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Part 1 General

Article 1-1. Purpose

This technical standard shall provide necessary matters concerning the in-progress inspection, completion inspection and periodic inspection for network facilities and power plants. In-progress inspection for thermal power plants and hydro civil works, completion inspection for hydro civil works are out of scope of this technical standard.

Article 1-2. Scope of application

The stipulation in this standard shall apply to inspection work for network, hydro and thermal facilities. Here, the facilities mean those connected to Vietnamese electric power grid. The scope of application for each facility is stipulated as follows.

1. Network facilities

   The articles regarding network facilities are stipulated in Part2. They apply to inspections for engineering work of electric facilities such as transmission & distribution lines, substations up to 500kV. The facilities are not only electric power company's but also private company's, such as factory. The completion inspections for structure such as tower, pole and foundation are excluded from this standard.

2. Hydro power plants

   The articles regarding hydro power plants are stipulated in Part3.They apply to civil works and electrical equipment of hydro powerplants designated as follows respectively:

   (1) Civil works of all hydro powerplants located in Vietnam and connected to the Vietnamese Grids, excluding hydro civil works with the special dams defined by the Government Decree No. 143/2003/ND-CP;

   (2) Electrical equipment of hydro powerplants located in Vietnam and connected to the Vietnamese Grids, with rated output equal to or greater than 30MW.

3. Thermal power plant

   The article regarding thermal powerplants are stipulated in Part4. They apply to inspections of mechanical and electrical facilities such as boiler, steam turbine, gas turbine and generator of thermal power plants located in Vietnam and connected to the Vietnamese Grids, with rated output equal to or grater than 1MW.

Article 1-3. Definitions

1. *"Authority"* means Ministry of Industry or organizations upon which Ministry of Industry devolves specified competence in enforcement of inspection of network, hydro powerplants and thermal

powerplants.

2. *"Owner"* means any person, unit, or municipality, or combination thereof that owns powerplants and has a legal responsibility for operation of those powerplants.
3. *"Inspector"* means a person belonging to or appointed by Ministry of Industry who carries out inspection based on the Electricity Law, Decree No.: 105/2005/ND-CP and this technical standard;
4. *"In-progress Inspection"* means inspection done to confirm implementation of each stage of field construction work including repair and overhaul work for each equipment or each kind of work.
5. *"Completion Inspection"* means inspection done on completion of engineering work to confirm comprehensive qualities of the work before commencement of operation.
6. *"Periodic Inspection"* means inspection carried out through visual inspections and measurements if necessary, to maintain normal function and prevent accidents at regular interval.

Article 1-4. Formulation of inspection

1. The Owner shall conduct all the inspections according to this standard. The Owner shall conduct the inspection by himself in principle. The Owner may have contractors conduct the inspections on his own responsibility. In that case, the Owner should have contractors observe this technical standard. The Owner shall supervise the inspections, demand to submit the inspection report, check the report in terms of purposes, contents, methods and results of the inspection. Those who would be responsible for conducting inspection except the Owner are prescribed in applicable articles. With regard to such inspection the Owner shall grasp purposes, contents, methods and results and keep necessary records.

2. The Authority shall check the observance of this standard regarding the Owner. The methods are by field inspection or by examination of documents submitted and shall be selected by the judgment of the Authority. In case that violation or non-conformity to the technical standard is found by the Authority, the Authority may order the Owner to take necessary treatments or countermeasures according to the Electricity Law (No.: 2004/QH11), and Detailed Regulations and Guidelines on Implementation of the Electricity Law (No.: 105/2005/ND-CP).

3. This technical standard stipulates legal minimum requirements for major structures and equipment in point of prevention of public hazards and huge power system collapse. Therefore the Owner shall carry out necessary inspections and investigation to detect failure potentials, and shall take necessary countermeasures if necessary in addition to the provisions of this technical standard.

4. This technical standard shall set a framework of inspection. The Owner shall decide methods and detailed procedures based on the status of each facility. The method is not limited to those

presented in this technical standard. The inspection can be conducted by any other appropriate methods if they have technological grounds that can accomplish the purpose of inspection.

5. This technical standard shall not stipulate the Owners' routine inspection during operation and special inspection after special events such as natural disaster.

Part 2 Transmission & Distribution Line and Substations

Chapter 1 General Provisions

Article 2-1. Definitions

The following definitions apply in this technical standard.

1. *"Procurement specifications"* means documents that describe specification of equipment or materials in detail. The Owner submits it to manufactures when order the equipment or materials.
2. *"Wiring work"* means work of string overhead wire on supporting structure.
3. *"Substation"* means the facilities that transform electricity. This includes the facilities on the pole.
4. *"Overhead Transmission Line"* means the circuits or facilities that conducts electricity overhead.
5. *"Supporting Structure"* means the structure that support electric conductors, such as wooden pole, steel tower, or concrete pole and so on.
6. *"Engineering work specifications"* means documents that describe specification of engineering work in detail. The Owner submits it to contracted constructor when commits the work.
7. *"Ground wire"* means conductor connected to earth or lightly insulated, usually installed above the phase conductors of a power line or a substation to protect them from lightning strikes.
8. *"OPGW"* means ground wire built optical fiber cable.
9. *"Nominal voltage"* means voltage by which a system is designated.
10. *"Rated voltage"* means voltage assigned generally by a manufacturer, for a specified operating condition of component, device or equipment.
11. *"Factory inspection"* means the inspection carried out by manufacture before ship the equipment or materials to the Owner to ensure the performance on manufacture's responsibilities.
12. *"Visual Inspection"* means the inspection from the outside of objects visually to ensure the leliability of the equipment.
13. *"Route Exploration"* means the inspection by exploration along the route to ensure the performance from out side. This is mainly for transmission line.

Chapter 2　Organizations and Management of Operation and Maintenance

Article 2-2.　Organizations

Fulfillment of requirements on organization stipulated in the technical standard Vol.6 Part2 Chapter1 shall be checked at the completion and periodic inspection.

Article 2-3.　Documentation

Fulfillment of requirements on documentation stipulated in the technical standard Vol.6 Part6 Chapter1 shall be checked at the completion and periodic inspection.

Chapter 3　Acceptance Inspection

Article 2-4.　General provisions

This inspection shall be done by contractors at the time of delivery to the engineering work site to confirm quantities and shapes as well as proper transportation without any damage. The Owner shall have primary responsibilty to confirm these condition based on the inspection record performed by manufacturers or engineering contractors.

Article 2-5.　The detail of inspection

It shall be checked on product deliveries that numbers and shapes of the products comply with procurement specifications and that the deliveries have been properly performed without any damages to the products. It also shall be checked based on test results performed by manufactures at their factories that the products have the structures, performances and properties specified in the procurement specifications based.

Chapter 4　In Progress Inspection

Section 1.　General

Article 2-6.　General provisions

This inspection shall be done to confirm implementation of each stage of field construction work including repair and overall work for each equipment (for example, Transformer, Circuit Breaker, etc.) or each kind of work (for example, wiring work, underground cable connection work, etc.). The owner of the facilities supervises this inspection. The owner shall require that contractors submit inspection reports. The owner shall supervise and check the entire work based on the reports.

Section 2.　Overhead Transmission Line

Article 2-7.　Earth resistances of supporting structures and buried earth wires

Earth resistances of supporting structures for transmission lines and states of buried earth wires shall be checked.

1.　Earth resistances of supporting structures

Earth resistances of supporting structures shall be measured according to the following procedures. For steel towers, the combined resistance of the four legs shall be measured by an earth resistance meter on completion of backfill of the tower base. For poles, the measurements shall be performed after the poles have been erected and the earth wires buried. The owner shall check the entire work to see that the earth resistances are bellow the values specified in Technical Standards Vol.1 Chapter7.

2.　States of buried earth wires

Types, thickness, diameter, conditions of buried earth wires and any abnormalities of the terminal connections of the wires shall be checked. The owner shall check the entire work to see that the earth resistances are bellow the values specified in Technical Standards Vol.1 Chapter7.

Article 2-8.　Overhead wire inspection

Types, dimension and conditions of overhead conductors and overhead ground wires shall be checked

on completion of the wiring work. The following items shall be visually checked.

1. Overhead wires and overhead ground wires (numbers, loosening, damages, etc.)
2. The accessory.

The owner shall check the entire work to see that there is no loosening or damage on the wires or ground wires and that the fastening torques are the values specified in engineering work specifications.

Article 2-9. Wire Connection Inspection

Conditions of compression connecter sleeves that are used in connecting wires and ground wires shall be checked.

The owner shall check all connections according to the following criteria.

1. The cross sectional side lengths conform to the compression gauge and there is no abnormality The elongations of the sleeves are between 10% and 20%.
2. For aluminum conductors steel-reinforced, there is no eccentricity to the sleeve.

Article 2-10. OPGW Inspection

Conditions of optical fiber composite ground wires that affect the transmission performance of the wires shall be checked.

On completion of and after wiring, the owner shall check visually and measure the following items.

1. There is no damage on OPGW.
2. The fastening torques of grasp bolts are bellow the values specified in the manufactures' specifications or engineering work specifications.
3. Bending diameters shall be complied with manufacture's specifications.
4. The transmission losses of optical fibers are not greatly different from the measurement before the shipment from factories. If any major difference, proper countermeasures shall be taken. For example, the loss may be measure again by an Optical Domain Reflect-meter (OTDR) in order to identify the loss generating point.

Article 2-11. Insulation Clearance Inspection

Insulation distances between a wire and supporters or between wires shall be checked after completion of wiring work.

The owner shall check to see that the distances are not smaller than the design regulation stipulated in Technical Standard Vol.2Chapter5.

Article 2-12. Insulator Inspection

Types and conditions of insulators, and the number of insulators in one string etc. shall be checked after installation of insulators.

The owner shall check any abnormality for the following items visually or in other ways

1. Types (product numbers), dimensions, suspension types and number of trains conform to the engineering work specifications.
2. There is no crack, damage or pollution on insulators. Tolerances for external defects shall comply with IEC 60381-1(1993) "Insulators for overhead lines with a nominal voltage above 1000 V - Part 1: Ceramic or glass insulator units for A.C. systems - Definitions, test methods and acceptance criteria."
3. Insulator clamps have no deformation or any other abnormality and are installed according to the insulator train diagram.
4. Split pins are more than 45 degrees open.
5. There is no abnormality (stream line, undulation, etc.) to suspension insulators.

Article 2-13. Span Lengths, Horizontal Angles and Minimum Heights above Ground

Actual span lengths, horizontal angles and minimum heights above ground shall be checked after completion of wiring works.

The owner shall measure the center locations of iron towers and poles to see the differences from the designed locations and actual span lengths and horizontal angles. The owner also shall check the minimum hights based on the inspection record carried out by the constructor.

Section 3. Underground Transmission Line

Article 2-14. Inspection of Cable Joint

It shall be checked that cable joint boxes that are constructed on-site comply with the construction methods and dimensions of manufactures' specifications.

1. Insulation Resistance

It shall be checked that each cable is insulated from the ground. (For multi-core cables, it shall also be checked that those cores are mutually insulated.) The measurement shall be performed generally by the megger specified in IEC 61557-1: "Electrical safety in low voltage distribution systems up to 1000 V A.C. and 1500 V D.C.- Equipment for testing, measuring or monitoring of protective measures." The insulation resistance shall be measured after imposing a test voltage for 1 minute, except for those cables including long underground cables that have so large capacitance that the megger's needle would not settle in a short time, the insulation resistance of which shall be measured after the needle has settled. Temperature and humidity shall be recorded at the measurement. Resistances large enough to ensure that the cables are insulated shall be employed as

criteria.

2. Construction Methods and Dimensions of Cable Joint Boxes

It shall be checked based on quality and construction records produced by engineering work companies that joint boxes are constructed according to Manufactures' specifications, and that the dimensions of the construction comply with the specifications (construction diagram) where all relevant items including the length of removing cable jacket, length of exposed shielding layers and length of penciling on insulating materials shall be checked to meet the tolerances specified by manufactures.

3. Straightness of Cables

According to manufactures' specifications, cables shall be straightened by heat and the straightness of cables shall be measured to see that the curvature of cables meets the specifications.

4. Insertion of Conductors (only EB-GS, EB-OS1)

As an inadequate insertion of conductors to GIS[2] causes ill contact and overheat that lead to equipment failures, a cable marking shall be performed for a secure insertion. After conditions of the insertion being checked by hearing and touching, the distance from the GIS bottom plate to the marking shall be measured and checked to meet manufactures' standards.

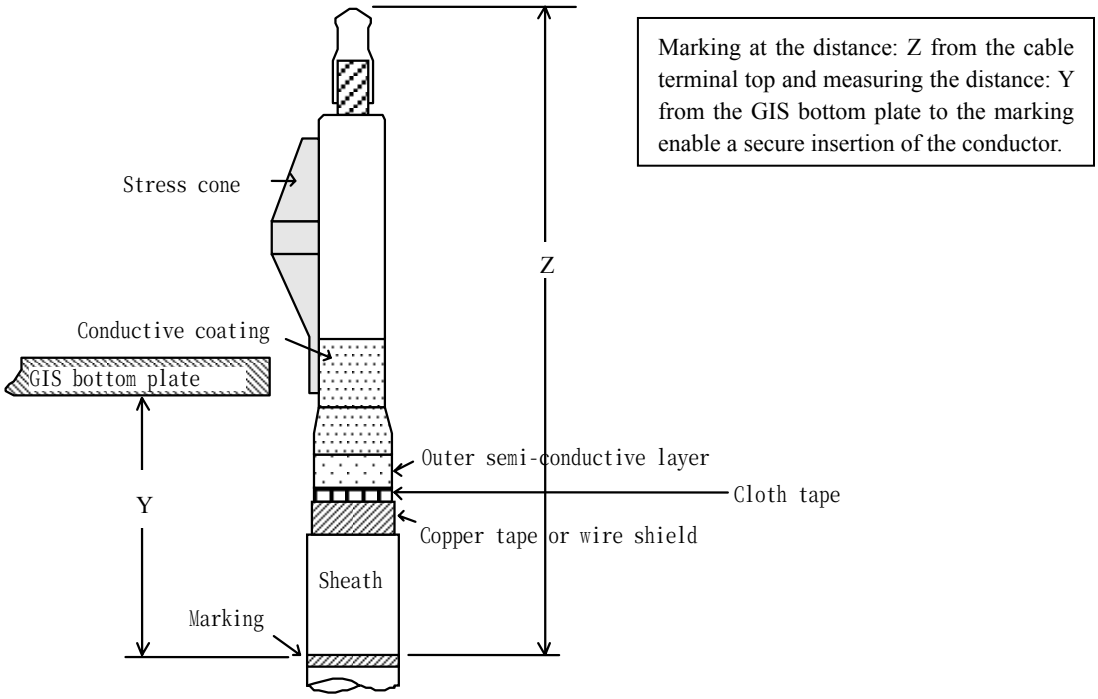

Fig.2-14-1 Structure of Slip-on Type Cable Terminal (Reference Drawing)

[1] EB-OS: Oil-filled terminal box (slip-on type)
[2] GIS: Gus Insulated Switchgear

Article 2-15. Phase Check

On completion of a cable engineering work, a final phase check shall be performed at both ends of the cable in order to prevent wrong joints. Measurement terminal and grounded terminal are considered. With each phase at the grounded terminal is grounded in turn, the insulation resistance between conductor and earth at the measurement terminal shall be measured. A measurement of 0 M-ohm shall decide that this phase is grounded while a measurement of rising resistance shall decide this phase is open.

Article 2-16. Earth Connection

It shall be checked that metal sheathes and protectors of underground wires are adequately grounded.

1. Conditions of earth connection

Earth connection shall be checked to comply with the engineering work Specifications.

2. Earth resistance

Earth resistance shall be checked to be less than 100Ω.

Article 2-17. Conditions of cable supporters

Conditions of cable supporters shall be checked to comply with engineering work specifications. Number, appearance (surface damage), position and bolt fastening of cable supporters shall be visually checked.

Article 2-18. Cable Installation

It shall be checked that no excessive load weighs on the cable, that there is no harmful damage on the cable and that the cable is not bent with a radius less than the permissible bending radius.

1. Cable tension

The following permissible cable tension shall be observed so that there would be no distortion or movement of cable core.

Permissible cable tension = 70 × N × A (N)

N: number of cores, A: cross sectional area (mm2)

2. Permissible cable lateral pressure

It shall be checked that there is no change in surface damage strength or abrasion resistance of cable jacket of the cable and that there is no cable distortion due to external pressure.

3. Cable bending radius

Bending radius in the following table shall be observed so that electrical and mechanical characteristics of the cable would not deteriorate.

Table 2-18-1 Permissible Bending Radius of Cables

Cable type		Bending radius
CV	Single core	10 ×（Cable outer diameter）
	Triplex	8 ×（Cable apparent outer diameter）
Aluminum sheath OF	Single core	15 ×（Average outer diameter of aluminum sheath）
	Three core	12 ×（ 〃 ）
Lead sheath OF	Three core	10 ×（Average outer diameter of lead sheath）
Stainless sheath CV	Single core	17.5 ×（Average outer diameter of stainless sheath）
(Permissible bending radius during installation work)＝(Permissible bending radius)× 1.5		

Article 2-19. Insulation Resistance of Cable Jacket

Insulation resistance between the cable jacket and the ground shall be measured to see that there is no abnormality on the layer. The measurement shall be performed by the megger specified in IEC 61557-1: "Electrical safety in low voltage distribution systems up to 1000 V A.C. and 1500 V D.C.- Equipment for testing, measuring or monitoring of protective measures" and it shall be checked that the insulation resistance is more than following criteria.

Table 2-19-1 Permissible insulation resistance for Cable Jacket

Cable type	Insulation resistance
Cables with water sealing layers	More than 10MΩ・km
Extra-nonflammable cables	More than 1MΩ・km
OF	More than 1MΩ・km

Article 2-20. Cable Snaking

It shall be checked that the cables are installed according to the design specifications. Pitches and spans of snaking shall be measured and checked to meet permissible values. Positions and numbers of constraining cleats shall be checked to comply with the design specifications.

Article 2-21. Grounding Points

For many short spans of single core cables, one end is grounded to prevent circulatory currents due to electromagnetic induction. The grounding shall be checked to comply with the design specifications.

Article 2-22. Clearance from Other Cables, Pipes, etc

It shall be confirmed that the clearance between the cable and other lines (light current, low voltage, high voltage, gas pipe, etc.) is adequate by visual check, or otherwise, that an adequate safety measure is employed.

Section 4. Substation Equipment

Article 2-23. The Inspection Item for Transformers

1. Measurement of Insulation Performances

(1) Measurement of Insulation resistances of windings: R60

This measurement shall comply with the following conditions.

a. Inslation resisntances for transformers lower than 150kV shall be measured at 10℃ and higher, and ones for transformers higher than 220kV are measured at 30℃.

b. Insulation resisntances for transformers higher than 110kV and 80,000kVA shall be measured at temperature to exceed ±5℃ in comparison with temperature when manufacturer measured the insulation resistance. For transfomers lower than 150kV and 80,000MVA, this difference of temperature shall not exceed ±10℃.

Nevertheless, in the case that the temperature in the field is different from the one in the factory, the measurement result of the insulation resistance shall be compensated by using the coefficient K_1 in Table 2-23-1.

Table 2-23-1 Coefficient K_1

Difference of temperature[℃]	1	2	3	4	5	10	15	20	25	30
Coefficient K_1	1.04	1.08	1.13	1.17	1.22	1.50	1.84	2.25	2.75	3.40

If difference of temperature is not included in Table 2-23-1, coefficient corresponding to it shall be calculated by multiplication of each coefficient.

Ex.) Difference of temperature is 9 ℃;

$K_{[9℃]} = K_{[5℃]} K_{[4℃]} = 1.22 \times 1.17 = 1.42$

c. The temperature of windings for transformers lower than 35kV is considered to be equal with oil. On the other hand, the one for transformers higher than 35kV is considered to be equal with the temperature of phase B of primary windings calculated by the following formula.

$t_x = R_x/R_0(235+t_0)-235$

R_0: the winding resistance measured at temperature t_0 in the factory

R_x: the winding resistance measured at temperature t_x

d. The measurement for the transformers higher than 110kV shall be carried out for 120 seconds after grounding the windings. If the measurement is repeated, it should be carried out for 300 seconds after grounding the windings again.

If there are no data of inspection done by manufacturers at factories, it is possible to refer to the permissible minium value in the Table 2-23-2.

Table 2-23-2 Insulation resistance [MΩ]

Voltage level for primary windings	Windings temperature [℃]						
	10	20	30	40	50	60	70
Lower than 35kV and lower than 10,000kVA	450	300	200	130	90	60	40
Higher than 35kV and higher than 10,000kVA or higher than 110kV	900	600	400	260	180	120	80

In the case that transformer is fully not filled with oil, measurement of winding resistance can be carried out if oil level is 150 to 200 mm from top of the transformer and main insulating parts are in the oil fully.

(2) Measurement of Insulation resistances for control circuits

Insulation resistances between control circuits and the ground shall be measured by a 500V megger to see that they are more than 2MΩ.

(3) Measurement of tan δ

Measuremnet of dielectric loss angle (tan δ) shall be applied to the transformer of voltage 110kV and over.

This measurement shall comply with a), b) and c) in article 2-23-(1)-(i). Tan δ measured in the field shall be compared with the data of factory inspection or latest inspection. However, it is possible to refer to the permissible maxium value in the Table 2-23-3 if there are not these data.

Table 2-23-3. Tan δ for windings of transformers

Voltage level for primary windings	windings temperature [℃]						
	10	20	30	40	50	60	70
Lower than 35kV and lower than 10,000kVA	1,2	1,5	2,0	2,6	3,4	4,5	6,0
Higher than 35kV and higher than 10,000kVA or higher than 110kV	0,8	1,0	1,3	1,7	2,3	3,0	4,0

In the case that the temperature in the field is different from the one in the factory, the measurement result of tan δ shall be compensated by using the coefficient K_2 in the Table 2-23-4.

Table 2-23-4 Coefficient K_2

Difference of temperature[℃]	1	2	3	4	5	10	15	16
Coefficient K2	1,05	1,10	1,15	1,20	1,25	1,55	1,95	2,4

If difference of temperature is not included in above table, coefficient corresponding to it shall be calculated by multiplication of each coefficient as well as R60.

Since this measurement is influenced by insulating oil, it is necessary to exclude the influence in order to evaluate the result correctly.

$$\tan\delta_{Tr} = \tan\delta_{Me} - K(\tan\delta_{Oil2} - \tan\delta_{Oil1})$$

$\tan\delta_{Tr}$: Actual value of $\tan\delta$ for windings of transformer

$\tan\delta_{Me}$: Measurement value of $\tan\delta$ for windings in the field

$\tan\delta_{Oil1}$: $\tan\delta$ for oil in the transformer measured in the factory which compensated into the mesurement temperature.

$\tan\delta_{Oil2}$: $\tan\delta$ for oil in the transformer measured in the field which compensated into the mesurement temperature.

Tan δ for oil is compensated by using coefficeint K3

Table 2-23-5. Coefficient K_3

Difference of temperature[℃]	1	2	3	4	5	10	15	20	30
Coefficient K3	1,03	1,06	1,09	1,12	1,15	1,31	1,51	2,0	2,3

If tan δ measured in the field is lower than 1%, it is admitted to satisfy the standards regardless of the result of the factory inspection.

2. Measurement of Transformation Ratio

Transformation ratio shall be measured for each tap of transformers. The difference between the measurement and the manufactures' specification shall be less than 0.5%.

3. Polarity and Phase Sequence Test

Polarity, wire connection and phase sequence of transformers shall be checked. For single-phase transformers, all windings shall be checked for polarity. For three-phase transformers, all windings shall be checked for wire connection and phase sequence to see that there is no difference from the manufactures' specifications.

4. Measurement of Winding Resistance

Winding resistances of transformers shall be measured using direct current. The difference between the measurement and the manufactures' specification shall be less than 2%.

5. Measurement of No-load current and loss

No-load current and loss shall be measured and checked to meet manufactures' specifications.

6. Insulation Oil Test

Insulation performances of transformer insulation oil shall be checked before oil filing to see that the performances comply with the criteria shown in Table 2-23-6.

Table 2-23-6 Insulation performances of transformer insulation oil

	Dielectric Strength	Moisture in Oil	Gas in Oil	Total acid number	Volume resistivity
500kV	Greater than 70kV/2.5mm	Less than 10ppm.wt	Less than 0.5%·vol	Less than 0.02mgKOH/g	Less than 1×10^{12} Ω·cm (at 50℃)
110～220kV	Greater than 60kV/2.5mm		Less than 1.0%·vol		
Lower than 110kV	Greater than 45kV/2.5mm		Less than 2.0%·vol		
15～35kV	Greater than 35kV/2.5mm				
Lower than 15kV	Greater than 30kV/2.5mm				

7. Oil Tightness Test

Oil tightness shall be checked that there is no oil leak under the following conditions.

(1) Pressure: higher than 0.02MPa.

(2) Pressurizing time: more than 24 hours.

8. Tap Changer Inspection

(1) Switching operation test

It shall be checked that On-Line Tap Changer (OLTC) can be switched without any abnormality both manually and by electric drive.

(2) Measurement of currents of electric motors

Currents of electric motors shall be measured to see that the OLTC switches smoothly without any abnormality on electric drive mechanism. The currents shall be within the tolerances of manufactures' standards.

9. Bushing CT Inspection

Bushing Current Transformer (CT) inspections shall be performed according to CT inspection items specified separately in Article 2-25.

10. Cooling System Inspection

Transformer cooling systems shall be inspected to see that pumps and fans operate without any abnormality. Currents of the cooling systems shall be measured and checked to meet the manufactures' specifications. Phase rotations shall be checked to be the positive direction.

11. Silica Gel Inspection

Silica gel, which is used to eliminate the moisture of oil-filled transformers, shall be checked of its color.

Article 2-24. The Inspection Item for Potential Transformers (PT)

1. Measurement of Insulation Resistance

(1) Measurement of insulation resistance of primary windings

Insulation resistances between a winding and the ground, and between windings shall be measured by a 1,000V megger. Standards for the resistances by type are as Table 2-24-1.

a. Winding type

Table 2-24-1 Standards of Insulation resistance for winding type PT (MΩ)

Oil temperature / Nominal Voltage (kV)	20℃	30℃	40℃	50℃	60℃
Higher than 66	1,200	600	300	150	75
20～44	1,000	500	250	125	65
10～19	800	400	200	100	50
Lower than 10	400	200	100	50	25

b. Condenser-type and dry mold-type

The insulation resistance of primary windings shall be more than 50MΩ.

c. SF6 gas insulation-type

The insulation resistance of primary windings shall be more than manufactures' specifications.

(2) Measurement of insulation resistances for control circuits

Insulation resistances between control circuits and the ground shall be measured by a 500V megger to see that they are more than 2MΩ.

2. Measurement of Transformation Ratio

Transformation ratio shall be measured for each tap of potential transformers. The measurement shall be performed with the potential transformers being connected to control boards. With the primary circuit of potential transformers being energized, the voltage of secondary circuit shall be measured at the test terminal on control board in order to comprehensively confirm that the transformation ration and the wire connection are adequate.

3. Polarity Test

Polarity of potential transformers shall be checked. The primary circuit of transformers shall be connected to a tester, and then the polarity of the secondary circuit shall be checked.

Article 2-25. The Inspection Item for Current Transformers (CT)

1. Measurement of Insulation Resistance

(1) Measurement of insulation resistance of primary windings

Insulation resistances between a winding and the ground, and between windings shall be measured by a 1,000V megger. Standards for the resistances by type are as follows.

a. Porcelain-type

Table 2-25-1 Standards of insulation resistance for porcelain type CT (MΩ)

Oil temperature / Nominal Voltage (kV)	20℃	30℃	40℃	50℃	60℃
Higher than 66	1,200	600	300	150	75
20～44	1,000	500	250	125	65
10～19	800	400	200	100	50
Lower than 10	400	200	100	50	25

b. Bushing CT-type

Not necessary to measure insulation resistance of primary windings.

(2) Measurement of insulation resistances for control circuits

Insulation resistances between control circuits and the ground shall be measured by a 500V megger to see that they are more than 2MΩ.

(3) Measurement of tan δ

Measurement of dielectric loss angle (tan δ) should be measured for the current transformer of Nominal Voltage 110 kV and over. The measured value of tan δ at temperature + 20°C should not exceed the values stipulated as Table 2-25-2.

Table 2-25-2 Standards of tan δ for CT

Test Object	Dielectric loss value tan δ % at nominal voltage (kV)		
	35	110	150-220
Oiled current transformer (with oil paper insulation)	2.5	2	1.5

2. Measurement of Transformation Ratio

Transformation ratio shall be measured for each tap of current transformers. The measurement shall be performed with the current transformers being connected to control boards. With the primary circuit of current transformers being applied test current , the current and phase angle of secondary circuit shall be measured at the test terminal on control board in order to comprehensively confirm that the transformation ration and the wire connection are adequate.

3. Polarity Test

Polarity of current transformers shall be checked. The primary circuit of transformers shall be connected to a tester, and then the polarity of the secondary circuit shall be checked.

4. Measurement of Excitation Characteristics

Excitation characteristics of current transformers shall be measured to see the change of the characteristics caused by any core movement or gap. Only those current transformers that have split type cores are relevant. The measurement result shall be compared with factory inspection records to see that there is no difference.

Article 2-26. The Inspection Item for GCB

1. Measurement of Insulation Resistance

(1) Measurement of insulation resistance of primary conductors

Insulation resistances between the primary conductor and the ground, and between poles shall be measured by a 1,000V megger to see that the insulation resistances are more than 1,000MΩ.

(2) Measurement of insulation resistances for control circuits

Insulation resistances between control circuits and the ground shall be measured by a 500V megger to see that they are more than 2MΩ.

2. Measurement of Contact Resistance for Direct Current

(1) Measurement of contact resistance for GCB primary circuit

Contact resistances for primary circuits shall be measured and checked to meet manufactures' specifications. In principle, the measurement shall be performed for each contact. However, a measurement for all contacts in block may be performed if the measurements for individual contacts are impossible due to the structure of Gas Circuit Breaker.

(2) Measurement of contact resistance of auxiliary switches

Contact resistances of auxiliary switches shall be measured and checked to meet manufactures' specifications.

3. Tightness Test of Pneumatic Systems

Only those GCB that have pneumatic drive mechanisms are relevant. After the drive mechanism has been filled with air at the rated pressure, air leakage shall be measured and checked to be less than 3% per 12 hours.

4. Slow Leak Test of Oil Pressure Systems

Only those GCB that have oil pressure drive mechanisms are relevant. Slow leak time of the oil pressure system shall be measured and checked to meet manufactures' specifications. The slow leak

time is the time for the oil pressure to drop to the pump restart pressure due to the oil leakage after the oil pressure has been set to stop the oil pump.

5. Gas Density Detectors Test

The following pressure shall be measured and checked that it meets manufactures' specifications.

(1) SF6 gas pressure that detectors are activated for alarm and lock of operation of GCB.

(2) SF6 gas pressure that alarm and lock of operation of GCB are reset.

6. SF6 Gas Analysis

SF6 gas filled in the GCB shall be analyzed after more than one day has passed since the gas was filled. Moisture in SF6 gas for each gas compartment shall be measured and checked to be less than manufactures' specifications.

7. Opening and Closing Operations Test

(1) Manual opening and closing operations test

It shall be checked that there is no abnormality in the GCB by opening and closing it three times by manual handle or press button in the field.

(2) Opening and closing operations test

It shall be checked that there is no abnormality in the GCB by opening and closing it three times at the rated voltage (pressure) by remote control.

(3) Trip free mechanism test

It shall be confirmed the GCB is opened immediately and not closed again if tripping command is inputted during closing operation.

After that, it shall be confirmed the GCB can be closed if both of closing and tripping command are canceled.

Those GCB that have no trip free mechanism are irrelevant.

8. Measurement of Opening and Closing Characteristics

(1) Contact opening time and closing time

Contact opening time and closing time shall be measured and checked to meet manufactures' specifications.

(2) Minimum operational voltage (pressure)

In the state where voltage is not applied to the primary circuit, either the voltage of electromagnetic coil or the pressure of compressed air shall be maintained at rated value, and the minimum voltage or pressure when GCB completely operates shall be measured by changing the other parameter (pressure or voltage). At this time, the opening-and-closing speed characteristic of GCB does not need to meet manufacturer's specifications.

It shall be checked that the measured value of the minimum operating voltage (pressure) does not exceed the value shown in Table 2-26-1.

Table 2-26-1 Standards of Minimum operating voltage (pressure) for GCB

Items	Standards
Minimum closing voltage	Lower than 75% of the rated control voltage
Minimum opening voltage	Lower than 70% of the rated control voltage
Minimum closing pressure（only for pneumatic drive）	Lower than 85% of the rated pressure
Minimum opening pressure（only with pneumatic drive）	Lower than 85% of the rated pressure

(3) Three-phase imbalance

Three-phase imbalance of opening and closing time shall be measured and checked to meet the standards shown in Table 2-26-2.

Table 2-26-2 Standards of three-phase imbalance for GCB

Nominal Voltage	Standards
lower than 110kV	less than 0.006sec.
110kV and higher	less than 0.004sec.

(4) Operational timing of auxiliary switches

Operational timing of make contact (a-contact) and break contact (b-contact) in auxiliary switches shall be measured and checked to meet the procurement specifications. If they aren't given in the procurement specifications, they are checked to meet manufactures' standards.

9. Phase Missing Timer Test

Only those GCB that are operated phase-separately are relevant. After one phase has been opened from a state of three phases closed, the time before other two phases trip shall be measured and checked to meet the procurement specifications.

10. Associated Tank Capacity Test

Only those GCB that have pneumatic or oil pressure drive are relevant. It shall be confirmed that the GCB can be opened and closed consecutively more than once (more than twice for those GCB that have duties to re-close) when the associated tank is not connected to driving sources (pressurized air or power source).

11. Interlocking System Test

(1) Locking by SF6 gas pressure

It shall be confirmed that the GCB cannot be opened or closed when SF6 gas pressure is lowered to the operational pressure of locking system.

(2) Locking by oil pressure drive

Only those GCB that have oil pressure drive are relevant. It shall be confirmed that the GCB cannot be opened or closed when oil pressure is lowered to the operational pressure of locking system.

(3) Locking by pneumatic drive

Only those GCB that have pneumatic drive are relevant. It shall be confirmed that the GCB cannot be opened or closed when air pressure is lowered to the operational pressure of locking system.

12. Operation Test of Safety Valve

Only those GCB that have pneumatic or oil pressure drive are relevant. It shall be confirmed the safety valve operates before the air or oil pressure rises to the tank maximum allowable pressure.

Article 2-27. The Inspection Item for GIS

Field tests that are performed on GIS installation shall be specified. GIS herein does not include GCB.

1. Measurement of Insulation Resistance

(1) Measurement of Insulation resistance of primary conductors

Insulation resistances between the primary conductor and the ground, and between poles shall be measured by a 1,000V megger to see that the insulation resistances are more than 1,000MΩ.

(2) Measurement of Insulation resistances for control circuits

Insulation resistances between control circuits and the ground shall be measured by a 500V megger to see that they are more than 2MΩ.

2. Measurement of Contact Resistance for Direct Current

(1) Measurement of contact resistance for GIS primary circuit

Contact resistances for primary circuits shall be measured and checked to meet manufactures' specifications. In principle, the measurement shall be performed for each contact. However, a measurement for all contacts in block may be performed if the measurements for individual contacts are impossible due to the structure of GIS.

(2) Measurement of contact resistance of auxiliary switches

Contact resistances of auxiliary switches shall be measured and checked to meet manufactures' specifications.

3. Air Tightness Test of Pneumatic Systems

Only those GIS that have pneumatic drive mechanisms are relevant. After the drive mechanism has been filled with air at the rated pressure, air leakage shall be measured and checked to be less than

3% per 12 hours.

4. Gas Density Detectors Test

The following pressure shall be measured and checked that it meets manufactures' specifications.

(1) SF6 gas pressure that detectors are activated for alarm and lock of operation of GCB.

(2) SF6 gas pressure that alarm and lock of operation of GCB are reset.

5. SF6 Gas Analysis

SF6 gas filled in the GIS shall be analyzed after more than one day has passed since the gas was filled.

Moisture in SF6 gas for each gas compartment shall be measured and checked to meet the manufacture's specifications.

6. Opening and Closing Operations Test in Disconnector

(1) Manual opening and closing operations test

It shall be checked that there is no abnormality in the disconnector by opening and closing it three times by manual handle or press button in the field.

(2) Opening and closing operations test

It shall be checked that there is no abnormality in the disconnector by opening and closing it three times at the rated voltage (pressure) by remote control.

7. Arrestors Inspection

Arrestors inspections shall be performed according to inspection items specified separately in Article 2-34.

8. PT Inspection

PT inspections shall be performed according to inspection items specified separately in Article 2-24.

9. CT Inspection

CT inspections shall be performed according to inspection items specified separately in Article 2-25.

10. Sequence and Interlock Tests

Control circuits of GIS control boards shall be checked.

(1) Sequence test of GIS control boards

Sequence test shall be performed to confirm that the control circuits conform to Manufactures' specifications.

(2) Interlock test of GIS control boards

Interlock test shall be performed independently for GIS to confirm that both the electrical and mechanical interlocks conform to the procurement specifications.

11. Phase Check

Phase check shall be performed for each outlet of GIS to confirm that the primary circuit connection conforms to the procurement specifications.

Article 2-28. The Inspection Item for VCB

1. Measurement of Insulation Resistance

(1) Measurement of Insulation resistance of primary conductors

Insulation resistances between the primary conductor and the ground, and between poles shall be measured by a 1,000V megger to see that the insulation resistances are more than 1,000MΩ.

(2) Measurement of Insulation resistances for control circuits

Insulation resistances between control circuits and the ground shall be measured by a 500V megger to see that they are more than 2MΩ.

2. Opening and Closing Operations Test

(1) Manual opening and closing operations test

It shall be checked that there is no abnormality in the VCB by opening and closing it three times by manual handle or press button in the field.

(2) Opening and closing operations test

It shall be checked that there is no abnormality in the VCB by opening and closing it three times at the rated voltage by remote control.

(3) Trip free mechanism test

It shall be confirmed the VCB is opened immediately and not closed again if tripping command is inputted during closing operation.

After that, it shall be confirmed the VCB can be closed if both of closing and tripping command are canceled.

Those VCB that have no trip free mechanism are irrelevant.

3. Measurement of Opening and Closing Characteristics

(1) Contact opening time and closing time

Contact opening time and closing time shall be measured and checked to meet manufactures' specifications.

(2) Minimum operational voltage

In the state where voltage is not applied to the primary circuit, the voltage of electromagnetic coil shall be changed, and the minimum voltage when VCB completely operates shall be measured. At this time, the opening-and-closing speed characteristic of VCB does not need to meet manufacturer's specifications.

It shall be checked that the measured value of the minimum operating voltage does not exceed the value shown in Table 2-28-1.

Table 2-28-1 Standards of Minimum operating voltage for VCB

Items	Standards
Minimum closing voltage	Lower than 75% of the rated control voltage
Minimum opening voltage	Lower than 70% of the rated control voltage

(3) Three-phase imbalance of opening and closing time shall be measured and checked to meet the standards shown in Table 2-28-2.

Table 2-28-2 Standards of three-phase imbalance for VCB

Nominal Voltage	Standards
lower than 110kV	less than 0.006sec.
110kV and higher	less than 0.004sec.

(4) Operational timing of auxiliary switches

Operational timing of make contact (a-contact) and break contact (b-contact) in auxiliary switches shall be measured and checked to meet the procurement specifications. If they aren't given in the procurement specifications, they are checked to meet manufactures' standards.

Article 2-29. The Inspection Item for OCB

1. Measurement of Insulation Resistance

(1) Measurement of Insulation resistance of primary conductors

Insulation resistances between the primary conductor and the ground, and between poles shall be measured by a 1,000V megger to see that the insulation resistances are more than 1,000MΩ.

(2) Measurement of Insulation resistances for control circuits

Insulation resistances between control circuits and the ground shall be measured by a 500V megger to see that they are more than 2MΩ.

2. Measurement of Contact Resistance for Direct Current

(1) Measurement of Contact resistance for OCB primary circuit

Contact resistances for OCB primary circuits shall be measured and checked to meet manufactures' specifications. The measurement shall be performed for each phase.

(2) Measurement of Contact resistance of auxiliary switches

Contact resistances of auxiliary switches shall be measured and checked to meet manufactures' specifications.

3. Opening and Closing Operations Test

(1) Manual opening and closing operations test

It shall be checked that there is no abnormality in the OCB by opening and closing it three times by manual handle or press button in the field.

(2) Opening and closing operations test

It shall be checked that there is no abnormality in the OCB by opening and closing it three times at the rated voltage (pressure) by remote control.

(3) Trip free mechanism

It shall be confirmed the OCB is opened immediately and not closed again if tripping command is inputted during closing operation.

After that, it shall be confirmed the OCB can be closed if both of closing and tripping command are canceled. Those OCB that have no trip free mechanism are irrelevant.

4. Measurement of Opening and Closing Characteristics

(1) Contact Opening and Closing Time, and Speed Characteristics

Contact opening time and closing time shall be measured for OCB of all voltage classes. In addition, opening and closing speed characteristics shall be measured, in principle, for all OCB of higher than 35kV. Both of the measurements shall be checked to meet manufactures' specifications.

(2) Minimum Operational Voltage (Pressure)

In the state where voltage is not applied to the primary circuit, either the voltage of electromagnetic coil or the pressure of compressed air shall be maintained at rated value, and the minimum voltage or pressure when OCB completely operates shall be measured by changing the other parameter (pressure or voltage). At this time, the opening-and-closing speed characteristic of OCB does not need to meet manufacturer's specifications.

It shall be checked that the measured value of the minimum operating voltage (pressure) does not exceed the value shown in Table 2-29-1.

Table 2-29-1 Standards of Minimum operating voltage (pressure) for OCB

Items	Standards
Minimum closing voltage	Lower than 75% of the rated control voltage
Minimum opening voltage	Lower than 70% of the rated control voltage
Minimum closing pressure（only for pneumatic drive）	Lower than 85% of the rated pressure
Minimum opening pressure（only with pneumatic drive）	Lower than 85% of the rated pressure

(3) Three-phase imbalance of opening and closing time shall be measured and checked to meet the standards shown in Table 2-29-2.

Table 2-29-2 Standards of three-phase imbalance for OCB

Nominal Voltage	Standards
lower than 110kV	less than 0.006sec.
110kV and higher	less than 0.004sec.

(4) Operational timing of auxiliary switches

Operational timing of make contact (a-contact) and break contact (b-contact) in auxiliary switches shall be measured and checked to meet the procurement specifications. If they aren't given in the procurement specifications, they are checked to meet manufactures' standards.

5. Insulation Oil Test

Insulation oil before filling shall be tested for all OCB. Except for LOCB of lower than 110kV, insulation oil after filling also shall be tested. Test contents shall comply with Article 2-23-(6).

6. Bushing CT Inspection

Bushing CT inspections shall be performed according to CT inspection items specified separately in Article 2-25.

Article 2-30. The Inspection Item for Disconnector

1. Measurement of Insulation Resistance

(1) Measurement of Insulation resistance of primary conductors

Insulation resistances between the primary conductor and the ground, and between poles shall be measured by a 1,000V megger to see that the insulation resistances are more than 1,000MΩ.

(2) Measurement of Insulation resistances for control circuits

Insulation resistances between control circuits and the ground shall be measured by a 500V megger to see that they are more than 2MΩ.

2. Measurement of Contact Resistance for Direct Current

Contact resistances for primary circuits shall be measured and checked to meet manufactures' specifications.

3. Opening and Closing Operations Test

(1) Manual opening and closing operations test

It shall be checked that there is no abnormality in the disconnector by opening and closing it three times by manual handle or press button in the field.

(2) Opening and closing operations test

It shall be checked that there is no abnormality in the Disconnector by opening and closing it three times at the rated voltage (pressure) by remote control.

4. Operational Timing of Auxiliary Switches

Operational timing of make contact (a-contact) and break contact (b-contact) in auxiliary switches shall be measured and checked to meet the procurement specifications. If they aren't given in the procurement specifications, they are checked to meet manufactures' standards.

5. Interlock Tests

Interlock between main blade and grounding blade of disconnector shall be checked that the object of interlock does not operate just as described in manufacturer's specifications.

Article 2-31. The Inspection Item for Air Compressor

1. Pressure Gauge Test

Accuracies of pressure gauges shall be checked to meet manufactures' specifications.

2. Safety Valve Test

It shall be confirmed the safety valve operates before the air or oil pressure rises to the tank maximum allowable pressure.

3. Automatic Start and Stop Test

It shall be confirmed that the compressors shall automatically start at the starting pressure and stop at the stopping pressure.

Article 2-32. The Inspection Item for Compact Switch Gear Cubicle

1. Measurement of Insulation Resistance

Insulation resistances of distribution cubicles shall be measured.

(1) Measurement of Insulation resistance of main circuits

Insulation resistances shall be measured by a 1,000V megger. Standards for the resistances are as

follows.

a. Each equipment

The insulation resistance of each equipment shall be more than 1,000MΩ.

b. Total equipment

The insulation resistance of total equipment shall be more than

$$\frac{10 \times \text{Nominal voltage (V)}}{\text{N (number of insulators)} \times 1{,}000} \quad (\text{M}\Omega).$$

(2) Measurement of Insulation resistances for control circuits

Insulation resistances between control circuits and the ground shall be measured by a 500V megger to see that they are more than 2MΩ.

2. Sequence and Interlock Tests

Control circuits of distribution cubicle control boards shall be checked.

(1) Sequence test of distribution cubicle control boards

Sequence test shall be performed to confirm that the control circuits conform to Manufactures' specifications.

(2) Interlock test of distribution cubicle control boards

Interlock test shall be performed to confirm that both the electrical and mechanical interlocks conform to the Manufactures' specifications.

3. Phase check

Phase check shall be performed for distribution cubicles to confirm that the primary circuit connection conforms to the Manufactures' specifications.

Article 2-33. The Inspection Item for Power Capacitor

1. Measurement of Insulation Resistance

Insulation resistances of power capacitors shall be measured.

(1) Measurement of Insulation resistance of main circuits

Insulation resistances shall be measured by a 1,000V megger. The resistances shall be more than 1,000MΩ.

(2) Measurement of Insulation resistances for control circuits

Insulation resistances between control circuits and the ground shall be measured by a 500V megger to see that they are more than 2MΩ.

2. Conduction check of discharge resistance

Conduction check at the terminals of discharge resistance shall be measured by using a circuit tester.

3. Sequence Tests

Sequence test shall be performed to confirm that the control circuits such as alarm circuits conform to the Manufactures' specifications.

Article 2-34. The Inspection Item for Surge Arrester

1. Measurement of Insulation Resistance

Insulation resistances of surge arresters shall be measured.

(1) Measurement of Insulation resistance of main circuits

Insulation resistances shall be measured by a 1,000V megger. The resistances shall be more than 1,000MΩ.

(2) Measurement of Insulation resistances of insulation base

Insulation resistances of insulation base shall be measured by a 500V megger on condition that measurement terminals for leakage currents are detached. The resistances shall be more than 2MΩ.

Article 2-35. The Inspection Item for Battery

1. Measurement of Voltage

Voltages of each cell shall be checked. The voltage of the exhausted cell shall not deviate more than 1~1.5% in comparison with the average voltage of remained cells. Quantity of the exhausted cells shall not exceed 5% of the total number of cells in the battery.

The allowed band of each cell shall be as Table 2-35-1.

Table 2-35-1 Allowed band of charging voltage for batteries

Charging voltage (V)	2.15, 2.18	2.26, 2.30, 2.34	2.40, 2.45, 2.50
Allowed band (V)	±0.05	±0.10	±0.15

2. Equalizing charge test

Equalizing charging test shall be conducted to correct unbalanced voltage and specific gravity and homogenize the upper and lower layer of electrolytes. The test procedure shall comply with the Manufactures' specifications.

Article 2-36. The Inspection Item for Protection Relays and Control Equipment

1. Unit Test

Performance and property tests cited bellow shall be implemented for each meter and relay, and activation points shall be set for relays. These unit tests shall be conducted with relay circuits for open and close command signals as well as CT and PT circuits being completely separated.

(1) Meter error measurement

(2) Relay activation point measurement

(3) Voltage and current property test

(4) Phase property test

(5) Operational time measurement

2. DC Circuit Test

Tests cited bellow shall be implemented for DC circuits.

(1) DC sequence test

(2) Insulation resistance measurement

(3) Load measurement

3. AC Circuit Test

(1) Secondary Circuit Test

Tests cited bellow shall be implemented for AC circuits in distribution boards (CT and PT) with a voltage and current applied, in order to check meters and relays.

a. Meter and relay operation test

b. Insulation resistance measurement

c. Load measurement

d. AC sequence test

(2) AC Circuit Test (Simulation Test)

Relay operational properties shall be checked with simulated faults (with AC or DC input level being sharply changed), and automatic operation systems shall be checked with simulated operation maneuvers.

a. Fault simulation test

b. Operational simulation test

4. Correspondence Test

Comprehensive operation tests shall be implemented for equipment and transmission channels that are installed in two or more electric stations and exchange information with one another.

