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Ministry of Industry and Trade (MOIT)

**Guideline for
Technical Regulation
Volume 3**

**Construction and Installation of
Power Network**

Final Draft

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Japan International Cooperation Agency
Electric Power Development Co., Ltd.
Shikoku Electric Power Co., Inc.
West Japan Engineering Consultants, Inc.

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Chapter 1 GENERAL

Article 1. Purpose

As stipulated in Technical Regulation.

Article 2. Scope of application

As stipulated in Technical Regulation.

Article 3. Definitions

As stipulated in Technical Regulation.

Chapter 2 GENERAL PROVISIONS

Section 1 GENERAL

Article 4. Scope of application

As stipulated in Technical Regulation.

Article 5. General provisions

As stipulated in Technical Regulation.

Article 6. Technical conditions and methods

As stipulated in Technical Regulation.

Article 7. Applicable related regulations

As stipulated in Technical Regulation.

Article 8. Electrical equipment with oversea specifications

As stipulated in Technical Regulation.

Article 9. Requirements for qualifying persons

As stipulated in Technical Regulation.

Article 10. Construction site patrol

Engineering Manager should execute the patrol items that are shown in the following table.

Table 10 Patrol items

Items	Check contents
Technical Regulation	It is confirmed that the enforcement contents of construction work and construction equipment conform to Technical Regulation and related laws.
Process	The progress of construction work is checked frequently and it is confirmed that there is no delay in comparison with schedule.
Worker	<ul style="list-style-type: none"> - It is confirmed that the number of workers and the technical skill persons are arranged correspondingly to work content. - It is confirmed to be able to observe the safe action and the work discipline performed by workers.
Materials	<ul style="list-style-type: none"> - It is confirmed that there is no fear of quality loss (rusting, polluting, and breaking), theft of the materials under keeping, fire, and flood damage. - It is confirmed that the materials satisfy the quality described in specifications.
Tools	<ul style="list-style-type: none"> - It is confirmed that the tools are checked and maintained appropriately. - It is confirmed that the use of the tools is suitable for applications.
Safety	<ul style="list-style-type: none"> - It is confirmed that appropriate safe protection tools are used surely. - It is confirmed in the state that the general public around construction place is endangered.
Transportation	<ul style="list-style-type: none"> - It is confirmed that means of transportation, course, loading method, and shipping-and-discharging work are appropriate to the situation of construction place and conveyance things.
Environment	<ul style="list-style-type: none"> - It is confirmed that there is no trouble for general public around the construction place because of noise, vibration, polluted mud generated by construction and heavy machine.

Article 11. Site quality management training

Engineering Manager should execute the site quality management training that its contents are shown in the following table.

Table 11 Contents of site quality management training

Items	contents of site quality management training
Construction work outline	<ul style="list-style-type: none"> - Purpose and content of construction work - Construction work organization and work assignment - Communication organization and communication method
Construction quality	<ul style="list-style-type: none"> - Date and time of work schedule (Including interruption working hours) - Construction method and procedure - Items and quantity of main materials and tools - Technical important notice
Safety measure	<ul style="list-style-type: none"> - Range of live parts and interruption parts - Other related works - Supervisory method of work - Items and quantity of safety and hygiene protection tools - Safety important notice

Section 2 INDUSTRIALIZATION OF CONSTRUCTION AND INSTALLATION PRACTICES

Article 12. Accelerated adoption of industrialized methods

As stipulated in Technical Regulation.

Article 13. Computerization of design materials

As stipulated in Technical Regulation.

Article 14. Construction steps

As stipulated in Technical Regulation.

Article 15. Assembling process

(1) Preliminary Check

It should be checked there is no malfunction and required number of the parts and materials before facility installation. If there are inadequate preparations, report it to the facility owner.

(2) Cleaning

Each part should be cleaned before their installations; especially the parts that are covered by concrete should be cleaned carefully to remove oil.

(3) Construction Work

During facility installation, it is important to handle the facilities carefully to prevent inflicting damages and to confirm the exact measure according to the specifications. When they are assembled in the site, it should be fixed by bolts with proper torque. After tightening the bolts, they should be marked to be easily identified. (refer to Vol.3 article 137)

(4) Cleaning after work

After installation and assembling work, clean the site area and repaint the equipment if necessary.

Article 16. Installation of bus bars

Regarding bus bars such as an aluminum pipe bus or cubicles bus bar which are not required the site works, it is recommended to assemble them in a qualified factory to secure high quality.

Article 17. Encouragement of prefabricated methods

For large scale equipment, it is recommended to assemble them in a qualified factory to secure the high quality. When equipment is too large to be sent at one time, the transportation should be divided into proper units considering the maximum size and weight allowed for the conveyance.

Article 18. Test, adjust the measurement mounted on construction equipment

The meters and the gauges attached on equipment should be confirmed their specification and the result of the factory test satisfy their requirement for accuracy and function. Additionally, periodical tests should be taken to compare them with the result of the factory test, if necessary.

Article 19. Grounding stakes and their accessories

As stipulated in Technical Regulation..

Article 20. Poles

The poles of the over head power line must be made available in the workshop, built and tested prior to shipping:

- 1) No cracks in the test load,
- 2) No crack after the test load

Section 3 PREPARATIONS FOR CONSTRUCTION AND INSTALLATION PRACTICES

1. Requirements for design materials

Article 21. Design materials

As stipulated in Technical Regulation.

Article 22. Design documents for agencies in charge of installation site

As stipulated in Technical Regulation.

Article 23. Applied conditions to the design materials

Regarding design document comparison, if there are mismatches in installation site, size or quality between site condition and design documents, the facility owner should take appropriate measures to meet their specifications.

Unexpected condition during the works also should be reported to the related organizations, and should take appropriate measures.

Article 24. Regulation for content, procedures of construction design materials

As stipulated in Technical Regulation.

Article 25. Design consultancy works

As stipulated in Technical Regulation.

Article 26. Hand over documents

Contractors who received technical documents and progress should be complied with the real documentation. During construction, the contractor shall deliver the documents related to the investment themes:

- (1) Daily report / monthly report
- (2) Result of the survey and site photos
- (3) Result of the measurements and the benchmark
- (4) Result of inspection of the material and method of site inspection
- (5) Schedule of the works and its progress and achievements
- (6) Memorandums from meeting at work
- (7) Pending problems against the environmental protection
- (8) Condition of material and tools provided by a company
- (9) Report on work modification and its reasons
- (10) Detailed design documents

Article 27. Foreign manufacturer's design

As stipulated in Technical Regulation.

2. Requirements of equipment supply

Article 28. Documents from manufacture

As stipulated in Technical Regulation.

Article 29. Electrical equipment supply for power of construction

Temporary power supplies can only be applied to the related (approved) building, and it should comply with the same safety and technical regulation as normal supply.

After the submission of an application form, every customer should pay the bill based on their power consumption.

3. Procedures and conditions for acceptance, maintenance, and handover of electrical equipment as well as construction and installation materials

Article 30. Process of hand-over of electrical equipment

For safe and efficient operation of the storage, the following daily checks should be conducted.

1. Aren't there heavy equipment on shelves?
2. Are there measures to prevent downfalls and tumble?
3. Are there prevention measures against corrosion and dust?
4. Are there anti-theft measures in open storages?
5. Are there displays of equipment data and its weight on each device?
6. Do hoists and forklifts operate normally?

Article 31. Unloading equipment

Loading and unloading of equipment should be carried out by the following equipment:

1. Crane and Hoist

Implement self inspection every year

Shall be self-inspected once in every year

2. Fork Lift

Conduct monthly and annual inspections

Shall be inspected monthly and annually

Article 32. Checking at hand over process

The inspections mentioned in Volume 5 are the minimum requirements for power utilities, and necessary inspections should be conducted recommended by manufactures consultation with their manufactures.

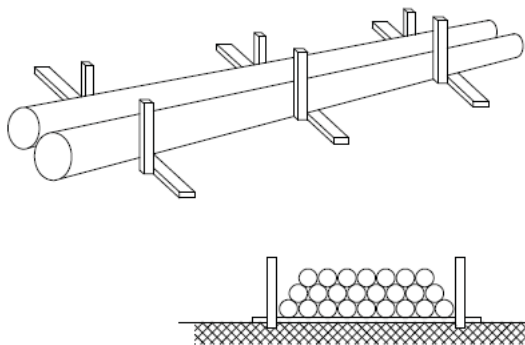
Article 33. Equipment in warehouse

It is recommended to check storage code number and actual equipment number before delivering equipment from storage. It is also recommended to compare storage number with the storage equipment constantly.

Article 34. Classification of equipment at yard

As stipulated in Technical Regulation

Article 35. Outdoor storages (store openings)



Regarding outdoor storage of electric equipment, they should not be placed on the ground directly, but place them on a stand to prevent them from rust.

Regarding switch box includes a panel space heater which is used for moisture proof, the heater should be operated by using external power source. Additionally, heavy equipment should be fixed by anchors to prevent it from falling down on the ground.

Article 36. Indoor storages (sealed storage)

Equipment stored in the warehouses need to tidy up and keep a way for vehicle for loading and unloading. For precision, the electrical panel needs to be preserved in the stock closed roof with air conditioner if it is long storage time.

Article 37. Condition of stored equipment

Equipment shall be stored properly and efficiently to keep their functions, quality as well as security shall be secured in consideration of the items in the table below.

Table 37 Storage of equipment

Note	Items	measurements
1. Must be stored indoor	Electrical equipment, wires and cables, nonferrous metals, insulators and line fittings, accessories of column	Take anti-theft measures, ventilation measures, anti-corrosion, dirt and leaking. Cover with sheets (if it's kept for long time)
2. Recommended to be stored indoor	Electrical panel, electronic equipment, precision equipment, Measurement	Measures against water penetration into the device. Air conditioning
3. May be stored outside	Poles, outdoor devices, iron and steel and construction	Put on square timber to prevent adherence of the soil. (Not on the ground directory)

Article 38. Preservation of capacitor

Oil contained equipment should be stored with oil collecting system to prevent oil leakage referring to the article 55, 353, 354 and 359 inVol.1.

Article 39. Preservation of battery

Battery should be stored in a room with ventilation system or room stipulated in Chapter 4-2-10 inVol.1 and Chapter 3 Section 6 inVol.3. Floating charge should be operated properly to prevent the battery life from deteriorating while it is stored

Article 40. Maintenance of equipment in warehouse

Spare parts and facilities should be inspected at the same interval, and their condition should be grasped properly. When the results of the inspections are out of the requirements, they need to be repaired promptly.

Article 41. Transportation measurement

As stipulated in Technical Regulation.

Article 42. Storage of metal structure

Iron and steel structures should be stored on pieces of square timber to avoid corrosion and scratch.

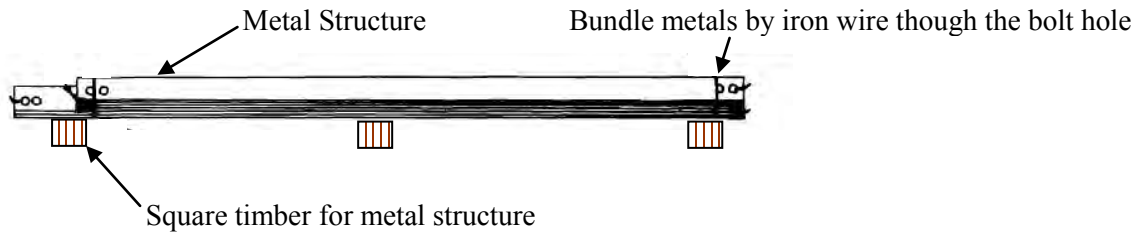


Figure 42 Storage of metal structure

Article 43. Sort by category

Equipment should be stored by classifying as follows,

1. Support work equipment (arms and bolts)
2. Insulation work equipment (cramps, metal accessories)
3. Wire work equipment (spacers, dampers)

Additionally, applying oil to bolts is efficient way to prevent corrosion, but on the other hand, it needs to be reminded that the tightness of the torque is reduced compare with the normal ones.

Article 44. Damaged equipment in warehouse

When loading and classifying facilities, all the materials should be checked the followings and stored excluding defective equipment:.

1. Standards, Specification and amount
2. Cracks damages and bends
3. Corrosion, stain, and rust

Here are the examples of concrete poles with different kinds of cracks. Defective ones can be judged according to the degree of the cracks.



Figure 44 Example of cracks on concrete poles

Article 45. Storage of Conductor and Insulator

Wires, Cables and insulators should be stored properly as follows;

1. Wire drums need to be stored with stoppers to avoid moving
2. Accessories such as wire sleeves and terminals should be stored in an indoor room to avoid the wet
3. As insulators are fragile, they should be stored in a wooden box and avoid accumulating
4. Accessories should be classified in every (types of) tower.

Article 46. Storage of Cement

The quality of cement is degraded when it is exposed to the air. It can be kept in good condition for approximately three months with appropriate preservation. Cement bag should be closed tightly, and covered with a plastic sheet from the top. Cement mixed with water beforehand must not be used.

Article 47. Storage of Explosive Materials and Warhead

The location to store explosives should be clearly distinguished from the other storage and managed with a lock.

The storage should be located far from the boundary where the storage can be kept away from the public.

Section 4 REQUIREMENTS ON CONSTRUCTION WORKS FOR INSTALLATION OF ELECTRICAL EQUIPMENT

Article 48. Plan preparation before installation of equipment

1. Loading road

Loading roads should withstand the weight of vehicles and materials to transport. The width of the road shall be wide enough considering safety of vehicle and conveyance of materials.

2. Resting room

Considering workers to evacuate from bad weather and to take rests, resting rooms or tents are necessary to be set at each work site. The location of the rooms should not interfere with construction.

3. On-site office

Set up an on-site temporary office for construction works. The location of the office should be easily accessed as well as convenient to transport materials

4. Fire extinction facilities

At the place that fire engines can not reach, prepare portable fire extinguishers which is not expired.

5. Lifting facilities

Appropriate measures should be taken for scaffoldings and ladders to prevent turnover and fall.

6. Water supply

Water supply facilities are necessary for workers.

Article 49. Preparatory order of construction

As stipulated in Technical Regulation

Article 50. Works inspection and acceptance report

Refer to article 249 of Vol.4.

Article 51. Basis for acceptance of Works

Acceptance test is mentioned in Vol.5.

Article 52. Acceptance of Order

Acceptance test is mentioned in Vol.5.

Article 53. Prefabricated construction items

As stipulated in Technical Regulation

Article 54. Items on wall and utility gallery

As stipulated in Technical Regulation.

Article 55. Underground electrical projects

Underground electric materials should be confirmed their size and strength from factory inspection.

Article 56. Installation of construction machines

As stipulated in Technical Regulation.

Article 57. Other items in the design document

As stipulated in Technical Regulation.

Article 58. Machine foundation

As stipulated in Technical Regulation.

Section 5 TECHNOLOGY AND AUTOMATION FOR POWER INSTALLATION WORK

Article 59. Assembly at workshop

As stipulated in Technical Regulation.

Article 60. Welder

As the quality of welding is important, welders should be trained well and have sufficient knowledge and techniques. All the welders need to have the qualifications of welding.

Article 61. Installation of main bus bars

As stipulated in Technical Regulation.

Article 62. Working overhead line without crane

As stipulated in Technical Regulation.

Article 63. Tensioning of big size electric wire

It is recommended to use a tower winch to practically adjust sag of multiple conductors' line so that it enables to reduce the labor force.

Article 64. Transportation of large equipment

When there is no ceiling crane in a room, heavy equipment should be moved by using a cart or air caster to prevent vibrations and turning over.

If the load limit is not enough for the equipment, put an iron plate on the floor to disperse their weight evenly.

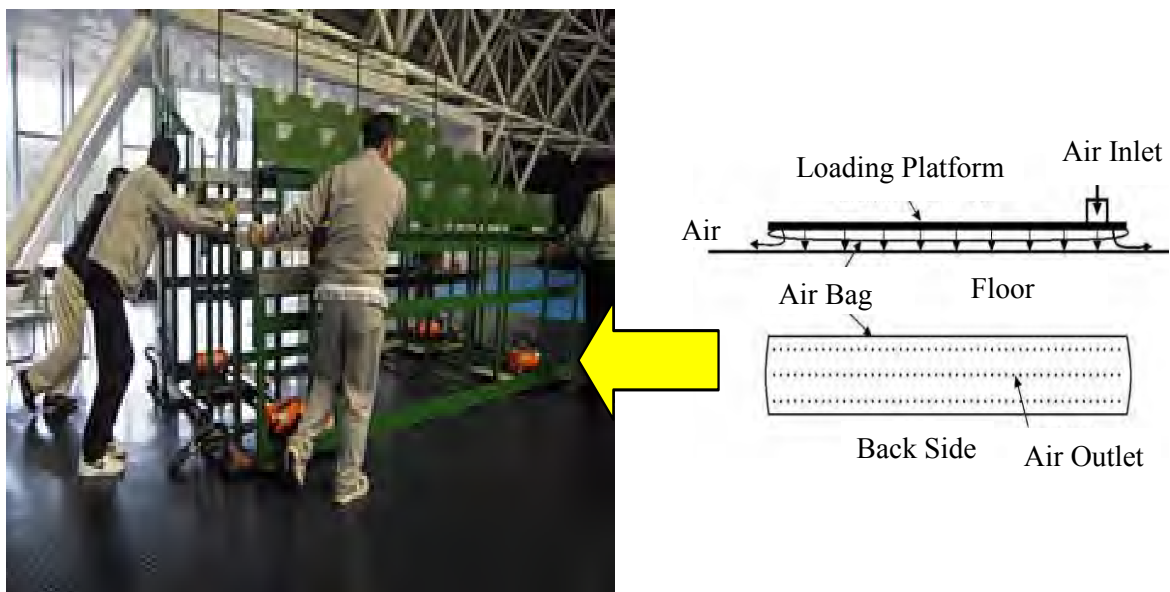


Figure 64 Transportation of large equipment

Article 65. Installation of electric switchboards and cubicles

When an old switch boards or cubicles need to be replaced to a new one, the old equipment need to be removed from the channel base as follows. The removal work should not cause vibration to prevent the miss trip of the protective relay if there is a protective relay next to the equipment. To lock the relay is one of recommendable measures.

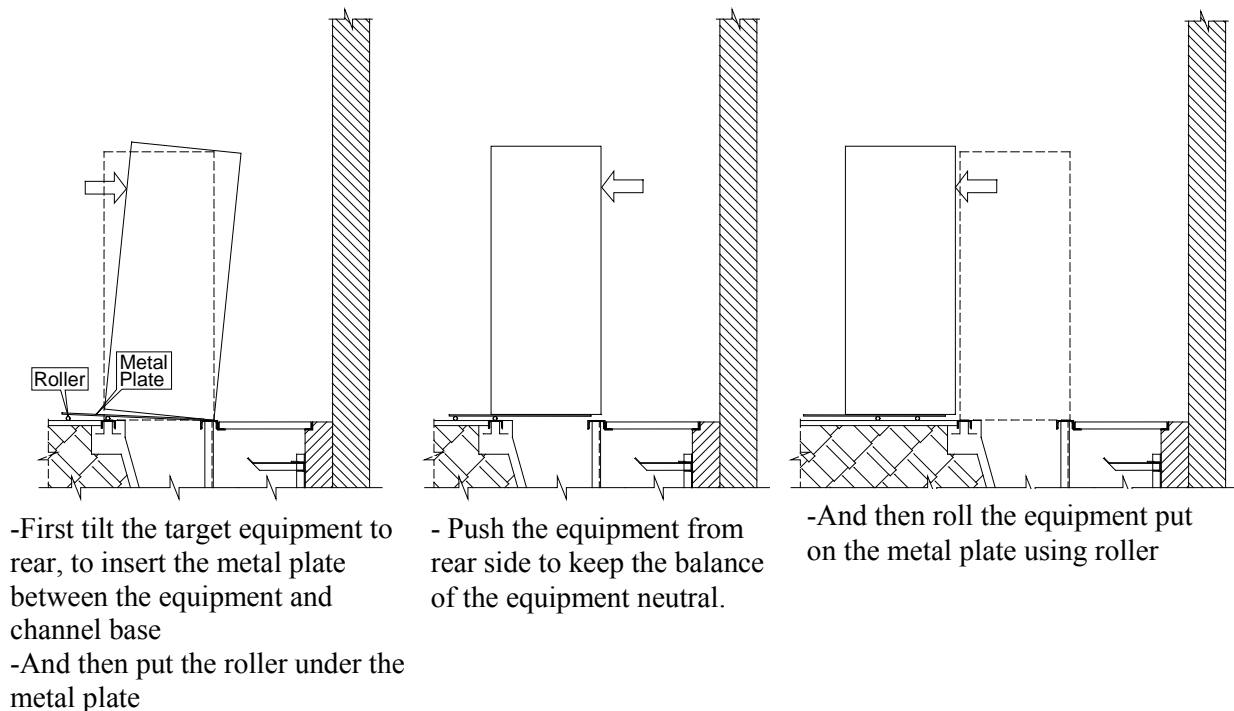


Figure 65 Removal method example of electrical equipment

Article 66. Transportation and preservation of high voltage oil soaked insulators

As stipulated in Technical Regulation.

Article 67. Installation of earthing equipment

To install earthing equipment deeply under the ground, it is recommended to make deep holes by using special drill and water jet, and then insert earth rods in it.

Article 68. Transportation of transformer

As stipulated in Technical Regulation.

Article 69. Installation of electrical equipment

It is the easiest way to use a crane in installation of electrical equipment, but it is strongly suggested to check carefully the environment around work site. If there are hot lines nearby, roller is a useful way to move heavy equipment. (see article 64 and 65)

The minimum clearance between a crane and hot wire is stipulated in article 335 of Vol.1 of Technical Regulation.

Article 70. Unloading and transportation of cables

As cable drums are very heavy, transportation and loading works need to be carried out by using forklift or crane to prevent them from damages



Figure 70 Transport cable drums

Article 71. Cables crossing over railway and national road

An underground cable is recommended when a cable line crosses over a railway or national road.

Refer to the guideline Vol.1 for more details.

Article 72. Construction of underground cables

The following cable laying accessories should be used in the cable laying work not to apply partial tensile stress to the cable.

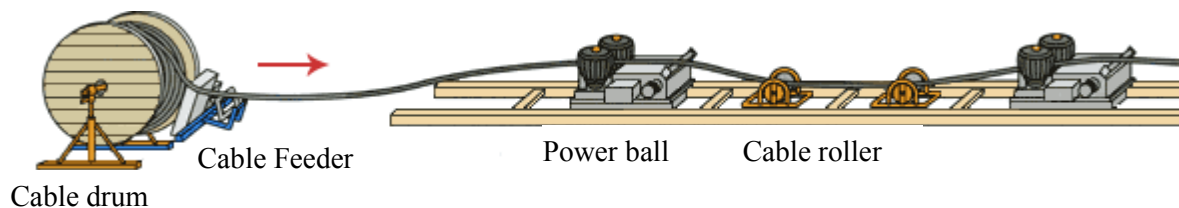


Figure 72 Installation of underground cables

Article 73. Mechanization in construction of transmission line

As stipulated in Technical Regulation.

Article 74. Transportation of concrete poles

To secure the safety it needs to keep balance of concrete pole on a vehicle during the transportation. Also, balance the left and right side of a jack to avoid turnover when pulling a cable out from a cable drum.

Article 75. Construction of pole foundation

As stipulated in Technical Regulation.

Article 76. Construction of pole foundation in rocky mountainous areas

Refer to article 67.

Article 77. Installation of concrete poles

Heavy machinery such as a crane should be used at the time of installation of concrete poles.



Figure 77 Pole assembly by crane

Article 78. Anchor poles when pulling wire

As stipulated in Technical Regulation.

Article 79. Construction of steel poles

Heavy machinery such as a crane should be used to install steel poles.

If there are hot power lines near the site, use rubber tubes around the live wire to prevent electric shock.

Article 80. Laying conductor and earthing wire

The cable winch or the motor winch should be used for laying conductor and earthing wire. During the operation of cable winch, it is vital to make sure the right balance of the machine to prevent from overthrown the heavy cable.

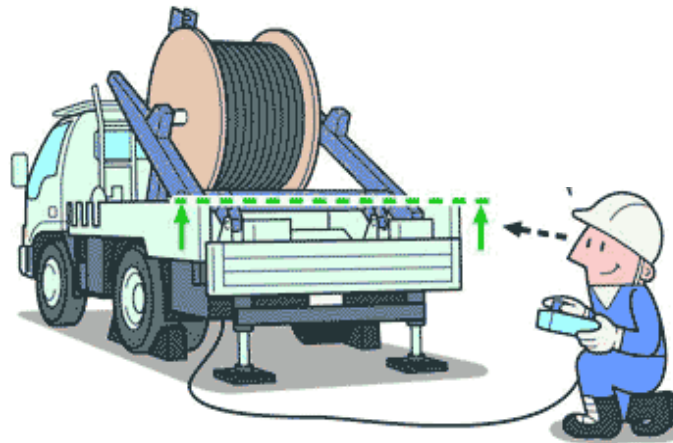


Figure 80 Laying wires by cable winch

Chapter 3 INSTALLATION OF POWER DISTRIBUTION SYSTEM AND DISTRIBUTION SUBSTATIONS

Section 1 INSTALLATION OF POWER DISTRIBUTION SYSTEMS

Article 81. Scope of application

As stipulated in Technical Regulation.

1. General requirements

Article 82. Installation of equipment

The equipment and the busbar must be installed by design and manufacturer's instructions.

Article 83. Oil level in the equipment

Oil level

The oil leakage from oil-immersed equipment shall not be happened, and the appropriate amount of insulation oil in equipment (e.g. a transformer) can be checked by attached oil gauge. The change of the oil depends on the expansion of the oil temperature (extending 0.07% / °C) and in the case of oil is lower than the permitted level, check for any leakage and additional oil.

