28	33	38
30	29	46	53	59
40	52	71	80	87
50	87	107	116	125
60	126	149	159	168
Tensile stress 40N/mm^2				
20	11	24	30	35
30	22	39	47	54
40	35	56	66	75
50	55	80	92	102
60	86	113	124	136
Tensile stress 60N/mm^2				
20	05	14	21	27
30	12	26	35	43
40	21	39	50	60
50	32	54	85	98
60	44	71	137	153

Note: It is able to use interpolation method for intermediate values not stated in the table

Table 3 – Stretch and sag of aerial bundled cable bearing even load, with aluminum core of 4x50m^2

Pole span, m	Cable sag at environmental temperature, cm			
	0^{o}C	**20^{o}C**	**30^{o}C**	**40^{o}C**
Tensile stress 30N/mm^2				
20	15	28	33	38
30	28	45	52	59
40	44	65	74	82
50	72	94	104	113
60	106	130	141	151
Tensile stress 40N/mm^2				
20	10	23	29	34
30	21	38	46	53
40	34	55	65	74
50	48	74	85	96
60	71	99	111	123
Tensile stress 60N/mm^2				
20	05	13	19	26
30	11	24	33	41
40	20	37	48	58
50	30	52	64	76
60	43	69	83	96

Note: It is able to use interpolation method for intermediate values not stated in the table

Table 4 – Cable 3x70mm^2 + 1x54.6 mm^2

Pole span, m	Tension stress of load-bearing neutral core, daN						
	10°C	**15°C**	**20°C**	**25°C**	**30°C**	**35°C**	**40°C**
10	180	160	140	125	115	105	95
15	195	175	160	150	140	130	120
20	215	200	190	180	170	160	150
25	225	210	200	190	185	180	170
30	225	220	210	200	195	185	180
35	220	210	200	195	190	185	180
Pole span, m	**Sag of load-bearing neutral core, cm**						
	10°C	**15°C**	**20°C**	**25°C**	**30°C**	**35°C**	**40°C**
10	8	9	10	11	12	14	15
15	16	17	20	21	23	25	26
20	27	29	31	33	35	37	39
25	40	43	45	47	49	52	54
30	58	61	63	66	68	70	72
35	83	86	88	91	93	96	98
40	108	111	114	117	119	122	125

Note: It is able to use interpolation method for intermediate values not stated in the table

Table 5 – Cable 3x70 mm^2 + 1x70 mm^2

Pole span, m	Tension stress of load-bearing neutral core, daN						
	10°C	15°C	20°C	25°C	30°C	35°C	40°C
10	167	146	129	116	105	97	90
15	193	175	161	148	138	129	122
20	213	198	185	174	164	156	148
25	228	198	185	174	164	156	148
30	240	229	219	211	202	195	183
35	250	240	232	224	216	210	203
40	258	249	242	234	228	222	216
Pole span, m	**Sag of load-bearing neutral core, cm**						
	10°C	15°C	20°C	25°C	30°C	35°C	40°C
10	9	10	11	13	14	15	16
15	17	19	21	22	24	26	27
20	28	30	32	34	36	38	40
25	40	43	45	47	50	52	54
30	55	58	60	63	65	68	70
35	72	75	78	81	83	86	89
40	91	94	97	100	103	106	109

Note: It is able to use interpolation method for intermediate values not stated in the table

Table 6 – Cable 3x150 mm^2 + 1x70 mm^2

Pole span, m	Tension stress of load-bearing neutral core, daN						
	10°C	15°C	20°C	25°C	30°C	35°C	40°C
10	196	179	165	153	142	134	126
15	224	211	199	189	180	172	165
20	244	233	223	215	207	200	193
25	257	248	241	233	227	220	214
30	267	260	253	247	241	236	231
35	273	268	262	257	252	248	243
40	278	274	269	265	261	257	253
Pole span, m	**Sag of load-bearing neutral core, cm**						
	10°C	**15°C**	**20°C**	**25°C**	**30°C**	**35°C**	**40°C**
10	12	13	14	16	17	18	19
15	23	25	26	28	29	31	32
20	38	40	41	43	45	46	48
25	56	58	60	62	63	65	67
30	78	80	82	84	86	88	90
35	104	106	108	110	113	115	117
40	133	135	138	140	142	144	147

Note: It is able to use interpolation method for intermediate values not stated in the table

Annex II.5

Table II.5.1 – Allowable minimum cross section of overhead transmission line by mechanical strength

Characteristics of overhead transmission line	Conductor wire section, mm^2			
	Aluminum	Steel-cored aluminum and aluminum alloy	Steel	Copper
1. On normal pole spans of overhead transmission line:	35	25	25	16
2. On pole spans of overhead transmission line over-passing navigable river, channel	70	35	25	25
3. On pole spans of overhead transmission line over-passing constructions of:	70	35	25	25
- Communication line	70	35	25	25
- Surface pipeline and transport cable line	70	35	25	25
- Railway				