5. Comprehensive Test with Field Equipment

(1) Insulation resistance

Comprehensive insulation resistance of principal and relevant systems and field equipment including connecting terminals shall be measured.

(2) Field equipment open and close operation test

It shall be checked that open and close command signals from control systems operate only intended field equipment and cause no abnormality.

(3) Interlock test

Field equipment shall be checked to properly operate corresponding to interlock conditions.

(4) Protection relay operation and alarm indication test

It shall be checked that protection relays and control systems are properly connected to primary equipment and that fault indication and alarm as well as operation of relevant equipment properly correspond to the relay or control system operation.

6. Comprehensive Test with PT Circuits

(1) Insulation Resistance Measurement

It shall be checked with earth circuits being disconnected that comprehensive circuits including PT, control cables and distribution boards are properly insulated (with no short circuits or ground faults).

(2) Polarization test

It shall be checked that secondary and tertiary circuits of PT that are connected with control cables are properly connected with one another according to design plans.

(3) Transforming ratio test

With a voltage being applied to PT primary circuit, voltage and phase angle shall be measured at PT test terminals in distribution boards that are connected to the PT secondary (tertiary) circuit in order to check that transforming ratio and connection between the PT and distribution board are proper.

(4) Load measurement

With the subject PT being fully loaded, the PT secondary circuit shall be applied with rated voltage, and comprehensive load including distribution board and control cable shall be measured in order to check that it is the same level as design values.

(5) Core check

In case that transforming ratios for two or more PT are simultaneously measured, it shall be checked that the secondary and tertiary circuits of each PT are properly connected to distribution boards by rendering a knife switch or circuit breaker "Off."

7. Comprehensive Test with CT Circuits

(1) Insulation resistance measurement

It shall be checked with earth circuits being disconnected that comprehensive circuits including CT, control cables and distribution boards are properly insulated (with no short circuits or ground faults).

(2) Polarization test

It shall be checked that secondary and tertiary circuits of CT that are connected with control cables are properly connected with one another according to design plans.

(3) Transforming ratio test

With voltage being applied to CT primary circuit, current and phase angle shall be measured at CT test terminals in distribution boards that are connected to the CT secondary circuit in order to check that transforming ratio and polarization as well as connection between the CT and distribution board are proper.

(4) Load measurement

With the subject CT being fully loaded, the CT secondary circuit shall be applied with rated current (5A or 1A) and comprehensive load including distribution boards and control cables shall be measured in order to check that it is the same level as design values.

(5) Core check

While a primary current is flowing through CT in a transforming ratio test, the CT secondary circuit shall be suddenly short circuited at the terminal block and it shall be checked that the reading of ampere meter connected to distribution board drop to zero, thus the subject CT is connected to a proper destination.

Chapter 5 Completion Inspection

Section 1. General

Article 2-37. General Provision

This inspection shall be done on completion of engineering work to confirm comprehensive qualities of the work before commencement of operation under the condition that each equipment is connected as whole system. Done for substation, overhead transmission line and underground cable separately. The owner of the facilities supervises this inspection.

Section 2. Overhead Transmission Line

Article 2-38. Measurement of Insulation Resistance

It shall be checked that the transmission line is well insulated by measuring the insulation resistance of the transmission line. The measurement shall be carried out for the cases: 1) line to ground; and 2) line to line. The insulation resistance meter prescribed in IEC 61557-1 "Electrical safety in low voltage distribution systems up to 1000V A.C. and 1500V D.C. - Equipment for testing, measuring or monitoring of protective measures" shall be used as a standard at the measurement. The criteria for this measurement shall be:

- Not less than 4 [MOhm] for line to ground;
- Not less than 8 [MOhm] for line to line.

Article 2-39. Phase Test

The arrangement of the transmission line phases shall be checked. Phase test shall be carried out through the measurement of the secondary voltage of potential divider in the substation or the measurement with the instrument such as insulation resistance meter.

Article 2-40. Power-Frequency Withstand Voltage Test

It shall be checked that the transmission line has the prescribed dielectric strength by applying normal line-to-ground voltage for 10 [min].

Section 3. Underground Transmission Lines

Article 2-41. Appearance Inspection (Route Exploration)

It shall be checked that the engineering work is completed according to the design specifications and the technical standards.

The following items shall be visually checked to comply with the design specifications.

- Number and installation method of cables
- Position of cable terminals (CH)
- Conditions of supporting for cables, terminal and joint boxes, and conditions of earth wires

Article 2-42. Insulation Resistance

It shall be checked that each core is insulated from the ground (and from other cores for multi-core cables excluding sealed type cables). The measurement shall performed generally by the megger

specified in IEC 61557-1 "Electrical safety in low voltage distribution systems up to 1000 V A.C. and 1500 V D.C.- Equipment for testing, measuring or monitoring of protective measures" after 1 minute of imposing the test voltage. If the cable capacitance were so large in case of long cables and others that the needle of the megger would not settle in a short time, the reading when the needle has settled shall be employed. The insulation criteria shall be such values that enable confirmation of the insulation.

Article 2-43. Phase Check

It shall be checked following the procedure prescribed in Article 2-15.

Article 2-44. Withstand Voltage Test

The test voltage specified in Appendix 1 according to the cable voltage shall be imposed for 10 minutes to see that the cable has the specified dielectric strength.

As the primary insulation of cable joints is constructed on-site, the quality of insulation significantly depends on the on-site work. Therefore, the test voltage specified in Appendix 1 shall be imposed except for "those cables that withstand voltage tests have been performed on at factories and the confirmed insulation characteristics of which are considered to be maintained on-site." A test with normal voltage to the groung shall not replace the above mentioned dielectric strength test.

In case that a DC voltage is used for the test, the DC voltage shall be twice as large as the AC test voltage.

Article 2-45. Clearance between Live Part and Fence or Wall

It shall be checked that the distance between exposed live part at equipment terminals and fence or wall meets the required clearance stipulated in Article 2-46-3.

Section 4. Substation Equipment

Article 2-46. Visual Inspection

1. State of installation of equipment which generates arc

It shall be checked that the equipment which generates arc such as circuit breaker and disconnector is isolated from combustibles with the distance safe enough.

2. State of installation of charged part

It shall be checked that the charged part (excluding the equipment which is enclosed with earthed container, e.g. GIS) is isolated with the distance shown in Table2-46-1 so that it may not be touched

easily. Here, the charged part includes supporting insulator which is not surrounded by fence.

Table 2-46-1 Distance between charged part and guard fence, guard net

Nominal Voltage level [kV]	Height of charged part [m]	Distance between charged part and guard fence, guard net [cm]	
		Outdoor	Indoor
6.6	2.2	25	12
11		30	18
33		50	42
66		85	73
110		140	---
220	2.5	260 ~ 270	---
500		500 ~ 800	---

3. Installation of fence, wall

It shall be checked that the substation is surrounded by fence, wall and is equipped with locking-up instrument so that unauthorized persons may not be able to enter the substation yard easily. The height of fence, wall shall be checked not less than 1.5 [m].

Nominal Voltage	Sum of the height of fence or wall and the distance from the live part: (a+b)
Less than 35,000V	More than 5m
More than 35,000 V and less than 160,000 V	More than 6m
More than 160,000V	6m plus a 12cm for each 10,000V

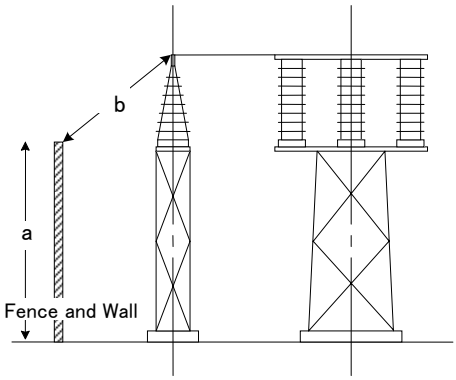

Table 2-46-2 Clearance between Live Part and Fence or Wall

Article 2-47. Measurement of Grounding Resistance

Grounding resistance of substation shall be measured and checked not exceeding the standard value shown in the Table 2-47-1.

Table 2-47-1 Grounding resistance of substation

Substation to be checked	Standard value [Ohm]
Substation whose maximum operating voltage is less than 110kV (Substation where the transmission line of solidly grounded neutral system is connected shall be excluded.)	5
Substation whose maximum operating voltage is 110kV or above Substation where the transmission line of solidly grounded neutral system is connected	3,000 / (Fault current at the time of single line-to-ground fault [A])

Grounding resistance is set so that the voltage rise at the fault point may not exceed 3,000V at the time of occurrence of ground fault. Since large ground fault current may flow in solidly grounded neutral system, the standard for grounding resistance is prescribed separately.

Article 2-48. Supervisory and Control Test

1. Switching test

By operating circuit breaker, disconnector which are controlled from the control room, it shall be checked that each equipment works properly and the indication in the control room changes correspondingly. In addition, switching indicator of the controlled equipment shall also be checked to work properly.

2. On-load tap changer test

By giving tap-changing instruction from the control room to the transformer, it shall be checked that the tap changes in accordance with the instruction.

3. Protective device test, Alarm indication test

By activating relay compulsorily for every protective device or alarm device, it shall be checked that the operation of the related equipment and the indication in the control room correspond exactly to the design diagram.

4. Actual Loading Test for Protection relay and control equipment

As a final check using voltage and current on actual power system, the following tests shall be implemented.

(1) Voltage and phase check

(2) Voltage, current and phase angle measurement

(3) Directional test

(4) Residual current and voltage measurement

(5) Id (differential current) check

Article 2-49. Interlock Test

Interlock between circuit breaker and the related disconnector shall be checked that the object of interlock does not operate just as described in manufacturer's specifications.

Article 2-50. Withstand Voltage Test

Withstand Voltage of each equipment shall be checked by applying test voltage shown in Appendix 1 for 10 [min].

Article 2-51. Operation Supervision Test

In order to check the soundness of GCB, GIS, system voltage shall be applied for 72 [hours] to carry out the following tests.

1. Measurement of temperature distribution

It shall be checked that no abnormal localized overheat exists by measuring temperature distribution on the surface, at the terminal of GCB, GIS.

2. Measurement of decomposed gas in SF6 gas

Gas density of SO_2 shall be checked to be not exceeding 2 [ppm] by measuring decomposed gas in SF_6 gas.

Article 2-52. Measurement of Noise and Vibration

Noise and vibration level measured on the boundary of the substation yard shall be checked to be not exceeding regulatory standards at the area where the substation is located. In the case the source of sound other than substation exists, the effect shall be eliminated for the judgment.

Table 2-52-1 Regulatory standards for noise

Area		Time		
		From 6h to 18h	From 18h to 22h	From 22h to 6h
Area I	The places requiring special silence, hospitals, schools, libraries, sanatorium, churches, temples	50	45	40
Area II	Residential areas, hotels, resorts, administrative offices	60	55	50
Area III	Residential areas alternated with commercial, service, productive areas	75	70	50

When regulatory standards for noise of Pollution Control Ordinance of each local government where

the substation is located is severer than the regulatory standards shown in Table 2-52-1 (Noise Regulation Law), the former shall be applied.

Table 2-52-2 Regulatory standards for vibration

Area	Applicable areas	Time	
		Daytime	Nighttime
Area I	Areas where maintenance of quiet is particularly needed to preserve a good living environment and where quiet is needed for as they are used for residential purposes.	60 ~ 65dB	55 ~ 60dB
Area II	Areas used for commercial and industrial as well as residential purposes where there is a need to preserve the living environment of local residents and areas mainly serving industrial purposes which are in need of measures to prevent the living environment of local residents from deteriorating. Areas used for commercial and industrial as well as residential purposes where there is a need to preserve the living environment of local residents and areas mainly serving industrial purposes which are in need of measures to prevent the living environment of local residents from deteriorating.	65 ~ 70dB	60 ~ 65dB

When regulatory standards for vibration of Pollution Control Ordinance of each local government where the substation is located is severer than the regulatory standards shown in Table2-52-2 (Vibration Regulation Law), the former shall be applied.

Chapter 6 Periodic Inspection

Section 1. General

Article 2-53. General Provision

This inspection shall be done periodically through visual inspections and measurements if necessary, to maintain normal function and prevent accidents of Network facilities.

Article 2-54. Frequency of periodic inspections

Inspection frequency shall be set by judgment of a person responsible for equipment management, but the shortest interval shall be limited to three years. Extension or shortening of inspection interval shall be reconsidered and judged by a person responsible for equipment management based on the trend of actual occurrence of equipment troubles. The exact interval shall be decided by a person responsible for equipment management.

Section 2. Overhead Transmission Line

Article 2-55. The Inspection Item

The inspection item and the contents of inspection in the periodic inspection are shown in Table2-55-1.

Table 2-55-1 Periodic Inspection Item of Overhead Transmission Line

Inspection item	Contents of inspection
Body of steel tower	It shall be checked that there are no abnormalities, such as change of shape, crack, and remarkable rust, of steel tower member by viewing from the ground. It shall also be checked that neither falling-off nor remarkable rust of bolt and nut exists.
Concrete pole	It shall be checked that there are no abnormalities, such as crack and damage, on the body of concrete pole. It shall also be checked that the body of concrete pole is not inclined by viewing from the ground.
Foundation	It shall be checked that there are no abnormalities, such as damage of foundation concrete, exposure of the foundation due to outflow of earth and sand, and burying due to inflow of earth and sand.
Guy wire	It shall be checked that there are no abnormalities of guy wire, such as slackness, remarkable rust, and snapping of strand.
Earth Equipment	It shall be checked that there are no abnormalities of earth equipment, such as corrosion, damage, and snapping. Grounding resistant shall also be measured, and the regulation value prescribed in design regulation shall be applied.
Insulator	It shall be checked that there are no abnormalities, such as crack, breakage, remarkable stain of insulator, trace of arc on insulator, and remarkable rust on cap and pin. It shall also be checked that there is no unusual noise, such as leak noise.

Conductor wire, Ground wire	It shall be checked that there are no abnormalities, such as damage, melting, snapping of strand, kink, and looseness. It shall also be checked that jumper wire is kept apart with appropriate clearance from the body of tower by checking the state of change of shape of jumper wire and inclination of suspension insulator string.
Hardware attached to overhead transmission line	It shall be checked that there are no abnormalities, such as crack, damage, unusual change of shape, remarkable rust in hardware. With regard to the transmission line where arcing horns are installed, it shall also be checked that there are no abnormalities, such as damage and remarkable rust on arcing horn.
Guard fence	It shall be checked that there are no abnormalities, such as unusual rust and breakage of wire net, pole, etc. of the guard fence, which is built in order to prevent entry of the general public to transmission line facility.
Damper	It shall be checked that there are no abnormalities, such as remarkable rust and s breakage of wire.

Section 3. Underground Transmission Line

Article 2-56. The Inspection Item for Cable

It shall be checked that there are no abnormalities, such as inappropriate state of attachment, breakage, change of shape, corrosion, looseness of fixing hardware, oil leakage (for OF cable), troubles of related equipment, regarding each object of inspection shown in Table2-56-1.

Table 2-56-1 Inspection Items for Cable

Objects of Inspection	Contents of Inspection
Cable (Including the Cable Off-set Part)	(1) Oil Leakage (2) Break, Expansion, Change of Shape (3) Cable Curve Condition (4) Change of Shape of Off-set (5) Clearance against other Cables
Duct End	(1) Condition of the Water Prevention Equipment (2) Break, Corrosion (3) Setting Condition (4) Water Leakage
Cable Rack and Support Hardware	(1) Break, Corrosion (2) Loose of Bolt and Nut (3) Setting Condition

Objects of Inspection	Contents of Inspection
Cleat and Bracket	(1) Break, Corrosion, Condition of Buffer Material (2) Loose of Bolt and Nut
Support Hardware and Insulator for Cable Support	(1) Break, Rust Occurrence (2) Setting Position, Setting Condition (3) Loose of Bolt and Nut
Protection Pipe	(1) Break, Corrosion, Crack, Change of Shape (2) Loose of Bolt and Nut
Earthing Conductor	(1) Disconnection (2) Wire Disconnection (Partially) (3) Corrosion
Prevention Board against Small Animals	(1) Break, Corrosion, Crack, Change of Shape (2) Setting Condition (3) Loose of Bolt and Nut
Sign Label	(1) Dropout (2) Break, Change of Shape (3) Setting Condition

Article 2-57. The Inspection Item for Cable Terminal

It shall be checked that there are no abnormalities, such as inappropriate state of attachment, breakage, change of shape, corrosion, looseness of fixing hardware, oil leakage (for OF cable), troubles of related equipment, regarding each object of inspection shown in Table2-57-1.

Table 2-57-1 Inspection Items for Cable Terminal

Objects of Inspection	Contents of Inspection
Terminal (Including the flat Plate to be attached)	(1) Wire Disconnection (Partially) (2) Break, Crack, Corrosion (3) Change of Shape (4) Loose of Bolt (5) Dropout or Detachment or Discoloration of Heat Detective Tape
Water Prevention Cover	(1) Break, Rust Occurrence (2) Change of Shape (3) Striction Condition (4) Leakage of Compound or Oil

Objects of Inspection	Contents of Inspection
Insulator	(1) Contamination (2) Break, Crack (3) Existence or Nonexistence of Arc Trace (4) Leakage of Compound or Oil
Support Insulator	(1) Contamination (2) Break, Crack (3) Existence or Nonexistence of Arc Trace
Insulation Seat	(1) Break (2) Insulation Resistance Measurement
Protected Part by Lead	(1) Oil Leakage (2) Break, Crack (3) Change of Shape
Attachment Hardware under GIS	(1) Corrosion, Change of Shape (2) Striction of Bolt
Divergent Joint Box	(1) Oil Leakage (2) Break, Rust Occurrence (3) Loose of Bolt
Cupper Tube at the Divergent Joint Box, Lead Sheath	(1) Oil Leakage (2) Crack, Expansion, Change of Shape (3) Detachment or Discoloration of Corrosion Prevention Tape
Bracket	(1) Break, Corrosion, Condition of Buffer Material (2) Loose of Bolt
Connector and Semi-stop Valve	(1) Oil Leakage (2) Existence or Nonexistence of Cap
Insulated Tube	(1) Contamination (2) Break (3) Change of Shape
Cable (Including the Cable Off-set Part)	(1) Oil Leakage (2) Break, Expansion, Change of Shape (3) Cable Curve Condition (4) Check of the Slipped down Volume (5) Detachment or Discoloration of Phase Display Tape
Cleat	(1) Break, Crack, Corrosion (2) Loose of Bolt
Protection Pipe	(1) Break, Crack, Change of Shape, Corrosion

Objects of Inspection	Contents of Inspection
Steel Pedestal	(1) Change of Shape, Crack (2) Rust Occurrence (3) Loose of Bolt
Earthing Conductor	(1) Disconnection (2) Wire Disconnection (Partially) (3) Corrosion
Sign Label	(1) Dropout, Break, Discoloration (2) Setting Condition
Protective Equipment for Cable Jacket	(1) Dropout (2) Loose of Bolt and Nut (3) Setting Condition (4) Overheat (5) Current Leakage

Article 2-58. The Inspection Item for Cable Joint

It shall be checked that there are no abnormalities, such as inappropriate state of attachment, breakage, change of shape, corrosion, looseness of fixing hardware, oil leakage (for OF cable), troubles of related equipment, regarding each object of inspection shown in Table2-58-1.

Table 2-58-1 Inspection Items for Cable Joint

Objects of Inspection	Contents of Inspection
Cable Joint	(1) Leakage of Compound or Oil (2) Break, Crack, Expansion, Change of Shape (3) Defect at Protected Part by Lead (4) Abnormal Sound, Overheat (5) Defect at Connector and Semi-stop Valve (6) Contact (7) Movement (8) Cleaning
Cable (Including the Cable Off-set Part)	(1) Oil Leakage (2) Break, Expansion, Change of Shape (3) Change of Shape of Off-set (4) Clearance against other Cables

Objects of Inspection	Contents of Inspection
Support Hardware and Insulator for Cable Support	(1) Break, Rust Occurrence (2) Setting Position, Setting Condition (3) Loose of Bolt
Slipped down Prevention Equipment	(1) Break, Rust Occurrence (2) Fixing Condition
Clamp for Joint (OF Cable Only)	(1) Break, Rust Occurrence (2) Setting Condition (3) Loose of Bolt
Bonding Conductor	(1) Wire Disconnection (Partially) (2) Disconnection (3) Corrosion (4) Connecting Condition
Earthing Conductor	(1) Wire Disconnection (Partially) (2) Disconnection (3) Corrosion
Sign Label	(1) Dropout (2) Break, Discoloration (3) Miss-display, Setting Condition
Protective Equipment for Cable Jacket	(1) Dropout (2) Setting Condition (3) Loose of Bolt and Nut (4) Overheat (5) Current Leakage

Article 2-59. The Inspection Item for Oil Supply Equipment

It shall be checked that there are no abnormalities, such as inappropriate state of attachment, breakage, change of shape, corrosion, looseness of fixing hardware, oil leakage (for OF cable), troubles of related equipment, regarding each object of inspection shown in Table2-59-1..

Table 2-59-1 Inspection Items for Oil Supply Equipment to Cable

Objects of Inspection	Contents of Inspection
Oil Tank	(1) Oil Leakage, Gas Leakage (2) Break, Rust Occurrence

Objects of Inspection	Contents of Inspection
Oil Meter, Gas Meter	(1) Oil Leakage, Gas Leakage (2) Break or Crack of Glass (3) Existence or Nonexistence of Dew (4) Valve Condition (5) Accuracy of Indication Value (6) Insulation Resistance Measurement
Breather	(1) Break, Crack (2) Change of Oil Properties, Discoloration of Oil (3) Discoloration of Absorbent
Steel Lumber, Foundation	(1) Break, Rust Occurrence (2) Change of Shape (3) Loose of Bolt
Insulating Connector	(1) Oil Leakage (2) Break, Change of Shape (3) Discoloration or Detachment of Tape
Valve, Panel	(1) Oil Leakage (2) Break (3) Valve Condition (4) Condition of Packing
Lead Tube, Connector	(1) Oil Leakage (2) Break, Crack, Change of Shape (3) Setting Condition
Control Cable	(1) Break (2) Existence or Nonexistence of Identification Tape (3) Insulation Resistance Measurement
Control Box	(1) Break, Rust Occurrence (2) Condition of Packing (3) Loose of Bolt (4) Insulation Resistance Measurement
Alarm System	(1) Operating Condition (2) Indicating Lamp and Buzzer (3) Insulation Resistance Measurement
Earthing Conductor	(1) Wire Disconnection (Partially) (2) Disconnection (3) Corrosion
Sign Label	(1) Dropout (2) Break, Discoloration (3) Setting Condition

Article 2-60. The Inspection Item for Insulating Oil Analysis of OF Cable

The purposes of this analysis are to maintain the function of OF cable equipment and to prevent faults from occurring. This analysis consists of dissolved gas analysis, moisture-in-oil analysis, and electrical characteristic analysis.

1. Dissolved Gas Analysis

When insulating oil or insulating paper is pyrolyzed, combustible gas is generated and insulation performance deteriorates. The purpose of this analysis is to analyze the deterioration of insulation performance, and the following gases which have correlation with actual abnormalities are applied as deterioration criteria for judgment.

Table 2-60-1 Object Gas of Analysis and its Cause of Outbreak

Object gas of analysis			Outline of the cause of abnormality
Gas to judge abnormality	* Hydrogen	H_2	Thermolysis of insulating oil, corona discharge
	* Methane	CH_4	Thermolysis of insulating oil at low temperature
	* Ethane	C_2H_6	Corona discharge at low discharge energy
	* Ethylene	C_2H_4	Thermolysis of insulating oil at high temperature, corona discharge
	* Acetylene	C_2H_2	High discharge energy
	* Carbon monoxide	CO	Thermolysis of insulting paper, corona discharge
	[Total combustible gas]	TCG	General evaluation of generation of abnormal gas

TCG: The total amount of the above-mentioned *-marked gas

Deterioration judgment shall be made by the amount of acetylene gas and total combustible gas as Table2-60-2.

Table 2-60-2 Deterioration Judgment based on the Amount of Generated Object Gas

Evaluation	Management item and standard value		Countermeasures
	Acetylene (C_2H_2) [ppm]	Total combustible gas (TCG) [ppm]	
Dangerous state in terms of insulation performance	$50 \leq C_2H_2$	---	Prompt repair is necessary
	$10 \leq C_2H_2 < 50$	$2{,}000 \leq$ TCG	
Having great influence on	$10 \leq C_2H_2 < 50$	TCG $<$ 2,000	Appropriate follow-up

insulation performance	$0<C_2H_2<10$	$10,000 \leq TCG$	supervision and repair plan based on the result are necessary
Having influence on insulation performance	$0<C_2H_2<10$	$100 \leq TCG<10,000$	Appropriate follow-up supervision and proposal of repair plan if necessary
	0	$1,000 \leq TCG<10,000$	
Having little influence on insulation performance	$0<C_2H_2<10$	$TCG<100$	Carrying out inspection continuously
	0	$TCG<1,000$	

2. Moisture-in-Oil Analysis

The moisture which infiltrated into the oil-immersed insulator is mainly adsorbed by the insulating paper, and the moisture influences insulation performance greatly. The purpose of this analysis is to analyze the deterioration of insulation performance. The deterioration judgment based on the amount of moisture in insulating oil shall be carried out as described in Table2-60-3.

Table 2-60-3 Deterioration Judgment based on the Amount of Generated Moisture

Abnormal level	Having no influence on insulation performance	Having influence on insulation performance	Dangerous state in terms of insulation performance
Management value	Lower than 1 [%]	1 [%] and over ~ lower than 3 [%]	3 [%] and over
Counter -measures	Carrying out inspection continuously	Investigation into the cause of infiltration of moisture and countermeasures (refill of new oil or putting moisture absorbent) are necessary	Prompt repair is necessary

3. Electrical Characteristic Analysis

As electrical characteristics of insulating oil, volume resistivity and dielectric loss angle are selected.

Volume resistivity is used for evaluation of insulation performance of insulating oil, and decrease of the value is seen when insulating oil became impure due to infiltration of moisture or foreign substance at the time of connection work. Dielectric loss angle increases as the amount of moisture in the insulating paper becomes large due to infiltration of the moisture. It also increases as insulating oil becomes impure due to infiltration of foreign substance at the time of connection work etc. The purpose of this analysis is to analyze the deterioration of insulation performance as mentioned above. The deterioration judgment based on electrical characteristic analysis shall be carried out as described in Table2-60-4.

Table 2-60-4 Deterioration Judgment based on the Electrical Characteristic Analysis

Item	Management value
Volume resistivity	1 * 10^{13} [Ohm-cm] (at 80°C)
Dielectric loss angle	2 [%] (at 80°C)

Section 4. Substation Equipment

Article 2-61. The Inspection Item for Transformer

1. Visual Inspection

It shall be checked whether the transformer has abnormalities, such as oil leakage, rust, crack, breakage, looseness at screwing parts, etc. or not.

2. Measurement of Insulation Resistance of windings

It shall be carried out in accordance with Article 2-23-1-(1).

3. Insulating Oil Test

Insulation performances of transformer insulation oil shall be checked to see that the performances comply with the criteria shown in Table 2-61-1.

Table 2-61-1 Insulation performances of transformer insulation oil

Nominal / Nominal Voltage	Dielectric Strength	Moisture in Oil	Gas in Oil	Total acid number	Volume resistivity
500kV	Greater than 60kV/2.5mm	Less than 25ppm.wt	Less than 2.0%·vol	Less than 0.25mgKOH/g	Less than 1×10^{12} Ω·cm (at 50℃)
110～220kV	Greater than 55kV/2.5mm				
Lower than 110kV	Greater than 40kV/2.5mm				
15～35kV	Greater than 30kV/2.5mm				
Lower than 15kV	Greater than 25kV/2.5mm				

4. Dissolved Gas Analysis

Abnormalities inside an oil-immersed transformer are generally followed by localized overheat, and the heat causes thermal decomposition of insulating material around and combustible gases are generated. The purpose of this analysis is to diagnose the abnormalities of transformer by analyzing

the kind and content of gas dissolved in insulating oil. As the criteria of the amount of detected gas, the standard of IEC 60599 (1999-03), "Mineral oil-impregnated electrical equipment in service - Guide to the interpretation of dissolved and free gases analysis" shall be applied.

Table 2-61-2 Criteria of dissolved gas analysis for oil immersed transformers

[ppm]

Gas / Criteria	H_2 (Hydrogen)	C_2H_2 (Acetylene)	C_2H_4 (Ethylene)	CO (Carbon Monoxide)
Criteria	60	3	40	540

5. On-load Tap Changer Inspection

(1) Inspection of motor-drive mechanism

a. Inspection of control circuit

(a) Repair of contact of magnetic contactor

(b) Check of screwing point of terminal

b. Inspection of drive mechanism

(a) Check of operation by manual handle

(b) Check of operation by motor drive

(c) Check of gears and bearings

(d) Check of bolts and pins

(e) Check of brake

(2) Withstand voltage test of insulating oil

Withstand voltage of insulating oil shall be checked to be not less than 20 [kV].

6. Inspection of BCT and Protective Device for Secondary Circuit of Bushing CT

(1) Inspection of Bushing CT

Insulation resistance shall be measured with insulation resistance meter whose test voltage is 500 [V] and over, and the measured value shall be checked not less than 2 [MOhm].

(2) Inspection of protective device for secondary circuit of Bushing CT

Operation test of protective device for secondary circuit of Bushing CT shall be carried out.

7. Cooling Equipment Inspection

(1) Inspection of air blower, oil-circulating pump, cooling-water circulating pump

a. Visual inspection, cleaning

b. Foreign substance, vibration

c. Oil supply etc.

(2) Inspection of control panel (including relays and switches)

a. Check of relays, timers, and switches

b. Check of screwing point of terminal

c. Cleaning of control panel etc.

8. Operation Test of Alarm and Indication

Operation of various kinds of alarm and indication of transformer shall be checked either by activating detector actually or by making the alarm circuit short-circuited at the terminal near the detector.

9. Operation Test of Protective Device

Operation of protective devices, which detect sudden change of oil pressure, oil flow, gas pressure, etc. when internal fault occurs in the transformer, shall be checked. In the operation test, it shall be checked that circuit breaker and alarm operate following the operation of protective device.

Article 2-62. The Inspection Item for Potential Transformer (PT)

1. Measurement of Insulation Resistance

It shall be carried out in accordance with Article 2-24-1.

2. Insulating Oil Test

It shall be carried out in accordance with Article 2-61-3.

Article 2-63. The Inspection Item for Current Transformer (CT)

1. Measurement of Insulation Resistance

It shall be carried out in accordance with Article 2-25-1.

2. Insulating Oil Test

It shall be carried out in accordance with Article 2-61-3.

Article 2-64. The Inspection Item for GCB

1. Measurement of Insulation Resistance

It shall be carried out in accordance with Article 2-26-1.

2. Measurement of Contact Resistance for Direct Current

It shall be carried out in accordance with Article 2-26-2.

3. Analysis of Decomposed Gas in SF_6 Gas

Decomposed gas in SF_6 gas shall be measured, and gas density of SO_2 shall be checked not exceeding 2 [ppm]. The purpose of this analysis is to check whether partial discharge or localized

overheat occurs inside the GCB or not. Since the density of SO_2 is high immediately after interruption, it is necessary to measure when enough time passed after interruption.

4. Opening and Closing Operation Test

It shall be carried out in accordance with Article 2-26-7-(2).

5. Measurement of Opening and Closing Characteristics

It shall be carried out in accordance with Article 2-26-8.

6. Gas Density Detectors Test

It shall be checked that gas density detectors are appropriately activated for alarm and lock of operation of GCB when SF6 gas pressure falls to the set pressure.

7. Error Measurement of Metering Device

Pressure gauge for SF_6 gas shall be compared with reference pressure gauge, and it shall be checked that error of metering device is not exceeding half of the minimum division of scale in pressure gauge.

8. Operation Test of Safety Valve

It shall be carried out in accordance with Article 2-26-12.

Article 2-65. The Inspection Item for GIS

Ordinary inspection of GIS is described below. GIS mentioned here shall not include GCB.

1. Measurement of Insulation Resistance

It shall be carried out in accordance with Article 2-27-1.

2. Gas Density Detectors Test

It shall be checked that gas density detectors are appropriately activated for alarm and lock of operation of GIS when SF6 gas pressure falls to the set pressure.

3. Analysis of Decomposed Gas in SF_6 Gas

Decomposed gas in SF_6 gas shall be measured, and gas density of SO_2 shall be checked not exceeding 2 [ppm].

4. Error Measurement of Metering Device

Pressure gauge for SF_6 gas shall be compared with reference pressure gauge, and it shall be checked that error of metering device is not exceeding half of the minimum division of scale in pressure gauge.

Article 2-66. The Inspection Item for VCB

1. Measurement of Insulation Resistance

It shall be carried out in accordance with Article 2-28-1.

2. Measurement of Contact Resistance for Direct Current

(1) Measurement of contact resistance of VCB primary circuit

Contact resistance between contacts of VCB shall be measured, and the measured value shall be checked not exceeding manufacturer's specifications.

(2) Measurement of contact resistance of auxiliary switch

Contact resistance of auxiliary switch shall be measured, and the measured value shall be checked not exceeding manufacturer's specifications.

3. Opening and Closing Operation Test

It shall be carried out in accordance with Article 2-28-2-(2).

4. Measurement of Opening and Closing Characteristics

It shall be carried out in accordance with Article 2-28-3.

5. Withstand Voltage Test of Vacuum Valve

Test voltage described in the manufacturer's specifications shall be applied between contacts for 1 [min] keeping vacuum valve open-circuited, and it shall be checked that there is no abnormality in the vacuum valve.

Article 2-67. The Inspection Item for OCB

1. Measurement of Insulation Resistance

It shall be carried out in accordance with Article 2-29-1.

2. Measurement of Contact Resistance for Direct Current

It shall be carried out in accordance with Article 2-29-2.

3. Opening and Closing Operation Test

It shall be carried out in accordance with Article 2-29-3-(2).

4. Measurement of Opening and Closing Characteristics

It shall be carried out in accordance with Article 2-29-4.

5. Withstand Voltage Test of Insulating Oil

Withstand test of insulating oil with alternative voltage shall be carried out and checked to meet the standards shown in Table 2-67-1.

Table 2-67-1 Standards of dielectric strength for insulating oil

	Dielectric Strength
500kV	Greater than 70kV/2.5mm
110～220kV	Greater than 60kV/2.5mm
Lower than 110kV	Greater than 45kV/2.5mm
15～35kV	Greater than 35kV/2.5mm
Lower than 15kV	Greater than 30kV/2.5mm

6. Operation Test of Pressure Relay

Only the OCB with pneumatic operating system shall be tested. It shall be checked that pressure relay are appropriately activated for alarm and lock of operation of OCB when air pressure falls to the set values.

Article 2-68. The Inspection Item for Disconnector

1. Measurement of Insulation Resistance

It shall be carried out in accordance with Article 2-30-1.

2. Measurement of Contact Resistance for Direct Current

It shall be carried out in accordance with Article 2-30-2.

3. Opening and Closing Operation Test

It shall be carried out in accordance with Article 2-30-3-(2).

4. Measurement of Opening and Closing Characteristics

(1) Measurement of Minimum Operating Pressure

Only the disconnector with pneumatic operating system shall be measured. In the state where voltage is not applied to the primary circuit, the pressure of compressed air shall be changed, and the minimum pressure when disconnector completely operates shall be measured.

It shall be checked that the measured value of the minimum operating pressure does not exceed 75 [%] of the rated pressure.

(2) Measurement of Opening and Closing Time

Opening time and closing time of disconnector shall be measured, and the measured value shall be checked to meet manufacturer's specifications.

Article 2-69. The Inspection Item for Protection Relays and Control Equipment

Tests cited bellow shall be carried out for protection relays and control equipment in accordance with Article 2-36.

1. Unit Test

(1) Relay activation point measurement

(2) Voltage and current property test

(3) Phase property test

(4) Operational time measurement

2. DC Circuit Test

(1) Insulation resistance measurement

3. AC Circuit Test

(1) Secondary Circuit Test

a. Meter and relay operation test

b. Insulation resistance measurement

(2) AC Circuit Test (Simulation Test)

a. Fault simulation test

4. Comprehensive Test with Field Equipment

(1) Protection relay operation and alarm indication test

Part 3 Hydro power plants

Chapter 1 General Provision

Article 3-1. Definitions

In addition to the definitions prescribed in the article 1-3, the following definitions also apply in the part 3.

1. *"Abutment"* means a part of the valley side against which the dam is constructed;
2. *"Air valve"* means a device that provides a mechanical vent allowing air flows in and out of a penstock in order to secure safety against watering-up, dewatering and some conditions during operation;
3. *"Class"* means a grade of projects defined in the TCXDVN285:2002 (Ministry of Construction No.26/2002/QD-BXD, 28 August 2002);
4. *"Dam"* means an artificial barrier that impounds and diverts river water. Dam height is defined as that from the lowest elevation of excavated foundation to the top of the dam. Tailing dams are excluded in this technical standard;
5. *"Headtank"* means a regulating facility installed at a joint between unpressurized headraces and pressurized waterways such as penstocks in order to regulate discharge change due to operation of power plant;
6. *"Headworks"* means structures constructed at the front side of waterways to take water from a river, a lake and a reservoir. Usually it includes an intake structure, intake gates and a facility to flush sediment;
7. *"Hydromechanical equipment"* means mechanical appurtenant equipment to civil works such as spillway gates, intake gates, outlet gates, draft gates and valves or gates of outlet works in this technical standard. Inlet valves are classified to electro-mechanical equipment;
8. *"Intake structure"* means an inlet structure of water, which is usually installed at the most upstream end of waterway;
9. *"Multi-purpose reservoir"* means a reservoir which has two or more objectives such as flood control, electric power generation, navigation, irrigation, water supply and so on;
10. *"Outlet"* means a structure located at the downstream end of the waterway, through which water can be freely discharged to the reservoir or the river. In case of pumped storage power plant, an outlet functions as an intake reversely when pumping up;
11. *"Outlet works"* means one of dam appurtenances that release water from a reservoir in order to supply water to downstream or to drawdown reservoir water level;

12. *"Penstock"* means a pressurized pipeline. Materials of penstock are usually steel or concrete. Plastic such as fiber-reinforced plastic (FRP) may be used depending on design conditions;
13. *"Phreatic surface"* means a free surface of water seeping at atmospheric pressure through soil or rock;
14. *"Piping"* means progressive development of internal erosion by seepage. Usually this phenomena is governed mainly by particle sizes of media and seepage water gradient, i.e. seepage velocity;
15. *"Pumped storage power plant"* means a kind of electric power storage facility. In the time zone with little electric power consumption such as night or a holiday, pumped storage power plant receives supplies of surplus electric power from other nuclear and thermal power plants, pumps up water from the lower pond to the upper pond, and generates electric power at a peak time in consumption;
16. *"Reservoir"* means a large pond with capacity enough to regulate natural river flow for water use in some period such as season or year;
17. *"Spillway"* means a structure over or through which water is discharged from a reservoir. Apart from this definition, "spillway" also means a structure installed at a headtank to spill excess water to a downstream river or reservoir in case that water used at a hydraulic machineries is decreased due to operation;
18. *"Surgetank"* means a structure to mitigate a dynamic pressure rise or fall in the penstocks and headrace tunnel, which is constructed of steel plate, rock or reinforced concrete and located above ground as a free standing structure, as a large shaft in rock, or underground in a rock cavern;
19. *"Waterway"* means a structure to lead water with or without pressure. It usually consists of open channels, tunnels, pipe conduits, or combination thereof.

Chapter 2 Organization and Management of Operation and Maintenance

Article 3-2. Organization

Fulfillment of requirements on organization stipulated in the Chapter 1 of Part 2 of the technical standard Volume 6 shall be checked by the Inspector at periodic inspection.

Article 3-3. Documentation

Management records of operation and maintenance shall be checked by the Inspector pursuant to the provision in the Chapter 1 of Part 4 of the technical standard Volume 6 at periodic inspection. However,

as for documents to be submitted by the Owner to the Authority regarding the following items, their extent to be covered shall be within the scope of the technical standard Volume 5:

- Maintenance results;
- Independent periodic inspection results;
- Special inspection results;
- Instrumentation results.

Chapter 3 In Progress Inspection

Article 3-4. Documentation

Fulfillment of requirements on organization stipulated in the technical standard Vol.6 Part 6 Chapter 1 shall be checked at the in progress inspection.

Article 3-5. Grounding resistance measurement

Grounding resistance and status of ground wire of power plant shall be confirmed for securing safety from public hazard.

Methods of measurement of the grounding resistance value shall be used resistance tester or voltage decrease method. Grounding resistance value should be less than 0.5 ohm for safety reason.

Article 3-6. Insulation resistance measurement

In Hydro power plant, during assembling and installation of electrical equipment, insulation resistance measurement shall be carried out for confirmation before and after of Dielectric test if it is surely insulated. As the measurement device, meg-ohm meter or other equivalent devices built-in DC power source shall be used.

The calibration voltages shall be 500V for low voltage circuit which is less than AC 600V or less than DC 750V for low voltage equipment (excitation circuit, etc.), 1,000V for high voltage circuit which is over than AC 600 to 7000V or over than DC 750V to 7000V, and 2500V for the Extra High Voltage equipment which is over than AC 7000V and DC 7000V.

The measurement values shall meet the Technical Requirements, with regard to the installation status, test environment, specifications, materials, structure, and capacities of power plant. The test result is judged by the responsible person of the test.

Article 3-7. Dielectric test

The purpose of this test is to confirm of no abnormality and maintaining necessary dielectric voltage in the electric circuit or electric equipment. The test procedure is as follows:

(1) For confirmation of no abnormality of electrical circuit, regulated dielectric test voltage for rotating machine is applied between field, armature winding and earth using dielectric test devise.

Dielectric test should not be repeated. If, however, a second test is nesessary, after further drying the rotating machine 80 % of the test voltage shall be applied. The test voltage shall be stepped up gradually within 10 second. Duration time of the test shall be within 1 minute after reach the test voltage value.

(2) Dielectric test by DC current or other equivalent method may be carried out in case of the industrial power frequenvy test voltage is not available.

Dielectric test valtage by DC current shall be 1.7 times of r.m.s value given in industrial power frequency test voltage.

Dielectric test voltage shall be applied according to the values stated in Table 3-7-1 and confirmed withstand the necessary dielectric test voltage value under the regulated time.

Table-3-7-1. Dielectric Test Voltage under industrial power frequency

	Test Object	Characteristic of Electric Machines	Testing Voltage (V)
1	*(1)*	*(2)*	*(3)*
	- Stator Coil	- Capacity less than 1kW (kVA) with nominal voltage less than 100 V	2 Un + 500
		- Capacity less than 10,000 kW (kVA)	2 Un + 1000V (min. 1500V)
		- Capacity more than 10,000 kW (kVA)	
		(1) Un□24,000 V	2 Un + 1000V
		(2) Un ›24,000 V	Subject to agreement with manufacturer
2	Field windings of synchronous generators Started not induction motor	Up to including 500 V	10Ef (min. 1,500 V)

	Test Object	Characteristic of Electric Machines	Testing Voltage (V)
		Above 500 V	2Ef + 4000 V
	Started induction motor		
	When the machine is intended to be started either with the field windings short-circuited or connected across a resistance of value less than ten times the resistance of the winding		10Ef (min. 1,500 V, maxi. 3,500 V)
	When the machine is intended to be started either with the field windings connected across a resistance of value equal to, or more than, ten times the resistance of the winding, or with the field windings on open circuit with or without a field-dividing switch.		2Ef + 1000 V (min.1,500 V)
3	- Stator Coil of Synchronous Generators while the stator assembly proceeded at site (For hydropower generator, after the completion of coil assembly and insulating the connectors)		A repetition of the tests should be avoided if possible, but if a test is performed on a group of machines and apparatus, each having previously passed its withstand voltage test, the test voltage to be applied to such an electrically connected arrangement shall be 80% of the lowest test voltage appropriate for any individual piece of the arrangement.
4	Exciter (except as below)		Withstand voltage shall be of the values item. 2.
	Exception 1: Exciters of synchronous motors (including synchronous induction motors) if connected to earth or disconnected from the field windings during starting.		1000 V + 2Ef (min.1500 V)

Un: Rated voltage

Ef: Field voltage

Article 3-8. Air gap measurement

The air gap of the generator between stator and rotor coil shall be measured to avoid contact and damage.

The measuring points should be symmetrical 8 points of both upper and lower coil end portion.

For preventing damag by contact of stator and rotor, the air gap shall be less than the value calculated by following formula:

(Measuring value Max.-Min.) / Average value <10 %

Article 3-9. Dielectric loss angle and absorption current

For confirmation of initial characteristics of stator windings, dielectric loss angle and dc absorved current shall be measured.

Dielectric loss angle（Tan δ）test is carried out from 2kV to the Rated voltage with Schering bridge method. Absorption current measurement is carried out with DC 1000V meg-ohm meter.
Dielectric loss angle (Tan δ) shall be less than 3%, and PI（Polarity Index) shall be not less than 2.

Article 3-10. Characteristic test of Generator

1. No load saturation characteristic test

The purposes of this test is measurement of line voltage balance, relation between field current and induction voltage on amature winding under no load condition.

The characteristic shall be confirmed at terminal of stator coil is open-circuited and the generator is rotated at rated speed. DC current of the field circuit gradually increase and measure the field current and terminal voltage up to 120 % of the rated voltage.

The no load characteristic and balance of line voltage shall be kept within design value.

2. Axial voltage Measurement

The purpose of this measurement is to confirm whether the main shaft of the generator has enough insulation. The axial voltage shall be measured at rated voltage under no load saturation characteristic test. The voltage shall be measured between upper bearing and lower bearing, upper bearing and earth, and lower bearing and earth for 3 points. The measured voltage shall be confirmed noabnormality comparing with normal condition.

3. Three phase short circuit test

The purpose of this test is to measure and confirm the short-circuit saturation curve, and relation between armature current and field current. The phase balance of armature current shall also be confirmed.

Test method is to separate between generator and bus circuit, generator side is short circuited at outlet terminal of stator coil or primary side of circuit breaker, and measure the amature current by flowing of the field current at under rated speed.

As the result, the values of short circuit ratio and synchronous impedance shall be kept within design value.

Article 3-11 Hydraulic turbine system operation test

1. Wicket gate operation test

After installation of wicket gate, the operation test of wicket gate shall be executed for confirmation of the proper performance.

By opening and closing operation, servomotor pressure and operation time of servomotor stroke shall be measured. Wicket gate, guide ring and operation mechanism shall also be confirmed.

Opening and closing pressure of servomotor shall be constant except start and stop motion.

Opening and closing time of servo motor stroke and closing characteristic shall be kept within design value.

2. Governor control characteristic test

This test shall be executed for confirmation of the control characteristic of governor if it is within design value.

Input voltage and current of control unit shall be set design value and change their values between the parameters of maximum head to minimum head, and the servomotor stroke shall be measured

As the result, the characteristics of no-load opening, opening position of servomotor and load limitter depend on each outputs shall be confirmed and kept within design value.

Article 3-12 Inlet valve operation test

1. Inlet valve sealing test

This test shall be executed for confirmation of the sealing mechanism of inlet valve if it operates smoothly.

After installation of Inlet valve, sealing mechanism of upper stream side and down stream side shall be confirmed opening and closing pressure using oscilloscope or pressure meter.

As the result, sealing mechanism shall be operated without abnormality under the design value.

2. Opening and closing test

This test shall be executed for confirmation of the operating mechanism if it is operated smoothly and kept the performance of design value.

Opening and closing pressure shall be measured using pressure meter or oscilloscope.

As the result of test, the friction of operation mechanism shall be move smoothly at full stroke except start of opening and closing position under the design value.

3. Leakage water measurement

This measurement shall be executed for confirmation of the leakage water of inlet valve to prevent abnormal water leakage. After sealing of upper and lower side, the leakage water from drainage pipe of upper stream side shall be measured. The lower stream side, the leakage water shall be measured at drainage pipe on casing.

As the result of measurement, the leakage water quantity shall be kept within design value.

Article 3-13 Auxiliary equipment operation test

This test shall be executed for confirmation of auxiliary equipment such as Water, Oil and Air supply system operate under the design conditions and prevent breaking off the pipe, abnormal water outcome and flowing out the oil.

Auxiliary equipments are composed Oil supply system, Water supply system and Air supply system.

For operation smoothly of Generator, Hydraulic turbine, following tests shall be executed.

1. Non-destructive test, hydraulic pressure test or other necessary test
2. Continuous operation test for pumping motors and compressor.
3. Confirmation of safety valve operation.
4. Confirmation of air tank and oil pressure tank capacity.