2. Joining the busbars of the indoor distribution equipment

Article 84. Conducting busbars

Construction work requirement for busbar

- As for the insulation method of bus-bars of air insulation, the air insulation is applied between phases, and the insulation by insulators is applied between live components and the ground. Connecting terminals between bus-bars shall be plated by tin, solder or silver.
- The copper bar of bus conductors shall be selected from the table below according to the rated current. It is preferred that bus conductors are supported by insulators not to sag down.

Table 84 Branch bus-conductor

Rated Current (A)	Copper Bar	
	Size (mm)	Quantity
400	50X6	1
600	50X6	1
800	75X6	1

Each phase in bus-bars and branch parts shall be identified by indication.

Article 85. Fixation of the busbars

As stipulated in Technical Regulation

Article 86. System fixing the busbars

As stipulated in Technical Regulation.

Article 87. The Joints of the busbars

Requirement for busbar and its connection

- The special conical spring washer shall be used for the bolt of the conducting busbar connection parts, and add tightening power to spring washer. The temperature rise limit in connected part shall not exceed the value in the table below.
- In the joint of main circuit, temperature indicators shall be attached on the position that can be easy to look at from the outside.

Table 87 Temperature rising limit in the cubicle

Place		Temperature rising limit (Thermometer method) deg C	Remarks
Busbar and connected conductor		65	
Contact part	Copper contact	35	The connection mechanism of DS, CB, etc.
	Silver contact	65	
Joints of terminal and conductor	Copper and copper	40	
	Between Tin solder platings	45	
	Between silver platings	65	

3. The installation of busbars of the outdoor distribution equipment

Article 88. The bending deflection of the flexible busbars

As stipulated in Technical Regulation.

Article 89. The Flexible busbars

Flexible busbars

When connecting electric wires, the strength of electric wire (represented by a tensile load) shall keep 80% or more except. When the jumper cable is connected or when the tension that is added to the electric wire is remarkably small compared with strength of the electric wire.

Article 90. Jointing of the hard busbars with poles of the equipment

Consideration point for thermal expansion of the joining of the hard busbar is as follows.

For example, when connecting hard conductors to the right angle direction, it shall be necessary to connect between hard conductors using flexible conductors to absorb the thermal expansion of hard conductors. (see the following figure)



Figure 90 Application examples of flexible conductors

Article 91. Jointing of the flexible busbars with poles of the equipment

As stipulated in Technical Regulation.

Article 92. Joints of busbars

Corrosion measures of the busbar joints

(1) The bolt for terminal connection of main circuit

In order to prevent the galvanic corrosion, appropriate material shall be used for the bolt and the terminal, so that the difference of ionization potential between the bolt and the terminal shall become small. For example,

- When the main circuit terminal is copper; the bolt shall be made of stainless steel
- When the main circuit terminal is aluminum; the bolt shall be hot dip zinc-coated bolt

Table 92 Electrode potential of various metals

Metal	Electrode potential (V)
Copper	-0.02
Austenitic stainless steel and copper	-0.25
18% chromium stainless steel and copper	-0.35
12% chromium stainless steel and copper	-0.45
High-strength aluminum alloy	-0.60
Non-high-strength aluminum	-0.75
Silicon-based aluminum casting alloy	-0.75
The aluminum alloys except silicon-based aluminum casting alloy	-0.80
Molten zinc plated copper	-1.05

(2) Caulking of the main circuit terminal

In order to prevent the galvanic corrosion, the main circuit terminal shall be caulked, not to enter the moisture between the terminal and the bolt.

Article 93. Install distribution system outdoors

As stipulated in Technical Regulation.

4. Circuit breakers of the voltage 1kV or more and their transmission systems

Article 94. Inspection of circuit breakers

As stipulated in Technical Regulation.

5. Disconnecter and its transmission system

Article 95. Disconnectors

When open and close disconnecting switch and the earthing switch manually, it shall be smooth enough that one human power can operate. The electrically controlled operation of the disconnecting switch and earthing switch shall be operated without trouble by all the voltages of variation ranges in the table below.

Table 95 Tolerance of the power supply

(IEC 60694)

Type of voltage	Relative tolerance of power supply
DC	85% to 110%
AC	85% to 110%

Article 96. Actions close-cut

As stipulated in Technical Regulation.

Article 97. Actuating detent

As for the structure which uses the twisting device, the twisting angle shall be fixed surely by the stopper so that the structure shall not be changed. In addition, in case of twisting angle adjustment type, setting angle shall not be changed for a long period.

The disconnecting switch and the earthing switch must be installed with a safety device or the similar device to protect circuit in the case that they do not open and close automatically by electromagnetic force or other external force in the state of short circuit, open circuit, and close circuit.

Article 98. Adjustment for disconnecter

After the adjustment of disconnecter contacts, opening and closing test, main circuit resistance measurement and main circuit insulation measurement shall be tested to satisfy the standards of the manufacturer.

Temperature Indicators should be attached to the contacts to detect abnormal temperature rise (if any).

Article 99. Signaling and locking transmission system

As stipulated in Technical Regulation.

Article 100. Interlock

In a power line, the breaker of line and the breaker of busbar connection and the disconnecting switch shall satisfy the interlock conditions of breaker and disconnecting switch, and they are shown in the following table and chart.

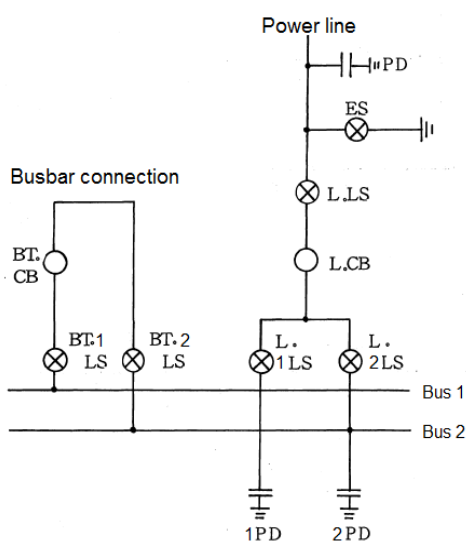


Figure 100 Single line diagram for interlock

Table 100 Conditions of interlock

Operation	Conditions
L.LS ON(in) / OFF	(1)L.CB off + ES off
ES ON(in) / OFF	(1)L.LS off + With NO LINEVOLTAGE
L.1LS ON(in) / OFF	(1)L.CB off + L.2LS off (2)BT.1LS in + BT.2LS in + BT.CB in + L.2LS in + L.CB in
L.2LS ON(in) / OFF	(1)L.CB off + L.1LS off (2)BT.1LS in + BT.2LS in + BT.CB in + L.1LS in + L.CB in
BT.1LS ON(in) / OFF	(1)BT.CB off
BT.2LS ON(in) / OFF	(1)BT.CB off

Note: L.LS: Line Switch for power lines
ES: Earthing Switch

L.CB: Circuit Breaker for power lines
BT: Bus Tie

6. Instrument current transformers

Article 101. Short-circuit ends of wires unused

About the secondary circuit of instrument transformer, when there is a neutral point, one arbitrary point of neutral wire shall be grounded. When there is no neutral point, one point of an arbitrary wire shall be grounded.

7. Prefabricated distribution equipment and compact substations

Article 102. Requirement for boxes' doors

Requirement for boxes' doors

- The revolving angle of doors shall be 90 deg C or more.
- The operation of switchgear shall be operated easily, and there shall be 1m and more of the effective distance of door that the door can be opened and closed safely and do not interfere to the person's movement.

Article 103. Specifications of compact switchgear cubicle

Specifications of the cubicle

(1) General

The cubicle shall have enough electrical and mechanical durability, and the tightening parts shall not be loosen easily. Also maintenance shall be ensured safely and easily.

Especially, consumption equipment (like lamp and so on) shall be replaced easily.

(2) Mechanical strength

The cubicle shall bear the stress at the time of operation and the electromagnetic force of a short circuit.

8. Painting and Markings

Article 104. Painting and markings

Phase arrangement in painting and marking

The phase sequence shall comply with the phase identification and the following requirements.

- (1) For indoor distribution equipment which uses 3 phase alternating current (AC)
 - a. If busbars are arranged in vertical direction: Highest is phase A (Yellow), Middle is phase B (Blue) and Bottom is phase C (Red).
 - b. Branches of main busbar: Left branch – A (Yellow), Middle branch – B (Blue), Right branch - C (Red) (if busbar is viewed from entrance hall. If there are 3 entrance halls, it is necessary to view middle entrance hall).

- (2) For outdoor distribution equipment which use 3 phase alternating current (AC)
- a. Busbar near transformer: Nearest - phase A (Yellow), Middle - phase B (Blue), Farthest - phase C (Red).
 - b. Branches of main busbar: left branch - phase A (Yellow), Middle branch - phase B (Blue), Right branch - phase C (Red) (if transformer is viewed from the highest voltage side).
- (3) For direct current (DC), marking for busbar is used as follows :
- a. Busbar is arranged in vertical direction: Highest is Neutral, Middle is Negative bar (-)(Black), Bottom is Positive bar (+)(Red).
 - b. Busbar is arranged in transverse direction: Highest is Neutral, Middle is Negative (-)(Black) and Nearest is Positive (+) (Red) (busbar is viewed from entrance hall).
 - c. Branches of main busbar: Left branch (or left bar) is Neutral, Middle branch is Negative (-), Right branch is Positive (+) (busbar is viewed from entrance hall).

It is prohibited to paint the place to measure the junction temperature and the connecting point for portable grounding equipment. And painting for the connecting point which is connected by bolts shall be carried out after complete installation to ensure the secure electrical connection.

9. Installation of compartment

Article 105. Corridor in electrical room

- (1) For a transformer, the distance between main part of the power receiving equipment such as switchboards and transformer shall be taken higher than the possession distance in table below in consideration of necessary space for maintenance check and effective space on fire prevention.

Table 105 Maintenance distance of incoming transfer room

	Front or operation sides (m)	Back or inspection sides (m)	Between rows (inspection sides) (m)
High-voltage or Low-voltage distributing board	1.0	0.8	1.8

- (2) The passage which is necessary for the safety check shall be 0.8m or more in width and 1.8m or more in height. In cramped position, the width may be reduced to 0.6 m
- (3) The passage shall be kept save to prevent any danger of slipping and stumbles.

Article 106. Installation of meshwork fence

For the installation of a fence, the meshwork shall be smaller than 15mm.

It may be combined 2 types of mesh fence and solid wall type.

The height of the fence should be higher than 1.9m.

Article 107. Outlet in the room of the distribution equipment

The provisions of this article shall refer to the Article 353 of Volume 1.

Article 108. Installation of Ending parts of conductor and cable

As stipulated in Technical Regulation.

Section 2 POWER TRANSFORMERS

Article 109. Scope of application

As stipulated in Technical Regulation.

Article 110. Dryness of transformers

As stipulated in Technical Regulation.

Article 111. Arrangement of expansion compartment

As stipulated in Technical Regulation.

Article 112. Transformer fixation

When a transformer mounted on rails, the wheels must be inserted to make on all sides.

When a transformer is placed directly on the foundation, the transformer must be fixed by the anchor bolt.

- (1) When there is a vibration-proof rubber, pull up the anchor socket to stick it to main body plate, and remove the gap as it prevents generating the bending stress.
- (2) When there is no vibration-proof rubber, prevent bending stress by sticking the foundation and the main body plate.

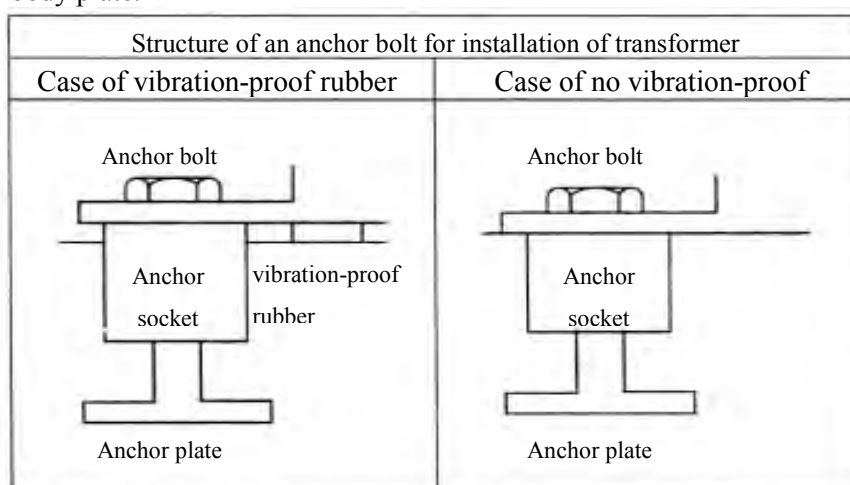


Figure 112 Structure of an anchor bolt for installation of transformer

Article 113. Prevention from flood and collapse

As stipulated in Technical Regulation.

Article 114. Signing transformers

The provisions of this article shall refer to the Article 104.

Section 3 GAS INSULATED SWITCHGEAR (GIS)

Article 115. Scope of application

As stipulated in Technical Regulation.

Article 116. Condition of assembling work of GIS

The preparations of assembling work of GIS are made as follows.

1. Confirmation of weather condition
Confirm it is not raining
2. Confirmation of assembling environment
 - (1) Humidity: 80% or less
 - (2) Dust: 20CPM or less
 - (3) Velocity of the wind: 5m/s or less
3. Confirmation of working environment
 - (1) Confirm that there is not dust source.
 - (2) Confirm that there is no live part in the swivel range and the wrecker installation place.

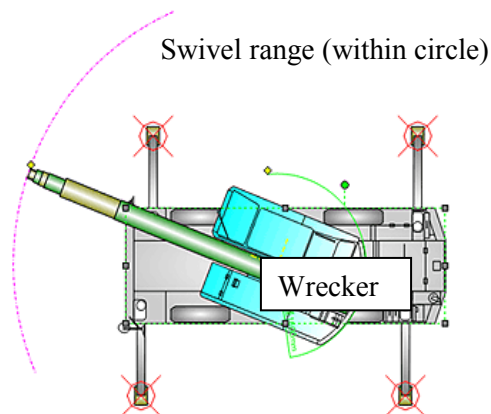


Figure 116 Swivel range of wrecker

4. Assembling and organizing of dustproof place
 - (1) The place shall be ensured enough space for assembling equipment
 - (2) Dust, dirt, etc. shall not be inside of the dustproof place.
5. Tool
Tools which are well maintained shall be used

6. Clothes

According to the departmental order, wear the clothes, hat, and shoes which are non-electroconductive and dustproof.

Article 117. Against dust during the assembly work

The provisions of this article shall refer to the Article 116.

Article 118. Apparel for worker

As stipulated in Technical Regulation.

Article 119. Check before starting assembly

The on-site installation work of GIS shall be conducted as follows.

1. Confirmation of foundation and position of ground line

It shall be collated surely with the drawing, and confirm that they are the same as which shown in the drawing.

2. Installation position setting in accordance with the drawing

It shall be collated surely with the drawing, and confirm that they are the same as which shown in the drawing.

3. Confirmation of horizontal degree

After installation, the degree of horizontal shall be confirmed. It shall be confirmed that the air bubble displacement is below 0.5mm in the spirit level.

4. Confirmation of oxygen density in the GIS tank

The work shall be started after confirming that the oxygen density in the GIS tank is 18% or more by using oxygen meter.

5. Cleaning of GIS tank

Before assembling and connecting, the GIS tank inside shall be cleaned, and the followings shall be noted

- (1) It shall be checked visually whether there are not any crack, deformation, foreign matters, etc. in the connection part (flange spacer, etc.).
- (2) While cleaning inside of a GIS tank, it shall be checked that there are not any crack, modification, foreign matters, and omission of objects such as bolts and pins inside of the GIS tank.
- (3) It shall be checked that there are not any crack, modification, and foreign matters in internal connection parts (conductor part and contactor).Also conductive grease shall be applied to a conductor terminal area.

6. Confirmation of join part size

The joint part shall be measured, and be confirmed that the size is the same as which shown in the drawing.

7. Confirmation of O ring surface and its size

It shall be checked that there are not any crack and adhesion of foreign substance on O ring surface. It is checked that the size is the same as which shown in the drawing.

The grease seal is applied to O ring surface.

8. Connection of unit

The unit connection shall be conducted surely using a guide pin etc so that the inner conductor is connected appropriately without the excessiveness.

9. Use of torque wrench for tightening joint part

In case of fastening a bolt with excessive torque, the bolt may break and the effect of spring washer is lost, therefore, the bolt shall be fastened with adequate torque specified by the manufacturer.

10. Installation of adsorbent*

It shall be checked that the installation position of the adsorbent is the same as which shown in the drawing.

Article 120. The time of unit connection

At the time of unit connection, centering of the internal conductor shall be carried out so that the conductor is connected within the manufacturer's specified error under the manufacturer's orders.

Article 121. Grease for the connecting part

The provisions of this article shall refer to the Article 119.

Article 122. Tightening bolts Use of torque wrench

The provisions of this article shall refer to the Article 119.

Article 123. The duration of exposure of adsorbent to atmosphere

The provisions of this article shall refer to the Article 119.

Article 124. Making vacuous and filling up SF₆

Gas treatment

1. The measure against foreign matters of gas recycle equipment

It shall be confirmed that there is not any foreign matters in the connected part etc. of the recycle unit and be cleaned as needed.

It shall be checked that the filter is equipped and there is not any crack.

2. Vacuum influence

Vacuum degree is confirmed by a pressure gauge. It is preferable to continue vacuuming for 30 minutes or more after it has reached 133Pa in GIS tank.

3. Gas charging

Gas in GIS tank shall be charged at rated pressure according to the outside temperature.

Article 125. SF6 gas analysis

The confirmation of filled gas shall satisfy the following.

1. Measurement of moisture in gas

Measured moisture content in the gas shall be less than the value instructed by the manufacturer. If the value is not provided by the manufacturer, the measured moisture content in the gas should be less than the values below.

500ppm or less: the device which generates dissolution gas

150ppm or less: the device which doesn't generate dissolution gas

2. Gas purity

More than 97% of gas purity is required

More than 98% of purity of new gas is required.

3. Gas leakage test

Gas leakage test of parts which was assembled on site is inspected by a gas leak detector.

(1) Test method

Accumulation method shall be designated as the standard test method, and trace method is used only for the region that the accumulation method can not be performed easily.

The accumulation method: Surround the tank-binding part and whole gas fitting circumference with polyethylene sheets, the accumulated leakage gas in the sheets shall be detected with the gas leak detector after the appropriate time elapsed.



Figure 125 Accumulation method for gas leakage test

The trace method: The existence of gas leak is checked by bringing gas leak detector closes to the tank connection part and gas piping directly.

(2) Test evaluation

The inspector shall confirm that a leakage gas can not be detected by gas leakage detector.

Article 126. SF6 gas leakage test

Regarding the waterproofing, the caulking of the joint part of GIS tank shall be carried out using sealing materials after gas leakage test.

Article 127. Gas valves in SF6 gas tank

Gas collection work flow

1. Preparation work

(1) Gas measurement of SF6 gas collect cylinder

The purity of the gas and the amount of moisture in cylinder are measured.

- The purity of the gas are more than the standard value.
- The amount of moisture are less than the standard value.

(2) Device installation and connection

The packing for connection, etc. are checked and it is exchanged if necessary.

It shall be checked with a gas distribution diagram not to remove gas from non-targeted unit.

It shall be confirmed that the spacer of the gas division will not be damaged by performing vacuum pulling.

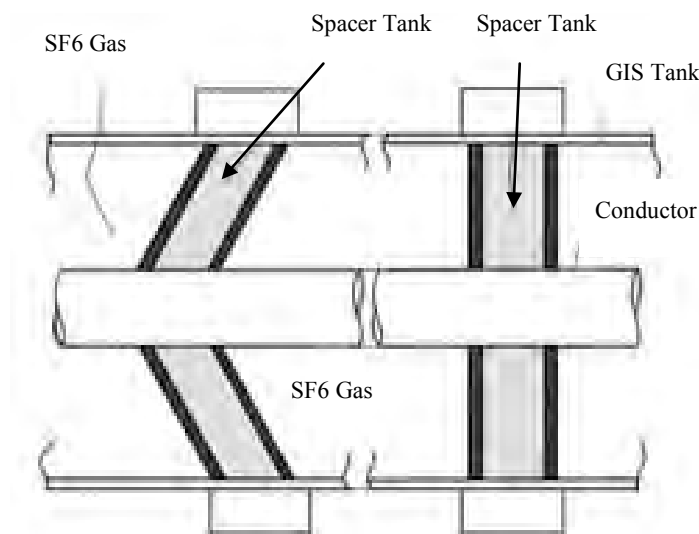


Figure 127 Spacer of gas division

(3) Measurement and record of cylinder weight

Measurement and record of single cylinder weight

Measurement and record of cylinders and hose after the connection

(4) Gas measurement and record of objective equipment

The purity of the gas and the amount of moisture in objective equipment shall be measured, and it is checked that they satisfy the standard values.

In case of the driving equipment, cracked gas (sulfur dioxide SO₂, hydrogen fluoride HF) shall be measured and confirmed that they are undetected.

- (5) Vacuum pulling of hose and device

The amount of gas leak from the hose and equipment is checked for 30 minutes at 133Pa.

2. Collection

- (1) The gas pressure of each tank after the collection shall be less than 0.015MPa.
- (2) Measurement and record of weight of cylinder (including hose).
- (3) Measurement record of collected gas.

It is checked that the purity and the amount of moisture satisfy the standard values.

- (4) Confirmation of gas valve

Based on the gas distribution diagram, it is checked that the gas valve is in the suitable state at the ending time of work.

Article 128. SF6 gas recovery

The provisions of this article shall refer to the Article 127.

Article 129. Inspection of GIS

GIS components shall be checked according to the guidelines of volumes 5.

Section 4 PANELS AND BOXES

Article 130. Scope of application

As stipulated in Technical Regulation.

1. Assembly of structures, meters, equipment and busbar systems

Article 131. Earthing non insulated systems to cubicle cover

In terms of electric shock prevention with indirect contact, when neither the box nor the plate for the fixation of equipment and the main pipe that contacts with metallic equipment are grounded, the metallic equipment concerned shall be ground to the cubicle cover with electric connection. In addition, the cubicle cover shall be grounded by the guideline in the Article 212.

Article 132. Rubber mattress for a number of equipment

As for the devices that may malfunction due to external vibration, such as the auxiliary relay used to trip circuit of circuit breaker, the main contact of protective relay and high-sensitive meter, etc., it is necessary to sandwich a cushion for shock absorption and vibration isolation devices between the devices concerned and the enclosure in order to prevent malfunction due to vibration

It is preferable to exchange at an appropriate cycle because the elastomeric force might be lost by the aged deterioration as for the cushioning material.

Article 133. Installation of disconnecter and fuse tube

It shall be necessary to install the blade of the disconnecter to operate smoothly and surely so as not to cause a gap, a deformation, and the fixation of operation mechanism part. In addition, the circuit

breaker and the fuse that operate at the time of the short-circuit or the ground-fault, shall have the ability to interrupt the possible maximum short-circuit current, and endure the mechanical shock caused by the short-circuit current.

Article 134. Protection for charged parts

As for electric shock prevention with direct contact, the following measures are effective.

- Insulation: by completely covering the live parts with an insulating material
- Barriers and enclosures: by placing live parts inside enclosures designed to protect against inadvertent contact with live parts.
- Obstacles: these shall prevent unintentional approach to the live parts and unintentional contact with live parts in normal service
- Placing out of reach: by placing accessible parts at different voltages out of arms reach

Therefore, in consideration of the constrained conditions for the equipment concerned, appropriate measures shall be carried out to prevent electric shock by direct contact.

Article 135. Fitting of switches

As for the electric cable for the secondary circuit of instrument transformer, appropriate specification and construction technique shall be deliberated, because the current capacity of electric cable is different according to ambient temperature and construction condition.

As for the switching gear, in consideration of the interrupting capacity and rated current, etc., appropriate specification shall be deliberated, in addition, protection of live parts and insulation distance shall be deliberated in the layout design.

Article 136. Connection of the equipment and the busbars of the cubicle

The provisions of this article shall refer to the Article 87 and 92.

Article 137. Fixation of switchgear

In case of using bolts for equipment fixation, the spring washer shall be used to prevent from looseness and falling off of the bolt.

In case that the bearing surface is not enough against the axial tension, for example, the through-hole is bigger than the diameter of the head of bolt and the nut or fastening a soft material, the flat washer shall be used.

In case of fastening a bolt with excessive torque, the bolt may break and the effect of spring washer is lost, therefore, the bolt shall be fastened with adequate torque specified by the manufacturer.

In addition, the inspector who confirms the fastening shall mark up the bolt and nut concerned after confirming.

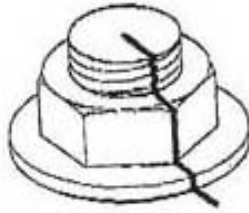


Figure 137 Marking example after tightening confirmation

2. Painting and signing

Article 138. Painting and panels and accompanied equipment

The provisions of this article shall refer to the Article 104.

Section 5 SECONDARY CIRCUITS

Article 139. Scope of application

As stipulated in Technical Regulation.

1. Electric wires

Article 140. Installation of wires and cables

Wiring by electric conduit work is as follow.

