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Designing Regulation of Network System

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Chapter 1-1 General Issues

Article 1. General

1) Terms

In this Regulation, the terms used shall have the following meanings:

1) **Must, shall**: mandatory to implement
2) **Need**: necessary but not mandatory
3) **Normal or conventional**: widely used
4) **Should**: not mandatory but advisable to implement.
5) **Permitted or permissible**: if implemented, will be satisfactory and necessary.
6) **Not smaller than or at least etc.**: minimum
7) **Not exceeding or at most etc.**: maximum
8) **From.. to..**: including initial and terminal values
9) **Distance**: from center to center.
10) **Space**: from edge to edge.

2) Scope of Technical Regulations

The Technical Regulation is applicable for newly constructed power projects with voltages of up to 500kV.

For the renovation and expansion to consider and coordinate the application of this Technical Regulation with Rules were applied to older projects, so make a logically, economical, and will be approved.

3) Rated Value

A Rated Value is the value of a quantity, usually given by the manufacturer under operation conditions specified for an element, piece of equipment or tool.

4) Noise Level

The Noise Level is the permissible noise level when power projects are newly constructed or rehabilitated. Noise reduction measures must be applied to ensure the noise level does not exceed permissible levels.

5) Insulation Level

The Insulation Level is a characteristic determined by a number of indices indicating insulation withstand voltage for specific part of equipment.

The insulation level shall be chosen according to the established highest voltage for equipment (Um), and/or impulse withstand voltage (switching impulse withstand voltage, short-duration power-frequency withstand voltage) and basic insulation level (BIL). (Refer to Table 335-1, 2)

The choice shall be made primarily to ensure reliability in service, taking into account the method of neutral earthing in the system and the characteristics and the locations of overvoltage limiting devices to be installed.

6) External Insulation

The External Insulation is the distances in atmospheric air, and the surfaces in contact with atmospheric air of solid insulation of the equipment which are subject to dielectric stresses and to the effects of atmospheric and other environmental conditions from the site, such as pollution, humidity, vermin, etc.

7) Internal Insulation

The Internal Insulation is the internal distances of the solid, liquid, or gaseous insulation of equipment which are protected from the effects of atmospheric and other external conditions.

8) Self-restoring Insulation

The Self-restoring Insulation is the insulation which, after a short time, completely recovers its insulating properties after a disruptive discharge.

9) Non-self-restoring Insulation

The Non-self-restoring Insulation is the insulation which loses its insulating properties, or does not recover them completely, after a disruptive discharge.

10) Insulation Co-ordination and double insulation

- Insulation Co-ordination is the selection of the dielectric strength of equipment in relation to the operating voltage and overvoltage which can appear on the system for which the equipment is intended and taking into account the service environment and the characteristics of the available preventing and protective devices.
- Double insulations: 2 insulators of the same type, the same specifications are arranged in parallel

11) Imbalance Factor

An Imbalance factor is expressed as a ratio between the root mean square or R.M.S. value of a negative (or zero) sequence component to a positive sequence component of voltage or current in a 3-phase system.

12) Minimum Working Clearance

The Minimum Working Clearance is the minimum safe distance to be observed between normally exposed live parts and any person working in a substation.

13) Minimum Clearance

The Minimum Clearance is the smallest permissible clearance in air between live parts or between live parts and earth.

14) Transmission of Electricity

Transmission of Electricity is the transmission of electrical energy from an area to other area.

15) Distribution of Electricity

Distribution of Electricity is the distribution of electrical energy to customers in electrified areas.

16) Connection Point

A Connection Point is a connecting point of power generating units or power networks of users to power the transmission network of the national power grid.

17) Stand Alone Power Supply Resource

A Stand Alone Power Supply Resource is an electric resource that is supplying power independent from the National Grid.

18) High Voltage Providing Electricity

High Voltage Providing Electricity is a way to supply high voltage electricity to households.

19) Synchronous Operation of Power Systems

Synchronous Operation of Power Systems is the status of power systems whereby all power plants are operated synchronously.

20) Interconnection of Power Systems

An Interconnection of Power Systems is an interconnection of many power lines between power transmission systems via power lines or transformers to exchange electricity between power systems.

21) National Grid

National gird is the electrical power system composed of power generating stations, transmission and distribution lines, power transformers and other relevant equipment, which is operated nationwide in order to produce manage and control supplying electrical power.

22) Area Classification

The areas for installing power facilities are classified four categories according to environmental condition and power facilities are designed depending on these area conditions.

1. Populated area is a geographic area where households live currently or are planning to transfer into the area.
2. Non-populated area is a geographical area where households can not live in the area, though households can often frequent the area and motorized vehicles can go through the area such as fields, hills, trees, forests and gardens.

   Uninhabited areas as below are also included in non-populated area:
   - The area where it is difficult for pedestrians to access.
   - The area where it is very difficult for pedestrians to access (ex. rocks, cliffs etc.)
3. Area required high safety level is as below.
   - Public areas where public often gather into, which include markets, squares, hospitals, fairs, schools, exhibitions, cultural areas, parks, stadiums, wharfs, docks, stations, car port, beaches, amusement areas, industrial zones, high technology zones, export processing zones, important

works related to security and defense, the historical and cultural landscapes had been classified by the State.

- Housing and welfare service works in Residential Land in populated area *).

Note *) Residential Land is a land for households and individuals such as housing construction, construction works for living, gardens and ponds in the same parcel in rural or urban areas, and a land in accordance with residential construction plans approved by competent state agencies. (15/2003/QH11 Land Law - articles 83 and 84)

4. Polluted area: Areas where the air or land is polluted or salinity remains.

23) System Diagram

A System Diagram is a topological representation of a system in which the information content depends on a specific requirement.

24) System Operational Diagram

A System Operational Diagram is a system diagram representing a particular operational condition.

25) Power System Planning

A Power System Planning is the whole range of studies involved in the development of a technically and economically sound system of electricity supply.

26) Power System Stability

A Power System Stability is the capability of a power system to regain a steady state, characterized by the synchronous operation of the generators after a disturbance due, for example, to variation of power or impedance.

27) Load Stability

A Load Stability is the capability of a load consisting of rotating machines to regain a steady state of operation after a disturbance.

28) Steady State Stability (static stability) of a Power System

A Steady State Stability of a Power System is power system stability in which any disturbances occurring have only small rates of change and small relative magnitudes with in regulated on power limitation.

29) Transient Stability of a Power System

A Transient Stability (dynamic stability) of a Power System is a back-to-steady stability process of power system, in which disturbances may have changing larger rates and/or larger than regulated limitation relative magnitudes.

30) Conditional Stability of a Power System

A Conditional Stability of a Power System is a steady-state stability condition of a power system that can only be achieved with the assistance of automatic control.

31) Operation Regulation

An Operation Regulation is the regulations on economic indicators, technical standards, synchrony and safety, reliability of the power system promulgated by competent State agencies for making plan, modes and operation of the national power system.

32) System Demand Control

A System Demand Control is the control of the power demand of the consumers on a power system.

33) Management Forecast of a System

A Management Forecast of a System is the preparation and checking of the programs for the generation of electricity, means of reserve of capacity and operation capacity, including network diagram analysis for providing the most economic supply of expected loads with the necessary power security within a given period of time, in a given system, all present and foreseeable circumstances being taken into account.

34) Reinforcement of a System

A Reinforcement of a System is addition or substitution of some elements in a power system (transformers, lines, generators, etc.) so that it will be able to meet an increased load or provide a better quality of supply.

35) Cold start-up of a Thermal Generating Set

The Cold start-up of Thermal Generating Set is the process by which the generating set is raised to speed, the machine connected to the system and loaded after a long period of being out of operation.

36) Hot start-up of a Thermal Generating Set

The Hot start-up of a Thermal Generating Set is the process by which the generating set is raised to speed, the machine connected to the system and loaded after a short period of being out of operation which did not change very much the turbine thermal state.

37) Overload Capacity

An Overload Capacity is the highest load which can be maintained during a short period of time.

38) Load Shedding

A Load Shedding is the process of deliberately disconnecting preselected loads from a power system in response to an abnormal condition in order to maintain the integrity and stability of the remainder of the system

39) Available Capacity of a Unit (or of a power station)

An Available Capacity of a Unit (or of a power station) is the maximum power at which a unit (or one power station) can be operated continuously under the prevailing conditions.

40) Reserve Power of a Power System

A Reserve Power of a Power System is the difference between the total available capacity and the power demand from the system.

41) Hot Stand-by

A Hot Stand-by is all the means of generation ready to start-up for prompt coupling to the system.

42) Cold Reserve

A Cold Reserve is the total available capacity of generating sets in reserve for which the starting up in need may take several hours.

43) Outage Reserve

An Outage Reserve is a stand-by capacity which can be mobilized for operation within 24 hours.

44) Load Forecast

A Load Forecast is an estimate of the expected load of a network at a given future date.

45) Generation Mix Forecast

A Generation Mix Forecast is an estimate of the composition of a generation system at a given future date.

46) Steady State of a Power System

A Steady State of a Power System is the operating conditions of a network in which the system state variables are considered to be sensibly constant.

47) Transient State of a Power System

A Transient state of a power system is the operating condition of a network in which at least one of the state variables is changing, usually for a short period.

48) Balanced State of a Polyphase Network

A Balanced State of a Polyphase Network is the condition in which the voltages and currents in the phase conductors form balanced polyphase sets.

49) Unbalanced State of a Polyphase Network

An Unbalanced State of a Polyphase Network is the condition in which the voltages and/or currents in the phase conductors do not form balanced polyphase sets.

50) Service Reliability

A Service Reliability is the ability of a power system to meet its supply function under stated conditions for a specified period of time.

51) Service Security

A Service Security is the capability of a power system at a given moment in time to perform, following regulated condition its supply function in the case of a fault.

52) Economic Loading Schedule

An Economic Loading Schedule is the most economic use of the available components of the network.

53) Balancing of a Distribution Network

A Balancing of a Distribution Network is an allocation of the consumer services between the various phases of a distribution network, so as to minimize the voltage unbalance.

54) Load Recovery

A Load Recovery is the after voltage recovery, the increase in load of a consumer or system, at a rate depending on the characteristics of that load.

55) Basic Impulse Insulation Level (BIL)

A Basic Impulse Insulation Level is a reference impulse (voltage) insulation strength expressed in terms of the peak value of the withstand voltage of a standard impulse voltage (lightning) wave. It is used to express the ability of electrical equipment such as a transformer, a switchgear, etc. to withstand certain levels.

Article 2. Electrical Equipment

1) Electrical Equipment

Electrical Equipment refers to assemblies and connections of electrical equipment used for producing, transforming, transmitting, distributing and consuming electricity. In this standard, electrical equipment is divided into two categories:

+ Category with voltages of up to 1,000V
+ Category with voltages exceeding 1,000V

2) Installation location

Outdoor Electrical Equipment includes electrical equipment to install outdoors.

- Open-type outdoor electrical equipment: includes the electrical equipment which is not protected from direct contact and not covered, prevented against environmental impacts.
- Closed-type outdoor electrical equipment: includes the electrical equipment with protective cover for being protected from direct contact and environmental impact.

Indoor Electrical Equipment includes electrical equipment installed inside buildings or closed rooms.

Open-type indoor electrical equipment: means the electrical equipment without full protection against direct contact.

Closed-type indoor electrical equipment: means the electrical equipment with full protection against the direct contact.

3) Conductor, Wire, Line and Cable

A Conductor is an element intended to carry electric current.

A Wire is an element intended to carry electric current (conductor), with or without insulating cover.

A Line is a device connecting two points becoming linear circuit for the purpose of conveying electromagnetic energy between them in the network.

A Cable is one or more core conductors, which is covered by insulating material corresponding to the level of voltage, and with or without protective cover.

4) Distribution Line and Transmission Line

A Distribution Line is a line with voltage up to 35kV, and a line with voltage of 110kV that have function power supply to the distribution substations to customers using electricity..

A Transmission Line is a line with voltage of 220kV and more, and a line with voltage of 110kV that have carrying function receives power from power plants and / or transmission of the national electricity system

A House and outside wirings is a distribution line installed in houses (include buildings and enterprises) or installed outdoor (on structures, walls, in construction sites, etc.).

A Power cable line is a transmission and distribution line, that use underground cable installation, cable works, in water (river and sea), in the factory, and so on.

An Overhead power line is a transmission and distribution line whose electrical conductors are set outdoors, hanging on electrical insulators and fittings, placed on poles or on the structure of other works.

Applicable scope of transmission and distribution lines is shown in the following table.

Table 2 Applicable scope for transmission and distribution lines

<table>
<tr><th rowspan="2">Type of lines</th><th rowspan="2">Main installation Place</th><th rowspan="2">Kind of conductor</th><th colspan="5">Applicable scope</th><th rowspan="2">Reference</th></tr>
<tr><th>up to 1kV</th><th>Exceeding 1kV to 35kV</th><th>110 kV</th><th>220 kV</th><th>500 kV</th></tr>
<tr><td>House and outside wirings</td><td>- In buildings, offices, enterprises
- On construction structure, walls, in construction sites</td><td>- Insulated conductor
- Cable
- Bare conductor</td><td>A</td><td>A</td><td>-</td><td>-</td><td>-</td><td>Article 6
Chapter 2-3-1
Chapter 3-1</td></tr>
<tr><td>Power Cable line</td><td>- Underground
- In works cable structures, water and production halls</td><td>- Cable</td><td>A</td><td>A</td><td>A</td><td>A</td><td>-</td><td>Article 7
Chapter 2-3-2
Chapter 3-2</td></tr>
<tr><td rowspan="2">Overhead power line</td><td rowspan="2">- On concrete pole and steel tower</td><td>- Insulated conductor
- Cable</td><td>A</td><td>A</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Article 8
Chapter 2-3-3
Chapter 3-3</td></tr>
<tr><td>- Bare conductor</td><td>A</td><td>A</td><td>A</td><td>A</td><td>A</td></tr>
</table>

<Note> A: Applicable scope, -: Not applicable scope

5) Busbar

A Busbar is Busbar circuits, that, from wire or bars with a low impedance. It is the main circuit to the other separate circuit connected to it

The busbars shall be painted as follows:

General provisions:
For hard bar: paint directly onto the busbar

For bar made of flexible wire: painted porcelain legs phases of equipment or paint dots in the bar support

- For AC 3-phase power network: phase A is in yellow, phase B is in green colored, phase C is in red, white neutral busbar is for isolated neutral network, and black neutral busbar is for directly grounded neutral network.
- For single-phase power network: conductor connecting the starting point of power supply winding is in yellow, conductor connecting the endpoint of power supply winding is in red. If the busbar of single-phase power network is branched from the busbar of 3-phase power network, it must be painted in colors as specified for the phases in the 3-phase power network.
- For DC power network: positive busbar (+) is in red, negative busbar (-) is in green and the neutral busbar is in white.

The busbars shall be arranged and painted in accordance with the below instructions:

- For more busbar system diagram, the nearest transformer busbar.
- For indoor distribution equipment, AC 3-phase power network:
  a. For vertical busbars: upper busbar (A) is yellow; middle busbar (B) is green; lower busbar (C) is red. When busbars are in horizontal, oblique or in triangular arrangement arranged, the furthest busbar (A) is yellow, the middle busbar (B) is green, the nearest busbar (C) is red. In case a person can access from two sides, the busbar (A) near to fence or wall will be yellow colored, the busbar far (C) from the fence or wall will be in red color.
  b. Branches from busbar: if viewing from operation corridor, left branch (A) is yellow, middle branch (B) is green and right branch (C) is red.
- For outdoor switchgear devices, AC 3-phase power network:
  a. Busbars and rings: the busbars (A) nearest to the power transformer is yellow, middle busbar (B) is green and the furthest busbar (C) is red.
  b. Branches from the busbar system: if viewing from outdoor switchgear device to outlet terminals of the power transformer, the left busbar (A) is yellow, middle busbar (B) is green and the right busbar (C) is red.
  c. Inlet line to the substation: if viewing from the inlet line to the substation, at connecting point, the left busbar (A) is yellow, the middle busbar (B) is green and the right busbar (C) is red.
- For DC power network:
  a. When the busbars are vertically arranged: the upper busbar (neutral) is white; the middle busbar (-) is green; the lower busbar (+) is red.
  b. When the busbars are horizontally arranged: if viewing from operation corridor, the furthest neutral busbar is white; the middle busbar (-) is green and the nearest busbar (+) is red.
  c. When the busbars are horizontally arranged: if viewing from operation corridor, the furthest neutral busbar is white; the middle busbar (-) is green and the nearest busbar (+) is red.
  d. In the exceptional case, if the above arrangement causes the difficulty for installation or additional construction of supports for busbars of substation for the phase transposition must be constructed, the color order of busbars are permitted to be changed.

6) Oil-Immersed Electrical Equipment

Oil-Immersed Electrical Equipment is equipment with parts immersed in oil to avoid contact with the surrounding atmosphere, enhancing electrical insulation and cooling.

7) Explosive Resistant Electrical Equipment

Explosive Resistant Electrical Equipment refers to electrical equipment which can be used in areas including flammable and explosive environments at all levels.

8) Electrical Materials

Electrical Materials are materials used in electrical engineering

Article 3. Electrical Facilities

1) Electrical Hall

An Electrical Hall is the hall or separate section of a building used for housing electrical equipment and/or electrical cubicles, boards.

A Dry Hall is the hall whose relative humidity does not exceed 75%. In case of no conditions as specified in the following hall or place (hot hall, dusty hall, chemical active medium place), such hall is called the normal hall

A Humid Hall is the hall whose relative humidity exceeds 75%.

A Very wet Hall is the hall whose relative humidity is almost 100% (ceiling, floor and objects in hall are in sweating).

A Hot Hall is the hall whose temperature exceeds +35oC in 24 hours consecutively.

A Dusty Hall or Place is the hall or place with many dusts. Dusty halls or places are classified into electrically conductive halls or places and electrically non-conductive halls or places.

A Attic Hall is located under the roof of the building.

A Chemical Active Medium Place is the place where the gas, air, liquid are frequently available or available in long duration, and can cause the moulds which damage insulated parts and/or conductive parts of electrical equipment.

Depending on the danger level caused by electrical current to man, the halls or places where the electrical equipment is installed can be classified as follows:

A Dangerous hall or place is the hall or place where one of the following factors exist:

a. Wet or conductive dusts (refer to "Humid Hall" and "Dusty Hall").
b. Conductive floor, ground (made of metal, soil, concrete, reinforced concrete, bricks, etc).
c. High temperature (refer to "Hot Hall").
d. Possible for people, at the same time, to contact metal structures of building, technical equipment, machines which are earthed, at one side, and metal enclosures of the equipment, at the other side.
e. Electric intensity is higher than permissible level.

A Very dangerous hall or place is the place where one of the following factors exist:

a. Very wet (refer to "Very wet hall").
b. Chemical active medium (refer to "Chemical active medium place").
c. Two factors of dangerous halls are existed at the same time.

A Less dangerous hall or place is that not belong to one of the above two categories.

2) National Load Dispatch Center

The National Load Dispatch Center is an agency which dispatches operation of the national power system, including preparation of power generation plans, operation modes and dispatching power generators connected to the national power system, controlling power transmission systems, dispatching electricity purchase, sale with power systems outside Vietnam.

3) Gas Insulated Switchgear (GIS)

Gas Insulated Switchgear (GIS) is switchgear which is placed in the enclosures and the internal electrical insulation of which is performed by pressurized insulation gas.

Article 4. Electrical Systems

1) Energy System

An Energy System is a collection of power plants, power lines, substations and heat supply networks which are closely related in terms of operation conditions, production and distribution and consumption processes of electricity and thermal energy.

2) Power System

A Power System is a part of the energy system without a thermal network.

3) Supervisory Control Data Acquisition System (SCADA system)

A Supervisory Control Data Acquisition System is a system used at control centers for observation and control of equipment in electrical facilities.

4) Reactive Power Compensation System

A Reactive Power Compensation System consists of either a capacitor or synchronous compensator.

Article 5. Voltage

1) Voltage Level

The Voltage Level is one of the nominal voltage values used on a power system.

2) Nominal Voltage of a Power System

The Nominal Voltage of a Power System is an approximate voltage value suitable for clarifying or identifying a power system.

3) Operating Voltage in a Power System

The Operating Voltage in a Power System is a voltage value under normal operation conditions at a given time and point of the system.

4) Highest (or Lowest) Voltage of a Power System

The Highest (or Lowest) Voltage of a Power System is the highest (or lowest) operation voltage under normal operation conditions at any time and at any point in the system.

5) Highest Voltage for Equipment

The Highest Voltage for Equipment is the highest effective phase-phase voltage for which equipment is designed in terms of its electrical insulation as well as other voltage-related characteristics based on appropriate equipment standards.

6) Voltage Deviation

The Voltage Deviation is expressed as a percentage between the voltage at a given time at one point of the system and the reference voltage, such as nominal voltage, average value of operation voltages or supply voltage according to an agreement.

7) Voltage Fluctuation

A Voltage Fluctuation is series of cycle voltage changes or variations

8) Overvoltage

Overvoltage is any voltage between phase and earth or between phases with peak exceeding the corresponding peak of the highest voltage of the equipment.

9) Line Voltage Drop

A Line Voltage Drop is a voltage difference at a given time between two voltages measured at two given points on a power line.

10) Temporary Overvoltage

A Temporary Overvoltage is power frequency overvoltage of relatively long duration. This overvoltage is undamped or weakly damped. In some cases its frequency may be several times smaller or higher than power frequency.

11) Transient Overvoltage

A Transient Overvoltage is a short-duration overvoltage of few milliseconds or less, oscillatory or non-oscillatory, usually highly damped.

12) Voltage Surge

A Voltage Surge is a transient voltage wave propagating along a line or a circuit and characterized by a rapid increase followed by a slower decrease of the voltage

13) Voltage Recovery

A Voltage Recovery is the restoration of voltage to a value near to its previous value after a reduction, a collapse or a loss of voltage.

14) Voltage Unbalance

A Voltage Unbalance is a phenomenon due to the differences between voltage deviations on the various phases, at a point of a polyphase system, resulting from differences between the phase currents or geometrical asymmetry in the line.

15) Switching Overvoltage

A Switching Overvoltage is a transient voltage has its shape similar to that of standard switching voltage impulse, evaluated for purpose of insulation co-ordination.

16) Lightning Overvoltage

A Lightning Overvoltage is a transient overvoltage has its shape similar to that of standard lightning surge, evaluated for purpose of insulation co-ordination.

17) Resonant Overvoltage

A Resonant Overvoltage is the overvoltage resulting from a resonant oscillation sustained within the supply system.

18) Transient Recovery Voltage (TRV)

A Transient Recovery Voltage is the recovery voltage during the time in which it has a transient character after current interruption. The transient recovery voltage may be oscillatory or non-oscillatory or a combination of these depending on the characteristics of the circuit and the switching device. It includes the voltage shift of the neutral of a polyphase circuit. The transient recovery voltages in three-phase circuits is that across the first of three poles to clear.

Chapter 1-2 Definitions of Transmission and Distribution Lines

Article 6. House and Outside Wirings with Voltage up to 35kV

1) Applicable Scope for House and Outside Wirings with Voltage up to 35kV

House and outside wirings in this Regulation apply to AC and DC wirings with voltage up to 35kV. (Refer to this article, chapter 2-3-1 and chapter 3-1)

House and outside wirings are installed in houses (in buildings, offices, enterprises, etc.) and outside of houses (on structures, walls, in construction sites, etc.). Insulated conductors, cables and bare conductors are used for house and outside wirings. (However, cross-sectional area of cables used for house and outside wirings with voltage up to 1kV are limited up to $16mm^2$)

Branches from overhead power lines to houses, which suspended cables are used, must comply with requirements for house and outside wirings, but branches which insulated and bare conductors are used, must comply with requirements for overhead power lines.

Requirements of house and outside wirings are not applicable for special wirings supplying electricity to electrical equipment.

2) Construction and Category of House and Outside Wirings

House and outside wirings comprise poles, insulators, conductors, cables, accessories, and related protective devices that are installed in accordance with this regulation.

With respect to material types, house and outside wirings are divided into the following categories:

- Soft (wire)
- Hard (busbar).

Hard house and outside wirings are divided into those in which:

- The main busbar is connected to the distribution busbar, cubicle, board and separate equipment.
- The distribution busbar is mainly designed for connection to electrical equipment.

- The slide busbar is designed to supply electricity to mobile electrical equipment.
- The lighting busbar is designed to supply electricity to lamps and electricity with small capacity.

3) Opened and Closed House and Outside Wirings

Electrical power lines are categorized as follows:

- Opened house and outside wirings are power lines installed on the surfaces of walls, ceilings, rafters and other architectural parts of buildings and structures, on power poles etc.
- Closed house and outside wirings are power lines installed inside architectural parts of the building and structure, directly under the floor.

4) Outdoor and Indoor

- Outdoor: Outside wirings are power lines installed outside constructions etc.
- Indoor: House wirings are power lines installed inside constructions etc.

5) Extension House and Outside Wirings

Extension house and outside wirings are those with voltage exceeding 1 to 35kV between existing transmission lines and newly-constructed power plants or substations, which are installed to connect new power plants or substations to the power network.

Article 7. Power Cable Lines with Voltage up to 220kV

1) Applicable Scope for Power Cable Lines with Voltage up to 220kV

Power cable lines in this regulation apply to cable lines with voltage up to 220kV. (Refer to this article, chapter 2-3-2 and chapter 3-2)

Power cable lines are installed underground, in cable structures, water (river, sea), production hall, etc.

General regulations for power cable lines must be applied to both oil-filled and dry cables, besides oil-filled cables must satisfy specific regulations.

Power cable lines with voltage exceeding 500kV must satisfy special designs, or manufacturer and be approved by authorized agencies.

2) Power Cable Lines

Power cable lines are electrical power lines transmitting electricity or voltage signals, consisting of one or more cores and connected by a cable connection box, connection terminal and cable fixing part.

In addition, for oil-filled cable lines, there are also an oil supplier and oil pressure alarm system.

3) Cable Structures

Cable structures include the following categories:

- A cable tunnel is an underground structure, which includes a structure to house cables and connection boxes and which facilitates access to lay, repair and check cables.
- A cable cellar is an underground structure; cable is placed directly in the ground.
- A cable canal is a structure totally or partially underground, which is inaccessible and used for placing cables. Before placing, checking or repairing cables, the covering part is dismantled.

- A cable story is a part of a building limited by the floor and ceiling, with a minimum distance between floor and ceiling plate of 1.8 m.
- A double floor is a space between the walls of a room or between the floor and ceiling plate, which can be dismantled over the total or partial room area.
- A cable block is a structure consisting of pips for placing cables, usually together with a cable well.
- A cable room is an underground structure, closely constructed with a concrete plate and used for placing cable connection boxes or for inserting cables into cable blocks.
- A cable well is a vertical underground structure, with a hook or ladder to climb.
- A cable bridge is an opened structure arranged higher than or near the ground surface, horizontally or inclined. A cable bridge can be passed or not passed through by person.
- A cable corridor is a fully or partially closed structure, arranged higher than or near the ground surface, horizontally or at an incline. A cable corridor can be passed through manually.
- A cable trough is an opened structure for placing cables, indoors or outdoors. The trough can be with one-piece or holed wall and made of non-flammable material.
- A cable rack is a support facility to set cables at appropriate intervals and keep them in a proper state by separating harmful materials from the surrounding environment.

4) Cable Channel and Cable Bracket

Cable channel and cable bracket must facilitate for laying or repairing cables.

5) Safety Corridor for Power Cable Line

- The corridor length of the electric cable from the cable go out of the boundary location is protected location of this substation to enter the protected boundary of the next substation or from the first cable connection point to the connection point at the end of the cable.
- The corridor width is limited by:

a) On the outside of the channel for cables Installation in the channel;

b) Two vertical side cable to the outside of the shell, or outer strands on two sides of the electric cables for underground cables Installation directly in the soil, in water

- Height from the ground or water to:

a) The outside foundation bottom cable channels for cable Installation in it;

b) Depth below the lowest point of the cable shell that placed directly in the ground or in water; specified in the following table.

Table 7 Distances of safety corridor for power cable lines underground or in water

Distance	Underground		In water	
	Stable ground	Unstable ground	No passage of boats or ships	Passage of boats or ships
Horizontal distance	1.0m	1.5m	20.0m	100.0m
Depth	1.5m			

Article 8. Overhead Power Lines with Voltage up to 500kV

1) Applicable Scope for Overhead Power Lines with Voltage up to 500kV

Overhead power lines in this regulation apply to overhead lines with voltage up to 500kV which bare conductors are used, and overhead lines with voltage up to 35kV which insulated conductors and cables are used. (Refer to this article, chapter 2-3-3 and chapter 3-3)

Overhead power lines are installed on concrete poles, steel towers, etc.

Requirements of overhead power line shall not apply to special overhead lines such as electrified railways, tramcars and electrical cars etc.

Branches which insulated and bare conductors are used must comply with requirements for overhead power lines.

Branches which cables are used, and cable sections directly connected to overhead power lines with voltage up to 220kV must comply with requirements for power cable lines.

2) Limitation of Overhead Power Lines

An overhead power line with voltage up to 1kV includes a branch from a main overhead power line to houses, buildings and that with voltage up to 500kV starts from the point of a conductor installed on the cross arm of a gantry pole of one substation to the opposite substation.

3) Mechanical Design Condition

In the mechanical design condition:

1. The normal condition of an overhead power line is an operating condition whereby the power and lightning conductors are not broken.
2. A fault condition of an overhead power line is a working condition whereby one or more power or lightning conductors are broken.
3. The assembly condition of overhead power lines is a working condition whereby poles, power conductors and lightning conductors are erected and installed.

4) Large Overcrossing Span

A large overcrossing span is a span with length exceeding 500m has a pole of 50m height and above, or a crossing span with length exceeding 700m has a pole of height by the design.

5) Safety Corridor of Overhead Power Lines

Safety corridors of overhead power lines are space along the lines and are limited as follows:

a) The length of the safety corridor is from the position where the line goes out the protected boundary of a substation to the position where the line goes into the protected boundary of the next substation.

b) The width of the safety corridor is limited by two vertical planes on both parallel sides of the line and the distance from the outer edge conductor in a static state on both sides shown in Table 8-1.

c) The height of safety corridor is measured from the foundation bottom to the point which adds the vertical safety distance shown in Table 8-2 to the highest point of the construction works.

d) Each clearance in safety corridor must comply with the distance shown in Table 8-3, 8-4 and 8-5.

Table 8-1 Horizontal distance between the outer edge conductor and the vertical plane of the safety corridor

Voltage	Up to 22kV		35kV		110kV	220kV	500kV
Type of conductor	Insulated conductor	Bare conductor	Insulated conductor	Bare conductor	Bare conductor		
Distance	1.0 m	2.0 m	1.5 m	3.0 m	4.0 m	6.0 m	7.0 m

Table 8-2 Vertical distance of the height of the safety corridor

Voltage	Up to 35kV	110kV	220kV	500kV
Distance	2.0 m	3.0 m	4.0 m	6.0 m

Table 8-3 Discharge safe distance

Voltage	UP to 22kV		35kV		110kV	220kV
Type of conductor	Insulated conductor	Bare conductor	Insulated conductor	Bare conductor	Bare conductor	
Discharge safe distance	1.0 m	2.0 m	1.5 m	3.0 m	4.0 m	6.0 m

Table 8-4 The minimum distance from the conductors to the nearest point of the equipment, tools and working facilities in the safety corridor of high-voltage power grid works

Voltage	Up to 35kV	110kV	220kV	500kV
Distance	4.0 m	6.0 m	7.0 m	8.0 m

Table 8-5 Minimum distance from overhead power lines to tree within safety corridor

Detailed description of distance	**Voltage (kV)**	**Type of conductor**	**Minimum distance (m)**
Distance from conductors to any part of trees in cities, provincial towns or district townships	Exceeding 1 to 35	Insulated conductor	0.7
		bare conductor	1.5
	110	bare conductor	2.0
	220	bare conductor	3.0
	500	bare conductor	4.5
Distance from the conductor at static state to any part of the tree outside the city, town or township and trees have grown up in special-use forests or protective forests and trees plantations have grown up in authorized gardens or forests with a reasonable agreement.	Up to 1	Insulated conductor	0.5
		bare conductor	0.7
	Exceeding 1 to 35	Insulated conductor	0.7
		bare conductor	2.0
	110	bare conductor	3.0
	220	bare conductor	4.0
	500	bare conductor	6.0

Chapter 1-3 Definitions of Distribution Equipment and Substations

Article 9. Distribution Equipment

Distribution equipment refers to the equipment used to take over power in the power distribution system, including circuit breakers, control equipment, measurement and protection devices, other conductor, disconnector, architectural structures and related auxiliary equipment (compressor battery, etc.).

1) Outdoor equipment distributor that is the all equipment or other major equipment placed outdoors.
2) Indoor Equipment distribution which is equipped distributors are Installation in the house.
3) Distribution of the full set of equipment is fitted distribution was complete, the assembly or partially prepared for assembly link into blocks consisting wholly or partly compartment or block was built electrical equipment, control equipment, protection, measurement and auxiliary equipment.

Distribution of the full set of indoor distribution equipment should be placed in the house.

Distribution equipment to complete the full set of outdoor equipment for distribution of the full set is placed outdoors

Article 10. Substation

A substation is an electrical facility in which electrical energy received from outside is transformed according to voltage and transmitted by transformers, distribution or transmission equipment, and including controlling, protective, measurement and auxiliary equipment.

Substations are mainly divided into outdoor and indoor types

1) An Outdoor Substation is a substation of which main components such as transformers circuit breakers and bus conductors are placed outdoors
2) An Indoor Substation is a substation that is built inside the house.

   In addition to the above, other classifications of substation are as following definitions.
3) An Adjoining Substation is a substation that is built next to the main house.
4) A Workshop Substation is a substation that is placed inside a manufacturing workshop (within a shared space or separate compartment).
5) A fully-equipped substation is a substation equipped with a transformer and full set of electrical apparatus (indoor or outdoor fully-equipped distribution cabinet, etc.) that was fully pre-assembled or partially prepared for the installation.