As the result of the inspection at operation test, capacity for each auxilialy equipment and the performance shall be satisfied the design value.

Article 3-14 Vibration measurement

This measurement shall be executed for confirmation of no abnormal vibration during operation of rotating electrical machines.

Measurement of the vibration of electrical machine shall be measured at the mounting of the measuring point of the machine.

It is necessary to measure the vibration on the machine alone, under properly determined test conditions, without any influence from other equipment.

The result of measurement, the vibration is change at operation condition; therefore it shall be compared with normal condition and judged under design criteria.

Chapter 4 Completion Inspection

Article 3-15. Documentation

Fulfillment of requirements on organization stipulated in the technical standard Vol.6 Part 6 Chapter 1 shall be checked at the completion inspection.

Article 3-16. Initial run

After the installation of hydro turbine generator, for confirmation of no contacting between rotation and static parts, noise and vibration, initial rotation shall be executed.

Openings of Inlet valve, and opening of wicket gate, soon after confirmation of starting unit, close the inlet valve and wicket gate simultaneously.

As the result of initial run, it shall be confirmed no abnormality on contacting between rotation and static parts, noise and vibration.

Article 3-17. Bearing run

This test shall be executed for confirmation of no abnormality of temperature rise, vibration, axial

swing and bearing oil level of Generator rotation.
Through continuous operation of the generator under rated rotation speed by opening of Inlet valve and opening of wicket gate until the bearing temperature saturate, no abnormality on temperature rise, vibration, axial swing, noise and bearing oil level shall be confirmed.
As the result temperature rise, vibration, axial swing and bearing oil level shall be maintained within design value.

Article 3-18. Automatic start and stop test

This inspection shall be executed for confirmation of performance of designed sequential control from start to rated load operation of the generator.
Starting operation, rated load and stop operation shall be controlled from generator control board or control room for each step under designed control method..
As the result of this inspection, sequential control shall be controled without abnormality under the design value.

Article 3-19. Load rejection test

This test shall be executed for confirmation of transferring the Unit to no load operation smoothly at the load rejection.
Operation of the load rejection shall be shut down each unit during operation under the conditions of 1/4, 2/4, 3/4, 4/4 load. The plurar unit connected to the same penstock is recommended to reject the load at the same time.
As the result of this test, hydraulic pressure rise of penstock shall be kept within design value. It shall be confirmed that there is no abnormality and transferred the unit to no load operation smoothly.

Article 3-20. No load no excitation test

This test shall be executed for confirmation if the generator is transferred to no load no excitation operation mode by operation of the protection relay.
During generator normal operation, by operating of protection relay for no load no excitation under the sequencial control, it shall be confirmed the operation of unit controller is changed to no load no excitation mode automatically.

Article 3-21. Emergency stop test (heavy electrical trouble)

This test shall be executed for confirmation of sequential control for emergency stop operation in case of electrical heavy trouble occurred.
The test shall be used protection relay for emergency stop.

Article 3-22. Quick stop test (heavy mechanical trouble)

This test shall be executed for confirmation of sequential control for quick stop operation in case of mechanical heavy trouble occurred.

The test shall be used protection relay for quick stop.

Article 3-23. Load test

This test shall be executed for confirmation of continuous rated load operation without abnormality.

Operation of the generator shall be continued until the bearing temperature saturated at rated load condition.

As the result, it shall be confirmed continuous rated load operation without abnormality.

Article 3-24. Output test

This test shall be confirmed the relation between wicket gate stroke and operation output.

As the method of this measurement, wicket gate servomotor stroke shall be changed and measured the operation scope and output limitation under the load condition.

As the result of this test, under each load operation condition, it shall be confirmed vibration, swing of axis, and hydraulic pressure are no abnormality.

Article 3-25. Pumping operation test

After completion of pumped storage power plant, pumping operation shall be confirmed without abnormality.

The pumping operation shall be controlled and started under the stipurated starting method without time delay of starting equipment.

Chapter 5 Periodic Inspection

Section 1. General

Article 3-26. General provision

In addition to the provision prescribed in the article 1-4, periodic inspection for hydro civil works and appurtenant equipment shall be carried out according to the following items.

1. Periodic inspection consists of two parts; one is examination of documents submitted by the Owner pursuant to the article 3-3. The other is field inspection of civil works and appurtenant

equipment at each hydro power plant. Considering characteristics such as class, latest condition and hazard risks of each hydro power plant, field inspection may be selectively carried out according to judgment of the Authority. The Owner may not file a complaint against the decision of the Authority on field inspection.

2. The Authority shall evaluate results of the periodic inspection comprehensively based on a classification shown in Table 3-26-1, and notify to the Owner within three months from the day following the date when the periodic inspection is terminated.

Table 3-26-1 Classification for results of periodic inspection

Rating	Description
A	There is no nonconformance with the technical standard Volume 5.
B	Minor nonconformance is detected and desirable to be rectified.
C	Detected nonconformance is not serious but shall be rectified up to next periodic inspection.
D	Detected nonconformance is serious, and shall be rectified immediately.

Article 3-27. Frequency of periodic inspections

1. Periodic inspection shall be carried out every three years or more in principle for each hydro power plant.
2. The Authority may shorten the interval between the last periodic inspection and the next one, in case that the rating of the last inspection result defined as in Table 3-26-1 is “D”;
3. Prior to the impoundment of reservoir or smaller pond, the Owner shall inspect civil works and relevant hydromechanical equipment based upon this technical standard to grasp initial conditions of those works and equipment. This result shall be submitted to the Authority at the first periodic inspection.
4. The first periodic inspection shall be carried out at earlier point of the following items:
   - Reservoir water level reaches the high water level;
   - One year after commencement of operation.
5. The second or subsequent periodic inspections shall be carried out at the interval specified in paragraph 1 of this article.

Section 2. Dams

Article 3-28. General

Dam safety shall be judged comprehensively not only by visual inspection but also by evaluating monitoring data on performance of dams, if available. In addition to the inspection on dams, appropriateness of measuring instruments and relevant facilities shall be also checked elaborately at the periodic inspection.

Article 3-29. Concrete dams

The following requirements shall be fulfilled in order to secure stability and safety of concrete dams.

1. Appearance

(1) Settlement and horizontal movement of the dam shall not be observed by checking alignment visually at the crest of the dam;

(2) Severe erosion that may damage the dam safety shall not be observed at around abutment of the dam due to water flow;

(3) Newly developed excessive cracks or progress of existing conspicuous cracks, which may damage the dam safety, shall not be observed on the dam and in the inspection gallery;

(4) Severe deterioration due to the alkali-aggregate reaction or water quality of the reservoir shall not be observed on the surface of the dam.

2. Leakage and Seepage

(1) Leakage from joints of concrete dam and seepage from drainage boreholes to reduce uplift shall be stable approximately or variable slightly depending on reservoir water level and temperature, excluding transitional period just after the impoundment of reservoir. If seepage rate through drainage boreholes in foundation decreases, it shall be checked carefully that the decrease of seepage rate does not cause the increase of uplift pressure;

(2) Indication of piping in dam foundation shall not be observed when checking turbidity in leakage or seepage water from drainage boreholes in foundation etc.

3. Displacement

(1) Horizontal displacement of dam shall be linked properly and stably together with reservoir water level and temperature;

(2) Conspicuously irregular or abnormal performance shall not be observed in comparison with precedent records of displacement obtained by instrumental monitoring or survey work.

4. Uplift

(1) Uplift pressure shall be less than or equal to the design assumption;

(2) Uplift pressure shall be linked properly and stably together with reservoir water level and tail water level, or to be constant approximately;

(3) This paragraph shall be applied for concrete dams where uplift pressure is measured.

Article 3-30. Fill dams

The following requirements shall be fulfilled in order to secure stability and safety of fill dams.

1. Appearance

(1) Conspicuous cracks shall not be observed at the crest or the slopes of fill dam;

(2) Sliding, erosion, sinkholes or uneven settlement shall not be observed at the crest or the slopes of fill dams;

(3) There shall be no plants or trees on the crest or the slopes, excluding those specified in the design.

2. Leakage and seepage

Leakage from dam and foundation shall be stable or change rationally, considering precipitation, reservoir water level, groundwater level and time-dependent clogging in seepage path. This provision is applied to fill dams where a facility to measure leakage is installed.

3. Deformation

(1) Settlement of fill dams shall be within very slow deformation level due to consolidations, excluding large settlement at initial stage;

(2) Horizontal deformation of fill dams shall be stable after reservoir water level reaches the high water level first, excluding very slight plastic movement.

4. Pore water pressure

(1) Pore water pressure inside impervious zone of fill dams and in their foundation shall be linked properly and stably together with reservoir water level, or be constant approximately, excluding transitional period just after impoundment of reservoir. This provision is applied to fill dams where piezometers are installed inside impervious zones of fill dams and in their

foundation;

(2) Phreatic surface in the abutment of the fill dam shall be stable approximately, taking precipitation and variation of reservoir water level into consideration. This provision is applied to fill dams where groundwater level gauges are installed at abutment.

5. Others

In case that the dam site locates in an area where activities of termite are anticipated, existence of nest of termite inside soil part of fill dams and soil foundation shall be checked by careful observation or by using proper equipment such as a ground-penetrating radar periodically.

In addition to the provisions prescribed above, the following requirements shall be fulfilled for each dam type.

6. Homogeneous earthfill dam

A phreatic surface inside homogeneous fill dam shall be stably below design level, and be safe for piping.

7. Rockfill dam with impervious core

In case that pore water in downstream rockfill may not be drained smoothly and quickly due to low permeability, the provision on a phreatic surface in homogeneous earthfill dam shall be applied to the downstream rockfill.

8. Rockfill dam with upstream facings

(1) Damage of upstream facing due to settlement of rockfill etc. shall not be observed;

(2) Deterioration that may threaten the water-tightness of facing shall not be observed;

(3) Notable increase of leakage from joints or face slab shall not be observed not only at periodic inspection but also during operation.

Furthermore, in case that rockfill dam with impervious core or homogeneous earthfill dam is applied in pumped storage power plants, stability of the upstream slope shall be sufficiently maintained for rapid change of reservoir water level.

Article 3-31. Spillway

The following requirements shall be fulfilled in order to secure sustainable stability, safety and reliable function of spillway.

1. Impediment such as driftwoods left during flood, excessive growth of grass and weed, trees, debris, or landslide deposits shall not be observed at an approach part and chute channel of spillway;
2. Severe erosion of spillway chute shall not be observed in order to secure safety of spillway and its

foundation;

3. Severe deterioration of spillway concrete shall not be observed in order to prevent successive erosion or structural instability;
4. Severe cracks and spalling in spillway concrete shall not be observed in order to prevent washout of fine materials behind the concrete slab, erosion, more cracks, or structural instability of spillway chute and walls;
5. Misalignment or deformation of spillway chute and walls shall not be observed. Once those geometrical abnormalities are found, causes shall be investigated carefully, clarified and removed properly, and abnormalities shall be repaired so as to secure structural safety and smooth water flow;
6. Severe relative displacement such as gaps and offset at the joints shall not be observed in order to prevent successive erosion due to cavitation;
7. Undermining around the spillway outlet due to discharge shall be checked periodically. Dam and appurtenant structures located near the spillway outlet shall be protected securely against undermining;
8. Drainage system shall be workable properly, in case spillway chute or walls are equipped with drainage system to reduce back pressure.

Section 3. Waterways

Article 3-32. Pressurized waterways

1. Scope of application

Pressurized waterway may be used as headrace tunnels, penstocks and tailrace tunnels etc. From structural viewpoint, the following type or combination thereof is employed for pressurized waterway:

(1) Unlined tunnel;
(2) Concrete-lined tunnel;
(3) Steel-lined tunnel;
(4) Steel penstock;
(5) Reinforced plastic penstock.

This article shall be applied to periodic inspection for the above-mentioned structures. Furthermore technical requirements on air valves and supports of penstocks are also stipulated in this article as important appurtenances. As for reinforced plastic penstock, fiber reinforced plastics (FRP) or fiber reinforced plastics and mortar (FRPM) are stipulated here.

2. Unlined tunnel

The following requirements shall be fulfilled in unlined tunnel. This is to be checked by visual inspection:

(1) Rock mass around tunnel shall be stable, and large-scaled rock fall shall not be observed inside tunnel.

(2) Severe erosion shall not be observed in unlined tunnel.

(3) Sedimentation that may impede smooth water flow shall not be observed inside tunnel.

3. Concrete-lined tunnel

The following requirements shall be fulfilled in concrete-lined tunnel. This is to be checked by visual inspection:

(1) Excessive leakage or seepage shall not be observed;

(2) Cracks, spalling, and deformation of concrete lining that may damage structural safety of tunnel shall not be observed;

(3) Excessive abrasive erosion shall not be observed on lining concrete;

(4) Sedimentation that may impede smooth water flow shall not be observed inside tunnel.

4. Steel-lined tunnel

The following requirements shall be fulfilled in steel-lined tunnel. This is to be checked by visual inspection:

(1) Excessive damages, deformation, corrosion and leakage shall not be observed on the surface of steel liner;

(2) Excessive rust, peeling, cracks shall not be observed for coating on steel surface.

5. Steel penstock

The following requirements shall be fulfilled in steel penstocks. This is to be checked by visual inspection. In addition to those checks, shell thickness of aged and exposed penstock shall be checked by an ultrasonic thickness gauge etc. at fixed points on penstock shell at periodic inspection.

(1) Outside of exposed steel penstock

a. Excessive damage, deformation, corrosion, pitting, deterioration and leakage shall not be observed at penstock shells, welded joints, and expansion joints;

b. Signs of significant rusting, pitting, cracks or other defects shall not be observed at welded joints;
c. Bolted or riveted joints shall be secure and free from excessive rust and deterioration. Bolts and rivets shall not be loosened or dropped out;
d. Excessive deterioration or defects shall not be observed on coating of steel surface.

(2) Inside of steel penstock
a. Excessive corrosion, pitting and deterioration shall not be observed at penstock shells and welded joints;
b. Excessive deterioration or defects shall not be observed on coating of steel surface.

6. Reinforced plastic penstock

(1) The following requirements shall be fulfilled in FRP or FRPM penstocks. This is to be checked by visual inspection:
a. Leakage from joints shall not be observed;
b. Excessive deterioration, damages or abrasion shall not be observed on the surface of penstock shell. If protection layer is lost even partially, immediate repair work shall be carried out in order to protect inner structural layer.

(2) Obvious change in stiffness of FRP or FRPM penstock shell shall not be observed. Because it may be symptom that failure strength of FRP or FRPM shell reduces by long term loading. It can be checked by measuring strain change of exposed penstock shell during dewatering or watering-up.

7. Air valve

Integrity of air valves shall be checked in order to secure proper operation and protection of penstocks during watering-up, dewatering, and usual operation.

8. Penstock supports

(1) Settlement or movement that may damage structural safety of penstocks shall not be observed at support structures of penstocks.
(2) Excessive damage, deformation and deterioration shall not be observed at concrete support structures.
(3) Excessive corrosion, pitting and deterioration shall not be observed at steel parts of supports.

Article 3-33. Unpressurized waterways

1. Scope of application

Unpressurized waterway may be used as canals, headrace tunnels, and tailrace tunnels etc. From structural viewpoint, an open channel, unpressurized tunnel, culvert, pipe conduits, or combination

thereof is employed for unpressurized waterway. This article shall be applied to periodic inspection for those structures.

2. Open channel

The following requirements shall be fulfilled for open channels in order to secure safety and smooth water flow:

(1) Side slopes of the open channels shall be stable;

(2) Excessive erosion shall not be observed at side slopes and bottom of channels;

(3) Excessive sedimentation shall not be observed inside channels.

3. Unpressurized tunnel

The following requirements shall be fulfilled for unpressurized tunnels in order to secure safety and smooth water flow:

(1) Excessive cracks, spalling, and deformation of concrete lining that may damage structural safety shall not be observed for concrete-lined tunnels;

(2) Rock mass around tunnels shall be stable for unlined tunnels;

(3) Excessive erosion or sedimentation shall not be observed inside tunnels.

4. Culvert

This paragraph shall apply to concrete culverts. The following requirements shall be fulfilled for concrete culvert in order to secure safety and smooth water flow:

(1) Excessive cracks, spalling, and deformation of concrete that may damage structural safety shall not be observed for culverts;

(2) Excessive erosion or sedimentation shall not be observed inside culverts.

5. Pipe conduit

This paragraph shall apply to steel pipe conduits. Provisions of steel penstocks stipulated in the paragraph 5 of the article 3-32 shall also apply to the unpressurized pipe conduits.

Section 4. Appurtenant Structures to Waterways

Article 3-34. Intakes and outlets

The following requirements shall be fulfilled at intakes and outlets in order to secure sustainable safety and their function:

1. Excessive damage, deformation, cracks, and abrasive erosion shall not be observed at intakes and outlet structures;
2. Sedimentation or other obstacles that may impede smooth water flow shall not be observed in front of intakes and outlets.

Article 3-35. Settling basins

The following requirements shall be fulfilled at settling basins in order to secure sustainable safety and their function:

1. Excessive damage, deformation, cracks, and abrasive erosion, which may damage normal function of settling basin, shall not be observed at settling basins;
2. Facilities to remove sediment in settling basins shall be operable as designed;
3. Excessive sedimentation, which may impede smooth water flow in settling basins, shall not be observed.

Article 3-36. Surgetanks and headtanks

The following requirements shall be fulfilled at surgetanks and headtanks in order to secure sustainable safety and their function:

1. Excessive damage, deformation, cracks, and abrasive erosion shall not be observed at surgetanks and headtanks;
2. Conspicuous collapse, landslides and excessive seepage, which may damage stability and safety of surgetanks and headtanks, shall not be observed at surrounding slopes of those structures;
3. Excessive damage, deformation, corrosion, pitting and deterioration shall not be observed at steel shells or steel liners for steel or steel-lined surgetanks. Excessive deterioration or defects shall not be observed on coating of steel in those surgetanks.

Article 3-37. Spillways at headtanks

The following requirements shall be fulfilled at spillways of headtanks in order to secure safety of the public and civil works. The first item shall be checked by visual observation on surrounding state of spillway outlet:

1. Excess water caused by output change at power plant shall be discharged downstream safely, including proper energy dissipation and minimal influence to the downstream area;
2. In case that steel pipe is employed as spillway of headtank, the provisions on steel penstocks shall apply to steel conduits.

Section 5. Powerhouses

Article 3-38. Structures of powerhouses

The following requirements shall be fulfilled at a powerhouse:

1. Conspicuous deformation, cracks and excessive seepage shall not be observed at the concrete structures such as underground walls and foundations of powerhouses;
2. Conspicuous deformation, cracks and damages shall not be observed at walls or posts to support overhead cranes.

Article 3-39. Rock supports

The following requirements shall be fulfilled at arch and sidewalls in underground powerhouses and appurtenant caverns.

1. Conspicuous deformation or cracks, which may damage safety of the caverns, shall not be observed at concrete lining or shotcrete;
2. Drop out of heads of rock anchors or rockbolts shall not be observed;
3. Excessive seepage, which may cause mechanical instability of surrounding rock mass or exceed an allowable drainage capacity, shall not be observed;
4. In case of unlined caverns, symptoms for serious instability of the surrounding rock mass shall not be observed.

Article 3-40. Slope stability around powerhouses

Conspicuous collapse, landslides or excessive seepage, which may vitiate sustainable operation of powerhouse, shall not be observed at the surrounding slopes of on-ground powerhouses.

Section 6. Hydromechanical Equipment

Article 3-41. Gates and valves

1. This article shall be applied to the following gates and valves:
   (1) Spillway gates;
   (2) Intake gates;
   (3) Valves and gates of outlet works;
   (4) Control gates at headtanks;
   (5) Draft gates;
   (6) Tailrace gates.

2. The following requirements for gates and valves shall be fulfilled. This may be checked by operation or maintenance records at periodic inspection:
   (1) It shall be confirmed that gates or valves work normally and smoothly;
   (2) Notable deterioration, damages or deformation on gate leaves and guide frames shall not be observed;
   (3) Excessive deterioration or defects shall not be observed for coating on steel surface;
   (4) Sufficient water-tightness shall be maintained for gates and valves.

Article 3-42. Gate hoists

The following requirements for gate hoists shall be fulfilled. This may be checked by operation or maintenance records at periodic inspection:

1. Movement of hoists shall be smooth;
2. Hoists shall work normally by ordinary power supply and by standby power supply respectively;
3. Serious damage, deformation, corrosion, and deterioration shall not be observed at steel part of hoists;
4. Excessive deterioration or defects shall not be observed for coating on steel parts of hoists.

Article 3-43. Standby power supply

The following requirements for standby power supply shall be fulfilled. This shall be checked by test operation at periodic inspection:

1. Standby power supply shall starts quickly;
2. Rated power output shall be as designed stably;
3. Temperature increase during operation shall be within guaranteed limit;
4. Abnormal noise and excessive vibration shall not be observed;
5. All necessary expendable supplies and material such as oil, water and fuel shall be provided in order to meet emergency operation;
6. There shall not be any leakage of oil, cooling water, or fuel.

Section 7. Reservoir and River Environment at Downstream of Dams

Article 3-44. Slope stability

1. Signs of collapse or landslides, which may cause the loss of lives and property existing around reservoir, and serious damage to the dam, shall not be observed at reservoir area;

2. Signs of collapse or landslides of slopes caused by operation of hydro power plants, which may damage power plant facilities and equipment, lives and property at the riverside, shall not be observed at the downstream area of the dam and power plant. Downstream area where the Owner is responsible for public safety in relation to power generation activities shall be agreed with the Authority in advance.

Article 3-45. Sedimentation in reservoir

1. During flood, unusual water level rise due to sedimentation may cause flood damage to the public at around inlet and upstream of reservoir. In order to prevent such damages, excessive sedimentation shall not be observed at those areas.
2. Severe sedimentation that may induce dangerous influences to the dam shall not exist. This shall be checked by latest survey record on sedimentation.

Article 3-46. Erosion of riverbed and riverside

Erosion at riverbed or riverside at downstream of dam and power plant due to power generation and flood release shall not be serious for surrounding environment. Progress of erosion shall not be notable.

Section 8. Measuring Instruments

Article 3-47. Condition and performance of measuring instruments

1. There shall be no serious damages on measuring instruments and relevant structures;
2. The site where measuring instruments and relevant structures are installed shall be safe and stable, and free from unfavorable obstacles for measuring such as severe sedimentation;
3. The measuring instruments shall work normally, and shall be protected adequately from natural accidents or artificial disturbances.

Article 3-48. Calibration of equipment

1. Official equipment calibration shall be performed for measuring instruments used in monitoring and observation for performance of facilities and relevant natural conditions. This provision shall be applied to the instruments for which the official calibration is mandatory;
2. As for other measuring instruments except for those prescribed in the preceding paragraph, normality of the measuring instruments shall be checked by comparing with results of other independent measurement if applicable.

Section 9. Electrical Equipment

Article 3-49. Frequency of periodic inspection

Periodic inspection frequency shall not exceed the value stipulated in table 3-49-1.

Inspection frequency shall be set by judgment of the owner for equipment basically.

In case of the equipment judged that it should be extended the frequency by the condition, it is permited to extend by approval of the owner.

The judgement of extension or shortening of frequency interval shall be decided by the owner.

Table-3-49-1 frequency of periodic inspections

Equipment	Periodic ordinary inspection (year)	Special inspection (reference) (year)
(1) Generator and apparatus		
Generator	3	Same as hydraulic turbine
Cooling system	3	Same as hydraulic turbine
Exciter	3	Same as generator
AVR	3	Same as generator except control devise (1/2 of generator)
Starting system	3	Same as generator
(2)Hydraulic turbine system		
Hydraulic turbine	3	
-Francis, Pelton	3	14 ～ 17 for Overhaul inspection
-Kaplan, Tublar	3	12 ～ 15 for Overhaul inspection
-Pump	3	11 ～ 15 for Overhaul inspection
Inlet valve	3	2 times of hydraulic turbine
Oil pressure, lubrication system	3	Same as hydraulic turbine
Governor	3	1/2 of hydraulic turbine
Hydraulic turbine operating control and auxiliary system	3	Same as hydraulic turbine

Article 3-50. Documentation

Fulfillment of requirements on organization stipulated in the technical standard Vol.6 Part 6 Chapter 1 shall be checked at the periodic inspection.

Article 3-51. Visual inspection

Visual inspection shall be executed for confirmation of following items:

Deformation, crack, rust, missing and loosening of bolts and nuts, loosening of terminal connection, discoloration, damage of insulation, wear of brake ring and gap measurement, noise, vibration, abnormal temperature, leakage of oil, water from piping and valves, other abnormality shall be checked.

Article 3-52. Insulation resistance

(Referr to Article 3-6 Insulation resistance in Chapter 3 In progress Inspection)

In Hydro power plant, during assembling and installation of electrical equipment, insulation resistance measurement shall be carried out for confirmation before and after of Dielectric test if it is surely insulated. As the measurement devices, meg-ohm meter or other equivalent devices built-in DC power source shall be used.

The calibration voltages shall be 500V for low voltage circuit which is less than AC 600V or less than DC 750V for low voltage equipment (excitation circuit, etc.), 1,000V for high voltage circuit which is over than AC 600 to 7000V or over than DC 750V to 7000V, and 2500V for the Extra High Voltage equipment which is over than AC 7000V and DC 7000V.

The measurement values shall meet the Technical Requirements, with regard to the installation status, test environment, specifications, materials, structure, and capacities of power plant. The test result is judged by the responsible person of the test.

Article 3-53. Dielectric test

(Referr to Article 3-7 Dielectric test in Chapter 3 In progress Inspection)

The purpose of this test is to confirm of no abnormality and maintaining necessary dielectric voltage in the electric circuit or electric equipment. The test procedure is as follows:

1. For confirmation of no abnormality of electrical circuit, regulated dielectric test voltage for rotating machine is applied between field, armature winding and earth using dielectric test devise.

   Dielectric test should not be repeated. If, however, a second test is nesessary, after further drying the rotating machine 80 % of the test voltage shall be applied. The test voltage shall be stepped up gradually within 10 second. Duration time of the test shall be within 1 minute after reach the test voltage value.

2. Dielectric test by DC current

   Dielectric test by DC current or other equivalent method may be carried out in case of the industrial power frequenvy test voltage is not available.

   Dielectric test valtage by DC current shall be 1.7 times of r.m.s value given in industrial power

frequency test voltage.

Dielectric test voltage shall be applied according to the values stated in Table 3-53-1 and confirmed withstand the necessary dielectric test voltage value under the regulated time.

Table 3-53-1. Dielectric Test Voltage at industrial power frequency

(Referred to Table-3-7-1in Chapter 3 In progress Inspection)

	Test Object	Characteristic of Electric Machines	Testing Voltage (V)
1	*(1)*	*(2)*	*(3)*
	- Stator Coil	- Capacity less than 1kW (kVA) with nominal voltage less than 100 V	2 Un + 500
		- Capacity less than 10,000 kW (kVA)	2 Un + 1000V (min. 1500V)
		- Capacity more than 10,000 kW (kVA)	
		(1) Un≦24,000 V	2 Un + 1000V
		(2) Un ›24,000 V	Subject to agreement with Manufacturer
2	Field windings of synchronous generators		
	Started not induction motor	Up to including 500 V	10Ef (min. 1,500 V)
		Above 500 V	2Ef + 4000 V
	Started induction motor		
	When the machine is intended to be started either with the field windings short-circuited or connected across a resistance of value less than ten times the resistance of the winding		10Ef (min. 1,500 V, maxi. 3,500 V)
	When the machine is intended to be started either with the field windings connected across a resistance of value equal to, or more than, ten times the resistance of the winding, or with the field windings on open circuit with or without a field-dividing switch.		2Ef + 1000 V (min.1,500 V)
3	- Stator Coil of Synchronous Generators while the stator assembly proceeded at site (For hydropower generator, after the completion of coil assembly and insulating the connectors)		A repetition of the tests should be avoided if possible, but if a test is performed on a group of machines and apparatus, each having previously passed its withstand voltage test, the test voltage to be applied to such an electrically connected arrangement shall be 80% of the lowest test voltage appropriate for any individual piece of the arrangement.
4	Exciter (except as below)		Withstand voltage shall be of the values item. 2.
	Exception 1: Exciters of synchronous motors (including synchronous induction motors) if connected to earth or disconnected from the field windings during starting.		1000 V + 2Ef (min.1500 V)

Un: Rated voltage Ef: Field voltage

Article 3-54 Axial voltage measurement

(Referred to Article 3-10-2 Axial voltage measurement in Chapter 3 In progress Inspection)

The purpose of this measurement is to confirm whether the main shaft of the generator has enough insulation.

The voltage shall be measured between upper bearing and lower bearing, upper bearing and earth, and lower bearing and earth for 3 points at rated voltage under no load saturation characteristic test.

The measured voltage shall be confirmed noabnormality comparing with normal condition.

Article 3-55. Vibration measurement

(Referred to Article 3-14 Vibration measurement in Chapter 3 In progress Inspection)

This measurement shall be executed for confirmation of no abnormal vibration during operation of rotating electrical machines.

Measurement of the vibration of electrical machine shall be measured at the mounting of the measuring point of the machine.

It is necessary to measure the vibration on the machine alone, under properly determined test conditions, without any influence from other equipment.

The result of measurement, the vibration is change at operation condition; therefore it shall be compared with normal condition and judged under design criteria.

Article 3-56. Hydraulic turbine inspection

1. Hydraulic turbine

(1) Runner

Cavitations shall be checked.

(2) Main shaft

Rust, loosening bolts of shaft cover shall be checked.

(3) Bearing

Contamination of Lubrication oil contents and purification shall be done.

(4) Turbine cover

Loosening of bolts and nuts, damage of sheet liner, wicket gate sealed packing shall be checked.

(5) Casing, Speed ring

Painting discoloration, welding parts, packing of manhole shall be checked.

(6) Draft tube

Damages, rust, packing of manhole shall be checked.

(7) Wicket gate operation mechanism

Share pins shall be checked.

Non destructive inspection, damages shall be checked.

Wicket gate, the operation test of wicket gate shall be checked and confirmed the performance.

Servomotor pressure shall be measured using pressure meter during opening and closing stroke.

Opening and closing time of servo motor stroke and closing characteristic shall be measured.

Damage of vanes and shaft shall be checked. Side and shutter gap shall be checked.

(8) Main shaft sealed packing

Leakage water shall be checked.

Sealed gap shall be checked.

(9) Opening and closing pressure shall be constant except start and stop motion.

Opening and closing time of servo motor stroke and closing characteristic shall be adjusted according to the design value.

The gap shall be adjusted within design value.

2. Governor

(1) Electrical and mechanical control parts, rust, loosening of terminals, insulation of heater shall be checked visually.

(2) Calibration of Meters, Operation of Protection relays shall be checked.

(3) Opening and closing stroke of auxiliary servomotor, main servomotor shall be checked.

(4) Input voltage and current of control unit shall be set designed value and change their values between the parameters of maximum head to minimum head, then the servomotor stroke shall be measured

(5) Characteristics of no-load opening, opening position depend on each outputs shall be check and kept within design value.

Article 3-57. Inlet valve inspection

1. Visual inspection

(1) Outside of inlet valve, damages rust, anchor bolts shall be checked.

(2) Inside of inlet valve, damages rust, erosion, discoloration shall be checked.

(3) Valve sealing mechanism of upper stream side and down stream side, opening and closing pressure shall be measured. The sealing mechanism shall be confrmed if it is operated within design value.

2. Opening and closing inspection

This inspection shall be executed for confirmation of the operating mechanism if it is operated smoothly and kept the performance of design value.

Opening and closing pressure shall be measured using pressure meter or oscilloscope.

As the result of test, the friction of operation mechanism shall be move smoothly at full stroke except start of opening and closing position under the design value.

3. Leakage water measurement

This measurement shall be executed for confirmation of the leakage water of inlet valve to prevent abnormal water leakage. After sealing of upper and lower side, the leakage water from drainage pipe of upper stream side shall be measured. The lower stream side, the leakage water shall be measured at drainage pipe on casing.

As the result of measurement, the leakage water quantity shall be kept within design value.

Article 3-58. Auxiliary equipment operation test

(Referred to Article 3-13 Auxiliary equipment operation test in Chapter 3 In progress Inspection)

This test shall be executed for confirmation of auxiliary equipment such as Water, Oil and Air supply system operate under the design conditions and prevent breaking off the pipe, abnormal water outcome and flowing out the oil.

Auxiliary equipments are composed Oil supply system, Water supply system and Air supply system. For operation smoothly of Generator, Hydraulic turbine, following tests shall be executed.

1. Non-destructive test, hydraulic pressure test or other necessary test
2. Continuous operation test for pumping motors and compressor.
3. Confirmation of safety valve operation.
4. Confirmation of air tank and oil pressure tank capacity.

As the result of the inspection at operation test, capacity for each auxilialy equipment and the performance shall be satisfied the design value.

Article 3-59. Automatic start and stop test

(Referred Article 3-18 Automatic start and stop test in Chapter 4 Completion Inspection)

This inspection shall be executed for confirmation of performance of designed sequential control from start to rated load operation of the generator.

Starting operation, rated load and stop operation shall be controlled from generator control board or control room for each step under designed control method..

As the result of this inspection, sequential control shall be controled without abnormality under the design value.

Part 4　Thermal Power Plants

Chapter 1　General Provisions

Article 4-1.　Definitions

In addition to the definitions prescribed in the article 1-3, the following definitions also apply in the part 4.

1. *"Technical Requirements"* means technical matters which are required for equipment to be kept and consist of standards which are adopted at each stage of design, manufacture and installation of power facilities, such as national standards, international standards, organization standards and manufacturer standards;
2. *"Facility Specification"* means documents and/or drawings which show major specifications of power facilities such as boiler, turbine and generator to be installed;

Chapter 2　Organization and Management of Operation and Maintenance

Article 4-2.　Organizations

Fulfillment of requirements on organization stipulated in the technical standard Vol.6 Part2 Chapter 1 shall be checked at the completion and periodic inspection.

Article 4-3.　Documentation

Fulfillment of requirements on documentation stipulated in the technical standard Vol.6 Part5 Chapter1 and Vol.6 Part6 Chapter1 shall be checked at the completion and periodic inspection.

Chapter 3　Completion Inspection

Section 1.　General

Article 4-4.　General Provision

In addition to the provision prescribed in the article 1-4, completion inspection for thermal power facilities shall be carried out according to the following items.

1. The completion inspection shall be conducted to confirm comprehensive function of thermal power plant after the installation, rebuilding, and relocation of the thermal power facilities. It shall be confirmed that construction work of the equipment is carried out in accordance with the Facility Specifications and meets the Technical Requirements.
2. Regarding the pressure vessels which are specified to be inspected in the “regulation of pressure vessel and list of relevant document”, inspection shall be made in accordance with the said regulation.
3. As for electric equipment in thermal power plant which are not mentioned in this chapter such as circuit breaker, transformer and so on, inspections shall be conducted according to relevant articles in Part 2.

Section 2.　Mechanical Equipment

Article 4-5.　General inspection

Make sure by visual inspection and actual measurement that the construction work of power facilities is carried out in accordance with the Facility Specifications and meets the Technical Requirements, with regard to the installation status, specifications, materials, structure, and capacities of power facilities.

As for the specifications, materials, and structure of facilities, record inspection is acceptable for judgment.

Article 4-6.　Safety valve test

The inspection shall be conducted for safety valve of drum, super heater, etc.

1. Confirmation of the installation status, etc.

Visually check the specifications of safety valve such as type, popping pressure, and relieving

capacity through identification plate, etc.

Visually check the installation location, numbers, and installation status of safety valve.

2. Operation test

Test is conducted through real operation. However, should it be difficult to conduct test under real operation, hydraulic action method can be applied instead.

It shall be confirmed that popping pressure falls in the range of error tolerance and, make sure that nothing abnormal (e.g. chattering, leaking) takes place at the time of popping and reseating.

Article 4-7. Alarm device test

1. Boiler-related alarm device test

Ensure that alarm devices which detect the abnormalities in control system, pressure, temperature, and so on regarding boiler, function normally.

(1) Make sure that alarm appears at the designated design value through actual function or input of simulated signal into detector.

(2) Alarm items can be properly selected from feed water system, fuel system, draft system, steam system and so on.

(3) The design value of alarm device is set to ensure that emergency measure can be taken with sufficient time when alarm appears in the process of operation.

2. Steam turbine-related alarm device test

Ensure that alarm devices which detect the abnormalities of control system, pressure, temperature, and so on regarding steam turbine, normally function.

(1) Make sure that alarm appears at the designated design value through actual function or input of simulated signal into detector.

(2) Alarm items can be properly selected from steam turbine proper, bearing oil system, condensate system, cooling water system, extraction steam system and so on.

(3) The design value of alarm device is set to ensure that emergency measure can be taken with sufficient time when alarm appears in the process of operation.

3. Gas turbine-related alarm device test

Ensure that alarm devices which detect the abnormalities of control system, pressure, temperature, and so on regarding gas turbine, normally function.

(1) Make sure that alarm appears at the designated design value through actual function or input of simulated signal into detector.

(2) Alarm items can be properly selected from gas turbine proper, bearing oil system, cooling water system and so on.

(3) The design value of alarm device is set to ensure that emergency measure can be taken with sufficient time when alarm appears in the process of operation.

Article 4-8. Interlock test

1. Boiler-related interlock test

Make sure that purge interlock and MFT interlock are indicated in the designated order respectively, and their operations are carried out without any obstacles.

(1) Furnace purge interlock

Make sure that purge starts only if conditions of start-up preparation have been satisfied and the indication of "Purge over" appears upon the time set by timer. Besides, make sure that MFT is reset only after the purge is finished (MFT won't be reset until the purge is finished), that all the fuel shutoff valves can be opened up, and that the ignition becomes possible.

(2) MFT interlock

Make sure shut off of the fuel system and proper action of the associated equipment and the valves through the actual action or simulated signal input of the various failure factors (for example, abnormally low drum water level, high furnace pressure, all FDF trips, and fuel loss).
In addition, this test shall be conducted during shutdown unless it is considered necessary to be conducted during operation for the sake of safety.

It shall be confirmed that interlocks are configured on the basis of planned conditions, each device operates in accordance with the interlock, and alarms and necessary indications normally appear.

2. Steam turbine-related interlock test

Make sure that main stop valve, reheat stop valve, etc. are surely shut off in the presence of various steam turbine failure factors (for example, solenoid trip, low bearing oil pressure trip, low vacuum trip of exhaust hood, high temperature trip of exhaust hood, thrust bearing friction trip).
It shall be confirmed that interlocks are configured on the basis of planned conditions, each device operates in accordance with the interlock, and alarms and necessary indications normally appear.

3. Gas turbine-related interlock test

Make sure that fuel stop valve is surely shut-off in the presence of various gas turbine failure factors (for example, low bearing oil pressure, high exhaust gas temperature)
Just like in the case of Boiler-related interlock test, the purge interlock before ignition shall be also examined.
This test shall be conducted during shutdown unless it is considered necessary to be conducted

during operation for the sake of safety.

It shall be confirmed that interlocks are configured on the basis of planned conditions, each device operates in accordance with the interlock, and alarms and necessary indications normally appear.

4. Auxiliaries-related interlock test

It shall be confirmed that interlocks are configured on the basis of planned conditions, each device operates in accordance with the interlock, and alarms and necessary indications normally appear.

(1) Automatic start of turbine auxiliary oil pump

Conduct auxiliary oil pump automatic start test under low outlet pressure of turbine main oil pump or low bearing oil pressure.

This test is to confirm that value of automatic start is set at the designed value and nothing is abnormal with the start by using test valve during no-load operation of turbine or by actual low pressure when stopping the operation of turbine.

(2) Automatic start of emergency oil pump

Conduct the test in the same way as that for auxiliary oil pump. However, in the absence of test circuit, do it during the shutdown of turbine.

It shall be confirmed that interlocks are configured on the basis of planned conditions. Besides, each device operates in accordance with the interlock, and alarms and necessary indications normally appear.

5. Coal equipment-related interlock test

Operate the receiving and extracting system and make sure that the receiving and extracting system-related facilities shut down safely through actual function of each protective device or input of simulated signal into each protective device.

It shall be confirmed that interlocks are configured on the basis of planned conditions. Besides, each device operates in accordance with the interlock, and alarms and necessary indications normally appear.

6. Smoke treatment equipment-related interlock test

Operate the smoke treatment equipment and make sure that the smoke treatment equipment-related facilities shut down safely through actual function of each protective device or input of simulated signal into each protective device.

It shall be confirmed that interlocks are configured on the basis of planned conditions, each device operates in accordance with the interlock, and alarms and necessary indications normally appear.

7. Unit interlock test

Make sure at low load operation that safety devices for the main facilities function, the related

facilities shut down or start up, and valves surely function by the actual action or simulated signal input of the various failure factors of Boiler, steam turbine, or gas turbine.

It shall be confirmed that interlocks are configured on the basis of planned conditions, each device operates in accordance with the interlock, and alarms and necessary indications normally appear.

Article 4-9. Speed governor working range test

Confirm the speed range (upper limit and lower limit) within which speed governor can adjust under the condition of no-load operation of steam turbine. It shall be confirmed that operation limit of speed governor is as same as designed.

Set steam turbine in the state of no-load operation and change the output of speed governor to the lower limit. Then, confirm the rotating speed of steam turbine under this condition.

In the same way, change the output of speed governor to the upper limit. Then, confirm the rotating speed of steam turbine under this condition.

Article 4-10. Emergency governor test

Function emergency governor by lifting the upper limit of speed governor working range and then gradually raising turbine speed at the time of no-load turbine operation. Check the rotating speed when turbine trips.

It shall be confirmed that all the valves are operating in accordance with the designated interlock, and alarms and necessary indications normally appear.

Article 4-11. Load dump test

Make sure that control by governor functions well and there is nothing abnormal with turbine rotating speed, generator voltage, etc., when shedding the load from the load operation. And make sure that turbine and generator are safely transferred to no-load operation.

This article shall not be applied to power generating unit with induction generator.

1. Power generating unit by steam turbine

With regard to the related valves, conduct operation test prior to load dump test by using the testing equipment installed at each individual valve to make sure that all the valves function well.

Conduct load dump test at four stages of 25% output or minimum output required for stable operation, 50% output, 75% output, and 100% output under each conditions of control method, respectively.

Before load dump, check the steam temperature, steam pressure, and flow rate, and make sure by visual examination or actual measurement that nothing abnormal such as operational values of turbine, generator voltage and so on is detected. After load dump until settling to no-load, make sure that nothing abnormal with each individual section is detected. Besides, make sure that the turbine

speed neither reaches the tripping speed at which the emergency governor functions, nor vibrates continuously.

It shall be confirmed that in transition to the permanent speed, everything is normal with each section and all the individual devices are operating properly, and operational values are the variable values which have no impact on safety.

2. Power generating unit by gas turbine

Except for the following, do the same as that for "1. Power generating unit by steam turbine".

(1) Conduct load dump test on gas turbine system in the state that outside air temperature is close enough to the design temperature to ensure gas turbine output.

(2) When performance confirmation of speed governor is required at 100% output or intermediate output under the typical condition such as the control method with maximum increase rate of rotating speed, etc. and load dump test under the output concerned is difficult to be conducted, if it is assessed that the testing results at the possible output can substitute the required confirmation, load dump test under the output concerned can be conducted.
In this case, immediately conduct load dump test, when the load dump test becomes possible.

(3) In case that it is assessed that result of load dump test for the same type of gas turbine can be available, the maximum increase rate of rotating speed may be confirmed on the basis of operation chart of the gas turbine concerned and the test result of the same type of gas turbine after conducting load dump test at the possible output.

It shall be confirmed that in transition to the permanent speed, everything is normal with each section and all the individual devices are operating properly, and operational values are the variable values which have no impact on safety.

Article 4-12. Load test

1. Power generating unit by steam turbine

Make sure by visual examination and with permanent instruments that there is no problem with any sections while turbine generator is operating at 100% output.

Make sure that there is no problem at each section while boiler operates continuously with 100% (rated output) at the status closest to rated steam temperature and pressure during 72 hours. In this case, the Boiler is considered as over the load test.

In case that there is sub-combustion method, when the operation is continued from that by main combustion method, continuous operation by the sub-combustion method can be completed for suitable period based on the status of combustion technology if nothing abnormal is identified in particular with any sections.

In this case, with regard to steam turbine, boiler, auxiliary facilities, etc. confirm whether measuring points are appropriate, what measurement methods are applied, whether instruments have adequately been calibrated, and whether operation is carried out in accordance with design specifications.

Measure the generated flue gas (sulfur oxides, nitrogen oxides, and dust).

It shall be confirmed that the operational values of all the sections of mechanical and electrical equipment are appropriate and, the volume and concentration of flue gas shall meet the emission standards.

2. Power generating unit by gas turbine

Except for the following, do the same as that for power generating unit by steam turbine.

(1) Conduct load test on gas turbine system under the condition that outside air temperature is close enough to the designed one to ensure gas turbine 100% output.

(2) When load test under 100% output is difficult, if it is assessed that testing results at the possible output can substitute the required confirmation, load test under the output concerned can be conducted.

In this case, immediately conduct load test, when the load test becomes possible.

(3) In case that it is assessed that result of load test for the same type of gas turbine can be available, the status of equipment may be confirmed on the basis of operation chart of the gas turbine concerned and test result of the same type of gas turbine after conducting load test at the possible output.

(4) Measure the generated flue gas (sulfur oxides and nitrogen oxides).

It shall be confirmed that the operational values of all the sections of mechanical and electrical equipment are appropriate, and the volume and concentration of flue gas shall meet the emission standards.

Article 4-13. Others

1. Gas turbine under 10,000kW which is assembled in manufacturing plant

Carry out completion inspection for gas turbine under 10,000kW on the basis of test results in the manufacturing plant.

In this case, if it is confirmed by the Owner that quality control in the manufacturing plant is appropriate, the output of load test can be based on possible output (the output at that time).

2. Other inspections

Carry out inspections that are considered necessary in terms of safety by the Owner in view of the

equipment status.

Section 3. Electrical Equipment

Article 4-14. Visual Inspection

1. Checking of grounding

Make sure by visual inspection that grounding conductor is connected to devices.

2. Countermeasure against live part

Make sure by checking documents or conducting visual inspection that live parts of equipment of AC of more than 600V and DC of more than 750V are not easily accessible to the staff concerned.

3. Protective device

Make sure by visual inspection that the protective devices required for generator and synchronous compensator are installed.

(1) Overcurrent or ground fault occur at AC circuit of more than 600V and DC circuit of more than 750V;
(2) Overcurrent occurs at generator
(3) Internal fault occurs at the generator of 12,000kVA and above
(4) Serious abrasion or temperature rise happens to the thrust bearing of steam turbine with its capacity bigger than 10,000kW
(5) Internal fault occurs at the synchronous compensator of 12,000kVAr and above

Article 4-15. Measurement of grounding resistance

Measure grounding resistance value of power plant with resistance tester such as direct-reading grounding resistance tester (earth tester) and so on. As for wide-ranging mesh grounding, it is desirable to measure the resistance value by voltage decrease method.

It shall be confirmed that the grounding resistance value shall be less than 10 ohm.

Article 4-16. Measurement of insulation resistance

Measure insulation resistance of AC circuit of 600V and below and DC circuit of 750V and below that are considered especially necessary (generator excitation circuit, etc.), and AC circuit of more than 600V and DC circuit of more than 750V. As for AC circuit of more than 600V and DC circuit of more than 750V, measurement of insulation resistance shall be carried out before and after the dielectric strength test.

Test is carried out with “one minute value” by using the insulation resistance tester of 500V for equipment and circuit of AC of 600V and below and DC of 750V and below and the one of 1,000V for equipment and circuit of AC of more than 600V and DC of more than 750V.
It shall be confirmed that the following value shall be satisfied.

(1) AC circuit of 600V and below and DC circuit of 750V and below
0.5 M ohm and above

(2) AC circuit of more than 600V and DC circuit of more than 750V
The circuit to be tested is insulated from earth.

Article 4-17. Dielectric strength test

Apply a test voltage to AC circuit of more than 600V and DC circuit of more than 750V as specified in Appendix 1 according to the working voltage of circuit and equipment.
It shall be confirmed that after having applied test voltage continuously for 10 minutes, there is nothing abnormal with insulation through insulation resistance test.

Article 4-18. Protective device test

Regarding each of the protective device as specified below, conduct the test by manually closing the related relay joint or actually functioning the relay.

1. The protective device that automatically breaks the circuit at the time of overcurrent or ground fault of AC circuit of more than 600V and DC circuit of more than 750V;
2. The protective device that automatically shuts down the generator at the time of overcurrent of generator
3. The protective device that automatically shuts down the generator when internal fault occurs at the generator of 12,000kVA and above
4. The protective device that automatically shuts down the generator when serious abrasion or increase of temperature occurs in the thrust bearing of steam turbine with its capacity bigger than 10,000kW;
5. The protective device that automatically shuts down synchronous compensator when internal fault occurs at the synchronous compensator of 12,000kVAr and above.