- (1) When a metallic conduit is buried under concrete and the stone wall, the thickness of the metallic conduit shall be 1.2mm or more in consideration for strength and the corrosion of the metallic conduit.
- (2) The insulated cable shall be adopted.
- (3) All metallic conduit and the connection box shall be grounded with electric bonding for risk prevention, if an electric leakage occurs due to the insulation deterioration of the electric cable in the metallic conduit.
- (4) Inside the metallic conduit or insulating conduit, the electric cable shall not be connected to each other. (It shall be connected in the connection box)

Article 141. Wires connection of wires to the oil-filled equipment

When the electric cable is connected to the oil-immersed equipment, the metallic conduit which is not affected by insulation oil or the machine oil, etc. shall be used for an electric conduit work.

In addition, an oil proof electric cable shall be used. However, since the oil resistance of an electric cable changes with types of oil to be used, the appropriate electric cable shall be adopted with the type of oil which is used.

Article 142. Connection to crips

The connecting terminal of the electric cable shall basically use the crimping terminal. The connection between terminal and cable by soldering shall be available in exceptional cases. (Refer to the figure below).

In case of the terminal of the wrap tightening structure, core cable is wrapped more than $3/4$ around the neck of the bolt tightly. (Refer to the figure below).



Figure 142-1 Crimping terminal example



Figure 142-2 Wrap tightening example

Article 143. Extra length of wires and cables

It is required to have an extra length of cable so that it can be reconnected at the time of breaking of cable.

In addition, since many cables are connected in the terminal, in case of new cable laying work or the removing work of the existing cable, the existing cable already connected to the terminal may be pulled by the external force arisen from the above work.

As the result, the core wire of the existing cable may be broken. Therefore, it is necessary that the core wire connect to the terminal with an extra length to prevent the breaking of cable.(Refer to the figure below)



Figure 143 Terminal connection example (Japanese example)

Article 144. Use of soft-copper core wires

As for the doors such as a cubicle, etc, it has a big rotation angle so that it may be seen by the door illustrated in the guidelines of articles 102. Therefore, the cable used in the back of the door shall use a flexible stranded cable with an insulating sheath to prevent from breaking of cable. Because the above part of the cable is subjected to bending stress caused by opening and closing of the door.

2. The rows of the clips for wire connection

Article 145. For distribution equipment above 1kV

For the circuit with voltage 1kV or more, experimental clamps must be used to ensure safety and improve reliability for power supply. When checking the secondary circuit of the switchgear, current transformers, voltage transformers without the need to cut the power primary circuit.

Article 146. Condition of the clips for wire connection

The contact face of the clip and the equipment shall be polished lightly before connection, to remove the dust and the oxide film enough. After that, the clip shall be connected tightly.

Moreover, in regard to the treatment of the clip for the distribution equipment, Connection with the distribution equipment needs to in the joint box, cubicle, etc. not to expose the live part.

3. Markings

Article 147. Secondary circuit

It is desirable to specify the following items in the cable connection diagram, in order to connect between equipment securely and maintain the cable after connection easily.

- The cable classification (including the number of the core wires, cross-sectional area of core wires, etc.)
- The cable name (number)
- The connection terminal name

- The core wire color and number
- The use application (power supply circuit, VT circuit, CT circuit, control signal, and display circuit, etc.)
- Power supply polarity and phase expression, etc.

Article 148. Materials used at the ends of wires

The insulating material which withstands the working voltage shall apply to the cable identification plate and the fixation material etc.

In addition, the terminal exposure part (live part) shall be covered with the insulating tubing, etc.

Section 6 STATIONARY BATTERY SYSTEM

Article 149. Scope of application

As stipulated in Technical Regulation.

1. The conductor bar system

Article 150. Materials of the conductor bars

In regard to the connecting conductor between the battery cells, since the acid or alkaline mist is discharged during operation of the battery, the connecting bar or wire made of the lead or lead alloy coated steel or copper etc shall be used.

Ceiling busbar shall be made of steel, copper or alloy.

Article 151. Fixation of the conductor bars

The connecting conductor shall be supported appropriately using a support insulator, etc.

At the time of fixation of conductors to the support insulators, bolts shall be tightened with a torque wrench by the torque for which the manufacturer provides.

2. The installation of batteries

Article 152. Cells of batteries

In regard to the specification of conductors and the countermeasure of the corrosion of the joint part, refer to Article 87 or 92.

At the time of fixation of conductors to the cell, bolts shall be tightened with a torque wrench by the torque for which the manufacturer provides.

Article 153. Installation of Battery System

Battery shall be placed in the cleaned dry place, without direct sunshine, and in the place where the room temperature was managed.

The width of the passage of the battery system for operation and maintenance shall be below.

- The case of placing the battery on one side of the passage: 0.8m or more
- The case of placing the battery on both sides of the passage: 1m or more

It is necessary to attach the attention plate of "Flammable - Keep Fire Away" on the door in battery room.

Article 154. Transportation of Battery

(Reference)

The transportation of batteries shall comply with the ICAO (International Civil Aviation Organization) rule, etc. based on "Admonition concerning transport of dangerous material" that the United Nations establish in the point of view of the safety transportation. Because corrosive substances are contained in electrolytes.

The battery shall be transported by containers and packaging as specified in this requirement in marine transport and the airlift. Because these batteries are specified in Class 8 corrosive substances.

Article 155. Ventilation System of Battery

A lot of hydrogen and oxygen are generated at the charge end because a lot of electrical energy is spent on electrolysis of moisture in electrolyte when the charge approaches completion.

Since the explosion limit of the hydrogen gas is a low value such as about 4% or more, the ventilation shall be carefully.

Therefore, the hydrogen concentration in the battery compartment or the cubicle shall be less than 4% by natural ventilation or forced ventilation in any situation.

In addition, the required amount of air ventilation per hour (V) is calculated by the following formula.

$$V [m^3] = 0.07 * n * I_n \quad (n: \text{Number of battery units}, I_n: \text{Maximum charge current [A]})$$

In addition, the necessary ventilation volume calculated from this formula shall confirm whether satisfy the manufacturers requirement in comparison with the amount of necessary ventilation that the manufacturer specifies.

As for the ventilation system specification, the specification concerned shall comply with the following items.

- The compulsion ventilation system should be an explosion-proof specification.
- Piping for the exhaust should prevent rain water from extending from the roof outside by 1.5m or more, and invading. Do not share this piping with a gas pipe and a general gas system.
- In case of exhausting from the top or bottom of the compartment, the fresh air shall be breathed from the opposite side.

- Although the ceiling of the battery compartment shall be flat in order to flow the air smoothly, in case that a ceiling has a difference in level, It is necessary to ventilate all hydrogen so that hydrogen may not stagnate.
- When the ceiling inclines, it is necessary to exhaust from the highest location. It is necessary to install the upper part of the ventilation tube opening section within 100mm from the ceiling, and the opening of the bottom to be within 300mm from the floor. The airspeed of the battery compartment under the operation of the ventilation system shall comply with "the hygiene requirements on industrial projects designing at the time ".
- A temporary ventilation system shall equip with an enough pipe for space and ventilation for the equipment installation.

Article 156. Leak of electrolyte solution

The material of the electrolysis vessel shall has a acid and alkali resistance, and a sufficient mechanical strength.

It is necessary to seal up a gap between the electrolysis vessel and the lid by the sealing compound, so that the gas generated from the battery shall not leak excluding the exhaust outlet.

Article 157. Charging procedures for batteries

When the charge approaches completion, the terminal voltage of the battery is raised and the electrolysis of water in electrolyte occurs. After that, the terminal voltage becomes constant. The temperature of the battery is raised by the heat that the electrolysis of water generates. At this time, the electrode active material deteriorates and the corrosion of positive electrode develops especially and so, the life duration of the battery is affected. Therefore, it is necessary to charge at an appropriate charge voltage, the charging current, and charging time corresponding to the type of the storage battery.

3. Painting and marking

Article 158. Painting and marking

The provisions of this article shall refer to the Article 104.

Section 7 THE CAPACITORS TO IMPROVE THE COEFFICIENT

Article 159. Scope of application

As stipulated in Technical Regulation.

Article 160. Earthing of capacitors

As for the ground of the capacitor bank, both the chassis and the support structure for each capacitor shall be grounded. The wiring of the ground wire shall comply with the follow. (Refer to the figure below)

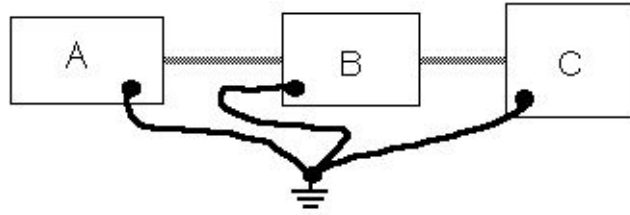


Figure 160-1 Example of correct connection of the ground wire

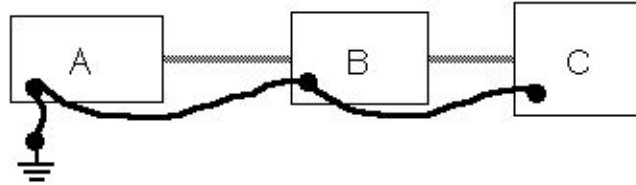


Figure 160-2 Example of incorrect connection of the ground wire

- When the ground fault of a capacitor C occurs, the fault current flows also into the chassis of the capacitors A and B which are not related to the fault, and a voltage rise occurs. (The voltage rise will become large if ground wire length becomes long)
- In the case of removal of the capacitors A or B, the ground wire of the capacitor C may be cut off (At the time of removal of the capacitor A, bypass of the ground wire for the capacitor B and C is needed before removal work)

Article 161. Painting and marking

The provisions of this article shall refer to the Article 104.

Section 8 FIRE PREVENTION MEASUREMENTS

Article 162. Floor of the compartment for transformers

As for the floor where the transformer is installed, the inclination toward the collection oil tank shall be taken as provided by the ministerial ordinance. For the main transformer of the effective ground type, the oil outflow prevention equipment shall be set up as the following.

1. Weir of oil outflow prevention

Concrete block weir are installed around every transformer to prevent outflow of the spout oil from transformer and the water for extinguishing fires (hereafter, oily water). It shall be filled with gravel so that oily water does not penetrate to the basement.

2. Oil draining tank

When capacity of the oily water weir outflow prevention is not sufficient, the oil draining tank is installed around the transformer.

3. Oil gathering pool

When oily water outflow preventions which stated above can not hold oily water, the common gathering oil pool between each bank shall be set up, and be connected with these equipment. Rain water in the container is processed with waste water pump etc.

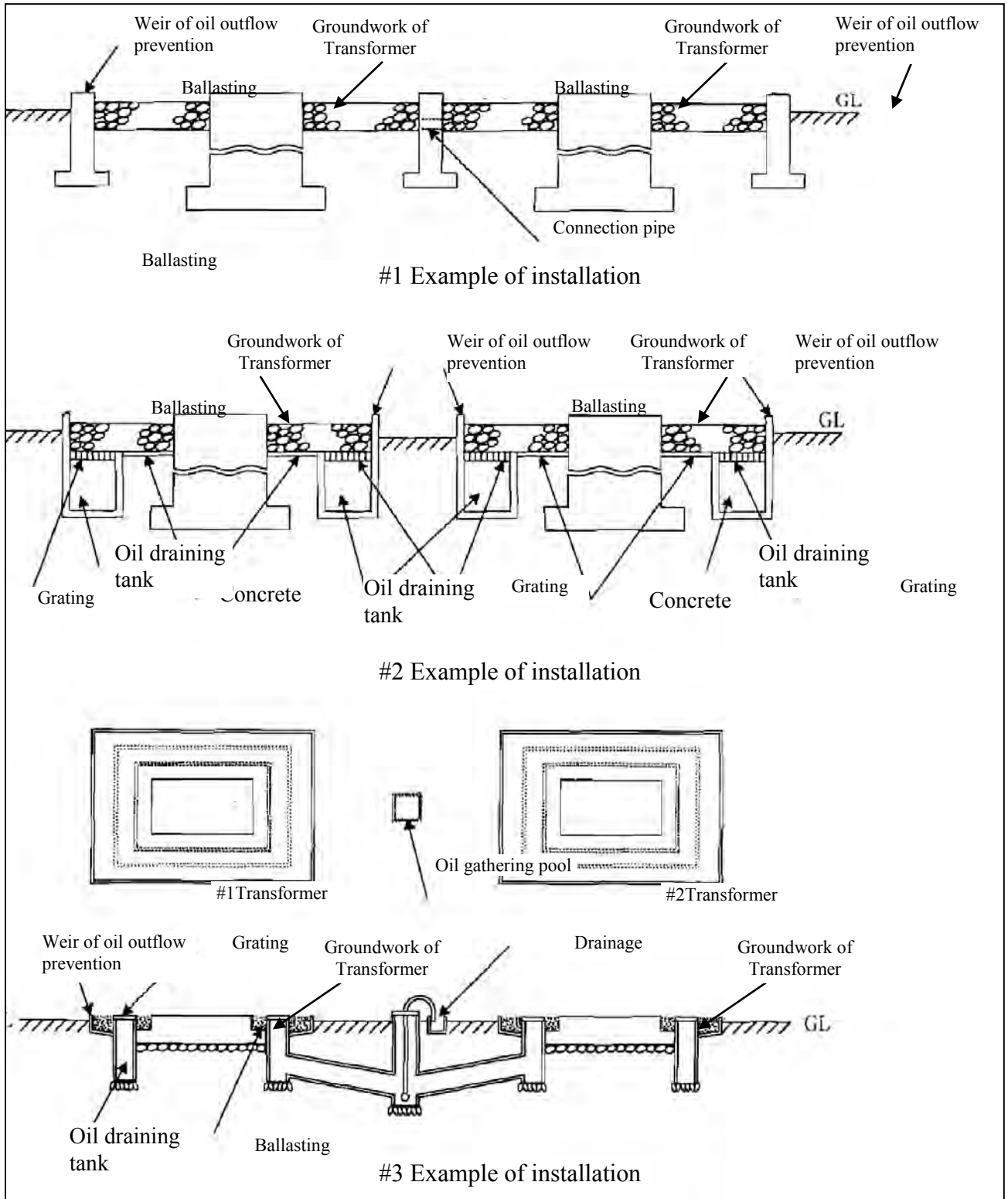


Figure 162 Example of preventing equipment of oil leakage for transformer

Article 163. Door (gate) of transformer compartment

Door (gate) of transformer compartment shall satisfy the requirements described in Vol.1, Chapter 4-2-1.

Article 164. Equipment in transformer compartment

As stipulated in Technical Regulation.

Article 165. Exit to the outside in transformer compartment

A fire prevention door and other fire prevention equipment shall be installed in the transformer room. They (except heated area) shall bear the general fire for 20 minutes from when the fire has started.)

As for the alignment and the number of door, it shall be necessary to consider the following items.

- (1) Transformer's capacity
- (2) Relation with the room next door
- (3) Easy-open/close handling
- (4) Secure quick and safe evacuation at the time of the transformer accident

In addition, as shown in the following figure, it is desirable to install a door which is opened outward from each room considering the easiness of evacuation.

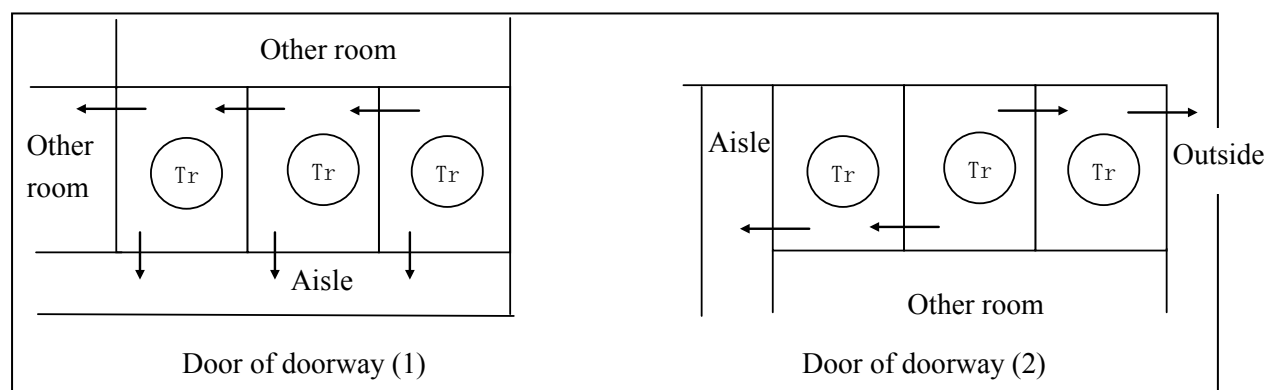


Figure 165 Door layout of transformer compartment

Article 166. Horizontal distance from door in transformer compartment

As stipulated in Technical Regulation.

Article 167. Ventilation system of transformer compartment

Ventilation system of transformer compartment shall ensure release of heat from transformers and is not connected with other ventilation system.

Ventilation pipes shall be made of flameproof materials with fire resistance capacity of 0.75 hour. The pipe and its air holes shall be designed so that the influent water from outside stagnated in the pipe will not flow into the transformer.

Air holes of ventilation pipe shall be covered with a mesh material sized 10 x 10mm (corresponding to IP2X) and prevented from the water inflow.

Article 168. Ventilation pipe of transformer compartment

Ventilation pipe of the transformer compartment adjoined to other house where the walls are fireproof but the roof is made of inflammable materials shall be placed at least 1.5m far from house walls or separated by a barricade wall that is made of nonflammable materials and at least 0.6m higher than the roof of the house.

It is forbidden to place the top opening of the ventilation pipe opposite to the window of the house.

It is not allowed to place the top opening of the ventilation pipe on the wall right under the inflammable lean part of roof or near the air hole on the wall of the adjacent house.

If there is a window above the door or above the top opening of the ventilation pipe, a protection board juttred out at least 0.7m shall be constructed under such window. The protection board shall be wider than the window by at least 0.8m at each side of the window.

Article 169. Compulsory cooling system in inside transformer

A cooling system shall be made into the structure which does not leak any oil, and rotating machines such as oil delivery pump and fan shall have less vibration and endure long-term use, and be replaced easily.

In addition, the valve that can stop the inflow and the outflow of the insulation oil shall be installed in the cooler.

Compulsory cooling system of the transformer is based on the below.

1. Air-cooling oil system

- (1) The cooling system is divided into 2 groups, the 1st group is started automatically when the transformer is excited by interception device, and the 2nd group is started when the load reaches to specified value (50% to 60%) or stipulated oil temperature. In addition, the manual operation method can be used for each group or each unit by switching the manual/automatic switch.
- (2) During operation of either the first group or the second group, if the operating group stops by failure, the remaining group will be started automatically.
- (3) Selection of the 1st group and the 2nd group is able to change suitably with a change switch.
- (4) Starting of the oil delivery pump is based on the following items for the prevention from malfunction of a pressure relay.
 - The transformer for power transmission: It is assumed that it starts one by one, and the time difference depends on manufacturer's standard.

- The transformer for the supply of electric power: The pressure relay shall be locked when the batch of oil delivery pump is operated. The lock time depends on manufacturer's standard.

In addition, during transformer is operated, when the power supply in the substation loses, it is required that the pressure relay does not malfunction.

2. Self-cooling oil system

- (1) The oil delivery pump starts automatically when the breaker is turned on and the transformer is excited.

In addition, it is possible to change the operation method of each unit to manual by changing the manual/automatic switch.

- (2) The same as 1. The air-cooling oil system (4)

In the case that the cooling system stops, the capacity of the cooler is designated in the table below as the standard.

Table 169 Capacity of cooling oil system (Japanese case)

Cooling system	Self-cooling capacity	Reserve of cooler	The capacity at the time of partial failure of cooler, etc.
Oil-immersed self-cooling system	100%	None	-
Derived oil self-cooling system	50% or more	None	In case the 1 set of oil delivery pumps of the transformer for power transmission stops, it shall bear 90% or more of rated load capacity.
Air-cooling oil system	-	1 set of reserve (cooler and pump)	Even if 1 set of the oil delivery pump and a fan is stopped, and the reserve does not start operating, it shall bear 90% or more of rated load capacity.
Indoor Cooler type separation	-	None	The oil delivery pump and the fan etc. shall be installed two units though the cooler can be one per a transformer. Even if 1 set of oil delivery pump and a fan is stopped, it shall bear 70% or more of rated load capacity.

Article 170. Cooling system installed apart from transformer

As stipulated in Technical Regulation.

Article 171. Valves of the cooling system

As stipulated in Technical Regulation.

Article 172. The exposed oil pipeline of the cooling system

As stipulated in Technical Regulation.

Article 173. Inspection of oil and water pump

Inspection of oil pump and water pump

It shall be checked that the pressure gauge value of the pump under operation is lower than the value of the manufacturer's standard.

Article 174. Foundation of the cooling system

As stipulated in Technical Regulation.

Article 175. Resistant of vibration of control panel board

As stipulated in Technical Regulation.

Article 176. Alarm signal of compulsory cooling system

When the compulsory cooling system of transformer has breakdown, the fault shall be displayed on the control panel.

When the oil circulation system and the cooling system stop, the signal shall be given as shown in the following figures, and the reserve system shall be operated automatically.

In the control board, the breakdown display return button is provided, and when the device returns normally, the display returns.

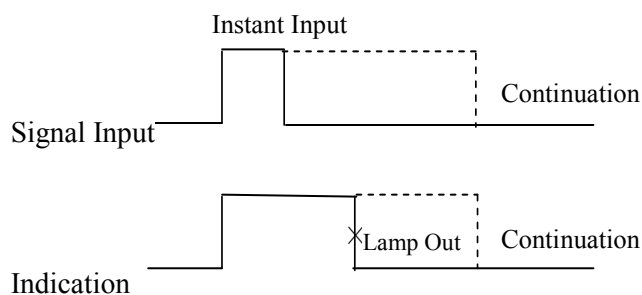


Figure 176 Time chart of Alarm signal and indication

Article 177. Absorbing of compulsory cooling system

As stipulated in Technical Regulation.

Article 178. Electric drying system

As stipulated in Technical Regulation.

Article 179. Nitrogen containing flexible bags

The conservator shall be set up in the main body of transformer and elephant room, and it shall be no pressure sealing type which the insulation oil does not touch air.

(The conservator for main body of transformer and elephant room can be shared.)

Moreover, the insulation oil of a diverter switch oil compartment is allowed to touch air. (open type), but the structure of the diverter switch oil compartment shall be the one which the cracked gas does not be mixed in main body of transformer oil.

Furthermore, the capacity of the conservator shall be large enough to hold the volume change of the oil by overload operation and ambient temperature.

Article 180. Consideration of repairing of the transformer

As stipulated in Technical Regulation.

Chapter 4 ELECTRICAL LIGHTING EQUIPMENT

Article 181. Scope of application

As stipulated in Technical Regulation.

Section 1 GENERAL

Article 182. Terminal of cables and wires

Connection of electric wire and equipment terminal

1. As for the connection between electric wire and equipment terminal, it shall be connected electrically and mechanically, also the connection shall not have exceeding tension.
2. The connection shall be tightened, and double nut and the spring washer shall be used when it is possible for the connection to be loosen by vibration etc.
3. The number can be connected is up to two for the terminal where two or more electric wires can be connected.
4. When terminal lug is used for the terminal of the equipment, electric wire shall be connected as the following.
 - (1) The number of the terminal lug which can be attached with one terminal is two pieces.
 - (2) Connect only one electric wire to a terminal lug.
 - (3) Attach an insulation cap or an insulation cover to a terminal lug without insulation covering.
5. When terminal lug is not used, the electric wire shall be wrapped firmly from 3/4 to 1 around the screw.

Article 183. Structure parts of lighting equipment

As for the metal material used for an instrument, it is desirable to finish up by painting or plating by the following.

Outside surface and reflective surface is painted uniformly.

Table 183 Example of painting/plating for lighting equipment (Japanese case)

Usage		Material	Pretreatment *1	Final coating
Equipment	General type	Steel board	Phosphate processing	Amino alkyd resin baking finish
		Zinc plating steel board	Phosphate processing or plasma etching	
	Waterproof type	Steel board	Phosphate processing and rustproof painting	Acrylic resin or epoxy modified melamine resin baking finish
		Zinc plating steel board	Phosphate processing or plasma etching	
		Stainless steel (Painted)	-	
		Stainless steel (cleared)		Transparent acrylic resin or transparent polyurethane resin baking finish

*1 In a pretreatment, each specification is removed grease.

Section 2 LIGHTS

Article 184. Requirement for installation of lights

Requirement for installation of lights

The illumination and the direction of office or room need to satisfy the requirements given in design documents, illumination may be referred to the following.

Table 184 The illumination standard of an office (Japanese case)

Illumination	Place		Work
1,500	Office, business room, design room, drawing room, entrance hall (daytime)		Designing, drawing, typing, calculating and keypunching
750	-	Office, conference room, print room, telephone exchange room, electronic calculator room, control room	-
500	Reception room, Waiting room, Dining room, Cooking room		
200	-	Library, electric room, machine room, elevator	
	-	Lavatory, kettle, bathroom, corridor, stairway, washroom, and toilet	
150	Tea room, rest room, night-duty room, locker room, and warehouse		
75	Indoor emergency staircase		
30			

Article 185. Strength of structures of lighting equipment

As stipulated in Technical Regulation.

Article 186. Adjustment of headlight

It is adjusted concerning the focus control of the illumination, usually, by the shape of light of perpendicular facing, but when the vertical is not used, the shape of light is irradiated onto a horizontal plane with the main body of the lighting inclined because of the maximum corner according to the design material, the tilt angle is corrected.

The error of this angle must not exceed 2 times.

Article 187. Lights of hermitic types and dust prevent types

In the place the insulation performance is possibly deteriorated by dust, the lighting of the hermitic type and the dust prevent types shall be used.

The switch, circuit breaker etc. are put into a box etc. to prevent dust from entering.