   A fully-equipped substation with its components placed indoors is called an indoor fully-equipped substation, that placed outdoors is called an outdoor fully-equipped substation.
6) An On-pole Substation is an outdoor transformer of which all the high-voltage components are mounted on pole parts of poles or pillars, with sufficient height for public safety instead of a surrounding fence.
7) Transmission Substation is the substation with voltage level 110kV which directly connects power stations or with voltage level 220kV and more.

8) Distribution Substation is the substation with voltage level up to 35kV or with voltage level 110kV which distributes electric power to consumers.

Article 11. Switching Station

A **Switching Station** is an electrical facility which is equipped with switchgears, distribution or transmission equipment, and excluding power transformer.

Article 12. Installation Compartments

An installation compartment is a compartment in which electrical equipment and the busbar are installed.

An enclosed compartment is a compartment that is shaded tightly from all directions, with an exit door made of tight board (without lattice material).

A fencing compartment is a compartment where all the holes are covered, completely or partially (by a mesh material or combination of meshwork and tight board).

An explosion-proof compartment is an enclosed compartment to house equipment that shall be separated from others in order to prevent adverse effects in the event of any internal failures occurring. Its door opens to the outside or toward the fire-exit corridor.

Article 13. Safety corridor, operation corridor and explosion- exit corridor in the substation

1) A Safety corridor of substation is the space around the substation and limited as follows:

a) For substations without walls, fence surround, protective corridors of substations is limited by the space surrounding the substations with the distance to the nearest live parts of the substation as specified in the following table.

Voltage	Up to 22kV	35kV
Distance	2.0 m	3.0 m

b) For Substations with fixed walls or fences surrounding protected corridor width is limited to the outer surface of the wall or fence; corridor height is measured from the bottom of the deepest foundation of the substations to the highest point of the substations plus vertical safety distance as specified in the following table.

Voltage	Up to 35kV	110kV	220kV	500kV
Distance	2.0 m	3.0 m	4.0 m	6.0 m

Houses and buildings near the safety corridors of the power substation to ensure no damage to any part of the power station; **not infringe upon the road to the power station**; road drainage of the stations safety corridor, underground power cables and overhead power transmission lines; does not obstruct the ventilation system of the power substation; not to waste water intrusion damage to power works

2) An **operation control corridor** is a passageway along electrical cabinets or fully-equipped distribution cabinets, from which electrical equipment is operated.

3) An **explosion-exit corridor** is a corridor into which the door of the explosion-proof compartment opens

Chapter 1-4 Definitions of Protective Relays and Control Systems

Article 14. Protective Devices

Protective devices are those which automatically break the protected electric circuit in the event that it malfunctions.

Article 15. Types of Protection

The main protection is the key protection that the tripped time is set so that it works first

Double protections are two independent forms of main protection with the same operation time. A back-up protection is an auxiliary one which operates in case the main protection does not operate.

Article 16. Remote Control Systems

A remote control system includes a remote control, remote signals, SCADA (supervisory control and data acquisition system), telemetry and controlling systems.

Article 17. Secondary Circuits

A secondary circuit is a set including circuits: controlling, measuring, signaling, checking, automated, and protecting circuits of electricity works.

Chapter 1-5 Definitions of Metering

Article 18. Electricity Meter

An **Electricity Meter** is equipment used to determine how much electricity has been used.

Article 19. Multi Tariff Meter

Multi- tariff- meter is the power meter capable to set different power tariff

Article 20. Checking Meter

A **Checking Meter** is a meter for verifying and monitoring.

Chapter 1-6 Definitions of Earthing

Article 21. Earth Fault

An earth fault is an electrical connection between live electric parts of electrical equipment and structures not insulated from earth or earthed directly. Earthed enclosures are electrical connections between live electric parts of electrical equipment, machines and their enclosures or earthed structures.

Article 22. Earthing System

Earthing system is total earth electrodes and earthing conductors.

1) Earthing Electrode

An earthing electrode is a conductive object or group thereof which are electrically inter-connected and embedded in the ground.

2) Earthing Conductors

An earthing conductor is a metal conductor connecting electrical equipment to an earthing electrode.

Article 23. Zero Area of Voltage

The “zero” area of voltage is the ground area outside the dissipation area of the earth fault current.

Article 24. Resistance of Earthing

The resistance of the earthing system (earthing resistance) is the total impedance of the earthing electrodes, earthing conductors and the touch resistance between them and the earth.

Article 25. Earth Fault Current

The earth fault current is the current flowing to earth through a single earth fault point.

1) Large Earth Fault Current

Electrical equipment with a large earth fault current is equipment with voltage exceeding 1000V and phase earth fault current exceeding 500 A.

2) Small Earth Fault Current

Electrical equipment which has a small earth fault current is equipment with voltage exceeding 1000V and phase earth fault current smaller than or equal to 500A.

Article 26. Neutral of Power System

Neutral of transformer with voltage above 1kV has two kinds: direct earthed neutral and isolated neutral.

1) Direct Earthed Neutral

A directly earthed neutral is the neutral point of transformer or generator, which is directly connected to an earthing system or earthed through small resistance (e.g. a current transformer).

2) Isolated Neutral

An isolated neutral is the neutral point of a transformer or generator which is not connected to an earthing system or connected to an earthing system via signalizing, measuring, protecting, arc extinguishing equipment earthed as well as through other similar equipment with large resistance.

3) Effective Earthed Neutral

An effective earthed neutral is the neutral of a 3-phase electric power network with voltage exceeding 1,000V, of which the over voltage factor does not exceed 1.4 in the event of an earth fault short circuit.

An over voltage factor when an earth fault short circuit happens is -the ratio between the voltage of normal phase after the earth fault short circuit happens and the voltage of this phase before the earth fault short circuit fault happens.

4) Neutral Conductor

A neutral conductor is a conductor connected with the neutral point of a transformer or generator.

The working neutral conductor is the conductor supplying electricity to equipment in a 3-phase electric power network. For a 3-phase-4-wire network, this conductor is connected to the directly earthed neutral point of the transformer or generator.

For one phase electric power networks, the working neutral conductor is connected to the middle point of single phase of power resource and is earthed.

For DC power supply sources, this conductor is connected to the earthed middle point of the power resource. This also works as the balancing conductor when the loads on each phase are not balanced.

Protective earth conductor at equipment with voltage up to 1000V is the conductor, which connects the necessary parts of the equipment to the earth neutral point of the transformer or generator in a 3-phase electric power network.

Neutral conductor can be used as protective earth conductor.

Article 27. Protective Breaking

Protective breaking is automatic breaking implemented by protective devices of all phases or poles when a fault happens at one part of the electric power network.

Article 28. Main Insulation

- Insulation of live part that has its main function of keeping from electricity shock.
- Main insulation is not necessary to include exclusive insulation for functional purposes.

Article 29. Auxiliary Insulation

Independent insulation that added to main insulation to keep from electricity shock in case the main insulation is broken.

Article 30. Double Insulation

Insulation consists of two insulators which have the same specifications.

PART 2 GENERAL REQUIREMENTS

Chapter 2-1 General Issues

Article 31. Electrical design and conditions

The structure, application, installation method, insulation class of materials and design shall comply with the nominal voltage of the electrical power grid or electrical equipment, environmental conditions and requirements specified in the Technical Regulation

Article 32. Specifications of Electrical Equipment

The electrical equipment used in the electrical power projects shall have specifications suitable for the working conditions of the projects.

Article 33. Electric Mode

AC power shall be usable as a power resource for internal operation to simplify and reduce costs.

Article 34. Civil Part

The civil part of the project (building structures and parts inside buildings, ventilation, water supply and drainage etc.) shall comply with the national standards and norms for construction.

Article 35. Security in Power Projects

Power projects must have appropriate measures to ensure safety.

Article 36. Prevention of Personal Accidents

To avoid accidents affecting people due to electrical current and electrical arcing, all electrical equipment must be suitably protected in compliance with standards concerning electricity use, experiments and standards on electrical safety.

Article 37. Enclosures or Covers of Electrical Live Parts

Inside residential, public houses, shops etc. enclosures or covers of electrical live parts shall not have any holes. In electrical halls or production halls, holed enclosures, covers or the net type may be used.

Article 38. Requirements of Barriers and Covers

Barriers and covers shall have structures which can only be opened using special tools.

Article 39. Firefighting

Firefighting and fire prevention for electrical equipment with parts containing oil, e.g. submerged in oil, impregnated with oil and with painted insulation and so on shall be implemented in compliance with the requirements specified in the respective sections of these standards and regulations on firefighting and fire prevention issued by the local firefighting agency.

Article 40. Compliance for Electricity Supply

The electricity supply for underground structures, electrical cars etc. must comply with not only the requirements specified in this technical standard but also applicable professional standards and codes.

Article 41. Electricity Supply Plan

Supplying electricity to users, including selection of numbers and making arrangements for substations shall be solved holistically, depending on the energy situation in the area, electricity demand survey and projected economic development in the coming decade, as well as considering the provisional conditions. Apart from that, the capability and measures for reducing short circuit currents and electricity loss shall also be taken into account.

Article 42. Electricity Supply Alternatives

Selecting electricity supply alternatives shall be based on the need to ensure technical criteria, comparison of investment costs, annual production expenses in the return back period and a comparison of the advantages of each alternative.

Article 43. General Electricity Development Plan

The design and construction of new power networks and upgrades to those existing shall meet the common requirements of the general electricity development plan at all times and be expandable in future at least within the coming decade.

Article 44. Power Transmission Capacity in Industrial Enterprises

Power lines and transformers connecting specialized plants of industrial enterprises to the national grid must be designed to match the capacity of power plants, special purpose, to be able to load up or receive power from the system when needed.

Article 45. Agreement of Managing Agency of National Power Grid

When putting power plants into operation in the power grid, the power plants' owners shall have an agreement with the managing agency of the national grid.

Article 46. Coordinate power supply for industrial enterprises and residents

When the consumption capacity of industrial enterprises is lower than the transmission capacity of the power lines, the electricity supply to residential households from these power lines shall be combined according to the agreement.

Article 47. Categorization of Electricity Users

Categories of electricity users shall be divided depending on the reliability of the electricity supply. Appropriate methods of supplying electricity for each category shall be selected.

Article 48. Electrical Diagram

A simple, reliable and high voltage electrical supply diagram shall be used when the new construction or rehabilitation of the power network is established.

The electrical distribution diagram in the enterprise shall ensure the supply of electricity to production lines.

Article 49. Design for Power Networks

The power network must be calculated taking into account the loads of all consumers under normal conditions and fault conditions.

Article 50. Future Electricity Supply in the event of Extension of the City

When planning extensions of the city, the diagram of electricity supply for the future shall be prepared considering the implementation of stages appropriate to the city development in the future.

Article 51. Electricity Quality in the Power Network

1) Voltage

- The voltage levels of the points in the power system shall be defined according to the operation regimes, maximum and minimum loads. In the normal conditions, the voltage is allowed to fluctuate from -5% to +5% compared to nominal voltage and defined at secondary side of the transformer supplying to the electricity users and from -5% to +10% at the connection points with power plants.
- When the power network is not yet stable, voltage is allowed to fluctuate from -10% to +5%.
- In the normal working conditions of the electricity supply center, during the time when total load is reduced to 30% of the maximum load, the voltage at the busbar must be kept at the nominal voltage level of the power network.

2) Power Factor

Electricity supplier shall ensure power factor of $\cos\varphi \geq 0.85$. at the Measurement Point of the buyer have capacity from 80 kW and above or transformer with capacity of 100kVA and above In case $\cos\varphi$ < 0.85, that due to the load of using customer. These customer must take measures to ensure power factor of $\cos\varphi \geq 0.85$

In case, consumers are able to generate reactive power to power system, both sides will make agreement on reactive power purchase.

3) Frequency

In normal working conditions of the power network, the frequency is allowed to be fluctuated from -0.2Hz to +0.2Hz compared to normal frequency 50Hz. In the case when the power network is not stable, the frequency is allowed to be fluctuated from -0.5Hz to +0.5Hz (in 15 seconds.)

4) Harmonics

Permission maximum value for the total voltage distortion (Calculate by percent% of nominal voltage) by the components of higher harmonics cause voltage for 110kV, 220kV and 500kV must be less than or equal to 3%.

Permission maximum value for the total deformation of the load (Calculate by percent (%) of Nominal current) is with respect to voltage at 110kV, 220kV and 500kV must be less than or equal to 3%.

Total Harmonic Distortion (THD) shall be defined as the ratio of the RMS voltage of the Harmonic content to the RMS value of the fundamental voltage, expressed in percent.

$$THD = \sqrt{\frac{\sum V_i^2}{V_1^2}} * 100\%$$

Where:

THD = Total Harmonic distortion of the voltage

Vi = Voltage component of Harmonic order i

V_1 = Voltage component of fundamental frequency (50 Hz)

Total Harmonic Distortion of the voltage at any Connection Point, shall not exceed these limits that stipulated in the following table.

Table 51-1 Limit of harmonics

Voltage level	**Total Harmonic Distortion**	**Individual Distortion**
110kV, 220kV, 500kV	3%	1.5%
MV and LV	6.5%	3.0%

The value of unusual peak voltage in distribution network in short term is allowed to exceed the value of total harmonic distortion that stipulated in clause 2 of this Article, however do not damage equipments of customer using distribution network.

5) Voltage Flicker

In the normal condition, value of voltage flicker at any connection point does not exceed the limitation value that is stipulated in the following table.

Table 51-2 Limit of voltage flicker

Voltage	**Allowed Tolerance**
110kV, 220kV, 500kV	$P_{st95\%} = 0.80$ $P_{lt95\%} = 0.60$
Medium Voltage	$P_{st95\%} = 1.00$ $P_{lt95\%} = 0.80$
Low Voltage	$P_{st95\%} = 1.00$ $P_{lt95\%} = 0.80$

Refer to the IEC1000-3-7 standard, at connection point in medium voltage and low voltage, short term voltage flicker (Pst) does not exceed 0.9 and long term voltage flicker does not exceed 0.7

Article 52. Inspection of Voltage Fluctuation

Each power system from the power supply center to users shall be inspected in terms of permissible voltage deviation with consideration of the voltage condition at the busbar of the power supply center.

Article 53. Increased Surface Temperature caused by Solar Radiation

The impacts of solar radiation on indoor electrical equipment need not be considered. However, in some special cases, where equipment is located in areas exposed to sunlight, attention must be paid to the increased surface temperature.

Article 54. SF_6 Gas Leakage

In the electrical halls house equipment which contains SF_6 gas and are placed on the ground, the application of natural ventilation must be sufficient. In these cases, half the ventilating holes should be arranged near the ground surface. If this requirement is not met, forced ventilation must be applied.

Article 55. Oil Leakage

The transformers and shunt reactors shall have separated faulted oil containers or a common oil sump in order to prevent the leakage of oil.

Article 56. Materials for Electrical Equipment

According to the physical properties, materials used for manufacturing electrical equipment or parts thereof shall have appropriate characteristics.

Article 57. Protection against corrosion

The metal parts of the power projects must be painted, plated, coated to protect against corrosion.

Article 58. Distinction of Elements

In an electrical power project, measures are required to distinguish elements in a single part such as diagrams, equipment layout schemes, lettering, numbering, different color paints etc.

Article 59. Avoidance of Interference for Telecommunication Projects

In order for power projects not to interfere with and endanger telecommunication projects, existing related standards and norms must be complied with. There must be countermeasures for telecommunication systems against interference from industrial electrical currents.

Article 60. Automated Equipment for unmanned substation

For unmanned operation of the substation, SCADA system and automated equipment (ex. auto voltage regulator, auto recloser and etc.) designed for the target substation, must be installed so that various supervision and control that were conducted by the manned operation can be conducted from dispatch center.

Article 61. Short Circuit Currents for All Equipment with Shunt Reactors

For all equipment with shunt reactors when connected to the national power grid, short circuit currents after reactors shall be chosen.

Article 62. Utilization of Overhead Lines and Underground Cables

In places without any approved planning, the use of overhead power lines is recommended. In places where power development planning is stable, it should be used in underground cable

Article 63. Overload Capacity

Regarding the reserved power source, the overload capacity of electrical equipment regulated by the manufacturer and standby power supply sources must be considered.

Article 64. Conditions of Fault Calculation

When calculating fault conditions, simultaneous fault cutting and repair cutting at several sections of power line or several lines shall not be taken into account.

Article 65. Selecting of Conductor Size

The cross-sectional area of conductors constructed in the initial stage must be selected in compliance with the general electrical development diagram.

Article 66. Transmitting Signal of Fault Circuit Breakers

In power networks with standby power supply sources and automatic closing standby devices for users, signal from the damaged circuit breakers at switchyard must send to the load dispatch room

Chapter 2-2 Electrical Equipment

Chapter 2-2-1 The Selection of the Conductor Cross-Section Area

Article 67. General provisions

This provision is applied for the selection of conductor cross-sectional areas, including bare conductors, sheathed conductors, cables, busbars, by economical current density, by permissible voltage drop, by permissible current (or permissible heating) and by corona condition. If the selected conductor cross-sectional area is smaller than that selected according to other conditions such as permissible voltage deviation, mechanical strength, overload protection, dynamic stability and thermal stability, the maximum calculated area of conductor shall be chosen.

Article 68. Selection by Permissible Heating

All conductors (bare conductors, sheathed conductors, cables and busbars) shall meet permissible heating conditions, not only under normal operating conditions but also under the system fault condition.

The permissible continuous current of underground cables is selected according to the permissible heating temperature of the conductor core.

Article 69. Selection by Permissible Voltage Drop

All conductors (bare conductors, sheathed conductors, cables and busbars) shall meet permissible voltage drop conditions.

Article 70. The Selection of up to 1kV

In power networks with voltage up to 1kV (not including 1kV), the conductor cross-sectional area is selected according to article 68 and article 69.

Article 71. Selection conductors of over 1kV

The cross-sectional area of conductors over 1kV is selected with respect to economical current density taking into account which allows for heating conditions; allows voltage drop and corona conditions. Additionally, increasing the number of power lines or the number of power line circuits, or upgrading by increasing the conductor cross-sectional area due to overload or Short-term or temporary operation while the incident with the conductor’s cross-sectional area is selected by conditions allowing for heat and appropriate operation mode must be based on technical-economic calculations.

Not be selected by the current economic density in the following cases:

1. Busbar of all voltage levels.
2. Wires to the variable resistors, resistor startup

Article 72. The Selection of Bare Conductors with large cross-section

When conductors with larger cross-sectional area are selected, they must be selected according to economical current density and must have a suitable configuration in order to minimize loss due to the surface effect, nearness effect and ensuring optimal cooling.

Article 73. Inspection by Corona Conditions

For voltage of 110kV and above, conductors must be checked by corona conditions, air average temperature and air density dependent on elevation above sea water.

Article 74. The Selection of Lightning Conductor

When selecting lightning conductors, in addition to ensuring different calculated conditions on the physical-mechanical properties, thermal stability conditions must be checked in the event of a short circuit of one phase.

Chapter 2-2-2 The Selection of Electrical Equipment by Short Circuit Conditions

Article 75. General provisions

This provision is applied for the selection all of electrical equipment with frequency of 50Hz and conductors according to short circuit conditions.

Article 76. Short circuit current calculation scheme

When selecting a diagram for calculating short circuit currents, only permanent working conditions of electrical equipment are considered but not shot-term temporary working conditions.

Article 77. Calculate the time thermal stability

When checking thermal stability, the calculation time is assumed to be equal to the total time required for the trip of the main protective relay and circuit breaker

Article 78. Increasing Temperature in Fast Self-Reclosing Devices

When checking the thermal stability of equipment and power line conductors with fast self-reclosing devices, the increase in temperature due to the increase in total short circuit time must be taken into account when reclosing failed.

Article 79. Short Circuit Currents

For electrical equipment, conductors, cables and support structures must be selected according to the maximum short circuit current passing through. When they are protected by a fuse with a limit current, the thermal stability must be checked by the maximum instant short circuit running through the fuse.

Cases where different phases are earthed at two different points at the same time are not considered.

Article 80. Checking Items for Short Circuits

Short circuit checking conditions include the following items:

1. Electrical equipment with voltage up to 1,000V
   Only the distribution board, conductors, and electromotive cubicles. Not short-circuit test for current transformers.
2. Electrical equipment with voltage exceeding 1,000V
   (1) Electrical equipment, conductors, cables, support structures and their force bearing parts.
   (2) Overhead power lines with impulse short circuit currents from 50kA and above.

Exceptionally, the following items are not checked for short circuits:

1. The electrical items with voltage exceeding 1,000V
   a) Dynamic stability of equipment and conductors protected by fuses of all types with nominal electrical current up to 60A.

b) Thermal stability of equipment and conductors protected by fuses of all types.
   Fuses must be sensitive enough to break minimal short circuit currents.

2. Electricity conductors for separate electricity users, including workshop transformers with total capacity up to 1000kVA, primary voltage up to 22kV, if the electricity supply interruption can be recovered easily.
3. Conductors of overhead power lines, except the above-mentioned item 2-b) of this article.
4. Busbars and equipment of voltage transformer circuits, which are placed separately or after the auxiliary resistor.

Article 81. Electromotive Forces

Electromotive forces acting on rigid busbars, transmitted to the insulator and rigid support, must be calculated with respect to maximum instantaneous short circuit current, taking into account phase shift and omitted mechanical oscillations of busbar structures.

Article 82. Permissible Values for Heated Conductors

The temperature of a heated conductor when a short circuit occurs must not exceed permissible values.

Article 83. The Selection of Circuit Breakers

To select a circuit breaker in terms of breaking capacity, the breaking current must be determined according to the conditions specified in articles from article 76, article 79 and article 77.

Apart from being selected according to breaking capacity, for 500kV circuit breakers shall also be selected based on transient recovery voltage (TRV) after short circuiting. The TRV capacity of the circuit breaker must exceed that calculated specifically in each location of the circuit breaker in the network.

Article 84. The Selection of Fuses

When a fuse is selected with respect to breaking capacity, the effective value of the short circuit current of the first cycle must be taken as the calculated breaking current

Chapter 2-3 Transmission and Distribution Lines

Chapter 2-3-1 House and Outside Wiring Systems with Voltage up to 35kV

Article 85. Cross-Sectional Areas

Cores of insulated conductors and cables of house and outside wirings must have appropriate cross-sectional areas.

Cross-Sectional area of the grounding conductor and the neutral grounding conductors are regulated in Article 572.

Article 86. Installation of Conductors and Cables

In pipes etc. that belong to constructions, insulated conductors and cables must be installed based on the applied condition.

Article 87. Provisional Length of Conductors and Cables

The provisional length of insulated conductors and cables of house and outside wirings must be arranged at the place of connection, branch of conductor and cable for carrying out connections, branching or re-connection.

Article 88. Installation of Connections and Branches

Connections and branches of insulated conductors and cables of house and outside wirings must be installed by the applied method to ensure strength and insulation and be installed in the connection and branch box, to remain easily accessible for inspection and repair.

Article 89. Construction and Material of Connections, Branch Boxes and Clamp Connectors

The construction of the connections, branch boxes and clamp connectors must be suitable for the installation method and environmental conditions.

The connections, branch boxes and insulated enclosures of the clamp connector must be made of non-flammable or flame-resistant material.

Article 90. Protection against Corrosion for House and Outside Wiring Systems

Metal parts of house and outside wirings must be protected against corrosion with respect to environmental conditions.

Corrosion protection shall comply with article 57.

Article 91. Crossing with Thermal Expansion Slots and Fracture Slots

Arrangement of house and outside wirings must take into account possible shifting in places where house and outside wirings cross thermal expansion slots and/or fracture slots.

Article 92. Protection against Chemical Substances

In places where the air contains active chemical substance which can destroy part of house and outside wirings, support structures and electrical insulation, house and outside wirings with voltage up to 35kV must have appropriate structures and other measures applied to protect them from the above-mentioned impact.

Article 93. Calculation and Selection Condition of Conductors

The calculation and selection of conductors, insulating materials, accessories, structures and instruments for house and outside wirings with voltage up to 35kV must comply with normal working and short circuit conditions (see Chapter 2-2-2).

Article 94. Symbols and Paint

Live parts of house and outside wirings with voltage up to 35kV must have symbols and be painted in a color to distinguish phases in accordance with in item 5 in Article 2.

Article 95. Method for Preventing Conductor Proximity at Short Circuits

House and outside wirings with voltage up to 35kV must have a method to prevent phase conductors getting too close to each other when a short circuit current goes through.

Article 96. Earthing Live Parts

To earth live parts of house and outside wirings with voltage up to 35kV, a fixed or movable disconnector and grounding rod must be arranged in compliance with requirements for earthing measures and induced voltage.

Article 97. Mechanical Load and Temperature Requirements

The mechanical load on house and outside wirings with voltage up to 35kV and calculation temperature of the environment must be determined in compliance with requirements for safety factors of conductors, insulators and accessories specified in article 328-331.

Article 98. Combination and Configuration for Installation and Maintenance

Combinations and configurations of house and outside wirings with voltage up to 35kV must take into account convenience and safety for carrying out installation and maintenance.

Article 99. Protection against Lightning

Outside wirings with voltage from over 1 to 35kV in the specified cases must be protected against lightning strikes by lightning conductors or arresters

Article 100. Reduction of Electricity Loss

For AC house and outside wirings with voltage up to 35kV and symmetrical load currents of 2.5kA and above, measures must be applied to reduce electricity loss at busbar support parts, accessories and structure due to magnetic impact for currents from 1 to 2.5kA, the above measures should be applied.

Article 101. Eliminating Dangerous Stress

The necessary measures must be applied in order to eliminate dangerous stresses such as temperature changes, explosions, vibration of transformers, uneven foundation sunk etc.

Article 102. Connection of House and Outside Wirings

Connections of house and outside wirings with voltage up to 35kV which cannot be dismantled must be welded or pressured. A pressure clamp or turn clamp, bolt catch may be applied for branch soft house and outside wirings .

Connection of house and outside wirings using different materials must be performed such as to eliminate corrosion of the contact surface.

Article 103. Cross-Sectional Area for Permanent Permissible Current

The selection of the cross-sectional area of the conductor of house and outside wirings with voltage exceeding 1 to 35kV must ensure the permanent permissible current under both normal conditions and after faults. The potential for increased load must be taken into account; however, the current cannot exceed 25-30% of the calculated current.

For house and outside wirings with voltage up to 35kV, the permanent permissible current must be determined according to the method specified in chapter 2-2-1.

Chapter 2-3-2 Power Cable Line Systems with voltage up to 220kV

Article 104. Design and Construction Requirements

The design and construction of power cable lines must be based on technical-economic calculations, taking into account power system developments, the importance of power cable lines, features of power cable line routes, cable arrangements, the construction method of cables and cable specifications.

Article 105. Cable Route Selection

The power cable line route must be selected to have minimal length and ensure the safety in terms of chemical or mechanical damage, vibration, corrosion, overheating and arcs caused by power cable lines.

The placement of power cable lines crossing each other or over other pipelines shall be avoided.

When selecting cable line routes, areas with soil corrosive to the metal sheath of cables must be avoided or protective treatment applied.

In slushy areas traversed by power cable lines, the calculation and selection of cables must take into account the geological, chemical and mechanical conditions.

Article 106. Requirements in the Installation and Operation Process

In order to prevent damage to power cable lines and the action of dangerous mechanical forces, during installation and the operation process, the following requirements must be complied with:

- The cable must have a reserve length sufficient for snake installation and expansion in the event of land movement or thermal deformation as well as the cable itself. A reserve cable in the form of a coil is prohibited.

- A cable horizontally laid on a structure, wall or beam must be fixed at the terminal point, to both sides of the bent section and at the connection box.
- A cable laid vertically along the structure or wall must be clamped and reinforced so that the cable sheath and connection are not deformed and damaged due to the action of its weight.
- Steel structures supporting cables without covers must avoid mechanical damage by inserting an elastic lining.
- Cables including steel covered cables installed in places traversed by vehicles, machine transport, goods and people etc. must be protected from collision.
- When installing new cables adjacent to those in operation, measures for protecting existing cables from damage must be applied.
- Spacing between cables and heat resources must be ensured to avoid the risk of overheating. Measures to protect cables from hot matter going onto cable connection boxes must be applied.

Article 107. Protective Cables

Power cable lines must comply with the requirements to protect against fault currents and corrosion due to soil in this regulation and other regulations on protection against corrosion for construction projects and measures must be applied to protect against sunlight and the impact of other heat resources.

Power cable lines which are installed in explosive, flammable or high temperature places, must have measures applied to protect against such stresses.

Article 108. Factors in Calculations for Underground Cables

When calculating the construction of underground cable projects, the cable weight, soil layer, covering soil layer for making roads and load of the transport means passing through must be taken into account.

Article 109. Cable Placement Requirements

The structure used to place cable must be made of non-flammable material. The temporary installation of the cable structure and on any support parts of equipment, including material, is prohibited. Temporary cable placement must comply with all cable placement requirements and permission of operation unit.

Article 110. Bended Cable

When bending the cable, the minimum bending radius must comply with the cable specification requirement.

Article 111. Cable Tension

Cable tension during pulling and placement must be determined by the mechanical tension withstand capacity of the cable core.

Article 112. Nameplate

If the power cable line consists of many cables installed in parallel, it should be labeled with the name and number for each cable.

Openly arranged cables and cable connection boxes must have nameplates.

Nameplates must be firmly fixed at proper intervals and be unaffected by the action of the surrounding environment.

On the underground cable route, cable route marks must be arranged in the field.

Article 113. Routes Underground or Underwater

The route of each power cable line underground or in the water must be sufficiently mapped with coordinates corresponding to the marks of already constructed projects or special landmarks. The location of the cable connection box must also be marked on the map and in the field.

Article 114. Arrangement Pattern

Power cable lines must be arranged in a cable structure that takes into account the number and type of cables, installation place and operating voltage of power cable lines.

When selecting the pattern for placing cables in urban areas, the initial investment costs, costs related to maintenance, repair as well as convenience and economic aspects of the project must be calculated.

Chapter 2-3-3 Overhead Power Line Systems with voltage up to 500kV

Article 115. Consideration Requirements and Conditions

In the implementation of this regulation, if there are many different requirements, the most stringent requirement or the least favorable condition must be taken into consideration.

Article 116. Calculation Method

In terms of calculation of the mechanical-physical requirement for overhead power lines, the following methods must be used:

- Conductors: permissible stress method
- Insulators and accessories: destructive load method

Foundations and poles: state limitation method. The standard load must be taken according to the value specified in chapter 3-3.

Article 117. Installation Condition for Poles

Overhead power lines must be arranged so that poles do not block access to houses and human/vehicle traffic.

Article 118. Protection and Signal against Vehicles

Protective measures for poles of overhead power lines must be applied at locations where traffic vehicles might collide the poles.

Article 119. Transposition

Transposition of phase conductors of overhead power lines must be applied, if the asymmetry of each current and voltage needs to be limited.

Transposition of overhead power lines with the aim of preventing the impact of overhead power lines on communication lines shall be calculated by a special method.

Article 120. Access for management and maintenance

In order to manage the operation of overhead power lines with voltages of 110-220kV, pedestrian ways must be arranged to access overhead power line routes and foots of poles.

In order to manage operations and maintain overhead power lines with voltage of 500kV, roads for transport must be arranged to access overhead power line routes.

Article 121. Installation of Poles near Areas with Water

Poles of overhead power lines near areas with water shall be located to avoid any harmful impact and influence of flood and erosion.

Where it is difficult to locate poles in the above-mentioned places, protective measure for poles and feet of poles must be applied.

Article 122. Pole Signs

Pole signs of overhead power lines must be installed in prominent positions. The numbering plates on the pole are recorded in specified with operating

Article 123. Protection against Corrosion

Appropriate anti-corrosion measures must be applied for the metal feet of poles installed in areas with frequent flood.
Corrosion protection shall comply with Article 57.

Article 124. Warning Signs and Warning Lamps

Poles of overhead power lines at least 80m in height must be painted with warning signs (daily warnings) and have warning lamps (nightly warnings) to ensure security for airplanes and ships in compliance with State regulations.

Poles must be painted in white and red colors from the height of 50m upward.

Warning lamps (signal lights) must be installed on top of the poles in the following cases:

- The height of poles is 80m or more.

- The height of poles at positions of special requirements is from 50m or more (Poles on the hill or mountain are higher than surrounding areas).

Article 125. Fault Locating Equipment

Fault locating equipment must be installed for overhead power lines with voltage of 110kV and above.

Article 126. The Selection of Alternative Routes

When overhead power lines traverse areas with disadvantageous surrounding conditions, alternative routes must be considered and selected based on a technical-economic comparison in order to avoid the area in question.

Article 127. Determination of Climate Conditions

Determination of climatic conditions for the calculation and selection of structure of overhead power lines must be based on the result of multiple years of observed data treatment on wind speed and air temperature in areas traversed by overhead power lines to be constructed.

Processing of observed data must consider micro-climatic conditions, wind pressure, natural conditions as well as the existing structure or be designed and constructed structures in areas traversed by overhead power lines.

Article 128. Calculation and Consideration of Wind

Standard wind pressure, wind pressures by region and factors increasing or reducing wind pressure for overhead power lines going into areas sheltered from the wind must have appropriate impact and load values.

Standard wind pressure shall be calculated in consideration of wind pressures established by area, the areas of power and lightning conductors blocking the wind, the angles between wind directions and axial direction of the overhead power line route, aerodynamic coefficients and coefficient related wind pressure deviation in the span.

For overhead power lines with voltage up to 22kV, when conductors are installed at a height of less than 12 m, standard wind pressure can be reduced, except in cases in which a wind block coefficient applies to reduce wind pressure in areas sheltered from wind.

Wind pressure acting on conductors of overhead power lines shall be determined in consideration of places traversed by overhead power lines and the height of conductors.

Wind pressure acting on the structure of poles must be determined according to the height counted from the ground surface.

In calculation of the wind pressure acting on power and lightning conductors, the angle between the wind direction and conductors shall take 90, 45 and 0degree.

In calculation of the pole of overhead power lines, the angle between the wind direction and axial of overhead power line routes shall be 90 and 45degree.

When designing overhead power lines, normal and exceptional climatic conditions must be taken into consideration.