It shall be confirmed that the related circuit breakers, and fault indicator and alarm device of the circuit breakers operate well.

Article 4-19. Protective device test for hydrogen and seal oil

Conduct this test on the following items during the shutdown of turbine generator.

1. Low hydrogen gas purity

Make sure that the indication and alarm of low hydrogen gas purity occurs through the actual

function of hydrogen gas purity gauge or the simulation test.

2. High and low hydrogen pressure

Make sure that the indication and alarm of abnormal hydrogen pressure occurs.

3. Low outlet pressure of main seal oil pump

Make sure that the indication and alarm of low outlet pressure of seal oil pump occurs by functioning pressure switch with test valve and that emergency seal oil pump automatically starts up.

It shall be confirmed that the relevant protective device is reliably functioning and the relevant fault indicator and alarm are working precisely.

Article 4-20. Protective device test for the stator cooling system of generator

Conduct this test during the shutdown of turbine generator.

Make sure that indication and alarm accurately occurs and that standby cooling pump automatically starts up by manually or actually functioning relay that detects abnormality with stator cooling system.

It shall be confirmed that the relevant protective device is reliably functioning and the relevant fault indicator and alarm are working precisely.

Article 4-21. Unit interlock test

Same as “Article 4-8. 7. Unit interlock test”.

Article 4-22. Load dump test

Same as “Article 4-11. Load dump test”.

Article 4-23. Load test

Same as “Article 4-12. Load test”.

Article 4-24. Measurement of noise and vibration

Measure noise and vibration at the boundary of power plant.

It shall be confirmed that the noise and vibration shall meet their standards.

Chapter 4 Periodic Inspection

Section 1. General

Article 4-25. General Provisions

In addition to the provision prescribed in the article 1-4, periodic inspection for thermal power facilities shall be carried out according to the following items.

1. The periodic inspection shall be conducted to detect the damage, deformation, abrasion, and abnormality of thermal power facilities and to confirm the state of function and operation periodically after the commencement of operation of the equipment.
2. Regarding the pressure vessels which are specified to be inspected in the “regulation of pressure vessel and list of relevant documents”, inspection shall be made in accordance with the said regulation.
3. As for circuit breaker, transformer and so on installed in power plant, inspection items shall be conducted according to relevant articles in Part 2.

Article 4-26. Frequency of periodic inspections

1. Periodic inspection shall be carried out at the following frequency or more in principle for each thermal power facility.

   (1) Boiler, independent superheater, and steam accumulator and their auxiliary equipment
   Within six (6) years

   (2) Steam turbine and its auxiliary equipment
   Within six (6) years

   (3) Gas turbine and its auxiliary equipment
   The interval shall be set by the Owner based on instruction of the manufacturer, but if there is no such a instruction, the interval shall be as follows.
   a. Within two (2) years for the output of 10,000kW or more
   b. Within three (3) years for the output below 10,000kW

   (4) Generator and motor and their auxiliary equipment
   Within six (6) years

2. The inspection can be extended and conducted at the time designated by the Authority if it is approved by the Authority that inspection doesn't need to be conducted on the basis of this

interval in consideration of the equipment status.

Section 2. Mechanical Equipment

Article 4-27. General Provisions

It shall be confirmed that there is no damage, deformation, abrasion, and other abnormality of mechanical equipment in thermal power facilities through methods stipulated in this section.
And it shall be confirmed that thickness is not less than the stipulated value by thickness measurement, and operation value is within the stipulated range by operation test and trial operation.

Article 4-28. Boiler

1. Steam drum (Including flush tank for start-up bypass)

Conduct visual examination inside the drum and liquid penetrant test (hereinafter referred to as "PT") of weld line inside the drum after removing necessary numbers of steam separators.
Steam separator welded to steam drum doesn't need to be removed.

2. Water drum

Conduct visual examination inside the drum and PT of weld line inside the drum after taking out necessary numbers of internal equipment.
Internal equipment welded to steam drum doesn't need to be removed.

3. Header

Conduct external inspection of header and lifting ring of header.
Select more than two typical headers and conduct internal inspection of them. Heat insulating materials that are fitted on header don't need to be removed.

4. Tube

(1) Evaporation tube

Conduct external inspection on the tubes inside furnace.
Conduct visual examination by putting up scaffold to the burner level inside furnace, by using gondola, by using inspection robot or the like.
If erosion countermeasures are not applied, measure wall thickness at typical points of tube which receives steam cutting for the boilers excepting oil-fired, gas-fired and black liquor-fired boilers.
For the black liquor-fired boiler, measure the wall thickness of uncovered tube when scaffold is put up to the burner level.

For the black liquor-fired boiler, measure the wall thickness of smelt spout at typical locations.

(2) Superheater tube, Reheater tube, Economizer tube

Conduct external inspection of superheater tube, reheater tube, and economizer tube.

For the boilers excepting oil-fired, gas-fired and black liquor-fired boilers, conduct touch inspection of superheater tube, reheater tube, and economizer tube if erosion countermeasures are not applied.

For the boilers excepting oil-fired, gas-fired, black liquor-fired boilers, measure wall thickness of superheater tube, reheater tube, and economizer tube at typical points if erosion countermeasures are not applied.

5. Safety valve

Conduct inspection by disassembling safety valve and power control valve of drum, superheater, and reheater.

Increase steam pressure to the designated pressure or more and make safety valve actually function.

Operation test can also be conducted by hydraulic action method.

6. Boiler main stop valve, Feed water stop valve

In case that hard erosion occurs at valve body and seat, disassemble and conduct inspection.

7. Boiler circulation pump

Conduct external inspection of boiler circulation pump. If necessary, conduct open inspection, too.

Conduct operation test of boiler circulation pump.

Article 4-29. Boiler auxiliary equipment

1. Feed water pump

Conduct external inspection of feed water pump. If necessary, conduct open inspection, too.

Conduct operation test of feed water pump.

2. Fan (Forced draft fan, Induced draft fan, Gas recirculating fan, Gas mixing fan)

Conduct external inspection of draft fan. If necessary, conduct open inspection, too.

Conduct operation test of fans.

3. Combustion equipment

Conduct external inspection of burner from inside furnace.

4. Tube attached to boiler

In consideration of status of each tube, conduct the following management for tube thickness if necessary.

(1) Measure tube thickness based on measurement program developed by the Owner.
(2) In addition to the a. mentioned above, assess remaining life on the basis of the results of tube thickness measurement conducted during the last periodic inspection and so on, or check and review the finished assessment of remaining life.
(3) When necessary, develop or revise measurement program of tube thickness.

Article 4-30. Steam turbine

1. Casing

Remove upper part of high- and middle-pressure casing, and conduct inspection of diaphragm and labyrinth packing without removing them.

Remove upper part of low-pressure casing and conduct inspection of diaphragm and labyrinth packing without removing them.

Conduct PT as needed.

2. Rotor, turbine disk, rotating blade

Within the opened range of casing, inspect the following by quietly rotating rotor without removing it.

(1) Rotor
(2) Turbine disk
(3) Blade and blade dovetail
(4) Shroud ring and lacing wire

Conduct PT as needed.

3. Diaphragm, nozzle, stationary blade

Check the first stage of nozzle at the upper part of high- and middle-pressure. Conduct inspection with diaphragm fixed in casing.

Conduct PT if needed.

4. Bearing

Conduct external inspection for bearing.

Disassemble bearing and conduct inspection inside.

5. Main valve (Main stop valve, reheat stop valve, governor valve)

Disassemble each individual main valve and conduct inspection of strainer, valve body, valve seat, etc.

Conduct PT if needed.

6. Emergency stop device

Conduct external inspection on emergency governor, tripping device, etc.

In the case of disassembled and open inspection, conduct operation test on emergency stop device after reassembling.

7. Condenser

Open condenser water box and visually check the inside and condenser tubes to the extent possible.

Article 4-31. Steam turbine auxiliary equipment

1. Tube attached to Steam turbine

In consideration of status of each tube, conduct the following management for tube thickness if necessary.

(1) Measure tube thickness based on measurement program developed by the Owner.

(2) In addition to the a. mentioned above, assess remaining life on the basis of the results of tube thickness measurement conducted during the last periodic inspection and so on, or check and review the finished assessment of remaining life.

(3) When necessary, develop or revise measurement program of tube thickness.

Article 4-32. Gas turbine (internal combustion)

1. Compressed combustion gas supply equipment and its auxiliary equipment

The auxiliary equipment of compressed combustion gas supply equipment is the equipment that supplies compressed gas for combustion to gas turbine together with gas compressor proper.

(1) Gas compressor proper

Conduct disassembled inspection. If disassembled inspection is periodically conducted by means of time management and so on according to the equipment properties, conduct disassembled inspection as long as it may be necessary.

Conduct operation test.

(2) Gas receiver, Gas cooler, Oil separator

Conduct external inspection.

(3) Safety valve

Conduct external inspection on valves.

Disassemble valves and conduct inspection as the need arises due to the factors such as heavy abrasion of valve body, valve seat, valve stem, and seal.

Operation test shall be conducted. In case of disassembled and open inspection, operation test shall be conducted after reassembling. Operation test can also be conducted by hydraulic action method.

(4) Tube

Conduct external inspection on main tubes.

2. Casing

(1) Horizontally split gas turbine

Remove upper part of casing, and conduct inspection.

Conduct PT and clearance gap measurement as needed.

(2) Cylinder casing gas turbine

Disassemble compressor, combustion chamber and turbine and conduct inspection for that equipment.

3. Rotor, turbine disk, rotating blade, shaft coupling

(1) Horizontally split gas turbine

Inspect the following by quietly rotating rotor without removing it.

a. Rotor
b. Turbine disk
c. Blade and blade dovetail
d. Shaft coupling
e. Section where counterweight is installed

Conduct PT, etc as needed.

(2) Cylinder casing gas turbine

Appropriately disassemble rotor, turbine disk, rotating blade and so on of compressor and turbine, and conduct inspection for that equipment.

Conduct PT, etc as needed.

4. Diaphragm, nozzle, stationary blade

(1) Horizontally split gas turbine

Remove nozzle only at upper part and conduct inspection.

Conduct PT, etc if needed.

(2) Cylinder casing gas turbine

Appropriately disassemble diaphragm, nozzle, stationary blade and so on of compressor and turbine, and conduct inspection for that equipment.

Conduct PT, etc as needed.

5. Bearing

(1) Horizontally split gas turbine

Conduct external inspection of bearing.

Conduct open inspection when taking out rotor as needed.

(2) Cylinder casing gas turbine

Disassemble bearing and conduct inspection.

6. Emergency Governor

(1) Horizontally split gas turbine, Cylinder casing gas turbine

Conduct external inspection of emergency governor, tripping device, etc.

Conduct operation test on emergency stop device.

7. Reduction gear

(1) Cylinder casing gas turbine

Conduct open or disassembled inspection.

Conduct operation test after reassembling reduction gear.

Article 4-33. Gas turbine (external combustion)

For those except blast furnace gas expander, conduct proper inspection by referring to this article.

1. Casing

Remove the upper part of casing and conduct inspection. If needed for inspection, remove diaphragm and labyrinth packing.

2. Rotor, turbine disk, rotating blade, shaft coupling

Remove rotor and inspect the following.

(1) Rotor

(2) Turbine disk

(3) Blade and dovetail

Conduct PT if necessary.

3. Diaphragm, nozzle, stationary blade

If needed, remove the diaphragm from casing and conduct inspection.

Conduct PT if needed.

4. Bearing

Disassemble bearing and conduct inspection.

5. Reduction gear

Conduct open or disassembled inspection at every other time of periodic inspection.

Conduct operation test after reassembling reduction gear.

6. Main valve (Emergency shut-off valve)

Conduct inspection of valve body, valve seat, valve stem, and seal.

7. Emergency governor

Conduct external inspection of emergency governor, tripping device, etc.

Conduct operation test on emergency stop device.

Article 4-34. Independent superheater

1. Independent superheater proper

Conduct visual inspection of the outer surface of tubes.

Open the inspection holes at header.

Select typical parts of tubes, then conduct nondestructive inspection for them or conduct inspection after cutting off them as needed.

2. Heavy oil combustion equipment, forced draft fan, soot blower, Steam receiver (including drain separator)

Conduct visual inspection of the outer surface of tubes.

Open the inspection holes at header.

Select typical parts of tubes, then conduct nondestructive inspection for them or conduct inspection after cutting off them as needed.

3. Tube attached to independent superheater

In consideration of status of each tube, conduct the following management for tube thickness if necessary.

(1) Measure tube thickness based on measurement program developed by the Owner.

(2) In addition to the a. mentioned above, assess remaining life on the basis of the results of tube thickness measurement conducted during the last periodic inspection and so on, or check and review the finished assessment of remaining life.

(3) When necessary, develop or revise measurement program of tube thickness.

Article 4-35. Steam accumulator

1. Steam accumulator proper

Open the manhole and conduct internal inspection.

Take out internal facilities and conduct inspection.

2. Tube attached to steam accumulator

In consideration of status of each tube, conduct the following management for tube thickness if necessary.

(1) Measure tube thickness based on measurement program developed by the Owner.
(2) In addition to the a. mentioned above, assess remaining life on the basis of the results of tube thickness measurement conducted during the last periodic inspection and so on, or check and review the finished assessment of remaining life.
(3) When necessary, develop or revise measurement program of tube thickness.

Article 4-36. Trial operation

Regarding the equipment (excluding the gas turbine below 10,000kW and blast furnace gas expander) that is inspected by the method illustrated in this chapter, trial operation shall be conducted immediately after the completion of assembling. In this case, conduct trial operation at 100% output if at all possible.

Section 3 Electric Equipment

Article 4-37. General provisions

It shall be confirmed that there is no damage, deformation, abrasion, and other abnormality of electric equipment in thermal power facilities through methods stipulated in this section.
And it shall be confirmed that measured value is within the stipulated range by measurement inspection, and operation value is within the stipulated range by operation test and trial operation.

Article 4-38. Generator and synchronous compensator

1. Bearing bracket

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

2. Gas cooler, Air cooler

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

3. Stator

The following items shall be confirmed through external inspection and open inspection.
(1) Damage, defacement, and state of installation of each parts
(2) Oil leakage, water leakage
Measurement of insulation resistance of windings shall be conducted.
Measurement of insulation resistance of temperature-detecting components shall be conducted.

4. Bushing

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

5. Rotor

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of insulation resistance of rotor windings shall be conducted.

6. Rotor lead conductor

Damage, defacement, and state of installation of each part shall be confirmed through external inspection.

Measurement of insulation resistance shall be conducted.

7. Brush holder

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of pressure of brush shall be conducted.

8. Bearing

The following items shall be confirmed through external inspection and open inspection

(1) Damage, defacement, and state of installation of each parts

(2) Oil leakage

Measurement of insulation resistance of bearing seating and insulator shall be conducted.

9. Shaft gas sealing device

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of insulation resistance of insulator of casing and insulating bolt and insulating washer shall be conducted.

10. Alarm device for oil and water leakage

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Article 4-39. Excitation system (directly connected type)

1. AC & DC generator (Commutatorless)

(1) Housing

Damage, defacement, and state of installation of each part shall be confirmed through external

inspection and open inspection.

(2) Stator

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of insulation resistance of windings shall be conducted.

(3) Rotor

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Inspection after extracting rotor shall be conducted.

Measurement of insulation resistance of windings shall be conducted.

(4) Brush holder

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of pressure of brush shall be conducted.

(5) Bearing

The following items shall be confirmed through external inspection and open inspection

a. Damage, defacement, and state of installation of each parts

b. Oil leakage

Measurement of insulation resistance of bearing seating and insulator shall be conducted.

(6) Air cooler

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Check of tightening condition of bolt shall be conducted.

(7) Silicon rectifier

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of conduction and assigned voltage shall be conducted.

2. AC generator (brushless)

(1) Housing

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

(2) Stator rectifier

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Reverse current test and thyristor check shall be conducted.

Measurement of resistance shall be conducted.

Measurement of insulation resistance shall be conducted.

(3) Stator

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of insulation resistance of windings shall be conducted.

(4) Rotor

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Inspection after extracting rotor shall be conducted.

Measurement of insulation resistance of windings shall be conducted.

(5) Permanent magnetic generator

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of insulation resistance shall be conducted.

(6) Bearing

The following items shall be confirmed through external inspection and open inspection.

a. Damage, defacement, and state of installation of each parts
b. Oil leakage

Measurement of insulation resistance of bearing seating and insulator shall be conducted.

(7) Rotor lead conductor

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

(8) Air cooler

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Check of tightening condition of bolt shall be conducted.

Article 4-40. Excitation system (separate placement type)

1. Housing

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

2. Stator

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of insulation resistance of windings shall be conducted.

3. Rotor

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Inspection after extracting rotor shall be conducted.

Measurement of insulation resistance of windings shall be conducted.

4. Brush holder

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of pressure of brush shall be conducted.

5. Bearing

The following items shall be confirmed through external inspection and open inspection

(1) Damage, defacement, and state of installation of each parts

(2) Oil leakage

Measurement of insulation resistance of bearing seating and insulator shall be conducted.

6. Induction motor

Make inspection according to Article 4-43. Motor.

Article 4-41. Excitation system (static type)

1. Housing

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

2. Thyristor rectifier

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

3. Air cooler

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

4. Protective device

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of resistance of resistance unit shall be conducted.

Article 4-42. Auxiliary equipment of generator

1. Hydrogen control system

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of insulation resistance of gas dryer (electric heater) shall be conducted.

Measurement of conduction for lead of gas dryer shall be conducted.

2. Carbon dioxide supplying unit

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of insulation resistance of electric heater in vaporizer and water separator shall be conducted.

Measurement of conduction for lead in vaporizer and water separator shall be conducted.

3. Nitrogen filling unit

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

4. Seal oil control system

The following items shall be confirmed through external inspection and open inspection

(1) Damage, defacement, and state of installation of each parts

(2) Oil leakage

Inspection of pump and motor shall be conducted.

Measurement of insulation resistance and conduction of heating wire shall be conducted.

5. Stator cooling system

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Inspection of pump and motor shall be conducted.

6. Neutral grounding equipment

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of insulation resistance shall be conducted.

Measurement of grounding resistance shall be conducted.

7. Surge absorber

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of resistance of current-limiting resister shall be conducted.

Measurement of insulation resistance shall be conducted.

Article 4-43. Motor

As for motor of motor-driven valves, conduct inspections listed in this article in view of their status.

1. Stator

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Measurement of resistance of windings shall be conducted.

2. Rotor

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

3. Bearing

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

4. Cooling system

Damage, defacement, and state of installation of each part shall be confirmed through external inspection and open inspection.

Oil flushing shall be conducted.

Article 4-44. Trial operation

Same as “Article 4-36. Trial operation”.

Appendix 1 Test Voltage for Withstand Voltage Test

Withstand voltage test shall be carried out by applying test voltage to the main circuit with circuit breakers closed. It shall be checked that no abnormality exists by applying test voltage shown in the tables below for 10 [min].

Table Appendix 1-1 Test Voltage for withstand voltage test

Nominal Voltage level [kV]	Test voltage [kV]	Derivation	Neutral grounding system
3	4.7	1.5 times of maximum operating voltage (3 * 1.05) [kV]	All type
6	9.4	1.5 times of maximum operating voltage (6 * 1.05) [kV]	All type
10	13.1	1.25 times of maximum operating voltage (10 * 1.05) [kV]	All type except multiple earthing system
	9.6	0.92 times of maximum operating voltage (10 * 1.05) [kV]	Multiple earthing system
15	19.6	1.25 times of maximum operating voltage (15 * 1.05) [kV]	All type except multiple earthing system
	14.4	0.92 times of maximum operating voltage (15 * 1.05) [kV]	Multiple earthing system
20	26.1	1.25 times of maximum operating voltage (20 * 1.05) [kV]	All type
35	45.7	1.25 times of maximum operating voltage (35 * 1.05) [kV]	All type
110	126.5	1.1 times of maximum operating voltage (110 * 1.05) [kV]	Resistance grounded system
	143.8	1.25 times of maximum operating voltage (110 * 1.05) [kV]	All type
220	147.2	0.64 times of maximum operating voltage (220 * 1.05) [kV]	Solidly grounded system
500	336.0	0.64 times of maximum operating voltage (500 * 1.05) [kV]	Solidly grounded system

Duration is 10 [min].

When it is difficult to carry out withstand voltage test, applied voltage test by application of system voltage for duration of 10 [min] can be substituted for dielectric strength test.

Test voltage of withstand voltage test in the course of completion test is defined as the product of actually possible voltage multiplied by a margin.

At lower voltage levels, since surge voltage etc. affect considerably, the margin is set to 1.5. However, as the voltage level becomes higher, the effect becomes less, the margin is set to smaller value.

At solidly grounded neutral system, since voltage rise of the phases other than fault phase at the time

of single line-to-ground fault is smaller than that of ungrounded neutral system, smaller test voltage can be used.

Ministry of Industry

Technical Standards
Volume 6

Operation of Power Plants and Grid

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JAPAN INTERNATIONAL COOPERATION AGENCY

ECONOMIC DEVELOPMENT DEPARTMENT

Table of Contents

Part 1 General

Article 1-1. Purpose

This regulation defines technical requirements to be fulfilled during operation and maintenance of network facilities, hydro powerplants, and thermal powerplants in order to secure public safety, environmental protection, and reliability of the facilities and relevant equipment.

Article 1-2. Scope of application

This standard applies to all powerplants located in Vietnam and connected to the Vietnamese grids, and network.facilities. The scope of application of this standard is as follows.

(Network Facilities)

This standard applies to all network electrical equipment located in Vietnam and connected to the Vietnamese grids, excluding equipment that comes under 1,000V.

(Hydro Powerplants)

This standard applies to civil works and electrical equipment of hydro powerplants designated as follows respectively:

1.Civil works and appurtenant equipment of all hydro powerplants located in Vietnam and connected to the Vietnamese Grids, excluding hydro powerplants with the special dams defined by the Government Decree No. 143/2003/ND-CP;

2. Electrical equipment of hydro powerplants located in Vietnam and connected to the Vietnamese Grids, with rated output equal to or greater than 30MW.

(Thermal Powerplants)

This standard applies to all thermal powerplants located in Vietnam and connected to the Vietnamese Grids, with rated output equal to or greater than 1,000kW.

Article 1-3. Definitions

1. "*The Authority*" means Ministry of Industry in Vietnam
2. "*The Owner*" means any person, unit, or municipality, or combination thereof, that owns power plants or network facilities and has a legal responsibility for operation of those power plants;
3. *"The Grid Operator"* means those who manage and operate the Vietnamese grid in load dispatch center.

Part 2 Organization and system for operation

Chapter 1 Organizational Structure and Duties

Article 2-1. Duties

The Owner shall be responsible in fulfilling the technical requirements stipulated in this technical standards. Items which person, unit, or municipality, or combination thereof, other than the owner shall be responsible in fulfilling the technical requirements are stated in the relevant articles specifying those who are responsible.

The Owner and the Grid Operator must thoroughly understand characteristics of power generation facilities and its role in national economy and life.

Article 2-2. Clarification of organization

The Owner shall organize and maintain an appropriate organization to safely manage the network facilities and powerplants. In order to clarify the organization and its responsibility, the Owner shall prepare and update the organization chart, including roles and responsibility of each staff. In addition to this, an emergency communication chart shall be prepared and updated without delay whenever changes are given to the organization.

Chapter 2 Acceptance of Equipment and Plants for putting in operation

Article 2-3. Standpoint of inspection at completion

Powerplants and network facilities which have completed, finished their expansion, or completed in separate phases shall be allowed to operate without the checking in line with relevant regulations.

Article 2-4. Dealing with defect

After completion, detected shortcomings and errors shall be fixed. The duration for temporary operation of the equipment shall be determined, during which necessary tests and remedying for shortcomings and errors shall be carried out.

As for equipment series which are firstly introduced, commissioning duration shall be decided based on the plan of activities on improving and adjusting of such equipment.

Chapter 3 Repair of Equipment and Plant

Article 2-5. Implementation of repair

The repair of powerplant and network facilities shall be carried out with appropriate methods and intervals to maintain the reliability and economical operation. The intervals except for those stipulated in Volume 5 should be set by the Owner taking the condition and practical failure rate of the equipment into account.

Article 2-6. Approval for repair and overhaul

In case of structure change and structure change in repair of facilities, the work shall be implemented under the approved technical design.

Article 2-7. Preparation of long-term plan

A long-term plan on appropriate repair of facilities shall be prepared in order to operate effectively and to maintain reliability.

Chapter 4 Technical Materials

Article 2-8. Keeping of necessary materials

Essential technical materials for electricity activities shall be kept properly. The materials that shall be kept are stipulated in each part, namely Part 4 Chapter 1 Article 4-2, Part 5 Chapter 1 Article 5-1, and Part 6 Chapter 1 Article 6-1.

Article 2-9. Provision of relative standards

The standards that relate to inspection, repair, and maintenance shall be properly provided.

Article 2-10. Attachment of rating plate

Each piece of equipment of electric power facility shall be labeled with its rating plate.

Article 2-11. Numbering of equipment

Each piece of equipment of electric power facility including pipelines and bus-bar systems shall be numbered.

Article 2-12. Record and Indication of parameter for operation

Parameters of facilities shall be carried on the control panels that are used for operation in control centers and other control rooms. They shall also be recorded and shall be always available.

Article 2-13. Installation of equipment for record

In dispatching centers of power grid and central control rooms of powerplant, recorders must be installed to record the data in dealing with emergencies.

Chapter 5 Safety Technology

Article 2-14. Compliance of safety standards

Arrangement for operation and repair of electric power facilities shall comply with the requirement of ordinances of Ministry of Industry and other regulations.

Article 2-15. Registration of boiler, pressure tank and crane

Boilers, pressure vessels, and cranes that are subject to application of State's regulations must be registered in accordance with regulations of Ministry of Industry.

In case where the above-mentioned equipment is not subject to application of State's regulations, the owner shall take responsibilities by themselves to guarantee that equipment's safety.

Article 2-16. Inspection of safety protection system

Automatic protecting equipment and safe equipment and appliances for operation shall be inspected in accordance with existing regulations.

Article 2-17. Responsibility for safety and hygiene

If indirect staffs, who are related to realization of labor safety technical standards and hygiene, do not administer their responsibility and do not carry out necessary measures to prevent occupational accidents and infection, and if individuals violate occupational safe and hygienic regulations, they must bear appropriate responsibility for accidents and infections during the work.

Article 2-18. Report of accident

Each accident of facilities, occupational incident and accident shall be reported, investigated and listed timely, accurately and sufficiently under existing regulations. At the same time, solutions for dealing with must be promptly given to preclude such incident and accidents from reoccurring.

Article 2-19. Training of first-aid measure

All personnel who work in installation and repair of powerplants and network facilities shall be trained with first-aid measures for people who receive an electric shock.

Article 2-20. Preparation of first-aid dressings

First-aid dressings shall be prepared in each workshop, substations, and maintenance offices whose work may involve dangerous and noxious places.

Article 2-21. Outfit for electrical work

All staff shall wear pertinent appliances and coveralls when they are in work. The work means those in indoor and outdoor work and maintenance work of substations, work in powerplants and in manholes and the like.

Chapter 6 Fire prevention Equipment

Article 2-22. Fire prevention equipment in electrical facilities

Layout of powerplants and network facilities shall fully consider safety in fire prevention. The responsible person who bears overall responsibility in safety in fire prevention and fire fighting shall be assigned. The assigned person should be responsible for arrangement of implementing measures on fire prevention, check of abidance in fire prevention system, availability of automatic fire alarming system and firefighting equipment and methods, and arrangement of practicing firefighting.

Article 2-23. Implementation of firefighting training

By setting up plans for installing fire prevention equipment and implementing them, relevant regulations on fire prevention shall be observed. Firefighting practice must be organized periodically as regulations.

Article 2-24. Installation of fire prevention equipment

Installation and improvement shall be carried out based on the installation plan of fire prevention equipment approved by the relevant authorities. The fire prevention equipment must be well maintained and be easily recognized. It shall be checked periodically or replaced as required. If an automatic firefighting equipment is installed, it shall conform to relevant regulations.

Part 3 Plan, Houses and Power Plants

Chapter 1 Plan

Article 3-1. Hygienic condition for plan, houses and power plant

For smooth operation and upkeep of hygienic condition for plan, houses and works, it is necessary to abide requirements on environmental protection and keep the following items in good conditions:

1. Surface and underground drainage system for the whole plan of power plant, substation and relevant facilities;
2. Dust precipitating system and ventilating system;
3. Waste water treatment systems;
4. Water supply system and drainage system;
5. Sources for domestic water, reservoirs and protecting system for water sources;
6. Railways and roads in yards of power plant, substation and relevant facilities;
7. Fences, illumination for parks, other cultural works and public works;
8. Systems for monitoring underground water level.

Article 3-2. Protection of water route, gas pipeline and cable route

Clear, visible and solid warnings shall be displayed for underground water routes, wastewater system, gas pipelines and cable routes.

Article 3-3. Water treatment

Wastewater and drained rainwater in the yard shall be lead to water treatment system. In case that water discharged to reservoir has a possibility to be contaminated with pollutant such as oil, chemicals, and water quality shall be checked in accordance with industrial hygiene regulations.

Article 3-4. Stability of plan

In case that the settlement, landslide and fracture are detected on the plan, proper measures shall be carried out to exclude or mitigate causes for above-mentioned phenomena and tackle their consequences.

Article 3-5. Railway and road

Railways and relevant works located in the yard and the area under the control of the power plant shall be managed and maintained in line with regulations of railways. Management and maintenance of roads in the same area shall be also in accordance with the technical regulations and standards of transport and communication sectors.

Chapter 2 Houses, Power Plant, Technical and Hygienic Equipment

Article 3-6. Principles in maintenance

Power plants and relevant facilities, houses and related structures shall be maintained in good condition, and secured for durable operation, reliable as design. They shall satisfy occupational safety and industrial hygiene for staffs.

Article 3-7. Periodic and special inspection of houses, works and equipment

The owner shall monitor the condition of houses, works and equipment to secure reliable operation, and check them comprehensively to detect damages and potential failure periodically. In case that the breakdown or natural hazards such as fire, earthquakes, heavy storm and flood would happen at the area where electrical facilities and equipment are installed, emergency inspection shall be carried out immediately after the incidents.

Article 3-8. Check of houses and works on particular ground

It is necessary to check carefully and continually the condition of houses and works constructed at new earth-filled area, settlement area and the location where vibration appears frequently during operation.

Article 3-9. Check of durability of houses and works

Once keeping a close watch on durability of houses and works, it is necessary to check the condition of supporting column, expansion gaps, welded seams, joints, structures of reinforced concrete, structures and parts affected by active load and heat.

Article 3-10. Countermeasures for fractures and damages

In case that fractures or damages on structures are detected, subsequent actions shall be selected carefully according to the degree, location and causes of fractures and damages. Excluding cases that the defects are structurally and functionally negligible or urgent repair works are executed immediately, careful successive inspection shall be carried out for detected fractures or damages. Depending on the conditions of defects, proper monitoring equipment such as plumb lines, crack gauges and displacement meters etc. shall be installed immediately. A series of investigations and countermeasures shall be recorded correctly for proper maintenance.

Article 3-11. Check of chimney

Chimneys' outside and inside of powerhouse shall be checked appropriately in view of the status of chimney. The interval of check shall be set by the Owner.

Article 3-12. Alteration of facilities

It is prohibited to alter facilities like piercing, arranging heavy machinery and materials, and installing ducts and pipelines, which may damage the stability and safety of facilities. Overload or alteration shall

be permitted on the condition that the safety would be confirmed by design calculation. If need be, such structures shall be reinforced properly.

At each section in floor surface, based on design, it is necessary to recognize allowable limit-load and put instructions at visible place.

Article 3-13. Corrosion protection of metal structures

Metal structures of houses and works shall be in corrosion protection conditions. Effective checking mode for corrosion protection shall be established depending on characteristics of each structure.

Part 4 Civil Works, Water Sources, and Management of Hydraulic Turbine and Powerhouse

Chapter 1 General Provisions

Article 4-1. Definitions

In addition to the definitions prescribed in the article 1-3, the following definitions also apply in the Part 4.

1. *"Air valve"* means a device that provides a mechanical vent allowing air flows in and out of a penstock in order to secure safety against watering-up, dewatering and some conditions during operation.
2. *"Automatic protection system of penstock"* means whole ventilating system installed at penstock to secure safety, which consists of air valves and appurtenances such as standpipes and ventilation pipes.
3. *"Civil works"* means structures constructed with earth, rock, concrete or combination thereof.
4. *"Headworks"* means structures constructed at the front side of waterways to take water from a river, a lake and a reservoir. Usually it includes an intake structure, intake gates and a facility to flush sedimentation;
5. *"Hydro-meteorology agency"* means the Headquarter or branches of National Center of Hydro Meteorological Forecast.
6. *"Independent periodic inspection"* means check of facilities and equipment carried out by the Owner at regular interval;
7. *"Outlet works"* means one of dam appurtenances that release water from a reservoir in order to carry out water supply, drawdown of reservoir;
8. *"Pressurized structure"* means a structure that is designed for non-atmospheric external and/or internal pressure such as steel penstocks.
9. *"Reservoir"* means a pond with capacity enough to regulate natural river flow for water use in some period such as season or year;
10. *"Special inspection"* means extraordinary check of facilities and equipment after heavy storm, strong earthquake, large flood etc.
11. *"Waterway"* means a structure to lead water with or without pressure. It consists of open channels, tunnels, pipe conduits or combination thereof.

Article 4-2. Preparation and preservation of necessary documents

1. The Owner shall prepare report on the following items and preserve them properly:
   (1) Operation results on water release from spillway and outlet works;

(2) Maintenance results such as repair work of civil works and mechanical equipment;
(3) Independent periodic inspection results;
(4) Special inspection results;
(5) Instrumentation results of civil works and mechanical equipment;
(6) Hydrometeorological observation results.

2. The Owner shall preserve following documents in good condition in order to operate and maintain civil works and appurtenant equipment properly:
(1) Fundamental legal and administrative documents such as operation manuals and Water right;
(2) Design reports and principal memoranda on design condition, design criteria, assumptions;
(3) Technical specifications of structures and equipment;
(4) Construction history records;
(5) Reports and records at the initial impoundment;
(6) As-built drawings;
(7) Precedent hydrometeorological data;
(8) Precedent monitoring data on performance of structures;
(9) Laboratory reports on materials, hydraulics;
(10) All previous reports and records on maintenance history, and official and independent periodic inspections.

Chapter 2 Civil Works and Mechanical Equipment for Civil Works

Section 1 Civil Works

Article 4-3. Taking over

1. In addition to the final design reports and construction reports, the Owner shall take over the following documents from contractors and design firms for smooth operation and maintenance of hydro power plant:
(1) All technical data for civil works such as construction history, surveying data and testing data obtained during construction;
(2) Instructions of measuring instruments installed at the civil works;
(3) Main principles, which were agreed upon by the related parties on water usage in reservoir;
(4) Hydraulic characteristics of spillway, hydrological characteristics of natural and regulated runoff.

2. After taking-over, the Owner shall carry out the first check of civil works according to the technical standards Volume 5 in order to grasp the initial state for periodic inspection.

Article 4-4. Principles of operation and maintenance

1. Civil works of hydro power plant (dam, weir, tunnel, channel, penstock, intake, spillway, stilling basin, powerhouse and so on) shall be operated and maintained so as to fulfill the design requirements on safety, stability, durability and sustainability.
2. Headworks and pressurized structures including foundation and adjacent parts shall fulfill the design requirements on waterproof.
3. Operation of civil works shall ensure safety, sustainability, consecutiveness and economy of equipment.
4. Damages of civil works, which may cause the loss of lives and property, and may harm equipment, facilities and environment, shall be fixed immediately.

Article 4-5. Prohibition of irregular operation or alteration against design

Irregular operation or alteration of civil works against the design shall not be allowed except for the cases approved by the Authority.

Article 4-6. Cares for concrete civil works

1. Concrete civil works shall be kept from damage by erosion, intrusion, fracture, distortion, deterioration and other abnormal phenomena caused by water, earth pressure or other loads. If damages or deterioration of concrete affected by water flow, water quality or water level change are anticipated, concrete durability shall be checked.
2. Once detecting damages in structural stability or water-tightness, or reduction of durability of structures comparing to the design, proper restoration or reinforcement solutions shall be applied.

Article 4-7. Cares for earthfill works

1. Occurrence of erosion or damages of earthfill works caused by surface flow, seepage, precipitation, plants, animals and lives such as termite etc. shall be checked periodically.
2. Plants and bushes shall not be allowed to develop on crest and slopes of dam and dykes against the design specifications.
3. When erosion or damages are found on earthfill works, they shall be repaired and reinforced immediately.

Article 4-8. Care for seepage line in earthfill works

If seepage line inside earthfill dams and dykes is higher than in the design, existing drainage system shall be checked or new drainage system shall be installed, or sufficient reinforcement shall be carried out in order to avoid landslide or collapse due to piping.

Article 4-9. Cares for drainage system

1. Discharge meters equipped in drainage system for seepage shall be kept in good condition and work properly, in order to grasp seepage rate and to check effectiveness of drainage system.

2. Seepage water shall be discharged consecutively.
3. In case that fine solids is detected in seepage water from earth-filled works or foundation, proper investigations and countermeasures shall be carried out immediately in order to avoid internal erosion due to piping.

Article 4-10. Cares for spillway

1. Spillway shall always be kept free of impediment such as debris, landslide deposits, or plants in order to secure the discharge capacity as designed.
2. Severe cracks, erosion and deterioration shall be repaired in order to prevent successive failure.
3. Undermining of spillway outlet shall be checked periodically. Proper measures shall be taken to protect dam and other structures located near spillway outlet against undermining if necessary.

Article 4-11. Operation of canal

In order to maintain stability and hydraulic characteristics of the canal, sedimentation or erosion in canal shall be prevented by proper operation and maintenance.

Article 4-12. Water filling and dewatering

1. Filling water and dewatering in reservoir, canals, tunnels and penstocks shall be carried out with proper rate so as not to damage stability and safety of those facilities. Especially the first water-filling shall be carried out with very careful check of civil works and equipment.
2. Allowable rate of water filling and dewatering shall be determined properly considering characteristics of facilities and related geological conditions.

Article 4-13. Prevention of erosion

Adequate measures to prevent erosion and wash-away of civil works or foundations shall be carried out to avoid dangerous consequences, if those risks are prognosticated considering runoff conditions of the river.

Article 4-14. General provision for penstocks

The following items shall be checked during operation of hydro power plant, and countermeasures shall be taken to secure safety of penstocks and appurtenances if unfavorable phenomenon is found:

1. Checking appearance of exposed penstocks such as damages due to rock falls or movement of supports;
2. Checking vibration of penstocks and appurtenances, and taking necessary countermeasures such as changing stiffness or adding supports in case that damages due to intensive vibration are anticipated;
3. Checking conditions of drainage around embedded penstocks, where decrease of external pore water pressure is assumed in the design;
4. Checking normal working condition and leakage of expansion joints;
5. Checking conditions of all supports, anchors and their abutments;

6. Checking abnormal phenomena such as new opening cracks, new spring water, and other symptoms of instability of ground in the area near to penstocks;
7. Checking an automatic protection system of penstocks so as to work reliably.

Article 4-15. Steel penstocks

In order to secure safety of steel penstocks, the following items shall be cared during operation and maintenance:

1. Metal parts of steel penstock shall be kept from rust and wear.
2. If water becomes acidified during operation for some reason (ph less than or equal to 4.0), proper countermeasures such as special coatings shall be taken for corrosion protection of steel penstocks.
3. Thickness of penstock shell shall be checked periodically for aged penstocks.

Article 4-16. Wooden penstocks

In order to secure safety of wooden penstocks, the following items shall be cared during operation and maintenance:

1. Wooden parts shall be kept from rotten.
2. Prohibiting leaving wooden section in dry condition beyond stipulated time in the design.

Article 4-17. Reinforced plastic penstocks

In order to secure safety of plastic penstocks, the following items shall be cared during operation and maintenance:

1. Leakage from joints, which may be a symptom of deterioration of sealing materials at joints, shall be checked;
2. If water becomes alkalized during operation for some reason, chemical durability of plastics shall be checked. In case that chemical deterioration is anticipated, proper countermeasures such as installation of protection layer shall be designed and carried out;
3. Abrasion of plastics shall be checked carefully. If excessive erosion of protection layer is detected, proper repair work shall be carried out;
4. Stiffness of plastic penstocks shall be checked periodically by measuring change of strain during dewatering and watering-up of penstocks.

Article 4-18. Emergency programs

1. Each hydro power plant shall have its own rules on fixing emergency cases such as breakdowns of civil works, heavy storm or severe earthquakes.
2. This rule shall include following contents:
   (1) Tasks of each staff;
   (2) Emergency contact list;
   (3) Measures to fix troubles;
   (4) Emergency Stocks (types, quantity and stockyard);

(5) Emergency telecommunications and transportation means;

(6) Securing access road etc.

Article 4-19. Recheck of safety

When fundamental design conditions such as design flood or design earthquake at the site of hydro power plant are revised by the Authority, stability and safety of civil works shall be rechecked according to revised conditions. If obvious danger is anticipated, necessary measures shall be investigated and taken.

Section 2 Check of Civil Works' Condition

Article 4-20. Periodic and special check

After commencement of operation, in order to confirm the safety of civil works and appurtenant mechanical equipment, state and working conditions of those works and equipment shall be checked periodically. In case that unexpected incidents such as earthquakes and heavy storm happen, special check of civil works and appurtenant equipment shall be carried out right after their occurrence.

Article 4-21. Revision of monitoring program

1. At the operation stage, monitoring program shall be revised properly on the following items depending on condition of civil works:
   (1) Quantity of measuring devices;
   (2) Type of measuring devices;
   (3) Target and location to be measured or tested;
   (4) Measurement intervals.
2. Records of installed measuring devices shall be always updated in point of types, quantity, calibration data, location, installed date, initial value, maintenance history, and so on.
3. Measuring instruments shall be calibrated periodically.

Article 4-22. Investigation of monitoring data

1. Monitoring data specified below shall be investigated periodically to evaluate state, behavior and working condition of civil works:
   (1) Settlement, movement of civil works and their foundation;
   (2) Distortion; cracks inside civil works and on their surfaces; condition of joints and construction gaps; condition of earthfill dam, dyke, canal etc.; condition of penstock;
   (3) Water seepage in ground, soil works and embankment; working conditions of drainage system and waterproof at subsurface parts of civil works; pressure working on civil works;
   (4) Influence of runoff on civil works such as erosion and abrasion; settlement, landslide and sedimentation, growth of plant in canal, reservoir; consolidation of earth-filled civil works.

2. Depending on conditions of civil works or occurrence of unexpected incidents such as earthquakes, the following surveys and investigations shall be carried out in addition to the normal inspection:
   (1) Vibration of civil works;
   (2) Seismic performance;
   (3) Durability and waterproof of concrete;
   (4) Behavior of structures due to thermal stress;
   (5) Corrosion of metal and concrete;
   (6) Conditions of welded seams;
   (7) Erosion of civil works due to cavitation, etc.
3. When working conditions of civil works become severe by some major changes in operating rules or natural conditions, additional surveys shall be carried out to check stability and safety of civil works.

Article 4-23. Location and geometrical features

In order to detect abnormal behavior of civil works, exact location and geometrical features of civil works shown below shall be clearly indicated, managed and checked periodically by a survey work etc.

1. Base marks and mediate ones of civil works such as dams, headworks and powerhouses;
2. Location and elevation of anchor blocks of exposed penstocks;
3. Geometrical features such as length, starting points, terminal points, radius of curves, and location of submerged and embedded equipment for dykes, dams, inlets, canals, and tunnels.

Article 4-24. Protection of measuring devices

Measuring instruments and relevant appurtenances shall be properly maintained and operated, and protected from natural hazards and artificial obstruction.

Article 4-25. Board on flood control

The Board on flood control shall be organized for each hydro power plant before flood season annually, in order to investigate and examine thoroughly activities of flood control for civil works and equipment, especially spillway gates, outlet works and procedures to release flood.

Section 3 Mechanical Equipment for Civil Works

Article 4-26. General

Mechanical equipment for civil works (valves, gates, trash racks and enclosed machineries), remote controlling or automatic system and their signals, as well as gate hoists shall be maintained to be always in good condition and in readiness for operation.

Article 4-27. Conditions of gates

1. Metal parts of gates and valves shall be kept from rust and wear;

2. Movement of gates shall be smooth and steady without being stuck or vibrant, or without malfunction;
3. Positioning of gates shall be correct;
4. Water leakage from gates shall not be excessively large comparing to the amount at the initial state;
5. It shall not be allowed to keep gates under dangerous operating conditions for long time, such as intensive vibration under partial open of gates.

Chapter 3 Management of Water Sources in Powerhouses, Assurance of Meteorology and Hydrology

Section 1 Water Regulation

Article 4-28. Principle of exploitation of water resources

For exploitation of water resources in relation to power generation, water demand of other economic sectors (waterway transportation, irrigation, aquaculture, water supply for life and industry), and terms for environmental protection shall be taken into account.

Article 4-29. Plan on water use

1. For each hydro power plant with multi-purpose reservoir, a plan on water use throughout the year shall be prepared and approved by the Authorities in advance.
2. This plan shall specify discharge and monthly working head.
3. Water use plan shall be revised quarterly and monthly based on hydrological forecast and working condition of hydro power plant.
4. In case that energy system covers some hydro power plants or cascade power plants, rules on runoff shall be operated so that it can reach maximum efficiency of the whole power system and simultaneously satisfy water demand of other sectors.

Article 4-30. Water discharge and storage regime

1. Operation of reservoir shall ensure:
   (1) After reservoir water level reaches normal water level, fluctuation out of the rules stated in the Article 4-29 Paragraph 4 shall be allowable in case that special requirement of water consumers and for multi-purpose reservoir;
   (2) Suitable conditions for release of left-over water and sediment;
   (3) Necessary conditions for waterway transportation, aquaculture, irrigation and water supply;
   (4) Balance of the best efficiency and benefits for entire energy system and satisfaction of agreed-upon water demands for other economic sectors;

(5) Rules of water discharge, fulfillment of requirements on safety and reliability during operation of civil works and flood control for downstream;

2. All water demands of consumers, who are out of energy sector and affected by reservoir operation due to energy demand, shall be adjusted and specified clearly in rules on water usage of reservoir.
3. During operation, principles agreed upon by the related parties on water usage in reservoir shall be abided.

Article 4-31. Adjustment of hydraulic characteristics of spillway and runoff

Hydraulic characteristics of spillway and hydrological characteristics of natural and regulated runoff shall be established based upon the actual data at the operation stage.

Article 4-32. Operation manuals for spillway

Overflow discharge from the gated spillway shall be controlled according to the operation manuals approved by the Authority in advance.

Article 4-33. Spillway operation

1. Increase of discharge from gated spillway shall be controlled so as to prevent the hazard at the downstream due to rapid rise of water level.
2. In case of water release from spillway or outlet works, the power plant shall inform related gauging stations and local authorities in advance.
3. As for discharge through hydraulic turbines, it shall not be required to regulate change rate of discharge and to inform related gauging stations and local authorities in advance.

Article 4-34. Discharge capacity for design flood

1. For design flood discharge, outlet works under management of other sectors such as ship lock shall be counted in a whole discharge capacity.
2. In the case referred to in the preceding paragraph, it is necessary to set up rules for identification of discharging conditions and operation sequence by negotiating with related organizations that manage those outlet works.

Section 2 Environment in Reservoir

Article 4-35. Sedimentation in reservoir

Sedimentation in reservoir shall be checked by survey periodically. If flood hazard due to excessive sedimentation is anticipated at the upstream of the reservoir, appropriate solution shall be applied, i.e. reinforcement of banks, construction of protective works, or other mechanical ways such as dredging.

Article 4-36. Restriction on use of chemical herbicide

If chemical treatment is applied to remove undesirable plants at riverside or around reservoir, the Owner shall fulfill the environmental regulations.

Article 4-37. Monitoring of reservoir water quality

Reservoir water quality shall be checked periodically according to the environmental regulations.

Section 3 Hydro-meteorological Activities

Article 4-38. Use of hydro-meteorological data for safe operation

1. Hydro power plants shall be operated safely by using hydrometeorological data and forecast supplied by the hydrometeorological agencies as well as those obtained by own measurement.
2. Rules on hydro-meteorological surveying in each power plant shall be in line with standards of hydro-meteorological sector.

Article 4-39. Grasp of daily runoff

1. The Owner shall quantify daily runoff through civil works and daily discharge through hydraulic turbines in each hydro power plant.
2. Hydro power plants shall collect and summarize actual result of runoff through ship lock, fishways and other works related to waterway.
3. Daily discharge through civil works and hydraulic turbines shall be given to hydro-meteorological sector by request.