The example of installation is shown bellow.

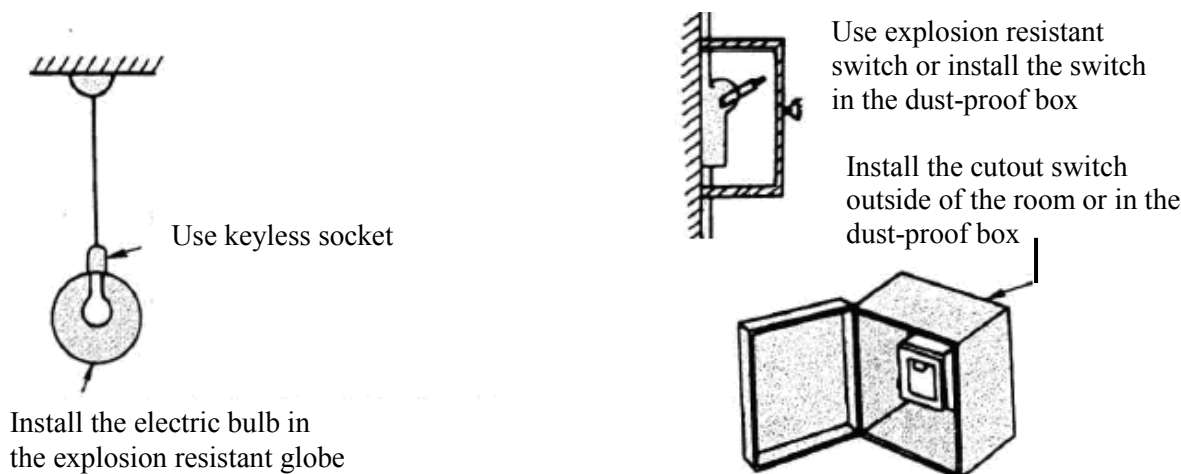


Figure 187 Example of Installation of lights, etc. in explosive room

Article 188. Installation of lights in explosive room

The facilities such as electrical machinery and apparatuses of the room where dangerous material exists are installed as the follows.

1. The lightning equipment is durably installed either directly or with the hanging pipe etc. to building parts.
2. The incandescence light and the discharge lamp shall have protective cover so that there is not fear of fire to the dangerous materials.

3. The light that is moved to use shall be protected by armor.
4. Electric wire and electric machinery and apparatuses should be connected to the connection part by using a lock nut, a spring washer, etc. not to loosen by vibration, and should be connected completely.

Article 189. Connection of lights to wires in doors

As stipulated in Technical Regulation.

Article 190. Earthing Light's body

As stipulated in Technical Regulation.

Article 191. Wire at lamp socket

For the internal wiring part passing through metal parts, laying pipe etc. are installed and protected to prevent electric wire coating from being damaged.

The tension end is performed by cord hanging instrument such as cord fasteners so that it prevents direct weight from the terminal.

Article 192. Prohibition of connection of wires inside stands and ducts

As stipulated in Technical Regulation.

Article 193. Rods for hanging lamps

(Reference)

When the down light instrument exceeds 3kg, the structure of bolt hanging shall be made.

Article 194. Wires supplying for public lights

As stipulated in Technical Regulation.

Article 195. Insulation of wires supplying for lighting equipment

As stipulated in Technical Regulation.

Article 196. Wires used for local lighting equipment

For electric wire of local lighting equipment, the important matters below shall be satisfied.

- (1) Wires must be placed on stands or be protected from mechanical forces.
- (2) Wires laid inside parts with hinges must not be strained or twisted.
- (3) Wires passing through holes of stands must have the diameter of at least 8mm. Holes could be out of shape locally within the diameter of at least 6mm. At the holes through which wires are passing, it is essential to use insulating bolted pipes.
- (4) Mobile structures of lighting equipment must be prevented from removing or swaying.

Article 197. Use of hermetic washers

As stipulated in Technical Regulation.

Article 198. Lighting equipment on cranes

As stipulated in Technical Regulation.

Article 199. Light for prevent of explosion

As stipulated in Technical Regulation.

Section 3 EQUIPMENT OF LIGHTING SYSTEMS

Article 200. MCCB and fuses

- (1) Protection of the electric trunk line is based on the following
1. Overload and short circuit protection shall be performed.
 2. The breaker shall be used as protection instrument according to the general rule of power distribution.
In addition, for electrical substation equipment, the short circuit current value is calculated, and the rated breaking capacity shall be selected more than the short circuit current value.
 3. For the trunk line equipment that has working voltage exceeding 300V, the earth leakage breaker shall be used according to the general rule. However, when all of the branching circuits are earth leakage breaker, the trunk line equipment shall be breaker.
 4. The fuse used as a breaker for power supply endures 1.1 times of the rated electric current, and the fuse shall melt down when 1.6 times or double of the rated electric current is conducted according to the classification of the rated electric current of the following table.

Table 200-1 Overload and short circuit protection using fuse

Division of rated current	Time(minutes)	
	When 1.6 times of the rated current is conducted	When 2 times of the rated current is conducted
30A or less	60	2
More than 30A but 60A or less	60	4
More than 60A but 100A or less	120	6

5. When the breaker for electric supply (MCCB) does not operate automatically with electric current of 1 times that rated current, and it operates with 1.25 times or 2 times of rated current, it shall operate automatically within the time according to the classification of the rated electric current of the following table.

Table 200-2 Overload and short circuit protection using MCCB

Division of rated current	Time(minutes)	
	When 1.25 times of the rated current is conducted	When 2 times of the rated current is conducted
30A or less	60	2
More than 30A but 50A or less	60	4
More than 50A but 100A or less	120	6

- (2) Protection of the branch circuit of electric light equipment is based on the following.
1. The protection of overload and the short circuit shall be performed.
 2. The breaker shall be used as the protection instrument of the light and the outlet circuit. However, the divergence equipment of the following divergence circuit shall be earth leakage breaker.
 - The circuit installed in wet room (including rest room, kitchen, dressing room etc.)
 - The outlet circuit installed outdoor
 - Outdoor light circuit
 - The lighting duct circuit installed at the height which people touch easily

Article 201. Arrangement of light switches

The control by a switch is based on the below.

1. The height of the switch is 1,300mm as the general rule. But for the multipurpose rest rooms, it is 1,100mm or appropriate height in consideration of the convenience of institution user.
2. For warehouse, storeroom, bookroom etc. where a person is not always there, the switch is arranged near doorway by passage with indicating light.
3. An indicating light is attached to the switch of the equipment of which operation cannot be checked easily such as ventilation fan.

Article 202. Installation of electricity meters

As stipulated in Technical Regulation.

Article 203. Laying wires on the surface of equipment

When laying electric wire along the undersurface or the side of building parts, the following requirements shall be satisfied and it shall be performed not to damage the covering.

Cable fixed distance measuring points:

- The horizontal cable distance of supporting points of a cable shall be 2m or less
- The vertical cable less than or equal to 6 meters and in places you can not touch.
- With rubber cable must be less than or equal to 1 m, without damage to the cable sheath during installation.

For devices that do not have specialized base for mounting directly on the wall to put more buffer as required insulation thickness.

Section 4 DISTRIBUTION BOARDS

Article 204. Requirement for installation of distribution boards

The specification of cubicle shall be satisfied with the specification which is stipulated in the Article 103. Because the main functions of the cubicle which place the distribution boards shall be secure prevention of electric shock and fire accident caused by the live parts of distribution boards.

Article 205. Place the Board between current-carrying parts

As stipulated in Technical Regulation.

Article 206. Locations for connecting input and output to distribution boards

In case that there are connection points in the rear of distribution boards, the structure of distribution boards shall adopt be hinge types in order to maintain from the front of boards or the minimum distance from the rear of boards to wall shall be more than the distance shown in the following table in consideration of workability.

Table 206 Minimum distance between rear manipulation panel of distribution boards and wall

The dimension of board in horizon [mm]	The minimum distance from the rear of boards to wall [mm]
400	200
500	300
800	400
1200	600

Article 207. Positions for wires passing to cubicles

When electric cables are passed through the penetrating part of the cubicle or metallic duct, it shall be necessary to install the insulating conduit which shown in the following diagram in the penetrating part, to avoid damaging the wire covering.

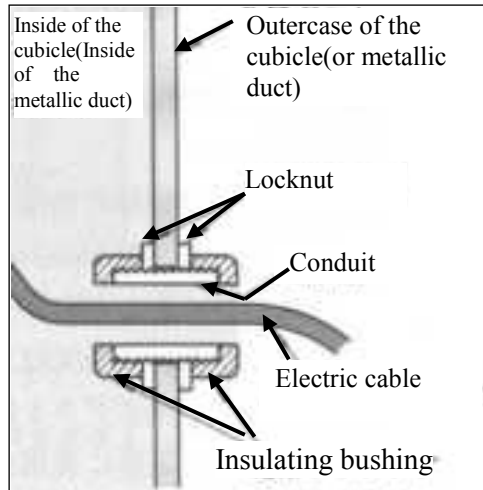


Figure 207 Example of protection for wiring through penetrating parts

Article 208. Painting and signing

The provisions of this article shall refer to the Article 104.

Article 209. Equipment connected to distribution boards

In the three-phase system, if load balance of each phase becomes unbalance, voltage and current unbalance take place. As a result, the following defects may occur.

- The malfunction of open-phase protective relay which is used for the protection of induction motor
- In case of induction motor, the occurrence of overheat and burnout caused by voltage unbalance

In order to avoid those defects, it is preferable to operate the voltage unbalance within 3% of the voltage unbalance factor (*VUF %*) which is shown in the following formula.

$$VUF \% = \frac{\text{Negative sequence voltage component } (V_n)}{\text{Positive sequence voltage component } (V_p)} * 100\%$$

The positive and negative sequence voltage components of method of symmetrical components are obtained by resolving three-phase unbalanced line voltages V_{ab} , V_{bc} , and V_{ca} (or phase voltages) into two symmetrical components V_p and V_n (of the line or phase voltages). The two balanced components are given by

$$\left\{ \begin{array}{l} \text{Positive sequence voltage } (V_p) = \frac{V_{ab} + a V_{bc} + a^2 V_{ca}}{3} \\ \text{Negative sequence voltage } (V_n) = \frac{V_{ab} + a^2 V_{bc} + a V_{ca}}{3} \end{array} \right.$$

The **a** vector operator swings vector quantities through 120° in an anticlockwise direction
 $a = 1 \angle 120^\circ$ and $a^2 = 1 \angle 240^\circ$.

The worker can measure VUF using a clamp meter or special measuring tools (e.g. power quality monitoring device).

Chapter 5 EARTHING SYSTEMS

Article 210. Earthing requirement

Generally, a copper wire or a zinc galvanized steel bar is applied to a grounding conductor. However, a flexible conductors such as a cable are applied to the part where flexibility is demanded with a grounding conductor. The both edges of the conductor must be firmly connected to the grounding pole (conductor) and an enclosure of equipment or steel frame respectively. Moreover, suitable measures shall be taken at the welding part of a grounding conductor as below so that corrosion etc. does not occur.

- Welded part should be painted with an antirust material such as a rust-resistant paint.
- The foreign materials such as dust or dirt should be removed from the contact faces of grounding conductor and enclosure of electrical equipment in order to ensure firm connection between them.

Section 1 GENERAL

Article 211. Grounded in positions explosive, explosive devices

The installation of the grounding conductor in the room with the explosive risk or the outdoors must be carried out from the viewpoint of safe securing of grounding system to satisfy the following conditions.

1. Condition of voltage of equipment which needs grounding

In usual case, grounding work is not necessary for electrical equipment with the voltage less than AC380V or DC440V in dry place and for the electric equipment with the voltage less than AC42V or DC110V without any covers, but in this case, grounding work shall be implemented at electric equipment with the voltage more than AC42V or DC110V. (Refer to Figure211)

2. Use of exclusive grounding conductor

It is decided that the grounding conductor shall be used exclusively and metal pipe and metal or lead cable cover shall not be used as the grounding conductor.

3. Connection of a grounding conductor and a main grounding conductor

The connection of a grounding conductor and a main grounding conductor shall be made at two places and more.

		AC 42V DC 110V	AC 380V DC 440V
Dry place	With cover		→
	Without cover	→	→
Explosive room	All cases	→	→

→ : To be grounded

Figure 211 Application range of grounding method

Article 212. Parts to be earthed

Normally, insulation between live parts and metal stands or metal enclosures of electrical equipment (the metal pipe for wiring is not included) is ensured. However, when the insulation at the winding or bushing is deteriorated, leakage current flows at these parts and accordingly the electric hazard could occur. In order to reduce such danger, the metal stand and metal enclosures of electrical equipment shall be grounded.

The capacitor with large capacity and the neutral grounding resistor, etc. which are connected to high voltage system cannot be grounded due to their structure. Therefore, instead of grounding work, a suitable fence can be installed in surroundings in order to prevent a person from touching.

When leakage current flows, the lower a ground resistance is, the lower a voltage is, which appears at metal enclosures, so that the possibility of electric hazard is reduced. Generally, the electrical equipment with high voltage shall be installed in such a way that it cannot be touched easily by a person. However, it is necessary to reduce ground resistance in order to reduce the danger in case of touch by a person, because voltage as well as leakage current is relatively large when leakage current flows.

In general, a secondary winding of potential or current transformer is extended to some switchboards. In this case, one grounding point can be shared by these switchboards. The grounding work is often carried out at a switchboard. Although the cross-sectional area of the grounding conductor shall satisfy the condition provided the design standard, it can be decreased, if a multi-conductor cable is applied to a secondary winding of potential or current transformer and the mechanical strength of this multi-conductor cable has sufficient strength.

Article 213. Objects not needed to be earthed

If there is little danger of electrical leakage, grounding work can be omitted in order to simplify construction. The requirements related to this issue are stipulated in this article. Grounding work can be omitted in the following cases.

- when electrical equipment is installed on a high pillar, a wooden pole or a reinforced column, which has high insulation in order to prevent a person from touching it
- when there is little danger even if a person touch it.
- when there can be equal effect to the ground resistance in case that grounding work is carried out.

- when electrical equipment with high insulation performance, such as double insulation, is used
- when electrical equipment is dealt on a stand or a floor with high insulation performance. Since there are few risks of being electrical shocked by leak current, grounding work can be omitted. The high insulation performance is considered as the dry stand or floor made of wood or stone, but concrete floor is not included.

Article 214. Replace earthing of equipment

The low-voltage or high-voltage electrical equipment must be installed based on one of the following conditions.

1. For indoor, equipment is installed in the place that only skilled workers can access
2. When equipment is installed as follows
 - a. In order to ensure that there is no possibility of a person touching, the suitable fence is installed around the electrical equipment.
 - b. The sum of the height of the fence or the wall and the distance from the fence, the wall, etc. to the live part of electrical equipment is not less than 5m.
 - c. The warning of danger is displayed.
3. The equipment is installed at the stand higher than 4.5m from the surface of the ground so that there is not the fear that a person touches it, and a cable or a high-insulation electric wire is used as a high-voltage power line attached to the electrical equipment.
4. The electrical equipment is put in a concrete box or a metal box of which the grounding work was carried out, and its live part is not exposed.
5. The electrical equipment of which live parts are not exposed is installed on the basis of the below
 - a. Simple measures to prevent a person from touching are installed
 - b. There is no fear of danger to a person or other structures even if there is temperature rise or voltage rise at electrical equipment caused by its malfunction.

When electrical instrument such as an electric motor is installed on a main electrical equipment, it is required to install based on the following conditions in addition to the four conditions mentioned above.

1. Grounding work shall be done to the main electrical equipment.
2. It is necessary to ensure the electrical connection between equipment such as electric motor and main equipment.
3. The live part of equipment such as an electric machine shall not be exposed.

Article 215. Earthing of equipment

As for the grounding conductor, it is desirable to use copper wires in consideration of the durability to be used for a long term.

A grounding conductor must be the one which fits the below.

1. The one which can lead fault current
2. The one which is the metal wire with the pull strength of 1.04kN which is difficult to be corroded, or the annealed copper wire of which diameter is 2.6mm and more
3. When grounding work is carried out at the metal enclosure of the mobile electric equipment, the single or multi core sheath cable shall be used for the part which needs flexibility, moreover, the cross-sectional area of the core shall not be less than 8mm².

When copper wire is used, it is desirable to use a flexible soft copper in consideration of workability in the grounding work, because the grounding conductor rarely receives tension load.

At the design of a grounding system, from the viewpoint of grounding resistance reduction, the method of grounding mesh by connecting each grounding electrode is adopted. In this case, each grounding electrode shall be connected directly, and jumper wires between the equipment are prohibited.

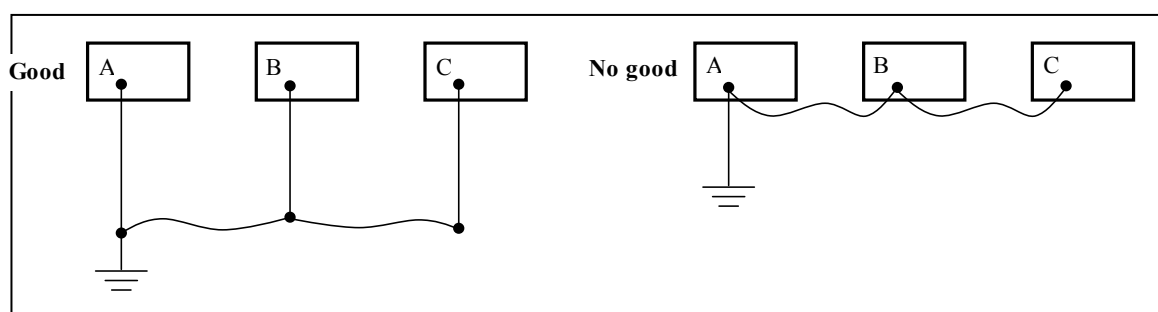


Figure 215 Connection method of grounding conductors

Article 216. Adopting objects as earthing equipment

This article stipulates the requirements on grounding work which utilizes the metal enclosure of a structure.

If the metal part of a structure can be used as an grounding electrode, a grounding resistance value can be reduced effectively. The metal part used as a grounding electrode must satisfy the following conditions.

1. Steel frame or metal part of a building of which ground resistance is 2 ohms or less can be used for the grounding electrode at grounding work.
2. The underground metal water pipes of which ground resistance is 3 ohms or less can be used for the grounding electrode at grounding work when fulfilling the following conditions.
 - a. The connection between a grounding conductor and a metal water pipe is carried out at the part where the diameter of the water pipe is not less than 75mm. If the diameter of the water pipe is less than 75mm, the connection is carried out at the part which is not more than 5m from the junction of the branch. However, when the ground resistance of a metal water pipe is 2 ohms or less, the connecting part can be more than 5m from the junction of the branch.

- b. The bypass conductor shall be connected firmly on both sides of a water meter when connecting a grounding conductor to the metal water pipe between the water meter and the building of water service consumer.
- c. When connecting a grounding conductor to a metal water pipe in a place with a possibility that a person touches, protective equipment shall be installed in order to avoid damage to the connecting point.
- d. The metal used for connection between a grounding conductor and a metal water pipe shall not cause electric corrosion at the connecting point.

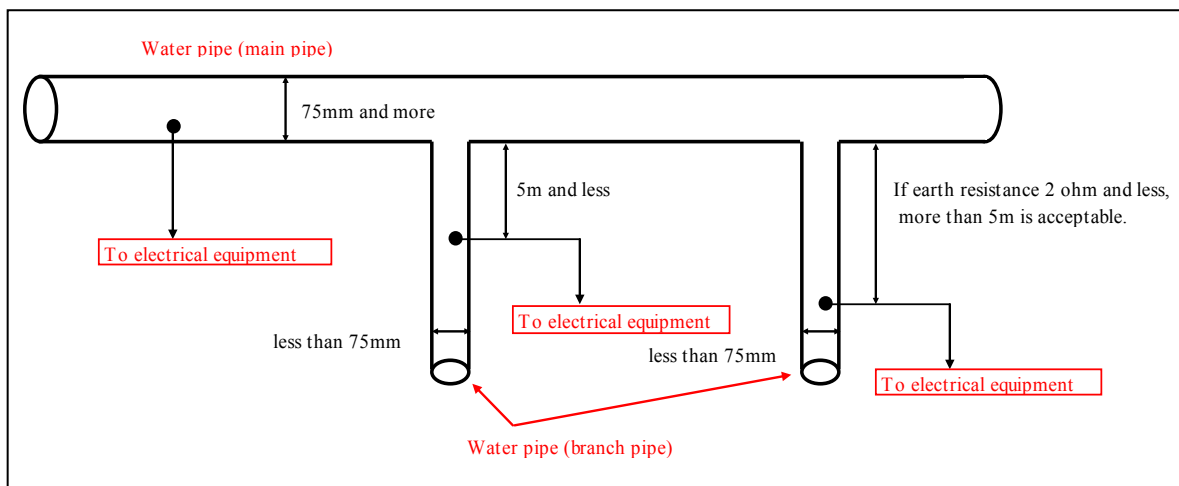


Figure 216 Acceptable connection points

Article 217. Connection of Natural earthing and mainly earthing system

These metals and main grounding conductor shall be connected at more than two points. However, as for neutral grounding work and grounding work of the metal sheath of cables, the rule mentioned above is not applied in order to make protective relay work properly in case of earth fault.

Article 218. Digging, fill grounding system

Grounding conductors of metal frame and electrical equipment shall be buried underground carefully, and the schedule of its installation work shall be consistent with the schedule of installation work of electrical equipment and its foundation. And grounding conductor shall be laid along the designated route. Moreover, it is necessary to pay attention not to cut the grounding conductor at the time of the foundation and duct construction. If the grounding conductor is broken, this broken part shall be repaired by suitable methods promptly. The method of digging and a backfill is as follows.

1. Digging

Suitable excavation method is selected according to the quality of soil. Basically, excavation without supporting is applied. Excavation shall be carried out to keep the necessary slope, appropriate digging range, and necessary depth.

2. Backfilling

Backfilling is performed carefully not to damage the grounding conductor or the equipment. In every thickness 300mm, it is necessary to make the sufficient leveling and tamping not to cause sink at the backfilled part.

Section 2 LAYING EARTHING WIRES

Article 219. Materials used for earthing system

As stipulated in Technical Regulation.

Article 220. Earthwires of mobile electrical tools

A cable shall be adopted for grounding conductors of portable electrical tools because flexibility is necessary for the grounding conductors and damage to the grounding conductors has to be avoided. The cross-sectional area of the core of the cable shall be large enough to let earth fault current flow safely. In addition to the above, the cross-sectional area also shall be 1.5mm^2 and more in order to ensure its strength.

Article 221. Protection of earthwires

From the viewpoint of prevention of damage of grounding conductors and reduction of ground resistance, burying depth of the grounding conductors shall be deeper than 0.75m. In addition to the above, from the viewpoint of prevention of damage of grounding electrode due to electrical corrosion and reduction of ground resistance, the appropriate interval of the each buried grounding electrode is about 4m. The location of buried grounding plate and the grounding electrode shall be pointed out by sign. Grounding conductors shall not be laid in cable duct or cable rack except special cases.

Article 222. Earthwires in trough-wall

When grounding conductor is laid in a cable trough, it is necessary to prevent the grounding conductors from damage by covering them with appropriate solid cover.

Article 223. Coupling of earthwires

Grounding conductors shall be connected with sleeve joints by using proper tools. In addition to this, if welding joint is acceptable, grounding conductors can be connected by welding. In this case, welding work shall be carried out in accordance with relative regulations.

As for connection of overhead grounding wires, the same connecting method as connection of main conductors can be adopted from the viewpoint of workability of connection work. But in this case, strength of connected part shall be ensured. If connection with sleeve is impossible or inappropriate, connection by welding can be permitted.

Article 224. Connection of earthwires with long earthing devices

As for the connection between water pipe and grounding conductor, pressure bonding with grounding clamp by using appropriate tools shall be adopted. If pressure bonding cannot be adopted, connection

by welding can be permitted. In this case, welding materials and welding method shall be in accordance with relative regulations.

If water meter is equipped with water pipe, bypass wire shall be connected firmly on the both sides of the water meter to prevent ground resistance of this grounding system with water pipe from increasing and exceeding the required ground resistance. The reason is that the ground resistance increases in case that water meter is removed temporarily due to repair or inspection of the water meter and accordingly the length of the water pipe is shorten.

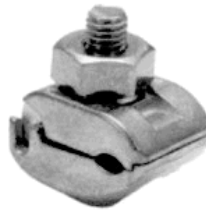


Figure 224-1 Grounding clamp

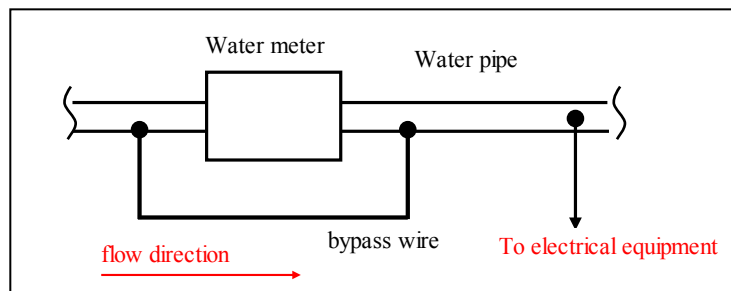


Figure 224-2 Bypass wire for water meter

Article 225. Bare earthwires

When bare grounding conductors are laid indoors without any covers, these grounding conductors should be laid along a wall in order to prevent damage to the grounding conductors. Moreover, it is desirable to fix the grounding conductors so that they do not move, and to cover them with insulation materials.