Chapter 2-4 Distribution Equipment up to 1kV

Article 129. The Selection of Appropriate Devices in Distribution Equipment and Substations

Conductors, busbars, electrical equipment, electricity meters and other components must be selected under the following conditions:

a) normal operating (operating power voltage and current level, accuracy rate, etc.)

b) short circuit (under the effects of heat, electricity current or limited interruption capacity)

Article 130. Instructions Provided at Each Facility

The status or condition of every distribution circuit and distribution board must be shown on the surface of the distribution panel.
The instruction must be written on the front of the distribution cabinet. If the operation can be performed on both sides, the instructions must also be attached to the back of the cabinet.

Article 131. Identification of the Circuit

Circuits must be classified in order to be positively identified: AC/DC as well as voltage.

Article 132. Arrangement of Phases and Electrodes

The correlative phase and electrodes in a distribution system must be placed in the right specified order.

Article 133. Coating with an Anti-corrosive Layer

All the metallic parts of the equipment must be painted, plated or coated with an anti-corrosive layer.

Article 134. Grounding

The grounding must be implemented in accordance with the regulations stated in Part 6.

Chapter 2-5 Substations above 1kV

Article 135. Electric Equipment Installation Condition

Electrical equipment, conductors, insulators, accessory tools for gripping or clamping, barricade fences, load-bearing structures, insulation distances and other distances must be selected and installed to ensure the following:

1. Under normal conditions of operation, static and kinetic forces, heating, arc and other phenomena (sparking, gas emissions…) shall not damage the equipment and design structure, or cause short circuit faults between phases or between phase and ground, and shall not endanger human lives.

2. Under abnormal operational conditions, damage caused by short circuit failures shall be mitigated.
3. When de-energizing a circuit for the safe implementation of activities such as testing, replacing or repair of equipment, conductors or components of that circuit, the normal operation of adjacent circuits shall be unaffected.
4. The potential for the safe and easy transportation of equipment must be ensured.

Article 136. No-load disconnector switching

When an open disconnect switch is used in an unloaded current of transformer, charging or balanced current of transmission lines, or a grounded current, the distances between energized components and energized components and ground must satisfy the requirements regulated in this chapter as well as in pertinent technical documents.

Article 137. Conditions of Kinetic Stability and Heat Stability

When selecting electrical equipment, conductors and insulators, conditions of kinetic stability and heat stability must be taken into account; as for circuit breakers, the breaking capacity shall additionally be considered and the requirements regulated in chapter 2-2-2 shall be met.

Article 138. Ability to Withstand Gravity Force

The structure on which equipment is placed and installed, as stipulated in article 137, must be strong enough to sustain the gravity force exerted by the equipment weight, wind force under normal weather conditions and other forces impacting during the operation of the equipment, even when a short circuit occurs.

Article 139. Installation of Disconnect Switches

Disconnect switches of the distribution system must be placed in visible positions to clearly show their operating status; identifying whether electrical devices (such as circuit breakers, current transformers, voltage transformers, fuses, etc.) are isolated from other power sources .

Article 140. Close or Open Indicators for Circuit Breakers

Circuit breakers or their operation devices must be equipped with indicators that show their operating status (close or open) accurately, securely and in visible locations. It is prohibited to use power lamp signals as the only indicator of the circuit breakers' status. In case the operation devices are separated from the circuit breaker by a wall, indicators must be installed in both locations.

Article 141. Insulation in Dirty Air Condition (Prevention of Dust, Harmful Gases, and Steam)

In case distribution systems and substations are placed in locations where the surrounding air contains elements potentially damaging to the equipment and conductors, or which may reduce the insulation capacity, appropriate methods shall be applied to ensure reliable and safe equipment operation.

Article 142. Installation at Higher Elevation at a height of 1000m

As for the installation of distribution systems and substations at locations exceeding 1,000m above sea level, in such cases, minimum clearance in air, insulator and external insulation related to the equipment must be selected depending on their elevation due to the reduction in insulating capacity corresponding to the reduced atmospheric pressure.

Article 143. Materials of Distribution System Conductors

Conductors of distribution systems and substations are usually made of aluminum, steel-core aluminum wire, and aluminum tubes or bars, technical aluminum alloy, copper wire, copper bar or copper alloy.

When tubular conductors are used, all ending parts must be tipped to guard against the accidental entry of birds or insects.

Article 144. Phase Symbols/Signs

Phase symbols/signs of electrical equipment and conductors of distribution systems and substations must be marked as prescribed.

Article 145. Switches with Interlocks

Distribution systems above 1kV must be equipped with interlocks to avoid:

- Closing of circuit breakers or disconnect switches while the grounding switch is closed.
- Connecting the grounding switch to the conductor while it is still live.
- Closing or opening the loading disconnect switch although not permitted by the design structure and functions of the disconnect switch.

Article 146. Grounding Switches

As for distribution systems and substations with voltage above 1kV, a fixed grounding switch should be used to ensure safe earthing for equipment and conductors.

The grounding blade must be painted black; the drive handle of the grounding blade must be painted red; and other drive handles must be painted in the specific color of the equipment

Article 147. Height of the Fence

Regarding outdoor distribution systems and substations, meshwork type or meshwork and board combination type barricade fencing around the conductor or electrical equipment must be installed at a height of 1.8m. The height level for the indoor system is 1.9m.

Article 148. Prevention of Damage from Temperature or Vibration

Where required, methods against tensioning (force) shall be applied (by using flexible connector plates, decreasing the tensing force of the line, etc.) in order to prevent conductors from being deformed due to changes of temperature, or vibration that may generate mechanical tensioning (force) endangering conductors and insulators.

Article 149. Oil Indicator and Temperature Gauge

Indicators of oil level, oil temperature of the oil-filled transformer or equipment must be placed to facilitate observation, safely and without necessarily interrupting power. In particular cases that cannot be implemented in this way, reflecting mirrors may be used to confirm the indicator of oil level.

Article 150. Oil-resistant Material for the Facilities

Conducting wires in systems of protection, measurement, signal and lighting installed in the location of oil-filled equipment must be protected with oil-resistant insulation.

Article 151. Color of Transformers, Reactors, Capacitors

Transformers, reactors, capacitors and other electrical equipment placed outdoors must be painted in a light color to reduce the heating temperature directly caused by solar radiation. The paint must be oil-proof and resistant to weathering.

Article 152. Lighting System in Substation

Distribution systems and substations must be electrically illuminated.

Independent lighting sources reserved for emergency cases shall be determined depending on specific projects. Lighting systems must be installed to ensure operation management can be implemented safely and favorably.

Article 153. Communication System in Substation

Distribution systems and substations must be equipped with communication channels in accordance with operational system requirements.

Article 154. Transportation Accessibility

As for the installation of outdoor and indoor distribution systems, the ability for using machinery for transportation, assembling or repair must taken into account.

Article 155. Noise Regulations

As for distribution systems and substations located near residential areas or in industrial project areas, methods to control noise emissions from the equipment shall be installed in accordance with relevant regulations (transformers, synchronous compensators, etc.). Make sure not to exceed the allow level in the following table

Table 155-1 Maximum permissible noise levels in public and residential areas (unit: dB)

Area	Time		
	From 6am to 6pm	From 6pm to 10pm	From 10pm to 6am
1. The places requiring special silence: hospitals, schools, libraries, sanatorium, churches, temples	50	45	40
2. Residential areas, hotels, resorts, administrative offices	60	55	50
3. Residential areas alternated with commercial, service, productive areas	75	70	50

Table 155-2 Sound pressure levels at some working places

Working place	Equivalent sound pressure level (dBA)	Sound level at octaves of medium frequencies (Hz), not exceeding (dB)							
		63	125	250	500	1,000	2,000	4,000	8,000
At working, production places	85	99	92	86	83	80	78	76	74
Remote control room, experimental rooms with noise resources	80	94	87	82	78	75	73	71	70
Remote control room, experimental rooms without noise resources	70	87	79	72	68	65	63	61	59
Functional rooms (accounting, statistics etc.)	65	83	74	68	63	60	57	55	54
Research, design, computer, experimental and data treatment rooms	55	75	66	59	54	50	47	45	43

Article 156. Corrosion Regulation

Metallic components of indoor, outdoor distribution systems, substations, and underground metallic components and open metallic parts of ferroconcrete must be protected against corrosion.

Corrosion protection shall comply with Article 57.

Article 157. Oil Collecting Systems

In distribution systems and substations, except on-pole substations, which are equipped with oil-filled equipment, an oil collecting system must be installed to collect the entire amount of discharged oil at the time of the incident.

In order to prevent oil leakage restrict spread of fire in case failure of transformer which contains oil more than 1,000kg/unit and oil circuit breaker with voltage of 110kV and above, the oil collecting sumps shall be arranged. Oil drainage system and oil collecting sumps shall satisfy the following requirements:

1. Dimensions of oil collecting sumps shall be larger than the dimension of each equipment at least by:
   - 0.6m : Oil content is up to 2,000kg
   - 1.0m : Oil content is from above 2,000kg up to 10,000kg
   - 1.5m : Oil content is from above 10,000kg up to 50,000kg
   - 2.0m : Oil content is above 50,000kg; dimensions of oil collecting sumps can be reduced by 0.5m on the side towards wall or partition whose distance to transformer is less than 2m.

   Capacity of oil collecting sump is calculated as follows:
   - The total amount of oil of the transformer (reactor) plus rain water, if oil collecting sump is not oil tank.
   - 20% oil of the transformer (reactor), if oil collection sumps have drainage system to oil tank.
2. Oil collecting sump and drainage system of transformers shall be arranged so that oil (or water) of sump of one transformer can not overflow into sumps of other transformers or into cable ditch or into other underground works, and not causing fire spreading or block the oil drainage line.
3. Oil tank have oil volume of equipment with the largest oil.
4. Allow in the collection pit built oil collection tank.. In such case, the sump shall be deep enough to contain the entire quantity of oil filled in the equipment and covered by grating, on which a layer of clean gravels or broken stones sized from 30 to 70mm is laid, with thickness of at least 0.25m.

   Drained water and oil can be taken from sump by portable pumps or gravity flow.

   If water and oil intake and exhaust out in portable pump then appropriate device to identify the existence of oil or water in the sump shall be equipped.
5. Oil-collecting sump with common catchment tank can be sunk-type (its bottom laid lower than ground level) or surface-type (its bottom is laid on the ground level). For the sunk-type sump, it is not required to install protection border around, provided that its capacity conform to the requirement stated in Point 3 (It is 100% quantity of oil of the largest transformer).

   Surface-type oil reservoir shall be formed with the weir of oil outflow prevention. The height of the weir shall be from 0.25 to 0.5m above the surrounding ground level.
6. Oil drainage system shall lead quantity of oil and water (including quantity of rain water and water from fire extinguishing equipment) to a safe place. In addition, the entire quantity of water and quantity of 50% oil shall be drained off within 0.25 hour.

   Oil drainage system may be of underground pipelines or ditch.

Article 158. AC Power Source

In all substations, an AC power source should be utilized in the operation of closing circuits of the equipment provided that this method is simple and economical while still ensuring system reliability.

Article 159. Utilization of Isolating Power Transformers

For power grids with voltage up to 1,000V, in places where safety conditions mean electrical equipment cannot be directly connected to the power grid, isolating power transformers or step down transformers with secondary voltage up to 42V shall be used. However, when the above-mentioned transformers are used, indications must be complied with.

Chapter 2-6 Measure the electrical energy (Metering) system

Chapter 2-6-1 Metering System

Article 160. General Requirements

(1) The requirement of power metering system

1. Power counting system must be equipped with the main metering system to determine the accuracy, completeness measurable quantities, delivery through power connection points and eliminate the factors affecting the measurement results from the ring structure of the power system.
2. Backup power measurement system fitted to perform the following functions:

   a) Replace the main metering system to measure, as a basis for calculating the purchase and sale of electricity in case of metering system at the measurement location incorrect operation or incident;

   b) Support the monitoring, inspection measuring results of the main measuring system in the case of main system working normally;

   c) Combined with the main metering system and other redundant measuring system to calculate the output power delivery in some special cases.
3. Measuring system for power grid voltage of 110kV or more:
   - For the grid, at the connection point voltage of 110kV or more, place a (01) main meter and a (01) backup meter;
   - For the power plants connected to the grid voltage of 110kV or more, at each connection point to place (01) main meter and two (02) different locations to install the backup meters;
4. Measuring system for power grid voltage 1000V to 35kV:
   - For the grid, at the connection point voltage of 1000V to 35kV, place a (01) the main meter, power distribution units and the Customer will agree reserve meter installation if necessary;
   - For the power plants connected to the grid voltage 1000V and 35kV, at each connection point to place (01) main meter and one (01) other placement to install the meter for reserve ;
5. Power measuring system for low voltage grid:

   Low voltage level at the connection point, to place a (01) main meter, power distribution units and the Customer will agree reserve meter installation if necessary;

(2) The location of the meter installation

Purchase electricity meter installed identical or adjacent to the connection point or at a convenient location agreed upon by the buyer and the seller.

(3) Backup Meters

Billing electricity meters are electricity counters which count the amount of electricity as a basis for payment between electricity sellers and buyers, including generated electricity, electricity consumed by consumers or electricity purchased at boundaries. Electricity metering systems with billing meters must be installed in the management boundary.

(4) Payment meters

Payment meters are electricity counters which count the amount of electricity as a basis for payment between electricity sellers and buyers, including generated electricity, electricity consumed by consumers or electricity purchased at boundaries. Electricity metering systems with billing meters must be installed in the management boundary.

Article 161. Power metering system configuration

Backup metering is necessary for counting electricity in the event of faulty billing electricity meters.

Article 162. Measure the electrical energy system

Measure the energy system installed for the electrical system:

(1) Electric power measuring system 110kV and above

(2) Electric power measuring system from 1kV to 35kV

(3) Low-voltage measurement system

Meters and related metering equipment such as current transformers and voltage transformers must be verified in compliance with existing regulations and provisions in the Regulations.

Article 163. Technical requirements of energy measuring system

Cross-sectional areas and conductor lengths connecting the meter with current or voltage transformers must ensure measurement transformers work accurately and that voltage drops in voltage circuits to meters do not exceed 0.5% of nominal voltage.

Article 164. Technical requirements for sealed, pair of lead and security

Energy metering system including wiring box, VCT, power meter and etc. must be lead-sealed to prevent from unauthorized open.

Chapter 2-6-2 Electrical Measurements

Article 165. Electrical Measurements

Electrical measurements involve measuring electricity by fixed measuring instruments, although this is not applicable for electrical measurements in laboratories, by portable measuring tools and emergency tools for electrical measuring in fault conditions.

Article 166. Requirements for Electrical Measuring Instruments

Electrical measuring instruments must satisfy the requirements of relevant regulations.

Article 167. Measuring Voltage in 3-Phase

Metering voltage in 3-phase electric power networks should be carried out using one phase-phase voltmeters.

Article 168. Measuring Points for AC & DC Currents

AC & DC currents for measuring electricity current must be measured at appropriate places.

Article 169. Measuring Points for Voltage

Voltage must be measured at appropriate points.

Article 170. Measuring Points for Power

Power must be measured in compliance with the requirements.

Article 171. Measuring Points for Frequency

Frequency must be measured at appropriate places.

PART 3 TRANSMISSION AND DISTRIBUTION LINES

Chapter 3-1 House and Outside Wiring Systems with Voltage up to 35kV

Chapter 3-1-1 The Selection of Types of House and Outside Wirings with Voltage Up to 35kV and Installation Methods

Article 172. Appropriation for Power Projects

House and outside wirings with voltage up to 1kV must be appropriate in terms of environmental conditions, the purpose and value of the project, and their construction and architectural features.

Article 173. Selecting Lines and Conductors, Cable Installation Methods

The process of selecting house and outside wirings with voltage up to 1kV, conductors and the cable installation methods must consider electrical safety and fire protection safety requirements and be suitable for the environmental condition.

The neutral conductor must have insulation equivalent to that of the phase conductor.

Article 174. Fire Safety Protection Conditions

The installation of insulated conductors and cables, and pipes and boxes containing conductors and cables must comply with fire protection safety conditions.

Article 175. Arrangement of Switching Devices and Protective Devices

Switching and protective devices for branches from house and outside wirings with voltage up to 1kV must be directly arranged on power lines or branch boards (article 419).

This equipment must be arranged in order to prevent inadvertent contact with live parts. To operate the devices from inaccessible points at elevation, suitable facilities shall be equipped and the situation of the switchgear shall be indicated.

Article 176. Safety Warning Plates

Throughout the entire accessible stretch of house and outside wirings with voltage up to 1kV and without a protective cover, safety warning plates must be arranged.

Chapter 3-1-2 House Wirings with Voltage up to 1kV

Article 177. Prevention against Contact

Opened conductors without protective covers must be installed as protection against mechanical action and installed at a height to prevent inadvertent contact by people.

Inadvertent contact with the conductors without protective covers by people on cranes must also be prevented.

Table 177 Minimum height of conductor without protective cover

Voltage (V)	Installation place	Minimum height (m)
Exceeding 42 to 1000	Less dangerous hall	2.0
	Dangerous hall	2.5
Up to 1000	Production hall	1.5
	Platform of crane car	2.5

Article 178. Conductors without Protective Covers

If opened conductors without protective covers cross electrical conductors with or without protective covers and the distance between them are insufficient, then at the intersection, each conductor without protective cover must be covered with additional insulation layers.

Article 179. Crossing with and Installation in Parallel Pipes

When opened conductors with or without protective covers cross pipes and insulated conductors and cables are installed nearby the pipe in parallel, a safe distance must be ensured from the conductor and cable to the pipe.

When insulated conductors and cables cross a hot pipe, they must be protected against the effects of high temperature or via an appropriate specification.

When opened insulated conductors and cables are installed in parallel with a hot pipe, they must be protected against the effects of high temperature or must have suitable technical characteristics.

Table 179 Minimum distance from insulated conductor and cable to pipe

Situation of insulated conductor, cable and pipe	Type of pipe	Minimum distance (mm)
Insulated conductors and cables cross pipes	Pipes (except the pipes below)	250 (50*)
	Pipes for flammable fuel and gas, etc.	250 (100*)
Insulated conductors and cables go nearby pipes in parallel	Pipes (except the pipes below)	100
	Pipes of flammable fuel and gas, etc.	400

*Note: Above figures apply to insulated conductors and cables protected against mechanical action with the length longer than 250mm at each side of the pipe.

Article 180. Condition for Traversing Walls and Floors

In places where insulated conductors or cables traverse walls or floors or are laid outside, ease of replacement must be ensured.

Article 181. Installation in Dry and Humid Halls

When opened insulated conductors and cables are laid from dry hall to dry hall or humid hall to humid hall, the installation of all conductors in a single isolated pipe is permissible.

When the insulated conductors and cables go from a dry hall to a very humid hall or from either hall to outside, each conductor must be placed in a separate isolated pipe. When the conductor goes from a dry hall to a humid or very humid hall or outside the building, the connection of the conductor must be arranged in a dry or humid hall.

Article 182. Limitation for Conductors and Cables Installed in Bundles

The permanent permissible current of indoor opened insulated conductors and cables installed in bundles or many layers must be selected taking into account the reduction coefficient, quantity and arrangement of conductors in the bundle and the quantity and arrangement between bundles (layers), including unloaded conductors.

Article 183. Connection of Pipes, Boxes and Hoses

Pipes, boxes and hoses must be connected to protect the insulation and cover of indoor opened insulated conductors and cables from the adverse effects of vapor, gas, oil and dust.

The connection of metal pipes functioning as earthing or neutral conductors must satisfy the requirements specified in this chapter and in Part 6.

Article 184. Prohibition of Installation in Ventilation

The installation of wirings in channels and ventilation tunnels is prohibited. These channels and tunnels may, however, be crossed by single insulated conductor or cable installed in steel pipes.

Article 185. Installation in Roofed Halls

In roofed halls, the following types of house wirings may be installed:

Opened type:

Insulated conductors and cables placed in pipes as well as insulated conductors and cables with protective covers made of non-flammable or flame-resistant material: at any height.

One core insulated conductor without a protective cover, placed on an insulated pulley or insulator and at a height exceeding 2.5 m. When the height to the conductor is equal or less than 2.5m, the conductor must be protected against earth fault and mechanical damage.

Closed type: on walls, roofs made of non-flammable material: at any height.

Article 186. Conductors in Roofed Halls

Aluminum core insulated conductors and cables may be installed in roofed halls:

- In buildings with roofs made of non-flammable materials: insulated conductors and cables openly installed in steel pipes or closely installed on walls or roofs made of non-flammable material.
- In production buildings with roofs made of flammable material if insulated conductors and cables are openly installed in steel pipes preventing dust penetration and branch boxes connected by threads.

Article 187. Connections and Branches in Roofed Halls

Connections and branches of copper or aluminum core insulated conductors and cables in roofed halls must be arranged in metal connections and branch boxes, by welding, pressuring or bolts, suitable for the material area and the number of cores.

Branches from the house wirings installed in the roofed hall to electrical equipment installed outside the same are permissible provided the power line and branching are openly installed in steel pipes or closely in a wall or roof made of non-flammable material.

Article 188. Switching Devices in Roofed Halls

Switching devices for lighting circuits and other electrical equipment installed in the roofed hall must be installed outside this hall.

Chapter 3-1-3 Outside Wirings with voltage up to 1kV

Article 189. Requirements for Outside Wirings

Insulated conductors without protective covers of outside wirings must be arranged or separated in sites completely inaccessible to the public.

Insulated conductors and cables must also be ensured at a safe distance from other conductors, ground and buildings etc. shown in Table 189-1 and 189-2.

Table 189-1 Minimum distance from conductor of opened outside wirings installed on wall to ground and buildings

<table>
<tr><th>Direction</th><th>Installed place</th><th>Minimum distance (m)</th></tr>
<tr><td rowspan="4">Horizontal arrangement</td><td>Upward from balcony, stairs and roof of industrial building</td><td>2.5</td></tr>
<tr><td>Upward from window</td><td>0.5</td></tr>
<tr><td>Under balcony</td><td>1.0</td></tr>
<tr><td>Under window (counted from threshold)</td><td>1.0</td></tr>
<tr><td rowspan="2">Vertical arrangement</td><td>To window</td><td>0.75</td></tr>
<tr><td>To balcony</td><td>1.0</td></tr>
<tr><td>Height</td><td>From ground surface</td><td>2.75</td></tr>
</table>

Table 189-2 Minimum distance between conductors in one circuit

Span-length (m)	Minimum distance (m)
Up to 6	0.10
Exceeding 6	0.15

When two outside wirings with voltage up to 1kV are located on the same pole, the vertical distance between the two lines shall not be less than the value in Table 189-3.

Table 189-3 Minimum distance between outside wires with voltage up to 1kV

The place of the two lines	The distance between the wires	Minimum distance (m)
Vertical arrangement	- Between the bare conductor - From bare conductor to insulated wires and cables	0.4
	- Between the insulated wire or cable	0.2
Horizontal arrangement	- Between the bare conductors - From bare conductor to insulated wires and cables	0.2
	- Between the insulated wire or cable, between the pole span up to 6m	0.1
	- Between the insulated wire or cable, between the pole span of more than 6m	0.15

Article 190. Distance to Firefighting Roads

The minimum distance from insulated conductors of outside wirings to firefighting roads, where outside wirings and roads intersect, must be 6m in sections traversed by firefighting cars, and 3.5m in other sections.

Article 191. Installation in Pipes and Boxes

The installation of insulated conductors and cables of outside wirings in metal pipes, boxes and hoses must comply with the requirements of pipes etc. on house wirings and sealing must be applied in all cases. The installation of conductors in steel pipes and boxes buried underground outside the building is prohibited.

Chapter 3-1-4 House and Outside Wrings with Voltages exceeding 1kV to 35kV

Article 192. Installation Height

House and outside wirings must be installed at elevation for safety as protection against the surrounding environment and to comply with the protection class of the conductor.

Table 192 Minimum height from floor to conductor

Place	Conditions	Minimum height (m)
Production hall	- Conductor with protection class less than IP 41 and more	2.5
	- Conductor with protection class of IP 41 and more - Only professional staff can enter the hall	Not stipulated
Electrical hall	- Conductor with protection class less than IP 41	2.5
	- Conductor with protection class of IP 41 and more	Not stipulated

Article 193. Lightning protection for Outside Wirings

For outside wirings must comply with the requirements of lightning protection in Article 99 in Technical Regulation Vol.1.

Article 194. Installation in Tunnels and Corridors

The installation of house and outside wirings in tunnels and corridors must comply with the requirement for minimum gap and human safety, such as the width of the corridor, height of the barricade, earthing switch, lighting system and ventilation.

Table 194 Minimum height of barricade

Items	wirings	Minimum height (m)
Height from floor to the top of barricade	House and outside wirings without protective cover	1.8

Article 195. Installation of Soft Outside Wirings

Soft outside wirings with voltage exceeding 1 to 35kV and technical pipelines are installed on the same pole is prohibited.

Article 196. Distance from Live Parts

The distance between live parts of soft outside wirings with voltage exceeding 1 to 35kV and distance from live parts to earthing, buildings and other structures as well as to cars, roads or railways must be selected in compliance with the value specified in chapter 3-3.

Article 197. Condition for the Checking Distance

The distance from soft outside wirings with voltage exceeding 1 to 35kV to other structures at intersection must be checked in consideration of the additional load due to spacer between phases and in one phase and the potential for the conductor to reach the maximum temperature.

Article 198. Expected Location of Earthing Connection for Extension of Soft Outside Wirings

The extension of soft outside wirings with voltage exceeding 1 to 35kV must be arranged with the projected location for connecting earthing mobile means. The number of earthing mobile connections must be selected to comply with the requirements of earthing means and the induced voltage.

Article 199. Calculating Conditions for Soft Outside Wirings

The calculation of soft outside wirings with voltage exceeding 1 to 35kV must be based on the following requirements:

1. Tension force and stress in conductors corresponding to different external load combinations must be selected with regard to the permissible standard tension force of each phase, depending on the strength of the pole and the force bearing structure.

2. Additional load on the conductor due to the fixed spacer between phases and in one phase must be taken into account.
3. Calculation of wind pressure on the conductor must be carried out in compliance with article 128.

Chapter 3-2 Power Cable Line Systems with Voltage up to 220kV

Chapter 3-2-1 The Selection of Cables

Article 200. Requirement for Different Environmental Conditions

If the power cable line traverses areas with different environmental conditions, the structure of the power line and the cross-sectional area of the cable must satisfy the requirements for the area with the most severe conditions.

If extended sections of power cable line route are installed in areas with different installation conditions, the structure of the cable line and the cross-sectional area of the cable must be selected appropriately for each section.

Article 201. The Selection of Cables and Protection

The type of cable and cable protective measures must be selected taking into account the installation environment, operating condition and technical-economic benefit.

Article 202. Design for Oil-Filled Cables

For oil-filled power cable lines with voltage from 110 to 220kV, the type and structure of the cable must be specified in the design.

Article 203. Installation of Neutral Conductor

In power networks with 4 conductors, 4-core conductors must be used and the separate installation of neutral conductors from phase conductors is prohibited.

In AC 3-phase power networks with 4-core - aluminum sheath - conductors, earthed neutral conductors and voltage up to 1kV, 3-core, the conductor aluminum sheath may be used as an earthing neutral conductor, except in the following cases:

a) Installation in an explosive environment (indoor and outdoor).
b) Installation in places where under normal operation conditions, the current in the neutral conductor exceeds 75% of the permissible current of the phase conductor.

In the above-mentioned places, using a lead sheath of a 3-core cable as a neutral conductor is only permitted in the case of 380/220V power network (urban area) rehabilitation.

Article 204. Oil Cable Systems

Oil cable systems shall comply with the requirements of the manufacturer.

Chapter 3-2-2 Installation of Cable Connection Boxes and Cable Terminals

Article 205. Installation of Cable Connection Boxes and Terminals

The installation of cable connection boxes and cable terminals must be implemented smoothly alongside the operation of the cable and surrounding environment. For cable connection boxes and cable terminals, must ensure no harmful substance can penetrate the cable.

Article 206. Requirements for Cable Connection Boxes

Full- and half harness connection boxes must be installed in the cable well. When the cable is buried in the ground, the cable box shall be placed in the cable cellar and covered with fine soil or sand.

In areas with electric transport means (underground electrical car systems, electrical trains and railways) or in areas with soil harmful to the metal cover of the cable, the cable box must be easily accessible to check.

Chapter 3-2-3 Special Requirements for Power Cable Lines

Article 207. Provisions against Fire

The main power connection diagram, auxiliary power diagram and control system diagram, equipment type and cable combination in power plants or substations must be installed so that if a fire happens inside or outside the cable combination and some power generating unit of the power plant can still be normally operated, there is no interruption of the reserve connection of switch equipment and substations as well as the firefighting and fire warning systems.

Article 208. Cable Structures in Power Plants

When installing cable groups in power plants, the power cable line routes must be selected taking the following into account:

- Cables heated up due to heat generated by technical equipment.
- Cracks and deformation of cables, cables becoming dirty due to dust.

Transit cables must not be installed in technical tunnels, ventilation tunnels of power plants, chemical treatment plants as well as in places where corrosive chemical pipeline systems are arranged.

Article 209. Spare Cables

Spare cables must be installed so that in the event of a fire, they are not damaged at the same time.

Chapter 3-2-4 Cables Installed Underground

Article 210. Installation Underground

When a power cable line is installed underground, it must be placed in a cellar. Clean soil free of gravel, stone, ash or waste shall be laid under and over the top of the cable. Along the whole power cable line, protective measures must be arranged to prevent any impact from mechanical action.

For power cable lines with voltage up to 1kV, protection shall be arranged only for sections potentially prone to be damaged by mechanical action.

Article 211. Depth of Buried Cables

1) Power cable lines shall be installed at an appropriate depth depending on voltage to avoid car loads or construction work. When the cable goes near a building or underground structure, if the stretch of cable route is short, the depth can be reduced, but the cable must be protected against the action of mechanical impact.
2) Power cable lines must be at a safe distance from the foundations of buildings or other structures.

Table 211 Minimum depth of buried cable

<table>
<tr><th>Voltage (kV)</th><th>Minimum depth (m)</th></tr>
<tr><td>22</td><td>0.7</td></tr>
<tr><td>35</td><td>1.0</td></tr>
<tr><td>110</td><td rowspan="2">1.5
(0.5*)</td></tr>
<tr><td>220</td></tr>
</table>

*Note: Above figure applies to cables protected against mechanical impacts at cable sections with length less than 5 m, entrances of building or intersection with underground structures.

Article 212. Installation Nearby and Crossing Other Cable Lines

If power cable lines are near each other or intersect other cable lines, the power cable line must be at a safe distance from the other lines.

Table 212 Minimum distance between cables

The crossover cables	Minimum distance* (mm)
- Between power cables with voltage up to 10kV - Between power cable with voltage up to 10kV and secondary cable	100
- Between power cables with voltage from 22kV to 35kV - Between power cable with voltage from 22kV to 35kV and other cable	250 (100*[2])
- Between cables of different agencies	500 (100*[2])
- Between power cable and communication cable	500 (250*[2])

The crossover cables	Minimum distance* (mm)
- Between power cable protected against short circuit with voltage up to 10kV and communication cable	250
- Between cables with voltage from 110kV to 220kV - Between cable with voltage from 110kV to 220kV and other cable	500 (250*[2])
- Between secondary cables	Not stipulated

*Note: The values of minimum distance apply the cable without the specification.

*[2]Note: In narrow topography conditions, unified management agencies can reduce the clearance between the power cables or clearance between the cables managed by different organizations to 100mm. Clearance between power cable lines with voltage up to 220kV or clearance between them and communication cables can be reduce to 250mm, if conditions jacketed cable is protected against fire or a cable is usually placed in the pipe without firefighting.

Article 213. Installation in Parallel to Other Objects

If a power cable line is installed in parallel to other objects such as pipelines, heat pipelines, railways, electrical car roads and car roads, the power cable line must be at a safe distance from the other lines and objects and have protective measures to prevent the harmful influence of the latter.

When a power cable line is installed in parallel with a railway, the power cable line must be placed beyond the boundary of the railway corridor. In special cases, subject to the agreement of the railway management agency, the power cable line may be installed within the railway boundary.

Table 213 Minimum distance from power cable line to other object

Description of distance	Minimum distance (m)
Distance from power cable line with voltage up to 35kV and oil-filled cable line to pipe (water pipe and water canal) and gas pipeline with pressure from 0.0049MPa to 0.588MPa.	1.00 (0.50*, 0.25*[2])
Distance from power cable line with voltage up to 35kV and oil-filled cable line to gas pipeline with pressure exceeding 0.588MPa to 1.176MPa.	2.00 (0.50*, 0.25*[2])
Distance from power cable lines with voltage of 110kV and 220kV to pipelines (except liquid fuel and gas pipelines), which are placed near pipelines at section length up to 50m with partitions to avoid the damage by mechanical action.	0.50
Distance from power cable lines to heat pipelines.	2.00*[3]
Distance from power cable lines installed within railway boundary to central axis of railway	3.25*[4]
Distance from power cable lines to central axis of electrified railway.	10.75*[5]
Distance from power cable lines to central axis of electric car ways.	2.75*[5]
Distance from power cable lines to road of categories I and II.	1.00*[6]

*Note: Above figures apply to the distance from power cable lines with voltage of 35kV to pipelines (except liquid fuel and gas pipelines) at narrow spaces.

*2Note: Above figures apply to the cable lines in "*Note" placed in pipes along the whole length.

*3Note: Power cable lines with thermal insulation layer to avoid the increase of temperature are permissible to reduce the distance.

*4Note: Installation of power cable lines within railway boundary shall be agreed by railway management agency.

*5Note: Power cable lines which placed in insulated pipes or blocks for the whole length at narrow space are permissible to reduce the distance.

*6Note: The distance can be reduced if transport management agency agrees.

Article 214. Crossing Other Objects

If power cable line crosses other objects such as pipelines, heat pipelines, railways, car roads, car railways, car halls, streams, water canals or alluvial banks, it is important to secure a safe distance between the power cable line and other objects, a safe depth from the road surface and respective protective measures.