Article 4-40. Survey of operating conditions and criteria

Methods and time to survey following items shall be clarified in each hydro power plant:

1. Upstream and downstream water level of weir, intake and canal;
2. Water discharge through civil works and hydraulic turbines;
3. Water turbidity and sedimentation in reservoir;
4. Temperature of water and air;
5. Criteria on water quality for power generation use and discharge from civil works.

Article 4-41. Reliability and accuracy of gauging stations

Gauging stations shall be maintained properly by confirming the following items so as to keep reliability and accuracy in measurement of runoff:

1. Keeping reliability of measuring instruments;
2. Grasping accurate shape of cross section of river;
3. Revising relationship between water level and discharge properly;

4. Checking stability of gauging stations.

Article 4-42. Notification for exceptional violation of regulation on water usage

In case that hydro power plant discharges contaminated water and violates regulations on water usage in an emergency situation, it shall be informed to the hydro-meteorological agencies and the environmental management agencies immediately.

Chapter 4 Hydraulic Turbine

Article 4-43. Oil treatment

Insulation oil or turbine oil shall be prevented of flow out to outside.

Owner of Power Plant shall take an appropriate measure for above protection.

The power plant shall be separated from power grid connection in case of the oil pressure decreases less than lower limited condition and/or loses power sources for servo motor of runner blade, wicket gate operation system, needle servo motor and deflector system.

Article 4-44. Efficient operation

Once operating hydraulic generators, it is necessary to make sure their consecutive operation, optimal efficiency of hydropower plant corresponding to proposed load and operating mode in power system, as well as readiness of receiving rated load.

Article 4-45. Changeable operation

As for hydraulic generators that can operate in generation and/or in synchronous condenser mode, it is necessary to equip remote control and automatic controlling system to shift operating modes.

Article 4-46. Joint operation

In case the power plant is equipped with power joint control system, it shall be kept the joint mode operation until the order of stop.

Article 4-47. Protection of Powerplant

After repairing, once hydraulic generator is put into operation, it is necessary to check comprehensively as existing regulations the following items: main equipment, protecting equipment for technology, interlocks, auxiliary devices, oil system, regulator, and remote control, testing and measuring devices, means of telecommunication.

Article 4-48. Vibration

Vibration of cross frame of vertical hydraulic generator with built-in rotating bearing, of hydraulic turbine's structures (guide bearing, cover and supports) and vibration of bearing of horizontal hydraulic generator at rated rotary frequency must not be excessive the design values.

Hydraulic generator, which has vibration higher than allowable value, shall be only allowed to operate temporarily in short time once getting approval of owner of Power Company.

Article 4-49. Work in turbine pit

In case where works need being implemented in turbine pit, it is imperative to discharge all water from penstock and close emergency gate of turbine pit or penstock. As for hydropower plant which its generators share the penstock, once working in turbine pit, it is imperative to close emergency gates of that generator and apply measures to avoid mistaken opening.

In case where works need being implemented on rotor of generator, it is imperative to fix or sealing water guiding facility, jack rotor on brake and apply measures to ensure safety.

Article 4-50. Hydraulic pressure

Pressure inside penstock at load rejection must not be excessive designed value. Once reducing valve is available, its automatic operation must be in line with technical specification of equipment and not cause water loss.

Vacuum valves of hydraulic turbine must open once vacuum occurs under turbines cover and close after pulling vacuum out.

Part 5 Mechanical and Thermo Equipment of Power Plants

Chapter 1 General Provisions

Article 5-1. Documentation

The Owner of facilities should keep and maintain following technical materials in each thermal power plant.

1. Minutes on granting land.
2. Minutes on set up foundation and profile of boring holes.
3. Minutes on check and acceptance of underground works.
4. Minutes (or records) on settlement of houses, works and foundations for installing equipment.
5. Check-list on testing equipment of fire fighter.
6. Completed work documents (record drawings, explanations, etc.)
7. Technical history of houses, works and equipment.
8. Plan for layout of firefighting equipment and means.
9. Records of engineering work
10. Results of Completion Inspection and Periodic Inspection

Chapter 2 Fuel Transportation and Supply

Article 5-2. General provisions

Fuel transportation and supply shall satisfy the following points:

1. Fuel transportation to power plant must be carried out in accordance with regulations on management and operation of railway and waterway of Ministry of Transport
2. Receiving and confirming fuel volume and quality;
3. Keeping fuel in good situation as regulations with the lowest loss;
4. Timely supply fuel for boiler or pulverized coal processing system

Article 5-3. Specification of fuel

Quality of fuel supplied to power plant shall be in line with State regulations and technical specifications mentioned in supplying contract.

Article 5-4. Examination of fuel quality

In power plant, it is necessary to examine quality of imported fuel periodically. Moreover, in case that doubts about quality of fuel, examination shall be carried out immediately

Imported fuel sampling shall be conducted in accordance with existing standards and regulations. In case that the data are not matched with what in supply contract, supplier shall be invited to check it and take minutes and deducting or adding fuel volume shall be done based on the supply contact.

Article 5-5. Check of measuring device

Measuring devices for identification of fuel volume shall be checked and conducted as scheduled approved by the Owner. In addition, these devices shall be verified by Directorate for Standards and Quality.

Article 5-6. Fuel transportation by railway

Fuel transportation by railway shall be in line with "Regulations on constant transportation, tracks between power plant and neighboring stations" set up for each power plant under the guidelines of railway.

Article 5-7. Railway facilities

Building and equipment for railway station, signal and telecommunication system and train under power plant management shall be kept in good conditions and repaired in line with requirements of railway.

Article 5-8. Check of fuel facilities

Testing devices, automatic controlling equipment, remote control, protection equipment and interlock of loading equipment, fuel feeding devices, and fluid and gas fuel system shall be kept in good condition and checked periodically.

Article 5-9. Unloading of fuel

When using tipping device and other equipment, it is necessary to abide by the regulations of railway for the safety of car.

Article 5-10. Protection for rotating parts

Equipment in coal stock yard shall be in readiness for operation and ensured to operate at rated capacity. All open spinning parts of machineries as end of pivot, belt-type wheel and cogwheel, etc shall have protection fences or nets.

Article 5-11. Prohibition of operation of crane and coal conveyor

It is prohibited to operate crane and coal conveyor when detecting breakdown of brake, claw, and switch and deviation reducer.

Article 5-12. Coal stock yard

Coal stock yard in power plant shall be equipped with drainage system, fire horse and nozzles.

Article 5-13. Operation of coal feeding system

Equipment of coal feeding system shall operate as scheduled and ensure rated capacity. Standby equipment shall be in readiness for operation respectively.

Article 5-14. Interlock of coal feeding system

When interlock operates, protection equipment and signals shall be sure to operate reliably for stable, safe and uninterrupted operation of coal feeding system, so that if one facility stops, other facilities upstream of that also stop.

Article 5-15. Prohibition of operation of coal feeding system

It is prohibited to operate equipment of coal feeding system when protection devices such as fence system and brakes are not available or broken.

Article 5-16. Response to Coal dust

Coal dust shall be prevented from attaching to inner structures and equipment of coal feeding system. Machineries of coal feeding system shall be covered tightly, and air cleaner under hygienic standards shall be equipped with rooms of coal feeding system. Dust in rooms of coal feeding system shall be checked in line with regulations on safety and firefighting of coal feeding system in power plant. When air cleaner operates, it shall satisfy the standards on cleaning and precipitating dust.

Article 5-17. Chute of heavy oil tank

Chute shall be kept in good condition and clean. Chutes, hydraulic valves, dampers and filters of heavy oil basins shall be cleaned when it is necessary.

Article 5-18. Temperature of heavy oil

Heavy oil in basin shall be heated enough to make oil pumps work well. In basins and reservoirs of heavy oil storage, it is prohibited to heat heavy oil more than limiting temperature.

Article 5-19. Fluid fuel system

Fluid fuel system shall ensure to supply uninterruptedly the fuel which has been filtered and heated, while satisfying demand of boiler and gas turbine with necessary pressure and viscosity for normal operation of fuel burners.

Article 5-20. Backup equipment

Standby oil pumps, heaters and filters shall be always in readiness for operation if need be.

Article 5-21. Repair of fuel pipe

When having pressure pipes and recirculation fluid pipes of boiler and gas turbine repair, they shall be completely isolated from online pipes. Fuel oil in the pipes shall be discharged completely and cleared by pneumatic tube.

Article 5-22. Stipulation of fuel oil reservoir

Each oil reservoir shall be equipped with necessary fire extinguisher. Oil stock area shall have fence and good illumination. Electrical equipment installed in oil stock and auxiliaries shall be safe on explosion-resistance.

Article 5-23. Safety regulation of gas equipment

Equipment and operation of gas supply system of power plant, control of gas pipelines shall be in line with regulations on the safety in gas system of Boiler Inspection Board.

Article 5-24. Pressure of gas pipeline

Pressure in gas pipeline of boiler shall not be over values mentioned in power plant's regulations. At intervals decided by the Owner, operation of pressure signal from maximum to minimum in gas pipeline of boiler downstream of automatic pressure regulator shall be checked.

Article 5-25. Purge of gas pipe

When supplying gas to pipeline, air inside pipeline shall be exhausted. Inert gas, etc. shall be used for the purge and after the completion of purge is confirmed by measuring oxygen concentration, gas shall be supplied.

When purging gas from pipeline, exhaustion of gas shall be carried out at places where the gas cannot be burst into flame due to some fire. Inert gas, etc. shall be used for the purge and the completion of purge is confirmed by measuring gas concentration.

Article 5-26. Check of underground gas pipeline

As scheduled and method decided by the Owner, check shall be carried out throughout underground gas pipeline in area under management of power plant.

Article 5-27. Gas analysis in underground structure

For checking gas accumulation in basements, manholes and other underground structure, gas analyzer shall be used.

It is prohibited to get down into manholes, pits and other underground structure to take air sample.

Analyzing air in basements of building can be carried out at basements by safe analyzer. In case that such analyzer is not available, air sample shall be taken out for analyzing.

When checking basements of building and manholes, pits and other underground structure, it is prohibited to smoke and use fire.

Article 5-28. Cause investigation of gas leakage

When detecting gas somewhere in structure, it is necessary to find the cause of gas leakage.

Article 5-29. Detection of gas leakage and repair

It is prohibited to use fire to detect leakage.

If leakages and damages in online gas pipeline are detected, they shall be fixed immediately.

Article 5-30. Safety regulation on coke-burning

Gas supply and burning in blast furnace and coke-burning boiler in power plant shall be in line with safety regulations on gas system of metallurgy plant.

Article 5-31. Characteristics of gas burning

Operating characteristics when supplying and burning gas in boiler, industrial emission (Inclusive of SO_2), and sulfur in natural gas (inclusive of mercaptan) shall be identified in design and regulations of power plant.

Chapter 3 Pulverized Coal Processing

Article 5-32. General Provision

Processing equipment for pulverized coal shall operate for the consecutive supply of pulverized coal with required fineness and moisture to burner, and corresponding amount of boiler's demand.

Processing mode of pulverized coal processing system shall be in line with operation flow diagram set up based on technical specifications of manufacturer and experiments on coal processing equipment and combustion chamber's equipment. In every operating mode of pulverized coal system, possibility of pulverized coal remained in components of system shall be removed.

Article 5-33. Explosion protection

In pulverized coal processing system, measuring, adjusting and protection devices shall be put in operation and interlock system shall be in good condition under regulations on explosion-resistance of pulverized coal processing equipment and pulverized coal burning equipment.

Tardy reacting time of temperature meter built in automatic, controlling, protection and interlock system, as well as measurers shall not be over time stipulated in their design.

Article 5-34. Protection equipment

After being repaired and stopped over 72 hours, before starting pulverized coal processing equipment, its measuring instruments, remote control system, protection equipment, signaling system, automatic and interlock system shall be checked for good condition. It is prohibited to start the pulverized coal processing equipment in case that interlock and protection system are broken.

After being assembled or rehabilitated, before starting equipment, it is necessary to lift covers and manholes to observe and clean up remaining pulverized coal. Such observation and cleaning shall be carried out until all remaining pulverized coal is removed

Article 5-35. Check during operation

When operating pulverized coal processing system, it is necessary to check:

1. Feeding of raw coal for pulverizer
2. Amount of raw coal and pulverized coal shall not be lower or higher than amount stipulated in regulations of power plant.
3. Temperature of pulverized coal in the system must not be over the stipulated limit;
4. Perfection of safety valve
5. Heat insulation and tightness of all parts of equipment. Holes which cause the air and pulverized leakage must be sealed immediately.

Article 5-36. Sampling of pulverized coal

After starting pulverized coal processing equipment, which has just assembled, rehabilitated or overhauled, it is necessary to take a sample of pulverized coal and measure their specifications in order to set up or revise operating mode scheme of the system.

Article 5-37. Pulverized coal processing system with heater

Operation of pulverized coal processing system with air heater and gas heater shall be in line with regulations of power plant and instructions of manufacturer. Power plant's regulations shall cover measures on explosion-resistance safety of pulverized coal processing system.

Article 5-38. Purge of pulverized coal

When stopping system longer than stipulated time and before having boiler overhaul, it is necessary to exhaust coal dust from the system.

It is prohibited to bring coal to combustion chamber when boiler is in stop. Pulverized coal shall be discharged from the system before stopping coal pulverizer and other equipment for processing coal.

Article 5-39. On-site welding

Welding carried out in pulverized coal processing plant shall be allowable only when equipment is offline and pulverized coal free.

Chapter 4 Boiler and its Auxiliary

Article 5-40. General Provisions

When operating boiler and its auxiliary, it is necessary to pay attention to the following items:

1. Main equipment and auxiliary facilities operate safely;
2. To come up to rated steam value, steam and water quality;

3. To be in economical operating mode without unstable burning and be identified based on experiments and procedures of manufacturer. To maintain demand range that is determined for each type of boiler and fuel.

Article 5-41. Cleaning of boiler

After construction before being put in operation the boilers should be cleaned. After overhaul the cleaning should be carried out if necessary. Right after washing off, measures for protecting washed surfaces shall be carried out to keep such surfaces from corrosion.

Article 5-42. Confirmation before starting up boilers

As for boilers which are repaired or are in long standby (over 72 hours), before being put in operation, it is necessary to check condition of protection equipment and interlock.

In case that the damages are detected, they shall be repaired timely. It is prohibited to start up boiler in case that tripping circuit of boiler is broken.

Article 5-43. Boiler Feed Water Treatment

Water to be fed to boiler before starting up shall be treated one. Detailed standards for feeding boiler with water shall be stipulated in power plant's regulations.

Article 5-44. Ventilation by fan

Before starting up and after stopping boiler, it is necessary to operate induced draft fan (flue blower) and forced draft fan during the time that is decided by the Owner according to manufacturer's instruction.

Article 5-45. Water gauge

From start-up of boiler, water level in steam drum shall be monitored closely. Upper level gauge (water level) shall be cleared when necessary. During starting up boiler, it is necessary to check and calibrate water level indicator in control room so that the level is matched with level of level gauge.

Article 5-46. Start-up time

Duration of starting up boiler from various heat conditions shall be in line with start-up scheme, which is determined based on experiments on start-up mode and procedures of manufacturer.

Article 5-47. Start-up from cold mode

During starting up boiler after overhaul or minor repair, expansion points of steam drum and header, and temperature status of steam drum shall be monitored. Speed of increase and decrease of steam drum's temperature, temperature difference between upper and lower of steam drum should be stipulated in power plant's regulations.

Article 5-48. Connection to main line

Boiler just started up shall be connected to main line after the connector is heated, remaining water is discharged, and boiler pressure almost reaches pressure of main line.

Article 5-49. Operation mode

Operating mode shall be in line with mode set up based on experiments and tests. Modes need to be revised in case that fuel quality changes or boiler is renovated.

Article 5-50. Monitor of temperature

When operating boiler, it is necessary to monitor heating status to maintain allowable steam temperature at each level and current of primary super-heater and re-heater.

Article 5-51. Cleaning equipment of heating surface

Heating surface of boiler shall be kept clean by maintaining optimal burning and using cleaning equipment (dust blower, ball-cleaner, etc). These equipment and their remote control and automatic devices shall be in readiness for operation if need be.

Article 5-52. Induced draft fan and forced draft fan

Discharge and pressure of induced draft fan and forced draft fan shall satisfy boiler's requirements. As for the boilers with either two induced draft fan or two forced draft fan, when one of two stops, gas or air shall not be leaked through the stopped fan so as to regularly distribute air for burners.

Article 5-53. Gas emission standard

Gas emission shall meet environmental standard at any mode during the boiler operation.

Article 5-54. Heavy oil burner

It is prohibited to operate heavy oil burner without feeding hot air.

Article 5-55. Thermal insulation

Boiler's thermal insulation shall be always kept in good condition. Temperature of thermal insulation's surface shall not be over $55^{o}C$.

Article 5-56. Commissioning after change of fuel

It is necessary to implement the boiler commissioning when it is put in operation after the change of fuel type.

Article 5-57. Wear resistance measures

When the boiler is put on standby or repaired, wear resistance measures should be applied according to need.

Article 5-58. Cooling of steam drum

When the boiler just stops operating, feeding steam drum with water and discharging water shall not be done at the same time to push up the coolness of steam drum in case that temperature of water in steam drum can't be controlled.

Article 5-59. Water discharge for fire-tube boiler

After stopping fire-tube boiler, water discharge shall be only carried out when boiler pressure is equal to ambient pressure and water temperature is not over 80^{o}C.

Article 5-60. Monitoring when stopping boiler

When the boiler has been stopped, the operator shall watch over until its pressure comes to ambient pressure and power supply to boiler is disconnected.

Article 5-61. Emergency stop of boiler

The boiler shall be stopped urgently by protecting equipment or operator. However, the items can be changed through discussion with the Owner and manufacturer.

1. Water level in steam drum is higher or lower than standard, or all water indicators and signal are broken;
2. All boiler feeding pumps are broken, or feed water flow rate is lower than stipulated value;
3. Pressure in steam main is over allowable limitation;
4. Steam of maximum continuous rating can't be discharged through safety valves due to their malfunction;
5. Combustion instability such as flame lost and abnormal pressure of fuel ;
6. All induced draft fans and forced draft fans stop, or furnace draft is outside the stipulated range;
7. Steam doesn't flow through reheater;

Article 5-62. Stop of boiler

The operator shall stop boiler if the following cases have a large impact on operation of boiler,

1. Detecting leak-out on heat tube's surface, on steam mains, headers, water feeders as well as flange valves are blown off or leaked out;
2. Metal temperature and heating surface is hotter than standard, and after changing operating mode, the temperature does not come up to allowable values;
3. Remote level indicators are broken;
4. Feeding water quality is suddenly bad in comparison with standard;
5. Dust precipitators of pulverized coal-fired boiler are broken;
6. Some protection equipment, automatic and remote control equipment and indicators, meters are broken;
7. Explosion in combustion chamber, explosion or fire of fuel deposit remained in flue or dust precipitators, incandescence of steel structure of the boiler's body, or other damages threaten operator's life;
8. Fires threaten operator's life and equipment, remote controlling circuit which can touch boiler's protection circuit;

9. Outage of remote control, automatic equipment, testers and meters;
10. With gas-fired boilers, apart from above-mentioned requirements, technical standards on safe gas system are violated.
In these cases, off-line duration of the boiler shall be decided by the Owner.

Article 5-63. Gas emission standard

Ash content in gas emission to atmosphere shall not exceed allowable calculated values for each power plant.
It is prohibited to stop dust precipitator in case that the gas emission doesn't meet the values without the dust precipitator.

Article 5-64. Monitor of dust precipitator

In power plant, it is necessary to strictly watch over the operating mode of dust precipitator so that gas emission meets environmental standards.

Article 5-65. Dust disposal

Operation of ash and slag disposal system shall ensure:
1. To dispose timely and continuously
2. Safety for equipment and works inside and outside of ash and slag disposal system;
3. To prevent water source, air and surrounding areas from being contaminated by ash and wastewater.

Article 5-66. Maintenance and inspection

Meters and testers, protection equipment, interlocks and signals of wet type ash and slag disposal system and compressed air shall be kept in good condition and checked periodically.

Article 5-67. Ash pond

It is necessary to periodically check ash pond such as elevation of the surfaces and depth of settling area.

Article 5-68. Discharge of wastewater

Wet type ash and slag disposal system shall be closed cycle system, and it is only allowed to discharge final clarification water from ash pond to rivers and common water ditches when getting approval from Ministry of Health, Ministry of Aquiculture and Irrigation, etc.

Chapter 5 Steam Turbine

Article 5-69. General provision

When operating steam turbine, it is necessary to pay attention to the following items:

1. Safe operation of main equipment and auxiliaries;
2. Availability of rated load at heating demand;

Article 5-70. Turbine control

Turbine adjusting system shall satisfy the following requirements:

1. Maintaining rated power demand and heat demand steadily;
2. Keep turbine stably in no-load condition with rated revolutions of rotor at rated steam conditions and start-up one.
3. Ensuring well-balanced change of power and heat demand when operating turbine's adjusting structure.
4. When suddenly shedding load to zero (including disconnection of generator from power network) at maximum steam flow at rated steam condition, revolutions of turbine's rotor must be kept lower than adjusted limit.
5. Regularity of adjusting rotary frequency of turbine (at rated steam condition) must be within the design value. As for back-pressure and cogeneration turbine, it also must be within the design value.
6. Insensitiveness (sluggishness) at rotary frequency must not exceed the design value.
7. Irregularity in adjustment of extraction steam pressure and back-pressure must satisfy manufacturer's instruction so as not to activate safety valves.
8. Insensitiveness in adjustment of extraction steam pressure and back-pressure must not be higher than the design value.

Article 5-71. Emergency governor

Emergency governor shall be calibrated to operate when rotary frequency of turbine exceeds 9 - 11% comparing to rated one, or reaches specifications stipulated by manufacturer.

When emergency governor is activated, main steam stop valve, reheat steam stop valve and extraction valve shall close automatically.

Article 5-72. Steam stop valve and regulating valve

Stop valve and regulating valves of main steam and reheat steam can be opened at rated steam pressure at inlet of turbine and vacuum of condenser. Turbine's rotor shall not be revolved when these valves are closed.

In case that all stop valves are closed and regulating valve are opened and vise versa, rotary frequency of turbine's rotor shall not be over value of manufacturer.

Article 5-73. Check of closing and opening of valve

It is necessary to check the smooth closing and opening of stop valve and regulating valves of main steam and reheat steam, extraction non-return valve according to need.

Article 5-74. Check of operation of extraction non-return valve

It is necessary to check the operation of all non-return extraction valves before each start-up and stop of turbine, as well as during turbine's normal operation according to need.

It is prohibited to operate turbine's steam extract slot when corresponding non-return extraction valve is broken.

Article 5-75. Turbine oil feeding system

Oil feeding system of turbine shall ensure:

1. Reliable operation of turbine in every operating mode;
2. Safe firefighting;
3. Ability to maintain oil quality corresponding to criteria;
4. Ability to prevent oil leakage into cooling water system.

Article 5-76. Check of oil pump

In operation, it is necessary to check auxiliary and emergency oil pumps, and their automatic start-up devices of such pumps at necessary frequency, as well as before starting up and stopping turbine.

Article 5-77. Temperature of heat exchanger

In operation, heat exchanger system shall ensure:

1. Reliability of heating exchanger in every operating mode;
2. Rated feeding water temperature;
3. To keep rated temperature difference in each heating exchanger

It is necessary to check temperature in heating exchanger and heat recovery system before and after having turbine engine overhauled, after having heater repaired and as scheduled decided by the Owner.

Article 5-78. High-pressure heater

It is prohibited to operate high-pressure heater when protection and adjusting equipment is not available or broken.

In case that high-pressure heater group share emergency exist, it is allowed to operate that high-pressure heater group when one of the protecting and adjusting equipment for high-pressure heater's drain line is not available or broken, when disconnecting line of any high-pressure heater.

Article 5-79. Check of safety protection equipment, etc.

Before starting up turbine (after repair or from shutdown condition), it is necessary to check the perfection and readiness of main equipment and auxiliary devices, protection equipment, remote control interlock, testing and measuring devices and means of telecommunication. All detected damages and faults should be fixed as soon as possible.

When starting up turbine from any condition, operation of protection equipment and interlock shall be checked as rules in power plant's regulations.

Article 5-80. Prohibition of turbine start-up

It is prohibited to start up turbine in case that,

1. Parameters of heat and mechanical condition of turbine exceed limitation;
2. One of protection equipment for stopping turbine is broken;
3. Faults of speed governing system cause turbine's over-speed with main steam and reheat steam.
4. One of oil pumps or interlock of oil pump is broken;
5. Oil quality does not come up to standard oil quality for operation, oil temperature is outside the stipulated range;

Article 5-81. Vibration

Vibration of turbine bearings, generators and exciters shall not exceed the values decided by the manufacturer:

Article 5-82. Emergency stop of turbine

Turbine shall be stopped immediately by stopping stop valve and disconnecting generators by disconnector in the following cases. However, the items can be changed through discussion with the Owner and manufacturer. ,

1. Rotor's frequency speeds over stipulated value which automatic speed reduction gear shall operate;
2. Lubricant pressure in lubricating system reduces lower than allowable limitation;
3. Oil level in oil tank is lower than allowable limitation;
4. Abrasion or temperature of thrust bearing exceeds allowable limitation;
5. Generator is stopped due to internal fault or malfunction of generator-relating facilities;
6. Vacuum in condenser reduces lower than allowable limitation;
7. Temperature of intake steam or reheated steam reduces lower than allowable limitation;
8. Generator is stopped due to malfunction of electric system.

Stop of generator with vacuum destruction shall be specified in power plant's regulations, which are in line with manufacturer's instructions.

Power plant's regulations shall cover specific guidelines for the cases when checked values are higher than allowable limitation of engine.

Article 5-83. Load reduction and Stop of turbine

Reducing output or stop of turbine shall be conducted at the Owner’s judgment in consideration of status of the equipment in cases that, ,

1. Stop valve of main steam or reheat steam is stuck;
2. Governing valve for steam coming to turbine is stuck or valve pin is broken;
3. Faults in speed governor;
4. Faults on the auxiliaries, diagram, tubes of boiler and so on occur, and such faults cannot be fixed while turbine is in operation;
5. Detection of faults in protection equipment which operates to stop equipment;
6. Detection of leakage of oil tubes, main steam pipe, extraction steam pipe, reheat steam pipe, major drain pipe, feed water pipe, header, welded seams or flanges, valves and casing;
7. Oil burst into flames in turbine engine and no capability to stamp fire out promptly with existing firefighting equipment;
8. Oil pressure difference of sealing system of hydrogen cooling generator reduces lower than allowable limitation;
9. Oil level in vacuum reducer of cooling system (for hydro engine) reduces lower than allowable limitation;
10. All oil pumps of hydro system for cooling engine are stopped;
11. Overload in final blades of back-pressure turbine;
12. Vigorous vibration is arisen suddenly in turbine energy;
13. Metal noises and strange ones occurred inside turbine;
14. Sparks or smoke come from bearings and spindle sealing devices of turbine and generator;
15. Hydraulic shock arisen in intake steam pipe or inside turbine;
16. Oil pressure of adjusting system reduces lower than allowable limitation;

Article 5-84. Overload operation

Operation of turbine with output , which have not been taken account in technical requirement, is only permitted according to manufacturer's instruction.

Article 5-85. Rust-resistance measures

When putting turbine in long standby, it is necessary to apply rust-resistance measures inside turbine in accordance with existing regulation of maintenance of thermo equipment.

Article 5-86. Cooling water

Cooling water for power plant shall be in uninterruptedly supplied, and adjustment of heating status shall be ensured to maintain the best vacuum condition to keep condenser and circulating tubes from dirtiness.

Article 5-87. Cooling tower

When operating cooling tower, it is necessary to ensure:

1. Optimal operating mode to reach best vacuum condition;
2. Cooling efficiency must satisfy standard characteristics;
3. Check of water supplying system;

Chapter 6 Unit-type of Thermal Power Plants

Article 5-88. General provision

When operating unit-type plant, it is necessary to pay attention to the following items:

1. Balanced operation of boiler and turbine
2. Stable operation at rated output

Article 5-89. Prohibition of unit start-up

It is prohibited to start up unit in case that,

1. Protection equipment to stop unit's equipment is broken;
2. Remote control, which acts on adjusting components, and emergency valve are broken;
3. When having conditions on prohibiting to start up main equipment and accessories;
4. De-salinator of the unit has not been in readiness yet;
5. Bracket and frame of pipe are broken;

Article 5-90. Response to rapid load reduction

It is prohibited to maintain unit's operation in case that demand of turbine-generator is reduced to self-station demand or to no-load value if fast cut back is equipped with boiler.

Chapter 7 Gas Turbine

Article 5-91. General provision

When operating gas turbine, it is necessary to pay attention to the following items:

1. Stable operation of main equipment and auxiliary devices;

2. Possibility to operate at rated parameters;
3. Without air leakage or fuel, lubricating oil and water leakage.

Article 5-92. Control system

Regulating system of gas turbine shall satisfy the following requirements:
1. Maintain assigned power demand stably;
2. Keep turbine in operation at no-load mode when rotary frequency reaches rated value;
3. Make sure the safe operation of gas turbine when starting up and stopping equipment in emergency;
4. Make sure the smooth operation (no vibration) of gas turbine when load changes irregularly;
5. Keep the rotor's rotary frequency from emergency governor when shedding maximum load to zero (for independent gas turbine, shedding load to house load of power plant);
6. Keep turbine inlet gas temperature as requirement, so as not to increase to the limitation which causes the operation of protection equipment.
7. Insensitiveness of gas temperature controlling system must not be higher than the designed value.

Article 5-93. Temperature impulse

Temperature impulse applied in adjusting and protection equipment shall be representative temperature measured in characteristic section.

Article 5-94. Protection equipment for gas temperature

Protection equipment, which keeps gas temperature from exceeding limitation, shall be calibrated for being able to operate at the stipulated temperatures of manufacturer when it's necessary.

Article 5-95. Emergency governor

Emergency governor shall be calibrated to operate when rotor's rotary frequency increases 10 - 12% against rated value or reaches to stipulated values of the manufacturer.

Article 5-96. Dust measures

During operation of gas turbine, measures on minimizing air dust attacking gas turbine's inlet (plant grass on vacant spaces, spread asphalt on the roads, air-filters, spray water, etc.) shall be carried out, and keep wind boxes from attack of wastes.

Article 5-97. Check of air filter

It is necessary to check condition of air filter while operation. It is necessary to prevent oil or other materials from dropping inside air intake of gas turbine through air filter. It is necessary to check and clean air filter, clean duct and keep them from dust and soot, and air filter shall be checked and cleaned when it is necessary.

Article 5-98. Bypass of air filter

Air filtering system shall be equipped with auxiliary valves which automatically open to bypass the filter to ensure automatic open when differential pressure on the filter exceeds limitation, or residual pressure appears in filter.

Article 5-99. Fuel valve

Stop valve and fuel regulating valve of gas turbine shall be closed tight. Fuel shall not be leaked out through valves. Valves shall be checked before each startup. Tightness of valves shall be checked at interval set by the Owner.

Article 5-100. Check before start

After restarting gas turbine after refurbishment or standby of more than 72 hours, it is necessary to check the perfection and readiness of protection equipment, interlock of auxiliaries and lubricating system, auxiliary and emergency oil pump. Detected faults shall be fixed.

Article 5-101. Prohibition of start up

It is prohibited to start up gas turbine in case that,

1. Gas turbine is broken or stopped by any actions of protection equipment, but the cause is not specified and recovered yet;
2. Shortcomings of adjusting system, accordingly, gas temperature increases over allowable limitation or turbine speeds up;
3. One of grease pumps or their interlock system are broken;
4. Fuel or grease quality does not come up to standard, and fuel pressure (or oil pressure) is lower or higher stipulated limitation;
5. Mechanical and thermal parameters of gas turbine exceed allowable limitation.

Article 5-102. Purge of flue gas duct

Before burning fuel in combustion chamber, gas duct of gas turbine shall be ventilated when rotating rotor by facility for start-up. Ventilation time shall be stipulated in power plant's regulations.

In case that gas turbine fails to be started up and is re-started, it is prohibited to re-burn fuel without ventilating roughly entire system.

Article 5-103. Stop of start up

Startup shall be stopped immediately by operation of protection equipment or operator in the following cases:

1. Gas temperature at inlet of gas turbine increases over allowable limitation against startup diagram;
2. Noises of metal when stroke together (grinding, click) and generator becomes more vibrant;
3. Starter's load exceeds allowable limitation;
4. Axial rotating frequency reduces less than stipulated value after removing startup equipment;

5. Occurring instability in gas turbine's air compressor;
6. Outlet air pressure of air compressor goes under allowable limitation.

Article 5-104. Emergency stop

Gas turbine shall be stopped urgently by operation of protection equipment in the following cases. However, the items can be changed through discussion with the Owner and manufacturer.

1. Turbine's inlet gas temperature exceeds allowable limitation;
2. Rotary frequency of rotor exceeds allowable limitation;
3. Shaft vibration exceeds allowable valuelue;
4. Lubricating oil pressure reduces lower than allowable limitation;
5. Combustion instability such as flame lost and abnormal pressure of gas or fluid;
6. Malfunction of electric system such as loss of power for regulating, automatic equipment and measurers, indicators;
7. Power cut-off due to inside failures of generator;
   Together with disconnection of gas turbine, it is necessary to disconnect generator by operation of protection equipment or operators.

Article 5-105. Stop of gas turbine

Reducing output or stop of gas turbine shall be conducted at the Owner's judgment in consideration of status of the equipment in cases that,

1. Stop valve, regulating valve and compressor intake pressure reducing valve are stuck;
2. Surface temperature of turbine body, combustion chamber, and exhaust duct exceeds allowable limitation and change of operating mode cannot reduce it;
3. Inlet air temperature of high-pressure air compressor exceeds allowable limitation, as well as in case that normal water feeding mode is violated;
4. When some online protection devices, indicators or meters are broken;
5. Fissures and bursts occurred in grease duct and high-pressure fuel manifold.
6. Noises of metal when stroke together (grinding, click) and strange noises come from inside gas turbine and its' parts;
7. Strong vibration suddenly appears in turbo-generator;
8. Sparks or smoke is risen from bearing, washers of gas turbine or generator;
9. Grease or fuel burst into flames without ability to extinguish immediately with existing firefighting equipment;
10. Bang comes from combustion chamber or gas duct;
11. Air compressor faces instability or almost touches unallowable values of unstable limitation;

Article 5-106. Fire extinction of soot

When soot in heater or economizer of water system burst into flames and such situation does not cause dangerous change of parameters, such equipment shall be kept in operation to cool heat exchange surface. When soot burst into flames in cold gas turbine, it is necessary to operate extinguishers.

Article 5-107. Purge of gas

After stopping gas turbine, it is necessary to ventilate efficiently entire system and give ventilations on fuel header and burner with air or inert gas. When completing ventilation, damper at intake or gas exhaust duct shall be closed. Time and period for ventilation and rotation of rotor when cooling gas turbine shall be stipulated clearly in power plant’s regulations.

Article 5-108. Maintenance

Rules on technical maintenance shall cover following contents:

1. Periodically cleaning turbine and heating exchangers, investigating turbine blades and checking the tightness of valves, damper and accessories;
2. Checking operation of protection equipment and automatic controlling system of gas turbine, including checking its automatic starter, main parameters of air and smoke, fuel pressure and load of starter corresponding to estimated starting diagram;
3. Examining and checking tightness, output of fuel burner and spraying angle of fuel at nozzles of burner;
4. Checking auxiliary and emergency oil pumps and their interlock;
5. Examining and cleaning fine-meshed screen of grease filter, fuel, air and water filter.

Article 5-109. Load dump

Check of operation of gas turbine by shedding load suddenly through disconnecting generator from power grid shall be carried out when it's necessary. For example;

1. Checking and taking over gas turbine for putting in operation after assembly;
2. Appearing changes of dynamic characteristics of gas turbine, or changes of static and dynamic characteristics of regulating system after innovation;
3. When detecting changes of static and dynamic characteristics of regulating system during operation or after refurbishment (after fixing the detected shortcomings).

Article 5-110. Vibration

Vibration of turbine, air compressor, generator and exciter shall not be exceeding the values based on specifications of manufacturer.

Vibration of aero and marine gas turbine operating in power system shall be determined based on specifications of manufacturer.

Article 5-111. Check interval

Interval for gas turbine's overhaul except for inspections mentioned in Vol. 5, medium scale inspection and minor inspection shall be set up based on regulations of manufacturer and actual condition of equipment such as gas turbine's operating time, number of start up, fuel and number of trouble.

Chapter 8 Diesel Generator

Article 5-112. General provision

When operating diesel generator, it is necessary to make sure the safe and uninterrupted generation.

Article 5-113. Protection device

Diesel generator is only allowed to operate provided that protection equipment and auxiliaries work well such as emergency governor, circulating pump, oil pumps and oil filter of generator, generator's starter, controlling circuit, measuring circuit, main breaker, distributing bus-bar, etc.

Article 5-114. Control system

Regulating system of diesel generator shall ensure:

1. Smooth automatic or manual startup and stop of generator;
2. Stable operation in every load;
3. Maintenance of rated speed when shedding its load.

Article 5-115. Check after overhaul

When putting diesel generator in operation after overhaul, it is necessary to investigate diesel generator comprehensively as regulations decided by the Owner.

Article 5-116. Vibration

Allowable vibrant value of generator shall be based on specifications of manufacturer.

Article 5-117. Connection of device

Ducts, equipment of fuel system, lubrication system, cooling system, pneumatic start-up system, etc, shall be connected tight without any leak.

Chapter 9 Automation and Thermo-measuring Equipment

Article 5-118. General provision

When operating automatic and thermo-measuring equipment, it is necessary to check the conditions and protection of thermo-mechanical equipment, control such equipment, and ensure reliability in their operation.

All automatic and thermo-measuring equipment used for automatic control, remote control and automation, regulating valve, stop valve with protector and interlock, meters and indicators for thermal, physical parameters, chemical and mechanical quantities, computers and controlling equipment shall be kept in good condition and online when thermo-mechanical equipment operate.

Article 5-119. Standby power supply

Automatic thermo-measuring equipment shall be equipped with standby power supply with automatic and manual switchgear according to need.

Article 5-120. Installation of power cable

As for installation of power cable and measuring one for automation and thermo-measurement, amount and period for checking insulation resistance of such cables shall be in line with these technical standards.

Article 5-121. Service condition

Ambient temperature, humidity, vibration, radiation, magnetic and electric field, and dustiness at locations of equipment, indicators and meters shall not technically exceed allowable values of such equipment.

Article 5-122. Inspection

As for indicating and metering instruments in power plants, the Owner shall have inspection by State-owned metrology agencies (or authorized units).

Article 5-123. Protection device

Industrial protectors, which have been in operation, shall operate during the operation of main equipment. It is prohibited to disconnect protectors, which are in smooth operation, from the operation.

Protectors for online equipment shall not be disconnected from the operation except for cases that safety is secured.

It is prohibited to repair or calibrate online protecting circuit.

Article 5-124. Record of operation status

All cases for operation of protector as well as the cases that protector does not operate over set value shall be listed and analyzed.

Chapter 10 Water Treatment and Hydration

Article 5-125. General provision

Hydration of power plant shall ensure the safe operation of main thermo-equipment and auxiliaries.

Article 5-126. Water treatment

Water treatment modes in operation of power plant’s equipment shall be appropriately controlled and checked.

Article 5-127. Wear resistance measures

Devices, pipes and valves of all water treatment equipment of condensate and industrial wastewater filters, inside which contacts strong corrosive condition, including accessory structures, which contact strong corrosive condition, shall be processed by wear-resistance materials, or their surfaces shall be protected by wear-resistant coat if it's necessary.

Article 5-128. Safety for chemical agent

Equipment, devices and vehicles shall be safe for loading, storing and transporting caustic soda, ammonia, hydrazine, chlorine, lime chloride, strong acids, other corrosive chemicals and their solution in technological process. It is necessary to strictly abide by safety technical rules when using chemicals and the above-mentioned chemical solutions.

Article 5-129. Wastewater treatment

Power plant’s wastewater, which contains alkali, acid, ammoniac, hydrazine, grease sludge and other noxious substances shall be treated before discharging them outside.

Article 5-130. Chemical analysis

Chemical analyses in power plant shall satisfy the following contents:

1. Have a thorough grasp on corrosive and residue condition of water treatment and thermo equipment.
2. Define quality of water, steam, remaining salt, chemicals, organic fuel, ash, slag, gas and oil;
3. Check the gas infection of rooms, manholes, tunnels and other works;
4. Define discharge water quality.

Article 5-131. Boiler water standard

Standards on quality of boiler water shall be stipulated based on thermo-chemical experiments and identification of allowable limitation of rated impurities (total salt content, silica acid content, etc) in various operating modes of boiler. Quality of such steam shall ensure the cleanness of boiler’s heating surfaces, as well as keep metal from erosion and destruction.

Article 5-132. Discharge of boiler water

Continuous discharge of boiler shall be measured with flow meter.
Periodic discharge of boiler from bottom shall be carried out when starting up and stopping boiler, as well as during boiler's operation as schedule of power plant.

Chapter 11 Pipelines and Valves

Article 5-133. Inspection

Pipelines and valves shall be examined carefully before being put in operation. After refurbishment or long offline period, the perfection of thermo insulation, thermal expansion indicator, fixed frames, brackets and sliding supports shall be checked. Free thermal expansion ability of pipeline when being heated, conditions of water discharge valve, exhaust valve, safety valve and thermometers, pressure gauge and flowmeter shall be checked.

Article 5-134. Check items

When pipelines are operated under existing regulations, the following items shall be conducted at an appropriate time:

1. Check the thermal expansion by readings of indicators. Pipelines must not be stuck and vibration must not be increased;
2. Periodically monitor metal conditions as well as check the shortcomings of welded seams;
3. Observe the tightness of valves and jointed flanges;
4. Check the working temperature mode of metal in each startup and stop;

Article 5-135. Connection of high-pressure line

Pipelines layout and their operation shall be kept from the risk of damages on low-pressure lines when contacting high-pressure ones.

Article 5-136. Test and calibration of valve

After repairing, valves shall be tested for their tightness according to the existing regulation of pressure vessel. After repairing, safety valve shall be calibrated in testing stand according to the existing regulation for safety valve.

Article 5-137. Thermal insulation

Thermal insulation of pipelines and equipment shall be kept in good condition, and surface's temperature of thermal insulation shall not exceed a value set by the Owner.

Chapter 12 Auxiliaries for Thermo-mechanical Section

Article 5-138. Confirmation before start-up

After repairing or stopping operation over period set by the Owner, status of protectors, automatic and safety equipment, valves and meters shall be checked before energizing auxiliaries for operation.

Article 5-139. Prohibition of energizing

It is prohibited to energize auxiliaries after any stop due to the fault of protectors to stop auxiliaries until the fault is removed.

Article 5-140. Safety valve

Safety valve of auxiliaries shall be checked according to the existing regulation of pressure vessel. Safety valves shall be calibrated according to the existing regulation of pressure vessel.

Article 5-141. Pressure reducer and attemperator

It is prohibited to operate pressure reducer and attemperator when safety valve at depressurized steam point is locked or broken.

Article 5-142. Vibration

Vibration of auxiliaries metered in bearings shall not exceed rated value in power plant’s regulations.

Part 6 Electrical Equipment of Power Plants and Grids

Chapter 1 General Provision

Article 6-1. Documentation

The Owner of facilities should keep and maintain following technical materials in each substation and maintenance office.

1. Minutes on granting land.
2. Minutes on set up foundation and profile of boring holes.
3. Minutes on check and acceptance of underground works.
4. Minutes (or records) on settlement of houses, works and foundations for installing equipment.
5. Check-list on testing equipment of fire fighter.
6. Completed work documents (record drawings, explanations, etc.).
7. Technical history of houses, works and equipment.
8. Plan for layout of firefighting equipment and means.
9. Records of engineering work
10. Results of Completion Inspection and Periodic Inspection

Chapter 2 Generator and Synchronous Compensator

Article 6-2. General provisions

When operating generator and synchronous phase modifier, it is necessary to maintain their uninterrupted operation with stipulated values of allowable mode, by ensuring the stable operation of exciter, cooling and protecting system.

Backup generators and emergency power source which shall supply electricity to important machineries of power plant when the faults occur, shall be in readiness to start up automatically. Perfection and readiness for automatic startup of that generator shall be checked periodically.

In case of over current flows in the Generator circuit, the Power plant shall be separated by protection system automatically.

Article 6-3. Seal oil standby equipment

Seal oil standby equipment for hydrogen cooled generator shall automatically start up in case that main seal oil equipment stops, or oil pressure decreases lower than stipulated limit.

Seal oil tank shall be always put in operation to backup the main seal oil supply systems for power generator.

Article 6-4. Cooling methods

Hydrogen cooled steam turbine generator and synchronous phase modifier shall operate with stipulated pressure of hydrogen, and ensure the automatic adjustment of seal oil supply system.
As for power generator, which owns hydrogen or water directly cooled rotor, and hydrogen cooled stator, load operation shall not be allowed when being cooled by air.
That power generator is only allowed to operate shortly when being cooled by air in no-load mode without excitation if ambient temperature is lower than values stipulated in regulations on generator operation of manufacturer.

Article 6-5. Firefighting facility

Firefighting facilities for air cooled generator and synchronous phase modifier shall be equipped with appropriate firefighting extinguisher system.

Article 6-6. Filter

Filters in water system to air cooler or gas cooler and heat exchanger for cooling power generator and synchronous phase modifier, and filters in demineralized water circulation system or oil circulation system shall be always operated.

Article 6-7. Hydrogen purity

Hydrogen purity shall not be lower than 95%.

Article 6-8. Seal oil pressure

Seal oil pressure while rotor of generator is at a stop or rotating shall be higher than hydrogen pressure in generator. Minimum and maximum difference of pressure shall be stipulated in regulations of manufacturer.

Article 6-9. Current of stator and rotor

In case of faults, stator and rotor current of power generator and synchronous phase modifier is allowed to be overloaded in transience as conditions of manufacturer's design value.

Article 6-10. Current in between phases

It is allowed operating with unbalanced current; phases shall not exceed the designated value.
As for hydro generator, which has indirectly air cooled system for stator winding, currents in between phases are allowed displacement according to the manufacturer’s or international standards.
As for hydro generator, which has directly water cooled, it is allowed operating with current’s displacement in between phases is allowed in accordance with manufacturer's design or international standards.

In all cases, current of any phase must not be exceeding rated value.

Article 6-11. No-load operation and reactive load

Allowable no-load duration of power generator is only limited by working condition of turbine and under regulations of manufacturer.

Allowable reactive load of power generator with synchronous phase modifier mode, and of synchronous phase modifier operating without exciter (at capacitance angle) shall be stipulated based on special thermo tests or instructions of manufacturer.

Article 6-12. Power factor

Indirectly cooled winding power generator is allowed to operate at power factor higher than rated one, and up to 1 with full capacity is still kept at rated value.

Article 6-13. Vibration

Vibration of axial bearings of steam turbine power generator must be in line with manufacturer's design.

Article 6-14. Charge and discharge of hydrogen

In normal working condition, as for power generator, which owns hydrogen directly cooled winding, charge and discharge of hydrogen in power generator shall be carried out when rotor stops or being rotated by axial rotator.

When failures occurred, it is possible to start letting hydrogen out while rotor is in inertial rotation.

It is necessary to use carbonic gas or nitrogen gas to remove hydrogen or air out of power generator, synchronous phase modifier as regulations on operation of hydrogen cooling system of generator.

Chapter 3 Electric Motor

Article 6-15. Rotary direction

Electric motors and their generators must be displayed with arrow showing the rotary direction, and startup facilities must be shown clearly their generators.

Article 6-16. Overhaul and minor repair

Time for overhaul and minor repairs of electric motor shall be specified based on each location.

Chapter 4 Transformer, Auto-Connected Transformer, and Oil Reactor

Article 6-17. Operation of transformer and oil reactor

Once operating transformer[1] and oil reactor[2], their stable and durable operation must be maintained by:

1. Monitoring temperature, load behavior and voltage level;
2. Strictly examining criteria on oil quality and insulation characteristics;
3. Keeping facilities for cooling, voltage regulator, oil protector and other facilities in good condition.

Article 6-18. Firefighting facilities, oil collecting facilities and oil exhausting facilities

Fixed firefighting facilities, facilities for collecting oil under transformer (reactor) and oil exhausts from those points must be in readiness for operation.

Article 6-19. Painting and signing

Symbol and description showing specification of powerhouse or transformer, the common name as regulations of load dispatch center must be displayed on the cover of outdoor transformer (reactor),

On the cover of single-phase transformer (reactor), it is necessary to paint appropriately (in corresponding color).

Outdoor transformer (reactor) must be painted brightly with non-admixture paint which is weather and oil resistance.

Article 6-20. Power sources for supplying to cooling system

Live motor of cooling system of transformer (reactor), generally, must be supplied with electricity from 2 sources. As for transformer (reactor) with forced circulation oil system, it is necessary to equipped with auto-recloser for standby source.