In addition to the above, bending radius of grounding conductor shall not be smaller than the minimum bending radius specified according to the material of each grounding conductor in order to prevent it from being damaged by the stress caused by bending excessively. And it is desirable to enlarge the bending radius as much as possible.

Article 226. Earthwires on concrete or brick plates

A grounding conductor must be fixed firmly so that it does not move. In order to avoid the corrosion of a grounding conductor, in the indoor room with much moisture or harmful gas, a grounding conductor should be laid with enough distance from a wall in order to prevent moisture, gas, etc. from adhering to a grounding conductor.

Article 227. Wires intersecting with gutters

When bare grounding conductors are laid indoors without any covers, these grounding conductors should not be laid across gutters, passageways or corridors of persons in order to avoid damage to the grounding conductors. If bare grounding conductors are laid across ducts, etc, appropriate measures to avoid damage to the grounding conductors shall be complemented as follows.

In case of laying across gutters: insert protective layers at the edges of the ducts

In case of laying across passageways or corridors: protect grounding conductors with solid covers of which strength is enough to stand the maximum load of the passageways or corridors, or bury the crossing parts of the grounding conductors.

Article 228. Temporary connection with mobile earthwires

When grounding conductors of mobile electrical equipment are connected to the buried metal plate, the contact resistance between the grounding conductors and the metal plate possibly increases, and accordingly ground resistance of the mobile electrical equipment increases. Therefore, necessary measures to reduce the contact resistance should be executed. In addition to this, this metal plate shall be connected to grounding mesh to satisfy the required ground resistance value.

Article 229. Soil for filling cable trenches

Gutters where grounding conductors are laid shall be backfilled as follows.

1. The backfilling material must be compacted uniformly.
2. When water is in the location to be backfilled, backfilling is carried out after draining the water.
3. Frameworks or temporary materials shall be removed from the place to be backfilled and this place also shall be cleaned before starting to backfill.
4. Soil used for backfilling shall be compacted uniformly and firmly paying attention not to damage other equipment.

Article 230. Prohibition of use of water pipelines

When a water pipe is used as a grounding conductor, large earth fault current probably flows into this water pipe through common grounding mesh in case of earth fault at related power network. If a person touches this water pipe at this time, electrical shock may occur to this person. Therefore, the water pipe which public people can touch shall not be used as a grounding conductor from the viewpoint of ensuring safety. Therefore, the safety point of view, prohibit the use of water pipes for feeder cattle feeding and milking equipment in the cattle camp grounding wire.

Article 231. Use of welding or bolts

The connection of grounding conductor with electrical equipment is executed by welding. In this case, the welding method shall be in accordance with related regulations and welding shall be carried out after taking suitable measures so that any deformation and any adverse affect due to welding do not occur to the electrical equipment. Moreover, necessary inspection for welding shall be executed in accordance with the related regulations after welding is completed. When connecting grounding

conductor with enclosure of electrical equipment, welding method is not necessary adopted. In this case, it is necessary to connect grounding conductors with the enclosure firmly by using appropriate device such as grounding clamp. In addition to this, if large vibration may occur at connecting point, measures such as prevention of slack of bolts shall be taken appropriately.

Article 232. Contacting faces of connecting places

Measures to reduce contact resistance should be executed for connection point between grounding conductors and electrical equipment or metal structures of buildings in order to prevent ground resistance from increasing due to the above-mentioned contact resistance. Therefore, contact surface shall be cleaned sufficiently and oil or paint shall be removed from the surface completely. And the surface also shall not be painted.

Section 3 EARTHING DISTRIBUTION EQUIPMENT

Article 233. Earthing for distribution equipment

For safety of grounding system, grounding system and lightning grounding system must be connected to the main earthing grid wire at each branch.

Grounding system and grounding for lightning protection can be placed directly and located adjacently to equipment or along the mounting device.

Working grounding system working on electrical insulators is about 1m away from the connection point to the main earthing grid.

Section 4 EARTHING POWER EQUIPMENT

Article 234. Earthing for machines on sliding stands

As the statement in Article 232, measures to reduce contact resistance should be executed for connection point between grounding conductors and pedestal of electrical equipment in order to prevent ground resistance from increasing due to the above-mentioned contact resistance. Therefore, contact surface shall be cleaned sufficiently and oil or paint shall be removed from the surface completely. And the surface also shall not be painted.

Article 235. Earthing of instrument machines

This article stipulates that the metal wire or the metal duct which is grounded can be utilized as a grounding conductor of the enclosure of electrical equipment. By applying this stipulation to the building with metal structure such as steel-frame structure, steel-frame reinforced concrete structure or reinforced concrete structure, this metal structure can be utilized as the common grounding electrode.

In this case, the part of the metal structure shall be buried underground and all metal structure shall be connected with each other in accordance with the following stipulations. (The reason is that there should be less voltage at any parts of metal structure.)

1. The touch voltage in any conductive parts of building such as pillar, beam, floor or wall shall not exceed 50V in case that earth fault current flows through grounding wire of enclosure of high-voltage electrical equipment
2. The touch voltage in any metal parts of electrical equipment or other metal structure which is grounded shall not exceed 50V in case that earth fault occurs.
3. The touch voltage between any conductive parts and metal parts of outside wall of the building as well as adjacent building shall not exceed 50V in case that earth fault occurs. Moreover, in order to give flexibility to grounding conductor, a cable should be used for the grounding conductor of mobile parts of electrical equipment.

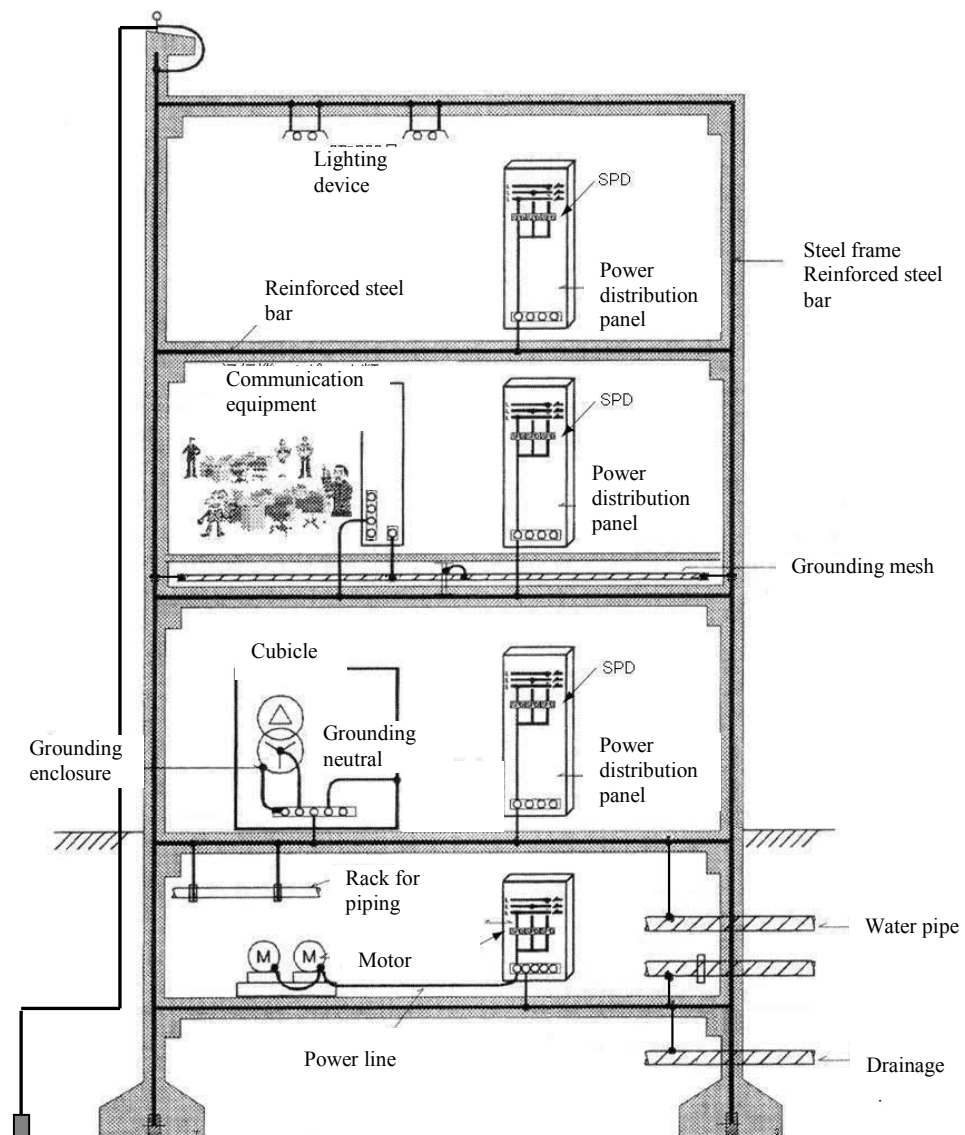


Figure 235 Metal structure in a building

Article 236. Earthing of rail cranes

This article stipulates that girder of crane is used as grounding conductor of electrical equipment. As the stipulation mentioned in the article 235, metal structure of the building such as steel-frame

structure, steel-frame reinforced concrete structure or reinforced concrete structure can be utilized as common grounding electrode. The detailed requirements are in accordance with the article 235.

Section 5 EARTHING IN CIRCUITS AND CABLE LINES

Article 237. Earthing of metal covers

This article stipulates that grounding conductors of iron pedestal or metal enclosure can be connected with metallic shielding layer of high-voltage cable in order to reduce ground resistance of grounding system. Instead of the grounding method in which each electrical equipment is provided with respective grounding work, grounding conductor of each electrical equipment is connected with each other to form one common grounding system from the viewpoint of reduction of ground resistance effectively. In this case, ground resistance of this grounding system shall satisfy the value stipulated in the relevant standard.

Even if ground resistance is difficult to meet the requirement, ground resistance can be reduced by adopting the above-mentioned grounding method because grounding conductor can be extended.

Article 238. Use of aluminum cover

This article stipulates that the aluminum cover of a cable can be used as a neutral wire. A neutral wire must be hard to corrode, and fault current must flow through it safely. Moreover, it is necessary to have sufficient mechanical strength so that disconnection etc. shall not occur. Therefore, the aluminum cover applied to a neutral wire must satisfy the predetermined value of a stress area, mechanical strength, and ground resistance provided in the design criteria.

Article 239. Terminal with earth wires

Grounding conductors must be connected firmly by pressure bonding or welding so that ground resistance does not increase by the contact resistance at a contact point. Moreover, the tensile strength of the connected grounding conductor should satisfy the value provided in the design criteria.

Article 240. Earthing of flexible links

When a grounding conductor is required to be flexible, an electrical insulated wire or a cable shall be used as the grounding conductor. The grounding conductor must be connected firmly with a bolt. Welding connection is permitted at the part where connection with a bolt is unsuitable.

Article 241. Use of steel conduits

This article stipulates that grounding system is composed by connecting metal ducts for wiring. In other words, this article stipulates the requirements in the case that metal ducts for wiring are used as a common grounding electrode in grounding system. The requirements are same as these stipulated in Article 235. In order to satisfy the required ground resistance, the metal ducts must have sufficient conductivity. Moreover, ducts and grounding conductor must be connected firmly to reduce touch resistance sufficiently.

Article 242. Lighting grouped grids

In spite of stipulation in Article 238, the metal or the lead sheath of a cable which is used for the circuit for lightings shall not be utilized as a neutral conductor. Moreover, when this sheath needs to be grounded, it shall be grounded firmly at two or more grounding points throughout the full length of the cable.

Article 243. Supplying or distribution cubicles

This article stipulates that a metal enclosure of switching/distribution board can be connected to metal pipes or metal sheaths of cables to form one grounding system. In this case, the specification on the kind and thickness of a grounding conductor must satisfy the requirements on ground resistance and tensile strength. In addition to this, a metal enclosure of switching/distribution board shall be connected to metal pipes or metal sheath of cables firmly with bolt or by welding in order to prevent slack of a connection point.

Article 244. Joint of earthwires with metal covers

A metal enclosures or iron pedestals of electrical equipment, a cubicle and a switchboard shall be connected to grounding conductors firmly so that breakage or disconnection of grounding conductors. In addition to this, before connection, the connection surface shall be cleaned up so that the imperfect contact between a metal enclosure or metal pedestal and grounding conductor, or insertion of foreign body into connection surface does not occur and increase of touch resistance or overheat at connection surface is not caused. The specifications on the kind, the cross-sectional area and the mechanical strength of the grounding conductor must satisfy what is provided in the design criteria.

1. grounding conductor shall let earth fault current flow safely.
2. grounding conductor shall be the metal wire which is difficult to corrode with its tensile strength of 1.04kN and more or the annealed copper wire of which diameter is diameter 2.6mm and more.

Section 6 METHODS OF PAINTING AND MARKING

Article 245. Protection of grounding wire

When a grounding conductor is laid at the place where a person can touch it easily, it shall be laid as follows. But these requirements are not applied to a power receiving electricity room and an electric room.

1. An electrical insulated wire, a cabtyre cable or a cable shall be used between grounding electrode and 60 cm above ground.
2. As for a grounding conductor between 25cm below ground and 2m above ground, it shall be covered with a synthetic resin conduit pipe with its thickness of 2mm and more, or the material which has equivalent insulation and mechanical strength to this conduit pipe.
3. When a grounding conductor is laid along a metal object such as a metal pole, a grounding electrode shall be buried apart from the metal object by 1m. However, if the grounding electrode

is buried in depth of 30cm and more from the bottom of the metal object, this requirement is not applied.

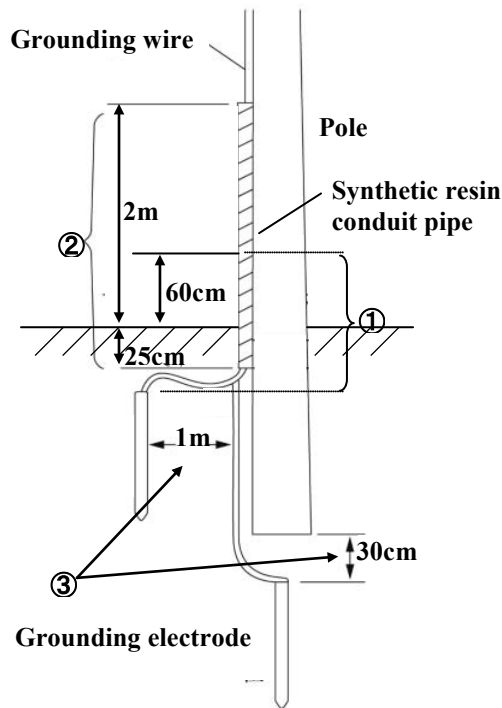


Figure 245 Installation of grounding conductor

Article 246. Painting of earthing system

A grounding conductor shall be marked by black color in order to enable to distinguish a grounding conductor from main conductors easily. But this requirement is not applied in the following cases.

1. Only a grounding conductor is laid alone, and accordingly, the grounding conductor can be distinguished easily
2. One core of a multi-core cable, a multi-core cable or a multi-core code which is used as a grounding conductor is a naked wire or is painted by black color.

In case that an electrical insulated wire painted by other than black color is used for a grounding conductor, this wire shall be marked by black tape at every suitable distance including its terminals.

Article 247. Use the bare earthed wires

A bare grounding conductor shall be painted two times and more with an undercoat and a finishing coat respectively.

After cleaning up the parts to be painted and confirming that there are no objects such as dusts, foreign bodies, etc on the surface, an undercoat shall be carried out immediately.

The finishing coat shall be carried out after confirming that an undercoat is dried completely when 24 hours has passed after completion of an undercoat.

When painting the parts near the devices which are prohibited from being painted, such devices shall be protected from being painted by appropriate measures.

Article 248. Places Joints with mobile earthwires

The grounded parts must be pointed out clearly. In addition to this, the sign for grounded parts shall be in accordance with the standard, IEC 60617.

Article 249. Earthing devices and underground earthing

In principle, a grounding conductor shall be buried at the time of foundation concrete placing at the location designated in advance, and shall not be laid on a cable rack or duct. As for the sign for the grounding conductor laid underground, it shall point out where a grounding electrode is buried and where a grounding plate is buried in order to make these matters clarified.

Chapter 6 METHOD OF LAYING WIRES AND CABLES

Article 250. Scope of application

As stipulated in Technical Regulation.

Section 1 GENERAL

Article 251. Wires stipulated by the design materials

The following is used for electric insulated wire.

- "OW electric wire": Exterior vinyl insulation electric wire
- "DV electric wire": Vinyl insulation electric wire for lead-in
- "IV electric wire": 600V vinyl insulation electric wire
- "VFF" (Vinyl insulated Vinyl sheathed Flat-type cable)
- 600V polyethylene insulation electric wire

(When the insulator is cross-link polyethylene construction, it is called "600V Bridge polyethylene construction insulation electric wire.")

- "RB electric wire": 600V rubber insulation electric wire

(Note) Do not use a polyethylene insulation electric wire except the incombustibility, polyethylene armored cable, etc. for the indoor wiring that the exterior of electric wire or cable is exposed.) a fire-resistant cable is used. (

Article 252. Insulation of cable joints

It should be considered to avoid the temperature rise of the cable insulation joints and thermal insulation with other parts of the cables. When the power current would rise to the allowable current in the connected part, the temperature of the conductor would rise to the maximum value. It is carefully managed according to the type of electric wire.

- 1) Both naked electric wires
 - a. Do not decrease the strength (tensile strength) of the electric wire more than 20%
 - b. To the connection part, the sleeve, a kind of the electric wire connector, is used to connect or braze.
- 2) When connecting point either electric insulated wires or an electric insulated wire, a code and a sheath cable, or a cable, it is applied in 1) that there are an insulator of the electric insulated wire of the part that is equal cover sufficient.

Article 253. Use of terminal and distribution boxes

- Installation of a pull box and a joint box

Do not conceal the box in building materials. It is needed to check the inside of a box.

The box should have the sufficient space to exchange or connect electric wires.

- It should have the proper measurements unless the moisture might not invade in the box, pull box and joint box.
- Connection and support between pipes, a pipe, and the accessories shall be strong to assemble material and others (metal pipe wiring adds "electrically connecting completely").

The distance between the supporting points shall be 1.5 m or less, when the pipe is supported with a saddle, etc. and establishing the supporting point in the point near each of the connection point and also pipe mutual connection point between the pipe edge, pipe and box.

(Note) A nearby part is about 0.3m.

(Note) The distance between supporting points shall be 1 m or less.

- The plug depth is more than 1.2 times (it is 0.8 time when using adhesives) of the outside diameter of the pipe, and connecting strongly by plug connection.
- When pipe is pulled into the box or pull box, the equipment shall be provided to prevent water from invading in the box or the pull box.

Article 254. Protection of wires at the output of boxes, conduits

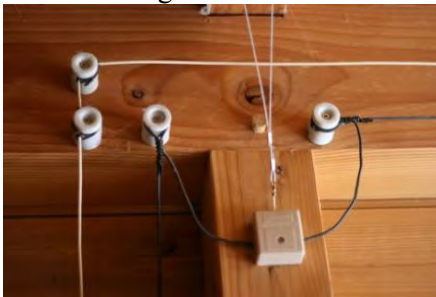
For indoor/outdoor wiring, the method of wiring depends on the wiring place. The following table is an example of this item.

Table 254 Facilities place and wiring method (300V or less)

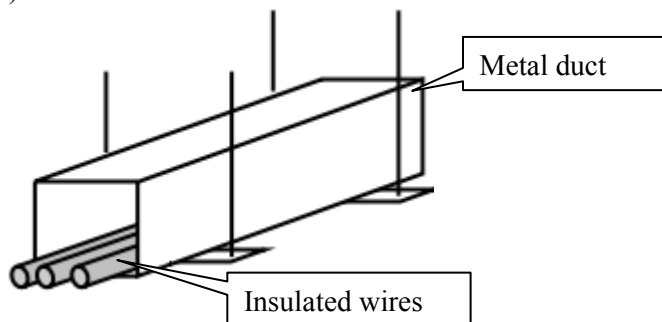
Wiring method	Indoor						Outdoor
	Exposure place		Blind place				
			It is possible to check.		It is impossible to check.		
	Dry place	Humid place or place with water	Dry place	Humid place or place with water	Dry place	Humid place or place with water	
(1) Insulator wiring	x	x	x	x	o	o	x
(2) Metal duct wiring	x	o	x	o	o	o	o
(3) Bus duct wiring	x	x	x	o	o	o	x
(4) Metal/Plastics conduit wiring	x	x	x	x	x	x	x
(5) Metal/Plastics raceways wiring	x	o	x	o	o	o	o
(6) Cellular duct wiring	o	o	x	o	x	o	o
(7) Floor duct wiring	o	o	o	o	x	o	o

Note x: Possible, o: Impossible

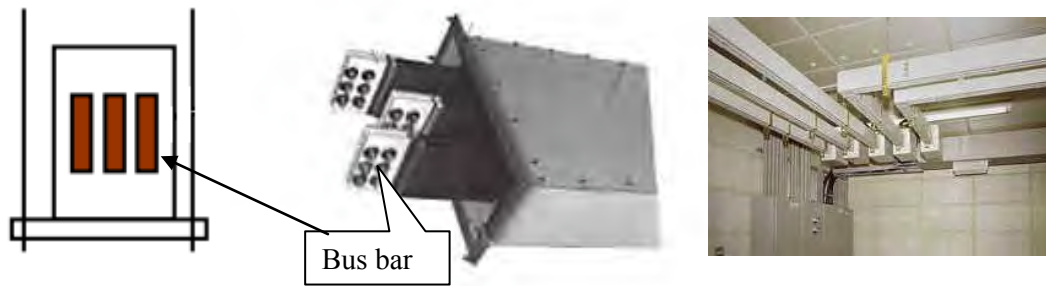
(1) Insulator wiring



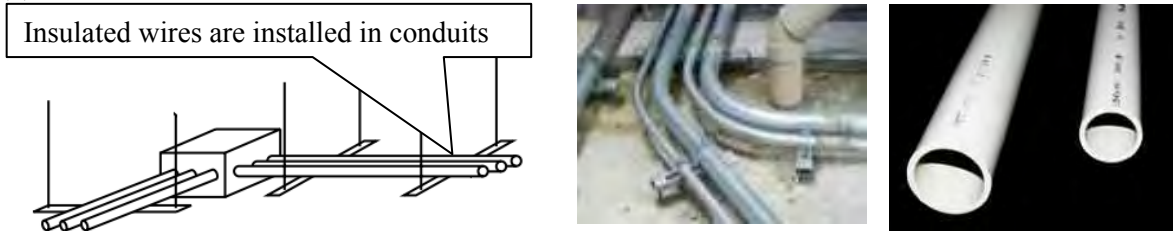
(2) Metal duct work



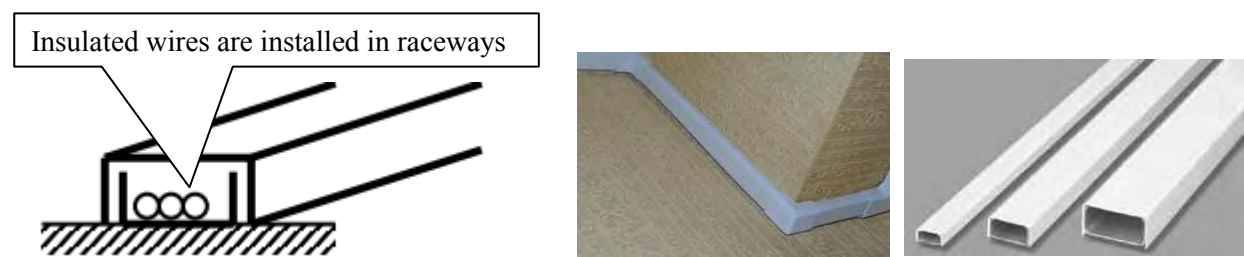
(3) Bus duct work



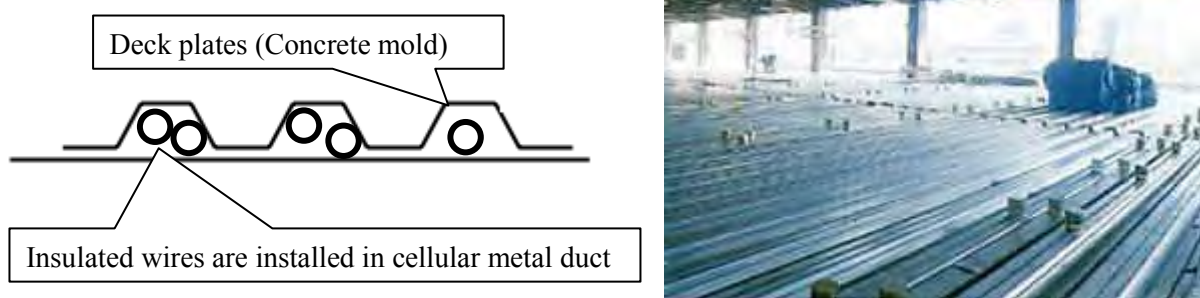
(4) Metal/Plastics conduit work



(5) Metal/Plastics raceways work



(6) Cellular duct work



(7) Floor duct work



Figure 254 Example of wiring work

Article 255. Height of installation wires

As stipulated in Technical Regulation

Article 256. Wires in high temperature place

The wiring in low pressure place, house inside and outside shall be above 15cm far from the heat emission device such as chimney and a heating pipe. However, it is acceptable when providing suitable protection equipment using heat-resistant materials between each other, such as glass fibers.

Article 257. Terminal boxes set up vertically or upside down

Allow opening wire has a length of less than 60cm (the tube comes out of plastic or metal wiring connected directly to the electrical equipment) and to ensure safe conditions for not only public but also equipment itself.

Article 258. Wires laid openly

As stipulated in Technical Regulation.