Table II.5.2: Allowable stress of conductor wire and ground wire by % of traction breaking stress

Cross section of conductor wire and ground wire	Allowable stress in compliance with 5 of traction breaking stress of conductor wire and ground wire	
	At maximum external strain and minimum temperature	At annual average temperature
Aluminum wire, mm^2:		
16-35	35	
50 and 70	40	25
95	40	
≥ 120	45	
Aluminum alloy wire, mm^2:		
16-95	40	
≥ 120	45	30
Ground wire of steel material of all cross section, mm^2	50	30
Steel-cored aluminum wire and steel-cored aluminum alloy wire, mm^2:		
16-25	35	
	40	

35-95 ≥ 120 when A: C = 6.11÷6.25 ≥ 120 when A:C = 4.29÷4.39 ≥ 150	40 45 45	25
Copper wire, mm^2	50	30

Table II.5.3: Minimum insulation distance at the pole between live part and earthed part of the line

Estimated condition when selecting insulation distance	Minimum insulation distance (cm) at the pole by voltage of overhead transmission line, kV					
	Up to 10	15÷22	35	110	220	500
a. Atmospheric over-voltage						
- Post insulator	15	25	35			
- Suspension insulator	20	35	40	100	180	320
b. Internal over-voltage	10	15	30	80	160	300
c. Maximum working voltage		7	10	25	55	115

Table II.5.4: Minimum insulation distance between phases at the pole of overhead transmission line

Estimated condition	Minimum insulation distance between phases (cm) by voltage of overhead transmission line, kV					
	Up to 10	15÷22	35	110	220	500
- When atmospheric over-voltage	20	45	50	135	250	400
- When internal over-voltage	22	33	44	100	200	420
- When working voltage	-	15	20	145	95	200

Table II.5.5 – Earth resistance of overhead transmission line

Resistivity of the earth, ρ, Ωm	Earth resistance, Ω
Up to 100	Up to 10
Over 100 to 500	15
Over 500 to 1000	20
Over 1000 to 5000	30
Over 5000	6.10^{-3} ρ

Table II.5.6a – Minimum distance from conductor wire of overhead transmission line to water surface of inland waterway at crossing area

Technical level of inland waterway	Dimension of narrow passage, m					Vertical safe distance from lowest point of conductor wire to annual average highest water surface, m			
	Natural river		Canal		Curve radius	Up to 35kV	110 kV	220 Kv	500kV
	Water depth	Bed's width	Water depth	Bed's width					
I	>3.0	>90	>4.0	>50	>700	13.5	14	15	16
II	2-3	70-90	3-4	40-50	500-700	12.5	13	14	15
III	1.5-2	50-70	2.5-3	30-40	300-500	10.5	11	12	13
IV	1.2-1.5	30-50	2-2.5	20-30	300-500	9.5	10	11	12
V	1-1.2	20-30	1.2-2	10-20	100-200				
VI	<1	10-20	<1.2	10	60-150				

Table II.5.6b – Minimum distance from conductor wire of overhead transmission line to in-navigable water surface

Characteristics of crossing area	Minimum distance (m) by voltage of overhead transmission line, kV			
	Up to 35	**110**	**220**	**500**
To floodplain or yearly flooded area	5.5	6	7	8
To the highest water level of river, canal at maximum air temperature	2.5	3	4	5

Table II.5.7 – Vertical minimum distance between conductor wires or between conductor wire and earthed wire of crossed overhead transmission lines

Length of pole span, m	With minimum distance from crossing area to the nearest pole of overhead transmission line, m					
	30	50	70	100	120	150
When overhead transmission line 500kV crosses with each other and crosses with other overhead transmission line of lower voltage						
200	5	5	5	5.5	-	-
300	5	5	5.5	6	6.5	7
450	5	5.5	6	7	7.5	8
When overhead transmission line 220kV crosses with each other and crosses with other overhead transmission line of lower voltage						
Up to 200	4	4	4	4	-	-
300	4	4	5	4.5	5	5.5
450	4	4	4	4	6.5	7
When overhead transmission line 110-220kV crosses with each other and crosses with other overhead transmission line of lower voltage						
Up to 200	3	3	3	4	-	-
300	3	3	4	4.5	5.0	-
When overhead transmission line 6-10kV crosses with each other and crosses with other overhead transmission line of lower voltage						
Up to 100	2	2	-	-	-	-
150	2	2.5	2.5	-	-	-

Table II.5.8 – Vertical minimum distance from conductor wire of overhead transmission line to conductor wire of overhead communication line or overhead signal line