Table 214 Minimum distance between cable and other object

Other object	Type of cable	Condition	Minimum distance (m)
Surface of railways or car road	Protected cable	- The cable at intersection is placed in the tube, the cable tunnel or cable block with the length of the entire intersection plus 0.5m on both sides.	1.0
All pipes except heat pipe	All cables without cable block and pipe	- Ground condition surrounding cables is stable	1.0
		- Ground condition surrounding cables is unstable	1.5
	All cables with cable block	- Not in special condition	Not stipulated
	All cables with pipe	- Not in special condition	0.25
Heat pipe	All cables without cable block and pipe	- Ground condition surrounding cables is stable	1.0
		- Ground condition surrounding cables is unstable	1.5
	All cables with cable block	- Heat pipes have thermal insulation which is as long as whole intersected section and 2m longer than the section at both sides. - Heat pipe are thermally insulated so that temperature of ground surrounding cables are not increased by 10 degree Celsius against the highest temperature in summer and 15 degree Celsius against the lowest temperature in winter.	Not stipulated
	All cables with pipe	- Ditto	0.25

Article 215. Installation of Cable Connection Boxes

When installing cable connection boxes, the distance from the cable connection box to the nearest cable must be not less than 250mm, and protective measures must be ensured.

For the installation of oil-filled cables on inclined routes, cable connection boxes must not be used. If there is no alternative to installing a connection box on an incline, a small horizontal area must be arranged for installation.

In order to replace a damaged cable connection box, reserve cable length must be arranged on both sides of the cable connection box.

Article 216. Protection against Stray Electricity Currents

If a power cable line is exposed to stray electricity currents at a dangerous level, the power cable line must have appropriate measures to protect against the same.

Article 217. Cable Pipes and Cable Blocks

Cable pipes and cable blocks must have protective functions for cables and the installation of the cable pipe and cable block must be determined to ensure the safe condition of the cable.

Article 218. Structures for Cable Arrangement

Cable arrangement structures must have measures to ensure the proper condition of the cable.

Chapter 3-2-5 Installation of Power Cable Lines in Cable Structures

Article 219. Reserve Cable Structures

Cable structures must have reserves for adding and replacement purposes.

Article 220. Requirements for Cable Structures

Cable structures must have fire resistant measures and shall be installed so that people can access easily.

Article 221. Requirements for Cable Tunnels, Canals and Other Cable Structures

In cable tunnels and cable canals, measures must be applied to prevent industrial effluent, oil inflow and pump discharge outflow of soil-sandy water.

In cable tunnels, pumps must be arranged to drain drainage water automatically depending on the water level.

The dimensions and weight for the installation of cable structures must take into account the persons using the same.

Article 222. Prohibition of Installation in Dangerous Places

In places where there may be molten metal, liquid or materials at high temperatures capable of damaging metal enclosures, the construction of cable canals is prohibited. In such places, arrangements of doors to cable cellars and cable tunnels are also prohibited.

Article 223. Limitation of Heat Exposure from Heated Pipelines

When power cable lines are installed together with heated pipelines in cable structures, increases in air temperature at the cable installation site due to the heated pipeline must be prevented as far as possible.

Article 224. Fire Resistance and Firefighting in Cable Structures

Measures for fire resistance and firefighting must be taken between power cable lines and other cables in cable structures.

Article 225. Requirement for Cable Wells

Cable wells must be at least 1.8m in height. Cable wells used for cable connection boxes and braking or fixed half of the braking connection boxes must have dimensions sufficient to install cable boxes without additional digging.

Cable wells on the ground where power cable lines go into water must have appropriate dimensions for the installation of reserved cables and other equipment.

In cable wells, metal ladders must be arranged.

Holes for access to cable wells and tunnels must have diameters of at least 650mm and locked metal covers which can be opened from inside without a key.

Article 226. Installation of Oil-Filled Power Cable Lines

Installation of oil-filled power cable lines comply with the requirement of the manufacturer.

Article 227. Ventilation Equipment and Lighting Systems

Cable structures, except for cable story and cable cellars used for placing cable connection boxes, cable tunnels and cable rooms must be equipped with ventilation.

Cable tunnels, cable rooms and outdoor cable bridges, must be equipped with lighting systems and power resources for portable lamps.

Chapter 3-2-6 Installation of Cable Lines in Production Halls, Water or Special Structures

Article 228. Installation of Cables in Production Halls

For installation of power cable lines in production halls, the following requirements must be complied with:

- Easy access for maintenance or open space for cable observation. Cables installed in areas traversed by machines, equipment and vehicles must be protected against damage as specified in article 106.
- It is prohibited to install cables in parallel with, above or below oil pipelines and around vertical pipelines with liquid fuel.

The installation of cables in ventilation compartments is prohibited. Cables may cross the ventilation compartment, but each cable must be installed in a separate steel pipe.

The open installation of cables in stair rooms is prohibited.

Article 229. Installation of Cables in Water

When power cable lines traverse streams, canals etc., they must be placed on the bottom section and banks with little excavation. In areas of river where the water flow varies and the bank is underwater, the installation of cables at the river bottom must be considered taking the particular local conditions into account. The depth for the installation of cables must be specified in the design.

Article 230. Installation of Cables under the Sea

The installation of power cable lines under the sea must pay attention to the depth, and the pushing force of the water due to wind at the point where the cable enters the water.

Power cable liens must be installed so that the electric shock do not occur and buried at the sea bottom except the place where they might be damaged in considerable of the topographical condition, chemical component of the sea bottom, chemical component of the sea water, the anchorage of marine vessels and halieutics by fisherfolk.

Article 231. Prohibition of Crossing Other Cables in Water

If a power cable line crosses other cables in the water, the cable must have the solutions agreed by manufacture and design agency.

Article 232. Warning Plates on Banks

At places where power cable lines cross rivers and canals, warning plates must be arranged on the bank according to the present transport law for waterways and seaways.

Article 233. Installation of Cables in Special Structures

Power cable lines in special structures must be installed to minimize the risk of damage to the cable from the surrounding structures and environment.

Chapter 3-3 Overhead Power Line Systems with Voltage up to 500kV

Chapter 3-3-1 Power Conductors and Lightning Conductors

Article 234. Requirements of Conductors with Voltage up to 1kV

Overhead power lines with voltage up to 1kV must use single- or multi-core stranded conductors. Depending on the physical-mechanical strength, overhead power lines must use conductors with sufficient cross-sectional area.

For branches from the main overhead power line into houses, the cross-sectional area of the conductor must depend on the length of the conductor and the load.

Table 234 Minimum cross-sectional area or diameter of conductor of overhead power line with voltage up to 1kV

Type of conductor	Minimum cross-sectional area (mm^2) or Diameter (mm)
- Stranded aluminum conductor	$16mm^2$
- Stranded aluminum conductor steel reinforced - Stranded aluminum alloy conductor steel reinforced	$10mm^2$
- Stranded copper conductor	$4mm^2$
- Single core copper conductor	3mm
- Insulated copper conductor for branch lines with length up to 10 m - Insulated copper conductor for branch lines with length exceeding 10m to 25 m	$4mm^2$ $6mm^2$

Article 235. Conductor Connections

Conductor connections of overhead power lines with voltage up to 1kV must be performed by pressing, welding or clamping (Screws, Bolts...).

For the connection of single-core conductors, the core shall be twisted and then welded or pressured. Attaching two ends of the core by butt welding is prohibited.

Connections of different metal conductors or conductors with different cross-sectional area with voltage up to 1kV must be performed by jumper, these connections must be free from force and electro-chemical corrosion.

Article 236. Condition of Sag

- Maximum sag of conductor is determined by the largest environmental temperature at the installation location when the wire carrying the current to cause the long-term heating in the wire.

- The distance from the conductor of overhead power lines to the ground surface, water surface or other structure counted from the lowest conductor when the maximum sag of the conductor in static state

Article 237. Requirements for Conductors with Voltage exceeding 1kV

According to mechanical strength, overhead power lines with voltage exceeding 1kV must use power and lightning conductors of the multi stranded type as shown Table 237-1 and 237-2. When selecting conductors of overhead power lines, the corona condition must be checked.

In a span-length of pole of OPL voltage above 1kV, each wire or lightning conductor is allowed only one connection, except for some exceptions

Table 237-1 Minimum cross-sectional area of conductor and lightning conductor of overhead power line with voltage exceeding 1kV

Description of overhead power line	Minimum cross-sectional area (mm^2)			
	Aluminum	Aluminum or aluminum alloy steel reinforced	Steel	Copper
In normal span-length of overhead power line	35	25	25	16
In span-lengths of overhead power line crossing rivers and channels where the boats and ships pass through	70	35	25	25
In span-lengths of overhead power line crossing communication lines, above-ground pipelines, cableways and railway	70	35	25	25

Table 237-2 Minimum cross-sectional area of one conductor according to voltage

Voltage (kV)	Minimum cross-sectional area (mm2)
110	120
220	240
500	330

Article 238. The Selection of Lightning Conductors

When selecting lightning conductors for overhead power lines with voltage exceeding 1kV, apart from calculating mechanical strength, a check of the thermal stability must be carried out, in the event of a one-phase earth fault short circuit at the pole of the overhead power line.

Article 239. Calculation Condition for Conductors and Lightning Conductors

Calculation must be carried out for power and lightning conductors of overhead power lines with voltage exceeding 1kV with respect to the following conditions:

(1) Maximal external load

(2) Lowest temperature and without external load

(3) Average yearly temperature and without external load

Article 240. Requirements against Rust

When overhead power lines with voltage exceeding 1kV are over areas where the conductor may be exposed to rust, corrosion-resistant conductors must be used or the overhead power line shall be located far from such areas.

Article 241. Protection against Vibration

Power conductors and lightning conductors of overhead power lines with voltage exceeding 1kV based on the ability of stress must be protected against vibration.

Article 242. Phase Divided Conductors

Multiple phase conductors in span of overhead power lines and tie conductors on anchor poles must be installed by the spacer frame.

Chapter 3-3-2 Arrangement of Power Conductors and Lightning Conductors

Article 243. Arrangement of Conductors, Neutral Conductors and Equipment

When power conductors and neutral conductors of overhead power lines with voltage up to 1kV are arranged at different heights, the neutral conductor shall always be placed under the power conductor. Outdoor lighting line conductors on the same pole of overhead power lines with voltage up to 1kV can be arranged under the neutral conductor.

Fuses and sectional disconnectors etc. placed on the pole must be arranged below the power conductor.

Article 244. Distance between Conductors in the Same Line

The distance between conductors must be selected with respect to their working condition in a pole span as well as the permissible distance between a conductor and the part of pole regarding electrical safety.

Article 245. Distance between the Nearest Conductors of Multiple Circuits

On a pole with multiple circuits of overhead power lines, (at the pole), the distance between the nearest conductors of two adjacent circuits with the same voltage must be applied to the following table. For multiple circuits on pole with different voltage, the distance must be applied to the one of the higher voltage.

Table 245 Minimum distance between the nearest conductors of two circuits

Voltage (kV)	Conductor	Insulator	Minimum distance (m)
Up to 22	Bare conductor	Standing or Suspension	2.0
	Insulated conductor and cable	Standing or Suspension	1.0
35	-	Post-type	2.5
		Suspension-type	3.0
110	-	-	4.0
220	-	-	6.0
500	-	-	8.5

Article 246. Distance from Live Parts on Poles

For overhead power lines requiring repair when the conductor is live, to ensure safety for people working on the pole, a safe distance from the conductor and accessory to the metal or reinforced concrete trunk of the pole, that people can climb, with no deviation of the conductor must be maintained.

Table 246 Minimum distance from live parts on poles to the pole body

Voltage (kV)	Minimum distance (m)
Up to 110	1.5
220	2.5
500	4.0

Article 247. Installation of Conductors with Different Voltages

Conductors with voltages varying from 110kV up to 500kV can be arranged on the same pole.

The distance between two adjacent circuits of different voltages must be selected as specified in articles 245, 246 with respect to conductors with higher voltage.

Conductors of overhead power lines with voltage no less than 110kV must be arranged to upper side conductors of with higher voltage, but the conductors must have cross-sectional area more than $120mm^2$ and double insulation must be used.

Chapter 3-3-3 Insulators

Article 248. Suspended Insulators

The number of insulators and the type of suspended insulator used for overhead power lines with voltage exceeding 1kV shall be determined according to the leakage current, neutral point connecting method, creepage distance according to the pollution of the installed environment, overvoltage, height from sea surface, height of pole and installation type of insulator.

Overhead power lines with voltage of 110kV and above shall use suspended insulators or other appropriate insulators.

Article 249. Mechanical Strength of Insulators

Insulators must have surplus mechanical strength in terms of their operating condition.

Chapter 3-3-4 Power Line Accessories

Article 250. Accessories

Accessories of conductors must have surplus mechanical strength in terms of their operating condition and be installed using an appropriate method.

Chapter 3-3-5 Overvoltage Protection

Article 251. Atmospheric Overvoltage Protection

Overhead power lines with voltage of 110kV and above and poles must be protected against direct lightning strikes by a lightning conductor arranged along the whole length of the overhead power lines, except for special sections in which arrangement of a lightning conductor is impossible. In such exceptional cases, lightning protection measures must be added.

Lightning conductors must be installed at appropriate positions, taking into consideration the protection angle and distance between the power and lightning conductors.

For stretches of overhead power lines with lightning conductors, the sag of the lightning conductor must not exceed that of the power conductor.

Article 252. Additional Lightning Conductor Requirements

Lightning conductors must be installed by appropriate measures. Special installation is allowed for lightning conductors with optical fibers.

Article 253. Lightning Protection

The equipment for lightning protection must be used metal lightning piles, grounding conductors, electrical discharge gap or lightning arresters made of zinc oxide.

Cable terminals connected to overhead power lines with voltage exceeding 1kV must be protected against atmospheric overvoltage by the installation of an arrester at the cable terminal.

Overhead power lines with voltage exceeding 1kV which cross large rivers or mountain gorges with poles higher than 40m but without lightning conductors must be installed with lightning arresters.

Article 254. Insulation Distance

When overhead power lines with voltage exceeding 1kV traverse areas at elevation up to 1000m above sea level, the insulation distance between the conductor, their live accessories and earthing parts, the pole must ensure sufficient distance for safety as shown in the following table.

Table 254 Minimum insulation distance (at Pole) between live parts and earthing parts

Calculation condition*	Minimum insulation distance (m)					
	Up to 10	22	35	110	220	500
Atmospheric overvoltage for post-type insulator	0.15	0.25	0.35	-	-	-
Atmospheric overvoltage for suspension insulator	0.20	0.35	0.40	1.00	1.80	3.20
Internal overvoltage	0.10	0.15	0.30	0.80	1.60	3.00
Maximum operational voltage	-	0.07	0.10	0.25	0.55	1.15

Note:* refer to article 128.

Article 255. Minimum Distance between Conductors at Branch or Phase Transposition Pole

The minimum distance between conductors of overhead power lines with voltage exceeding 1kV at poles with transposition, branches and at places with changed conductors must ensure sufficient distance for safety.

Table 255 Minimum insulation distance between conductors at pole

Calculation condition	Minimum insulation distance (m)					
	Up to 10	22	35	110	220	500
Atmospheric overvoltage	0.20	0.45	0.50	1.35	2.50	4.00
Internal overvoltage	0.22	0.33	0.44	1.00	2.00	4.20
Maximum operational voltage	-	0.15	0.20	0.45	0.95	2.00

Chapter 3-3-6 Poles

Article 256. Kinds of Poles

Overhead power lines must use appropriate kinds of poles based on the installation condition of overhead power lines, pole locations and the bearing force of the conductor.

Overhead power lines shall use support poles, straight anchor poles, corner poles, braking poles, dead end poles, branch poles, crossing poles, phase transposition poles and special poles.

Article 257. Anchor Wires

To enhance the force bearing capability, support or anchor wires are used for poles. Anchor wires must not obstruct human and vehicle traffic.

Anchor wires of overhead power lines must be earthed and their earthing resistance must comply with the requirement specified in this Regulation. If anchor wires are not grounded, they must be insulated by an anchor-shaped insulator from the voltage of the overhead power line and installed at a minimum height of 2.5m from the ground surface.

Article 258. Calculation of Poles

All pole types of overhead power lines with voltage up to 1kV must only be calculated with a load corresponding to normal operating conditions, conductor shall remain unbroken in the following two cases: maximum wind pressure and lowest temperature.

Poles of overhead power lines with voltage exceeding 1kV must be calculated with the gravity loads for normal and fault operating conditions of overhead power lines taken into consideration.

The load on poles must be calculated according to the rules for each type of pole.

Article 259. Material of Poles

For overhead power lines, steel and reinforced concrete poles must be used.

Article 260. Buried Portion of Poles

The depth of the pole buried in the ground must be calculated according to the topographical conditions, geological location of the pole as well as mechanical and physical properties of the pole.

Measures to protect against soil collapse must be applied when the pole is located in an area under water.

Article 261. Confirmation for Anchor Poles

The mechanical strength of anchor poles of overhead power lines with voltage exceeding 1kV must be confirmed with the installation condition of power and lightning conductors.

Article 262. Confirmation for Arms and Support Bars

The mechanical strength of arms and support bars of all poles of overhead power lines with voltage exceeding 1kV must be confirmed with the corresponding load according to the installation method in the design, tensile force of the anchor wire, weight of the power and lightning conductors, insulators, accessories and workers with installing tools.

These loads shall be placed at the point of insulator installation.

Article 263. Safety for Workers Climbing on Poles

Metal poles and reinforced concrete poles of overhead power lines must have a structure to accommodate workers climbing on the pole.

Chapter 3-3-7 Particular Requirement

Article 264. Confirming Condition of Conductors near Houses

When confirming conductors of overhead power lines with voltage up to 1kV near houses, the structure and architectural structure must be considered based on the condition of the wind pressure and maximum air temperature.

Article 265. Distance from the Outer Edge of Pole's Foundation

The distance from the outer edge of the pole foundation of overhead power lines with voltage up to 1kV to underground cable lines, underground pipelines and single pole on the ground must ensure sufficient distance for safety.

Table 265 Minimum distance from outer edge of pole foundation to other object

Other object	Minimum distance (m)
Water, gas, steam, heat or water drainage pipeline	1.0
Water tap for fire-fighting, trench or water well	2.0
Petroleum station	10.0
Underground cable (expect communication or signal cable)	1.0
Underground cable in pipe	0.5

Article 266. Crossing Overhead Power Lines with Voltage up to 1kV

Crossing between overhead power lines with voltage up to 1kV shall be arranged on a crossing pole.

Crossing on spans is also permitted. In this case, the vertical distance between the nearest conductors of crossing overhead power lines with voltage up to 1kV at the highest air temperature without wind must ensure sufficient distance for safety.

Table 266 Minimum vertical distance between the nearest conductors

Type of conductor	Minimum vertical distance (m)
Insulated conductor	0.5
Bare conductor	1.0

Article 267. Twisted Cable

Twisted cable of overhead power lines with voltage up to 1kV must be installed with appropriate condition.

When twisted overhead cable lines share a pole with other overhead lines with voltage up to 1kV, the distance between these overhead power lines with voltage up to 1kV must ensure sufficient distance for safety.

The distance from twisted overhead with voltage up to 1kV conductor lines to ground or architectural structures must also ensure sufficient distance for safety.

Chapter 3-3-8 Traversing Non Populated Areas

Article 268. Requirement for Non-Populated Areas

Overhead power lines with voltage exceeding 1kV which traverse non-populated areas must comply with the requirements for the use of conductors and the distance from overhead power lines to trees shown in Table 8-5. In case that trees rapidly grow in short time and the trees are no longer economic effect, they must be cut down and re-planting is prohibited.

Article 269. Vertical Distance for Non Populated Areas

The vertical distance from the lowest conductor of overhead power lines to the ground surface, under normal operating conditions, must be a safe vertical distance for non populated areas.

Table 269 Minimum vertical distance from conductor to ground in non populated area

Voltage (kV)	Minimum vertical distance (m)		
	Area where vehicles rarely pass through	Area which is difficult to access	Area which is very difficult to access
Up to 1	5.0	4.0	2.0
Exceeding 1 to 35	5.5	4.5	2.5
110	6.0	5.0	3.0
220	7.0	6.0	4.0
500	10.0	8.0	6.0

Article 270. Distance from Nearest Conductors

For conductors of overhead power lines with voltage exceeding 1kV, the distance from the nearest conductor at static state to the nearest stretched-out parts of structures must ensure sufficient distance for safety.

Table 270 Minimum distance from the nearest conductor to the nearest stretched-out parts of structures in non-populated area

Voltage (kV)	Minimum distance (m)
Exceeding 1 to 22	2.0 (1.0*)
35	3.0 (1.5*)
110	4.0
220	6.0

*Note: Above figures apply to insulated conductors and cables.

Chapter 3-3-9 Traversing Populated Areas

Article 271. Requirement in Populated Areas

Overhead power lines with voltage exceeding 1kV which traverse populated areas must comply with the requirements for the installation state and mechanical strength of power conductors, lightning conductors and other structures in the area

Table 271 Minimum horizontal distance from conductors to the houses or projects in populated areas

Voltage (kV)	Minimum horizontal distance (m)
Up to 1kV (balconies, veranda and windows)	1,5 (0,75*)
Up to 1kV (to surrounding walls)	1,0 (0,5*)
Exceeding 1 to 35	4.0
110	6.0
220	6.0
500	8.0

* Note: the above applies to insulated wires and cables.

The horizontal distance from the outer edge of the pole of overhead power lines with voltage exceeding 1kV to the edge of the roads (taking into account the expansion planning) must comply with safe distance shown in Table 293.

Article 272. Safe distance to Populated Areas

The distance from the lowest point of the conductor of overhead power lines to the ground surface, in normal operating mode, when the line is the largest sag, not be less than specified in the following table.

Table 272 Minimum vertical distance from conductor to ground in populated area

Voltage (kV)	Minimum vertical distance (m)
Up to 1	6.0 (3.5*)
Exceeding 1 to 35	6.5
110	7.0
220	8.0
500	14.0

*Note: Above figure apply to branch sections which enter the house, and the distance is from conductor to pavement surface or pedestrian way.

Article 273. Distance in Area Required High Safety Level

The distance from the lowest point of conductor of the overhead power lines to the ground, in normal operating mode, the conductors with the largest sag shall not be less than specified in the following table.

Table 273 Minimum distance from conductor to ground in area required high safety level

Voltage	Up to 35kV	110kV	220kV
Minimum Distance	14m	15m	18m

When overhead power lines cross or go through area required high safety level, they must add the electrical safety measures associated with construction as follows:

a) For the pole is made of steel or reinforced concrete; safety coefficients of the pole, beams and pole's foundation must not be less than 1.2.

b) Conductor is prohibited to be connected in the span, except for conductors with cross-sectional area of 240mm^2 or more which are permitted to be connected one point in the span. Safety coefficient of conductors must not be less than 2.5;

c) Insulators must be used by double insulators, both of which have the same type and specification. Conductors and lightning conductors with suspended strings type must be fixed by the fixed supporting clamp with locked style. Safety factor of insulators and accessories must be ensured to standards in the current regulations.

Article 274. Traversing Houses and Structures in Safety Corridor

1. Houses and structures which are in safety corridor of overhead power lines with voltage up to 220kV must comply with the following conditions:

a) Roofs and walls must be made of fire-resistant (non-flammable) materials.

b) Roofs, frame and walls made of metal must be grounded in accordance with the earthing regulation.

c) The houses and structures must not obstruct the access for inspection, maintenance or replacement works of overhead power lines with high-voltage.

d) The distance from any part of the houses or structures to conductors at the maximum sag and in static state must not be less than the distance shown in the following table.

Table 274 Minimum distance from houses or structures to conductor in safety corridor

Voltage	**Up to 35kV**	**110kV**	**220kV**
Minimum distance	3.0 m	4.0 m	6.0 m

e) The electric field intensity must not be more than 5kV/m at any point with the height of 1.0m above the ground outside the houses and not be more than 1kV/m at any point within 1.0m above the ground in the houses.

2. The service works activities such as bathrooms, toilets, animal barns or warehouses which are in safety corridor of overhead power lines with voltage of 500kV must have the wish by owners and comply with the following conditions:

a) The electric field intensity must not be more than 5kV/m at any point with the height of 1.0m above the ground in safety corridor.
b) The distance from any part of the works to conductors at the maximum sag in static state must not less than 8.0 m.
c) The works must comply with the provisions of a), b) and c) in item 1 in this article.
d) The owner must promise that the works do not violate the safety gap discharge shown in Table 8-3 and 8-4.
e) Trees in the hallway and safety corridor of overhead power lines must comply with the safety distance shown in Table 8-5 .

Chapter 3-3-10 Traversing Areas with Water

Article 275.   Requirement in Areas with Water

Overhead power lines with voltage exceeding 1kV traversing areas with water must have appropriate poles, power conductors and lightning conductors for the areas.

Article 276.   Crossing Areas with Water

Overhead power lines with voltage up to 1kV shall not cross areas with water where ships and boats pass through, except overhead power lines compliant with this chapter.

The distance from the pole of overhead power lines with voltage up to 1kV to the water edge in a horizontal direction must be at least the height of the pole.

The safety distance from the lowest conductor (in a static state as the largest sag). of overhead power lines with voltage exceeding 1kV to the highest point of the ship, boats, vehicle must comply with the provisions of Table 276-1

For areas in the flood season influent water and with the activities of the means of transportation, the safety distance of overhead power lines is calculated the same as for the waterway area with the normal activities of traffic means

The distance from the lowest conductor (in a static state and at the maximum sag) of overhead power lines with voltage exceeding 1kV to the highest point of the ship, boats or vehicle must comply with the distance shown in Table 276-1.

For the areas no ships and boats passing during the flood season, the distance must comply with the distance shown in Table 276-2.

Table 276-1 Minimum vertical distance from the lowest conductor to the highest point of transport means (ND 106)

Voltage	Up to 35kV	110kV	220kV	500kV
MInimum distance	1.5 m	2.0 m	3.0 m	4.5 m

Table 276-2 Minimum vertical distance from the lowest conductor at the maximum sag to the water surface with the highest height at average year where no ship and boat passing

Features of intersected area	Minimum distance (m)			
	Exceeding 1kV up to 35kV	110kV	220kV	500kV
The flood plain or places where suffer from flood annually The highest water level of river, channel streams, lakes, canals and creeks	5.5	6.0	7.0	8.0

Article 277. Arrangement of Signs and Signals for Areas with Water

At places where overhead power lines with voltage exceeding 1kV cross rivers, canals etc., where ships and boats pass through, signs and signals must be appropriately arranged on both banks.

Chapter 3-3-11 Crossing or Going Nearby Overhead Power Lines

Article 278. Requirement when Crossing and Going Nearby Other lines

Overhead power lines crossing or going nearby other overhead power lines must have appropriate structures which comply with the requirements for pole location and pole type, conductors, insulators, distance from conductors to poles and other structures depending on the operating voltage.

Table 278 Minimum distance from conductor to pole

Detailed description of distance	Minimum distance (m)
Horizontal distance from the nearest part of higher pole to conductors on lower pole at intersection of overhead power lines with voltage up to 220kV	6.0
Distance from conductors on the higher pole to the top of lower pole at intersection of overhead power lines with voltage up to 220kV	5.0
Distance from intersected point to pole of overhead power lines with voltage of 500kV	10.0

Article 279. Vertical Distance in Crossing Places

The vertical distance between the nearest power and lightning conductors of crossing overhead power lines must ensure sufficient vertical distance for safety as shown in the following table.

When determining the distance between power conductors of crossing overhead power lines, the potential for lightning strike on both overhead power lines must be taken into account and the distance shall be selected for the more unfavorable case.

Table 279 Minimum vertical distance between conductors or between conductor and lightning conductor at intersection of overhead power lines

Crossing situation	Span-Length (m)	Minimum vertical distance (m) at distance from intersection to the nearest pole of overhead power line					
		30 m	50 m	70 m	100 m	120m	150 m
Overhead power lines with voltage of 500kV crossed on overhead power lines with voltage up to 500kV	200	5.0	5.0	5.0	5.5	-	-
	300	5.0	5.0	5.5	6.0	6.5	7.0
	450	5.0	5.5	6.0	7.0	7.5	8.0
Overhead power lines with voltage of 220kV crossed on overhead power lines with voltage up to 220kV	Up to 200	4.0	4.0	4.0	4.0	-	-
	300	4.0	4.0	4.0	4.5	5.0	5.5
	450	4.0	4.0	5.0	6.0	6.5	7.0
Overhead power lines with voltage from 22kV to 110kV crossed on overhead power lines with voltage up to 110kV	Up to 200	3.0	3.0	3.0	4.0	-	-
	300	3.0	3.0	4.0	4.5	5.0	-
Overhead power lines with voltage from 6kV to 15kV crossed on overhead power lines with voltage up to 15kV	Up to 100	2.0	2.0	-	-	-	-
	150	2.0	2.5	2.5	-	-	-

Note: If the span-length is in between the above values, interpolation method can be applied.

Article 280. Horizontal Distance between Outer Edge Conductors

When overhead power lines with voltage exceeding 1kV approach and run parallel with each other, the horizontal distance between the outer edge of the conductors at static state must not be less than safety distance shown in Table 8-1.

Chapter 3-3-12 Crossing or Going Nearby peripheral telecommunication's cable network

Article 281. Crossing peripheral telecommunication's cable network

When overhead power lines cross with peripheral telecommunication's cable network, all lines must have appropriate structures which comply with the requirements for safety measures in terms of crossing location, position of lines, poles, power conductors, insulators, and the vertical distance from power conductor to peripheral telecommunication's cable.

Table 281-1 Minimum vertical distance allowed from the highest telecommunication's cable to the lowest power wire at the crossover point (Table 4-QC33)

Voltage (kV)	Minimum vertical Distance (m)	
	With lightning conductor	Without lightning conductor
Up to 10	2	4
35	3	4
110	3	5
220	4	6
500	5	-

Note:

1. When telecommunication's cables cross overhead power lines with voltage up to 1kV, the minimum distance from the cables to the lines at intersection must not be less than 0.6m.

2. It is permitted that telecommunication's cables cross over the top of the overhead power lines with voltage up to 380V, provided that the telecommunication's cables comply with the following conditions:

a) The mechanical factor of the cables must be more than 1.5.

b) The withstand voltage of the cable sheath must be more than 2 times the voltage of the conductors.

c) The span of telecommunication's cables which cross over the overhead power lines must shorten, both poles of the intersected span must be buried into solid and be reinforced.

3. Requirements on the pole for fixed telecommunication's cables under overhead power lines

a) The distance from the top of poles for telecommunication's cables suspended under overhead power lines to the lowest conductor of overhead power lines must not be less than shown in Table 281-2.

Table 281-2 Minimum distance from pole of telecommunication's cable to conductor of overhead power line

Voltage (kV)	Up to 10	35	110	220
Minimum distance (m)	5.0	6.0	7.0	8.0

b) It is prohibited that telecommunication's cables suspended on the pole are under overhead power lines with voltage of 500kV.

c) Pole of which telecommunication's cables go nearby overhead power lines with voltage of 500kV must comply with the following conditions:

- The distance from the top of the telecommunication's cables to the lowest conductor of overhead power lines with voltage of 500kV must not be less than 20m.
- The distance from the projection on the ground surface of the pole of telecommunication's cables to the nearest conductor of overhead power lines with voltage of 500kV must not be less than 15m.

Table 283-3 Minimum distance from the pole of the overhead power lines to the peripheral telecommunication's cable network

Detailed description of distance	Minimum distance (m)
Horizontal distance from poles of overhead power lines with voltage exceeding 1 to 220kV to the peripheral telecommunication's cable network	6.0
Horizontal distance from poles of the peripheral telecommunication's cable network to conductor of overhead power lines with voltage exceeding 1 to 220kV	7.0

Article 282. Requirement for Overhead Power Lines with Voltage of 500kV

The distance from the pole of the peripheral telecommunication's cable network to the vertical plane of the outer edge of conductors of overhead power lines with voltage of 500kV must be determined according to consideration of the impact of overhead power lines with voltage of 500kV on the peripheral telecommunication's cable network.

The distance from the top of cable terminal poles of communication and/or signal lines to the lowest conductor of overhead power lines with voltage of 500kV must be not less than 20m.

Arrangement on the same pole with the peripheral of telecommunication's cable network under overhead power lines with voltage of 500kV is prohibited.

Article 283. Other Requirements for Poles

Poles in limited cross spans which have the peripheral telecommunication's cable network and overhead power lines with voltage exceeding 1kV and poles adjacent to them must be protected against collision by vehicles.

, The protection gap on poles of the peripheral telecommunication's cable network or at intersections must also be arranged.

Article 284. Intersection with Underground Telecommunication's Cable

1. Underground telecommunication's cables must be arranged above underground power cable lines. When one of the underground telecommunication's cable and the underground power cable line has metal sheath or lays in metal pipes, the distance at intersection between the underground telecommunication's cable and the underground power cable line is permitted to be reduced to 0.25m
2. When the underground telecommunication's cable goes in parallel with the underground power cable line and the distance between the underground telecommunication's cable and the underground power cable line secure no less than 0.5m, the distance is permitted to be reduced to 0.25m, but the underground telecommunication's cable and the underground power cable line must be laid in to metal pipes in case of the voltage exceeding 10kV.

a) The telecommunication's cables buried in the ground directly must depart from earthing system of power lines to avoid increasing the voltage by the fault current through the earthing system. If the underground telecommunication's cables can not depart from the earthing system, the underground telecommunication cables must be the cables which can withstand high voltage or be laid into plastic pipes isolated from the ground. In the area where the fault voltage is too large, it is necessary to replace the underground telecommunication's cables to the copper cables with fiber or microwave system. The distance between the telecommunication's cable with the metal sheath buried in the ground directly and the earthing system of power lines of high voltage must not less than the distance shown in Table 284-1

Table 284-1 Minimum distance between telecommunication cables with metal sheath buried in the ground directly and earthing system

Ground resistivity (Ω.m)	**Minimum distance (m)**		
	Power lines		**Installation Area**
	Isolated neutral or arc-suppression coil grounding	**Direct grounding of neutral**	
Up to 50	2	5	Urban
	5	10	Rural
50 - 500	5	10	Urban
	10	20	Rural
500 - 5000	10	50	Urban
	20	100	Rural
Exceeding 5000	10	50	Urban
	20	100 - 200 (*)	Rural

Note: (*) Minimum distance in areas with ground resistivity more than 10,000 Ω.m apply to 200m

b) The horizontal distance between the telecommunication's cable with the metal sheath buried in the ground directly and the power cable with high voltage must not be less than the distance shown in Table 284-2

c) Telecommunication's cables buried in the ground directly must be laid into the hard PVC pipes to prevent from contacting power cable lines directly and the distance between the telecommunication cable and the power cable line must not be less than the distance shown in Table 284-2

Table 284-2 Minimum horizontal distance between telecommunication cables with metal sheath buried in the ground directly and the power cable with high voltage

Condition of ground	Stable	Unstable
Minimum distance (m)	1.0	1.5

Article 285. Installation on Same Poles

It is permitted that overhead power lines with voltage up to 1kV are installed on the same pole of overhead power lines with voltage up to 35kV with the safety measures.