Article 259. Wires in wet rooms

Insulator pulling wiring (possibility inspection place), metal conduit wiring, plastic pipe wiring, and metal flexible conduit piping are performed to prevent water from penetrating inside.

Article 260. Wires on flammable structures

As stipulated in Technical Regulation.

Article 261. Clamps used for fixing wires

If the pipe is made of metal, it will be supported strongly.

(Note) For the support point space, it is desirable to be 2m or less.

When plastic pipe is supported with the saddle, the distance between the support points is designated as below 1.5m, and the support points is established in the respective nearby place of the connection points of a pipe ends, a pipe and the box.

(Note 1) A nearby part is about 0.3m.

(Note 2) in case of the plastic flexible pipe, it is good to designate the distance between the support points as below 1m.

Article 262. Insulating cushions

As stipulated in Technical Regulation.

Article 263. Fixing wires and structures

Staples shall be used when installing flat polyvinyl wires or insulated polyvinyl sheathed cables (VVF)

Article 264. Use of metal clamps

Metal pipes, their accessories, and that parts may be stained or corroded and they shall be protected by antirust paint.

They are also strong products made of brass or copper. The thickness of pipe and thing that is imbedded to concrete is above 1.2mm or above 1mm.

Article 265. Standby section

As stipulated in Technical Regulation.

Article 266. Terminal boxes of underground wires

As stipulated in Technical Regulation.

Article 267. Prefabricated building components

As stipulated in Technical Regulation

Section 2 LAYING WIRES ON INSULATING STANDS (PULLEYS, INSULATORS)**Article 268. Position of laying wire**

As stipulated in Technical Regulation –Volume 1

Article 269. Insulating bases, etc.

As stipulated in Technical Regulation.

Article 270. Insulated 1-unit wires

As stipulated in Technical Regulation.

Article 271. Placing on insulators

As stipulated in Technical Regulation.

Article 272. Fixing wires in some position

As stipulated in Technical Regulation.

Article 273. Intersection of wires with pipelines

They should be installed not to be in contact each other. (this rule applies to pipes such as water pipes, gas pipes, etc.)

Fire resistant insulated pipes should be used when the circumstance temperature rises above the standard temperature. The appropriate measures in Article 293 should be conducted for insulated pipes.

Article 274. Wires passing through wall

When a wire penetrates through building materials, install it inside a pipe of which edges are out of the building materials by 3 cm or more. The edge which has more moisture should be placed downward to drop water.

Article 275. Wires passing through different floors

As stipulated in Technical Regulation.

Article 276. Wires laid through between two floors

Regarding floor duct wires between two floors,

1. Ducts, boxes and leads should be connected firmly and electronically.
2. Ducts, boxes and other accessories should be installed in the way which does not accumulate the rain water.
3. Ducts, boxes and leads should be installed not to stick out from the floor and not to accumulate the rain water.

Article 277. 2 or 3-core wires

As stipulated in Technical Regulation.

Article 278. Curving radius of wires

As stipulated in Technical Regulation.

Section 3 SUSPENDED WIRES

Article 279. Hanging Special wires and cables

The special-purpose wire cables and other wires are installed hanging on bearing steel cable by private clamping or by wrapping methods with appropriate force.

Article 280. Hanging cable

When suspending cables, it is required to strain the cables with minimum sags and corresponding forces must not exceed 0.7 times allowable forces of these cables.

Coupling boxes of socket types and lights must be suspended vertically in places of tap boxes. Vertical lines should use steel wires with the diameters of 2-3mm for power lines and from 1.5 to 2mm for lighting lines. All metal parts of suspended lines, including enforced cables, must be earthed.

In normal production rooms, it is possible to use cables for neuter lines belonging to grouped grids of systems with earthed neuter lines.

Using reinforced cables to be earth wires is prohibited. It is essential to use a dedicated wire or a dedicated core of wires (or cables) to be the earth wire. All metal parts of suspended wires shall be as follows:

1. Open parts of steel cables, the metal parts of slings including both cable wiring must be grounded.
2. Parts of tightening locks, ending tightening structures, clamps, etc must be coated by silicon oils.

Section 4 LAYING PROTECTIVE CABLES AND RUBBER-INSULATED CABLES

Article 281. Distance between protective wires and cables

When supporting cables, applicable saddles or staples should be used to anchor cables firmly without damaging them.

Article 282. Wires passing into terminal boxes or cable funnels

As stipulated in Technical Regulation.

Article 283. Horizontally laid wires

As stipulated in Technical Regulation.

Article 284. Bending radius of wires

When bending the cable, no damage to the coating and the radius of curvature to the following table if the manufacturer does not provide:

Table 284 Permissible bending radius of cable

Type of cable	Fixed time	Laying time
Cable without shield	Cable outside diameter × 4 times or more	Cable outside diameter × 10 times or more
Cable with braided shield	Cable outside diameter × 4 times or more	Cable outside diameter × 10 times or more
Braided coaxial cable	Cable outside diameter × 4 times or more	Cable outside diameter × 10 times or more
LAP sheath cable	Cable outside diameter × 6 times or more	Cable outside diameter × 15 times or more

Article 285. Cables and wires laid through wall

(In the case of installing piping on a surface of a wall plaster metal lath)

When insulated wires penetrate through building materials, synthetic resin conduits should be used, and they should be anchored firmly.

Article 286. Wires passing through floors and ceiling

Insulated wire is used for the floor duct electric wire.

Stranded wire with diameter bigger than 3.2mm (4.0mm for aluminum) is required.

The connection of the electric wire shall be in a junction box.

The floor duct, the box, and other accessories are made of metal plate not less than 2mm thickness, and coated by galvanizing or enamel, etc.

Minimum thickness of floor duct in the following table:

Table 286 Plate thickness of floor duct

The maximum width of floor duct (mm)	Plate thickness (mm)
150 or less	1.2 or more
More than 150 but less than 200	1.4 or more
200 or more	1.6 or more

Article 287. Intersection of cables and wires

As stipulated in Technical Regulation.

Article 288. Joints of metal pipes

Coupling is a coupler to joint each metal pipe which has screw cutter inside the metal.

Article 289. Prevent insulators from damages

As stipulated in Technical Regulation.

Article 290. Avoid aging insulation

As stipulated in Technical Regulation.

Article 291. Use of quick-dry paint

As stipulated in Technical Regulation.

Article 292. Coupling and branching of wires

Wire should not be tensed at the branching point.

Article 293. Earthing of metal covers of cables

The metal part of the protective device to put pipe and other cables in that has the voltage less than 300V is based on the article 568 and 572 of Vol.1.

Section 5 OPEN AND UNDERGROUND LAYOUT OF CONDUCTOR

Article 294. Requirements of Laying of flat wires indoor

A copper wire which is coated with vinyl chloride resin mixture (IV wire)

IV wire should not be installed above a ceiling without supporting, because it is not protected by sheath. IV wire should be installed inside pipes or ducts, or with insulation works. Installing places and the current value should be considered to keep the temperature of conductor below 60 deg C which is the maximum temperature allowance.

Wiring work using VVF cables is common for general internal wiring, and using only IV wire is not common except for the use of earth because the temperature of a conductor should be kept below 60 deg C.

Article 295. Laying openly wires

As stipulated in Technical Regulation.

Article 296. Lying wires under walls

As stipulated in Technical Regulation.

Article 297. Underground layout of wires on ceilings

As stipulated in Technical Regulation.

Article 298. Wires insulated by plastics

As stipulated in Technical Regulation.

Article 299. Laying wires underground

As stipulated in Technical Regulation.

Article 300. Laying wires over-cross with solid fuel or gas pipelines

As stipulated in Technical Regulation –Volume 1.

Article 301. Intersection of flat wires

Refer to article 300

Article 302. Use of 3-core wires

VVF (Vinyl insulated Vinyl sheathed Flat-type cable) is the simple structured wire that is covered by vinyl sheaths, and that is used commonly as a low voltage line inside the house.

VVF is used as power supply cables for lights and outlet that capacity is up to 15A.

Article 303. Bending of wires

As stipulated in Technical Regulation.

Article 304. Flat wires passing through partitions and floors

Stranded insulated wires of 3.2mm or more in diameter (4.0mm in case of aluminum) are appropriate for floor duct wiring. The connections should be completed in a junction box.

Article 305. Underground wires coming out from wall, floor

Floor ducts, boxes and other accessories should be made by steel plates more than 2mm in thickness with zinc plating.

Article 306. Joints and taps of flat wires

As stipulated in Technical Regulation.

Article 307. Prohibition of suspension of light on flat wires

As stipulated in Technical Regulation.

Article 308. Metal boxes near wires

Metal tubes and other accessories should be earthed properly. (Refer to article 293)

Article 309. Connecting wires to sockets, switches, etc

A wire and a switch shall be connected each other after removing the outer insulation materials. When a core wire and a terminal are connected each other, make sure the length of exposed core wire from the terminal is appropriate.

Article 310. Fixing flat wires laid open

As stipulated in Technical Regulation.

Article 311. Underground wires in wall

Wiring should not be installed on a soft material but on a hard ceiling or a wall such as a plaster board, wood, plywood and concrete.

Article 312. Prohibition of use of nails

As stipulated in Technical Regulation.

Article 313. Storage of wires

As stipulated in Technical Regulation.

Section 6 UNDERGROUND WIRES IN NON-METAL SLEEVES**Article 314. Prohibition of pipelines intersecting gas pipes, etc.**

Refer to Article 300

Article 315. Selecting the Pipelines on walls

Refer to Article 279

Article 316. Line's sections roundabout obstacles

As stipulated in Technical Regulation.

Article 317. Wire sleeves installed on walls

Refer to Article 311

Article 318. Wires under floors of hot factories

The lighting equipment, wiring accessories, and other equipment that are installed indoor should be used heat resistant materials, and it is considered that there is not the structure of exposure metal part in the position that people cannot touch easily such as exterior covering, stand, etc.

Article 319. Temperature of environment

As stipulated in Technical Regulation.

Article 320. Use soft pipes under floors

As stipulated in Technical Regulation.

Article 321. Use soft pipes cross the road transport

As stipulated in Technical Regulation.

Article 322. Protection of soft pipes coming out from base, wall, floor

As stipulated in Technical Regulation.

Article 323. Jointing of insulating pipes

As stipulated in Technical Regulation.

Article 324. Coupling of sections of soft pipes

As stipulated in Technical Regulation.

Article 325. Use of steel pipes soft pipes

As stipulated in Technical Regulation.

Article 326. Joints between metal and hard pipes

Underground cables should be connected inside a manhole or hand hole, and as considering the convenience of the maintenance and operation, the location of the connection is recommended as follows,

1. The proper span between manholes should be 200m considering cable works and replacement works. (The maximum span is 300m)
2. The proper location of manholes should be selected by considering the system operation and easiness of maintenance. The intersection of roads, exits and entrances of parking are not appropriate.
3. The direction of installation of branch type manholes should be decided by considering the easiness of cable works.

Article 327. Coupling and tap boxes in non-metal pipes and hard pipes

As stipulated in Technical Regulation.

Article 328. The Different conduits

As stipulated in Technical Regulation.

Article 329. Diameters of insulating pipes

Regarding underground electric power lines, the proper size of the pipe and cables are as follows,

Thickness of protection pipe (Inside diameter) \geq outside diameter of cable + 30mm.

Article 330. Distance between boxes

As stipulated in Technical Regulation.

Article 331. Distance between boxes of hard pipes

As stipulated in Technical Regulation.

Article 332. In long sections of pipes

(In a case of underground electric power line) It is preferable the conduit should be straight as much as possible, but if the bending is unavoidable, it is considered as the largest possible bending radius, and the minimum bending radius corresponds to the each type of pipe.

Article 333. Bending radius of non-metallic pipes

As stipulated in Technical Regulation.

Article 334. Non-metallic pipe bending

Curved pipelines should be constructed as follows;

1. Bend radius of pipes should be more than 5m unless it is an unavoidable situation
2. Straight pipes should be combined for the curve pipe of which bend radius is more than 30m.
3. A flexible pipe is used if it needs to detour around the other buried object.

Article 335. Protection of bends of soft non-metallic pipes

As stipulated in Technical Regulation.

Article 336. Insulating pipes with wires passing through wall and floor

As stipulated in Technical Regulation.

Article 337. Stuffing sleeves and insulating funnels when jointing pipes with boxes, cubicles, boards for pipe terminals

As stipulated in Technical Regulation.

Article 338. Terminals of Insulating pipes

As stipulated in Technical Regulation.

Section 7 LAYING UNDERGROUND WIRES IN GLASS PIPES

Article 339. Requirement of Glass pipes

As stipulated in Technical Regulation.

Article 340. Wires laid underground in glass pipes

As stipulated in Technical Regulation.

Article 341. Laying wires in area without vibration

As stipulated in Technical Regulation.

Article 342. Prohibition of laying wires

As stipulated in Technical Regulation.

Article 343. Conductors in the same pipes

As stipulated in Technical Regulation.

Article 344. Pipes laid on floors or on the wall

As stipulated in Technical Regulation.

Article 345. Glass pipes installed in brick wall and concrete-cinder-plaster partition

As stipulated in Technical Regulation.

Article 346. Pipes laid parallel

As stipulated in Technical Regulation.

Article 347. Prohibition of laying glass pipes

As stipulated in Technical Regulation.

Article 348. Conduits for main lines

As stipulated in Technical Regulation.

Article 349. Direction of pipe being changed

As stipulated in Technical Regulation.

Article 350. Joints of glass pipes

As stipulated in Technical Regulation.

Article 351. Terminal of glass pipes must have stuffing sleeves

As stipulated in Technical Regulation.

Article 352. Mounting lights

As stipulated in Technical Regulation.

Article 353. Intersecting with elastic gaps

As stipulated in Technical Regulation.

Section 8 OPEN AND UNDERGROUND LAYOUT OF CONDUCTOR IN STEEL PIPES WITH THIN WALL

Article 354. General

As stipulated in Technical Regulation.

Article 355. Bending radius

As stipulated in Technical Regulation.

Article 356. Fixed distances of pipes

Cables should be protected by a pipe for 2.5m from the ground and 0.2m underground, and the pipe should be earthed properly.

The edge of a pipe should be covered to avoid the rain water.

Article 357. Fixing exposed steel pipes

As stipulated in Technical Regulation.

Article 358. Distances between tightening boxes

As stipulated in Technical Regulation.

Article 359. Pipes laid on base of technological equipment

Regarding pipe works, fine sand is used for 20cm above the pipe to prevent damage to the pile. The pipes should be protected at the location which is subject to get shock such as the pipe terminal in a manhole or under soft ground.

Article 360. Pipes intersecting with elastic gaps

As stipulated in Technical Regulation.

Article 361. Jointing pipes in dry rooms

In a case of metal pipe wiring

- a. Wear, decaying, and other damages can be created easily at box, pull box, and other accessories, and in order to preventing dust from entering the inside, gaskets are installed.
- b. The connections between pipes, pipe with boxes or other accessories or pull boxes or equipment or electric tools using liquefied gaskets or parallel screw using for pipe line, etc. are used for the screw with the parallel pipe thread, after connecting the screw of 5 mountains or

more the method of connecting together or with the method of having the effect above equality to this in the significant part of the screw, doing, the dust that tries does not invade the electric wire inside of pipe section e.g., the paint or the black stickiness polyethylene insulating tape etc whose durability and adhesiveness are satisfactory are administered.

- c. The wiring of the part which needs flexibility in the small and short part linked to electric motor shall use flexible switch and dust-proof structure.

Article 362. The requirements of Couplings

As stipulated in Technical Regulation.

Article 363. Jointing underground pipes

Regarding the connection of underground pipes, the countermeasures for avoiding inflowing concrete, sand and water to the pipe should be taken, and make sure not to damage the pipes and clean them when they are connected each other.

Article 364. Sleeves of steel pipe

As stipulated in Technical Regulation.

Article 365. Working for terminal pipes

As stipulated in Technical Regulation.

Article 366. Installation of Stuffing pipes

As stipulated in Technical Regulation.

Article 367. Proper installation

The appropriate size of a manhole should be decided by considering the cable maintenance such as installation, removing and connection.

Refer to article 326.

Article 368. In wet places

Refer to Article 361

Article 369. Fixing steel pipes

Refer to article 356.

Article 370. Wires in steel pipes

As stipulated in Technical Regulation.

Article 371. Use of steel pipes

As stipulated in Technical Regulation.

Article 372. Thin steel pipes

As stipulated in Technical Regulation.

Article 373. Joints

As stipulated in Technical Regulation.

Article 374. Earthing steel pipes

Refer to Article 293

Section 9 WIRES BARE AND COVERED WITH THE VOLTAGE LESS THAN 1kV

Article 375. Permanent joints of wires

The connection between the aluminum and the copper conductor should be considered the electrolytic corrosion point.

One of the measures is to apply galvanic proof compound and sleeve.

Article 376. Requirements of Gap between bare conductors and pipes

As stipulated in Technical Regulation.

Article 377. Conductors placed in the factories

Wires should be installed in the way which does not damage the wire depending on the site situation.

1. Install wires away from the doorway
2. Cover wires with waterproof and anti-moisture materials if necessary
3. Make sure not to damage wires by screws in the connection box
4. Install an insulation wire on a pad to prevent the damage

Article 378. Arrangement of Instruments

Regarding switch gears of low voltage equipment, a switch such as magnetic switch or knife switch with a cover should be installed at easily reachable place for operators.

The switch should be operated by handle, knob or button which can be manipulated from the outside, and it needs to have the enough capacity to satisfy the maximum load current.

Article 379. Covered conductors

As stipulated in Technical Regulation.

Section 10 TERMINALS MARKING AND JOINTING WITH INSULATORS AND CABLES

Article 380. General

1. Indoor joint box

It is used for cable/wire connections and branch. The purpose of installing this is to protect connectors such as pressure sleeves.

2. Solderless pressed terminal, pressed sleeve, and terminal connector

It is connected by changing its shape being pressured by a connector tool without soldering.

3. Screw connector

The wire connector which has a screw inside the cap, and it is connected by screwing the terminal of a conductor.

4. Bolt connector

Mainly used outside, and consists of a U shape body and nuts.

Article 381. Joints and taps

As stipulated in Technical Regulation.

Article 382. Terminals and sleeves

Refer to article 380

Article 383. Terminal wing holes

As stipulated in Technical Regulation.

Article 384. Pressing terminals in the wet environment

As stipulated in Technical Regulation.

Article 385. Terminals

As stipulated in Technical Regulation.

Article 386. Pressing terminal of cable

As stipulated in Technical Regulation.

Article 387. Coupling aluminum wires of steel core

Regarding wire connection by pressing, it should be conducted as follows,

- 1) The tension strength of the wire should not be weakening more than 20% and electric resistance should not be increased after the connection.
- 2) Tape insulation vinyl or sleeve cover should not be exposed to the bare part of a conductor.
- 3) The terminal part should be filed off to adjust the extra parts. If the terminal of a strand wire was loosened, the part should be cut off.

- 4) Polish conductors with a brush completely before connection. Separate the brushes for aluminum and that for copper.
- 5) Compressor tools should be tested periodically, and the one which can keep the proper pressure should be used.
- 6) Dies of the compressor should be checked periodically, and the one shaved by friction should be replaced.

Article 388. Welding of aluminum wires of steel cores

As stipulated in Technical Regulation.

Article 389. Contacts to instruments

As stipulated in Technical Regulation.

Article 390. Making terminals in explosive rooms

Electric power facilities should not be installed in a powder magazine unless there are measures against ignition

Article 391. Restriction for Laying of line

As stipulated in Technical Regulation.

Article 392. Coupling copper wires

As stipulated in Technical Regulation.

Article 393. Coupling multi-unit copper wires

As stipulated in Technical Regulation.

Article 394. Making the terminal with multi-unit copper wires

Refer to article 387

Section 11 LAYING WIRES IN INFLAMMABLE AND EXPLOSIVE ROOMS

Article 395. General

As stipulated in Technical Regulation.

Article 396. Conductors in explosive rooms

Refer to article 361

Article 397. Coupling and tap boxes in inflammable house

Refer to article 361

Article 398. Earthing

As stipulated in Technical Regulation.

Article 399. Wires laid underground

As stipulated in Technical Regulation.

Section 12 PAINTING AND MARKING

Article 400. Rust protection

As stipulated in Technical Regulation.

Article 401. Exposed conductive parts

Refer to article 361

Article 402. Marking

As stipulated in Technical Regulation.

Article 403. Marking wires and cables

As stipulated in Technical Regulation.

Chapter 7 UNDERGROUND CABLE LINES

Article 404. Scope of application

When the underground transmission cable line of 220kV or less and the control cable are constructed, it shall be necessary to follow this chapter. It is necessary to follow not only this chapter but also related laws in other underground facilities such as subway, tunnel, and water and sewerage system. Therefore, the underground facilities within the range of the cable construction work should be investigated on the desk when the construction is planned, and be understood accurately.

Section 1 GENERAL

Article 405. Requirement of cable

The constructor should follow demands in specification, and if those demands are changed, it is necessary to confer on the change plan with the purchaser and to agree it between both sides. The cable type, the nominal cross sectional area, the number of cable's cores, the cable line route and the installation method should be confirmed carefully, and not be changed without any authorization because they are especially important.

Article 406. Inspection before installing

It is necessary to confirm by visual check that there is no damage to the cable during the transport before the construction works because the cable winding on the roller is heavy and the handling of it is very difficult.

When the damage of the cable is found, the cable construction work should be discontinued, and the cause why the damage was occurred should be confirmed among the manufacture, the transporter and the constructor.

Article 407. Cable cover

It is necessary to check the protective covering outer sheath of the cable strictly. The sheath should be confirmed certainly that there is no crack, scratch, hollow and size difference. When the above-mentioned trouble is detected, the correction treatment against the trouble should be carried out to satisfy the cable specification.

Article 408. Cable installation

The cable should be laid by the snaking installation so that it is avoided to be damaged due to the expansion and contraction by temperature change of the cable.

1. The cable should be laid at the part that can move freely to ease the stress and the part fixed to control the range of movement according to the expanding and contracting situation. However, a fixed point should be selected from the following.
 - The terminal and the connection point : the position should be selected which can prevent damage to the cable terminal box and connection box due to the movement of the cable. The distance from the cable terminal box or connection box to the position is about less than 0.5 m as a rough standard.
 - The bending point : the position should be selected which can be fixed easily according to the direction of the power cable line or the structure of the cable racks, etc..
2. When the cable is installed at the location with large vertical interval (wall, etc.), the cable should be installed by using a big fixing bracket and soft material is used to reduce the pressure, and the fixed location should be selected to bear responsibility by distributing the cable self-weight.
3. The mistake of the fixed direction, the defect of the specification or the lack of the number of fixing brackets may cause the cable damage after the long term. Therefore, the situation of fixed cable should be confirmed surely after construction works, if it is wrong, it should be corrected appropriately.
4. The cable should have the defense measures against the damage at the hanging part due to its self-weight or the scratch by friction with the floor and the wall. In addition, when the cable may be damaged by the contact with another things after the installation, the defense measures should be conducted.
5. It is preferable to install the waterproof gasket in the space of the hole of cable block and to prevent the underground water to the cable room. The gasket should be easily detached and installed, and should not accrete to the protective covering outer sheath.

Article 409. Cable fixing

Refer to Article 408 in this Guideline.

Article 410. Uncovered cable

The method of avoiding the thermal radiation to the cable should be selected in the following.

- The cable is covered with the heat insulator etc.
- The cable is installed in the pipe to shut out the sunlight.
- The cable is kept at enough distance from the heat source such as the heat pipeline. (The offset distance should be accordance with Chapter3-2-4 in Technical RegulationVol.1.)

Article 411. Bending radius

The bending radius should be accordance with Article 22 in Technical RegulationVol.5.

The cable should be handled with more than permissible bending radius even for the temporary bending in the construction work.

The permissible bending radius should be confirmed before its work is started because there are differences in each cable type, nominal cross sectional area of the cable and manufacturer.

Article 412. Pressure of Oil-filled cable

Oil supply systems should comply with the provisions of the manufacturer.

Article 413. Cable head box, connection box, and distribution box

In case that single phase load is connected between power cables and neutral cable in three phase four wire system, large current may flow in the neutral cable. Therefore, the connection and insulation of the neutral cable should be in accordance with particular regulations.

Article 414. Cable trench

A position, fixed situation, state of joint and internal cleaning situations of the cable canal should be checked before the cable is installed. When the cable canal is adjusted after the cable is installed, it may take long time or damage the cable because the cable need to be removed out of the canal. Therefore, it is preferable to check it beforehand so that it is not adjusted after the cable is installed.

The cable block for inserting cables should be applied to the requirements of Chapter 3-2-4.in Technical RegulationVol.1.

Article 415. Cable cellars and wells

1. Attached structure

(1) Door

It should be installed according to Article 220 in Technical RegulationVol.1

(2) Cable support structure

The cable rack should be arranged in consideration of the installation of the connection box and fixed firmly with the antirust bolt.

The hook for pulling the cable should be arranged in the wall surface and the floor surface which align in cable pulling entrance direction, and the concrete where the hook is fixed should be reinforced with metal parts and the rebar in order to withstand pulling entrance stress.

(3) Ladder (Refer to Article 225 in Technical Regulation Vol.1)

The ladder should be produced with the antirust material or painted the antirust painting. In addition, the ladder should be fixed so that it do not slip and fall down.

(4) Net

The net should have strength that withstands the weight of garbage and mesh that stops garbage.

(5) Drain system (Refer to Article 221 in Technical Regulation Vol.1)

The pump should be set up in the terminal part of the drain inclination. In addition, its performance including the amount of the water leakage, the height to lift water, the capacity of water tank and the operating time should be considered.