Article 6-21. Operation of on-load tap changer

On-load tap changer of transformer must be always in operation, normally, it runs automatically. It is necessary to check the operation of on-load tap changer based on readings on counter of trips.

Article 6-22. Performance of cooling system

Cooling system of transformer must ensure the operation of transformer at rated load.

Article 6-23. Operation of cooling system

As for forced oil immersed air-cooling transformer and forced oil immersed water-cooling transformer, their cooling system must be automatically on and off at the same time with the switching of transformer. Oil must be circulated forcedly uninterruptedly without depending on loading level.

Article 6-24. Oil level in conservator

Oil in conservator of offline transformer (reactor) must be at level equal to the level corresponding to oil temperature in transformer (reactor).

Article 6-25. Overload of oil immersed transformer

Each coil of oil immersed transformer is allowed to operate overload for long with current of 5% higher than the rated one of corresponding voltage level if voltage at that level is not higher than rated voltage.

Moreover, depending on operating mode, transformer is allowed to operate overload regularly. Overload limit and duration shall be based on sample procedures on operation of transformer and instructions of manufacturer.

As for auto-connected transformer which has low voltage coin connecting to power generator, synchronous compensator or load, it is necessary to check current at common part of high-voltage coil.

Article 6-26. Action of relay for alarm of inside failures

When relay for inside failures of transformer is activated for alarm, it is necessary to examine other of transformer (reactor), take a gas ample in relay to analyze and test the combustion of gas. If that gas is flammable or contains particles due to the disintegration of insulation materials, it is necessary to disconnect transformer (reactor) promptly.

Article 6-27. Re-energizing of transformer disconnected by action of relay

In case where transformer (reactor) is disconnected automatically due to the action of protector for inside failures of transformer (reactor), that transformer (reactor) is allowed to re-operate only after investigating, testing and analyzing gas sample and fixing the detected doubt points.

In case where transformer is disconnected automatically by other relays, other than differential and steam relays, it can be re-energized for operation without needing any check unless the fault is due to short circuit.

Article 6-28. Protection of oil in equipment

Oil in conservator of transformer (reactor) must be protected from directly contacting ambient atmosphere.

Oil in oil insulator must be protected from oxidization and wet.

Article 6-29. Connection of transformer to power grid

Transformer (reactor) must be connected to power grid by energizing full impulse voltage.

Transformer connects to generator under block diagram can be connected power grid together with power generator by increasing voltage from zero or by energizing full impulse voltage.

Article 6-30. Inspection of transformer

Transformer shall be checked in accordance with the contents of inspection prescribed in Vol.5.

Chapter 5 Distribution Network

Article 6-31. Operation of electrical equipment

The Owner of the facilities should be ensure working conditions of each electrical equipment of power distribution network at every type and voltage under its rated values in normal operating mode as well as in short-circuit, over-voltage situation.

Operators of power distribution network must understand thoroughly diagram and instructions under allowable operating mode of electrical equipment in normal and breakdown condition.

Article 6-32. Operation of distribution network

Once operating distribution network, it is necessary to frequently put segments and bus-bars system (except bypass one) as well as all electrical equipment (except standby one) in to operation.

Article 6-33. Insulation level of electrical equipment

Insulation level of electrical equipment must be matched with rated voltage of power grid. Insulation level of facilities to protect over-voltage must be in line with insulation level of electrical equipment.

In case where electrical equipment is installed at dusty area, it is necessary to put forward measures for the stable operation of insulators: as for outdoor distribution network, intensify insulators shall be used. They will be cleaned and covered with zinc coat for protecting from wet. For indoor distribution network, it is necessary to protect system from dust and cavitations. For distribution network assembly, it is necessary to use closed cubicles with insulator covered with zinc coat for protecting from wet.

Article 6-34. Allowable maximum temperature for structures

Structures to be hot closed to circuit and at the places where operator can touch easily, the temperature must not exceed + 50^{o}C.

Article 6-35. Allowable maximum temperature for indoor distribution network

Indoor temperature of indoor distribution network in summer must not exceed +40^{o}C. In case where the temperate is higher + 40^{o}C, it is necessary to give solutions for deceasing temperature of electrical equipment or of cooling air.

Article 6-36. Protection of outdoor distribution network from animals, plants and dusts

As for outdoor distribution network, it is necessary to have preventive measures to keep the system from animals and birds.

Floor coat is not allowed to formed cement dust. In between plants and live parts in distribution network, it is necessary to arrange the distance for keeping from discharge.

Article 6-37. Protection of cable trough and duct against fire and water

Cable trough and duct of outdoor distribution network and indoor distribution network must be covered with refractory covers. The holes in house, wall and ceiling where cable goes through to out of cable trough must be covered with refractory materials.

Cable trough and duct must be kept clean and equipped with facilities for letting stagnant water out.

Oil storage system, gravel pit and waste oil discharge system must ensure to work well.

Article 6-38. Oil level in equipment

Oil level of oil circuit breaker, measuring transformer and oil insulators must not exceed indicated level within allowable temperature (maximum and minimum) of ambient environment.

Oil in oil insulators must be protected from wet and oxidization.

Article 6-39. Check of heating at joints of busbars

In order to avoid heating at joints of bus-bar in distribution network, it is necessary to check fixed or mobile thermo indicator.

Article 6-40. Interlock for prevention of wrong operation

Power distribution network with the voltage from 3KV upwards must be equipped with interlocks to prevent wrong operation on disconnectors, short-circuit disconnector, trailer, earthed switch, etc.

Interlocks must be sealed even they are equipped with mechanical break.

Operators who directly operate the above-mentioned equipment are not allowed to open interlock without permission.

Article 6-41. Lock of disconnector and low-voltage distribution cabinet

It is necessary to lock disconnector’s driven arm and low-voltage distribution cabinet of transformer, tram cat and other projects, which are mounted on the pole without encompassed fence.

Fixed stairs for reaching working platform must be also equipped with interlock and disconectors, which are locked.

Article 6-42. Use of earthing switch

For grounding power distribution network of voltage from 3 kV upwards, it is necessary to use fixed earthing switch

Steering lever of earthed switch’s drive must be painted in red, its blade is covered in red and white.

Article 6-43. Indicator for switching position of breakers

Breaker and its drive must be equipped with indicator for positions to be switched.

As for breakers, which have built-in drive, indicator, for positions to be switched, is only needed being built in either breaker or drive. As for breakers, which their outer contacts are easy to observe positions to be switched, it is not a requirement for equipping such indicator.

As for drive of disconnector, earthed switch, circuit separator, short-circuit disconnector and other equipment, which have partitions, it is necessary to equip indicators for positions to be switched.

Article 6-44. Preparation for accident and fire of distribution network

At distribution network, it is necessary to equip mobile grounding facilities, devices for first aid in case where accident occurred, protecting and firefighting equipment as fire regulations and occupational safety (sand, extinguisher, etc.)

As for power distribution network, if self-services firefighting teams are available, the above-mentioned equipment and facilities shall be kept at that team's headquarters.

Article 6-45. Inspection of distribution network

Check and test of distribution network should be carried out based on technical standards for inspection (Vol.5) appropriately.

Article 6-46. Overhaul of distribution network equipment

The overhaul of distribution network equipment should be carried out with appropriate method and an interval to maintain the reliability and economical operation. The interval should be set based on the condition and actual failure of the equipment by the owner.

Chapter 6 Battery System

Article 6-47. Operation of battery

During operation, battery system must ensure to operate stably and durably at required voltage on DC bus-bar in normal and failure operating mode.

Article 6-48. Inspection of new battery

New battery shall be checked in accordance with the contents of field inspection and completion inspection prescribed in Vol.5.

Article 6-49. Ventilation for battery room

Ventilation with draft fan installed in battery room in power plants must be operated according to the specification of battery and the status of installation.

Battery rooms of transformer substation must be ventilated as local regulations.

Article 6-50. Operating Voltage of DC network

The voltage of DC bus which supplies power to protection system such as relays, meters, and automatic control equipment is allowed to be higher by 5% than the rated voltage of the receiving end.

All cubicles and main DC line shall be equipped with two power sources.

Article 6-51. Eearth fault in DC network

Once occurring earth fault in DC network, it is necessary to disconnect and keep that network from operation, otherwise in duration of detecting pole of earth fault.

Article 6-52. Signing

The batteries and accompanied equipment shall be signed in accordance with Vol.7 article 2-74.

Chapter 7 Overhead Lines

Article 6-53. Repair and overhaul

During operation overhead lines, it is necessary to implement technical maintenance and overhaul to ensure the reliable operation overhead lines.

Article 6-54. Implementation of repair and overhaul

As for main6tenance overhead lines, it is necessary to implement items to keep structural parts overhead lines from soon break by periodical checks and measurements and fix of faults and abnormal phenomenon.

In case where overhead lines are overhauled, it is necessary to carried out comprehensive measures to recover operating primary characteristics overhead lines, generally, or part of them, particularly, by fixing broken parts or replacing broken parts with more durable and economical to further improve operating characteristics overhead lines.

Article 6-55. Implementation of design

In agreement on technical conditions for designing overhead lines, Power Company and electricity administration enterprise must raise their request to designer on special conditions of area where overhead lines pass (climate condition, pollution and other local factors), for the consideration of designer in designing overhead lines.

Article 6-56. Taking over of overhead line

When accepting overhead lines for putting in operation, electricity administration unit must be provided by constructing unit with technical materials, which are in accordance with requirements in “Standards on checking and accepting power network projects).

Article 6-57. Watching over of site

Under-construction overhead lines, which will be handed over for power network unit for management and operation, that power network unit shall have to watch over, technically, during construction.

Article 6-58. Safe protection for power network project

Operating management overhead lines must strictly follow the regulation in "Decree on safe protection for power network projects" promulgated by Council of Ministers.

Power network managing units must inform other agencies and organizations near areas where overhead lines pass through of these regulations.

Power network managing units must have solutions to prevent other individuals or organizations from implementing activities in corridor overhead lines, violating the stipulated regulations in "Decree on safe protection for power network projects".

Article 6-59. Agreement with the owner of the corridor

Scheduled on repairing and recovering overhead lines passing through cultivating areas (plantation, a forestation yard, field, garden, etc.) must be agreed with the owners of those areas.

Article 6-60. Cutting tree in corridor of the route

Overhead lines route must be cleaned (from garbage, plants, etc.) periodically, and kept safety, without letting nearby fires damage. In corridor of the route, it is necessary to cut off all trees are likely to damage overhead lines as regulations stipulated in "Decree on safe protection for high-voltage power network projects".

Article 6-61. Maintenance of signals and signs

Signals and signs must be kept in good condition:

1. Signs on banks at gaps where overhead lines cross rivers where boats and crafts pass by frequently;
2. Light signal and signal paint mounted in high poles;
3. Signs, alert points are put permanently at poles overhead lines;

Article 6-62. Installation and maintenance of barriers

Power network managing units must monitor and ask railway managing units to put barriers at the railway sections where oversize cargos and cranes likely to pass by.

Installation and maintenance of such barriers shall be implemented by railway managing unit.

Article 6-63. Patrol

To detect, from the distance, the broken parts overhead lines at the voltage from 110 kV upwards, it is necessary to equip the required equipment and devices.

Power network managing units must be equipped with mobile devices to detect earthed fault pole of 6 - 35 kV- overhead lines.

Article 6-64. Limitation of the number of jointing point

During operation, in intervals between poles where overhead lines pass over other overhead lines and telecommunication lines, each conductor or earth line overpass overhead lines must not contain more than two joints.

Number of joints in conductors and earth line of lower overhead lines is unlimited.

Article 6-65. Cleaning of insulator

In case where contamination problem is serious, insulators must be cleaned or replaced, or damp-proof insulators will be used

Article 6-66. Compliance with standard of inspection

Check and test of overhead line should be carried out based on technical standards for inspection (Vol.5) appropriately.

Article 6-67. Countermeasure for defection

Failures and shortcomings detected during check overhead lines must be noted to diary (or particular book), depending on such failures, they shall be fixed immediately or during maintenance or overhaul overhead lines.

Article 6-68. Interval of repair and overhaul

The overhaul of overhead line equipment should be carried out with appropriate method and an interval to maintain the reliability and economical operation. The interval should be set based on the condition and actual failure of the equipment by the owner.

Article 6-69. Synchronized work of repair and overhaul

Technical maintenance and repair overhead lines must be carried out in harmony, at the same time, minimizing outage time.

Article 6-70. Restructuring of supporting structures

Change of poles' structures as well as other structures overhead lines must be under full set of technical materials and approved by chief engineer of electricity managing unit.

Article 6-71. Spare parts

Accessories and spare parts must be reserved in power network managing units as regulations for timely fixing faults on overhead lines due to breakdown.

Article 6-72. Operating management unit

In case various operating management units share one chain of poles for mounting line, preparation of schedule on repairing line must be agreed to each other. In case where repair is implemented due to breakdown, it is necessary to inform the related units (owners of lines share the poles for lines) in advanced.

Chapter 8 Power Cable Lines

Article 6-73. Implementation of maintenance and overhaul

During operation power cable lines, it is necessary to carried out technical maintenance and overhaul for their stable and reliable operation.

Article 6-74. Confirmation of continuous rated current

It is necessary to specify maximum allowable load current for each cable line, which just put in operation. Load current is identified by cable sections which shall stand the worst conditions if that section is longer than 10 m.

It is possible to put up load current based on testing results provided that increase of cable core's temperature shall not exceed regulations. Such temperature increase must be checked at the cable sections where own the worst cooling conditions.

Article 6-75. Air temperature in tunnels and cellars

Temperature in cable tunnels (cellars) must not exceed ambient air temperature of over 40^{o}C in summer.

Article 6-76. Overloaded operation

110-500 kV oil-filled power cable lines are allowed to operate in overload until temperature of cable core reaches 80^{o}C. Of which, consecutive overloaded duration must not exceed 100 hours, total overloaded time must not be higher than 500 hours per year with interval between two consecutive overloaded times not less than 10 days. As for outdoor 110 kV power cable lines, operating duration at 80^{o}C-cable core shall not be limited.

Article 6-77. Allowable insulating oil pressure (OF cable)

As for each oil-filled power cable, it is necessary to stipulate allowable limit of oil pressure. In case where oil pressure of cable exceeds allowable range, such cable shall be de-energized. The cable shall not be allowed to energize unless the faults are detected and fixed.

Article 6-78. Documents taken over

Once accepting once power cable line to put in operation, apart from required technical materials, which are stipulate, by construction and installation companies, managing units of power cable lines must be handed over the following documents:

1. Power cable line's map at scale of 1:200 or 1:500 (depending on the development of transport and telecommunication system of region, which power cable lines pass through);
2. Check-lists on underground items, which point out clearly the points that power cable lines are crisscrossed and nearby other underground cable lines (telecommunication cable and strength cable), underground pipes, check-lists on installation of coupling boxes.

3. Check-lists on conditions of cable in coil, if need be check-lists on checking of open cable coins and transportation should be available (as for imported cable, check-lists on checking of open cable coins must be shown).
4. Drawing of longitudinal section of power cable line at crossed points between power cable line and traffic road and other cable lines and pipelines (for power cable with voltage from 35 kV upwards), and at complicated power cable sections (for 6-10 kV power cable lines).
5. Check-lists on test of longitudinal ground section along power cable line based on characteristics of each section.

Article 6-79. Personnel presence from operating company at takeover

For power cable lines at any voltage which constructed by one company, then handed over to other company for its operation and management, so the expecting management unit or Power Company must arrange for technical supervision during laying cable out and construction of power cable line.

Article 6-80. Paint of metal supporting structures

Metal supporting structures must be painted periodically to be protected from rust and heat.

Article 6-81. Load measurement (Transformers at substations)

Load of each transformer must be metered every year, at least, at the peak time and at light load time.

Based on metered data, it is necessary to adjust mode and operating diagram of power supplying network.

Article 6-82. Inspection of power cable

Check and test of power cable should be carried out based on technical standards for inspection (Vol.5) appropriately.

Article 6-83. Countermeasure against rust

With areas where electrified traffic route passes through or intrusion area, power cable lines shall not be permitted to put in operation unless the measures for keeping cables from rust are applied.

In the above-mentioned areas, on power cable lines, it is necessary to meter erratic (stray) current, to establish and calibrate voltage diagram of cable network (or each cable section), systematically and map for intrusion area.

Article 6-84. Restriction of soil excavation above power cables

Excavation or any works of soil on power cable line shall not be allowed to implement unless the power cable line managing unit permits.

Article 6-85. Engineer's presence of field maintenance office for security of underground transmission lines

Electrical equipment inside the area that figure 6.87.1 shows shall need engineer's presence of field maintenance office, when other utilities conduct construction work. And the protection method such as stringing way and sustaining way shall be discussed between people who cause this matter and engineers are responsible for targeted equipment.

When paving work or roadbed improvement work just over the electrical equipment is conducted and the clearance can not secure 1m, engineer's presence of field maintenance office shall be necessary. Besides that, in case that covering soil layer is less than 0.7m, heavy machinery (Iyon) has steel needle shall be banned for removing old pavement. When special heavy machinery rather than Iyon is adopted to remove the old pavement, discussion about its usage shall be necessary.

When boring or chemical grouting work is performed inside 1m from electrical equipment, engineer's presence of field maintenance office shall be necessary. In case where more than 1m, engineer's presence of field maintenance office might be required depends on situation.

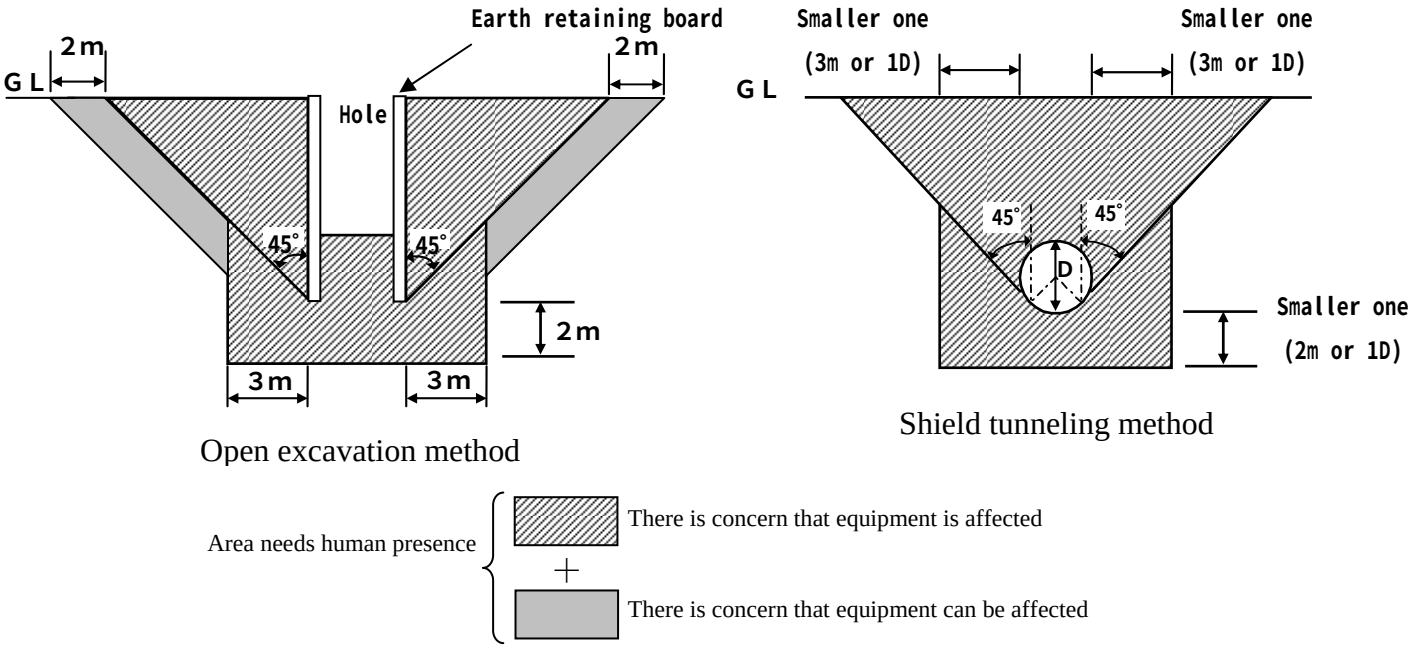

Figure 6.87.1 Excavation Area need Engineer's Presence of Field Maintenance Office

Article 6-86. Information to public on construction work of underground transmission lines

Power network managing unit must inform agencies and residents in the areas where power cable lines pass through, of way and procedures for carrying out activities and excavation nearby power cable route.

Article 6-87. Compliance with occupational safety and health regulation

During check of power cable lines and trough for detecting their faults, it is necessary to strictly abide regulations on occupational safety.

Chapter 9 Protective Relay and Automation

Article 6-88. Protection for electrical equipment

Electrical equipment of power plants and networks must be kept from short-circuit and failure in normal operating mode with protective relay, circuit-beaker or fuse and automatic electrical facilities including auto-regulating and auto fault-preventing devices.

Article 6-89. Management and operation

Electric power utilities, power suppliers and grid operators should take responsibility to manage and operate protecting system for relay, auto electrical equipment, electrical indicating and metering instruments and secondary circuit.

Article 6-90. Maintenance of conditions for operation

During operation, it is necessary to maintain conditions for normal operation of facilities for protecting relay, measuring and auto electrical equipment and secondary circuit under the national standards and technical procedures (temperature, humidity, allowable vibration and difference of working parameters against rated ones, etc).

Article 6-91. Requirement for protective relay and automation facilities

The Owner of the protective relay and automation facilities should male the panel to be recognized visibly and easily. On panel of electrical protective relay and automation as well as on control panels and desks, both sides (front and rear) should be described their name as regulations of load dispatch center. Facilities built in control panel or at the rear of control desk must be written and marked both sides in accordance with the diagram.

Article 6-92. Inspection of related facilities to protective relay and automation facilities

The Owner should make operator to be in charge of inspecting the accuracy of fuse, circuit breaker in controlling circuit, testing breaker and other equipment, exchanging high frequency protective signals, metering unbalanced current and bus-bar differential protection, testing autoreclosing facilities, backup power closer, auto wave recorder and other equipment and facilities.

Period for checking and testing equipment and facilities, as well as operating technology of operator once detecting the difference against standards, shall be under the local regulations.

Article 6-93. Inspection of protective relay, automation facilities and secondary circuit

Electrical protective relay and automation facilities and secondary circuit must be checked and calibrated periodically in accordance with existing procedures and guidelines.

After each time of wrong operation or failing to operate, such facilities must be checked additionally (after faults) with special procedures.

Article 6-94. Secondary winding of current transformer and voltage transformer

Secondary winding of current transformer must be always connected to relay of electric meter or bypassed. Secondary circuit of current transformer and voltage must have earthed pole.

Article 6-95. Protective facilities of operating circuit

Protective facilities (fuse and circuit-breaker) of operating circuit must be ready for operation.

Circuit breaker to be put fuses and fuse wire must have symbols (on function and current)

In panels (cabinets) of electrical protective relay and automation facilities, where operator switch circuit by locks, it is necessary to note corresponding position of above switchers in accordance with using modes.

Operating practices on such switchers must be note to operating diary.

Chapter 10 Grounding Equipment

Article 6-96. Accurate grounding of all metal parts

Grounding equipment must satisfy the requirement on safety for man and electrical equipment in every operating mode.

All metal parts of electrical equipment and works, which can be suffered from electrical leakage once their insulation broken, must be earthed.

Article 6-97. Accurate grounding metal parts with grounding system

Each component (of electrical works), which needs being earthed, must be connected to grounding system or main grounding shaft with separate earth continuity conductor.

Not allow to earth some components of electrical works in series connection.

Article 6-98. Grounding method

Connection of earth continuity conductor to grounding equipment, pole and ring must be welded and such connection to machineries and pole electrical equipment can be welded or tightly screwed with bolts.

Article 6-99. Paint of grounding components (rust-protective measures)

It is necessary to apply rust-protective measures on earth continuity conductors, open earth continuity conductor's section must be painted for recognition.

Article 6-100. Regulation of connection between electrical welding machines and mobile electrical equipment

Electrical welding machines and other mobile electrical equipment are not allowed to be connected to available earth continuity conductor unless these earth continuity conductor have required section.

Article 6-101. Inspection of grounding equipment

Check and test of grounding equipment should be carried out based on technical standards for inspection (Vol.5) appropriately.

Article 6-102. Time for grounding resistance measurement

It is necessary to meter resistance of grounding equipment as follows:

1. After assembly, refurbishment or overhaul of works in power plant, transformer substation and lines.
2. In case where carrying out maintenance of electrical poles mounted earth line of 110 kV line upwards because the insulator is broken or disrupted by electric arc.

Article 6-103. Check of rusty and its measure

As for grounding equipment of electrical works and poles, which are often rusty, the excavation for checking shall be carried out more frequently under the decision of responsible people of field maintenance office.

Chapter 11 Over-Voltage Protection

Article 6-104. Restriction for Laying of lines

Not allow to lay lines of any line up to 1000V on lamppost, chimney, water tower, as well as to lay such lines in exposable halls.

These lines must be either cables with metal sheath or wires covered with metal tube hidden underground.

Article 6-105. Inspection of Lightning arrester

Lightning arrester shall be checked in accordance with the contents of inspection prescribed in Vol.5.

Article 6-106. Single line earth fault

As for isolated neutral system or compensating reactor grounded neutral system, lines and cables are allowable to operate even single line earth fault, for that duration, the faults must be detected and fixed as soon ass possible.

In power network of generator's voltage as well as power networks, which are connected to high-voltage motor, working on lines shall be only allowed at regulations in line with Article 583.

Article 6-107. Compensation of earth fault capacitive current

Compensation of earth fault capacitive current by arc extinguishing devices must be carried out in case where capacitive current exceeds the following values:

Rated voltage of power network (kV)	6	10	15 - 20	35 and over
Earth fault capacitive current (A)	30	20	15	10

In block diagram of "Generator - Transformer" (at voltage of generator), it is necessary to installed arc extinguishing device once earth fault capacitive current higher than 5A.

In power network of 6 - 35 kV with lines having steel pole and reinforced concrete, it is necessary to installed arc extinguishing device once earth fault capacitive current higher than 10 A.

In order to compensate earth fault capacitive current in power network, it is necessary to use automatic or manual grounding arc suppression coils. Non-regulating arc suppression coil shall be permitted to use in block diagram of "Generator - Transformer".

Metering of capacitive current, current of arc suppression coil, earth fault current and deferential voltage at neutral point must be carried out when arc suppression coil is put in operation, or when power network operating mode change significantly, but at least once for every 5 year.

Article 6-108. Installation of arc suppression coils

Capacity of arc suppression coil must be selected based on capacitive current of power network with taking account of power network development plan.

Grounding arc suppression coils must be installed in transformer substation, which connected to compensation, network not less than 3 lines.

Arc suppression coils are not allowed to install in dead end substations

Arc suppression coil must be connected to neutral point of transformer, power generator or synchronous compensator through isolator.

Generally, transformer with "star-delta connection" diagram shall be used to connect arc suppression coil.

It is prohibited to connect arc suppression coil to transformers which are protected by fuses.

Output insulator of arc suppression coil for grounding must be connected to common grounding system through current transformer.

Article 6-109. Use of resonance regulator

Arc extinguishing devices must have resonance regulator.

It is allow using resonance regulator with regulating error up to 5% once resistant component (resistor) of earth fault current does not exceed 5A.

If arc extinguishing devices in 6 - 15 kV power network have big differential current at different branches, resonance regulator with resistant component of earth fault current up to 10A shall be allowed using. As for power network of 35 kV upwards, once earth fault capacitive current is lower than 15A, allowable regulating errors of resonance regulator must not exceed 10%.

It is allowed using regulator that does not reach compensation level, in line and cable network if any faults occurred, unbalanced capacitive current risen in phases (e.g. once lines are broken), without changing voltage of neutral point, is allowed exceeding 7% phase's voltage.

Article 6-110. Allowable voltage deviation at neutral point

In case where power network is not suffered from earth fault, voltage deviation at neutral point is allowed not to exceed the following values (in % against phase's voltage).

Long term	15
Within 1 hour	30

Reduction of voltage deviation and displacement of neutral point up to rated values must be carried out by balancing capacitive current of phases to ground in power network (change of reciprocal position between conductors as well as arrangement of high frequency connection between phases on line).

When high frequency capacitors and lightning protection ones for rotary generators are connected to power network, it is necessary to check the allowable unbalanced capacitive current of phases to be earthed.

Not allow switching on and off each phase of line and cable to make the voltage at neutral point exceed allowable value.

Article 6-111. Regulating level of manual regulator for arc suppression coil

In case where arc suppression coil with manual regulator is used, the identification of regulating level must be carried out by resonance compensation meter. If such equipment cannot be available, the selection of regulating level must be based on results of metering earth fault current, capacitive current and compensation current with taking account of voltage deviation of neutral point.

Article 6-112. Prevention of over-voltage due to self-arising neutral deviation or magnetic iron

In 110 - 220 kV transformer substation, in order to prevent over-voltage due to self-arising neutral deviation or during arise of dangerous magnetic iron, it is necessary to start operating from grounding neutral point of transformers, which are connected to no-load bus-bar system equipped with HKϕ-110 and HKϕ-220 transformers.

Before disconnecting no-load bus-bar system equipped with HKϕ-110 and HKϕ-220 transformers from power network, neutral point of feeding transformer (power-start) must be earthed.

In transformer substations of 220 kV upwards, operation of circuit breaker must be carried out so that HKϕ transformers shall not automatically disconnect from feeding bus-bar through capacitor, shunt connection with live and dead contact of air breaker.

As for 6 - 35 kV power network and connections, in case where necessary, measures to prevent self-arising neutral deviation must be put forward.

Article 6-113. Prevention of the fault involving two different voltages

Transformer should be taken adequate measures to prevent the fault involving two different voltages.

Article 6-114. Requirement for grounding neutral point of transformer

With 110 kV power network and over, neutral grounding disconnection of 110-220 kV windings of transformers, as well as the selection of operation of protection and automation system, must be carried out so that if different operations and automatic switching are presented, power network without neutral grounding transformer shall not be separated.

Over-voltage protection for neutral points of transformers, which have lower insulation than input insulator of transformer, must be carried out by lightning valve.

Article 6-115. Allowable voltage rise

With 110 kV network and over, once carrying out switching and having failure, industrial frequency voltage of equipment rises depending on time must not exceed the following limitation:

Voltage (kV)	Equipment	Allowable voltage rise lasts in (sec)			
		1200	20	1	0.1
110-500	Forced transformer and	1.10	1.25	1.9	2.0
	auto-connected transformer	1.10	1.25	1.5	1.58
	Shunt reactance and	1.15	1.35	2.0	2.10
	Electromagnetic transformer	1.15	1.35	1.60	1.65
Voltage type	Switch, capacitive transformer,				
	current transformer, capacitor, and	1.15	1.60	2.20	2.40
	hard bus-bar	1.15	1.60	1.70	1.80

With above-mentioned values, numerators are for phase - earth insulation in percentage of maximum voltage of operating phase, and denominators are for phase - phase insulation in percentage of maximum voltage of operating line (as for 3-phase electrical equipment). Maximum working voltage shall be defined in accordance with existing regulations.

Chapter 12 Electrical Indicating and Measuring Instruments

Article 6-116. Management and Supervision for electrical indicating and measuring instruments

Power Companies shall take responsibility to manage and supervise electrical indicating and measuring instruments and system. Power Companies shall decentralize the specific management and calibration to each unit.

Article 6-117. Inspection period of electrical indicating and measuring instruments

National and sectoral checking period for electrical indicating and measuring instruments shall be stipulated by national and sectoral standards and quality units.

Article 6-118. Requirement for electrical indicating and measuring instruments

No electrical indicating and measuring instruments shall be allowed to install and put in operation unless they satisfy the requirement on standardization and regulations, guidelines of manufacture on such electrical indicating and measuring instruments.

Article 6-119 Organization, implementing method and report for inspection of electrical indicating and measuring instruments

Organization, implementing method and report when electrical indicating and measuring instruments is checked, must be in line with requirements of standardized measuring materials stipulated by national and sectoral standards and quality units.

Article 6-120. Requirement for installation of electrical indicating and measuring instruments

Electrical indicating and measuring instruments for contact transformer and transmission lines at the voltage from 220 kV upwards in power plant and transformer substations, where permanent on-duty staffs are always available, must be installed separately for each connected circuit. Not allow to share one electrical measuring device for metering many connected circuits.

As for other metering circuits, it is allowed sharing the electrical measuring device or using device of central testing facilities.

Article 6-121. Installation of electricity meter in power plants

It is necessary to install meter for self-station service of operating and backup components in power plants. In addition, thermal power plants should be equipped with electricity meter for main electrical motor in mechanical line of each boiler and turbine, accordingly it is possible to recognize electricity consumption for each segment of technological line.

Article 6-122. Measuring of electricity consumption for self-station service

Each transformer substation of power system must calculate separately electricity consumption for their self-station service, for internal activities of electricity units as well as for other consuming components, which consume electricity from auxiliary bus-bar of transformer substation.

Electrical meters must be installed at feeders connected to power grid of transformer substations at voltage from 35 kV upwards to calculate energy balance, accordingly identify power loss increase of components in power network.

Chapter 13 Illumination

Article 6-123. Requirements for illumination

Illumination for operation, buildings, switchyards and vigilance must satisfy the standards on "Illumination in designing industrial works".

Vigilance spotlights should be marked or painted differently from office or house lights.

Signal lights for chimneys and other high works must be in accordance with existing standards.

Chapter 14 Electrolyte Station

Article 6-124. Instrument and operation

Instruments and operation of electrolyte stations shall satisfy the promulgated National safety standards.

Article 6-125. Confirmation during operation

When electrolyte station is put in operation, it is necessary to check status of equipment such as voltage and current of electrolyzer, pressure of hydrogen and oxygen and liquid level in instruments, pressure difference between hydrogen and oxygen systems, temperature of electrolyte and air in dryers, purity of hydrogen and oxygen in instruments and hydrogen content in electrolyte stations.

Normal values and limits of checked values shall be defined based on tested instructions of manufacturer, moreover, such values must be strictly watched over during operation.

Article 6-126. Protector

Protectors of electrolyte station shall trip to disconnect motor-generator set in case that the difference between the actual values and design values exceed the designated values.

In case that electrolyte station switches off automatically, control panels shall be displayed with alerting signals. After receiving alerts, the operator shall arrive at electrolyte station not more than 15 minutes from the stop of electrolyte station.

After protector being tripped, the operator shall not be allowed to restart unless detecting and clearing causes of faults.

Article 6-127. Safety valve

Safety valves in hydrogen and oxygen pressure regulators and in electrolyzer shall be calibrated at design values.

Article 6-128. Discharge of gas

Before putting electrolyzers in operation, all instruments and ducts shall be blown with gas designated by the manufacturer for safety.

Article 6-129. Discharge of air and hydrogen

In order to eject air or hydrogen from cylinder, it is necessary to use gas designated by the manufacturer. In case that the inside check of cylinders is carried out, they shall be ejected in advanced with air until oxygen content in ejected-air reaches 20%, approximately.

Article 6-130. Painting color

Ducts of electrolyzers shall be painted with stipulated color, in accordance with promulgated national standards. Instruments of electrolyte station shall be painted corresponding gas (hydrogen, oxygen). Cylinders shall be covered with bright color and circles, which are painted with color corresponding to gas in cylinders.

Chapter 15 Energy Oil

Article 6-131. Energy oil

Oil to be used in energy sector hereinafter referred to as energy oil. During using energy oil, it is necessary to make sure oil system of generator and oil-filled equipment operate stably.

Article 6-132. Inspection of insulating oil

Insulating oil shall be checked in accordance with the contents of inspection prescribed for each facility in Vol.5.

Article 6-133. Exchange, dryness and regeneration of absorbents

When the acid content became an upward trend as a result of the inspection for insulating oil prescribed with Vol. 5, the absorbents shall be exchanged, dried or regenerated.

Part 7 LOAD DISPATCH COMMAND - OPERATION

Chapter 1 Load Dispatch Command

Article 7-1. General

National load dispatch center, local load dispatch center and all owners of electrical facilities such as substations, transmission lines, power plants, etc. shall take responsibility to ensure the following based on AQTDD-11-2001.

1. Ensure sufficient electricity supply;
2. Ensure uninterrupted electricity supply for customers and stable operation of entire power system;
3. Ensure electricity quality as stipulated standards (on frequency, current voltage, etc.);
4. Ensure united power system and integrated power system and other single power systems to operate efficiently, to consume rationally fuel volume under targeted load curves.

Article 7-2. Load dispatch command

Load dispatch command is carried out from load dispatch stations. Load dispatch stations must be equipped with necessary instruments for load dispatch command in accordance with their standards.

Article 7-3. Submission of annual schedule on overhauls and repairs

Annual master schedule on overhauls and repairs of power plants and networks shall be submitted to National Load Dispatch Center.

In case that schedule on overhauls and repairs is changed, the change must be approved by National Load Dispatch Center.

Article 7-4. Allowable load limitation of electrical equipment and conductors

Allowable load limitation of electrical equipment and conductors must be set up by load dispatch division of power system, of integrated power system or united power system coordinate with local electricity units and power plants, based on operating mode and calibrated values of protective relay and automation system. This allowable load limit must be revised once for every year, at least.

Article 7-5. Load curve of hydropower plants

Load curve of hydropower plants must consider the demand of national economic sector (waterway transportation, irrigation, aquiculture, water supply, etc.) and be in line with “Regulations on using water resources”

Article 7-6. Keeping of assigned load curves and spinning reserves of power plants

Power plants are required to complete their assigned load curves and spinning reserves. In case where the assigned load curve cannot be obtained due to any reason, on-duty staffs must inform dispatchers of power system of situation immediately.

In case where necessary, dispatcher of power system has right to change load curve of power plant but maintain total load curve of entire power system set up by load dispatch center of integrated power system. Change of total load curve must be permitted by dispatcher of integrated power system.

Only dispatcher of load dispatch center of united power system has right to change power diagram among integrated power systems.

Dispatcher has right to ask power plant increase its capacity maximum or minimize its capacity based on technical condition of equipment.

Article 7-7. Frequency of power system

Current frequency of power system must be always kept at 50 Hz with the oscillation of ± 0.1 Hz. Power system is allowed to operate in transience with oscillation not higher than ± 0.2 Hz

Article 7-8. Voltage of power system

Voltage of power system must be always maintained at normal level, corresponding to targeted voltage.

Article 7-9. Disconnecting of equipment for repair and inspection

In order to disconnect equipment, automatic protective relay system, automatic frequency and power transmission regulator, instruments of load dispatch command and technology control from their operation and standby for repair or inspection, in any case (scheduled or unscheduled), the request in writing must be submitted to load dispatch center.

In particular case when the equipment requires unscheduled repair or fault clearance, requests must be submitted to and approved by Load Dispatch Center.

Article 7-10. Allowable time in the request

Time to be consumed for manipulations related to putting equipment in repair and putting equipment or lines in operation, time for burning boiler or starting up turbine shall be counted to allowable time in the request.

The approval from Load Dispatch Center is required in case that the time is changed.

Article 7-11. Approvals for starting repair and inspection

Even the approved request is available, every time when the equipment is disconnected from its operation and standby for repair or inspection, it is required the approval from the Load Dispatch Center before starting repair or inspection.

Article 7-12. Fault clearance procedures

Specific procedures on fixing faults must be available at each load dispatch office and electrical instrument which on-duty staffs are available.

In case where the faults occurred, Load Dispatch Center and related electric utilities must apply every measure to restrict the faults' widespread and recover electricity supply to customer as soon as possible.

Chapter 2 Operation on Energizing and De-Energizing Electrical Equipment

Article 7-13. Connection diagram of equipment

In control rooms of power plants and transformer substation (including clue transformers which from here, it is possible to inspect and control other substations) independent from control mode, and in load dispatch offices, connection diagram (diagram - simulator) of equipment installed at commanding site of dispatcher in those power plants, transformer substations and load dispatch offices.

Every change in connection diagram as well as change of grounding points must be shown clearly in diagram (or diagram - simulator) right after operation.

As for load dispatch offices and clue transformer substations where kept connection diagram of electrical equipment, which to be controlled from those load dispatch offices and clue transformer substations, it is not necessary to have operating diagram of such electrical equipment.

Chapter 3 Operator

Article 7-14. Operator

Electric power utilities, power suppliers and grid operators should assign the suitable engineer who own required qualification stipulated in relative standards as operator.

Here, operators of power systems, power plants, networks and steam system are:

1. On-duty staffs work as schedule of ongoing generation sections;
2. Operators and repairers for operation and operation in generation sections;
3. On-duty managers in operating shift, including:
    (1) On-duty dispatcher of united power system;
    (2) On-duty dispatcher of integrated power system;
    (3) On-duty dispatcher of single power systems;
    (4) On-duty dispatcher (on-duty engineer) of local electricity units, branches or thermal units;
    (5) Shift leader (on-duty engineer) of power plant.

Article 7-15. Maintenance of equipment for power sector

Maintenance of equipment for power sector shall be carried out by operators frequently or periodically as schedule for one instrument or group of equipment.

Article 7-16. Responsibility for supervise and maintenance of equipment and machineries

Electric power utilities, power suppliers should make Operators watch over, and maintain for the smooth operation of equipment and machineries without letting faults occurred. Moreover, he/she should maintain for the cleanness and tidiness as regulations.

Article 7-17. Inspection of facilities for operation

Operator must inspect the technological equipment, firefighting equipment, alerting signals, telecommunication equipment as well as correct the watch for accurate time at working place, periodically as operating technology.

Chapter 4 Dispatching and Controlling Devices

Article 7-18. Load dispatching and controlling devices

Load dispatch offices of Power Company, power plants, power network units and branches must be equipped with dispatching and controlling devices, in accordance with standards on technological design for load dispatch stations and points of dispatching and controlling devices of power system. In addition, such devices must be in line with essential rules on amount of remote mechanical instruments and telecommunication equipment in power system.

Controlling devices must be always kept in smooth operation.

Article 7-19. Telecommunication equipment and remote system

Transformer substations of 35 kV upwards with subscribers, or controlling of such transformer substations are under electric power railway system, oil manifold system, steam flues and industrial units, must be equipped with telecommunication equipment and remote system which are in good conditions.

Amount of remote system of subscribing transformer substations shall be determined based on requirements on reliability of controlling operation by relay communication channel of 35 KV upwards must be in line with power system.

Structure and maintenance of means of telecommunication and remote sysetem of subscribing transformer substations must be abided the regulations for each section.

Article 7-20. Operation of telecommunication network, remote system and communication transmission system

Operation of telecommunication network for generation, remote system and communication transmission system shall be carried out by telecommunication and remote terminal unit managing team.

Article 7-21. Documents for load dispatching and controlling devices

In order to operate load dispatch and technological controlling devices, operate computers and peripheral devices, computers' terminals, managing group of dispatch command and technology controlling devices and other generation branches, must have designing documents, materials of manufacturers, operating diagrams as well as technical passport of equipment and operation check-list

Article 7-22. Protection for landline telecommunication devices

Landline telecommunication devices must be protected and kept from hazardous impacts and interferences caused by high-voltage instrument, in line with “Regulations on protecting landline telecommunication devices of power system from voltage impact and hazardous current”

Article 7-24. Standby supply sources for load dispatching and controlling devices

Dispatching and controlling devices as well as computer’s devices which are involved directly in controlling process must be equipped with standby supply source which can auto-reclose once facing outage.

Such standby supply sources must be in line with requirements on “Instructions on designing power supply source for dispatching and controlling devices in power system”.

Article 7-23. Inspection of load dispatching and controlling devices

Electric power utilities, power suppliers load dispatching and controlling devices must inspect all devices periodically; especially pay attention to the positions of switches, connectors and faults alerts.

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Volume 7

CONSTRUCTION AND INSTALLATION

OF POWER PROJECTS

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ECONOMIC DEVELOPMENT DEPARTMENT

Table of Contents

Chapter 1 General

Article 1-1. Purpose

This technical standard defines the necessary terms and procedures on the construction and installation of power projects to secure that electrical facility are well developed.

Article 1-2. Scope of application

The stipulation in this technical standard shall apply to engineering work such as construction and repair of electric facilities for network. Here, the electric facilities are not only electric power company's facilities but also private company's, such as factory up to 500kV.

Article 1-3. Definitions

The following definitions apply to this technical standard.

1. *"Authority"* means Ministry of Industry or organizations to which Ministry of Industry devolves specified competence in enforcement of inspection of network, hydro powerplants and thermal powerplants.
2. *"The Owner"* means any person, unit, or municipality, or combination thereof that owns powerplants and has a legal responsibility for operation of those powerplants.
3. *"The Consultant"* represents any person, corporation, or combination that is committed to be in charge of design of construction or repair work by the owner.
4. *"The Contractor"* represents any person, corporation, or combination that is successful tender of construction or repair work and often plays a role of practical enforcement of them.
5. *"The Sub-contractor"* represents any person, corporation, or combination that is committed to be in charge of practical enforcement of construction or repair work by the contractor.
6. *"Design materials"* represents essential design documents including instruction of construction or repair work for contractors or sub-contractors to proceed their work accurately.
7. *"Prefabricated Method"* represents the use of electrical equipment that is assembled in the factories in advance.
8. *"Phase identification"* represents phase color allocation, where phase A is yellow, phase B is green, and phase C is red.
9. *"The testing cable"* represents control cable for lines, buses, generation facilities, and so on. Its main role is sending signals such as switching on or off to circuit breakers and others related to controlling power system.

Chapter 2 General Provisions

Section1 General

Article 2-1. Scope of application

These rules are applied for the construction and installation of electrical equipments with the voltage up to 500 kV.

Article 2-2. Compliance with regulations

The Owner shall check that electrical design and construction companies set up planning and construct in compliance with this regulation.

Article 2-3. Outline of applicable regulations

Technical conditions and methods that should fulfill technical requirements are not limited to those stipulated in this regulation, if safety of appropriate level can be ensured by other conditions and methods that have adequate technical evidence.

Article 2-4. Applicable related regulations

During the installation of electrical equipment, it is required to follow:

1. These technical standards
2. The present construction standards and rules
3. The rules for safety in construction, the requirements for safety-working as well as for prevention of fire, and explosion
4. The design proposals approved by the authorities, manuals from manufacturers

Article 2-5. Electrical equipment with oversea specifications

When electrical equipment from manufacturers overseas with its specifications out of these rules shall be used, it is necessary to follow the manufacturer's data.

Article 2-6. Construction work by qualified persons

For types of work such as: the installation of batteries, welding, binding, installation with pneumatic and drop hammers used or other installation tools etc, only qualified persons who were trained and have mastered the technical rules, procedures for technical process and safety rules shall be employed.

Section2 Industrialization of construction and installation practices

Article 2-7. Accelerated adoption of industrialized methods

During the electrical construction, it is essential to apply the industrialized methods as much as possible. This means the use of newly developed construction method and prefabricated method as well.

Article 2-8. Computerization of design materials

Designs for electrical installation and designs for construction practices shall be made in parts, counting the levels of machine use.

Article 2-9. Construction steps

Practices of electrical construction and installation must be made in two steps:

Step 1: all construction structures relating to the later installation of electrical equipment must be finished.

Step 2:electrical equipment, shall be installed. The installation practices of electrical equipment must be made with construction methods approved by authorities.

Article 2-10. Assembling process

For construction structures of assembly, parts to be assembled shall have slots, gaps, hollows for junction boxes, and conductors in accordance with requirements of design materials.

Article 2-11. Accelerated adoption of prefabricated products (Conductors)

For installation of conductors (both close and open), the prefabricated methods shall be applied as much as possible in factories.

Article 2-12. Accelerated adoption of prefabricated products (large equipment)

All the production of large groups and bulks such as conductors, skipping bars, main bars, and distribution equipment shall be made in factories

Article 2-13. Adjustment of meters at each device

Tests to adjust every device's meters shall be done at the factories and in installation practices.

Article 2-14. Accelerated adoption of prefabricated products (Grounding equipment)

Grounding stakes and accessories of grounding systems shall be prefabricated in factories.

Article 2-15. Accelerated adoption of prefabricated products (Wooden poles)

Wooden pillars for conductor of overhead lines shall be prefabricated in factories

Section3 Preparations for construction and installation practices

1. Requirements for design materials

Article 2-16. Compliance with regulations

Design materials shall comply with state requirements in terms of designs and estimates of industrial structures

Article 2-17. Approval of design materials

The Owner shall apply to relevant agencies in charge of installation practices and receive approval for design material.

Article 2-18. Description of applied conditions to the design materials

Design materials for agencies in charge of installation practices shall have a clear note of applied conditions.

Article 2-19. Preparation of construction design materials

If the owners do not make construction design materials, they shall hire a consultant or other professional agency. Components and procedures of construction design materials as well as installation plans must be accomplished in accordance with present state requirements.

Article 2-20. Deadline of the construction-design-materials preparation

Consultants that make construction design materials are required to meet the deadlines of the installation practices. Industrialization and new techniques shall be applied at the highest level in order to successfully accomplish the duties, reduce required workers and save cost.