Table 285-1 Vertical safety distance from the bottom wire of high voltage lines to the top wire of low voltage lines in windless conditions

Voltage (kV)	Distance (m)
Up to 15	2.0
22 - 35	2.5

It is permitted that peripheral telecommunication's cables are installed on the same pole of overhead power lines with voltage up to 110kV, provided that the distance between the peripheral telecommunication's cable and the lines must not be less than the distance shown in the following table.

Table 285-2 Minimum distance from telecommunication's cable or accessories to overhead power lines on the same pole

Voltage (kV)	Minimum distance (m)
Up to 1	1.25
22	3.00
35	3.50
110	4.50 (OPGW is determined by the design)
More than 110	Prohibition for installation on the same pole (except OPGW)

Article 286. Going Nearby Communication and/or Signal Structures

When overhead power lines with voltage exceeding 1kV go nearby communication and/or signal cable lines, even when buried underground, radio broadcasting and signal emitting stations, wireless receiver centers with many stations and local radio broadcasting stations, a safe distance must be ensured between the power conductor of the overhead power line and the nearest part of the above-mentioned structures.

In case overhead power lines with voltage exceeding 1kV are designed to traverse specially important radio receiving centers, the design of the overhead power lines must comply with the requirements of the surrounding structure.

Table 286 Minimum distance from overhead power lines to the antenna mast of radio broadcasting station

Transmit antenna	Minimum distance (m)	
	Exceeding 1kV to 110kV	220kV and 500kV
Medium and long-wave sending	100	100
Short-wave sending at main direction	200	300
Short-wave sending at low direction and indirection	150	200
Short-wave sending at remaining directions	50	50

Article 287. Protection against Electromagnetic Induction

Overhead power lines with earthed neutral conductor crossing or going nearby communication and/or signal lines must have protective measures applied to prevent damage to persons and the communication structure by electromagnetic induction, in exceptional cases to be agreed by the communication structure management agency.

Article 288. Prevention of Corona Noise and Radio, Television Wave Reception Interference

Overhead power lines must include measures to prevent corona noise and reception interference of radio and television waves.

Chapter 3-3-13 Crossing or Going Nearby Special Structures and/or Places

Article 289. Crossing or Going Nearby Electric Railways

The distance from conductors of the overhead power lines at the state of maximum deflection to the highest point of electric railway must not less than the distance shown in the following table.

Table 289 Minimum distance from conductor to electric railway

Voltage / Distance safe discharge	Up to 35kV	110kV	220kV	500kV
To the highest point (7.5 m) of the vehicle, electric rail transport works	3.0 m	3.0 m	4.0 m	7.5 m

Article 290. Crossing or Going Nearby Railways

Overhead power lines with voltage exceeding 1kV crossing or going nearby railways must have appropriate structures which comply with the requirements for crossing angles, limitations for poles and foundations and distances to railways.

Article 291. Distances to Railways

When overhead power lines with voltage exceeding 1kV parallel railways, they must have appropriate structures which comply with the distance requirements from the conductor or the pole of the lines to the railway as shown in the following table.

Table 291 Minimum distance from overhead power lines to railways

Voltage / Distance safe discharge	Up to 35kV	110kV	220kV	500kV
Vertical distance from conductor in a state of maximum sag to the highest point (4.5m) of the railway	3.0 m	3.0 m	4.0 m	7.5 m
- The distance from the outer edge conductor in a static state to the boundary of railway's safety corridor. - The distance from the pole of overhead power lines to the boundary of railway's safety corridor.	1.5 m	2.5 m	3.5 m	4.5 m

Article 292. Crossing or Going Nearby Car Roads

Overhead power lines crossing or going nearby car roads must have appropriate structures which comply with the requirements for poles, insulators and conductors in consideration of the class of road.

Article 293. Distances to Car Roads

Overhead power lines crossing or going nearby car roads must have a safe distance ensured as in the following table.

Table 293 Minimum vertical and horizontal distance from overhead power lines to car road assigned area classification and the class of car road

Detailed description of distance		Minimum distance (m)				
		Up to 1kV	Exceeding 1kV to 35kV	110kV	220kV	500kV
The vertical distance from the lowest point of the conductor with maximum sag to the car road at the intersection	Non-populated area	5.0	5.5	6.0	7.0	12.0
	Populated area	6.0	6.5	7.0	8.0	16.0
	Area required high safety level	6.0	14.0	15.0	18.0	-
The vertical distance from the conductors in fault condition (a conductor at adjacent span with cross-sectional area less than $185mm^2$ is broken) to the car road		5.0	5.0	5.0	5.5	10.0
The horizontal distance from conductors in static state to the edge of the car road of class I and II		1.0	2.0	4.0	5.0	10.0

Detailed description of distance	Minimum distance (m)				
	Up to 1kV	Exceeding 1kV to 35kV	110kV	220kV	500kV
The horizontal distance from the conductors in static state to the edge of the car road of class III to V	-	1.5	2.5	2.5	6.0
The distance from the pole of overhead power lines to the edge of the road of class I and II	1.0	3.0	5.0	6.0	10.0
The distance from the pole of overhead power lines to the edge of the road of class III to V	1.0	2.0	3.0	4.0	6.0

Article 294. Going Through Bridges

Overhead power lines with voltage exceeding 1kV traversing bridges must have appropriate structures which comply with the requirements for poles, insulators and installation situations.

Article 295. Distances to Bridges

The minimum distance from conductors of overhead power lines with voltage exceeding 1kV to parts of bridges must be selected with the agreement of the transport management agency.

The minimum distance from overhead power lines to the parts of the bridges must comply with the discharge safe distance shown in Table 8-3.

The minimum distance from overhead power lines to the road surface on the bridges must comply with the safe distance on the road shown in Table 293.

Article 296. Traversing Dams and/or Dikes

When overhead power lines with voltage exceeding 1kV traverse dams, dikes etc., a safe distance from power conductors to parts of the dike or dam must be ensured as shown in the following table.

When overhead power lines traverse dams and dikes that are used as transportation roads, the corresponding requirements for structure crossings or nearby roads must also be complied with the following table.

Table 296 Minimum distance from conductor to parts of dike or dam

Detailed description of distance	Minimum distance (m)		
	Exceeding 1kV to 110kV	220kV	500kV
Distance from conductor to surface of dike	6	7	10
Distance from conductor to bank of dike	5	6	8
Distance from conductor to surface of water overflowing dam	4	5	7

Article 297. Distances from Poles to Important Water Dams

Distances from the sites of poles to important water dams must be agreed among dikes, dam management agencies and power management agencies to ensure safety for dikes and dams in compliance with technical economical data for overhead power lines with voltage exceeding 1kV.

Article 298. Crossing or Going Nearby Aerial Transport Cable Lines and/or Pipelines

When overhead power lines with voltage up to 1kV cross or go nearby aerial transport cable lines and/or metal pipelines, they must have appropriate structures which comply with the requirements for the position of overhead power lines, protective measures and distances from power conductors to cable lines and pipelines.

Overhead power lines with voltage exceeding 1kV crossing or going nearby pipelines on the ground and/or aerial transport lines must have appropriate structures which comply with the requirements for poles, conductors, insulators, protective measures and the position of overhead power lines.

Table 298 Minimum distance from conductor to cable line of aerial transport and pipeline

Description of distance	Voltage (kV)	Minimum distance (m)
The distance from overhead power lines with voltage up to 1kV to the outer edge of the transport means on the aerial cable and / or metal pipes which cross or go nearby the lines. The conductor is arranged under the aerial transport.	Up to 1	1.0
The distance from overhead power lines with voltage exceeding 1kV to the outer edge of the transport means on the aerial cable and / or metal pipes which cross or go nearby the lines.	Exceeding 1 to 22	3.0
	35 and 110	4.0
	220	5.0
	500	6.5

Article 299. Distance to gas or oil pipeline and petroleum products

Overhead power lines with voltage exceeding 1kV cross or go nearby gas pipelines, oil and petroleum products must ensure the safety distance according to the regulations for oil and gas.

Article 300. Crossing or Going Nearby Underground Pipelines

Overhead power lines with voltage exceeding 1kV crossing, paralleling or going nearby underground pipelines must have appropriate structures which comply with the requirements for cross angles and a safe distance to the pipe, the exhaust valve.

Article 301. Crossing or Going Nearby Pressured Pipelines

When Overhead power lines with voltage exceeding 1kV cross or go nearby steam, oil or petroleum product pipelines with pressure, they must have appropriate structures which comply with requirements for distances from the edge of foundation or the nearest grounded component of them to the edge of above-mentioned pipelines according to the pressure of pipelines, installation location and welded joints.

Table 301 Minimum distance from the edge of foundation or the nearest grounded component to steam, oil or petroleum pipeline

Pressure of pipeline (MPa)	voltage (kV)	Minimum distance (m)
Up to 1.2	Exceeding 1 to 35	5
	110, 220, 500	10
Exceeding 1.2	Exceeding 1 to 35	5
	110, 220	10
	500	15

Article 302. Going Nearby Structures containing Explosives and/or Flammable Substance

Overhead power lines with voltage exceeding 1kV which go nearby structures containing explosive and/or flammable substances must have appropriate structures, which comply with the requirements for safety protection against fires and/or explosions.

In exceptional cases, structures for which a safe distance has been secured from overhead lines may be permitted.

Article 303. Going Nearby Oil and/or Gas Flames

For overhead power lines with voltage exceeding 1kV going nearby oil and/or gas flame, the distance from the overhead power lines to the flame must ensure 60m and more for safety.

Article 304. Going Nearby Airports

When overhead power lines with voltage exceeding 1kV go nearby airports, they must have appropriate structures which are approved by the airport management agency depending on the height of pole of the overhead power lines and the distance from overhead power lines to the airport.

Table 304 Pole condition for approval by airport management agency

Distance from overhead power line to the boundary of airport (km)	Height of pole
Up to 10	Poles with any height
Exceeding 10 to 30	Poles which the absolute height of top of the poles is equal or higher than the absolute height of the airport plus 50m
Exceeding 30 to 75	Poles with the height of 100m or more

PART 4 DISTRIBUTION EQUIPMENT AND SUBSTATIONS

Chapter 4-1 Distribution Equipment up to 1kV

Chapter 4-1-1 Electric Equipment Installation

Article 305. Safety Installation of Electrical Equipment

Electrical equipment must be installed in the appropriate location so that no electrical sparks or arcs endanger the operating staff, result in fire or damage to adjacent equipment and then lead to circuit breakage among the phases or between the phase and ground during its operation.

Article 306. Connection Method of Switching Devices

Power-switching devices must be installed so that the motive part of this device is electrically isolated after a power interruption

Article 307. Manually Controlled Switchgears

Manually controlled switchers (without driving set), used for switching the load current and the contacts point directed toward the operator, must be kept in a protective housing free of holes and gaps and made of fireproof materials.

If the switcher is only used for disconnecting power, it can be kept opened provided that it is placed in a location inaccessible to non-authorized personnel

Article 308. Identification of Switching Devices

Settings of “Power On” or “Power Off” must be legibly marked with signs on the drive engine parts of the switching devices for identification.

Article 309. Power Sources of the Automatic Circuit Breaker (Auto-breaker)

It is necessary to take into account the installation of circuit-breaking devices for auto-breaker when it needs to repair or removal/installation of them. For this purpose, the disconnectors or other breaking devices shall be installed wherever it is necessary. However, it is not necessary to install such circuit-breaking, if it is possible to securely ensure the safe work.

Article 310. Connecting Direction of Fuses

A screw socket type fuse shall be placed so that the conductor that transmits power from the supply side is connected to the bottom of the socket and the conductor that transmits power to the load side is connected to the cover of the socket.

Chapter 4-1-2 Distribution Panel Boards

Article 311. Minimum Clearance in Air of Bare Conductor

Air clearance between exposed live poles as well as between exposed live parts and non-live metal components shall be not less than 12mm. In the same case, creepage distance shall be not less than 20mm.

Air clearance between exposed conductors and protective barrier must be not less than: 100mm in case of wire mesh type and 40mm in case of insertable insulated walls.

Article 312. Site requirements for Electrical Cabinets

As for electrical cabinets that are installed in dry locations, conductors with insulation designed to operate at a voltage not less than 660V can be placed on a metallic surface protected by an anti-corrosive layer, and adjacent. In such cases, the power circuit must be calculated with the load current reduction factor taken into consideration.

Article 313. Conductor Material for Grounding Wire

Conductors and bars used for grounding can be free of insulation

Article 314. Controlling and Measurement Devices

Controlling and measurement devices must satisfy the requirements stated in chapter2-6. The cable installation must conform to the requirements stated in chapter 5-3.

Article 315. Flame-resistant Materials for the Distribution Panel Boards

The frame of the electric panel board must be made of flame-resistant materials while the housing and other parts must be made of flame-resistant or nonflammable materials. This requirement doesn’t cover the load dispatching diagram board or other similar boards.

Article 316. Prevention of Vibration for the Distribution Panel Boards

Distribution equipment must be placed and installed so that the vibration caused during its operation, including shaking effects caused by external force, will not damage the contacted joints and will not cause any disturbance or abnormal operation of the equipment.

Article 317. Safety Measures for Electrically Inexperienced Workers

In the compartment that electrically inexperienced workers can enter, all live components must be fenced with warning labels.

Article 318. Installation Outdoor

The outdoor installation of distribution equipment must comply with the following requirements:

1. Equipment must be placed at a position higher than the ground appropriately.

2. In electrical cabinets, where required, on-site drying out must be enabled to ensure normal operation of the components, relays, measuring tools and electric meters.

Chapter 4-2 Distribution Equipment and Substations above 1kV

Article 319. Scope of this Chapter

The requirements in this chapter shall apply to the installation of fixed distribution systems and substations at alternating current (AC) voltage from 1 to 500kV.

This is not applicable to the installation of specialized distribution systems and substations that are regulated by special technical requirements as well as the installation of mobile electrical equipment.

Gas insulated distribution equipment (GIS) shall comply with the requirements of the manufacturer.

Installation of GIS shall comply with Section 3 - of Vol.3 of Technical Regulations.

Chapter 4-2-1 Distribution Equipment and Outdoor Substations

Article 320. Transport routes

In the area of outdoor distribution systems and substations, transport routes must be constructed for transport, assemble, repairing and testing distribution equipments at voltages up to 500kV.

The minimum width of transport routes shall be 3.5m.

The road transferred in the station in frame with a width is of 4.0m and a height of 4.50m.

Within closed electrical operating areas, the passage of vehicles or other mobile equipment beneath or in proximity to live parts (without protective measures) the following condition is permitted:

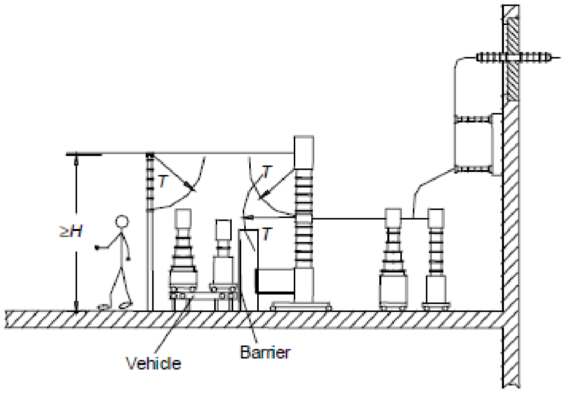
- The vehicle, with open doors, and its load does not infringe the danger zone: minimum protective clearance for vehicles T = N + 100 (minimum 500mm);

- The minimum height, H, of live parts above accessible area is maintained (see the Article 334)

Under these circumstances, personnel may remain in vehicles or mobile equipment only if there are adequate protective measures on the vehicle or mobile equipment, for example the cab roof, to ensure that the danger zone defined above cannot be infringed.

For the lateral clearances between transport means and live parts, similar principles apply.

Indoor installation



N : Minimum clearance in air
H : Minimum height of live parts above accessible area
T = N +100mm (Minimum 500mm)

Outdoor installation

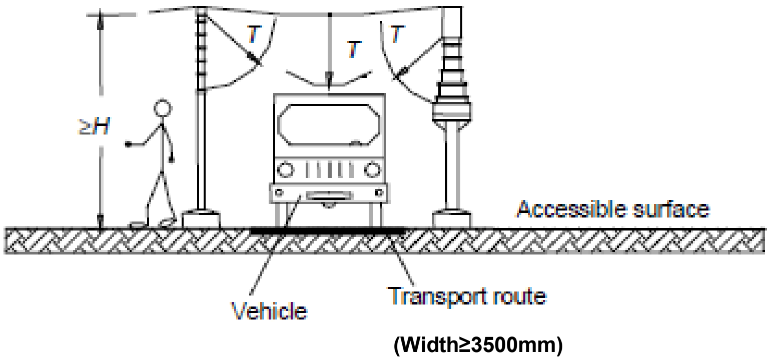


Figure 320 Minimum approach distance to transferred frame (mm)

Article 321. Prohibition the cut conductor among the pole span when connection branch

Flexible wires must be used for branch connection in the intervals between poles. Knotted joints of guy wires to the pole, branch wires to the main wire in the interval or wire ends clamped to the equipment can be tied by pressing, fusion welding or clamp bolt catch. While making the branch connection, cutting the main conductor in the interval between poles is prohibited.

Article 322. Arrangement of Branch Wire

Branch wires from main conductors are often arranged below the other conductors. Branches, in the same interval between poles, must not traverse two or more other line sections or of two and more other conductor systems.

Article 323. Calculation of Wind Load and Air Temperature

The wind load and air temperature impacted over the bar-conductors and structure must be calculated in accordance with the regulations in article 128.

Article 324. Mechanical Safety Factor Flexible Conductors

The mechanical safety factor (of temporary breaking stress) of flexible conductors impacted by force must be not less than 3.

Article 325. Mechanical Safety Factor Suspension Insulators

The mechanical safety factor (compared to the value to destroy the permissible load) for suspension insulators must be not less than 4.

Article 326. Mechanical Safety Factor Rigid Conductor

The mechanical force transmitted from the rigid conductor to the post type insulator must be calculated based on the requirements regulated in article 81.

Article 327. Mechanical Safety Factor Bridging Flexible Conductors

The mechanical safety factor (compared to the value to destroy the permissible load) for accessories for bridging flexible conductors at the corresponding loading capacity values must be not less than 3.

Article 328. Pole Material

The pole used to support conductors of outdoor distribution systems must be made of ferroconcrete or steel. If made of steel, it must be protected against corrosion. In the case of ferroconcrete, it must not be cracked or broken.

Article 329. Designing for Intermediary or Dead-end Anchor Poles

The pole to support conductors in outdoor distribution systems is determined and designed as a center or dead-end anchor pole with sufficient strength.

Any center pole that is temporarily utilized as a dead-end anchor pole must be reinforced with guy wire.

Article 330. Creepage Distance for Insulator

Post type insulators of substations must comply with standards on insulating surface leakage, calculated according to the maximum useful voltage of the transmission line in operation, subject to environmental conditions. It must have an insulating quality equivalent to that of the transmission line connected into the substation.

Article 331. Minimum Air Clearance of Outdoor Distribution and Substation Facilities

Minimum clearance in air of distribution and substation facilities between live parts as well as live parts and earth shall be greater than or equal to the minimum insulation clearance determined by the basic impulse insulation level (BIL).

Notwithstanding the foregoing, clearance of equipment inside facility such as cubicle and others do not necessarily have to satisfy the bellow-mentioned minimum clearance, but shall ensure to satisfy the BIL.

(1) Minimum clearance under the altitude up to 1,000m above sea level
Minimum clearance in air between live parts or between live parts and earth shall be the value mentioned in the table 331-1, 2, 3. These values are applied for the altitude up to 1,000m above sea level.

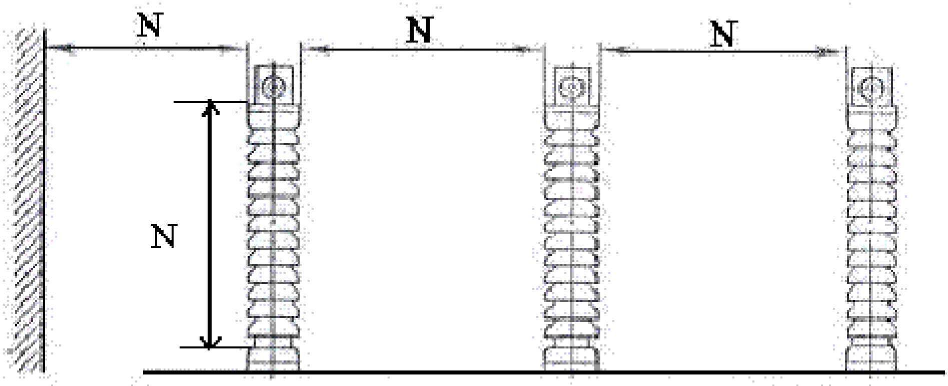


Figure 331-1 The minimum clearance (N) between live parts and between live hard bar and earth

Table 331-1 Values of rated insulation levels and Minimum clearances in air (7.2 ≤ Um ≤ 245)

[IEC-61936-1 Table 1, A.2]

Nominal voltage of system	**Highest voltage for equipment**	**Rated short-duration power-frequency withstand voltage [b]**	**Rated lightning impulse withstand voltage [BIL] [a]**	**Minimum phase-to-earth and phase-to-phase clearance, N**	
Un r.m.s.	Um r.m.s.	r.m.s.	1.2/50μs peak value	Indoor	Outdoor
kV	kV	kV	kV	mm	mm
6	7.2	20	40 60	60 90	120 120
10	12	28	75 95	120 160	150 160
15	17.5	38	75 95	120 160	160 160
22	24	50	125 145	220 270	330
35	38.5	75	180 195	320 -	400 -
	40.5	80	190	350	440
110	123	230	450 550	900 1,100	
220	245	395 460	950 1,050	1,900 2,100	

* Note:

- Minimum clearance (p-e, p-p) is determined from the rated lightning impulse withstand voltage (BIL).
- If 2 types of BIL exist in the same nominal voltage of system, the smaller BIL can be selected by introduction of a higher performance arrester. (Insulation Coordination)

(Ex. In case of Un=22kV, 2 types of BIL (125kV or 145kV) exist. If equipment with BIL 125kV are introduced, a higher performance arrester must be necessary in order that the equipment can withstand the surge reduced by the arrester.)

[a] The rated lightning impulse is applicable to phase-to-phase and phase-to-earth

[b] 48Hz ≤ power frequency ≤ 52Hz, duration = 60sec

Table 331-2 Values of rated insulation levels and Minimum clearances in air (Um = 550)

[IEC-61936-1 Table A.3]

Nominal voltage of system	**Highest voltage for equipment**	**Rated short-duration power-frequency withstand voltage [b]**	**Rated lightning impulse withstand voltage [a][BIL] [a]**	**Rated switching impulse withstand voltage 250/2,500μs**		**Minimum phase-to-earth clearance (N_{p-e})**		**Minimum phase-to-phase clearance (N_{p-p})**	
Un r.m.s.	**Um r.m.s.**	**r.m.s.**	**peak value 1.2/50μs**	**Phase - earth**	**phase-phase**	**Conductor - structure**	**Rod - structure**	**Conductor-conductor parallel**	**Rod – conductor**
kV	kV	kV	kV	kV		mm		mm	
500	550	680	1,550	1,175	1,763	3,100	4,100	4,200	5,000
		710	1,800	1,175	2,210	3,600	4,800	6,100	7,400

[a] The rated lightning impulse is applicable to phase-to-phase and phase-to-earth

[c] 48Hz ≤ power frequency ≤ 52Hz, duration = 60sec

Table 331-3 Minimum clearance between live parts and other parts of outdoor distribution equipment

Figure	Clearance	Symbol	Minimum clearance (mm) by Nominal voltage (kV)					
			≤ 15	22	35	110	220	500
335-1,2	- Phase-earth - Phase-phase	N_{p-e} N_{p-p}	160	270	400	1100	2100	3100 / (4100) [(a)] 6100 / (7400) [(b)]
337	Protective barrier clearance - Solid wall, height ≥ 1.8m	B1	160	279	400	1100	2100	4100
	- Wiremesh / Screens, height ≥ 1.8m	B2,3	240	350	480	1200	2200	4200
338	Boundary clearances - Solid wall, height ≥ 1.8m	C	1160	1270	1400	2100	3100	5100
	- Wiremesh / Screens, height ≥ 1.8m	E	1660	1770	1900	2600	3600	5600
338	Minimum height at the external fence/wall	H’	4300	45300	4300	6000	6600	8600
324 339	Minimum height at the accessible surface (without transport route)	H	2500	2520	2650	3350	4350	6350
324	Minimum clearance between live part and transport means, equipment	T	500	500	500	1200	2200	4200
339	Minimum working clearance	Dv	1160	1270	1400	2100	4100	6100

Note (a) Minimum clearance (phase-earth): between conductor and structure / between rod and structure for voltage of 500kV

(b) Minimum clearance (phase-phase): between conductor and conductor parallel / between rod and conductor for voltage of 500kV

(2) Minimum clearances between parts under special conditions

- The minimum clearances between parts of an installation which may be subject to phase opposition shall be 20% higher than the values given in table 331-1 and table 331-2.
- Minimum clearances between parts of an installation, which are assigned to different insulation levels, shall be at least 125% of the clearances of the higher insulation level.
- If conductors swing under the influence of short-circuit forces, 50% of the minimum clearances of table 331-1 and table 331-2 shall be maintained as a minimum.
- If conductors swing under the influence of wind, 75% of the minimum clearances of table 331-1 and table 331-2 shall be maintained as a minimum.
- As for flexible busbar utilized system, minimum clearance between live parts of phases between live parts with earth, called Nm (at U≤220kV) which are arranged in horizontal plane (Figure 331-2) shall be not less than:

$N_m = N + a$

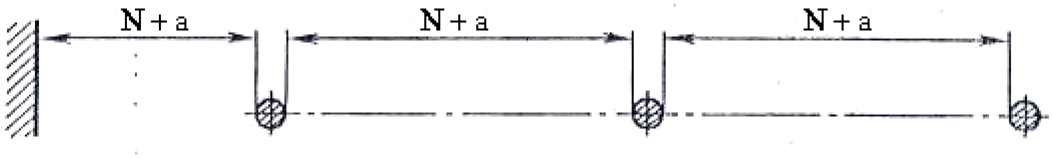


Figure 331-2 Minimum clearance between live parts of phases and between live parts and earth, in case of using flexible busbar

Where: a = f sin x

f = sag of conductor at annual average calculation temperature of 25 degrees C (m)

x = arctan (P/Q)

Q = weight of 1m conductor (N/m)

P = wind force on 1m of conductor (N/m), in which wind speed is selected equal to 60% of the value used in structural calculation.

For voltage of 500kV using soft bar, phase-phase clearance: N(p-p) = N(p-p) + a; and phase-ground clearance: N(p-e) = N(p-e) + a

- In case of rupture of one sub-chain in a multiple insulator chain, 75% of the minimum clearances of table 331-1 and table 331-2 shall be maintained as a minimum.
- If neither the neutral point nor a phase conductor is effectively earthed in an installation that is fed via auto transformers, the insulation of the lower voltage side shall be rated according to the highest voltage for equipment on the higher voltage side. Attention shall be paid to neutral point insulation according to the method of neutral earthing.
- In case that the equipment are installed altitude more than 1,000m above sea level, minimum clearance of N and Nm shall be increased by 1.4% for every 100m altitude above altitude of 1,000m.

Article 332. Withstand Voltage Test of Outdoor Distribution and Substation Equipment

Dielectric test shall be performed in specified conditions to prove that the insulation complies with a standard rated withstand voltage.

Article 333. Protective Barrier Clearances and Boundary Clearances

Minimum clearance between live parts and protective barrier/external fence shall keep horizontal insulation distance to prevent direct touch of live parts.

(1) Protective barrier clearances

Within an installation, the following minimum protective clearances shall be maintained between live parts and the internal surface of any protective barrier (see figure 333):

- for solid walls, without openings, with a minimum height of 1,800mm, the minimum protective barrier clearance is B1 = N;
- for equipment, where Um is greater than 35kV, a wire mesh, screen or solid wall, with openings, with a minimum height of 1,800mm and a degree of protection of IP1XB shall be used. The minimum protective barrier clearance is B2 = N + 100mm;

- for equipment where Um is up to 35kV, a wire mesh, screen or solid wall, with openings, with a minimum height of 1,800mm and a degree of protection of IP2X(But maximum mesh size is 25*25mm; Refer to the Article 147), shall be used. The minimum protective barrier clearance is B3 = N + 80mm.

For non-rigid protective barriers and wire meshes, the clearance values shall be increased to take into account any possible displacement of the protective barrier or mesh.

(2) Boundary clearances

The external fence of outdoor installations of open design shall have the following minimum boundary clearances in accordance with figure 334:

- solid walls C = N + 1,000mm;
- wire mesh/screens E = N + 1,500mm.

The maximum opening of the wire mesh/screens shall not exceed 50mm.

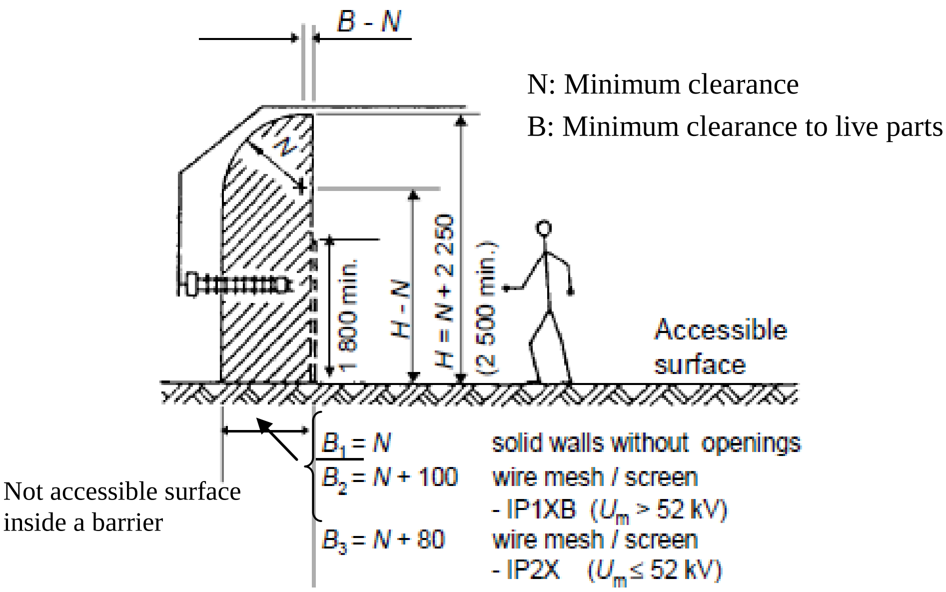


Figure 333 Protection against direct contact by protective barriers within closed electrical operating areas

Article 334. Minimum Height over Access Area

Minimum height between live parts above the ground to allow approach of general public must ensure the following:

(1) Electrical installation on mast, pole and tower

The minimum height H' of live parts above surfaces accessible to the general public shall be

- H' = 4,300mm for rated voltages Um up to 35kV;
- H' = N + 4,500mm (minimum 6,000mm) for rated voltages Um above 52kV;

where N is the minimum clearance.

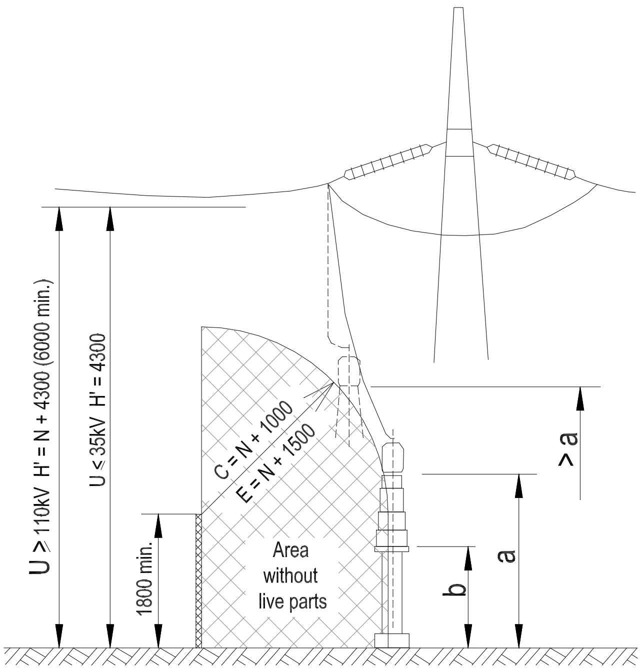
H' is calculated with the maximum conductor sag level.

(2) Minimum height over access area

Minimum height between live parts above ground or background, where only pedestrian access is permitted must ensure the following:

- for live parts without protective facilities, a minimum height H = N + 2,250mm (minimum 2,500mm) shall be maintained (see figure 335). The height H refers to the maximum conductor sag;

the lowest part of any insulation, for example the upper edge of metallic insulator bases, shall be not less than 2,250mm above accessible surfaces unless other suitable measures to prevent access are provided.



H' = Minimum clearance of live parts above accessible surface at the external fence [mm]

N = Minimum clearance [mm]

a: If this distance to live parts is less than *H*, protection by barriers or obstacles shall be provided

Figure 334 Boundary clearance and minimum height at the external fence/wall

Article 335. Minimum Working Clearance

Minimum working clearance is minimum safe distance to be observed between normally exposed live parts and any person working in a substation or any conductive tool directly handled.

The minimum working clearance (Dv) for electrically skilled or instructed persons is given in the following figure. This refers only to non-live working.

When circuits have different nominal voltages, the value (Dv) of higher nominal voltage shall be adopted.