(6) Ventilation equipment (Refer to Article 227 in Technical Regulation Vol.1)

The ventilation equipment should be set up at the position in which it does not obstruct the cable pulling entrance work and the cable arrangement work.

The ventilation hole should be set up in both ends of the cellar and necessary middle part.

(7) Electric equipment (Refer to Article 227 in Technical Regulation Vol.1)

Lighting equipment should be the vapor proof type, and enough number of lighting equipment according to the performance should be prepared to secure the brightness required for the work.

The outlet should be set up as the power supply for construction equipment.

The conductor to the outlet should secure the capacity which is more than that of the equipment used for the drain, the ventilation, the lighting and the construction.

2. Confirmation for succession

The following should be confirmed when succeeding.

(1) Constructed cable block

(2) Junction part of cable block and waterproof gasket

(3) Inside of cable block should be clean and dry, and the entrance edge of the cable block should be rounded not to be broadened at the construction work.

Section 2 CABLE INSTALLATION IN CABLE TRENCHES

Article 416. Directly installed cable

The caution tape of underground cable laid directly should be set up as follows.

- The buried position of the tape should extend to whole cable line and be about 50 cm over the cable and be about 50 cm outside both outer edge cables.
- The tape should be made of anti corrosion material such as a vinyl, and be striking colors to the color of the soil.
- The voltage, the name of the cable line and the management unit should be described on the caution tape at intervals of about 2 m.
- The steps needlework type of the caution tape should be used so that the tape is not cut when pulled by heavy civil machine.



Figure 416 Example of the caution tape

Article 417. Cable installation in chemical erosion soil

The vinyl and the polyethylene with the following characteristics are generally preferable as the material of the protective covering outer sheath to protect the cable from corrosion.

1. High insulation and a high dielectric strength are possessed and they do not decrease over a long time.
2. The waterproof, the oil-proof, chemical resistance and the flame resistance are possessed, and a chemical characteristic is stable over a long time.
3. Excellent weather resistance and resistance to aging are possessed.
4. Abnormality is not appeared in temperature of the outer sheath of the cable operated generally (About -10 deg C to 70 deg C).
5. Mechanically strong, excellent flexuous and abrasion resistance are possessed, and friction coefficient is not large.
6. The manufacturer can process easily.

Article 418. Compliance with cable installing route

In case that it is impossible to construct the cable line in designed route as other equipment of laying underground (pipeline and water service, etc.) exists or the owner of the construction land does not approve, the change in the route should be examined by conferring with the design unit.

Section 3 REQUIRED DIMENSIONS FOR INSTALLATION

Article 419. Depth of buried cable

Refer to Chapter 3-2-4 in Technical Regulation Vol.1.

Article 420. Parallel cables

Refer to Chapter 3-2-4 in Technical Regulation Vol.1.

Article 421. Clearance trees

When the cable is arranged through the forest or area where trees are planted, the distance from the cable to the root of a tree should be secured 2 m or more. If local concerned parties agree the arrangement and the cable is inserted in the protective pipe, the distance is permitted to be shortened. In the garden with small trees, the distance is permitted to be shortened up to 0.75m.

Article 422. Special cases

In case that the metal sheath of the cable may be corroded with the straying current from electric railways, a cable should be installed in the insulation cable block to prevent from corrosion. In addition, anti-corrosion by the protective covering outer sheath such as vinyl is also effective.

Article 423. Cable corridor

Refer to Chapter 3-2-4 in Technical Regulation Vol.1.

Article 424. Crossing each other

Refer to Chapter 3-2-4 in Technical Regulation Vol.1.

Article 425. Prohibition of installing cables in the same vertical plane

When the cable is laid directly on the top and bottom of other pipe such as gas pipe or heat pipe, the following fears may occur, so the cable should be inserted in the pipe to defend from them.

- The earth load concentrates on the cable.
- The adverse effect (heat, gas, and polluted material, etc.) that leaks from other pipe is received to the cable.
- When other pipe is constructed, the damage by the heavy civil machine for digging is received to the cable.

Section 4 CABLE INSTALLATION INSIDE CULVERT, CANAL AND PRODUCTION AREA

Article 426. General

Since the cable in the culvert or cable canal etc. is protected fundamentally, the additional cover should not be attached because it makes cable temperature rise. However, the additional cover should be used in consideration of a thermal influence when it is used to prevent the outer sheath from corrosion by the polluted material.

Article 427. Clearance between cable shelves

When the interval of the cable support part is short, the cable is rarely damaged by reducing the stress by the weight. When it is long, the snaking installation conducts easily and the change of the cable tension is decreased according to the expansion or contraction by heat.

The interval of the cable support part should be made as the design specification because of the above-mentioned reasons.

Article 428. Soft pad for cables

The cable without metal cover should be fixed by the soft pad to prevent the metal part of the support shelf to damaging the insulator.

- Condition of the soft pad

Soft pad does not make protective covering outer sheath changed by vicious chemical materials.

The rust of the metal part of the cable and the support shelf is not developed. (It does not become a damp or wet condition.)

Article 429. Cables go along the wall

When the cable with the lead-sheathed and the cable without the metal cover are installed along the concrete and the brick wall, the cable should be installed by making space between the cable and the wall to avoid the corrosion by rain water and the scratch by rubbing to the wall.

Article 430. Cables installation inside foundation

The cable should be put in the cable block or the cable canal to prevent it from being damaged because the danger of the fire or the electric shock may occur when the cable installed in the construction structure is broken.

Article 431. Cables on wooden floor

The offset distance from the cable to the surface of wooden floor should be secured 50mm or more because the danger such as a fire and the electric shock may occur. In addition, the cable in the wooden ceiling should be installed in a cable block or a nonflammable box.

Article 432. Cables go through wall

The conditions that the cable is permitted to be thrust through and be installed at wooden floor and wall are as the following.

- The distance of both sides of projection from the floor or the wall of cable block should be secured 50mm or more.
- The nonflammable material should be filled between the cable block and the cable. As exceptional case, it is permissible that the nonflammable material is not filled between the cable block and the cable when the distance of projection is 100mm or more and the distance from the cable to the wall is 50mm or more.

Article 433. Cable installation inside cable canal

It is preferable that the cable is arranged on the cable rack as much as possible to avoid the damage by the movement due to heat expansion and contraction, the corrosion due to underground water and water trees aging.

The rule of arrangement on a cable rack is as follows.

1. When there are cable racks in both sides of the cable tunnel or the cable canal, the control cable and the power cable with voltage up to 1 kV should be arranged on one side, and the other side should be secured for the power cable with voltage exceeding 1kV.
2. When there is a cable rack on one side of the trench, cable, control cables and power cable lines with voltage up to 1 kV should be arranged at the bottom but above power cable lines with voltage exceeding 1 kV on the same side.
3. The cables should be arranged on two different racks, which are operating or reserved cables used for the generator and transformer with voltage exceeding 1 kV and its for consumer class 1.

Article 434. Cables installed on the cable canal

Power cable lines installed on the cable canals should comply with requirement in article 7 in Guideline Vol.1.

Article 435. Prohibition of sand used as covering cables

The cables (Including the control cable) in the cable canal should not be covered with sand, since a lot of types of cables might be divided in the cable canal, and it is difficult to distinguish the cables.

However, it is allowed to cover with sand for the defense from the explosion.

Article 436. Requirement of installation cables

It is allowable to arrange the power cable with voltage up to 1 kV and the control cable as the way of Figure 438. However, the arrangement of the power cable with voltage exceeding 1kV and the offset distance between the power cable with voltage up to 1kV and the control cable should be in accordance with Article 434.

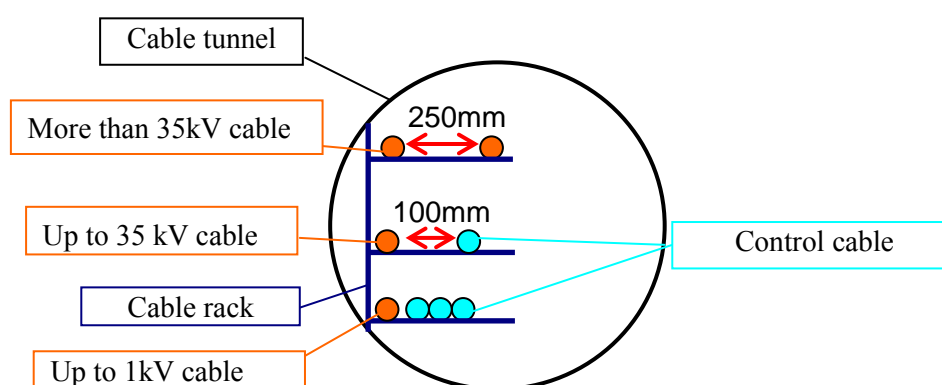


Figure 436 Example of Arrangement of power cable and control cable

Article 437. Cable installation structure

Each size of cable installation structures should be more than the numerical value in Article 434.

It is permitted to decrease the width of the passage on narrow ground to 0.6 m.

Section 5 CABLE INSTALLATION INSIDE BLOCK AND PIPE

Article 438. Progress inspection

The check contents below should be followed

1. Cable route

The cable route is the most important element related to the future management (at the house and the road in the surrounding, the offset distance with other buried objects and maintenance work in the future). Therefore, the center position and the length of the power cable line, the ground level and the row condition of the cable canal should be checked.

2. Depth of laying underground cable (amount of digging)

Depth of laying underground cable is an important element that influences the earth load by the weight of soil and vehicle going through the earth surface over the cable canal, and has implications to the strength of the cable canal. The depth of the hole to bury the cable canal should be checked surely, because the earth load by the weight of soil increases when the distance from the cable canal to the earth surface is too long, and the earth load by the weight of vehicle increases when the distance is too short.

3. Waterproof processing

It should be checked that the seam in the cable canal and the lid are tightly shut to prevent underground water from penetrating.

4. The distance from top surface of the cable canal to earth surface (the amount of backfill soil)

The distance from top surface of the cable canal to earth surface should be confirmed that it is appropriate, since the cable canal might be broken if the distance is inappropriate.

Article 439. Works for connecting points

The bump and the gap are generated easily at the joint point of the cable canal and the cable block. The joint point should be checked before pulling the cable, and be made smooth by joint adjustment and applying slipping powder, because the cable may be damaged due to the bump and the gap.

Article 440. Duct Cable size limitation

When the outside diameter of the cable is too large compared with the inside diameter of the cable block, the stress due to friction by the rigidity of the cable may be higher than the stress due to the cable's own weight at the curved part of the cable block. Therefore, the maximum outside diameter of cable which can be pulled into the cable block should satisfy the following formula.

(Outside diameter of cable) ÷ (Inside diameter of cable block) = (85 % or less)

Article 441. Cables installation in cables pipes

Refer to Chapter 3-2-4 in Technical Regulation Vol.1.

Article 442. Cable installation on cable pit

Refer to Article 433 in this Guideline.

Article 443. Inserting cable into block

The treatment of neutral conductor should be applied before installing the cable, because it may be difficult to handle the cable after installing in the cable block.

Article 444. Inspection before cable installation

The mandrill size of each cable block diameter (outside diameter and length) is as shown in the following table. However, the value of this table should be applied to the cable block of which bending radius is 10 m or more, and the outside diameter and the length of the test pipe for the cable block of which bending radius is less than 10m should be examined individually by below formula.

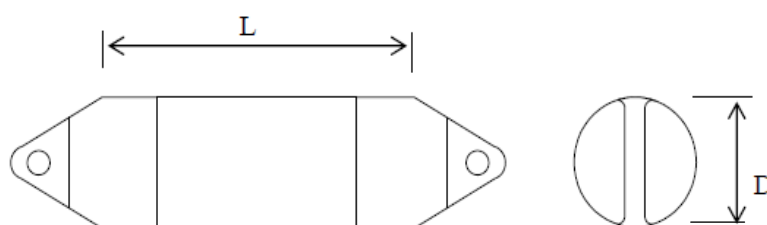


Figure 444 Test pipe

Table 444 Size of test pipe of each cable block diameter

Inside diameter of cable block : d (mm)	100	125	150	175	200
outside diameter of test pipe: D (mm)	90	115	140	165	190
length of test pipe: L (mm)	600	600	600	600	600

[Formula of the maximum length of test pipe]

$$L \leq 2 \times \sqrt{(R + d)^2 - (R + D)^2} \quad (\text{mm})$$

R : Bending radius of cable block (mm)

d : Inside diameter of cable block (mm)

D : Outside diameter of test pipe (mm)

Outside diameter of test pipe is generally 10mm less from inside diameter of cable block.

$$(D = d - 10\text{mm})$$

Article 445. Inspection of duct

Visual check by pipe camera

Video camera is inserted in the cable block to confirm the situation in the cable block. There are several types of methods for inserting the camera as shown in the following table.

When underground water has been infiltrated into the cable block voluminously, the damage or the gap of joint part of the cable block may occur. The defect should be found and be repaired

immediately, because the following damage is assumed when earth and sand outside of the cable block flows in.

- It is impossible to use the cable block due to blocking of earth and sand.
- Sinking of ground level along the flow of earth and sand on the cable block

Table 445 Visual check by pipe camera

Type	Method	Advantage	Disadvantage
a. Wire pulling type	The wire is passed in an empty cable block, video camera is pulled in.	It is easy to confirm the situation in the cable block because the position of camera can be adjusted by the wire.	The wire needs to be passed in the cable block in advance.
b. Self-propelled type	A small vehicle with video camera is made to run in an empty cable block.	The preparation work is not required in advance.	It is difficult to turn the position of camera exactly because a self-propelled vehicle goes forward by the fixed velocity.
c. One pushing	Video camera attached at the edge of carbon rod is pushed by human power.	It is applicable not only in an empty cable block but also a cable block inserted cable.	The whole aspect of inside cable block can not be seen, only the upper aspect of inside cable block can be confirmed. The applicable length is limited by the length of carbon rod. (up to 150m)

Section 6 CABLE INSTALLATION AT SWAMP, MUDDY REGION AND UNDER WATER

Article 446. General

When the cable is constructed in the curve section, the sedimentary soil and the water ditch, it should be constructed in the cable block to fix the cable position since the power (power returns bending and power where the soil and water move) may work to make the shift the position.

Article 447. Requirement of cable installation place

Even if the cable damage is minute, it might decrease the dielectric strength and the corrosion-proof performance.

The obstacle which the cable might be damaged should be removed in consideration of the range of the cable movement that is caused by the ambient temperature change, the heat contraction and expansion according to the energizing situation.

Article 448. The depth of installed cables

Depth of laying underground cable and the construction method should be complied with the design materials according to the traffic of ships and the situation of river. (Refer to Chapter 3-2-6 in Technical Regulation Vol.1)

Article 449. The distance between the cable

When the cable is constructed, the surplus length of the cable should be considered to deal with the change and the trouble of operated cable.

The surplus length of the cable is shown in Chapter 3-2-6 in Technical Regulation Vol.1.

The cable section that goes to river should be processed as shown in the design materials. (Refer to Chapter 3-2-6 in Technical Regulation Vol.1)

Article 450. Installation cables at collapsed position

The bank cable is laid underground should be prevented from collapsing because the cable might be damaged in the event of the collapse. (Refer to Chapter 3-2-6 in Technical Regulation Vol.1)

Article 451. Prohibition of cable intersection in the water

Intersecting cables in water is prohibited as shown in Article 231 in Technical Regulation Vol.1

Article 452. Notice sign

The notice sign at intersection point between the cable and the river should be installed as shown in Article 232 in Technical Regulation Vol.1

Section 7 CABLE CONNECTION AND CABLE HEAD MAKING

Article 453. Cable head making

Main materials of the cable head of the oil-filled cable should be materials shown in the following table.

Table 453 Main material of oil-filled cable head

Type	Material	Check content
Hollow porcelain	Porcelain	It should not have defects such as a void, a damage and a crack, and be superior to water absorptive resistant, and its material should be strong and coated with glaze.
Epoxy-resin Bushing	Epoxy-resin	It should not have a electric and mechanical defect, cracks and other harmful defects, a harmful cavity and peeled layer internally, and it should be made of an excellent material that has stable characteristics against the SF ₆ gas.

Article 454. Material of connection box

The quality of the material of a cable connection box should be as shown in the following table.

Table 454 Material of cable connection box

Voltage	Cable covering outer sheath	Material of connection box	Construction place
3 kV or more	Aluminum, Lead	Epoxy, Copper, Lead, Bronze	-
Less than 1 kV	Aluminum, Lead	Cast iron	The earth (directly buried)
-	Nothing	Lead, Epoxy	-

Article 455. Cables installed directly which have a joint

The offset distance from the connection box to the cable should be as shown Article 212 in Technical Regulation Vol.1, and the defense measures should be as shown Article 210 in Technical Regulation Vol.1.

When the pull force by the cable’s self-weight works at the connection box, and the connection box is corroded by the corrosion water, the connection box should not be installed vertically. When it is necessary by all means, the horizontal dry place should be prepared for the cable installation, and the connection box should be installed at a state without the pull force and corrosion water.

Article 456. Connection of cable in blocks

When the cable is installed in the cable block, the cable room for the cable connection should be installed at appropriate intervals (generally 300m or less) that meet the following requirements.

1. Cable pulling tension should not exceed the permitted tension of cable.
2. Cable pulling tension should not exceed the permitted tension of the hook for pulling the cable in the cable room.
3. Cable pulling lateral pressure should not exceed permitted lateral pressure.
4. Cable length of one span should not exceed maximum winding length of drum (Maximum winding length of drum is limited by transportable weight of the drum winded cable and tension capacity of cable pulling machine).
5. Sheath voltage to ground should not exceed 50V.

Article 457. Cable joint with rubber cover

Terminal processing and connected processing should be conducted in consideration of the following matters by understanding specifications and the site assembly manual etc. of each material completely.

1. Terminal processing and connected processing should be conducted in the way that impurities are not mixed inside the insulator and the cable is not bended too much.
2. As a rule, neither a terminal processing nor connected processing should be conducted during rain excluding indoor. When a rainfall starts while processing, the processing should be discontinued and the cable terminal and the material should be covered with the cover so that the drop of water does not adhere to them, and other waterproof processing should be conducted.
3. The sign which identifies the date of processing and the name of construction contractor should be installed at terminal and connection location.

Article 458. Plastic for cable joint

The permissible temperature of each cable is shown in the following table.

However, the temperature of butylene injected into the cable should not exceed 130-140 deg C for the connection box with porcelain, and the connection box and porcelain should be warmed up to 60 deg C before butylene is injected.

Table 458 Permissible temperature of cable connection box

Cable type	Permissible temperature [deg C]
1. Paper insulated cable	190
2. Rubber insulation cable	110
3. Plastic insulated cable	130

Article 459. Cable head

The insulated pipe should be molded by insulated EP rubber (Ethylene Propylene Rubber) or semi-conductive EP rubber with excellent electrical characteristics, and be with an internal semi-conductive layer and an external semi-conductive layer, and has no harmful defect such as bubbles.

Article 460. Connection, distribution of cable insulated by rubber

The code connection machine, the connection box and other apparatuses should be used at connection between the codes, cabtyre cables, cables or the connection between these cables. However, when connecting cabtyre cables with a cross sectional area of 8mm² or more, the connection part should be covered by the insulation with the equivalent or more effect of an electric insulated wire, and insulated cover should be sulfureted completely. (When a durable metallic defense device is given on connected part, above requirement is not applied.)

Article 461. Cable core insulated by paper

The terminal edge of cable insulated by paper should be tightly wrapped by plastic tape etc. to prevent penetrating water and dust into the cable.

Article 462. Cable core insulated by rubber

Refer to article 461.

Section 8 CABLE INSTALLATION IN EXPLOSIVE ROOM AND EXPLOSIVE OUTDOORS EQUIPMENT

Article 463. General

The explosive room and the explosive outdoor are defined as the room or outdoor where gunpowder is kept, the flammable gas is filled and a lot of flashover dust exists.

Article 464. Prohibited places for cable joints setup

The connection box and the branch box should not be installed in the explosive room or near the explosive outdoor equipment because the accidents at these boxes occur easily since they are normally assembled at the site.

Article 465. Place that have condenser equipment

The offset distance from cables to explosive equipment such as valves for gas pipelines, condenser for changing explosive gas to liquid, etc. should be secured over 100mm.

The cable cover should not be made of inflammable materials (jute and butylene) because the fire of the cable might continue and expand in the event of the explosion.

Article 466. Intersection with corrosive chemical pipe

The cable intersecting with the pipeline includes the corrosive chemical substance should be inserted in a pipe to prevent corrosion by the substance in the event of leaking the substance.

Article 467. Cable go in floor

When explosive substance might flow into adjacent place through the hole of the cable or the cable block, the hole or the cable block should be filled with a nonflammable material.

Article 468. In explosive room

The cable in the room where gas and hot air with the specific gravity of 0.8 or less exist together as well as its cable canal should be covered with sand. The cable canal should be covered with sand for 1.5m or more from the cable installation point, which is touching the wall of room with the explosion hazard.

Article 469. Protection to prevent erosive

When the cable might be damaged by eroded chemical substance, it should be covered strictly in a nonflammable defense box.

Article 470. Cable joints to electric equipment

When the cable is connected with the electric equipment or instrument, it should be surely connected with the connection box.

Article 471. Use of cable funnel and dry pit

Cable canal under dry condition or cover to seal slit in dust resistance box in explosive room is permitted to be used to prevent explosion.

It is prohibited that general public access near the room.

Article 472. Cable installation outdoor

When the cable pipe connected with other pipes is at the explosive and outdoor place, the cable should be inserted into a steel pipe, fixed firmly and installed in the following directions to avoid the damage.

1. When other pipes are made of a nonflammable material, the pipe is allowed to be constructed at the same side.
2. The cable is installed in the direction to avoid explosion hazard.
In addition, light specific gravity of hot air is defined as the specific gravity of 0.8 or less, and heavy specific gravity of hot air is defined as more than 0.8.

Section 9 PAINTING AND MARKING

Article 473. Painting for cables

A specific painting method should be executed by the following methods or more effective methods.

1. When the cable is constructed indoor under the normal environmental condition: Antirust paint (Oil or bitumen, etc.)
2. When the cable is constructed indoor under the environment condition which aluminum, lead and steel might be corroded : An appropriate paint with the chemical impact resistance
3. When the cable is constructed outdoor : Waterproof and antirust paint (Bitumen, etc.)
4. When the cable connection box and other support structures are constructed in water or underground: Anti-corrosion, waterproof and antirust paint (Bitumen or the high temperature bitumen, etc.)

Article 474. Display of cable information

Display of information of the cable line should be in accordance with to Article 112 in Technical Regulation Vol.1.

Article 475. Place of sign

The sign of cable should be made from the following materials.

1. Plastic, aluminum, and painted corrugated iron : Room with air conditioning facilities
2. Plastic, aluminum, and surely painted corrugated iron : Humid room and outdoor
3. Plastic: Room with corrosive substance and underground

Moreover, the figure mark of the sign should usually be described by good quality paint, and by casting if it is specially needed.

Article 476. Fixing the sign

The sign of the cable should be firmly fixed by galvanizing wire or steel wire of 1 to 2mm in diameter.

However, the steel wire should be painted by antirust material (Bitumen etc.).

Article 477. Sign of cable in the ground

The sign of underground cable and connection box should be tightly rolled by tape to prevent corrosion by underground water, and damage by earth and sand.

Chapter 8 OVERHEAD POWER TRANSMISSION LINES

Section 1 GENERAL

Article 478. Scope of application

Overhead power line should be constructed based on Article 8, Chapter 2-3-3 and Chapter 3-3 in Technical Regulation Vol.1 as well as this chapter.

Article 479. Requirement of installation

Even when the change work of the design is approved from the owner, the work should be complied with related standards.

Article 480. Principal works

1. Important items on planning of scheme of execution for overhead transmission line
 - (1) Contract terms
 - (2) Condition of construction site
 - (3) Whole process
 - (4) Construction technique and the construction order
 - (5) Selection of machines and equipment for construction
 - (6) Design and site planning for temporary equipment
2. Important items on preparation for materials, technology and labor
 - (1) Securing place, amount and time for construction
 - (2) Averaging the amount of construction work for effective execution
 - (3) Conducting efficient task by repeating the same work
 - (4) Avoiding the duplication of arrangements
3. Important items for improvement of efficient operation of machine and application of new technology in construction
 - (1) Applying the content, place and time of work for mechanical execution which can work with the wider range, larger weight and the higher speed than a human does.
 - (2) It is important for construction to use historical performance and experience, but new technology should be considered to be used which is expected the improvement of the term, quality, cost and safety of the site work.
4. Important items on adjustment for construction organization
 - (1) To show the role clearly that each construction organization plays in the entire construction. (Making construction system charts, etc.)
 - (2) Avoiding the duplication of the construction organizations or the long-term construction standby.

Article 481. Execution schedule

It is difficult to manage the work because the amount of men, time and materials are vast for constructing the huge structure in the construction site of the overhead transmission line.

Revising the defect might take a lot of trouble or it might be impossible to reuse the material dismantled for the revise in case that the defect is found on in-progress and completion inspection since foundation, pole, steel tower, insulator, conductor need to be assembled in number order when the overhead power line is constructed.

Therefore, it is an important factor in the overhead power line construction to manage the construction work, and four points of "Quality, economy, term of works and safety" are especially important control items. The construction site patrol should be executed as needed to confirm that the situation of construction site and work are appropriate to these control items.