Estimated condition	Distance (m) by voltage of overhead transmission line, kV				
	10	22	35	110	220
Normal condition	2	3	3	3	4
When wire is broken at adjacent pole span of overhead transmission line using suspension insulator	1	1	1	1	2

Table II.5.9 – Minimum distance from underground cable of overhead communication line or overhead signal line to earthed part or the nearest portion of pole foundation of overhead transmission line

Resistivity of the earth, ρ, Ωm	Minimum distance (m) by voltage of overhead transmission line, kV	
	Up to 35	From 110 and above
	$0.83\sqrt{\rho}$	
Up to 100		10
Over 100 to 500	10	25
Over 500 to 1000	11	35
Over 1000	$0.35\sqrt{\rho}$	50

Table II.5.10 – Minimum distance from overhead transmission line to antenna pole of signal station

Signal antenna	Minimum distance (m) by voltage of overhead transmission line, kV	
	Up to 110	220 and 500
Medium and long wave	100	
Short wave by major radiation direction	200	300
Short wave by remained directions	50	
Short wave	150	200

Table II.5.11- Minimum distance from overhead transmission line to radio receiver center

Receiver center	Minimum distance (m) by voltage of overhead transmission line, kV		
	6-35	110-220	500
Main receiver center, regional and local	500	1000	2000
Isolated receiver center	400	700	1000
Local receiver center	200	300	400

Table II.5.12 – Minimum distance when overhead transmission line crosses with railway or runs closely the railway

Crossing or running closely	Minimum distance (m) by voltage of overhead transmission line, kV			
	Up to 22	35-110	220	500
1. When crossing, from conductor wire to railway surface in normal condition of overhead transmission line	7.5	7.5	8.5	12
2. When running closely, from conductor wire of overhead transmission line to constructional boundary of the railway when the wire is deflected by wind to maximum	1.5	2.5	2.5	4.5
3. When crossing with electrification railway and contact network in normal condition of overhead transmission line	The same as for overhead transmission lines crossing with each other, see Table II.5.7			
4. Similar to item 3, with situation of breaking one wire at adjacent pole span	1	1	2	3.5

Table II.5.13 – Technical class of road way

Main criteria	Technical class of roadway						
	Terrain	I	II	III	IV	V	VI
Calculated speed, km/h	Plain	**120**	**100**	**80**	**60**	**40**	**25**
	Mountain	-	80	60	40	25	15
Number of traffic lanes	Plain	2-4	2-4	2	2	1	1
	Mountain	-	2	2	2	1	1
Width of road pavement, m	Plain	15.0	7.5	7.0	6.0	3.5	3.5
	Mountain	-	7.0	6.0	5.5	3.5	3.5
Width of embankment, m	Plain	26.0	13.5	12.0	9.0	6.5	6.0
	Mountain	-	13.0	9.0	7.5	6.5	6.0

Table II.5.14 – Minimum distance when overhead transmission up to 220kV crosses by or runs near roadway

Crossing or running near situation	Minimum distance (m) by voltage of overhead transmission line, kV		
	Up to 22	35-110	220
1. Vertical distance from conductor wire to the road surface:			
a. In normal condition	7	7	8
b. When breaking one conductor core at the adjacent pole span (for wire less than 185 mm^2)	5	5	5.5
2. Horizontal distance:			
From any component of the pole to the road verge:			
+ When crossing with roadway of class I and II	5	5	5
+ When crossing with roadway of other class	1.5	2.5	2.5
+ When overhead transmission line runs in parallel with roadway, distance from outmost conductor wire to the road verge when the wire is at static state	2	4	6

Table II.5.15 – Minimum distance when overhead transmission crosses with or runs near tramway or trolley bus-way

Crossing or running near situation	Minimum distance (m) by voltage of overhead transmission line, kV		
	Up to 110	220	500
1. Vertical distance from conductor wire to the road surface:			
a. When crossing with tramway (in normal condition)			
- To the rail surface	9.5	10.5	11.5
- To conductor wire of contact network	3	4	5
b. When breaking one conductor core at the adjacent pole span, to conductor wire of receipt network	1	2	-
c. When crossing with trolley bus-way (in normal condition):			
- To the highest point of traffic lane	11	12	13
- To conductor wire of contact network	3	4	5
2. Horizontal distance from conductor wire when being deflected by wind to maximum to the pole of contact network.	3	4	5

Table II.5.16 – Minimum distance from overhead transmission to elements of dyke, dam

Name of elements of dyke, dam	Minimum distance (m) by voltage of overhead transmission line, kV		
	Up to 110	220	500
To dyke surface or protrusion portion of the dyke	6	7	10
To slope of the dyke	5	6	8
To overflow surface of the dam	4	5	7