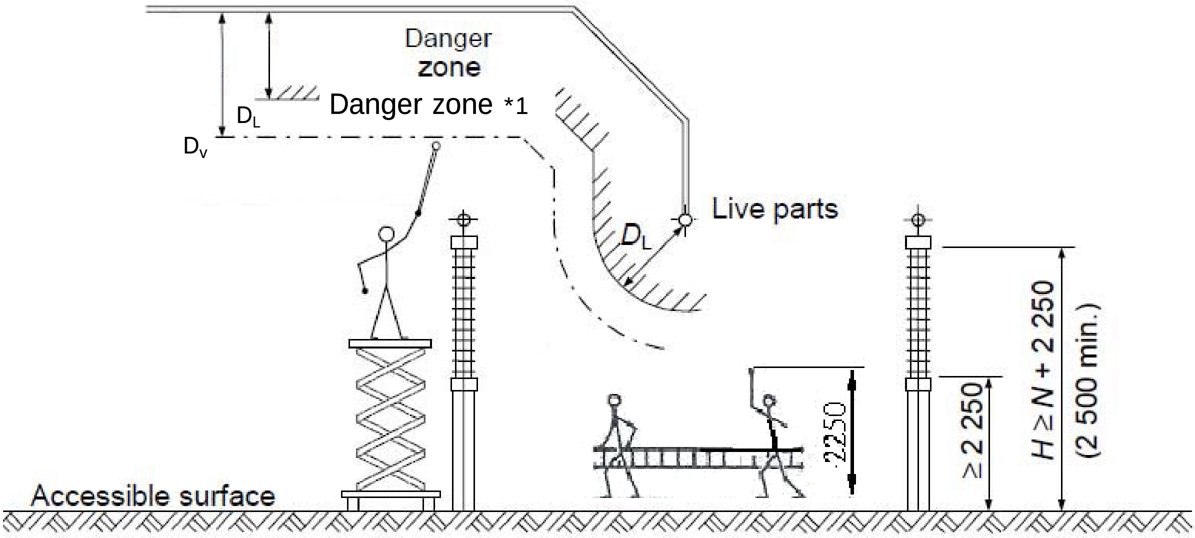


Figure 335 Minimum heights and minimum working clearances

N : Minimum clearance in air (Refer to the Table 335)

Un : Nominal voltage of system

$D_L = N$

D_v = N + 1,000mm for Un ≤ 110kV

D_v = N + 2,000mm for Un > 110kV

H: Minimum height over access area (Refer to the Article 334)

*1 Danger zone: Area limited by the minimum clearance around live parts without complete protection against direct contact

Figure 335 Minimum heights and minimum working clearances

Article 336. Prohibited to Install Overhead Line above the outdoor distribution equipment

It is forbidden to install a line used for lighting purposes, communications, signals and protective control above live parts of the outdoor distribution equipment.

Article 337. Fire Prevention Measures of Outdoor Substations

Outdoor substations shall have fire prevention measures according to current fire regulations.. Moreover, the facilities in outdoor substations must be designed to impede the spread of fire to other equipment or other objects in the event of fire.

(1) Minimum clearance from electricity distribution house to other production houses of the power plant and substation shall be 7m. If the walls of distribution house towards other houses have fire resistance capacity for 2.5 hours, the above mentioned clearances may not apply.

(2) Minimum clearance for outdoor transformer

Minimum clearance between outdoor oil-filled transformers with capacity over 1MVA, and between a transformer and structures (buildings etc.) shall be the value G given in the following table.

If the clearance is less than value G:

- In case between transformers: there shall be arranged separating walls with fire resistance degree for duration of over 60 minutes (refer to the figure 337-1).
- In case between transformer and building: the wall of building shall have fire resistance degree for duration of over 90 minutes (see Figure 337-2) or the separating wall shall be arranged which has fire resistance degree for duration of over 60 minutes.

(3) Fire extinguishing system (TCVN 3890-2009)

In the 110kV substations which have transformers with capacity of 63MVA / each and above, in 220kV and higher voltage substations which have transformers with capacity of 40MVA / transformer and above, and substations with synchronous compensators, there shall be water fire-extinguishing pipeline system with water fed from outside available water supply system or from own used water resource.

Instead of fire-extinguishing water pipeline system, it is allowed to build fire-extinguishing water tank fed from other water sources.

At the substations with voltages level from 35kV to 110kV and transformers with capacity less than 63MVA/transformer, installation of fire extinguishing pipeline and fire water tank are not required.

For transformer 500kV are not dependent capacity and transformer 220kV capacity 200MVA or higher must be installed at a fixed automatic fire extinguishing equipment.

(4) Foundation of transformers and oil-filled equipment

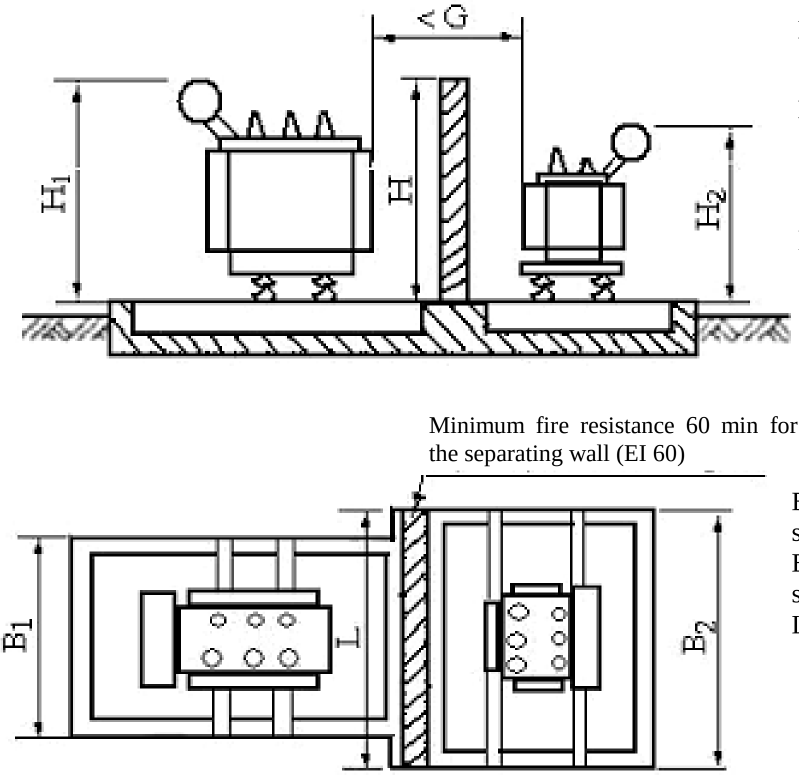
Foundations of transformers and oil-filled equipment shall be made of fireproof materials.

Table 337 Minimum clearance for outdoor transformer

[IEC-61936-1 Table 3]

Nominal capacity (MVA)	Minimum Clearance G to	
	Other transformers or non-combustible building surface (m)	Combustible building surface (m)
From over 1 up to 10	3	7.6
From over 10 up to 40	5	10
From over 40 up to 200	10	20
Over 200	15.2	30.5

For transformer outdoor to 1MVA, the clearance G is not less than 1.25m.



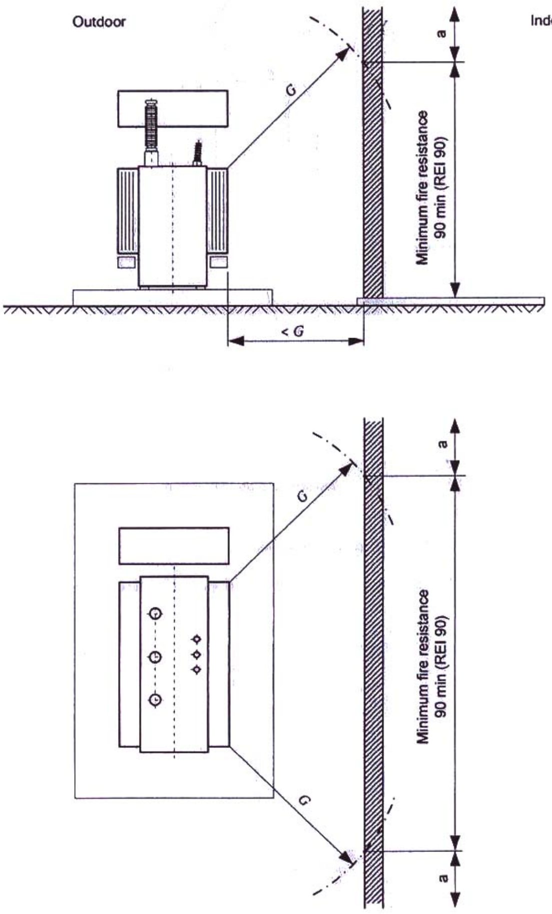
H1: Height of transformer 1
H2: Height of transformer

If H1 > H2 then H ≥ H1

B1: Width of oil collecting sump of transformer 1
B2: Width of oil collecting sump of transformer 2
L: Width of separating wall

If B2 > B1 then L ≥ B2

Figure 337-1 Separating walls between transformers



a: The wall in this area
to avoid a spread of fire
G: Refer to the Table 337
(Minimum clearance)

Figure 337-2 Fire protection between transformers and buildings

Article 338. Railways in Substations

Normally, railways are not installed in substations. Exceptionally case unable by a road used for transportation of main equipment such as a transformer may be installed in substations.

Article 339. Clearances to Building

Clearance from live parts of outdoor equipment to building shall keep insulation distance of the minimum safety clearance.

Where bare conductors cross buildings which are located within closed electrical operating areas, the following clearances to the roof shall be maintained at maximum sag: (see the following figure)

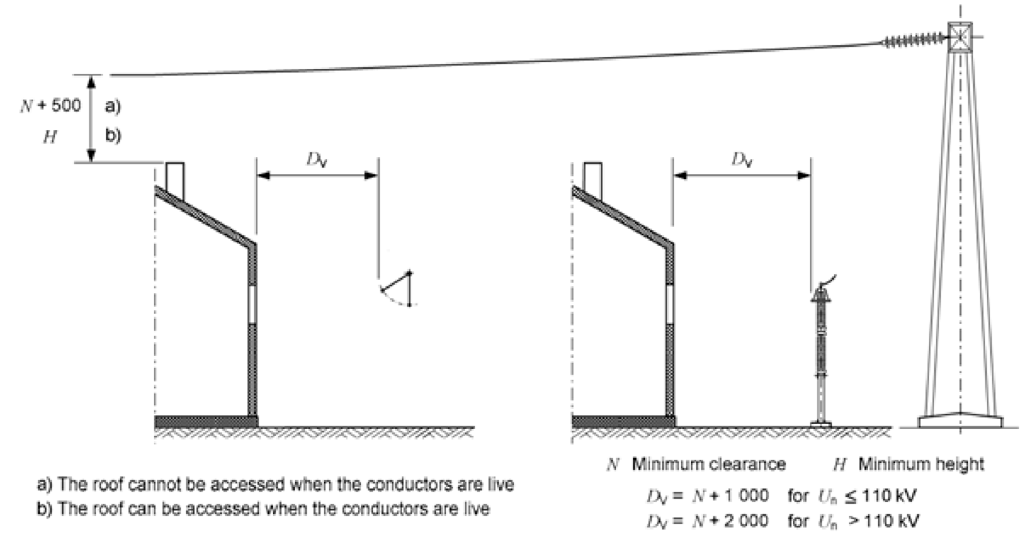
– the clearances specified in the Article 334 for live parts above accessible surfaces, where the roof is accessible when the conductors are live;
– N + 500mm where the roof cannot be accessed when the conductors are live;
– O_2 in lateral direction from the end of the roof if the roof is accessible when the conductors are live.

Where bare conductors approach buildings which are located within closed electrical operating areas, the following clearances shall be maintained, allowing for the maximum sag/swing in the case of stranded conductors:

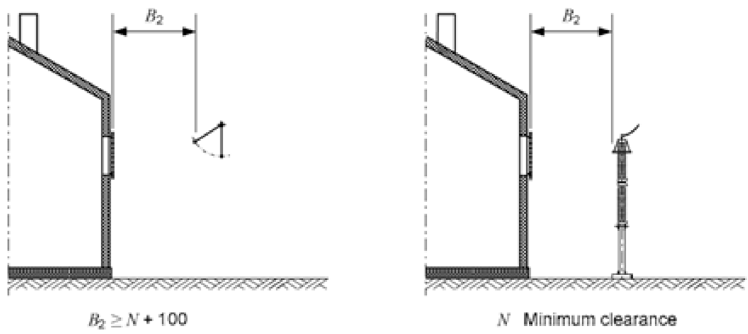
a) outer wall with unscreened windows: minimum clearance given by D_v;

b) outer wall with screened windows (screened in accordance with the Article 337): protective barrier clearances B_2 in accordance with the Article 337;

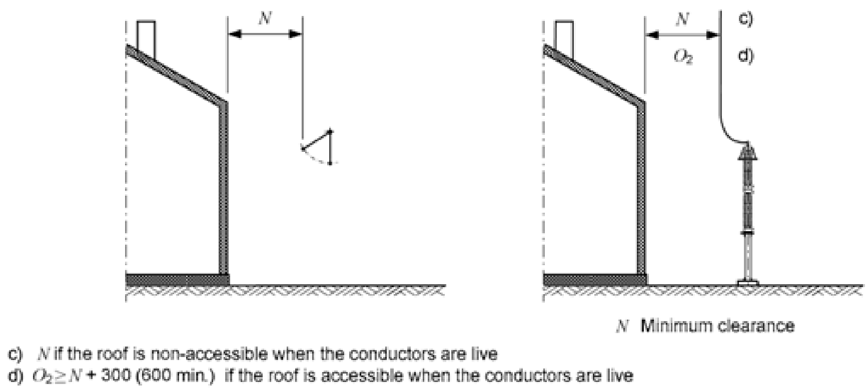
c) outer wall without windows: N.



1. Wall having windows with protection mesh



2. Wall having windows with protection mesh



3. Outer wall without windows

Figure 339 Approaches with buildings

Chapter 4-2-2 Indoor Distribution Equipment and Substations

Article 340. Flameproof level of Distribution Compartments

Distribution stations/compartments and transformer compartments must be made of flame-resistant materials with flameproof level in accordance with relevant regulations.

Article 341. Distance from Independent Distribution Stations

The distances from independent distribution stations to manufacturing halls and other premises in an industrial enterprise, to residential housing and public structures must be not less than the required values for transportation and the firefighting distance stipulated in relevant regulations.

Article 342. Separated Distribution Compartments

Indoor distribution equipment with voltage up to and exceeding 1kV should be installed in separate compartments. These requirements are not applicable to fully-equipped substations with voltages of up to 35kV. It is permissible to place equipment up to and exceeding 1kV in the same compartment, if they are all managed by a single organization.

Distribution equipment, transformers, etc. should be placed in compartments separated from other controlling or auxiliary devices.

Article 343. Condition of Installation Place

Transformers and distribution systems must not be located:

In damp conditions such as under wet production lines, near bathrooms, toilets, etc., unless there is no alternative. In such cases, appropriate measures must be taken to prevent water from infiltrating the transformer basement and distribution equipment.

Beneath or above rooms that accommodate more than 50 persons for periods exceeding 1 hour. This requirement is not mandatory for transformers that are dry or contain non-flammable substances.

Article 344. Selection of Insulators

Insulators at the input point and insulators subject to outdoor open conductors of generators with pole voltages of 6 and 10kV must be selected 20kV; 13.8 to 24kV must be selected 35kV. When installing the above-mentioned insulators in an area surrounded with polluted air, the pollution level must be taken into account when applying standards on insulating surface leakage.

Article 345. Minimum Air Clearance of Indoor Substation Facilities

The minimum clearance in air of indoor substation facilities between live parts as well as live parts and ground shall basically satisfy the requirements stipulated in the article 331 (see Table 331-1,2, 345). Similarly, protective barrier clearance, minimum height over access area, minimum working distance and so on also shall basically satisfy corresponding requirements of outdoor substations.(see the article from 333 to 335)

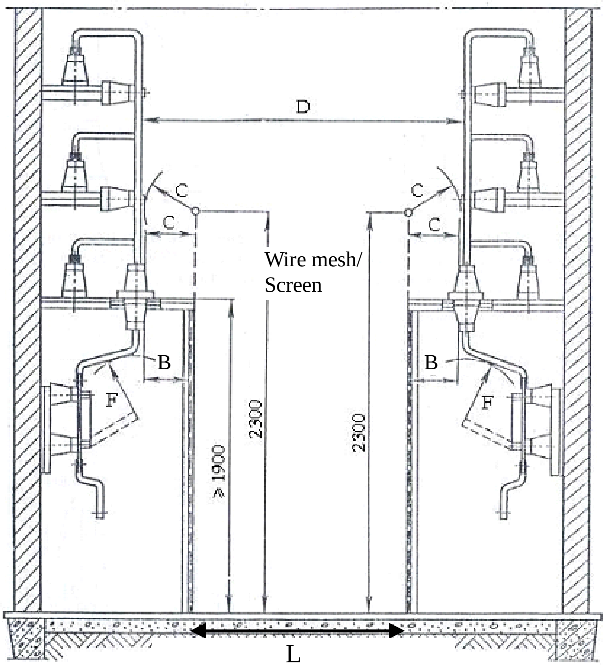
Table 345 Minimum clearances for indoor substation facilities

[IEC-61936-1]

Figure	Remark	Symbol	Minimum clearance (mm) by Nominal voltage (kV)							
			6	10	15	22	35	110	220	500
345-1	Protective barrier clearance	B ($N_{[p-e]}$)	90	160	160	270	320	1100	2100	3100 (4100) (a)
	Protective obstacle clearance	C (B+80/100)	170	240	240	350	400	1200	2200	3200 (4200) (a)
345-1	Minimum clearance between different circuits without protective barrier	D (2C + 2000)	2340	2480	2480	2700	2800	4400	6400	8400 (10400) (b)
345-2	Minimum height of substation equipment over access area	E (N+2250) (2,500 min)	2500	2500	2500	2520	2570	3350	4350	5350(6350) (a)
345-1	Isolating distance for disconnector	F ($N_{[p-e]}$)	90	160	160	270	320	1100	2100	3100 (4100) (a)
345-2	Minimum height of overhead line over access area	G	4300	4300	4300	4300	4300	6000	6600	7800(8600) (a)

Note (a) Minimum clearance (phase-earth) between rod and structure for voltage of 500kV

(b) Minimum clearance (phase-phase) between rod and conductor for voltage of 500kV



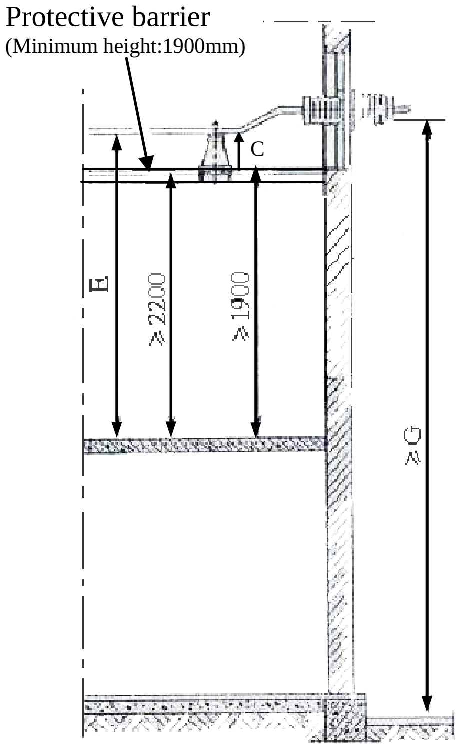
(see the article 349 and 362)

- Minimum clearance between different circuits without protective barrier D value shall be calculated as follows.

L = see the article 349 and 362

- The clearance from live parts to the blade at opened position of disconnector switch shall be not less than F values specified in the table 345.

Figure 345-1 Protective barrier clearance and minimum clearance between different circuits without protective barrier for indoor substation facilities



- If the overhead lines connected to distribution equipment house do not cross over roads or places that transportation vehicles are moving, etc, clearance from the lowest point of the conductor to the ground surface shall be not less than G value given in the table 345.
  G : Minimum height over acces(Um>35kV) article 334)
  - Um ≤ 35kV : 4,300mm
  - Um > 35kV : N + 4,500mm (mimimum 6,000mm)
    N: Minimum clearance (phase - earth) (see the table 331-1,2)
    Um: Highest voltage for equipment (see the table 331-1,2)

- If the clearance from overhead line to the ground surface is less than above mentioned G values, protective barrier with height of 2,500mm shall be installed under the line.

- For overhead line from indoor distribution equipment to outdoor substation area, G value shall be calculated as follows:
  N + 2,250mm (minimum is 2,500mm)

Figure 345-2 Minimum height over access area for indoor substation facilities

Article 346. Withstand voltage test of indoor substation equipment

Withstand voltage test of indoor substation equipment shall satisfy the requirements stipulated in article 331.

Article 347. Offset distance from live components with barrier

When a live component without insulation is arranged at place where it may be touched by persons by accident, it shall be placed in a compartment or fenced to protect. In this case, the distance between live component and fence shall be kept according to minimum air clearance of indoor substation facilities.

In case the live parts without insulation are placed lower than E values mentioned in the table 345, protective barrier shall be installed. The height of barrier shall be not less than 1,900mm.(see figure 345-3)

Live parts with protective barrier placed at height level of 2,300mm from the floor, but less than E value, shall be laid from the barrier surface in a distance of C values specified in the table 345. (see figure 345-2)

Live parts without protective barrier, which are connecting a line trap or control, protection equipment with a filter, shall be installed at height level of 2,200mm or more. A filter shall be placed at an appropriate height so that its repairs or adjusting will not require cutting electricity of the equipment connected to it. It is not necessary to install barriers for the equipment if the distance from the lowest edge of the insulators to the floor is not less than 2,200mm and the above-mentioned requirements are satisfied. (see figure 345-3)

Only barrier-rods which stipulated in the article 147 are used at the entry of compartments. But it is not allowed to use barrier-rods to protect live components in opened compartments.

Article 348. Distance between live components without compartment

When two live components are arranged without a protective barrier or a compartment between these two live components, the clearance between these two components shall be kept for ensuring the safety in case that one component is dead and the other component is still live.

The clearance without protective barrier between different circuits which placed at height level more than E value given in the table 345, shall be not less than D value given in the table 345. (see the figure 345-2)

The D value is calculated to provide working distance Dv. (see the article 335) Because as above mentioned, the clearance between these two circuits shall be kept for ensuring the safety in case that one circuit is dead and the other component is still live.

Article 349. Operation control corridor

The width of the operation control corridor between equipment and fences shall be sufficient for making it easier to do maintenance, operate and transport equipment.

Article 350. Fire Prevention Measures for Indoor Substations

Fire prevention measures for indoor substation shall satisfy the requirements stipulated in article 337.

Article 351. Doorway of Indoor Substation

Doors of the installation compartments of distribution systems must be of the swing-out type, opening to the outside or into other compartments. Doors must also be equipped with auto-locked latches so that they can be opened from the inside with no key required.

Article 352. Oil-immersed transformer installed indoor

When oil-immersed transformers are installed indoor , each transformer shall be placed in a compartment separately and shall be made of nonflammable material.

Article 353. Oil collection sump

Regarding indoor substations located in separated house, adjacent to or inside manufacture house, an oil collection sump should be equipped in each compartment for transformers, circuit breakers and so on. Or instead by method of a curb to prevent oil from flowing out of substation can be adopted. These compartment or curb shall be made of nonflammable materials.

Article 354. Installation of oil collecting sump

As for the compartments placed in basement or on the 2nd floor and upper with opened doors into fire exit corridor, then oil-collecting sump must be build under transformers, oil circuit breaker and oil-filled equipment.

Article 355. Ventilation System in Transformer Compartment

Compartments where transformer or reactor is placed must be equipped with ventilation system in order that in normal conditions of operation (taking into account overloading factor), even at the highest temperature of the environment will not make the transformer and reactor exceed its maximum allowable temperature.

Chapter 4-2-3 Workshop Substation

Article 356. Scope

This chapter applies to workshop substations with voltages of up to 35kV.

Article 357. Workshop Sites

Workshop substations can be placed on the first or second floor of the main or auxiliary manufacture compartments according to relevant fire regulations.

Workshop substations may only be installed in dusty or chemically noxious compartments, if appropriate methods to ensure safe operation of the equipment are applied in accordance with the requirements in article 360.

Article 358. Installation of Compartments

Transformers and distribution systems may be installed in separate compartments, or openly in manufacture compartments.

When installed openly, the transformer conducting components must be tightly sealed and the distribution system must be placed in sealed cabinets or otherwise shielded.

Article 359. Oil-collecting Sump

An oil-collecting sump must be built under transformers and other oil-filled equipment in accordance with article 353.

Article 360. Ventilation and Fire Prevention Measures of the Transformers Compartment

In the workshop substation, ventilation system and fire prevention measures must be installed depending on the size of distribution and substation system, and the arrangement of these system and measures must be determined in consideration of maintenance of them.

Article 361. Fire Prevention Measures

Compartments where oil-filled transformers or high oil content circuit breakers are installed must have doors made of fire-resistant materials.

Article 362. Clearance from Passageway

When a substation is placed beside a passageway for transportation, in order to protect against collision with vehicles, a sign or a barricade fence must be made.

Article 363. Height of the Equipment Compartment

The height of compartment shall be higher than the height of the highest components in substation

Chapter 4-2-4 Distribution Equipment and On-Pole Substation

Article 364. Scope

This chapter applies to Distribution Equipment and on-pole mounted substations, with voltages of up to 35kV and capacity not exceeding 630kVA.

Article 365. Configuration of Distribution Equipment and substation on-pole

- Distribution equipment such as transformers, circuit breakers, disconnector, measurement device ... allows installation on-pole, but must ensure that the conditions for insulation and safety conditions.
- Transformers installed on Pole are connected to the high voltage power grid via fuses in combination with a disconnecting switch or via an expulsion fuse. The drive engine of the disconnecting switch shall be equipped with a lock

To operate the substation on-pole, not installation the electric insulation chair, operating floor only installation in areas or wetlands and in places have not position for operations. Operator floor must safe railing and an elevator operator.

Open or closed state of the switchgear must be visible from the operation position

On-pole substation can be installed in combination with overhead lines pole, if it is permitted by technical requirements.

In area where vehicles may hit or strike the substation, appropriate method of protection shall be applied.

Article 366. Safety of substation on-pole

Safety measures shall be applied properly for substation on-pole. The minimum height between the live parts at voltage more than 1kV of a transformer and the accessible surface shall be 4.3m. (see the article 334)

In case of the on-pole substation without surrounding fence protection corridors of substations is limited by the surrounding space substations with the distance to the nearest live parts of the substations as prescribed in the following table:

Table 366 Minimum clearance between live parts and the nearest live parts of another on-pole substation

Nominal voltage	Minimum clearance [m]
up to 22kV	2.0
35kV	3.0

Article 367. Minimum clearance from operational floor

When disconnecting switch or fuse is at opened position, the minimum clearance between the live parts at voltage more than 1kV and operation floor shall be given in the following table.

Table 367 Minimum clearance between live parts and operational floor

Nominal voltage	Minimum height [mm]
up to 22kV	2,500
35kV	3,100

Article 368. Placement in an Enclosed Cabinet

The low-voltage electric panel board of the substation must be installed in an enclosed cabinet. On the low-voltage side, equipment must be placed so that its closed/opened status can be visible.

Article 369. Connecting Wires

Conducting wires linking the transformer and panel board and panel board and low-voltage overhead lines shall be protected against mechanical breakdowns (by placement into conduits or being guarded by covers, etc.) and shall conform to the requirements in chapter2-2.

The minimum height between outlet of overhead lines at voltage level up to 1kV and the accessible surface shall be 4.0m for bare conductors and 3.5m for insulated conductors.

Article 370. Minimum clearance for fire prevention

The minimum clearance from the substation to the building or architectural structure shall be kept to ensure safety and fire resistance based on the material used for the building or structure.

The minimum clearance according to fire resistance of materials is as follows.

- 3m : flame-resistant degree I, II or III
- 5m : flame-resistant degree IV or V

Chapter 4-2-5 Lighting Protection

Article 371. Outdoor Switchyard with System against Direct Lightning Strikes

Outdoor switchyard and distribution systems with voltages from 22-500kV must be protected from direct lightning strikes.

It is not required to protect against direct lightning strikes for outdoor switchyards at voltages from 22-35kV with transformers rated up to 1600kVA per unit, regardless of annual lightning hours.

Article 372. Protection against Direct Lightning Strikes for Indoor Substation

Housings of the distribution system and substations must be protected against direct lightning strikes. The roofs of such housings must be grounded if made of metal or ferroconcrete.

Article 373. Lightning Rods

Protection against direct lightning strikes to outdoor switchyards and distribution systems is often implemented by a lightning rod placing on top of constructions. High poles such as overhead line poles and headlight mounting pole etc. have lightning rods installed.

It is permissible to set up lightning rods on gantries near transformers or current-limiting reactors if the earth resistance is ensured to be small enough to t reduce the voltage rise in case of lightning strikes. It is also permissible to set up lightning rods on constructions of 110kV-distribution systems if the above-mentioned earth resistance condition is satisfied.

Article 374. Installing Lightning Rods on gantry of transformer

If lightning rods are higher than 15m far away from transformers and reactors along grounding conductors and the equivalent earth resistance in lightning season is with an appropriate value, lightning rods may be installed on gantry of transformer, reactor and structures of outdoor distribution system.

Article 375. Ground wires of overhead lines

Ground wire of overhead lines at voltage level of 35kV shall not be allowed to connect to the grounded structures of the outdoor distribution system (or substation).

The connection method between the ground wire of overhead lines at voltage level of 110kV and more and the grounded structures of the outdoor substation or distribution system (or substation) could be selected from the following.

- Direct connection between them
- No connection between them.

Article 376. Lightning Shields

Lightning Protection of the overhead line sections connected to the outdoor distribution system and substations must also be in accordance with the requirements in chapter6-2.

Article 377. Ground wires in Substations

To protect against direct lightning strikes for the section of overhead lines connected with 35kV substations and with transformers rated above 1600kVA, a grounded wire must be installed at the nearby substation section of the overhead line, but must stop in the last pole of the line.

If grounded wire of overhead power lines drag to the substation, then at the end point must be isolated from ground by a string of insulation using insulation standard for overhead power lines with voltage of 35kV.

Article 378. Lightning valves

Lightning valves should be installed in substations of 6kV or above connected to overhead line systems. Lightning valves must be selected based on protection capacity, as well as the insulation of the equipment. Also, the extinguishing voltage of the lightning valve must match the voltage of the location of the lightning arrester when a single-phase earth fault occurs.

The distance between the lightning arrester and the equipment to be protected may be increased in order to reduce the quantity of lightning arresters required; with this in mind, lightning arresters with capacities higher than that required by the specified requirements can be installed, but the equipment insulation must be taken into account in all cases.

Article 379. Insulation Co-ordination

To decrease the abnormal voltages which electrical equipment and/or entire power systems are required to withstand appropriately, the installation of arresters at points of connection with the power network is permissible, thus allowing the insulating strength of the electrical equipment to be reduced according to the decreased abnormal voltage.

Chapter 4-2-6 Lightning Protection for Rotation Machine

Article 380. Connection of Overhead Line

Overhead lines supported by steel or ferroconcrete poles may be connected to generator and synchronous compensator with their capacity of each up to 50MW (50MVA). The connection of overhead lines to generator and synchronous compensator with their capacity more than 50MW (50MVA) shall be permissible in case of the connection with an isolated transformer.

Article 381. Protection of Rotation Machines Connected to Overhead Lines

For the protection of generators, synchronous compensators, electric motors with their capacity more than 3MW (3MVA) connected to overhead lines, appropriate lightning valve and capacitor must be installed in every phase. Besides, overhead line sections connected to the power plant or substation must be protected against impulse current caused by lightning strikes.

Article 382. Protection of Overhead Lines with Rotation Electric Machine

If rotation machines and overhead lines are jointly connected to a bus bar of a power plant or a substation, the overhead lines shall be placed suitable ground wire.

Chapter 4-2-7 Internal Overvoltage Protection

Article 383. Internal Overvoltage Protection for 6-35kV

In the power grid at voltages of 6-35kV where an arc-suppression coil is installed, capacitance should be balanced between phases and ground.

The difference of capacitance between phases and ground must be kept within an appropriate range.

The location of arc-suppression coil must be determined based on a power grid diagram, its operation, fault calculation and influence of earth fault current to communication lines.

Article 384. Internal Overvoltage Protection for 110-220kV

In 110-220kV power grid with grounded neutral and 110-220kV transformers and autotransformers which have reinforced insulation of windings, it is not necessary to adopt the methods to prevent internal over voltage.

As for 220kV transformers and autotransformers which have normal insulation of windings, they must be protected from internal over voltage by arrangement of lightning arresters.

Article 385. Internal Overvoltage Protection for 500kV

In the 500kV power grid, appropriate methods shall be adopted to prevent abnormal voltage rise and voltage rise in normal operation.

Chapter 4-2-8 Installation of Power Transformers

Article 386. Installation Oil-Filled Equipment

In order to install, operate and maintain the oil-filled equipment of the substation, a mobile oil system must be set up, including tanks for containing and treating waste oil from oil pumps, oil filtering and recycling equipment, portable filtering and degassing equipment and barrels for oil transportation.

The site and scale of the mobile oil system must be subject to the approved alternative.

Article 387. Power transformer requirements

This chapter applies to the outdoor and indoor installation of fixed power transformers (including autotransformers) and oil-filled reactors (including arc quenching coil suppression coils) at voltages of 6kV or above. This is not applicable to special transformers.

Transformers and reactors are hereinafter reference to as transformers. The installation of auxiliary equipment for transformers (electric motors of cooling systems, measuring and testing instruments, control equipment, etc.) must conform to the relevant requirements in this chapter.

Article 388. Overload Operation of Power transformers

The selection of transformer factors must be based on its operation. The potential for overloading operations in the short- and long-term must also be taken into consideration. That requirement applies to every transformer winding.

Article 389. Oil level monitoring

Transformers must be placed so that their oil level can be readily and safely visible without necessarily interrupting power.

Where the general illumination is insufficient for observing the oil level, on-site lighting must be arranged instead.

Article 390. Buchholz relays

Buchholz relays of transformers should be placed so that people can safely approach to observe and obtain gas samples without necessarily interrupting power. If the height from the plane level on which the transformer is placed to the ground is 3m or more, a fixed ladder must be equipped.