Table 481 Control items

Control items	Management content
Quality	The material and the size, etc. demanded by the design material should be confirmed that they are constructed within the permissible range. The construction guidance is conducted at important time of construction work to secure the quality which is passed the in-process and completion inspection.
Economy	Construction cost should be confirmed regularly that it is within the budget (example, once a month).
Term of works	The construction work should be confirmed by comparing with the plan table that the scheduled work is completed by necessary deadline. In case that the delay of the work is foreseen, the cause of delay should be removed, and the measure to accelerate the speed of work should be considered (example, extra workers and heavy machine are added at the site).
Safety	It should be confirmed to secure woker's safety because site workers in the overhead power line often execute the risky work such as the underground excavation, the assembly work at high position and the work near live part. If the site works are dangerous, the guidance for the safety should be conducted.

Article 482. Adoption of standard method

The simple and well-understood construction method (example, the installation of the concrete pole by pole setting machine) should be executed for overhead power line with voltage up to 35kV since the constructive quantity is many and the constructive period is short.

The construction plan and method for overhead power line with voltage from 110 to 500 kV should be considered with economy and site location in detail because the line has to be highly reliable for power supply and requires a long period of time and huge cost for the construction work.

Article 483. Providing the dossiers, materials

The owner should prepare necessary material to make the constructor execute works properly and efficiently. Each material should be prepared before the commencement of related construction works.

Article 484. Submitting reports

1. Confirmation for clearance

The clearance between conductors and offset distance from conductor to other object (example, tree or house) around the line route should be confirmed to meet the requirement of Technical Regulation.

Element that should be included in confirmation

- Overhead power line (pole height, cross-arm size, conductor type, conductor size, conductor tension, conductor temperature)
- Geographical features in route
- Position and height of other object around route

2. Confirmation for foundation

The foundation on site should be confirmed that it demonstrates the strength required by the design.

Element that should be included in confirmation

- Geographical features around the foundation (state of ups and downs)
- Geological features at the foundation (ground strength of each depth)
- Water level of underground water (Only when it is possible to confirm the underground water).
- Situation of buried object or to position of other object around the foundation
- Construction method of foundation (right or wrong of use of heavy machine and pile driver for digging)

Article 485. Checking for pole

Construction materials should be confirmed that their items and amount is appropriate respectively by purchase specification, after they are carried to the construction site. The quality of construction materials should be visually confirmed that there is no damage and crack. Additionally, main materials should be checked their dimensions and capabilities by manufacture's data

- Main materials

Pole, steel tower, foundation pier and pile, concrete, re-bar, insulator, power conductor, overhead ground wire.

Article 486. Painted or galvanized the metal accessories

Metallic materials which the rust might develop should be conducted the anti-rust painting or the galvanizing to prevent the strength reduction of it before purchase or construction.

Article 487. Re-bar structure

It is difficult to confirm the re-bar laid in concrete after the construction work, though the re-bar is an important element that chiefly bears the tensile strength of a concrete structure. Therefore, the re-bar should be confirmed before the construction work that the assembled state about contents of the following table

Table 487 Confirmation of re-bar

Items		Confirmation content
Main body	Material	The factory testing result is confirmed in the document.
	Size	It is confirmed to meet the contents shown in specifications.
	Exterior	There is no damage, rust, oil and mud adherence.
Assembled state	Number	It is confirmed to meet the contents shown in specifications.
	Length	The difference from specifications is within -20mm to +20mm.
	Interval	The difference from specifications is within -20mm to +20mm.
	Distance from the surface of re-bar to the surface of designed concrete	The difference from specifications is within 0mm to +20mm.
	Position of joint	It is confirmed to meet the contents shown in specifications.
	Length of lapped joint	The tensile strength of lapped joint between re-bar and concrete is more than that of re-bar. (Refer to below sample of calculation)

Welded joints:

- The length of each compression type $L \geq 10D$
 - The length of each dragged type $L \geq 30D$
- L: Length of lapped joint (mm)
D: Diameter of re-bar (mm)

Article 488. Inspection of insulators and accessories

Inspection of insulators and accessories should be in accordance with Chapter 3 in Technical Regulation Vol.5.

Article 489. Stockyard for material of structure

Materials should be kept tidily so that they are prevented from the quality loss such as the rust, the stain and the damage, etc. and avoid the thefts, fires and flood damage. They should normally be kept in the stock room with the lock or the plaza enclosed by the fence with lock. In addition, they should be covered with the vinyl sheet etc. when keeping them outdoor.

Article 490. Execution nearby running power network

The constructor should preliminarily investigate the required document and its deadline for approval and license before construction work is started. Based on the results of the investigation, the constructor should complete necessary procedure by a required term. The corresponding construction work should not be started when necessary procedure can not be completed.

Contents for necessary procedure

1. Information items on the document

- Dates and hours of construction work.
- Dates and hours of forbidding operation of ships, boats, vehicles and so on.

- Dates and hours of scheduled outage
 - Protective methods for works around overhead power lines so as to avoid damages.
 - Technical method for safety of each main construction work item.
 - Full name of foreman of construction and installation agency.
 - Full name of representative of supervision agency.
 - Method of specific work items from the commencement to completion.
2. Other requirements
- When construction work is carried out in mountainous region and special crossings construction areas, transportation measure such as road or overhead cableway should be prepared to ensure supply of construction materials, equipment, machinery for each position before foundation works are started.
 - Excavating sand, pouring concrete for the foundation of poles and installing poles should be carried out in accordance with the technological diagram designed by construction organization. Laying and stringing work of conductors at each construction location should be carried out in accordance with technological diagram in compliance with the specific terrain of each laying section.

Section 2 FOUNDATION WORKS

Article 491. Excavation work of foundation

The excavation work should be executed as follows.

1. Decision of width of digging

The width of digging should be decided by the measured center position and the foundation design diagram.
2. Prevention of earth and sand collapse

The earth sheathing board corresponding to the digging scale and the type of soil should be set up to prevent the earth and sand collapse from the side of digging hole.

The earth sheathing fence should be set up at the sloping area to prevent the outflow of the dug earth and sand.
3. Maintenance for bottom of dug hole

The digging weaken the strength of the bottom of dug hole is prohibited.

When over-digging is conducted, the dug sand should not be returned to the bottom, and the concrete should be poured to the bottom.

In case of the digging by exploding, the final phase of digging should be done by human with the pick, etc. to prevent the bedrock in the bottom from being weaken.
4. Attention for excavation machine

The excavation machine should be selected a suitable type to the features of geography and ground.

The excavation machine should be set up at the position where is secured 2 m or more from the edge of digging hole to prevent the collapse of the digging hole sidewall due to its self-weight or its vibration and the its falling.

The observer should be set who urges attentions that an excavation machine does not fall even at the incline while an excavation machine operates.

It should try to maintain the original ground without digging. The ground should not be dug unnecessarily such as digging down for the feet of the excavation machine, etc.

Article 492. Checking of foundation bottom

The bottom of digging hole should be kept cleanly as shown in Article 491 in this Guideline.

The inclination, width, depth and decentering of the bottom of digging hole should be checked, and it is permitted to adjust the difference from the designed value if the difference is 100mm or less.

Article 493. Foundation bottom

The difference from the design value of inclination of foundation of tensile pole should be 10 % or less.

Article 494. Dimension of foundation

1. Excavation by driller

When there may be a underground buried thing at excavation hole, checking by manual excavation should be conducted before driller excavation. In case that the collapse may occur at soft ground, earth retaining method by cylinder formwork should be conducted.

2. Manual excavation

Manual excavation hole should be carried out gradually making the different depth of several stages since the collapse occurs easily as the excavation hole becomes deeper. The direction of the stages of the hole is generally the same as the direction of the overhead power lines.

Dimension of foundation and reinforcement measures should comply with the provisions of the design.

Article 495. Exploding mine to make foundation

The exploding mine should be approved to use by related regulation, and be handled carefully on actual transport, use and keep because explosive material is very dangerous.

Notes of work

- The ground around the digging hole should not be weakened due to the explosion.
- The adjustment of the amount of the detonating powder and the defense for safety should be conducted when other object such as building, etc. is near the digging location.

Article 496. Mine exploding for correct foundation

The use of the exploding mine should be limited for the bedrock and the hard large stone.

Article 497. Qualification for exploding work

The exploding work should be executed by the qualified person directly, not be executed by incompetent. The exploding work includes the punching hole, loading detonating powder, connecting wires, igniting, propelling charge of the misfire and checking and processing of the rest detonating powder.

Role of the qualified person

- To indicate the evacuation for the worker before ignition
- To indicate the shelter and path for ignition person
- To use the clock to alarm for the evacuation, in case that the number of ignitions is two or more
- To indicate the order and type of the ignition
- To give signs of the ignition and the evacuation to ignition person
- To check propelling charge of the misfire or the existence of remaining detonating powder
- To record the explosion.

Article 498. Requirement of exploding

Exploding work is prohibited when it is rain, storm, thunder that the explosion might not be operated properly and at nighttime that surrounding situation can not be confirmed.

Article 499. Management and control for exploding work

The observer should be arranged to confirm the safety of exploding work. The observer should understand about the process of work, a dangerous element of work and the measures for safety, and is preferable to be the qualified person.

Article 500. Countermeasure of submergence

When water has collected in the digging hole, the water should be pumped out to avoid reducing the quality and worsening work environment as the following.

- Reduction of the concrete strength due to the increase of moisture in the ready-mixed concrete.
- Reduction of the foundation strength due to the re-bar with mud that causes reduction of the adherence between re-bar and the concrete.
- Deterioration of condition of worker's feet by mud.

Article 501. Depth of foundation

The digging depth is an important element that decides the stability of the foundation (the strength of the ground, the frictional force and the amount of sand which resist pulling force from pole). Therefore, when it is impossible to dig as the design material because of very hard ground, the owner should be reported about the situation. The owner should reconsider the specification of the foundation which apply to actual site ground based on the report.

Article 502. Process of foundation and reinforced concrete foundation

The welding point should be cleaned certainly before welding because a proper welding is not enforceable when the garbage exists on the point.

The welded point and bolts should be painted by anti-rust paint because rust progresses easily to them. The thickness of the defense coating of the pre-cast concrete foundation should be 30mm or more.

Article 503. Foundation concrete

When the cement fluids and sewages might cause reduction of the water quality and pollution of the soil at the construction site, the chemical component of the water and soil picked up from the site should be investigated before and after the construction work. In case that abnormal water and soil due to the cement fluids and sewages are admitted on the investigation result, the countermeasure to recover it to the original condition should be conducted.

Article 504. Acceptance after foundation casting

At the construction of the foundation, prior checking and the confirmation of the checking should be done strictly because the completed foundation is almost buried underground. The owner should promptly execute the confirmation of checking because it is not preferable to leave the completed foundation for a long term. The constructor should not begin the backfill work until the confirmation is completed.

Article 505. Backfilling

The dug sand should usually be returned as backfill of foundation, and it should be tightly compacted every 30 cm or less as targeting the consistency of the original ground. It is prohibited to conduct all backfill at once because the foundation can not be stable due to insufficient backfill around the bottom.

The sand for backfill should be adjusted to appropriate moisture content as shown in the following table, because it is difficult to compact the sand tightly when the sand is dry or excessively wet.

Table 505 Appropriate moisture content

Type of sand	Appropriate moisture content
Argillaceous	30 ~ 40 %
Sandy clay	20 ~ 30 %
Sandiness	10 ~ 20 %

Article 506. Installation of foundation pier

The earth sheathing boards should be removed depending on the level of the backfill. They should be avoided to be removed at once before the backfill because removing them at once might cause weakening and falling the ground suddenly.

Article 507. Leveling after backfilling

The sand should be piled up for about 10 cm more than the appropriate level of the backfill because it of backfill subsides a little even if it is compacted tightly.

Article 508. Foundation casting

The concrete on the site should be constructed based on related norms because it might be excessively reduced the quality after the construction due to weather (air temperature and falling rain), transport, pouring and keeping until it hardens.

Section 3 INSTALLATION AND POLES ERECTION

Article 509. Site condition

The construction site should be confirmed that the extent of site, geographical features and the surrounding environment can be used the construction machine. In addition, the road for the transport should be confirmed the capital transport machine can pass.

The pole construction work should be executed by an appropriate work steps and schedule because the work has high risk of the high-place work and the work of handling the heavy load.

Article 510. Checking the pole before installation

The reinforced concrete pole should be checked according to items shown in the following table.

Table 510 Checklist of reinforced concrete pole

	Items	Required performance
Extern al view	Commissure of formwork for concrete	In the cement paste leakage, the width should be 1mm or less, length should be 300mm or less and the gap should be 2mm or less.
	Crack	A width of crack should not be 0.05mm or more.
	Blot of re-bar	The re-bar should not be exposed to the surface of a concrete pole, and the rust of re-bar should not seep out.
	Lack of surface of concrete	In the lack of surface of concrete pole, the depth should be 5mm or less and the area should be 100cm ² or less. A coarse aggregate should not be exposed.
	Defect of mixing cement and coarse aggregate	A defect of mixing cement and coarse aggregate should not be on the surface of concrete pole.
	Bending of the total length	Bending of concrete pole should be less than 0.1% of the total length.

Items		Required performance
Size	Length	Length should be from -10 to +50mm against the nominal length.
	External diameter	External diameter should be from -2 to +4mm against the nominal diameter of both ends.
	Thickness of concrete	Thickness of the bottom end should be from 0mm to 30mm against the regulated one. Thickness of the tip end should be from 0mm to 10mm against the regulated one.
	Deviation of thickness of concrete	The difference between the maximum value and minimum value should be within 10% of the average thickness.
Bending strength		At time of loading by the design load: A width of crack should be 0.25mm or less. At time of removing the design load: A width of crack should retain 0.05mm or less.
Mechanical failing load		Mechanical failing load should be twice or more against the design load.

Article 511. Checking of steel pole

The welding should be confirmed after execution at the site that the defect is not exist and the difference of the size suites the specification because the defect causes the remarkable deterioration of strength.

- The defect of welding

A crack, an incomplete penetration, an incomplete fusion, change in shape, hardening, softening and embrittlement.

Article 512. Poles wiring

The wire for the stringing work should be given the antirust processing such as the antirust paint to prevent the reduction of the wire's strength by rust, and confirmed that strands of wire are not damaged or cut down.

Article 513. Steel cable using for execution

Edges of the wire should be compressed to have the strength that exceeds the tensile strength of the wire, and fixed by the wire clip. In addition, the corroded wire, transformed wire or the wire cut its strands should not be used because the strength of such wires might be reduced.

Article 514. The insertion for centrifugal concrete poles

The back-filling of pole should be compacted by the sand tightly. When the pole needs to be backfilled more tightly, backfilling should be conducted by concrete. The concrete for backfilling of the foundation should be confirmed before being poured that its fresh concrete are satisfied confirmation items shown in following table.

Table 514 Confirmation item of fresh concrete

Items		Permissible value
Slump	Design value : from 8cm to 18cm	From -2.5cm to +2.5cm
	Design value : over 19cm	From -1.5cm to +1.5cm
Amount of air		From -1% to +1%

Article 515. Prior to erection of pole

The erection of the pole by hinge rotation method is shown in the following figure.

Notes of the method are as follows.

- The position of the winch should take the distance 2 to 3 times the length of the pole from the digging hole in consideration of the load pulling the wire and the fall of the pole. Moreover, the position should be selected to be straight against the position of a pulling wire, the pole and the digging hole.
- The anchor of the winch and support wires should be set up firmly.
- The worker should not enter the right under the pole at the erection of the pole.
- The inclination of the pole should always be adjusted carefully by support wires so that the direction of the pulling wire and the pole are straight. Moreover, the pole should be adjusted by support wires so that it is the vertical.
- Support wires should be used steel wires of 9mm or more in the external diameter or nylon ropes of 16mm or more in the external diameter.

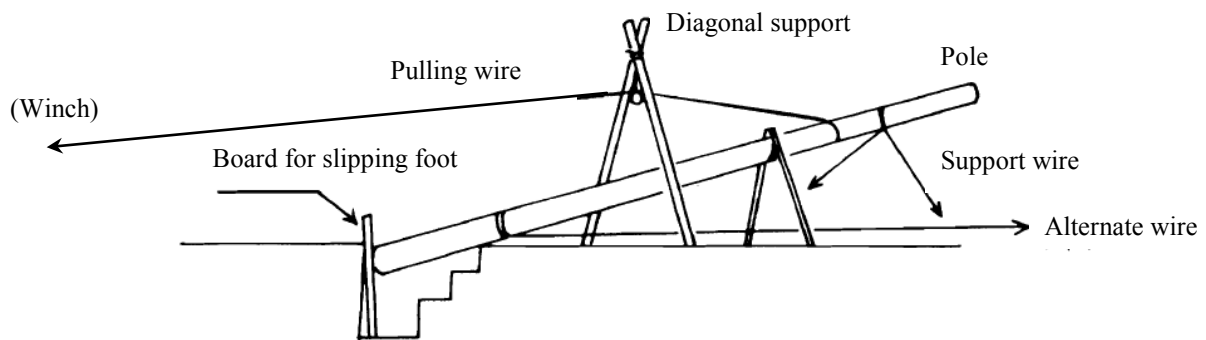


Figure 515 The erection of the pole by hinge rotation method

Article 516. Pole erection

The erection of pole before completion of acceptance and inspection for the foundation should not be started because constructing the pole on the foundation where the design is not satisfied is dangerous.

In addition, the connection for the foundation and the pole should be confirmed to be in a state appropriately before the erection of pole is started.

Article 517. Poles erection technical plans

At the time of planning for pole erection, allowable bearing capacity and strength of the pole should be considered sufficiently, the stress (pulling force at the erection of the pole and the compressive force of grip section of the pulling wire) depending on the construction work should not exceed the permissible strength of the pole.

Article 518. Fixing poles

The bolt should be tightened by torque wrench with the torque shown in the following table. In addition, the bolt and the nut should be lubricated with the rapeseed oil etc. before tightening the bolt, and should be tightened smoothly.

Table 518 Bolt tightening torque

Bolt Size	Bolt		Lubricant
	Strength division※	Tightening torque (Nm)	
M16	5.8	74	Rapeseed oil
M20	6.8	160	Rapeseed oil
M24	6.8	280	Rapeseed oil
M24	9.8	430	Rapeseed oil
M30	9.8	850	Rapeseed oil
M36	9.8	1,500	Rapeseed oil

※Strength division means the ratio of the yield point or yield strength for pulling strength.

(Example) Strength division 5.8: Numerical pulling strength 500N/mm², and 400N/mm² which the yield point is 80% of the pulling strength

Article 519. Checking pole after erection

The confirmation of the vertical degree of the pole should be executed after the erection of the pole. There are two methods; that are the method by the nylon string hanging the weight shake and the method by the measurement tool such as a transit. The position of the confirmation of the vertical degree should be at two points as shown in the following figure where the pole from the top to the bottom can be seen and can make a judgment of the vertical degree.

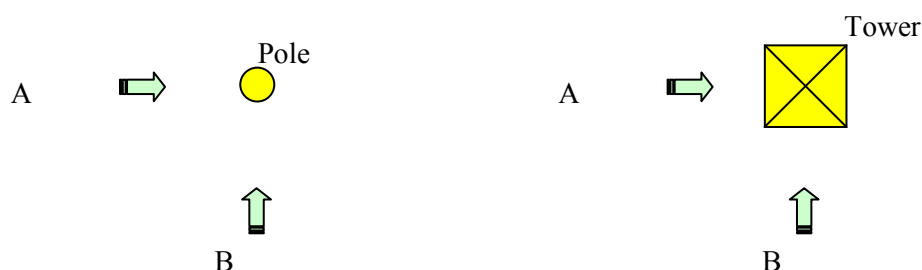


Figure 519 Position of the confirmation of the vertical degree (Bird's-eye view)

Article 520. Lightning and earthing Wire

Refer to Section 5 for the overhead ground wire in this Guideline.

Section 4 INSTALLATION OF INSULATOR AND WIRING ACCESSORIES

Article 521. Installation of insulator

Insulators should be lifted up right before the conductor is fixed to them to prevent the damage. Insulators should be protected by cloth sheet to avoid being damaged by the contact between insulators, with the pole and the conductor.

The standing insulator should be confirmed that the insulator endures the bending force by the maximum tension of the conductor at the bend location on the line.

Section 5 INSTALLATION OF CONDUCTION WIRE AND LIGHTNING SYSTEM

Article 522. Protection of wire

The conductor gripper is the part where strands of a conductor are cut easily due to the vibration by slight wind. Especially, it tends to be cut easily at the suspension clamp, the strain clamp of a copper conductor and the strain clamp of a thin aluminum conductor with cross sectional area of 100mm^2 or less.

As a preventive measure from strands of the conductor being cut off, there is a method of winding the armor rod which is the same material as outer strands of the conductor at the grip section. The armor rod should be wrapped tightly to the edge so that the decentering at the center position is 5 cm or less, and there is no strand gap.

The example of the tying to the standing insulator is shown in the following figure.

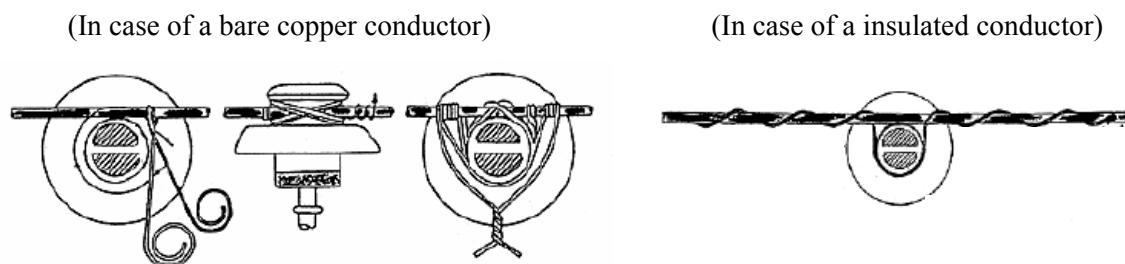


Figure 522 (Sample) Tying to the standing insulator

Article 523. Requirements for specification of wire

Cross sectional area of the supporting wire should be selected to have the strength to bear the pole or the conductor, and should not be less than the design material.

The connection of supporting aluminum wire or supporting aluminum wire with steel core should be in accordance with the connection of the conductor. (Refer to Article 524 in this Guideline)

Article 524. Connection of wire

Refer to the requirements for connection of the conductor in Chapter 3-3 in Technical Regulation Vol.1.

However, the cable with voltage up to 1,000V, communication network, roadway network and railway network, etc., and the conductor with cross sectional area of 240mm² or more are allowed to be connected within the span on heavy traffic roadway. The connection is prohibited around clamps where there is the contact between the connection part and the clamps, the tiredness by the vibration and the interference of installation of the damper, the distance between the connection point and the clamp should be 5 m or more.

The connection sleeve which has defects by the manufacture or the compression work should not be used

Article 525. Jointing pipe

The connection of conductors should be confirmed as shown in following table.

Table 525 Connection of conductor

Items	Confirmation contents
Position of connection sleeve	According to the specifications.
Cutting length of steel core	According to the standard cutting gauge.
Diameter of compressed sleeve	According to the compression gauge.
Displacement of sleeve	The center point of a sleeve should be at the center point of the connection.
Tying of soft aluminum wire	According to the specifications
Polishing conductor	There is no problem with the electric characteristic.
(Reference value) Expansion of conductor	Aluminum conductor : 7 to 12 % Steel core of conductor : 18 to 23 % Copper conductor : 8 to 13 % However, it is acceptable for the expansion of the conductor when there is no significant difference.

Article 526. Heat fusion welding method

The cable connections by welding should be ensured the expected strength and damp-proof carefully. The cable shall be sufficiently cleaned up not to penetrate impurities into them. The connection by heat fusion welding method shall not be conducted at points with mechanical loads are stressed because the mechanical strength of the connection points are very weak. In addition, If the connection points by heat fusion welding method are loaded mechanically, the connection points shall be removed in advance and exchange other connections (connection sleeves, etc.) with sufficient mechanical strength.



Figure 526 Heat fusion welding method

Article 527. Wiring work

The strength and the power transmission capacity of the conductor are reduced greatly when the conductor is damaged. To avoid this, the conductors should be in the state that makes them pending with pulleys etc., and avoid the contact to ground and the plant in the stringing work. The offset distance from the conductor to the road should be in accordance with Article 291 in Technical Regulation Vol.1.

Article 528. Installation of power wire and lightning wire

In the sag of conductors and overhead ground wires, the difference from the design value should be within 10 cm. In addition, in case of multiple conductors, the difference of the sag between the conductors should be smaller than the external diameter of the conductor.

Article 529. The distance from power wire to ground

The offset distance from the conductor to the ground, the pole, and the other conductor should be in accordance with Chapter 3-3 in Technical Regulation Vol.1.

Section 6 NUMBERING AND PAINTING

Article 530. Painting for anti-rust

The metallic part of steel tower, etc. should be conducted antirust treatment to prevent reducing the strength due to rust. The antirust treatment includes galvanizing or antirust painting, and should be conducted under proper management at the factory.

The following parts should not be painted.

- The connection of the earthing conductor : The earthing resistance might be increased by painting.
- The part buried in concrete : The adherence between the part and concrete might be reduced by painting.

The painting should not be mixed with the water or the foreign substance because these substances cause the reduction of the painting quality and hastening progression of rust. In addition, the painting should not be executed at the low temperature that the paint can not dry and harden properly.

Table 530 Prohibited condition of painting

Items	Prohibited condition of painting
Weather	When the rain or the snow might fall before the paint dries firmly. (The paint should be dried until it does not adhere to hand when it is touched.) When it is windy or when there are a lot of dust because foreign substances are mixed with the paint easily.
Temperature	When the air temperature is 5deg C or less. When the temperature of the metal part is significantly high due to sunlight because the paint causes bubbles by the heat, and it is impossible to paint properly.
Humidity	When humidity is 85% or more. When the metal part has the humidity by rain or dew.