Article 2-21. Materials provided to contractors in charge of design

Before the construction and installation practices, the following manufacturer's design materials shall be provided to the contractors or sub-contractors, successful tenders,:

1. Profile for machines, accessories and meters of complete equipment.
2. Assembly drawings of electrical equipment and complete equipment, diagrams for principles and assembly.
3. List of all items (attached with equipment)
4. Manufacturers' manuals for methods of installation and start-up of electrical equipment. Manufacturers' certified documents of assembly, balance tests, initial run, and checking and taking over the equipment.
5. Profiles for practical and manufacture tolerances obtained by tests at testing blocks.

Article 2-22. Design materials translated into Vietnamese

Foreign manufacturer's design materials, if any, shall be translated into Vietnamese and the required number of these documents shall be handed over to successful tenderers.

2. Requirements of equipment supply

Article 2-23. Design materials acquisition from manufacture

The owners are required to ensure that contractors obtain design materials from manufacture.

Article 2-24. Pre-supply of electrical equipment, and required materials

In order to have pre-installation of electric supply systems, it is necessary to give priority to pre-supply of electrical equipment, and required materials.

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

Article 2-25. Acceptance procedure of electrical equipment

Procedures and conditions for acceptance, storage of electrical equipment, cable accessories, and materials in stores shall comply with manufacturers' requirements.

Article 2-26. Machines for loading and unloading

Empty and hermetic stores, platforms, grounds for equipment maintenance shall have machines to load, unload, and arrange the equipment.

Article 2-27. Compliance with regulations relative to acceptance

Upon the acceptance, equipment shall be checked in accordance with the regulation of Inspection.

Article 2-28. Marks and codes confirmation before assembly

Electrical equipment in stores shall be kept in safe places, which are convenient for transportation, and assembly. If marks and codes of components or group components are faded or disappeared, re-checking is required before assembly.

Article 2-29. Display of nameplates showing a name of components

At maintenance places, it is required to have plates to show names of group components of electrical equipment. If these places are outdoor places, these nameplates must be hung up on poles. For large and heavy equipment, its weight must be shown (in tons).

Article 2-30. Storage method (floor without tiles)

In empty ground or stores without tiles, electrical equipment must be placed on stands. Contacting with ground must be avoided.

Article 2-31. Countermeasure of water and humidity proof

In outdoor and semi-outdoor stores, equipment is arranged and protected to avoid water and humidity accumulation. Components, large and heavy equipment shall be arranged so that deformation is avoided. The equipment shall be fixed to prevent falling.

Article 2-32. Equipment protection in the stores

Electrical equipment must be kept in clean, dry, and well-ventilated stores. The equipment must be also protected from harmful gases and coal dust. Pillow blocks shall be protected from rust.

Article 2-33. Electro-static capacitors and oil impregnated paper capacitors kept in stores

Electro-static capacitors and oil impregnated paper capacitors shall be kept in dry stores with temperature below + 35^0 C. It is not allowed to place capacitors in stores affected by vibrations (for example, nearby working machines). When capacitors are kept in dry stores, they must be kept away from electric generators and shielded from direct light. Capacitors shall be erected. Porcelain insulator shall not be turned upside down. Heaping up the porcelain insulator shall be avoided.

Article 2-34. Battery storage

Electrode plates of lead batteries shall be wrapped and placed in dry stores. Alkali batteries shall be kept in dry and ventilated stores (where temperature change is not so much). It is required to separate lead batteries from alkali ones.

Article 2-35. Regular check of equipment.

For equipment which is kept in stores for a long period components of the equipment must be regularly checked, and opened for maintenance and lubrication in accordance with manufacturers' period of warranty and specifications.

Article 2-36. Responsibility of delivering agency

Incompleteness and damages in delivering shall be treated by the agency for delivering.

Article 2-37. Maintenance of overhead transmission lines

Steel structures of power overhead line poles, steel poles, reinforced concrete poles, and accessories must be well maintained and arranged according to types, locations and placed on platforms to prevent humidity.

Article 2-38. Categories of overhead transmission lines and each storage method

Forged materials, bolts and accessories of power overhead lines must be divided into categories and kept in stores. For the outdoor type, it is required to make certain that their drainage is good. Bolt-threads of bolts and forged items must be lubricated with industrial lubricant.

Article 2-39. Exclusion of defective components

Damaged components shall be separated to avoid any mistake on delivering.

Article 2-40. Categories of wires and insulators, and each storage method

Wires and insulators shall be divided in categories of codes and kept on the ground with good drainage systems.

Article 2-41. Cement storage method

Delivered cement must have its wrappings. Cement stores shall have roofs and floors. These floors shall be empty for ventilation. It is not allowed to place cements of different codes and lots together.

Article 2-42. The maintenance of explosive for construction

The maintenance of explosive and warhead for construction and installation guns shall comply with the rules of explosive maintenance and transportation.

Section4 Requirements of structures for installation of electrical equipment

Article 2-43. Temporary works for installation of electrical equipment

Before installation of electrical equipment on structures, the preparations on the construction sites are as followings:

1. Building fixed roads or temporary roads. The width of the branch roads and temporary roads shall be large enough for transporting electrical equipment (including oversize equipment), materials and components to installation sites and positions.
2. Building temporary structures, and tents for electrical installation process.
3. Installing fixed or temporary electric, water, and compressed air systems for electrical installation as well as equipment for connecting to working machines.
4. Building road for fire trucks, laying pipes and necessary equipment for firefighting.
5. Building ladders and scaffoldings at positions where cranes can not operate.
6. Making sure to have drinking water

Article 2-44. Prior work of Electric supply structures and cranes

Electric supply structures (substations, trenches, cables etc…) and cranes must be pre-installed before the other structures are built.

Article 2-45. A report for inspection and taking over

A report for checking and taking over the houses and structures from construction companies, contractors or sub-contractors, for electrical installation shall be made and comply with prescriptions in this standard.

Article 2-46. Completed structure

Checking and taking over complete structures shall satisfy approved design materials.

Article 2-47. Inspection items at checking and taking over

When checking and taking over the construction parts such as houses, machines foundations, equipment foundations, poles, beams and cable trenches etc. it is required to check dimensions of houses, bases, foundations, bolts etc. as well as quality of the construction and installation.

Article 2-48. Installation order for electrical equipment

Construction parts of rooms for pre-assembled distribution equipment, electrical panels, control rooms, cubicles, rooms for tunnel transformers and other electrical rooms must be done before the installation.

Construction works shall be done at the levels that are safe enough and convenient for other electrical equipment installations. During installation, it is required to protect electrical equipment from sun, rain, soaking water and dust in order to avoid damages from construction works in progress.

Article 2-49. Dimensions of troughs and holes

Dimensions of compartments with troughs and holes on the walls etc. for later installation shall comply with design materials (in groups or every component)

Article 2-50. Reinforced concrete structures

Before installation of assembled reinforced concrete structures for power overhead lines, it is required to have all technical data, documents for checking and taking over in accordance with design materials.

Article 2-51. Installation of electrical equipment for construction

When installing electrical equipment relating to the installation of other machines, it is required to install these machines along with the equipment with a suitable progress.

Article 2-52. Installation of electric wire

If the design materials includes doing works such as: boxes for laying pipes, holes, trenches, niches etc. for electric wire installation, electrical equipment including wires, and communication machines etc. all these works shall be done in construction.

Article 2-53. Inspection for electrical engineering work

Finished foundations for machine installation must be checked, and hand over. Engineering report relevant to the engineering work shall be submitted from the installation agencies and sub-contractors.

Section5 Mechanization and Automation of all electrical installation works

Article 2-54. Electrical equipment assembly

Assembly of groups, bulks from manufactories shall be operated on assembly stands.

Article 2-55. Worker for welding

Worker for weld of assembled floors, stands, and overhead equipment should be regulated.

Article 2-56. Busbars installation

Installations of busbars need using cranes with secure stands

Article 2-57. Overhead transmission lines construction without a crane

During overhead operations without a crane, it is required to have mobile floors with protective banisters.

Article 2-58. Installation of overhead transmission of has large cross section

When wires, especially of a large cross section, are pulled, it is needed to use specialized winches or machines.

Article 2-59. Relocation work of Large equipment

Moving large equipment of control rooms, boxes, and compartments of pre-installed distribution equipment needs specialized machines.

Article 2-60. Installations of electrical panels

Installations of electrical panels, and boxes need cranes, winches, tackle block …

Article 2-61. Loading and unloading of electric breaker machines and transformers

Loading, unloading, moving and maintaining oil-filled high tension insulators of electric breaker machines and transformers are accomplished in a way that insulators are always in the vertical direction.

Article 2-62. The installation of grounding systems

The installation of grounding systems needs using specialized machines and equipment for driving stakes. Spiral steel stakes are used in case deep grounding stakes are needed.

Article 2-63. Transportation method of transformers

For short ways, transformers of rated capacity up to 1000 kVA can be transported by trucks or specialized equipment such as sliding boards, trailers etc… along with pulling machines.

Article 2-64. Installation of electrical equipment

Usually, electrical machines need cranes or other lifting equipment for their installations. In some special cases, cranes can not be used; it is possible to use trailers and tractors.

Article 2-65. Loading and unloading of cable drums

Loading, unloading drums and laying cables need using specialized transporting vehicles. Cranes are used to load and unload cable drums.

Article 2-66. Cross point between cables and railways (highways)

When cable lines cross railways, or highways, it is necessary to use the method of subterranean dig or the machine of subterranean dig.

Article 2-67. Cable installation method

All the cable installations shall be mechanized. Wrapping with lead or aluminum requires using specialized equipment.

1. Pressing the ends, joined pipes needs using specialized equipment (pliers, hydraulic press etc…)

2. Specialized cable lock and winches are needed for passing cables through pipes.

3. Specialized saws and cutters are used to cut off wires and cables.

Article 2-68. Transmission lines installation by mechanized method

During installation of conductor lines, machines shall be used as much as possible for the works such as loading, unloading, working the soil, installations and other hard works

During installation of conductor lines, specialized assembly lines are used.

Article 2-69. Transportation method of reinforced concrete piles

When reinforced concrete piles are transported to installation locations of power overhead lines, it is required to use trucks with specialized trailers. Loading and unloading poles need using cranes.

Article 2-70. Establishment of pole foundations

When pole foundations are dug, it is necessary to use drills, excavators, and bulldozers. When foundation holes are filled up, it is necessary to use excavators or tractors with leveling systems but it is required to carefully ram.

Article 2-71. Heavy machinery used at stony place

During operation on locations with many stones, it is essential to use pneumatic hammers, drills, and mines etc.

Article 2-72. Pole installation work

When poles are erected, it is required to use machines. It is prohibited to tie cables to rods for lifting poles.

Article 2-73. Preventive method against falling down after pole installation

After poles are erected, terminal of stay shall be fastened appropriately to prevent falling down.

Article 2-74. Steel pole assembly

When steel poles are joined, it is required to use trucks with cranes.

Article 2-75. Installation of conductor and ground wire

It is essential to use trucks or winches to lay wires and anti-lightning wires.

Chapter 3 Installation of Power Distribution System and Substations

Section1 Installation of power distribution systems

Article 3-1. Scope of application

All the requirements in this chapter are applied to installation of indoor and outdoor electrical equipment for power distribution systems with voltage from 1000V to 500kV.

1. General requirements

Article 3-2. Fixation of equipment and busbars

Equipment and busbars shall be securely fixed with weld, bolts, compression, etc.

Article 3-3. Oil level and leakage

Oil in the equipment shall be filled up to the level as indicated by the manufacturer.

It is not allowed for oil to leak through welds, flanges, joint valves, taps, joints, oil indicators, etc.

2. Joining the busbars of the indoor distribution equipment

Article 3-4. Requirement for stretching of the busbars

The busbars shall be stretched, and shall not be warped. It is required to avoid cracking at location where busbars are bent.

Article 3-5. Fixation of the busbar in consideration of thermal contraction and expansion

The busbars will expand much along its axis according to temperature change, so it is required to fix the busbar on the insulator in consideration of this thermal contraction and expansion.

Article 3-6. Prohibition of forming a closed magnetic circuit around the busbars

All the fixtures of the busbars and their cramps shall not form a closed magnetic circuit around the busbars, so one of cramps or all the bolts on one side of the busbars must be made by non-magnetic materials (brass, aluminum and its alloy, etc.) or it is necessary to apply the type of fixing the busbars which does not form a closed magnetic circuit.

Article 3-7. Requirement for the joints of the busbars

Regarding the joints of busbars, it is required to have sufficient strength against vibration from the equipment connected, own gravity of the conductor, wind pressure, electromagnetic force generated between conductors at the time of short-circuit fault, etc.

The joints of busbars shall be used weld, bolts or compression joint.

The joints of busbars are required not to be greater in the resistance than the busbar.

3. The installation of busbars of the outdoor distribution equipment

Article 3-8. Permissible range of bending deflection

The bending deflection of the flexible busbars may be deviated ±5% from the design materials.

Article 3-9. Damage of the flexible busbars

On the whole length of the flexible busbars, it is not allowed to have any wrings, twists, chips, nicks or any damaged separated line.

Article 3-10. Jointing of the hard busbars in consideration of thermo-expansion

During joining the hard busbars with poles of the equipment, thermo-expansion shall be considered.

Article 3-11. Types of clamps and caps for the joints

When flexible busbars or their branches are jointed, and when they are jointed to poles of the equipment, types of clamps or caps shall be suitable with the line's cross sections and materials.

Article 3-12. Countermeasures against corrosion for the joints of busbars

When jointing busbars, it is necessary to take countermeasures against corrosion at the joints including the bolts, nuts, and washers in consideration of the environment. When jointing different metals, such as aluminum busbar and copper busbar, it is necessary to take countermeasures against electric corrosion at the joints.

4. Circuit breakers of the voltage 1000V or more and their transmission systems

Article 3-13. Inspection of circuit breakers

Circuit breakers shall be checked in accordance with the items of in progress inspection prescribed in the Technical Standard Vol. 5 Article 2-26, 2-28, and 2-19, and acceptance inspection in Vol. 5 Article 2-46 trough 2-51., .

Article 3-14. Adjustment for circuit breakers

During installation of circuit breakers, and their transmission systems, it is required to use a plumb to adjust. Axles of oil circuit breakers (three-vessel style) must be carefully checked.

Article 3-15. Transmission parts of circuit breakers

Transmission parts of circuit breakers (switch on, switch off, breaking, trip hook, etc.) and the structure of transmission parts (mobile contacts, cutting off springs, buffer components, etc.) must work smoothly, and must not be stuck, grated, uneven or unstable.

Article 3-16. Fixation of transmission system

Positions jointed by bolts of transmission system, structures of transmission system of mobile and fixed contact points of arc quenching component must be secured.

Article 3-17. Operation of transmission systems of circuit breakers

Structure for closing on shall be adjusted so that during the period of switching on, the mobile parts are not strongly hit. Pressing forces of transmission systems shall be securely kept.

During the period of switching on, electric transmission systems should stably work. Voltage in operation may go up or down. Also, components of compressed air transmission systems shall be stably kept while pressure of compressed air may go up or down.

5. Disconnector and its transmission system

Article 3-18. Operation of transmission systems of disconnectors

The transmission system of disconnectors and all other practical systems shall work smoothly and precisely. Disconnectors and accompanied equipments shall be fixed securely in accordance with article 3-2.

Article 3-19. Motion direction of the steering wheel of the transmission system

When operating the disconnector and the circuit breaker, the steering wheel of the transmission system (lever type) shall have a motion direction as shown on Table 3.19.1.

Table3.19.1 Motion direction of the steering wheel or the crank on the actuating system of the disconnector and circuit breakers

Operation	Direction of motion	
	Steering wheel	Cranck
Switching on	Clockwise	Going up or to the right
Switching off	Counterclockwise	Going down or to the left

Article 3-20. Actuating system of disconnector of three phases

Detent parts in the actuating system with the disconnector of three phases shall be operated smoothly, precisely and reliably. In the end positions, actuating system must stop automatically.

Article 3-21. Adjustment for contact of disconnector

The state of contact when the disconnector is closed shall be adjusted appropriately according to the manufacturer's manual.

Article 3-22. Angles of the contact of actuating systems

Angles of the contact of actuating systems for signaling and locking transmission, the position of a disconnector shall give the signal of cutting after the blade has passed 75% of its whole way and only give the signal of switch on when the blade has touched the fixed contact jaw.

Article 3-23. Interlock

It is necessary to interlock between disconnector and circuit breaker as well as between main blade and grounding blade of a disconnector.

6. Instrument transformers

Article 3-24. Secondary windings of current transformers and voltage transformers

Ends of wires unused for secondary windings in current transformers need to be short-circuited.

It any case, except cases indicated in designs, one terminal of the ends of the secondary windings in current transformers of the circuit with the voltage of at least 500 Volt as well as of voltage transformers shall be grounded.

Article 3-25. Installation of through type current transformers

Steel structures for installed through type current transformers shall not form closed magnetic circuits surrounding one or two phases.

7. Prefabricated distribution equipment and compact substations

Article 3-26. Requirement for boxe's doors

Boxes' doors shall operate smoothly and require locks. The revolving angle of doors shall be at least 90°.

Every compartment shall be stored enough keys for all boxes.

Article 3-27. Specifications of compact switchgear cubicle

The specifications of all equipments of compact switchgear cubicle shall comply with technical requirements and manufacturers' manual.

8. Painting and Markings

Article 3-28. Painting and markings

Painting shall be carried out appropriately for the purpose of corrosion prevention in consideration of the environment.

Warning signs shall be displayed at the dangerous place appropriately in consideration of safety.

Equipment number signs, color of phases, etc. shall be indicated appropriately in consideration of maintainability, operability, etc.

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

1. For indoor distribution equipment that uses three-phase alternating current
   (1) If the busbars are arranged in the vertical direction, the top one is the phase A, the middle one is B, and the underneath one is C
   (2) Branches of the main busbar: the left branch - A, the middle branch - B, the right branch- C (if the busbar is seen from the lobby. If three lobbies are available, it is necessary to stand in the middle lobby).
2. For outdoor distribution equipment that uses three - phase alternating current
   (1) The busbar near the transformer: the nearest bar - phase A, the middle one - phase B, the farthest one - phase C.
   (2) Branches of the main busbar system: the left one - phase A, the middle one - phase B, the right one - phase C (if the transformer's output end is seen from the distribution equipment).
3. For the direct current, notations for busbars shall be used as the followings:
   (1) The busbars are arranged in the vertical direction: the top bar is neutral, the middle one is negative bar (-), the beneath one is positive bar (+).
   (2) The busbars are arranged in horizontal direction: the farthest bar is neutral, the middle one is negative (-), and the closest one is positive (+) (if busbars are seen from the lobby).
   (3) Branches of the main busbar: the left branch (or left bar) is neutral, the middle one is negative (-), the right one is positive (+) (the busbars are seen from the lobby)

Section2 Transformers

Article 3-29. Scope of application

The requirements in this section are used for the installation of transformers (including autotransformers and oil-filled induction coils) with the voltage up to 220 Volts.

Article 3-30. Dryness of transformers

Whether the transformer is dried depends on the manufacturer's requirements and insulator standards of transformers.

Article 3-31. Arrangement of expansion compartment

The layout in the expansion compartment shall be arranged so that nearby cable ends, conductor bars, and equipment are not splashed with oil when a problem arises.

Article 3-32. Chocks for transformer's wheels

It is necessary to chock steadfastly all of the transformer's wheels.

Article 3-33. Painting and signing

Transformers and accompanied equipment shall be painted and signed in accordance with article 3-28.

Section3 GIS (Gas insulated switchgear)

Article 3-34. Scope of application

The requirements in this section shall be applied to all installation works of GIS.

Article 3-35. Condition of working area for assembling work of GIS

In order to prevent water condensation inside the equipment, infiltration of foreign substance into the equipment, etc., assembly work of GIS for outdoor substation shall not be carried out in the cases of rainy weather and strong wind.

But if a rain-cover and countermeasures against dust are set adequately in working area, and temperature and humidity are kept adequate with dry air, it is acceptable to carry out assembly work regardless of weather.

In addition, the conditions of working area for assembling work shall comply with the following.

1. Humidity is 80% or less
2. Dust is 20CPM or less
3. Wind velocity is 5m/s or less

Article 3-36. Countermeasures for working area against dust

During the assembly work, countermeasures against dust, such as dustproof partition, dustproof net, dustproof sheet, shall be taken sufficiently.

Article 3-37. Countermeasures for worker against dust

Worker shall wear dustproof uniform, cap, and shoes. They shall be non-conductive for preventing adhesion of metal fiber due to static electricity.

Article 3-38. Cleaning for the tank of GIS

Before starting assembly and connection work, besides cleaning the inside of the tank, the following points shall be checked:

1. Breakage in flange surface and spacer;
2. Drop-off of bolt and pin inside the tank;
3. Adhesion of foreign substance or stain to the conductor, protrusion on the conductor;
4. Scratch, peeling of plating, etc. on the contact;
5. Scratch on the surface where O-ring is fitted.

Article 3-39. Centering for connection of internal conductor

At the time of unit connection, centering shall be carried out so that internal conductor be connected appropriately without excessive load.

Article 3-40. Requirement for grease

Conductive grease shall be applied to the connecting part of conductors and, grease for seal shall be applied to the surface where O-ring is fitted, and airtight surface.

Article 3-41. Use of torque wrench

When tightening bolts, torque wrench shall be used.

Article 3-42. Requirement for absorbent

The duration of exposure of adsorbent to atmosphere (from the time the seal is broken until the time of producing vacuum) shall not exceed 30 minutes.

Whenever the tank is made vacuous or opened, absorbent shall be changed for new one before filling up SF_6 gas.

Article 3-43. Making vacuous in the tank

Before filling up SF_6 gas, the tank shall be fully made vacuous.

Article 3-44. SF6 gas analysis

One or two days after filling up of SF_6 gas, SF_6 gas analysis shall be carried out, and the measured value shall be checked to meet the standards shown below.

1. Moisture in gas;

   For the equipment which may not generate decomposed gas: not exceeding 500ppm

   For the equipment which may generate decomposed gas: not exceeding 150ppm

2. Purity of gas;

   97% and over

Article 3-45. SF6 gas leakage test

After filling up of SF_6 gas, SF_6 gas leakage test shall be carried out. Gas leakage shall be 1% or less per year. After checking gas leakage by implementation of airtight test, waterproofing processing shall be performed to the sealing parts.

Article 3-46. Operating of gas valves for extracting SF6 gas

When extracting SF_6 gas from the tank, gas valve shall be operated after confirming gas partition with gas distribution diagram so that the gas may not be extracted from the tank of unit other than the object unit.
At the end of the work, gas valves shall be checked to be in appropriate state according to the gas distribution diagram.

Article 3-47. Use of recovery equipment for extracting SF6 gas

When extracting SF_6 gas from the tank, gas recovery equipment shall be used, and the gas shall not be emitted outside. SF_6 gas pressure in each tank after extracting shall be 0.015MPa or less.

Article 3-48. Inspection of GIS

Every component of GIS shall be inspected according to the contents of in progress inspection prescribed in Vol.5 article 2-27, and completion inspection in Vol.5 article 2-46 through 2-51.

Section4 Panels and boxes

Article 3-49.Scope of application

The requirements in this section are used to fit the boxes and plates and accompanied equipment.

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

Article 3-50. Fixation of equipment and main pipes

Metal equipment, which is not insulated from the boxes or the plates used to fix equipment and the main pipes, is required to be connected to cubicle cover.

Article 3-51. Fitting of circuit breakers, self- recording meters and high sensitive relays

The circuit breakers, self-recording meters, and the high sensitive relays shall be put on the elastic mattress such as a 3-4 mm thick rubber mattress.

Article 3-52. Operation of blades of circuit breakers

The circuit breakers are required to be put in order to ensure that blades of them work smoothly and tightly.

Article 3-53. Protection for charged parts

When the electric equipment, clip used to connect wires, and the wires that have 380V/220V of voltage are located on the shelf next to the equipment with the voltage lower than 220V, it is required to protect all of the electrically charged parts to avoid anyone's touching. It is required to have warning of different colors.

Article 3-54. Fitting of switches

The fitting of switches, starters from conductor bars of the secondary circuit and groundings of the boxes and panels are required to follow the design specifications .

Article 3-55. Connection of the equipment and the busbars of the cubicle

The equipments and the busbar of the cubicle as well as the main conductors and the branch conductors shall be connected in accordance with Vol.7 article 3-7 and 3-12.

Article 3-56. Prevention of self-getting loose for the bolts

The bolts and the split screws used to fix of switchgear of the cubicle compartments are required to be measured to avoid the self-getting loose.

2. Painting and signing

Article 3-57.Painting and signing

The panels, boxes and accompanied equipment shall be painted and sighed in accordance with Vol.7 article 3-28.

Section5 Secondary circuits

Article 3-58. Scope of application

The requirements in this section are widely adapted for electric wire installation of the control circuits, measurement circuits, protection circuits, transmission, and signal circuits. This means the applications are for all of the secondary circuits that are put in the compartments of distribution equipment, control boxes and panels.

1. Electric wires

Article 3-59. Requirement for laying wires and cables

When the electric wires and passing cables are laid, it is required to meet the following requirements:

1. For the concrete walls or the stone walls, it is required to cover these wires and cables by the steel pipes or insulated pipes or pass the wires through the holes that are surrounded by an iron box.
2. For the metal box compartments, it is required to put the wires and cables in to the insulated pipes or brush-looked rods.
3. For the insulated box compartments, it is acceptable to put directly the wires and the cables on their surfaces.

Article 3-60. Connection of wires to the oil-filled equipment

The wires connecting to the oil-filled equipment (i.e. gas relays) are required to have an insulated layer that is not damaged by oil and to have a protection in order to avoid physical damages.

Article 3-61. Connection of multi copper core wires and cables to equipment

The multi copper core wires and cables connected to clips and to equipment shall have heads and rings secured . It is acceptable to curve the cables' beginnings into rings to weld.

Article 3-62. Extra length of wires

It is required to have an extra length of each wire or cable core so that it can be reconnected in case the wires are broken.

Article 3-63. Use of soft-copper core wires

In case of the wires passing through the doors or other opening-closing doors (box doors), it is required to use soft-copper core wires.

2. The rows of the clips for wire connection

Article 3-64. Withstand voltage of the clips for wire connection

The clips for wire connection of the distribution equipment must have the voltage of 1000V or above. The group of contacts of circuit breaker and disconnector shall be arranged so that the primary circuit will not be cut off during the maintenance time.

Article 3-65. Condition of the clips for wire connection

The clips for wire connection shall not be damaged, dusty or rusty, and shall be securely fixed. The rows of the clips for wire connection the box compartments of the distribution equipment are required to be covered by boxes.

3. Markings

Article 3-66. Cable splicing map

The wires of the secondary circuit shall be connected to the clip rows, to the contact points of meters, equipment in accordance with cable splicing map.

Article 3-67. Materials used at the ends of wires

The small plates at the ends of wires for notations and the pipe for covering the wire heads shall made be from the insulator materials.

Section6 Fixed battery system

Article 3-68. Scope of application

The requirements in this section are applied for the installation of sealed lead acid storage battery and sealed alkali battery.

1. The conductor bar system

Article 3-69. Materials of the conductor bars

The conducting bars made up of steel, copper or aluminum shall be used.

Article 3-70. Fixation of the conductor bars

The conductor bars shall be securely fixed with the pulleys or insulators.

Article 3-71. Connection of the conductor bars and batteries

The conductor bars, branches and cells of batteries shall be securely connected in accordance with article3-7 and 3-12

2. The installation of batteries

Article 3-72. Leak of electrolyte solution

The vessels of lead acid storage batteries and alkali storage batteries shall not leak electrolyte solution.

Article 3-73. Charging procedures for batteries

The charging procedures for the lead acid storage batteries and alkali storage batteries shall comply with the manufacturer's manuals. The batteries must not be overcharged.

3. Painting and marking

Article 3-74. Painting and marking

The batteries and accompanied equipments shall be painted and signed in accordance with article 3-28.

Section7 The capacitors to improve the coefficient

Article 3-75. Scope of application

The requirements in this section are applied for the installation of the oil paper insulated capacitor groups or each capacitor tank in order to improve the capacity coefficient of alternating current machines with the frequency of 50Hz and voltage up to 10kV.

Article 3-76. Grounding of capacitors

The grounding of the capacitors shall comply with the requirements in Chapter 5 of "Earthing System". As a special caution, each cover of the capacitors shall be grounded by connecting the cover to the stand for the capacitor or to the grounding line.

The grounding wires shall be arranged in a way that it is convenient to replace the capacitors during operation.

Article 3-77. Painting and marking

The capacitors shall be painted and signed in accordance with Vol.7 article 3-28.

Chapter 4 Electrical Lighting Equipment

Article 4-1 Scope of application

Installing electrical equipment for indoor and outdoor lighting systems shall be conformed to these technical standards.

Section1 General

Article 4-2. Terminal of cables and wires

Terminals of cables, and copper and aluminum-unit wires connected to equipment, cubicles, lamps, etc. must comply with rules given in this chapter and chapter 6(Methods for laying wires). Terminals of wires connected to equipment, cubicle and lamps shall have a short section available for reconnection in case wires are broken.

Article 4-3. Structure parts of lightning equipment

Structure parts of lighting equipment such as stands, hooks, boxes, rods as well as fixed components, etc must be plated or painted for rust prevention.

Section2 Lights

Article 4-4. Requirement for installation of lights

It is required to check installation of lights with wires and pre-determined heights given in the design materials
When installing lights in places where architectural structures exist with patterns and aesthetic decoration, etc, it is essential to comply with requirements given in the design materials
Lighting directions of lights must be downward if there are not particular requirements of the design materials.

Article 4-5. Strength of structures of equipment

Fixed structures of equipment must be computed to stand the weight of five times equipment's weight as well as to stand the suitable weight with a standing person on it to do installation and maintenance. For the stand or poles that hang up decorated chandelier, it is necessary to add the weight of 80 kilograms.

Article 4-6. Adjustment of light spots and angle

Each headlight must be adjusted its focus according to shapes of light spots on the vertical plate. If the vertical plate is not available, light spots' shapes are taken in horizontal plates in condition that light's body is sloped to the largest angle, then re-corrected sloping angle according to the design materials . Error of this angle shall not exceed 2 degrees. The headline shall be fixed firmly into revolving parts.

Article 4-7. Lights of hermitic types and dust prevent types

Types of lights such as hermitic types, dust prevent types and other similar types must have washers and stuffing up holes hermitically for passing wires through if lights do not have caps.

Article 4-8. Installation of lights in explosive room

Lights in explosive rooms must be installed securely with close washers. Bolts-nuts with thimble-bolt etc must be tightened. The places through which wires are passing must be stuffed hermitically and fixed suitably with light's structure.

Article 4-9. Connection of lights to wires in doors

When connecting lights with wires in houses, public houses, manufactories, it is essential to use coupling clips.

Article 4-10. Lights with neuter wires

If in grids that require earthing light's body with neuter wires; it must not be connected to phase wires. The stipulations are not for mobile belongings and table lamps (they shall be connected by male plugs).

For earthed neuter wires, earthing light's body is done as follows:

1. When wires are laid on the surface, the earthwires between lamps and neuter wires shall be flexible wires and the ground point shall be on the closest fixed post of the lamp.
2. When wires with insulating covers are laid in the steel duct fixed into light's body at the specialized part, light's body shall be connected with neuter wires at the light.

Article 4-11. Prevention of damage of wires

Points of wires shall be prevented, through which wires are passing, from damaging. Contact points of lamp socket must not be mechanically forced.

Article 4-12. Prohibition of connection of wires inside stands and ducts

Connection of wires inside stands or ducts used for lamp installations is prohibited. Wires with leaden covers must be fixed firmly on the wall or stands.

Article 4-13. Rods for hanging lamps

Rods for hanging lamps can be made up of steel ducts, which shall have a suitable width in order to bear mechanical forces and be fixed firmly into lamp's stands.

Article 4-14. Wires supplying for public lights

Wires supplying for public lights must be flexible wires with the cross section of 0.4 squares millimeter for indoor lights and 1 millimeter squares for outdoor lights.

Article 4-15. Insulation of wires supplying for lightning equipment

Wires supplying for lighting equipment must have insulation that can bear the alternating voltage of 500 volts and the direct voltage of 1000 volts.

Article 4-16. Wires used for local lightning equipment

Wires used for local lighting equipment shall be two flexible cooper wires with the smallest cross sections of 1 square millimeter when lights are placed in fixed structures. Also it is required to meet the following requirements:

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 8 millimeters. Holes could be out of shape locally within the diameter of at least 6 millimeters. 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 4-17. Use of hermetic washers

Holes through which the wires and cables are passing to lights and outdoor equipment must have hermetic washers.

Article 4-18. Lighting equipment on cranes

Lighting equipment on cranes as well as shaken equipment is required to be hung up by resilient parts.

Article 4-19.Safety measures in dangerous place

In places which have inflammable, explosive and dangerous materials (including indoor and outdoor), it is required to prevent people from touching carelessly with wires, lamp socket and light bulbs.

In housing, metal lights that are hung up on fixed metal hooks, are require to have insulating ring cushions.

Section3 Equipment of lighting systems

Article 4-20. Equipment for protection of the grids

Step-down voltage interrupting machines and control-button fuses shall be connected into the grids so that when unbinding the buttons, the other side of fuses or interrupting machine will be dead.

Article 4-21. Arrangement of switches

Point switches shall be placed in alleys to the house (inside or outside) but must be arranged so that they will not be hidden when opening doors. Switches placed in bath-rooms or toilets must be set up outside of the door.

Article 4-22. Installation of electricity meters

Electricity meters placed on boards or cubicles must be fixed securely. The height of the meters must follow standard designs.

Article 4-23. Laying wires on the surface of equipment

When wires are laid on the surface, equipment must be placed on the insulating plates whose thickness is at lease 10 millimeters in case the structures of equipment do not have the special supports for installing directly to the wall.

Section4 Distribution boards

Article 4-24. Requirement for installation of distribution boards

It is required to place the boards in steel cubicles that have steel doors or steel doors with joined glasses and locks; as well as have hermetic holes for passing wires. This requirement applies for following objects:

1. Boards that are placed in electric rooms and laboratory.
2. Boards that are placed in the height of above 2.5 meters (this excludes boards placed in elevators or houses).
3. Boards that are a part of steel cubicles.
4. Boards with the electricity meter placed in houses.
5. Boards that are placed in niches.

Article 4-25. Position of distribution boards

When boards are placed between current-carrying bare parts and non-current caring metal parts, it is required to make certain that the minimum distance is 20 millimeters computed by insulating faces; or 12 millimeters computed by gaps.

In connection diagrams, it is required to make certain that the distance of light bulbs and coupling points is large enough so that power is off in mobile parts of cut-out equipment when they are in the off position.

Article 4-26. Locations for connecting input and output to distribution boards

Contact points for connecting input and output to boards must be placed in the locations that are convenient for testing and maintenance. Boards with contact points placed in the back must be of hinge types or it must be guaranteed that the distance of the rear of board and the wall follows the requirements given in Table 4.26.1.

Table 4.26.1 The minimum distance from boards to wall

The dimension of boards in horizon, in millimeters	The minimum distance from the rear of boards to wall, in millimeters
400	200
500	300
800	400
1200	600

Article 4-27. Use of insulated bolted ducts

Holes through which wires are passing to steel cubicles and drawers with conductor materials shall have insulated bolted ducts.

Article 4-28. Painting and signing

Boards shall have notations indicating: signs, board's functions and signs of outputs. When there are different phases of electricity, it is required to have clear signs and different color paints for each phase.

Article 4-29. Equipment connected to distribution boards

Connecting equipment to boards shall be in accordance with the design materials. Load shall be equally distributed between phases.

Chapter 5 Earthing Systems

Article 5-1. Earthing requirement

When setting up the earthing systems for alternating and direct equipment, it is required to comply with stipulations given in this chapter.

Section1 General

Article 5-2. Earthing of equipment in case of insulator breakage

If insulators are broken, it is essential to earth metal parts of the equipment and other equipment that may carry current.

1. For alternating or direct voltage of above 500 volts in any case.
2. For alternating or direct voltage of above 42 volts in dangerous rooms as well as outdoor equipment.

Earthing alternating installation with the voltage up to 42 volts is not required, except the particular requirements.

Article 5-3. Explosive rooms and outdoor installation

In explosive rooms and outdoor installation, it is necessary to comply with additional requirements

1. Alternating installation with the voltage under 127 volts and the direct voltage under 220 volts must be earthed.
2. When earthing, it is essential to use bare wires or specially insulating covered wires for earth wires as well as neuter wires. Exploiting other structures such as pipes and leaden covers of cables etc is only considered as additional methods.
3. Main grounded lines must be coupled to earthed objects at least two points.

Article 5-4. Parts to be earthed

Parts that must be earthed are as follows:

1. Covers of electrical machines, transformer, equipment, lights, etc.
2. Mobile parts of electrical instruments.

3. Secondary wire's coils of measurement alternating machines.

4. Frames of distribution cubicles, control cubicles, boards and others.

5. Metal structures of transformer substations and outdoor distribution equipment, metal covers of cable cubicles, and cable's metal covers (including testing cables and wires), metal pipes on which wires are passed through and etc.

6. Blocking fences, nets or plates made of metal to protect conductor parts, girders, and beams, floors made up of metal and other parts that are electrified.

7. Metal and concrete reinforced poles of overhead lines. Earthing of structures shall be conformed by requirements of the design materials.

Article 5-5. Objects not needed to be earthed

Objects that do not need to be earthed are as follows:

1. Spare parts and equipment set up on wooden poles of overhead lines and on the wooden structures of outdoor transformer substations if protective requirements are not essential to prevent from exceeding the voltage of atmospheres. These substations are as follows:
   (1) Spare parts of hung insulators.
   (2) Insulating stands.
   (3) Stands, light's rod and lamp shades.
2. Equipment placed on metal structures that are earthed but their contact faces between equipment and these structures must be clean and not painted.
3. Covers of meters and relays etc set up on boards, cubicles, and the wall of distribution equipment.
4. Rails in electrical plants, substations and industrial manufactories.
5. Parts that are normally removed or opened in distribution cubicles, fences, cubicles, doors as well as metal frames etc, are already earthed.
6. Electrical instruments with duplicate insulation.

Article 5-6. Direct earthing of machine body

It is possible to replace earthing of each engine, and other equipment placed on main machines, by directly earthing the machine's body but it is required to make certain the good contact between equipment body and the base.

Article 5-7. Wire material and prohibition of consecutive earthing

Parts of installation that need to be earthed must use particular wires to connect with the main earthing system. It is prohibited to connect consecutively parts, which need to be earthed, to the earthing system by the common wire.

Article 5-8. Objects of earthing

When earthing, it is possible to adopt objects as earthing equipment such as:

1. Water pipes and other metal ducts that are installed underground, except liquid fuel pipes, explosive gas pipes.
2. Pipes for watering.
3. Metal structures of constructional works that are installed partly underground.
4. Metal blocking plates of irrigational works, etc.
5. Leaden cover of cables that are laid underground (except that aluminum covers of cables must be insulated from ground). In case that only cable's covers are objects for earthing, at least two cables are required.

Article 5-9. Natural earthing

Natural earthing devices must be connected with mainly earthing systems at more than two different points. This requirement is not applied for repeating earthing of neuter wires and cable's metal covers.

Article 5-10. Use of under-ground type earthing devices

Earthing devices of under-ground types should be used. These devices are made up during executing bases of civil and industrial construction works. This part shall be as the same as that of overhead lines.

Section2 Laying earthing wires

Article 5-11. Use of steel earthing

Wires for earthing shall be normally made up of steel. This requirement does not apply for mobile electrical tools or devices, lighting lines for 3-phase 4-wire systems as well as for the case that using steel is faced up with difficulties about the structures.

Earthwires made up of steel must have cross section larger than values given in Table 5.11.1

Using aluminum bare wires that are fixed in the ground for earthing devices or wires is prohibited.

Table 5.11.1 Minimum dimensions of metal earthing devices and earthwires

Index	Device	Dimension	Methods of laying wires		
			Indoor	Outdoor equipment	Underground
1	Round wires	Diameter in millimeter	10	10	12
2	Rectangular wires	Cross section in millimeter square	64	64	64
3	Angle steel	Thickness in millimeter	3	3	4
4	Steel ducts without wielding	Thickness of ducts	2.5	2.5	3.5
5	Steep ducts with light wall and wielding	Thickness	1.5	Not permitted	

Article 5-12. Cross sections of cooper and aluminum earthwires

In installation with the voltage under 1000 volts, cooper or aluminum earthwires must have their cross sections larger than the values given in the Table 5.12.1.

Table 5.12.1 Minimum cross section of cooper and aluminum earthwires of installation with the voltage under 1000 volts

Index	Wire	Cross section in millimeter squared	
		Cooper	Aluminum
1	Bare wires laid openly	4	6
2	Insulating wires	1.5	2.5
3	Units for earthing of multi-unit cables that have protective covers with phase wires.	1	1.5

Article 5-13. Eearthwires of mobile electrical tools

Earthwires of mobile electrical tools must be in the common cover with phase wires and have the same cross section as that of phase wires.

Units of wires and cables that are used for mobile tools must be wires that are flexible and have minimum cross section of 1.5 square millimeters.

Article 5-14. Protection of earthwires

Earthwires must be protected from mechanical and chemical influences. In locations where earthwires cross with cables, pipelines, rails and other places that can cause mechanical failures, it is all required to have protective methods.

Article 5-15. Earthwires in trough-wall

Earthwires in through-wall places must be located in niches, ducts or devices with hard covers.

Article 5-16. Coupling of earthwires

When coupling earthwires, it is essential to make certain that contact points are good. The best way is solid welding. The length of welding points must be double the width of rectangular typed cross section wires or six times the diameter of round wires.

Connecting neuter lines of circuits and overhead lines could be done in the same way as methods of connecting phase lines.

In rooms which are wet and have noxious (eroding) gases, connections of wires should be done by welding. In case welding is impossible, it could be done by using bolts. At that time, the contacts of wires and connecting locks must have protective covers.

Article 5-17. Connection of earthwires with long earthing devices

Connecting earthwires with long earthing devices (such as water pipeline) is done outdoor by welding. If welding could not be performed, it is possible to use collar. Contacting faces of collar with earthing devices must be tin-plated. Places of installing collar with pipe must be cleaned.

Connecting locations and methods must be selected so that when pipes are removed to be repaired, it still ensures necessary earthing resistances by using convenient methods. Water meters, valves, etc must have earthed sections.

Article 5-18. Bare earthwires

For bare earthwires that are exposed, they could be laid vertically, horizontally or paralleling with slope structures of rooms. For earthwires whose cross section is rectangular, it is essential to place flatten faces parallel with faces of the structures. On the wires' sections that are laid directly, it shall not be bended at zigzag places.

Article 5-19. Earthwires on concrete or brick plates

For earthwires that are laid on concrete or brick plates, it is required to fit tightly on stands (such as porcelain pulleys…) that are at least 5 millimeter far from the wall in wet rooms and 10 millimeter in rooms which have eroding gas. In dry rooms without eroding environment, it is possible to lay earthwires made of flatten steel on concrete or cast iron plates. To fix earthed bars, using nails with special guns will give high productivity.

In gutters, earthwires must be placed at least 50 millimeters far from the back of concrete plates. The distances between earthwire's stands in direct sections shall be 600-1000 millimeters.

Article 5-20. Wires intersecting with gutters

When wires that are laid openly indoor intersect with gutters (in the locations where mobile heavy weights pass by), wires must be protected securely from any mechanical damages.

Article 5-21. Wires in elastic slots

When wires are laid horizontally through elastic slots of phase, it is required to have elastic cushions respectively. Electrical conductance of these cushions must be equal with that of earthwire's section with the same length.

Article 5-22. Temporary connection with mobile earthwires

Plates or corners to connect temporarily with mobile earthwires must be cleaned and coated with varnish. These plates or corners must be welded with earthwires or earthed with metal structures of main bar systems on distribution cubicles, outdoor substations…

Article 5-23. Soil for filling up gutters

Soil used for filling up gutters with earthwires must not be mixed with stones or litters.

Article 5-24. Prohibition of use of water pipelines

It is prohibited to use water pipelines to feeding troughs and to milking equipment in livestock feeding camps for earthing.

Article 5-25. Use of welding

Coupling earthwires with earthed structures must be done by welding. But when connecting earthwires with covers of equipment, electrical machines, etc, it is possible to use weld or bolts to fit tightly. In the shaking places, it is required to have protective methods from the phenomenon of removing bolts by themselves at the contacts (using braking bolts-nuts or cushion rings…). When earthing, equipment shall be normally removed or placed on mobile parts by using flexible wires.

Article 5-26. Contacting faces of connecting places

Contacting faces of connecting places of earthwires and structures and equipment, etc must be cleaned and coated with light varnish coat.

This requirement must also be done with faces of equipment's cover, controlling rods, mobile parts and other parts of equipment, placed on steel structures, drawers, steel frames of distribution equipment, and stands, etc.

1. To avoid wastes, steel ducts to make manmade earthing should not be used but irregular steel ducts like washers. Angle or round steels should be used.
2. The minimum diameter of earthwires given in table 5-1 must also apply for neuter lines of the networks and these of overhead lines to be used for earthing. At that time the diameter of neuter lines with single wire must be the same as that of phase lines.

Section3 Earthing distribution equipment

Article 5-27. Ends of secondary coil of measurement transformer

Ends of secondary coil of measurement transformer that need to be earthed are coupled with bolts on machine's cover or earthed with coupling clips in accordance to the design materials.

Article 5-28. Earthing of impedance coil

When phases are arranged horizontally, impedance coils must be earthed by solidly connecting earthwires with bolts on insulating stands. When phases are arranged vertically, insulating stands of lower phases must be earthed. Earthwires that are made up of steel must not connected to form closed circuits around impedance coils.

Section4 Earthing power equipment

Article 5-29. Machines on sliding stands

When machines are placed on sliding stands, it is required to connect earthwires with these stands for earthing. Contacting faces between machine and stands must be conformed Article 5-26.

Article 5-30. Earthing of instrument machines

To earth instrument machines (main machines, etc), earthed wires or steel ducts must be connected with the cover. At that time, it is required to ensure the good energization between equipment's cover and instrument's cover, including duct's connection points.

Equipment placed on mobile parts of machines must be energized by using flexible cables earthed by a dedicated core in these cables.

It is possible to use rails and girders of cranes in factories as earthwires for equipment of cranes.

Article 5-31. Earthing of rail girder cranes

Rail girder cranes that are used for earthing equipment of crane indoor or outdoor must be firmly earthed with earthing systems in two points. In the connection points of crane's girders, it is essential to use flexible butt welding links to ensure short-circuitIn rooms which have non-conductive dusts (such as cements, ash, soil to make patterns etc), it is essential to place brushes in front of wheels of cranes to remove dusts out of rails before cranes is moving.

Article 5-32. Cable materials for earthing cranes

It is required to use cables prescribed in the design materials to supply electricity to these cranes.

Section5 Earthing in circuits and cable lines

Article 5-33. Earthing of metal covers

When earthing metal covers of cables, metal covers and steel bands are connected and then coupled with the cubicle's covers (cable funnels and couple boxes) by flexible cooper wires. It is not necessary to use earthwires whose conduction is larger than that of cable cover. But in any cases, it is required to ensure their cross sections are not smaller than 6 square millimeters and not larger than 25 square millimeters.

Article 5-34. Use of aluminum cover

In installation that exploits aluminum cover of 3-unit cables for neuter wires, it is required to obey requirements of installing neuter lines.

Article 5-35. Terminal with earthwires

Installing ends with earthwires must be done by pressing or welding.

Article 5-36. Earthing of flexible links

For earthing flexible links, one end must use a steel wire tied tightly with steel cover and bands, and then welding. The other end shall be connected by bolts to cables and metal structures that are earthed.

Connection points of links with aluminum covers of cables must be coated with asphalts or oil paints after welding. In the wet rooms and tunnels as well as gutters, welding points must be coated with hot bitumen. Cross sections of flexible links must be commensurate with those of earthwires of the installation.

Article 5-37. Use of steel conduits

Steel conduits through which wires are passing are used for earthing devices or to earth securely. When these conduits are laid openly, it is possible to use coupling conduits that are coated with lead or other structures with good contacts.

When these conduits are laid underground, only coupling conduits that are coated with lead shall be used. To ensure the electrical continuity of earthing circuits, following requirements must be satisfied:

1. In any case that wire passes through conduits and cases that there are earthed neutral grids but conduits are laid openly, it is required to weld additional points on sides of coupling conduits. It is possible to weld metal links that are conductible enough.

2. For connectors of conduits with boxes, instrument and equipment covers, it is required to use “couple bolts-nuts” for earthing or apply other methods to ensure good contacts or to connect with boxes (such as cubicles, covers) by weld metal links with enough conductance.