Article 391. Lightning arrester for transformers

It shall be permissible to install lightning valves with voltages up to 220kV on the lid or body of transformers, if rated voltage of lightning valves is 110kV and 220kV with composite sheath.

Article 392. Wheels platform

As for wheeled transformers, a board indicating the direction of the wheels must be placed on its platform. To fix the transformer to the direction-indicating board, protection boards must be placed on both sides of the transformers wheel.

The platform must have a space in which to place the transformers jack.

Article 393. Gradient for the site

The transformer must be placed at a gradient in accordance with the requirements of the manufacturer (if any), in order that the produced gas can be transmitted to the Buchholz relay.

Article 394. Supplementary oil drums

The installation of a supplementary oil drum on a separate structure must not hinder the movement of the transformer from its foundation.

In such cases, a Buchholz relay must be placed close to the transformer so that it can be readily and safely accessed from the fixed ladder.

The supplementary oil drum can be placed on the gantry of the transformer compartment.

Article 395. Explosion-prevention tube

Transformers must be placed so that their explosion-prevention tubes are not directed toward adjacent equipment. In order to meet this requirement, if necessary, it shall be permissible to set up a barricade board in front of the tube’s hole.

Article 396. Series regulating transformer

A series regulating transformer must be placed next to the regulated transformer, to facilitate its transportation in the same way.

Article 397. Automatic fire extinguishers

As for 500kV transformers, regardless of capacity, and 220kV transformers rated 250MVA or higher, automatic fire extinguishers must be permanently installed.

Article 398. Indoor oil-Filled transformer

Each indoor oil-filled transformer must be placed in a separate compartment (see article 352 for exceptions) on the first floor, isolated from other compartments and with doors opening directly to the outside. It is permissible to place oil-filled transformers on the second floor or in a location 1m below the floor surface of the first floor in areas which are never liable to flooding, provided it is possible to move the transformer out and the emergency oil discharge system must conform to the requirements for a transformer with oil content exceeding 600kg.

Article 399. Clearance from Indoor oil-Filled transformers

If the transformer is installed indoors, the distance to the wall shall be kept to ensure adequate safety.

Chapter 4-2-9 Battery Systems

Article 400. Scope of Battery Systems

The requirements in this chapter shall apply to the installation of fixed type acidic batteries and alkaline batteries used in power projects.

Article 401. Battery Systems Compartments

The compartment where acid batteries system are placed (hereinafter called battery compartment) is categorized as dangerous explosion-prone area level A, if a battery cell (herein after called cell) is charged at voltage above 2.3V. The battery compartment where a cell is charged at float voltage under 2.3V, will be considered as dangerous explosion-prone area only when charging is finished or implementing after-repair power charging with voltage level over 2.3V/cell. In normal operating conditions that a cell is charged at float voltage under 2.3V, such battery compartment is not dangerous explosion-prone.

Article 402. Capacity of the battery platform

The energy source of battery systems must be capable of supplying one-way power to loads for the short- or long-term.

Specification for battery system must be selected appropriately depending on the importance of load.

Article 403. Charging Equipment

Equipment supplying power to acidic battery systems must be of sufficient capacity and voltage to charge batteries with 90% of nominal capacity within 8 hours, provided that the batteries had previously had their power discharged in accordance with the required process.

The selection of charging equipment for alkaline battery systems must conform to the instructions of the manufacturers.

The specification of such charging equipment must be selected appropriately.

Article 404. Auto-Breakers for Battery Systems

Battery system circuits must be protected by Auto-breakers.

Article 405. Battery racks and cabinets

Batteries must be placed on rack or in reliable cabinets. Supporting racks and cabinets, etc must comply with appropriate specification and be strong enough to sustain weight of the batteries system.

Article 406. Battery bus bar & cable

Bus bar of the batteries system must be bare copper bar or single copper-core cable with insulating sheath resistant to corrosive chemical substances. The specification of bus bar and its junction must be selected appropriately.

PART 5 PROTECTIVE RELAYS AND CONTROL SYSTEMS

Chapter 5-1 Protective Relays up to 1kV

Article 407. Scope of Application

This chapter shall provide the standards on the protection of indoor and/or outdoor grids up to 1kV. Other requirements for these grids shall be stipulated in other chapters of this standard.

Article 408. The Selection of Breaking Capacity

The breaking capacity of protective devices must be suitable for maximum short circuit currents at fault sections of protected grids (reference to Part 2 Chapter 2-2)

Article 409. The Selection of Rated Current

In every case, the rated current of fuses and calibrated current of auto-breakers to protect electric circuits (lines or power cables) shall be selected at the minimum calculated current of electric circuits, or at the rated current of power receivers. However, protective equipment must not be operated in the event of temporary overcurrent (starting current, peak load, self-starting current, etc.)

Article 410. Application of Fuses and Auto-Breakers

Auto-breakers or fuses must be used for protection. To satisfy the requirements of rapidity, sensitivity or selectivity, if necessary, relay protection (indirect operation) shall be usable.

1) In case fuses are used for protecting power grids, they must be installed on every phase or normal unearthed phase.

   It is prohibited to install the fuses on neutral lines.

2) In case Auto-breakers are used for protecting power networks with solidly earthed neutral, their interrupters must not be installed on earthed conductors.

   In case auto-breakers are used for protecting 3-phase-3-wire, and/or 1-phase-2-wire with isolated neutral power grids or DC power grid, it is necessary to fit an overcurrent detector of auto-breakers on 2 phases (for 3-wire power grids) and on 1 phase(pole) (for 2-wire power grids) at least. Note: one protective device should be equipped at the same phase.

Article 411. Display of Nominal Current

Each protective device must have its own label, which clearly displays the nominal current value as a requirement for the circuit protection.

Article 412. Short Circuit Fault Protection

The power grid must be equipped with protective devices to protect against short circuit current faults (short circuit protection) with minimum breaking time and selective breaking.

Such protection must ensure to break protected circuits where the following short circuit finally occurs:

1) Single- and multi-phase for solidly earthed neutral grids
2) Two- and 3-phase for isolating neutral grids.

Article 413. Overload Protection

Closed or open indoor power grids, which use inflammable sheath conductors, must be equipped with overload protective devices.

Overload protection must be equipped for the following indoor power networks:

- Illumination networks for housing, public works, stores, service housing of industrial enterprises; power network of portable, movable devices, or power networks in inflammable production compartments.
- Dynamic power networks in industrial enterprises, residences, public works, stores, if the technological process or operating mode of electric circuits may cause long-term overload for conductors and power cables.

1) Power networks in explosive compartments or areas in any case.

Article 414. Installation Location

Protective devices must be installed in locations to facilitate operation and maintenance and guard against mechanical damage. The installation of protective devices must ensure there is no risk of human harm and/or destruction of surrounding objects.

Article 415. Placement of Protective Devices

Protective devices must be installed at the following points:

- Connecting point of a branch line to a main busbar or line, the cross-section of which is smaller than that of the main busbar or line.
- The point to which the protected component is connected.
- The point required to ensure sensitivity and selectivity.

Article 416. Exception of Protective Devices

Protective devices need not be equipped for the following points:

1. Branches from buses in cubicles to instruments installed in the latter. In this case, the branch must be selected based on the calculated current for the same.
2. At points where conductors' cross-sections are downsized along feeding lines, or intersection points, if protective devices installed before downsized sections can protect the latter, or if downsized sections or branches has cross-sections no smaller than half the section of protected conductors.
3. Branches from feeding lines for measuring, controlling and signaling circuits, if such conductors are within machines or cubicles, or outside machines or cubicles but within pipes or covered in flame-resistant coating.

Chapter 5-2 Protective Relays above 1kV

Chapter 5-2-1 Common Protection Methods

Article 417. Applicable Scope

This chapter shall provide standards on protective relays for power system components at voltages from 1 to 500kV.

This chapter shall not apply to electrical equipment higher than 500kV as well as electrical equipment of nuclear power plants and DC transmission.

Requirements for the protection of power grids up to 1kV are mentioned in Part 5 Chapter 5-1.

Article 418. Purpose of Protective Relays

Electrical equipment must be equipped with protective relay system to:

1. Automatically disconnect faulty parts of power systems (electrical equipment) via circuit breakers from those in perfect working order; if faults do not cause any direct disturbance of the power system operation mode, the protective relay system shall only trip for signals.
2. React to dangerous and abnormal component operating modes in power systems. Depending on the operating mode and operating conditions of electrical equipment, protective relays must send signals or trip to interrupt components likely to cause faults if not cut off.

Article 419. Main Role of Protective Relays

Protective Relay must effectively cut off faulty parts as soon as possible to keep those in normal working order operating normally (stable operation of the Power System and electricity consumption, ensuring the ability to revert to normal operations with tripping of auto-recloser, an auto-changing standby resource device, auto-start function of electric motors, self-synchronization, etc.), and prevent any part fault from escalating and becoming more serious.

Besides, the protective relay must also ensure selective tripping so that only the fault part is cut off. (Remove / separate)

A protective relay may trip unselectively when an increased breaking time in the event of a short circuit can be guaranteed where required, however it shall be calibrated according to an auto-recloser or auto-changing standby power source device.

Article 420. Protection Zones

The protection zone of each protective relay shall overlap with those of the adjacent protective relays to the appropriate extent so that all parts are protected by protective relays throughout the power network.

Article 421. Selectivity of Protective Relays

The protective relay must operate only when the fault against which it is intended to protect occurs in its own protection range. It must not operate to cover any faults against which it is not intended to protect nor any faults outside its own protection range.

Article 422. Coordination of Operation Time

The operation time and protection zone of each protective relay shall be consistent with those of the other protective relays so that the protective relay disconnects the minimum necessary range of fault parts within the minimum operation time. The operation time and protection zone of the protective relay shall be determined in line with those of one of the other protective relays.

Article 423. Time-Delay Relays

Protective relays with time delays shall be usable to cover selective trips where:

- This will satisfy the requirements of article 419.
- Remote back up (reference to article 428)

Article 424. Improvement of Reliability

Relay protection reliability must be ensured by deciding on the respective parameters and structures according to its functions, as well as remaining consistent with its operation to prevent and detect damage in relay protection, which causes mal-operation.

Article 425. Operation Lock

Where protection relay includes a voltage circuit, the following devices must be equipped:

- Auto-locking relay protection where the automatic circuit-breaker is switched off, fuses are broken or their circuits damaged (if such failures can cause the wrong trips under normal operation) and sending signals on faults of such circuits.
- Sending signals on voltage circuit faults if such faults do not cause wrong trips under normal operation, but will do so in other operating modes.

Article 426. Relay Interlocks

Protection for power grids exceeding 110kV must include an interlocking function to block the trip of protection where electrical oscillation due to out-of-synchronization has occurred, provided that this power grid is prone to such electrical oscillation or out-of-synchronization causing wrongful tripping of the protection.

Similar interlocking may also be used for power grids below 110kV, which connect heavy supply sources (such power grids are prone to electrical oscillation and protection can involve incorrect tripping).

Protection without oscillation-blocking is permissible if the protection has been calibrated according to definite-time electrical oscillation.

Article 427. Double Protections

Double protections are two independent main protection with same name and same time to operate.

Main Protection is the protection system that operates at first.

Backup protection (subsidiary protection) operates only when the main protection does not work. Protective relay system must comply with current regulations.

On each component of power systems, main relay protection must be operable in case faults in protected components occur in a shorter time compared to the other relay protection on the component in question.

Power generators generating above 300 MW, and a group of generators of which capacities total more than 300 MW, OPL 500kV, the use of 500/220kV transformers should be considered with double protective relays equipped (excluding internal protection relay of the transformer)

Article 428. Back-up and Remote Back-up Relays

To protect neighboring components if their protection or circuit breakers fail to operate, a remote backup protective relay must be equipped.

In case the main protective relay of any component has absolute selectivity, the component in question must be equipped with a back-up protective relay. This shall not only provide a remote backup protective relay for neighboring components, but also protect its own component.

Article 429. Instantaneous Overcurrent Relays

For lines carrying over 22kV, to improve the reliability of fault breaking at the head of the line, instantaneous overcurrent protection can be equipped as a supporting protective measure.

Article 430. Breaker Failure Protection

Breaker failure protection, (e.g. a standby device in case the breaker fails to break) must be attached to equipment with voltages exceeding 1kV. Breaker failure protection shall trip for breaking of every component, which is connected to one busbar, in case one of the protective relays of the above-mentioned components starts but cannot protect against short circuits within a defined certain or reliable time.

Article 431. Setting of Sensitivity

The sensitivity factor shall be the ration between the calculated and operating values in the event of failure and shall be used to evaluate the sensitivity of the main protective relays. It shall be defined as follows:

- As for the main protective relays, which trip according to increased values in the event of failure, the sensitivity factor is the ratio between the calculated values (current or voltage) of direct fault short circuits in protected zones and the starting values of the protection in question.

- As for the main protective relays, which trip according to decreased values in the event of failure, the sensitivity factor is the ratio between the starting and calculated values (resistance or voltage) of direct fault short circuits in the protected zone.

Such calculated values must be based on the worst faults likely to occur during actual operation.

Article 432. Cooperation between Grounding Method and Protection Relays

In solidly earthed neutral power grids, due to the requirements of protective relays, the neutral mode of transformers must be selected so that in the event of an earth fault short circuit, values for current and voltage are sufficient to trip the protective relays of components in all operating modes of the power system.

Article 433. Accuracy of Current Transformers for Current Relays

Current transformers, which feed the circuits of short circuit protective relays, must satisfy the required rated load capacity and accuracy.

Article 434. Separation of Current Transformers for Measurement and Protection

Current circuits of measuring devices (electric meters) shall be connected to different windings with appropriate accuracy of current transformers.

Article 435. Usage of Fuses

To reduce the cost of electrical equipment, fuse bridges or fuse wires to be openly fitted can be used instead of circuit breakers, automatic circuit breakers and protective relays, provided the necessary requirements are satisfied.

Chapter 5-2-2 Protection of Generators

Article 436. Relay Components for Generators

For generators with voltage exceeding 1kV, capacities larger than 1MW connected directly to the busbar without a transformer, protective relays must be used to prevent all kinds of faults and abnormal operating modes as follows:

1. Multi-phase short circuits in stator windings of generators and terminals of generators;
2. Single-point earth faults in stator windings;
3. Grounding fault in two points, a point in the stator winding and a point outside the grid
4. Short circuits in between turns of one phase in stator windings (in case parallel branches of windings are conducted externally);
5. External short circuits; loads of negative (phase) sequence current (for power generators with capacity exceeding 30MW).
6. Overcoming load current reverse sequence (in parallel with the generator is capable of greater than 30MW)

7. Symmetric overload of stator windings;
8. Exciting current overload of rotor (for generators with directly cooled rotor conductors);
9. Single- or two-point earth faults in exciting circuit (corresponding to articles 445 and 40);
10. Asynchronous mode and loss of excitation (corresponding to article 446);
11. Overvoltage of stator winding of hydraulic turbine generator.

For generator with voltage exceeding 1kV, capacities larger than 1MW connected directly to the busbar without a transformer, protective relays must be used in accordance with the above-mentioned points 1, 2, 3, 5 and 7

For generators lower than 1kV and with capacity lower than 1MW connected directly to the busbar without a transformer, protective relays are equipped simply in accordance with article 448.

Article 437. Differential Relays

For multi-phase short circuit protective relays in stator windings of generators with voltage exceeding 1kV, capacities larger than 1MW, and terminals of each phase of stator winding at the neutral side, differential protection must be fitted. Such differential protection relay must trip all breakers of the power generator, extinguish the magnetic flux and stop the turbine.

In protected zones, apart from the power generator, the zone shall cover the joints between power generators to the busbar of the power plant (to circuit breaker).

Article 438. Differential Relays and Instantaneous Current Relays

In order to protect against multi-phase short circuits in stator windings of power generators with voltage exceeding 1kV and capacity lower than 1MW, which operate in parallel with other power generators or with a power system, an immediate time current protective relay must be fitted to the side of the power generator's terminals connected to the busbar. In case such quick-break protective relay is not sensitive enough, a vertical differential relay may be equipped.

Article 439. Grounding Protection stator of the generator

Regarding the design of earth fault protection system, single-phase earth faults in stator windings of power generators with voltage exceeding 1kV shall be based on the characteristics connected to the neutral point of the generator.

Article 440. Protection of Short Circuits in Coils

To protect coils of one phase in stator windings from short circuits, instantaneous horizontal differential protection must be equipped, which will trip in the same way as the protective relay mentioned in article 437.

Article 441. Negative Sequence Current Relays

To protect power generators with capacity exceeding 30MW from asymmetric (2-phase) external short circuits, and from overloads of negative sequence currents, a negative sequence current relay must be fitted, which will trip at 2-level time

Article 442. Under Voltage Relays attached to Overcurrent Relays

To protect power generators with capacity exceeding 30MW from symmetric (3-phase) external short circuits, over current protection must be equipped with under-voltage which consists of one current relay of phase current and one under-voltage relay of phase-to-phase voltage respectively.

To protect power generators with capacity of 1 to 30MW from external short circuits, an over current relay with a voltage starter must be used. Such protection will be enabled by connecting an under-voltage relay to phase -to-phase voltage, and one relay to filter negative sequence voltage to the breaking circuit of under-voltage relays if a relay is not integrated this functionality.

To protect power generators with voltage exceeding 1kV and capacity of lower than 1MW against external short circuits, current protection must be used connected to a current transformer installed on the neutral terminal side of the power generator.

Article 443. Symmetric Overload Protection of Stators

For power generators, the overload of the stator shall be protected. The temperature detector of the stator wiring and/or the overcurrent protective relay with inverse time shall be applied for this protection

Article 444. Overload Protection of Rotors

For power generators with directly cooled windings, they must be equipped with overload protection of rotors while operating with a main or auxiliary exciter.

Article 445. Protection of Grounding Faults at Exciters

Single-point earth fault protection must be equipped at exciting circuit. Moreover, it is also necessary to equip one set of 2nd-point earth fault short circuit protection in the main exciting circuit of the power generator. This protective relay shall be shared for some (but not more than three) power generators.

Article 446. Protection of Asynchronous and Loss of Field of Exciters

For power generators with directly cooled winding bars, a protective relay for asynchronous mode and loss of excitation must be fitted.

Article 447. Overvoltage Protection for Generators

For power generators which operate with long unloaded transmission lines in the event of faults in the power network, the generator shall be equipped with an overvoltage protective relay to prevent excessive voltage rise.

The voltage transformer for this protective relay and that for the excitation system of the generator shall also be respectively equipped.

Article 448. Circuit Breakers with Overcurrent Protection

To protect power generators of voltage of lower than 1kV and capacity of lower than 1MW with isolated neutral from all faults and abnormal operating modes, it is permissible to install an automatic circuit-breaker with an overcurrent interrupter, or a circuit breaker with an overcurrent protective device on two phases. Moreover, it is also permissible to attach a protective device for earth faults to the above-mentioned circuit breaker.

Chapter 5-2-3 Protection of Transformers and Shunt Reactors

Article 449. Relay Components of Transformers

Transformers must be equipped with protective relays to guard against all kinds of faults and abnormal operating modes, depending on the capacity and voltage of the transformer, as follows:

1. Multi-phase short circuits in windings and terminals.
2. Single-phase earth faults in windings and terminals.
3. Short circuits in turns of windings.
4. Overcurrent in windings due to external short circuits.
5. Overcurrent in windings due to overload.
6. Oil level decrease
7. Oil pressure increases to high level in transformer.
8. Oil pressure increases to high level in on-load tap changer.
9. Oil temperature increases to high level in transformer.
10. Transformer’s winding temperature increases to high level.

Article 450. Relay Components of 500kV Shunt Reactors

For 500kV shunt reactors, protective devices must be equipped for all kinds of faults and abnormal operating modes as follows:

1. One-phase earth faults in windings and terminals.
2. Multi-phase short circuits in windings and terminals
3. Short circuits in turns of windings.
4. Oil pressure increases to high level.
5. Oil level reductions

Article 451. Application of Buchholz Relays

Buchholz relays must be equipped for faults which create air inside transformers, and to keep the oil level from decreasing and the oil pressure from increasing for:

- Middle Transformers with capacity exceeding 6.3MVA.
- 500kV shunt reactors.

- Step-down transformers of the shop with capacity from exceeding 1000kVA.

Article 452. Short circuit protection incidents directly inside of Transformers and Shunt reactors

To protect against faults of terminals and inside transformers and shunt reactors, the following protective relays must be equipped:

1. Timeless vertical differential protection relay for transformers exceeding 6.3 MVA and 500kV shunt reactors, transformers of 4 MVA which operate in parallel.
2. In the radial electric network, quick-break current relays are installed on the supply side and protect partially covered transformer windings, where a differential protection relay is not available.

Such protective relays must trip to switch off all circuit breakers of transformers.

Article 453. Protection of Short Circuits in Turn

To protect turns of one phase in the main wiring from short circuits, the transformer shall be equipped with a horizontal differential protective relay.

Article 454. Countermeasures against Outside Faults

To protect transformers against overcurrent due to external short circuits, protective relays must be used in coordination with the operation time of the main protective device subject to fault.

Article 455. Back-up Protection for Outside Short Circuits

For step-up transformers exceeding 1 MVA and transformers with 2 and 3 supply sources, and auto-connected transformers, as required, backup protection should be equipped for earth fault short circuits in neighboring components with coordination of the operation time of the main protective device of the adjacent components.

Article 456. Protection against Earth Faults for Transformers

For step-down transformers and transformer main line blocks, which have voltage on the high voltage side lower than 35kV and windings on the low voltage side connected in a star to the earthed neutral, single-phase earth fault protection must be equipped on the low-voltage network by using:

1. External short circuit overcurrent protection installed on the high-voltage side of the transformer, if required, high sensitivity should be used with a 3-relay diagram.
2. An automatic circuit-breaker or fuse at the output of the low-voltage side.
3. A special zero sequence protective relay installed on neutral conductors of transformers (in case the sensitivity of the protective relay as mentioned in points 1 and 2 is insufficient).

Article 457. Overvoltage Relay for Overload Protection

For transformers exceeding 0.4 MVA, depending on the rate and overload withstand capacity, an overcurrent protective relay for overload protection should be equipped.

Chapter 5-2-4 Protection of Transformer and Generator Blocks

Article 458. Relay Components for Transformers and Generator Blocks

For generator-transformers with power generators exceeding 10 MW, protective relays must be equipped for all kinds of faults and abnormal operating modes in accordance with regulations for both generators and transformers. Regulations of the protection of generators and step-up transformers while they operate independently shall be those applied for blocks of generator-transformers (auto-connected transformers), except for some changes mentioned in articles 459-471).

Article 459. Protection for Grounding Faults

For generator-transformers with generators exceeding 30MW, an earth fault protective relay shall be equipped at the circuit of the generator and cover the entire stator winding.

Article 460. Differential Relays for Branches

For generators where the stator includes two or three parallel branches, a one-system transversal differential protection relay must be equipped to protect against short circuits in between turns in one phase.

Article 461. Overload and Overcurrent Protection

For blocks with generators exceeding 160 MW which have directly cooled winding bars, a negative sequence current protection relay must be equipped with a dependent integral in combination with a permissible negative sequence overload current protection relay of a protected generator. The protection relay must trip to break the circuit breaker of the generator, and if the circuit breaker is not available, the protection relay will trip to interrupt the entire block.

Article 462. Setting Value of Protection for Outside Short Circuit Currents

For blocks with generators of capacity exceeding 30MW, symmetric external short circuit protection must be set up in accordance with the regulations for generators mentioned in article 442.

For blocks with hydro generators of capacity lower than 30MW, external short circuit protection must also be set up in accordance with the regulations for generators mentioned in article 442.

Article 463. Back-up Protection for Generator-Transformer Blocks

Backup protection relays for generator-transformer blocks must consider the following requirements:

1. At the generator voltage side of the transformer, no protection relay will be equipped but the protection relay of the generator will be used.

2. The remote backup protection relay must have 2-level time, the first - separating the diagram at the high-voltage side of the block, the second - disconnecting the block from the power grid.
3. The nearby backup protection relay must trip to interrupt the block (generator) from the power grid, extinguishing the magnetic flux of the generator and stopping the block in case article 470 is required.

Article 464. Symmetric Overload Protection

For the block, which has a generator with symmetric stator overload protection, protection which applies to the generator operating on the busbar must be applied.

Article 465. Overload Protection for Exciter Circuits

For generators exceeding 160MW, which have directly cooled winding bars, the exciting current overload protection of the rotor winding must be set in a time-dependent manner, according to the permissible overload factor determined by the exciting current of the generator.

Article 466. Overvoltage Protection for Generator blocks

For blocks with generators exceeding 160MW and hydraulic generators, to prevent any high increase in voltage while operating in non-load conditions, a high increase voltage protective relay must be equipped. When the protective relay trips, it will securely shut down the magnetic flux of the generator and exciter.

Article 467. Protection for Grounding Faults at Exciter Circuits

Hydraulic generators, water cooled rotor winding generators, and all generators with capacity exceeding 160MW, must be equipped with single-point earth fault protective relays at exciting circuits.

The second point earth fault protective relay at the exciting circuit of generators must be installed at generators with capacity of lower than 160MW, in accordance with article 445.

Article 468. Protection for Asynchronous and Loss of Field of Exciters

For generators with directly cooled winding bars exceeding 160MW and for hydraulic turbine generators, a protective relay must be equipped for the asynchronous mechanism and loss of excitation.

This protective relay must also be equipped at generators with directly cooled winding bars with capacity lower than 160 MW.

Article 469. Backup Protection for Failure of Circuit Breakers

Where circuit breakers are available in circuits of generators with directly cooled winding bars, a backup protective relay must be equipped in case the circuit breaker fails to operate.

Article 470. Stand-by Device for Inner Faults

The protective relay of the stator of the power generator and transformer of the block for inside faults, and the protective relay of the generator rotor when tripping to interrupt must disconnect fault components from the power grid, extinguish the magnetic flux of the exciter of the generator, and start up the standby device.

Article 471. Cooperation of Protection Relays for Transmission Lines and Blocks

For generator-transformer line blocks, the main protective relay of the line and backup protective relay from the side of the power system must be operated based on the requirements of this chapter for line protection. From the block side, the backup protective relay for the line must become a backup one for the block.

Chapter 5-2-5 Protection of Overhead Lines and Cables with Isolated Neutral

Article 472. Relay Components for Overhead lines and Cables with Isolated Neutral

For isolated neutral overhead lines and cable lines with voltage of 6-35kV (including earthed neutral through arc suppression coil), multi-phase short circuit protective relay and one-phase earth fault protective relay must be equipped.

Overhead lines and cable lines can be equipped with a recorder to record parameters and fault conditions.

Article 473. Equipped with Short Circuit Protection Relays

Multi-phase short circuit protective relays must be installed on two phases and at two same-name phases of the entire voltage network to ensure any faults can be interrupted in most two-phase earth fault short circuits. To improve sensitivity to short circuits behind star-delta connected transformers, the use of a 3-relay diagram is permissible.

Article 474. Operation Time of Short Circuit Protection

For single lines with one side power sources, to protect against multi-phase short circuits, a 2-level short circuit current relay must be equipped, the first level is a quick-breaking protective relay, and the second is a time-dependent or time-independent overcurrent protective relay combined with an under-voltage protective relay.

Article 475. Selectivity of Short Circuit Protection

For a single line fed by two supply sources, with or without loop contact, as well as for lines in a closed loop network fed by one supply source, the protective relay must be set as one for a single line fed by one supply source (reference to article 474) but if required, the protective relay must trip directionally.

Article 476. Protection against Grounding Faults

Single-phase earth fault protection must be carried out in the following ways:

- Selective protection (set following the direction of faults), trip for sending signals
- Selective protection (set following the direction of faults), trip for interruption if required, at the safety requirements. The protective relay must be installed for every component fed by the supply source of the entire power grid.
- Insulation tester. In this case, the detection of fault components must be carried out by specialized devices. It is allowed to detect fault components by disconnecting the feeder, respectively.

Article 477. Relay Components for Parallel Transmission Lines with Isolated Neutral

For parallel lines fed by two and more supply sources, as well as at the head with a supply source of parallel one-side feeding lines, it is possible to use protective relays as those used for single lines.

Chapter 5-2-6 Protection of Overhead Lines and Cables with Efficient Earthed Neutral

Article 478. Relay Components for Overhead lines and Cables with Efficient Earthed Neutral

Efficient earthed neutral overhead lines and cable lines with voltage from 15 to 500kV must be equipped with multi-phase fault short circuit and earth fault short circuit protective relays.

Overhead lines and cable lines at voltage level from 10kV to 500kV should be equipped with a recorder to record parameters and fault conditions or protective relay with such functional recorder and fault locator.

Article 479. Countermeasures for Power Swing and Asynchronous

Protective relays must have a power swing block in case the network is likely to suffer from oscillation or asynchronous conditions causing the wrong trip of protective relays.

Article 480. Instantaneous Short Circuit Protection for 110kV to 500kV Power Lines

For important OPL 220kV and 500kV lines, two main protective relay must equipped to operate instantly in case the short circuit touches any point in the protected sections.

For OPL with 220kV or higher, regarding the protection against overvoltage caused by the load shedding due to the protective relay tripping, if required, interlocks must be equipped to break other circuit breakers at the opposite end of the line.

For 110 - 220kV lines, the selection of the main protective relay, including the need to use instantly operating ones where the short circuit touches any point in the protected sections, the first point involves considering the stable operation of the Power System.

For underground cables exceeding 220kV, apart from protection as mentioned for overhead lines, a temperature sensor must also be installed for monitoring the cable operating temperature and preventing any increase in temperature.

Article 481. Relay Components for Transmission Lines in Radial Networks of more than 220kV

For lines exceeding 220kV in radial networks with one supply source, to protect against multi-phase short circuits, a level current protective relay or level current with voltage protective relay must be equipped.

For transmission lines, the level distance relay should be used as the main relay and the current protective relay should be used as a back-up relay to protect against short circuits at the head of lines.

To protect against earth fault short circuits, in principle, a zero sequence protective relay with at least a 2-time level, with or without direction, shall be used. Moreover, also in principle, the protective relays shall be installed at the sides to which electricity can be supplied.

Article 482. Relay Components for Transmission Lines in Loop Networks of more than 220kV

For single lines exceeding 220kV with two or more supply sources, with or without loop contact, as well as for line in close loop with one supply source, as protection against multi-phase short circuit, it is necessary to use distance protective relay as main protective relay and use it as buck-up protective relay when differential protection is used for the line protection according to the regulations

Article 483. Relay Components for Parallel Transmission Lines with Efficient Earthed Neutral

For parallel lines fed by two supply sources or more, as well as for the head of supply sources of parallel lines fed with one supply source, protective relays corresponding to those applied to single lines may be used.

Article 484. Alternative Relay Components for Instantaneous Protection

If the protection as mentioned in articles 482 and 483 cannot satisfy the requirements for quick-act (reference to article 480), a high-frequency protective relay and vertical differential protective relay must be used for single and parallel lines which are fed by two supply sources.

Where the above-mentioned protective relays are used, the following protective relays shall also be used as backup:

- For multi-phase short circuit protection, a distance protective relay is often used, mainly 3-level.
- For earth fault short circuit protection, a level directional current protective relay and non-directional zero sequence current protective relay are often used.

Article 485. Reliability of Protection Relays for 500kV Transmission Lines

For main protection, a quick-act level of backup multi-phase short circuit protection for 500kV lines must be established to secure their normal function under normal operation mode under powerful transient electromagnetic conditions and excessive capacity of conductors.

Article 486. Relay Components for 15-35kV Distribution Lines

For 15 - 35kV lines in distribution networks with earthed neutral, where there is no special requirement, only relays to protect against quick-break overcurrent and earth faults are needed if their selectivity is maintained.

Chapter 5-2-7 Protection of Compensating Capacitors

Article 487. Protection Components of Shunt Capacitors at OPL

Shunt capacitors widely laid on overhead lines protected simply with an appropriate fuse or expulsion dropout fuse. Refer to the regulations in article 435 to select the fuses for capacitors.

Article 488. Protection Components of Shunt Capacitors at Substations

Shunt capacitor laid in concentration in substations, sets of shunt capacitors are often laid behind circuit breakers with the following protective devices:

- Fuses for protecting each individual capacitor. These can be laid outside or built into the condenser.
- An overcurrent protective relay for each phase.
- An unbalanced current protective relay between taps in one phase and/or an unbalanced protective relay between phases.
- Overvoltage protective relay

Article 489. Relay Components for Series Capacitors

A series capacitor is also equipped with protective relays like the shunt capacitor mentioned in article 488, otherwise, when the protective relays trip, they will not be disconnected from the power network, but close the circuit breaker bypassing the capacitor at 3 phases of the capacitor element.

Chapter 5-2-8 Protection of Busbars

Article 490. Protection Components for Busbars of 110kV or more

The following busbar systems of power plant and transmission substations exceeding 110kV must be equipped with particular protective relays:

- For 2-busbar systems (duplicated busbar systems, one and half circuit breaker diagrams, etc.) and sectionalized single busbar systems.
- For non-section single busbar systems, if the fault interruption function on the busbar with tripping of protective relays of components connected to the busbar is not available.

Article 491. Protection Relay Components for 35kV Busbars

For 35kV busbars of power plants and transmission substations, a particular protective relay must be equipped in the following cases:

- For duplicated busbar systems or sectionalized busbars, when a particular protective relay laid in a busbar circuit breaker (sectionalized circuit breaker), or a protective relay laid in components feeding this busbar system cannot reliably supply electricity to consumers (taking into account the ability to meet with an auto-recloser and standby automation).
- For busbars of closed distribution equipment, the above-mentioned protective relay for this busbar need not be installed.

Article 492. Differential Relays for Busbars of 110kV or more

To protect busbars of power plants and transmission substations of 110kV or more, a timeless differential current protective relay must be used, which covers the entire scope of components connecting busbars or sections of busbars.

For duplicate systems of power plants and transmission substations of 110kV or more, each component connected to the busbar shall have one circuit breaker, which must use a differential protective relay.

Article 493. Protection for 6-10kV Busbars with Generators

For busbars with sections of 6 - 10kV of power plants, a 2-level time non-full phase differential protective relay must be used.

Article 494. Protection Range

When live busbar system or section for trial, the protective relay must trip for selective interruption without time delay if the busbar system and section are broken.

Chapter 5-2-9 Protection of Synchronous Compensators

Article 495. Protection Components for Synchronous Compensators

Synchronous compensators, which are directly connected to busbars, must be equipped with the same protective relay as that for corresponding generators, but with some differences between them as follows:

1. Symmetric overload protective relays, which trip to send signals, must be locked to keep from operation when the synchronous compensator starts, if the protective relay is liable to trip (when the synchronous compensator starts).
2. Under-voltage protective relays, which trip to interrupt the circuit breaker of synchronous compensators, must operate with a time delay of 10 seconds and the starting voltage of the protective relay shall be from 0.1 to 0.2 U_{dd}.
3. A protective relay for tripping shall be equipped in case transmission substations suffer from transient outages (e.g. dead cycles of auto-reclosers of feeding lines).

4. For synchronous compensator exceeding 50 MVar, a protective relay must be equipped to trip for disconnecting synchronous compensators or sending signals in case the losses of excitation or exciting current exceed the permissible limit.
5. For synchronous compensators, which operate according to the transformer block, an earth fault protective relay must be equipped in the stator winding; this protective relay will be installed at the lower voltage side of the transformer.

Article 496. Protection for Grounding Faults for Synchronous Compensators

An earth fault protective relay must be used in the exciting circuit similar to that of the hydraulic generator (reference to article 467).

Chapter 5-2-10 Protection of Underground Cable Lines

Article 497. Relay Components for Underground Cables

The relay components of underground cables are selected and adjusted according to the requirements of the overhead line and cable line with or without directly earthed neutral

Article 498. Protection against Earth Faults for Underground Cable Lines

Regarding the earth fault protection of underground cables, the mal-operation of protective relays caused by harmonics due to the capacitance of the cable shall be considered and countermeasures shall be implemented.

Moreover, given the larger capacitance of the underground cable, the earth fault current of the underground cable is smaller. With this in mind, the sensitivity of the protective relay to earth fault shall be sufficient to detect and protect against earth faults.

Chapter 5-3 Control Systems

Chapter 5-3-1 Auto-reclosers

Article 499. Functions of Automation and Remote Control

Electrical automation equipment and remote control systems control and/or adjust the following:

1. Auto-reclose transmission lines, busbars, transformers and other components
2. Standby automation
3. Energize synchronous compensators and generators
4. Regulate voltage and reactive power
5. Regulate frequency and active power
6. Stability
7. Synchronous mode
8. Increases and decreases in frequency
9. Increases and decreases in voltage

10. Overload
11. Inspection of dispatching equipment and control systems

Article 500. Application Conditions of Auto reclosers

Auto-reclosers are used to promptly recover electricity supply to consumers or recover connections between power systems, or the internal contact of power systems by automatically operating live circuit breakers which may be de-energized due to protective relays.

Auto-reclosers must be installed at:

1. Overhead lines and cable-overhead lines at all voltages exceeding 1kV.
2. Busbars of power plants and transmission substations
3. Transformers
4. Other motors which are disconnected to ensure the self-start of key motors

Article 501. Case Auto recloser not be allowed to operate

It is prohibited to operate auto-reclosers in the following cases:

1. The operator manipulates the deactivation of the circuit breaker on site or via remote control.
2. The circuit breaker is automatically switched off due to the protective relay tripping right after the operator manipulates to energize the circuit breaker or by remote control.
3. The circuit breaker is switched off due to the tripping of the protective relay for faults inside the transformer and the electrical rotary machine or power cable line, as well as other causes, but the operation of the auto-recloser is prohibited.

Article 502. Operation Period Requirements

Generally, a 3-phase auto-recloser can be used to trip one or more times according to the condition of the power network.

Article 503. Operation Time Requirements

To accelerate the line recovery to normal operating mode, the time of the 3-phase auto-recloser (especially for the first cycle of auto-recloser with 2 trips on the line fed by one supply source) must be minimized, taking into account the duration for extinguishing the arc, deionization at the faulty point and the time required to prepare to re-energize the circuit breaker and driver.

Article 504. Required Application Conditions for Single Transmission Lines

For single lines fed with two supply sources, one among the following 3-phase auto-reclosers must be equipped:

1. 3-phase quick-act auto-recloser
2. Asynchronous 3-phase auto-recloser
3. Three-phase auto-recloser for auto-synchronization

In addition, it is possible to have a 1-phase auto-recloser in combination with various 3-phase auto-reclosers if the circuit breaker has a controller for each phase.

Article 505. Condition of Single Phase Auto-reclosers

One-phase auto-reclosers can only be used in large earth fault power grids. 1-phase auto-reclosers which do not automatically switch the line to long non-full phase operating mode (long loss-of-one-phase) in the event of stable phase displacement, should be applied for:

1. Heavy load lines with contacts among power systems or for live lines among internal power systems.
2. Heavy load lines with contacts among power systems from 220kV upwards with 2-bypass contacting systems and over, where one among them is disconnected, whereby an unstable power system may result.
3. Contact lines among or inside power systems of various voltages, where disconnecting 3 phases of high voltage lines may cause a prohibited overload of lower voltage lines and accordingly be likely to cause instability in power systems.
4. Contact lines with power plant systems with large blocks but less local load.
5. Live lines where voltage drops during the operation of 3-phase auto-reclosers may result in a sudden loss-of-load.

For the above-mentioned lines, 1-phase auto-reclosing will be carried out in combination with various 3-phase auto-reclosing. Subsequently, it is necessary to be prepare for locking 3-phase auto-reclosers, for 1-phase auto-reclosers or only where 1-phase auto-reclosing has failed to operate

Article 506. Required Functions to Prevent Malfunction of Circuit Breakers

In case the auto-recloser fails to operate to energize the first circuit breaker of a component with two or more circuit breakers, the operation of other auto-reclosers will be disabled.

Chapter 5-3-2 Auto Switching Power Supply Devices

Article 507. Application Conditions of Auto Switching Power Supply Devices

Standby automation devices are used to recover the power supply source for consumers via automatic live back-up sources, where an outage occurs at online sources, resulting in an outage of consumer electrical equipment. Standby automation devices are also used to automatically energize standby devices in case an outage occurs at online main devices, accordingly breaking technological procedures.

Standby automation devices can be installed at transformers, on lines, on electric motors, busbar circuit breakers and sectionalized circuit breakers, etc.

Article 508. Reliability Improvement Requirements

The operability of standby automation devices must be ensured in the event of outages in feeding busbars of components which have standby sources, or even short circuits in busbars.

Article 509. Required Functions of Observance of Overload

When operating standby automation, the overload condition of the standby source and self-startup ability of motors must be checked.

Article 510. Required Functions of Prevention of Asynchronous Conditions

Where standby automation devices can energize asynchronously synchronous compensators or motors and such asynchronous live is impermissible, these synchronous compensators and motors must be disconnected automatically, or switched to asynchronous mode by disconnecting automatic magnetic extinguishers, then re-energized or re-synchronized after recovering voltage based on the successful operation of automatic switching devices.

Chapter 5-3-3 Auto-synchronization of Generators

Article 511. Synchronization Mode

Generators must be energized for operation in parallel via one among the following modes: accurate synchronization (manually, semi-automatic and automatic) and auto-synchronization (manually, semi-automatic and automatic).

Article 512. Accurate Synchronization Application Conditions

Automation or semi-automation of accurate synchronization is the key mode to put the generator in parallel operation.

Article 513. Application Conditions of Auto-synchronization

Auto-synchronization shall be the key mode to put the generators in parallel operation for:

- Steam turbo-generators with capacity up to 3MW.
- Indirectly cooled steam turbo-generators with capacity over 3MW, directly operating in the busbar of generator voltage, and where the values of the component in the cycle of transient current when energized with auto-synchronization do not exceed $3.51I_{dd}$.
- Indirectly cooled steam turbo-generators and in completed operations with transformers.
- Hydraulic turbo-generators with capacity up to 50MW.

Application method of synchronization system to gas turbine is pursuant to the application method of steam turbine.

In case faults occur in power systems, the energizing of generators for their parallel operation - regardless of cooling systems and their capacities - shall be carried out by auto-synchronization

Chapter 5-3-4 Auto-control Exciter Systems, Auto-control of Reactive Power, Auto-voltage Regulators

Article 514. Required Functions of Auto-control Exciter Systems, Auto-control of Reactive Power, Auto-voltage Regulators

Auto-regulators for controlling exciters, reactive power and voltage functions:

1. To maintain voltage in power systems and in electrical equipment at the assigned characteristic curves in case the power system operates normally.
2. To allocate reactive load among reactive power sources under the stipulated rule.
3. To intensify the static and dynamic stability of power systems and damp oscillation occurring in transient mode.

Article 515. Application and Range Requirements

Synchronous electric equipment (generators, compensators, motors) must be equipped with auto-control exciter systems.

Article 516. Improved Reliability Requirements

High reliability must be ensured for auto-control exciter systems, auto-control of reactive power, auto-voltage regulators and other devices of excitation systems fed by voltage transformers, as well as high reliability for corresponding circuits.

In principle, there should be no sharing of voltage transformers, which have been connected to auto-control exciter systems,

Article 517. Sensitivity of stimulation for hydro-generators

Auto-control exciter systems of hydraulic turbo-generators must be arranged so that in the event of sudden loss-of-load and a governor operating accurately, the high-voltage protective relay shall be disabled.

Article 518. Required Functions of Excitation Regulators

An auto-control exciter system must ensure the stable regulation of exciting current from minimum to maximum allowable values.

Chapter 5-3-5 Auto-control Frequency and Active Power

Article 519. Required Functions of Auto-control Frequency and Active Power

Auto-control frequency and active power system functions:

1. To maintain the frequency of united power systems (national power systems) and independent power systems in normal mode in accordance with regulations of electricity quality standards.

2. To regulate power exchange among national power systems and limit power overcurrent through load dispatching centers inside and outside national power systems and independent power systems.
3. Power allocation (including economical power allocation) among controlling objects at all dispatches (among united power systems, single power systems in united power systems, power plants in power systems and generator units or blocks in power plants).

Article 520. Frequency Fluctuation Requirements

Auto-control frequency and active power systems in power plants, under the normal operating mode of power systems, must ensure an average frequency deviation is maintained within the frequency stipulated in this Technical regulation.

Article 521. Required Components

The auto-control frequency and active power system must be equipped with:

1. An auto-frequency controller, power exchange regulator and overcurrent limiter at dispatching locations.
2. A controlling signal distributor, between the controlled power plant and a power overcurrent limiter through the load dispatching center inside the system.
3. An active power regulator in power plants involved in power auto-control.
4. Sensors of active power overcurrent and remote control.

Chapter 5-3-6 Auto-prevention of Disturbances

Article 522. Required Functions of Auto-prevention of Disturbances

A device for auto-prevention of disturbance in power systems shall be equipped based on concrete conditions, wherever such device is considered sound, from economic and technical perspectives, to maintain optimal dynamic stability and secure standby normal static stability at the mode after fault.

Chapter 5-3-7 Auto-elimination of Asynchronous Mode

Article 523. Required Functions of Auto-elimination of Asynchronous Mode

To eliminate the asynchronous mode if it occurs, auto-devices must be used to disconnect the line with the load area when the asynchronous mode exceeds the criteria. These devices shall take responsibility for distinguishing asynchronous mode and synchronous oscillation, short circuit or other abnormal operating modes

Chapter 5-3-8 Auto-prevention of Frequency Decrease

Article 524. Required Functions of Auto-prevention of Frequency Decrease

The auto-prevention of frequency decrease must be calibrated so that if any power shortage occurs in united power system, power systems or in power system nodes, any frequency decrease over the permissible value shall be completely eliminated.

Article 525. Load Shedding in the event of Frequency Decrease

Automatic load shedding by frequency shall be carried out by de-energizing small amount of load parts depending on deviation of frequency decrease level or duration time of frequency decrease.

Article 526. Re-energizing after Load Shedding

Devices for re-energizing outage parts after the recovery of frequency are used to reduce the outage duration of consumers where frequency is recovered due to live power sources, re-synchronizing or synchronizing of de-energized transmission lines.

Chapter 5-3-9 Auto-prevention of Frequency Increase

Article 527. Required Functions of Auto-prevention of Frequency Increase

In order to prevent frequencies from exceeding the permissible limit for thermal power plants, which can operate in parallel with relatively large hydropower plants in the event of sudden loss-of-load, an auto-tripping protective relay must be used in case the frequency increases.

Chapter 5-3-10 Auto-prevention of Voltage Decrease

Article 528. Required Functions of Auto-prevention of Voltage Decrease

Auto-prevent voltage decrease devices are equipped to eliminate any breakdown of load stability and prevent chain reactions in the form of voltage decreases following fault-modes of power systems.

Chapter 5-3-11 Auto-prevention of Voltage Increase

Article 529. Required Functions of Auto-prevention of Voltage Increase

To reduce the period of voltage increase in high-voltage devices of power transmission lines, power plants and substations due to de-energizing of one side of the transmission line, auto-prevent voltage increase devices must be used if the voltage exceeds the allowable value

Chapter 5-3-12 Auto-prevention of Overload of Electrical Equipment

Article 530. Required Functions of Auto-prevention of Overload of Electrical Equipment

Auto-prevention overload devices are used to limit duration overload in lines, transformers and series power capacitor banks, if the duration exceeds the allowable limit.

Chapter 5-3-13 Remote Telecontrol Systems

Article 531. Required Functions of Telecontrol System

Remote control system, in addition to ensuring the requirements on the ability to monitor, measure, data acquisition, must also have remote control capability, remote set setting value for the frequency regulator, voltage regulator, protection relay and other related devices.

Article 532. Information Signal Requirements

Remote signals are used for:

- Informing load dispatch centers of the condition and status of switching devices of electricity works under direct managing units, or informing senior load dispatch centers, which play a decisive role in setting up the operating mode of power systems.
- Inputting data to computers or information processing devices.
- Transmitting faulty signals and alerting ones.

Article 533. Required Functions of Remote Control Systems

Telemetry must ensure master parameters on electricity or technology are transmitted (specific parameters on the operating mode of each work).

Article 534. Requirements for Communication Lines

The set of electrical equipment to be in remote control, requirements for remote controls and communication channels in remote control systems are identified by the accuracy, reliability and time delay of information when establishing designs for the auto-control of frequency and power flow in united power systems.

Chapter 5-4 Secondary Circuits

Article 535. Applicable Scope

This chapter shall provide the standards for secondary circuits.

Article 536. Applied Voltage

The operating voltage of secondary circuits must not exceed 500V. In case the secondary circuit cannot communicate with other secondary circuits and the equipment of such circuits is arranged separately, the operating voltage may reach 1kV.

Secondary circuit connections must be in line with surrounding conditions and safety standards.

Article 537. Requirements for Cross-Section, Accuracy and Mechanical Durability

Cross-sections of cable cores and conductors must satisfy requirements for short timeless circuit protection and permissible long-term load current in Chapter 2-2 – Part 2 as well as mechanical durability. Moreover, it must be refractory (for circuits from current transformers) and the accurate operation level and power loss from voltage transformers must also be ensured.

Article 538. Sharing Cable Cores

It is permissible to share multi-core cables for controlling, measuring, protecting and signaling AC and DC current circuits, as well as for motive circuit feeds for low-capacity consumers (valve motors). However, the total loads connected to the current and voltage transformer shall not exceed their stated capacity.

Article 539. Cable Installation

The selection of conductors and cables for secondary circuits, layout methods and protection must take account of the related requirements in Chapters 2-1, 2-3 – Part 2 and Chapter 5-1 – Part 4.

Cables of secondary circuits of transformers of 110kV upwards, connecting from transformers to panel boards, must be covered with armored sheaths and be grounded at two terminals.

Article 540. Cable Connection Method

The terminal clamp series, substation-contacts of the circuit breaker, isolator and other equipment as well as grounding conductors, must be laid out so that they can secure safety if the operators manipulate them without de-energizing the primary circuit with voltage exceeding 1kV.

Article 541. Circuit Insulation

The insulator of components in secondary circuits must conform with standards, identified by the operating voltage condition of the source (or isolating transformer) feeding this circuit.

Article 542. Circuit Protective Measures

The feeding source for the secondary circuit of each connection must pass through an individual auto-breaker.

Article 543. Signal Systems in the event of an Abnormal Operation or Fault

Generally, electricity works must be equipped with auto-signaling systems if the system operates abnormally and/or faults occur.

Article 544. Grounding in Secondary Circuits of Current Transformers

Grounding in secondary circuits of current transformers shall be carried out at the point nearby the current transformer in the clamp bank or on the poles of current transformers.

Article 545. Grounding in Secondary Circuits of Voltage Transformers

Secondary coils of voltage transformers must be grounded at neutral points or among outputs of coils with grounding devices.

PART 6 EARTHING

Chapter 6-1 Purpose of Earthing

Article 546. Applicable Scope

These Regulations are applied for designing and installing earthing system for all electrical equipment working with AC currents at all voltages.

Article 547. Need for Earthing Systems

All electrical equipment with voltage exceeding 42V must have one of the following forms of protection: grounded connection, neutral connected or trip function by protective devices, in order to secure people working at electric power facilities and protect electric equipment from lightning and internal overvoltage.

Article 548. Common Earthing Systems

A common earthing system must be established for equipment with different functions and voltages except for some cases specifically mentioned in this Regulation.

The resistance of common earthing systems must satisfy the requirements of equipment and must be smaller or equal to the minimum resistance of any equipment connected to the common earthing system.

For safety of grounding system, grounding system and grounding for lightning protection must be connected with the grounding grid by separate wires for each branch**.**

Chapter 6-2 Components to be Earthed in Power Networks

Article 549. Earthing Method of Neutral of Overhead Lines with voltage up to 1kV

Neutral conductors of overhead power lines must be repeatedly earthed at the end and branch poles. Along with the neutral conductor, there must be repeated earthing for each span of 200 -250 m.

For repeating earthing in AC power networks, man-made earthing objects must be used.

The above-mentioned earthing conductor must be covered with insulating material from 2m above ground to 75cm underground.

Article 550. Earthing of Power Cable Lines

Metal parts of cable power lines and other cable structures with the risk of exposing people to electric shocks must be earthed or connected to a neutral conductor by appropriate equipment and connection measures.

Article 551. Earthing for Oil-Filled Cable Lines

The earthing for oil-filled cable lines and the accessories must be installed according to manufacturer's requirements

Article 552. Earthing Neutral Conductors and Poles

For overhead power lines with voltage up to 1kV, earthing of neutral conductors by appropriate measures is applied. In power systems with earthed neutral conductors, pedestals of insulators or rod gap of phase conductors and steel of the concrete metal part of poles must be connected to neutral conductors.

Article 553. Additional Earthing Requirements

In populated areas, in order to avoid overvoltage due to lightning, earthing points must be arranged on overhead power lines with voltage up to 1kV.

Besides, earthing must also be applied in the following places:

a) At branch poles to building where many people may gather or places of high economic value.

b) At the end pole of overhead power lines with branches to buildings.

c) At poles mentioned in points a) and b), lower voltage lightning arresters should be installed.

d) At hanging wires for car road signs.

Article 554. Earthing of Overhead Power Lines with Voltage Exceeding 1kV

Overhead power lines with voltage exceeding 1kV must be earthed in consideration of the surrounding environment by appropriate measures and structures in the following cases:

1. Steel poles and reinforced concrete poles:
   - Overhead power lines with voltage of 110kV and above.
   - Overhead power lines with voltage up to 35kV, with fast residual protection or traversing non-populated areas.
   - Overhead power lines with voltage up to 35kV, with fast residual protection or accessing non populated areas with irregularity after 2 or 3 poles and earthed at poles, which cut across transport routes.
2. Steel poles and reinforced concrete poles with all voltages, with lightning conductors or lightning arresters as well as all poles on which power transformers or measuring transformers, disconnectors, fuses or other equipment are installed.
3. Poles of communication and signal lines at intersections of overhead power lines with voltage exceeding 1kV for which a protection gap is arranged.

Besides, earthing structures of overhead power lines with voltage exceeding 1kV shall be placed at a minimum depth of 0.5m in fields and of not less than1m in rocky areas. In addition, stones with not less than 0.1m thick shall be put on a overburden. When the thickness of stone cover does not meet the above requirements, the grounding wire is put on the rocks and covered with cement mortar.

Article 555. Earthing in Crossing Spans

In crossing spans, overhead power lines, metal pipelines, bridges, nets, metal fences and aerial transport cable lines must be earthed by appropriate measures.

Article 556. Earthing of Metal Objects near Overhead Power Lines

Metal objects influenced by electrostatic induction from overhead power lines with voltage exceeding 220kV must be earthed by appropriate measures.

Chapter 6-3 Components to be Earthed in Electrical Equipment

Article 557. Components to be Earthed

The metal parts of electrical equipment, for indoor as well as outdoor machines, must be earthed. The components which must be earthed include:

Enclosures and metal bases of electrical machines, enclosures of transformers, electrical instruments, lighting equipment etc.

The secondary circuit of current and voltage transformers shall be earthed at only one point among this circuit in accordance with the requirement mentioned in article 544 and article 545.

The frame of electrical distribution cubicles, control boards, electrical panels and electrical cubicles.

The metal structures of outdoor switchyards and substations, metal enclosures, power cable sheaths, cable terminal boxes, metal conduits for cables, and supports of electrical equipment.

Metal enclosures of mobile or portable electrical machines.

Arresters installed at circuits with voltage exceeding 35kV.

Article 558. Protection of Transformers with primary coil voltage above 1kV and secondary coils to 1kV

The transformer of which primary coil's voltage is more than 1kV and secondary coil's voltage is up to 1kV must be grounded at its neutral or at one of the phase wires of the secondary side. In the case that the above grounding cannot be applied, fault protective devices must be installed at the neutral point or at the secondary side of the transformer to prevent the voltage rise on the secondary side when the insulation between primary and secondary coils is damaged.

Chapter 6-4 Components Exempt from Earthing

Article 559. Components Exempt from Earthing

The following components need not be earthed among equipment which needs to be earthed:

(1) AC electrical equipment with voltage equal to or less than 380V which is installed in less dangerous halls, the dry floors of which have low conductivity (e.g. wooden, asphalt resin) or in clean and dry rooms (such as laboratories, office rooms).

Notwithstanding the foregoing, the above equipment must be earthed if during work, the operator may, at the same time, come into contact with both electrical and other earthed parts.

(2) Equipment installed on earthed metal structures, if effective electrical contact at the surfaces of these structures is ensured (the contact surface must be clean, smooth and unpainted).

(3) Structures for placing cables at any voltage, with metal enclosures earthed at both ends.

(4) Railways going out from areas of power stations, substations, switchyards and substations of industrial enterprises.

(5) Electrical tools with double insulation enclosures.

(6) Metal frames of distribution rooms, cubicles, barriers separating electrical cubicles, doors etc. can be dismantled or opened, provided that, there is no installed electrical equipment with AC voltage exceeding 42 V on these structures.

(7) Metal structures in battery rooms, with voltage no more than 220 V.

Electrical motors and dismounted parts, equipment on machine tools or other equipment may be earthed through the direct earthing base of the main machines instead of exclusive earthing conductor provided that there is effective contact between the equipment enclosures and the main machine base.

Chapter 6-5 Protection against Earth Faults

Article 560. Protective Breaking Time on Effective Earthed Neutral

For electrical networks of up to 1kV with directly earthed neutral, reliable automatic tripping must be ensured with shortest breaking time in order to disconnect damaged elements from the electrical network in the event of a fault. To ensure the above requirement, the neutral point of the transformer on the low voltage side (< 1,000V) must be connected to the earth electrode by the earthing conductor.

Article 561. Detection of Earth Faults in Transformers with Isolated Neutral

For transformers with isolated neutral and those with arc extinguishing coils with voltage exceeding 1,000V, the quick detection of earth faults must be ensured by voltage checking devices for each phase and section of electric power networks. If necessary, sending protection signals or auto-breaking of damaged elements must be available.

Article 562. Detection of Earth Faults in Transformers with Earthed Neutral

For transformers with earthed neutral with voltage exceeding 1,000V, the quick detection by overcurrent protective devices at earthed neutral points and/or voltage detective devices for each phase for selective disconnection of electric power networks must be ensured.

Article 563. Special Protection

In the following cases, special protective measures must be available in order to auto-disconnect equipment in the event of an earth fault:

a) In electrical networks with voltage up to 1,000V, isolated neutral point or one phase power resource with isolated outlet terminals supplying electricity to equipment requiring high electricity quality
b) In electrical power networks with earthed neutral points and voltage up to 1,000V.
c) For mobile equipment, if the earthing system cannot satisfy the requirements stipulated in this Regulation.

Article 564. Breaking Time in the event of Earth Faults

When determining the value of permissible touch and step voltages, the active calculated protecting time must be equal to the total time for protection trip and the time in which the circuit breaker completes breaking. In the operating location of workers, if the continued operation of the circuit breaker in opening or closing may result in a short circuit to structures accessible to people, the protecting time must be equal to that of back up protection.

Chapter 6-6 Resistance Requirements of Earthing System

Article 565. Earth Resistivity Measurement

When designing earthing systems for electrical equipment, the earth resistivity must be determined by measuring resistivity in the field. The investigation of soil resistivity used for design of grounding system shall be done considering variation of soil resistivity all through the year.

Article 566. Assurance of Security

For electrical equipment, voltage on earthing system in case of grounding fault must be limited to ensure safety for dielectric strength of the electrical equipment.

Article 567. Touch and Step Voltages

The earthing system must ensure touch and step voltages do not exceed the specified values at any time of the year when the short circuit current passes through.

Article 568. Resistance of Grounding System

Earth resistance shall be determined based on permissible touch and step voltages. Touch and step voltages shall be calculated properly according to relevant regulations.

Chapter 6-7 Calculation of Earth Fault Current

Article 569. Calculation of Earth Fault Currents

The value of the calculated current that applies to select the specification of earthing conductor must take the maximum of one phase stable fault currents having occurred in electrical systems and the distribution of stable fault currents among the earthing neutral points of the system shall be accounted into.

Article 570. Calculation Method of Earth Fault Currents

The calculated earth fault current must be determined according to the operation diagram of the electrical power network which can cause maximum short circuit currents.

Chapter 6-8 Earthing Conductors

Article 571. Connection between Neutral Wire and Earth Mesh

The neutral wire of electricity supply resources (electricity generators, transformers) must be solidly connected with earthing system via earthing conductors and the earthing system must be arranged closely to equipment. The cross-sectional area of the earthing conductor must be determined according to article 572.

Article 572. Cross-section and Material of Earthing Conductors

The material and cross-section of earthing conductors and electrodes must be sufficient to allow the maximum earth fault current to flow through during breaking time within the permissible temperature rise. Moreover, it must also have sufficient strength against external force.

The use of bare aluminum conductors buried in the ground for earthing parts is prohibited.

Article 573. Temperature Rise Requirements

For electrical equipment with voltage exceeding 1kV and large earth fault currents as well as small earthed fault currents, the cross-sectional area of the earthing conductor must ensure that when the calculated earth fault current passes through, its temperature must not exceed the permissible temperature rise of the conductor.

Article 574. Cross-section of Earthing Conductors at Isolated Neutral

For electrical equipment isolated from the neutral point, the conductivity of earthing conductors must be at least 1/3 the conductivity of the phase conductor, and the cross-sectional area must be determined according to article 572.

Article 575. Cross-section of Earthing Conductors at Effective Earthed Neutral

For electrical equipment with a direct earth neutral point, the cross-sectional area of the earthing conductor must ensure the earth fault current passes through. In order to meet the above-mentioned requirement, the earthing conductor must be selected by one of the following methods:

- 3 times the nominal current at the nearest fuse
- 3 times the maximum breaking current

The cross-sectional area of the protective earth conductor, in any case, must be a minimum of half the cross-sectional area of the phase conductor.

If the above requirements are not met at the enclosure of equipment or the earth fault current may potentially be touched by the public, the earth fault current shall be shut off by a special protective device immediately.

Chapter 6-9 Installation Method of Earthing Systems

Article 576. Earthing Electrodes and Earthing Rings

Earthing electrodes of earthing systems (pipes, bars etc.) must ensure its effectiveness for voltage leveling on the ground area where electrical equipment is installed.

Article 577. Material of Electrodes

Materials used for artificial earthing electrodes can be made of steel pipes, round steel, flat steel or shaped steel, and are vertically driven into the earth or round, flat steel horizontally placed.

The minimum dimensions of the earthing electrodes are determined according to article 572. In corrosive environments, earthing electrodes must be copper or buried horizontally in a circle.

Article 578. Voltage Leveling

To ensure safety for equipment with large earthed fault currents, the voltage leveling net must be installed by earthing ring around the device, except for equipment up to 35kV on the Pole substations.

Article 579. Arrangement of Earthing Electrodes

In order to level voltage and ensure the connection between electrical equipment and the earthing electrode system in areas where electrical equipment is placed, earthing electrodes must be arranged horizontally lengthwise and crosswise within the area and are inter-connected to form an earthing mesh.

Article 580. Prohibited Usage of Soil as an Alternative to Neutral

Using soil as a phase or neutral conductor is prohibited for electrical equipment with voltage up to 1kV.

Article 581. Installation of Earthing Conductors

It is prohibited to use armors of tube conductors, suspended cables of power line, metal covers of insulated conduits, metal handles, and lead armors of electricity conductors as earthing conductors or neutral protection conductors. In all rooms requiring earthing, all the above-mentioned metal armors must be firmly connected. At the connecting points and boxes, earthing conductors must be connected to their metal enclosures by welding or bolting. For bolt connections, anti-corrosion and anti-loosening measures must be applied.

Indoor or outdoor earthing conductors and neutral protection conductors must be placed without a cover to be checked. Checking is not applicable for neutral armored cables, steel reinforced concrete structures as well as for connectors placed in pipes, boxes or even constructions.

Steel earthing conductors placed outdoors must be zinc galvanized.

Article 582. Earthing Conductors on Effective Earthed Neutral

For voltage up to 1kV, directly earthed neutral conductors and/or protective neutral conductors need to be placed commonly and adjacently to phase conductors.

The operation of neutral conductors is checked with permanent operating current. A working neutral conductor may have the same insulating material as a phase conductor. The use of insulated working neutral conductors and/or insulated protective neutral conductors is permitted if the use of a bare conductor may result in an electricity (galvanic) polarization phenomenon or damage the insulation of the phase conductor due to electrical interference between the bare neutral conductor and enclosures or structures

Article 583. Mechanical and Chemical Protection of Earthing Conductors

Earthing conductors must be mechanically and chemically protected. Protection against mechanical destruction must be focused on for the cross-sectional area of earthing conductors. Protection against chemical destruction must be focused on particularly in corrosive environments.

Article 584. Signage and Paint for Earthing Conductors

At the terminals of earthing electrodes, there must be easily visible signs.

Article 585. Connection of Earthing Conductors

Effective connections of earthing conductors must be ensured by welding or appropriate exclusive locks. Welded connections must have sufficient overlapped length to ensure the sufficient strength of welded parts.

Chapter 6-10 Alternatives to Earthing Conductors

Article 586. Alternatives to Earthing Conductors

When designing earthing systems, artificial (man-made) earthing objects shall be used. Moreover, natural earthing shall be used as an alternative to earthing conductors.

The following parts can be used for natural earthing:

(1) Metal water pipelines and other pipes placed underground, except pipelines conveying flammable, explosive or gaseous materials.

(2) Drilled wells' pipes buried underground.

(3) Metal and reinforced concrete structures underground under buildings and constructions.

(4) Metal pipelines of irrigation projects.

(5) Lead armor of cables buried in the earth. Using the aluminum armor of cables as a natural earthing electrode is prohibited.

(6) Railways of cranes or internal railways of enterprises if rails are connected by a connecting bridge.

The natural earthing part must be connected to the main earthing system at least two points.

Article 587. Priority of Natural Objects as Earthing Conductors

The use of working neutral conductors to protect neutral conductors shall be prioritized.

For auxiliary earthing conductors and protective neutral conductor, the following natural conducting objects may be used:

(1) Molded or centrifugal steel reinforced concrete poles.

(2) Metal structured parts of buildings (bars, arms, columns etc. and equipment supports, iron frames, steel reinforced concrete poles etc.).

(3) Metal structures (railways of cranes, metal frames of travel means such as elevators, floors, vertical lifters etc.)

(4) Metal pipes of electrical equipment.

(5) Water metal pipelines conducting water, water waste, steam, thermal (except pipelines conveying flammable or explosive substances)

(6) Aluminum armor of cables.

When they are used as main earthing conductors, they must satisfy the requirements for earthing conductors specified in this Regulation.

Naturally electrically conductive objects must be rigidly connected to earthing systems.

Chapter 6-11 Earthing of Mobile Electrical Equipment

Article 588. Earthing of Mobile Electrical Equipment

Mobile generators must have earthing systems in accordance with the provisions of this regulation**.**

Article 589. Earthing of Enclosures of Mobile Electrical Equipment

Enclosures of mobile electrical equipment supplied with electricity from stationary or mobile generators must be connected to the earthing system of the power supply source.

In electricity networks with isolated neutrals, the earthing system must be arranged for mobile electrical equipment nearby. The earthing resistance value must comply with this regulation. If possible, the natural objects nearby can also be used for earthing.

Article 590. Alternatives to Earthing

If earthing of electrical mobile equipment is impossible or unfeasible, earthing can be replaced by devices to protect against earth faults.

Article 591. Conditions not Requiring Earthing

Earthing is not required for mobile electrical equipment and electricity generating station in the following cases:

(1) Mobile electrical equipment which has its own generator, which does not supply electricity to the other equipment and is directly placed on this equipment or a common metal base.

(2) Mobile electrical equipment (of a quantity not exceeding 2) receiving electricity from its own mobile electricity generating station, which does not supply electricity to other equipment at a distance not exceeding 50m or where the enclosure of mobile equipment is connected with that of the electricity generating source by a conductor.

Article 592. Earthing Conductors for Mobile Electrical Equipment

The selection of earthing conductors and enclosures of connecting conductors for mobile electrical equipment must comply with the requirements specified in this Regulation.

The earthing conductors, protective earth conductors and conductors connecting enclosures of equipment must be soft copper conductors with cross-sectional area equal to that of phase conductors and should be in the same cover with the phase conductor.