Article 5-38. Lighting grouped grids

In lighting grouped grids, using metal covers of wires passing through conduits or wire’s leaden covers for earthwires is prohibited.

In rooms which require the earthing of these covers, they must be earthed securely for their whole lengths. Sleeve and terminal boxes must be coupled with metal cover of pipes by welding or bolts.

Article 5-39. Earthing of metal or leaden covers

Metal cover of pipes, leaden cover of cables must be earthed with grouping, supplying or distribution cubicles by twisted cooper multi-unit wires whose cross section is 1.5-2.5 millimeter squared or by steel collar clipped tightly with earthed covers or butt welding into covers.

Article 5-40. Joint of earthwires with metal covers

For joint earthwires with metal covers of boxes, cubicles and boards, etc, they are required to be welded or fixed by bolts.

Section6 Methods of painting and marking

Article 5-41. Marking of earthwires

In places where earthwires are passing through into rooms, marking is required for easy differentiation.

Article 5-42. Openly laid earthwires

Earthwires laid openly, structures, wires as well as flatten steel bars of earthing grids must all be painted in black, except neuter lines.

Earthwires laid openly could be painted in other colors suitable to decorative colors of the wall but at least two black lines must be drawn 150 millimeters apart in places of joints and branch joints.

Article 5-43. Cleaning and painting of openly laid earthwires

Before installing bare earthed wires that are laid openly with fixed parts, wires must be cleaned and painted all sides. Joints are painted after welding is done.

In rooms which are wet and have eroding gases, it is essential to paint by mechanically protective types.

Article 5-44. Joints with mobile earthwires

In places jointing with mobile earthwires, it is required to mark by painting the wall with letters of “earthing” and earthing symbols.

Article 5-45. Underground earthing

It is not essential to paint earthing devices and wires that are laid underground. After checking and taking over, welding points must be coated every side with bitumen.

Chapter 6 Method of Laying Wires

Article 6-1. Scope of application

The requirements in this chapter shall be applied for installing power and lighting lines for the direct and alternating voltage up to 1000 volts indoor and outdoor by insulating wires and cables without steel covers and with small cross section. Bare lines must follow chapter 8 of these technical standards.

Section1 General

Article 6-2. Specifications of wires

Styles, cross section and types of wires shall be stipulated by the design materials in accordance to load and the locations.

Article 6-3. Insulation of cable joints

Joints and branching of wires and cables shall not bear mechanical pressures. Joints and branch joints of cable's core and wires must be insulated equivalent to insulation of intact places.

Article 6-4. Use of terminal and distribution boxes

It is required to use terminal and distribution boxes for joint as well as branch wires in hermitic boxes, in sleeves and flexible metal pipes when laid openly or underground.

Structures of terminal and distribution boxes must be suitable with methods of laying wires and environment. Internal boxes shall have lids. Conduits must be connected with branching wires by special clips with the insulating cover.

Article 6-5. Output of boxes

At the output of boxes, conduits, hard ducts and flexible metal pipes, wires must be protected from any damage. In the places where wires are cross over with elastic joints, it is required to use elastic materials' complement.

Article 6-6. Installation height

There are no requirements of the height of installation above the floor for insulated wires, wires in pipes with the insulated metal cover, wires and cables passed through steel pipes and flexible metal pipes, as well as flexible cables under heavy conditions. In the places where wires and cables may be damaged by mechanical forces, additional protective methods are required.

Article 6-7. Laying near high temperature pipes

When laying wires near high temperature pipes, wires and cables must be protected from heat or using suitable types of wires or cables.

Article 6-8. Terminal boxes set up vertically or upside down

When terminal boxes are set up vertically or upside down, it is required to fix tightly wires.

In rooms which need to be earthed, boxes and conduits must be laid to form an uninterrupted circuit for its whole length.

Article 6-9. Wires laid openly

Wires that are laid openly must be combined with the architecture of the houses to ensure the aestheticism.

Article 6-10. Wires in wet rooms

Length of wires placed on wet rooms (toilet, bathroom, etc) must be as small as possible. Wires should be laid outside of these rooms and lights should be placed near wires on the wall.

Article 6-11. Wires on flammable structures

Wires laid along the surface of structures that are flammables (gas lines, oven gas line etc) must not be hidden. When wires are laid openly on surfaces of gas lines or oven gas lines, etc, the temperature of surrounding air must not exceed 35 degrees.

Article 6-12. Direct sections of lines

On the direct sections of lines, clamps used for fixing wires, cables and pipes shall be placed equidistantly on the surfaces. On sections and ring places, clamps must be placed perpendicularly with lines.

Article 6-13. Use of metal hoops and clamps

When using metal hoops and clamps to fix wires, it is required to line insulating cushions.

Article 6-14. Use of nails

Nails, used for fixing wires into work's structures, shall be normally driven by using special guns or using other suitable methods. Nails must be selected and fixed on stand's surface according to manufacture's instructions.

Article 6-15. Use of metal clamps

All metal clamps used for fixing wires, cables and steel pipes must be coated with rusty protective paints.

Article 6-16. Underground wires

Wires laid underground must have a standby section of at least 50 millimeters near joints in tap boxes and near joints with lights, switches and sockets.

Article 6-17. Terminal boxes of underground wires

When wires are laid underground, terminal boxes and boxes with switches, sockets must be laid hidden in construction structures so that faces of boxes (faces of switches and sockets) must be placed level with those of the walls.

Article 6-18. Prefabricated building components

For prefabricated building components, formed from large plates and blocks of dwelling works made from factories and construction sites, it is essential to make conduits for placing wires, niches for switches, sockets and tap boxes and light bulbs suitable to these components.

Conduits and niches must be flat. The thickness of protective layers must be at lest 10 millimeters.

Section2 Laying wires on insulating stands

Article 6-19. Height of and distance between wires

The height of laying wire or the distance between insulated wires should be in compliance with design materials.

Article 6-20. Insulating bases, etc.

Insulating bases of curved types, stands with insulators must be fixed securely into main material of wall. Pulleys and insulators at corners must be placed far away from ceiling or wall in the distance of 1.5-2 times the

height of pulleys or insulators. Pulleys or insulators in pass-through places of the wall shall also follow above distances.

Article 6-21. Insulated 1-unit wires

Insulated 1-unit wires without protection must be tied tightly into pulleys or insulators by flexible steel wires. In wet rooms or outdoor, these steel wires must be coated by rust protective paints. Places where wires are tied must be bound by insulating bands for protection. It is possible to use rings or flexible plastic wires to tie un-protective wires with pulleys or insulators (except corners or terminals).

Places where wires are clipped tightly must be lined to prevent from damaging insulators.

Article 6-22. Placing on insulastors

Placing on insulators must be conformed to following requirements:

1. Intermediary insulation – laying wires on necks or tops of insulators.
2. Angle insulation: laying on necks of insulators.
3. Tightening terminal insulation: Using braking locks.

Stipulations for tap places must be done at pulleys or insulators.

Article 6-23. Insulated wires in corners, etc.

For insulated wires in corners, ends, branching girders, etc, it is essential to use cloth bands or ropes to tie wires to pulleys.

Article 6-24. Intersection with pipelines

When insulated wires are intersected with pipelines, the distances between them should be in compliance with design materials.

When intersecting with pipelines that have temperature higher than normal level, it is required to employ suitable methods for insulating.

Article 6-25. Wires passing through wall

When un-protective insulated wires passing through wall, it is necessary to place these wires in hard insulating pipes and be fixed. If indoor side is dry, it is possible to use insulating pipes. If it is wet, laying wires inside and outside must use funnels.

For wires through underground wall or wooden walls between dry rooms, it is possible to pass wires through insulating pipes with metal covers, metal pipes.

When un-protective insulating wires pass through dry rooms to other dry rooms, it is possible to pass all insulated wires through the same insulating pipes. In other cases (from dry places to wet places, etc), each wire must be passed through a dedicated insulating pipe. When wires are laid to wet places where temperature and humidity are different, it is required to coat closely in both sides by insulating plastics. When wires are passed from dry rooms to wet rooms or outdoor and coupling is required, it is essential to place the joints in dry place.

Article 6-26. Wires passing through different floors

When insulated wires and cables are passed through within different floors of buildings, it is required to have reserved pipes or holes in components to lay wires. Using entangled wires laid between two floors is prohibited.

Article 6-27. Wires laid through between two floors

When wires are laid through between two floors, it is possible to use insulating pipes placed under mortar layers of wall. Insulating pipes must be placed consecutively with lined conduits and laid till the surface.

Article 6-28. Entangled wires

For 2 or 3-core entangled wires, when these wires are laid circularly around dry rooms and blocked by obstacles, it is possible to pass wires through the same insulating pipes without splitting.

Article 6-29. Curving radius

Curving radius of un-protective insulated 1-unit wires must be at least three times the outer diameter of wires.

Section3 Suspended wires

Article 6-30. Special wires and cables

Special wires, cables as well as other wires shall be hung up to reinforced steel cables by special clips or suitable binding methods.

Article 6-31. Reinforced steel cables

Reinforced steel cables used for hanging up wires could be entangled with zinc-plated steel cores whose diameters are in compliance with design materials. Selection of reinforced cables used for suspending cables shall follow the requirements of the design materials .

Article 6-32. Suspending cables

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 2-3 millimeters for power lines and from 1.5 to 2 millimeters 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 earthwires is prohibited. It is essential to use a dedicated wire or a dedicated core of wires (or cables) to be the earthwire. All metal parts of suspended wires shall be as follows:

1. Open parts of steel cables.
2. Parts of tightening locks, ending tightening structures, clamps, etc must be coated by silicon oils.

Section4 Laying protective cables and rubber-insulated cables

Article 6-33. Distance between fixed points

In sections, distances between fixed points of protective wires and cables should be in compliance with design materials .

Article 6-34. Wires passing into terminal boxes or cable funnels

It is essential to use hooks to keep wires and cables in places through which wires are passing into terminal boxes or cable funnels and must be placed from 50 to 70 millimeters far from away their edges.

Distances from initial wire’s bending to the closest hooks must be from 10 to 15 millimeters.

Article 6-35. Horizontally laid wires

When wires or single cables are laid horizontally, intermediary fixed points could be done by using 1-handle clamps and their handles must be placed lower than wires or cables.

When wires or cables are laid vertically along wall, ceiling and corners, it is essential to use 2-handle clamps or flanges with buttons to keep wires.

Article 6-36. Wires with leaden covers

For wires with leaden covers, it is essential to stuff clamps with flexible material types. These stuffing plates must be jutted into two sides of clamps from 1.5 to 2 millimeters. Other cables do not need to be stuffed with any things.

Article 6-37. Bending radius

Bending radius of wires must be larger than manufacturer specification.

Article 6-38. Cables and wires laid through brick and concrete

When protective cables and insulating wires are laid through brick and concrete wall, they must be laid in metal conduits or insulating pipes in reversed holes with mortars.

It is possible to lay multi wires in the same circuit or many cables in the same pipes.

For insulated wires and rubber insulating conduits going through brick or concrete wall, both two ends, for passing wires, must have stuffed pipes.

Article 6-39. Wires passing through floors

When wires are passing through floors; it is required to pass them through pipes whose ends shall be 1.5 meters far from the end of floors. When going through the ceilings, lower ends of pipes must also be 1.5 meters far from floors. Sections, at which wires may be damaged, must be protected by suitable methods.

Article 6-40. Intersection of cables and wires

When two cables or wires intersect, one of them must be protected by:

1. Passing through insulating conduits.
2. Building gutters.
3. Laying in metal pipes.

Article 6-41. Joints of metal pipes

Joints of metal pipes must be faced to standing surface. When pipes are laid horizontally along the wall, joints must be faced down to avoid moisture.

Article 6-42. End splitting with metal covers

Splitting places of ends with metal covers must be bound at their outside in order to prevent insulators from damages. Wires with slippery material cover must have bands or ends to avoid slipping.

Article 6-43. Suitable types of paint

To avoid aging insulation of wires' cores with highly eroding, it is essential to use suitable types of paint. These requirements do not apply for wires' cores and cable laid into terminal boxes of electrical machines or closed instruments or dust- protective types or water resistance types.

Article 6-44. Use of quick-dry paint

Laying Cable on places, where paint or lime are new and wet, is prohibited. In case it is required to lay wires immediately, it is essential to coat quick-dry paint in advance.

Article 6-45. Coupling and branching

Coupling or branching cables and protective wires must be done in cubicles. When putting wires in cubicles and instruments as well as meters, it is necessary to pass wires through protective covers.

Article 6-46. Earthing of metal covers and cubicles

If metal covers of cables and wires as well as metal cubicles need to be earthed, it is possible to connect with the common earthed neuter lines but the consecutiveness of lines must be ensured.

All parts must be connected consecutively and painted on metal covers without any damage.

Section5 Open and underground layout of conductor

Article 6-47. Laying of flat wires indoor

It is possible to lay flat wires indoor except following cases;

1. Open layout:
   (1) In inflammable rooms
   (2) On upper ceiling.
2. Open and underground layout
   (1) In explosive rooms.
   (2) In specially wet rooms.
   (3) In rooms which have high eroding environment.
   (4) On wooden floors of kindergartens, hospitals, clubs, schools and dormitories.

(5) To supply electricity for suspended lighting equipment.

(6) On stages and audience's seats.

Article 6-48. Laying openly flat wires

It is possible to openly layout flat wires:

1. Directly on the wall, partitions, floors coated with dry plasters or wet mortar.
2. On the wall that are made up of uninflammable materials, partitions that are stuck by pasteboards (right on surface of boards).

Article 6-49. Lying flat wires under walls

Laying flat wires under the wall or partitions by granites or mortar shall normally conform with following conditions:

1. If walls or partitions are made up of uninflammable materials, it is essential to install wires in conduits with mortar or under wet mortar.
2. Shall be allowed in gutters and empty construction structures.
3. Shall be allowed in advance laid on prefabricated building components from manufactories.

Article 6-50. Underground layout of flat wires

Underground layout of flat wires must obey one of following methods:

1. Laying under mortar layers of the ceiling with uninflammable materials.
2. Laying in gaps between prefabricated concrete plates and coated with fine plastic outside.
3. Laying in reversed gutters in large reinforced concrete plates, and coated outside with fine plaster mortar.
4. Laying in walls and niches of reinforced concrete plates of the panel and in gutters between special plates of houses of larger-plate types.
5. In advance laying on prefabricated building components from manufactories (following special instructions).
6. Laying on dry floors, ceiling with uninflammable material of final floor (including basements), under sand-cement mortar or plaster with the thickness of 10 millimeters. In this case, if it is impossible to apply the requirements 1., 2., 3. , it is essential to use 2. and 5. For flat wires laid hidden in the ceiling, general requirements are to lay these wires in places which can prevent from mechanical damages.

Article 6-51. Flat wires insulated by plastics

For flat wires insulated by plastic that does not bear color (transparent – brown yellow), it is possible to lay underground.

Article 6-52. Laying wires underground

When laying wires underground, lines shall be selected as follows:

1. Normally, when laying horizontally along wall, it is essential to lay parallel with intersecting lines through wall and ceiling. Distances between wires and ceiling shall be 100 – 200 millimeters or between with edges, eaves or horizontal girders from 50 to 100 millimeters. Sockets must be placed horizontally.
2. When laying wires to lights, switches and sockets, it is essential to install wires vertically. In large-plate prefabricated houses, it is possible to install along available gutters.
3. When installing ceiling suspended wires (in mortar layer, gaps, empty layer of floors), it is possible to lay at minimum distances between tap boxes and lights.

Article 6-53. Laying wires over pipelines

When laying wires over-cross with solid fuel or gas pipelines, it is essential to install wires in the distances that is in compliance with design materials.

Article 6-54. Intersection of wires

Laying flat wires that intersect with each other is prohibited. If intersection of wires is necessary, intersected points must be reinforced by 3-4 layers of sticking plastic or rubber bands.

Article 6-55. Use of 3-core flat wires

When using 3-core flat wires in lighting networks, it is possible to use outer cores to be phase lines and the middle one to be the neuter line.

Article 6-56. Right angle bending

When bending to 90 degree angle on the wall or ceiling is necessary, it is essential to obey one of the following methods:

1. If bending along flat side to an angle of 90 degrees, it is not necessary to split insulating band, but contacts between cores must be avoided.
2. If bending along edge side, it is essential to split insulating bands and one core bound round inside.

3. If wires do not have insulating bands, they shall be bound along sides with suitable radius to prevent bends from breaking.

Article 6-57. Flat wires passing through partitions or floors

Flat wires openly passing through partitions, floors must be installed in insulating sleeve whose two ends must be stuffed with rubber or porcelain or plastic.

Article 6-58. Use of insulation sleeves and funnels

Only underground wires coming out from surfaces of floor or wall (such as connecting to lights, switches, etc) must pass through insulating sleeve or funnels.

Article 6-59. Joints and taps of flat wires

All joints or taps of flat wires must be welded or tied by using clips in tap boxes.

Tap boxes must be made up of insulating material or metal of insulating stuffs.

When wires are laid underground, tap parts of tap boxes and switches and sockets as well as lights in dry or moist rooms and branching boxes could be niches with caps in wall or existing floors.

When joining and branching underground flat wires, it is essential to leave standby sections of least 50 millimeters in length.

Article 6-60. Prohibition of suspension of light on flat wires

It is impossible to suspend light on flat wires.

Article 6-61. Metal boxes near wires

Metal boxes in places, through which wires are passing, must have insulating stuffing sleeves or enforcedly insulating bound by 3-4 layers of stick plastic or rubber bands.

Article 6-62. Connection of wire terminals

When connecting wires' terminal to sockets, switches, etc, it is required to split a necessary small section of insulating bands between cable's cores.

Article 6-63. Fixing flat wires laid open

Fixing flat wires laid open shall be carried on by following methods:

1. For wires with insulating bands, it could be done by using methods of sticking, or driving nails by using plastic or rubber clips.

2. For wires without insulating bands, it could be done by sticking and using clips.
3. Using metal wires to clamp and fit into stands.
4. Nails shall be used for driving on insulating bands of wires. It is required to select types of nails that have diameters of 1.4 – 1.8 millimeters and the length of 20-25 millimeters and cap's diameter of 3 millimeters. Nails must be driven in distances of 200-300 millimeters apart and in the middle of the bands.

Hammer for nailing must be small types. When driving nails, it is essential to use buffer to prevent hammer from smashing into wires.

In wet rooms, it is essential to use rubber or plastic buffers placed under nail's caps. When using clamps, distances between two clamps must be not exceeded 400 millimeters.

Article 6-64. Underground flat wires

When using underground flat wires, it is necessary to use fine plaster to fit wires temporarily before coating with mortar. In addition, it could use clamps or bands of insulating material (such as rubber, plastic, etc) to fix flat wires.

Article 6-65. Prohibition of use of nails

Using a nail to fix underground flat wires is prohibited.

Article 6-66. Transportation and storage of flat wires

When carrying and maintaining flat wires, it is required to prevent wires from mechanical damages or sunlight.

Section6 Underground wires in non-metal sleeves

Article 6-67. Prohibition of pipelines intersecting gas pipes, etc.

Pipelines in this case must not be coincided or intersected with gas pipes and burnt structure's surfaces.

Article 6-68. Pipelines on walls

Pipelines on the wall must be paralleled with architectural structures (door frames, edge, eaves, etc).

Article 6-69. Line's sections roundabout obstacles

Line's sections roundabout obstacles in horizontal sections must not be moistened.

Article 6-70. Wire sleeves installed on uninflammable walls

Wires' sleeves installed in uninflammable walls must be placed in conduits coated with mortar. It is essential to use fine plaster to fix wires temporarily in located points.

Article 6-71. Hot factories

Using non-metal pipes or metal-paper pipes under floors of hot factories such as casting, welding, forging, etc.

Article 6-72. Bitumen rubber pipes

When temperature of environment in lines' locations is higher than +35 degrees, using bitumen rubber pipes is prohibited.

Article 6-73. Bitumen rubber sleeves under floors

When using bitumen rubber sleeves under the floors, it is required to install sleeves under concrete mortar layers with the thickness of at least 50 millimeters, but not exceeding 400 millimeters.

Article 6-74. Use of metal sleeves

In places where bitumen rubber sleeves intersect with main paths in working shops, it is required to pass through metal sleeves. In case that concrete layers, which are above sleeves, are thicker than 100 millimeters, using metal sleeves is not required.

Article 6-75. Outlets of bitumen rubber sleeves from base, etc.

In the places where bitumen rubber sleeves come out from base, wall and floor, it is essential to use light metal sleeves for protective covers and sleeve's terminals must be stuffed closely. In the place where bitumen rubber sleeves come out from base and floors to be laid on uninflammable wall, these sleeves must be protected by steel or angle iron to the height of 1.5 meters.

Article 6-76. Jointing of sections of insulating pipes

Jointing insulating pipe's section with each other must use the same sleeve materials with sleeves and two sleeve's ends must be fit.

Article 6-77. Coupling of sections of bitumen rubber pipes

When coupling two bitumen rubber pipe sections, it is required to use sleeve with the same material and diameters larger than or equal to 100 millimeters. Sleeve can be made up of metal. Sleeves must be stuffed tightly and coiled tightly by steel wires.

Article 6-78. Use of light steel pipes

It is possible to use light steel pipes to joint bitumen rubber conduits. These joints with steel pipes must be stuffed the same as coupling by sleeve.

Article 6-79. Joints between metal and paper pipes

Joints between metal and paper pipes must be coupled by using special sleeves made up of thin pipe sections and placed on coupling boxes.

Article 6-80. Coupling and tap boxes

Branching and coupling wires in non-metal pipes and paper pipes must be done in coupling and tap boxes. Structures of above boxes must be suitable to laying methods and around environment.

Article 6-81. Use of medium hard conduits and bitumen rubber conduits

It is possible to install medium hard conduits and bitumen rubber conduits with wires on condition that wires could be replaced.

Article 6-82. Internal diameters of insulating pipes

Internal diameters of insulating pipes must be large enough to replace easily wires when necessary. These diameters must also be suitable to the number and diameters of wires as well as larger than 11 millimeters.

Article 6-83. Distance between boxes

To ensure that wires and pipes can be easily pulled and replaced, the distances between two coupling boxes must not exceed values given in design materials

Article 6-84. Distance between paper boxes

For paper pipes, the distances between two boxes must not exceed 9 meters.

Article 6-85. Radius of bending pipes

In case it is impossible to install joint boxes in sections with the length of less than 20 meters due to the structures of works (such as section in the middle of floors of elevators in large plate prefabricated buildings), radius of bending pipes could be 15 times outer diameter of pipes. The number of bends must not exceed 2. In addition, it is essential to choose pipes that are larger than distances between boxes satisfying stipulations given in Table 6.85.1

Table 6.85.1 Distance between boxes

Section between joint boxes	Distance between joint boxes (m)	
	Hard rubber pipes	Metal or rubber pipes
Straight	10	12
1 corner	7,5	8
2 corners	5	5
3 corners	5	3
4 corners	5	3

Article 6-86. Bending radius of medium hard rubber and bitumen rubber pipes

Bending radius of medium hard rubber and bitumen rubber pipes must not be smaller than 10 times internal diameters of pipes and 6 times for metal pipes.

Article 6-87. Places changing directions or lines and corners

It shall be avoided to bend metal-paper pipes, and fold up. Places changing directions or lines and corners need to be installed with coupling boxes or medium hard rubber pipes and other similar types.

Article 6-88. Protection of bends of medium hard pipes and bitumen rubber pipes

For medium hard pipes, bitumen rubber pipes, bends must be protected from breaking down by using 1.5 millimeter steel wires to coil outside with flange step of 8-10 millimeters.

Article 6-89. Insulating and metal-paper pipes with wires passing through wall and floor

Insulating and metal-paper pipes out of which insulated wires are passing through wall and floor must be solid and not be coupled. When laying pipes on surface coated mortar, it shall be avoided to use sleeve to joint insulating pipes in sections between two boxes.

Article 6-90. Stuffing sleeves and insulating funnels for pipe terminals

For pipes that are not made up of metal, and paper-metal pipes, when jointing pipes with boxes, cubicles, boards as well as protective boxes with conductor materials, terminals of pipes must have stuffing sleeve or insulating funnels.

Article 6-91. Insulating pipes not connected to boxes or instrument covers

When insulating pipes are not connected to boxes or instrument's covers, meters, pipe's terminals must have insulating stuffing sleeves or funnels.

Section7 Laying underground wires in glass pipes

Article 6-92. Glass pipes

Glass pipes must be designed according to standards for easily passing wires through when they are laid underground.

Article 6-93. Wires laid underground in glass pipes

Wires laid underground in glass pipes must satisfy requirements applied for lighting and power networks with the voltages of under 500 volts, and telephone and broadcasting networks. These wires could be laid under the wall or uninflammable floors, in rooms with preventing fire, including basement and other houses. It is possible to lay in basements of above mentioned buildings when their ceilings are made of uninflammable material.

Article 6-94. Laying wires in activity rooms and cultural houses

It is possible to lay wires according to requirements given in Article 6-104 in activity rooms, cultural houses with preventing fire and industrial factories without exposable and vibration effects of production equipment.

Article 6-95. Prohibition of laying wires

It is impossible to lay wires as given in 6-104 in places such as: any type of explosive rooms, special wet rooms, audient's seats (including stages) of theaters, exhibition halls, clubs, cultural clubs, etc, and dwellings in area where earthquake of above seven on the Richter scale may occur, area with risk of settlement.

Article 6-96. Prohibition of co-existence of high-current and low-current circuits

It is impossible to coincide wires of high current circuits with that of low current one (information) in the same pipes.

Article 6-97. Layout of pipes

Pipes shall be laid on floors by the shortest path, but they shall be laid vertically or horizontally on the wall. Pipes must be placed on stuffing plates that are within the length of pipes. The thickness of protective layers (concrete, cement, asphalt) over pipes must be at least 10 millimeters. When laying pipes on uninflammable stuffing plates on highest floor, the thickness must be at least 20 millimeters.

Article 6-98. Glass pipes installed in brick wall and concrete-cinder-plaster partition

When glass pipes installed in brick wall and concrete-cinder-plaster partition, it is necessary to place pipes in conduits coated with wet mortar. Then it is essential to pour plaster or cement over the whole length of pipes to level of surface of wall or partition. Conduits must have the depth of about 10 millimeters and 20 millimeters greater than outer diameter of laid pipes for basements or upper floors.

Article 6-99. Pipes laid parallel

Pipes laid parallel must be spaced at least 5 millimeter apart.

Article 6-100. Prohibition of laying glass pipes directly underground

It is impossible to lay glass pipes directly in the ground, under the base of the first floor or in basement if the buildings have basement.

Article 6-101. Conduits for main lines to elevator rooms

When laying conduits for main lines for supplying from input equipment to elevator's rooms, it is essential to lay these conduits on bases of the first floor or installed directly on enforced uninflammable walls.

Article 6-102. Use of prefabricated round glass conduits

In case where the direction of pipe needs being changed or sections should be circled around girders and posts, it is essential to use prefabricated round glass conduits. If these types are not available, it is possible to use supportive sleeves that are made up of firm material or other similar material.

Article 6-103. Joints of glass pipes

To joint glass pipes with each other or with other material pipes, it is required to use sleeves made up of medium firm rubbers, or to use plastic or metal sleeves. When jointing with metal pipes, it is essential to use metal sleeves.

Article 6-104. Terminal of glass pipes

In places where glass pipes are jointed with input or tap boxes as well as meters, boards, lights, switches as well as exposed sockets, terminals of pipes must be stuffed by rubber pipe sections. In places where pipes come out from niches of boards, terminals of pipes must have stuffing sleeves.

Article 6-105. Hooks for mounting lights

Hooks for mounting lights must be fixed independently into wall, not in relation to terminals of glass pipes and output wires.

Article 6-106. Glass pipes intersecting with elastic gaps

When glass pipes intersect with elastic gaps, it is essential to use transition sleeves made up of rubber or other similar flexible sleeves.

Section8 Open and underground layout of conductor in steel pipes with thin wall

Article 6-107. Steel pipes

Steel pipes (water pipeline, gas pipes) for laying conductors shall be only used in accordance with given range and design.

It is essential to file edges of pipes. Pipes must not be out of shape. If pipes have not had rust protective layers (plating layers), they should be cleaned and painted outer and internal sides. Pipes laid in concrete need to be painted inside only.

If pipes laid indoor are eroded, it is required to paint according to instructions.

Article 6-108. Pipe bending radius

When pipelines need to be branched, it is essential to bend the pipes and bend's radius must not smaller than 10 times pipe's diameters in following cases:

1. When laying pipes in concrete blocks (in particular case, bend's radius could be 6 times the diameter).
2. When wires with aluminum, leaden and plastic covers are laid in pipes, in any way of exposed or underground types, bend's radius must not smaller than 6 times diameter.
3. In other underground cases, with the condition that laying underground does not cause any special difficulty.
4. When wires with the diameter of above 3 feet are exposed, except cases given in b), bend's radii must not be smaller than 4 times diameters.
5. When laid wires are with the diameter up to 2 feet and ½, except cases given in b).

Article 6-109. Frames of pipes

Frames of pipes must not be out of shape or have edges.

Article 6-110. Fixed distances of pipes

Fixed distances of pipes when exposed must not exceed 2.5 meters for pipes with the diameter under ¾ feet; and 3 meters for pipes with diameter under 1 feet ½ ; as well as 4 meters for pipes with the diameter of above 2 feet.

Article 6-111. Fixing exposed steel pipes

Fixing exposed steel pipes could be done by using hooks, flange, etc, and water pipelines, gas pipe (without zinc-plate) or by welding into structure of rooms such as light's poles, etc but the pipes must be prevented from burning. It is essential to weld pipes before laying.

Article 6-112. Distances between tightening boxes

Distances between tightening boxes must not be larger than following values:

1. Not excess 1 in bend of 50 meters
2. Not excess 2 in bend of 40 meters
3. Not excess 3 in bend of 20 meters

Article 6-113. Pipes laid on base of technological equipment

Pipes laid on base of technological equipment must be fixed into stand structures or steel structures before pouring concrete.

Places where pipes come out of base to ground must be constructed according to the design materials to prevent pipes from breaking off when ground or base is sunk.

Article 6-114. Pipes intersecting with elastic gaps

In places where pipes intersect with elastic gaps, it is essential to lay pipes in special boxes with elastic parts or joint pipes with flexible elastic stuffing parts.

Article 6-115. Jointing pipes in dry rooms

Jointing pipes with each other in dry rooms with dusts (except explosive, inflammable or oil rooms, where water or emulsion could be fallen in pipes) could be done by using pipes, sleeves without hermitic stuff of joints.

Article 6-116. Jointing pipes in wet rooms, etc.

Jointing pipes in rooms which are explosive, inflammable and moist as well as fragile, and have steam, gas that may harm insulation of wires in places where water and emulsion may be fallen in pipes or equipment outdoor, must be done by using sleeves with bolting and hermitic stuff in joints. In dusty rooms, joints must be stuffed to protect dust.

Article 6-117. Jointing pipes in concrete

In any case of laying underground and in concrete, it is required to joint pipes by sleeves with bolts and to stuff closely in joints.

Article 6-118. Quality of bolts of pipe terminals

Quality of bolts of pipe's terminals must be ensured that tightening sleeves must be done normally. Sleeves must be tightened one out of two with each other. The length of cog's section must be equal to summation of that of sleeves and thickness of stopped bolts-nuts.

Article 6-119. Cleanliness and shape of terminal pipes

Terminals of pipes must be cleaned edge.

Article 6-120. Stuffing pipes

Stuffing pipes are required to prevent from damages before pulling wires in pipes.

Article 6-121. Ensuring of good contacts

Laying to boxes, cubicles, instruments and installation could be done by using proper methods to ensure the good contacts between them.

Article 6-122. Prohibition of pipe terminals

In places which are wet, hot, and dusty and eroding chemical etc, it shall be avoided to install terminal of pipes to instrument boxes etc. Using insulating plastic for hermetic stuff between pipes and wires is required.

Article 6-123. Wires laid in vertical pipes

Wires laid in vertical pipes must be fixed securely. Distances between fixed points of wires must not be larger than the regulation prescribed in design materials.

Article 6-124. Wires in same alternating circuits

Every wire in the same alternating circuits, including neuter lines must be laid in the same pipes.

In alternating circuits, it is possible to lay wires of the same phase in the common steel pipes if they are protected so that normal currents do not exceed 25 ampere.

Article 6-125. Use of steel pipes

This steel pipe types are only used in specific places in the design materials.

1. When open layout, it is not necessary to stuff closely joints of pipes and places where pipes are installed into coupling boxes for normal dry rooms.
2. Open and underground layout with hermitic stuff in joints and places where pipes are laid to niches in the wall, floor, or stuffing mortar layers or stuffing layers in bases and other structures of projects for normal rooms which are moist, hot, dusty, and inflammable. Particularly in normal rooms, it is possible to lay pipes in the ground.

It is impossible use these pipes in:

1. Rooms which are wet or specially wet.
2. Rooms which are explosive and have machines prone to erode.
3. Outdoor installation.

4. Outdoor underground.

Note: In explosive installation, it is possible to use steel pipes with thin wall, having thickness 0.5 millimeters smaller than that of normal pipes on condition that it is needed to use sleeves with bolts to joint pipes.

Article 6-126. Prohibition of welding

It is impossible to use welding to fix steel pipes with thin wall into metal structures.

Article 6-127. Use of standard sleeves with bolts

When joints do not need to be stuffed closely, it is essential to use standard sleeves with bolts.

Article 6-128. Earthing pipes with thin walls

When earthing pipes with thin wall or using them to be earthed devices, it is required to meet requirements of techniques given in chapter 5 (Earthing systems).

Section9 Wires bare and covered with the voltage less than 1000volts

Article 6-129. Permanent joints of wires

Joints of wires, without the need of opening or closing, are generally done by using methods of welding. At the joints by different metal, it is required to have the methods to prevent conductor parts from eroding.

Article 6-130. Gap between bare conductors and pipes

Indoors, the gap between parts of bare conductors and pipes must not be less than the regulation prescribed in design materials.

Article 6-131. Distances between conductor devices, etc.

The distances between the conductor devices of different phases or differences in the electrode conductors, and distances from those conductors to the walls and other earthed components must not be less than values given in Table 6-131.1.

Table 6.131.1 Minimum distances

Index	Item	The minimum distances (in millimeters)
1	Bare conductors	50
2	Conductors including many wires with the following distances between two fixed points.	
	Up to 2 meters	50
	From 2 meters to 4 meters	100
	From 4 meters to 6 meters	150
	Above 6 meters	200
3	Covered, dusty protected conductors	
	By insulating surface	20
	By the air	12
4	Water-splashed protected electrical conductors	
	By insulating surface	70
	By the air	50

Article 6-132. Conductors placed in the factories

The conductors placed in the factories, where people not in charge may approach, must be placed at the height of regulation prescribed in design materials. For indoor equipment in case of having protective layers there are not any stipulations when they are covered with insulating safety covers. The composition structures, which install the conductors, must be made of uninflammable materials.

Article 6-133. Instruments on supplying or distribution conductors

The instruments that are laid on supplying or distribution conductors must be placed next to tap points and ones where they can be approached to check and repair. They must be laid or covered in order to prevent workers from touching live parts carelessly.

If laying the instruments in high places causes difficulties for the operators, they can be laid on lower places.

In order to control switchgears that are laid too high compared with the height of people, it is necessary to have the appropriate equipment to operate. These instruments must have signs for indicating places of circuit breakers. These signs must be visible from the back.

Article 6-134. Covered conductors

Covered conductors must be laid or mounted at the same height. Posts and stands for conductors must be solid. The distances of fixed points of conductors must follow the instruction of design materials .

Section10 Terminals marking and jointing with insulators and cables

Article 6-135. Wires or cores made up of aluminum or copper

When connecting, tapping and making ends for wires or cores made up of aluminum or copper; the following methods can be used: welding, pressing, tin welding, and special clips.

Article 6-136. Insulating material for joints and taps

At joints or taps, wires must be wound by rubber insulating bands or plastic; they must be painted or coated with industrial vaselin before winding in moist rooms.

Article 6-137. Size of terminals and sleeves

Terminals, sleeves must be suitable to the cross section of wires.

Article 6-138. Size of terminal wing holes

Hole's diameter of terminal's wings must be appropriate for sleeve's diameter or pipe's section of terminals. Pressing bolts must be placed at middle of pipes and laid in front of terminals. It is required to check the depth of pressing in comparison with requirements of producers.

Article 6-139. Covering of traces of pressing terminals

In the wet environment, it is required to cover the traces by insulating bands after pressing terminals done.

Article 6-140. Cable funnels laid at the different heights

If the cable funnels are laid at different heights and oil could be leaked at terminals, terminals must be covered closely by winding the insulating bands round cable's cores and cylinder piece of terminals at the joints.

Article 6-141. Covering of hermitic connectors

It is required to use tin welding, or plastic or epoxy to cover hermitic connectors of the flat pressed sides of terminal's wings of pipe type, fixed with cable's cores by pressing.

Article 6-142. Use of aluminum welding and pressing

When coupling or branching by using 1-unit or multi-unit aluminum wires with cross section of 20 millimeter squared, it is required to use methods of aluminum welding or pressing.

Article 6-143. Welding of terminals of multi-aluminum cores

The welds that form terminals of multi-aluminum cores of wires or cables, shall be done so that all cores are covered by metal, but wire's bowel is not shrunk and there are not crack, melt, combustion in surface of wires. When welding, it is essential to use complement material. After welding is done, joints and terminals must be cleaned by alcohol (water shall be avoided) and coated with moist-protective plastic as well as wound by insulating bands. When making terminals for cable's cores, it is necessary to cover pipe parts of terminals and insulators of cores by insulating bands. Except contacts, terminals must be coated by plastic.

Article 6-144. Contacts between instruments and aluminum cores

If meters, instruments have points of contact or are connected to aluminum directly, it is possible to joint wire or aluminum-core cables with them solidly.

Article 6-145. Outdoor explosive equipment or inflammable rooms

In the outdoor explosive equipment, and explosive and inflammable rooms at all levels, connecting and making terminals of wire or aluminum-core cables must be done by welding or pressing (excluding the places where using aluminum-core cables is prohibited).

Article 6-146. Copper wires of small size

With the copper wires that have a section of less than 10 square millimeters, it is essential to couple them by using pressing methods with sleeve or thin sheet copper plates. In exception cases, it could be done by using brass plates. The height of the plates, number of layers, distance and height of pressing trace must be conformed to the instruction manual. It must not have gaps between copper plates and wires' cores in joints.

Article 6-147. Multi-unit copper wires of small size

When jointing multi-unit cooper wires with a cross section of up to 10 square millimeters and instruments, it is required to press a terminal or curve the wire's end into ear-ring forms.

Article 6-148. Copper wires of large size

For wires or copper core cables with the cross section of larger than 10 square millimeters, it is required to use step-pressing or continuous-pressing methods to joint and make the terminal. It can be done by using tin welding methods if necessary.

Section11 Laying wires in inflammable and explosive rooms

Article 6-149. Laying wires on explosive equipment

When laying wires on the explosive equipment, it is required to pass those though metal pipes and satisfy particular requirements:

There shall be at least five original bolts at the connection; the connection shall be filled up by cotton threads that are soaked with paint oil mixed with leaded powder. Welding is forbidden.

The tap boxes in rooms with levels must be anti-explode types and if in other levels, anti-explode or anti-dust types can be used.

There must be water-letting out points on sleeves. When passing wires, laid in sleeves, through covers of engines, instruments, meters, parts for connecting wires in and out to the explosive rooms, or installing wires from explosive rooms to others, it must be passed through inside pipes. The pipes must be chocked hermetically section by section. It is prohibited to exploit parts of linking sleeves to connect or tap wires

The rubber and the other materials used for chocking up hermetically or insulated must not be contacted with the liquid to prevent any damage.

Places through which wires are passing wall point must be chocked by uninflammable materials.

Article 6-150. Laying aluminum or copper bare conductors in explosive rooms

When laying the aluminum or copper bare conductors in the explosive rooms of level and inflammable rooms of all level, following requirements must be satisfied:

1. Joints of conductor bars without the need of disassembling must be welded.
2. Joints of busbar with instruments by bolts must be done securely and provided with countermeasures against natural disassembling itself
3. There shall be protective boxes and breathers with a diameter of at most 6 millimeter on the conductor bars.
4. In the explosive rooms, the protective boxes must be made up of metal and only opened by locks.
5. In the inflammable rooms, the protective boxes must be anti-dusty type.

Article 6-151. Coupling and tap boxes in inflammable house

The coupling and tap boxes that are laid in the inflammable house must be the anti dust type and made up of steel or durable materials, have the suitable dimensions for securely connecting and easily seen. If the box is made by steel, it must have internal insulating stuff layers. If it is made by plastic, it must be uninflammable plastic.

Article 6-152. Requirements for installing earthing systems

When installing earthing systems, it is required to apply requirements of earthing chapter (chapter 5).

Article 6-153. Wires laid underground in inflammable rooms

When wires are laid underground in the inflammable rooms where joints of wires with places without coupling boxes, it is required to connect through transitional boxes placed on the ceiling.

Section12 Painting and marking

Article 6-154. Rust protection

All metal parts must be protected against rusts, suitable to the environment conditions.

1. Indoors with the normal conditions, it can be painted by oil, asphalt.
2. Indoors with corrosive chemical environment, suitable paints must be used.
3. Outdoors, it must be painted by asphalt or equivalence

Article 6-155. Painting of exposed conductive parts

The protected exposed conductive parts must be painted except ones made up of wires.

This procedure shall comply with phase identification prescribed in the general provision in this standard.

All conductive parts of covered conductors must be painted in red color. In places where wires come out of boxes, it is essential to paint different phases in different colors over a section of least 0.3 meters long.
All boxes laid outdoors must be painted in grey color over the maximum electric current is less than 1500 amperes and in bright silver color if the electric current is greater than 1500 amperes.

Article 6-156. Numbering of pipes and cables

On the complex schemes, the pipes and wires must be numbered following the cable diary and, wires in the tap boxes and joints of instruments or equipment must be marked at the same time. Pipes shall be marked at the ends.

Article 6-157. Wires and cables in boxes or gutters

Wires and cables laid in the boxes or gutters shall be all marked.

Chapter 7 Underground Cable Lines

Article 7-1. Scope of application

The regulations in the Chapter are applicable for installation of underground power cables up to 500kV and testing cables. There are special norms for cables of special locations (subway, tunnel…).

Section1 General

Article 7-2. Compliance with design materials

Cable type, cross section area and number of cable's core, cable line route and installation method should be in compliance with design materials.

Article 7-3. Inspection of cable condition before installing cable

Before installing cable, conditions of cable winding on the roller should be checked. It is prohibited to install damaged cable.

Article 7-4. Inspection of cable lead cover

The lead cover of cable must not be cracked, scratched or sunken. In case treatment for those above-mentioned defects is necessary, thickness of cable's cover after treatment must not be smaller than the specified value by the manufacturer.

Article 7-5. Cable installation (Cable snake, Cable fixing, etc.)

The cable should be installed in order to avoid mechanical stretch or damage when it is put into operation.

1. Cable which installed on wall mounting shelf, floor… must be fixed at the ending points, bending point and connecting points. Cable must be fixed at either the center of the snake part or the end of the snake part.
   Cable fixing points should follow the design materials.
2. When the cable is vertically installed along the structure and wall, it must be fixed so that its self-weight will not cause any harms to the connecting point or cable cover.
3. Cable fixing condition defect might be a cause of harmful influence to cables. Therefore the necessary number of the fixing tool, i.e. cleats and bracket, and fixing condition must be checked when cable is installed.
4. There must be a pad for installation of the cable.
   If cable is installed at the places, where cable may be damaged due to reason caused by means of transport, heavy objects or human being, it should be protected at the height of 2m from the ground.
5. If the cable coming from cable tube into the house; tunnel… or go under floor, inside the wall, it should be put into pipe or specified component.
   When the cable installation is completed, waterproof attachment should be applied to prevent water from coming into the pits, manholes and so on.

Article 7-6. Cable fixing point

Cable fixing point must not be over 0.5m away from cable box and cable funnel.

Article 7-7. Protection for none-metal-cable-jacket cable

Uncovered cable should be protected so that heat radiation will not directly affect the cable.

Article 7-8. Compliance with the regulation of inner bending radius of the cable

Inner bending radius of the cable in comparison with the outer diameter must comply with inspection regulation.

Article 7-9. Appropriate pressure of cable insulated oil (Oil feeding system)

Oil feeding system supplies oil with cable system to keep appropriate pressure (more than atmosphere pressure and less than rated pressure) inside the cables. Neither void nor insulated oil ionization should occur.

Therefore oil-feeding tanks need enough capacity to be able to follow the variation of the oil volume due to change of conductor temperature by load fluctuation and due to the change of annual air temperature. Besides that, oil-feeding tanks need margin against oil leakage at failure.

The cable route should be designed to keep the oil presser in the proper range based on the mechanical strength of cable and its accessory. The allowable oil pressure is shown in the table 7.9.1

In case any change is necessary, such changes must be approved by the owner and in compliance with electric equipment norms.

Table 7.9.1 Maximum pressure of oil

Type of Cable	Maximum Oil Pressure	
	Normal State	Fault State (Short Term)
Lead Sheathed Cable	29.4Pa	58.9Pa
Aluminum Sheathed Cable	58.9Pa	107.9Pa

Article 7-10. Triple-core cable covered by aluminum with neutral conductor

Installation of cable head box, connection box, and distribution box of neuter working cable with triple-core and aluminum cover should be in accordance with particular regulations.

Then, the connection of cable-cover inside connection box, distribution box as well as connection of outside neuter wire with the cable-cover inside the connection box should be carried out by connector. The connector shall be made by flexible copper wire tightly urine-welded to cable-cover. The urine-welded area must be well insulated so that it will not be eroded.

Article 7-11. Cable trench cleaning before cable installation

Cable trenches shall be complete before cables are laid. The bottoms of cable trenches must be clean. The bottoms are also covered with a layer of soft soil. The pipes for passing through cables shall be placed at positions where cables intersect underground structures or routes (according to design materials). Tiles and protective plates must satisfy design materials requirements.

Article 7-12. Ancillary equipment for cable rooms and pits

Entrances of cable cellars and wells are required to have doors and locks. When cable cellars are designed, it is necessary to use underground items to install accessories of cable supports. It is required to use ladders and nets for preventing litters. Cable cellars and wells shall be able to be completely drained.

Before installing, agencies of installation and agencies in charge of delivery shall make a report for checking and taking over the equipment. The following works are needed:

1. Checking for laid pipes
2. Checking for connections of pipe, waterproof systems.
3. Pipes for passing through cables must be clean and dry. The ends of the pipes shall be slanting to avoid openings during connections.

Section2 Cable installation in canal

Article 7-13. Caution tapes laid above cable system

When the cable is installed directly in soil, the cable must be lined underneath and covered by fine and soft soil layer. There should be caution tapes on the every cable system to prevent cable system from outer damage like one caused by heavy machine.

Article 7-14. Cable installation in chemical erosion soil

Cable must not be installed in chemical erosion soil (salted soil, swamp, cinder soil, soil with rubbish…) and with electrical distribution current. In unavoidable cases, a lead or aluminum covered cable with protective plastic cover should be used. In case the protective plastic cover is not available, the cable should be put inside the insulation pipe.

Article 7-15. Compliance with cable installing route

Cable should be installed in designed line. There must be marking poles at the important junction points. As-built drawings should be done at the completion time.

Section3 Required dimensions for installation

Article 7-16. Depth of buried cable

The normal depth of installation for the cable up to 500KV shall be 0.7m. For installation crossing a road or square it shall be 1m.

Within 5m before coming into house, the allowable depth of cable installation shall be 0.5m. At the junction point, the depth shall be also the same level with the above but cable must be inserted into pipe.

When cable is installed along the house, the distance from cable to the house's foundation must be 0.6m.

Article 7-17. Clearance between cables (laid parallel)

When the cable is installed in parallel, the distance between 2 cables must be:

1. For testing cable: not applicable.
2. For power cables up to 10KV and power cable with testing cable: 100mm
3. For power cables of 10-35KV connected with each other or other cable: 250mm.
4. For power cables of more than 35kV, the distance prescribed in the design materials or guarantied by manufacturers shall be secured.
5. Between cables owned by different management organizations, between power cable and communication cable is 500mm

In case of narrow area and with agreement the management organizations, the standard at item (c), (e) can be reduced to 100mm, and in case of between power cable 10kV and communication cable to 250mm (except high-frequency communication cable), provided that there is flameproof protection when the power cable is partitioned (by cable insertion or with partition).

Article 7-18. Clearance between cable and trees

The clearance from trees in orchard must comply with design materials.

Article 7-19. Cable installation near electrical railways

When cables are installed near electrical railways, cable pipe should be insulated by cement etc.

Article 7- 20. Clearance between cable and other objects

The clearance between cable and other structure (railway ,motorway, tramlines, building, oil and gas pipe line etc.), must comply with design materials.

Article 7-21. Clearance between cables (Crossing each other)

When the cable lines intersect each other, the clearance between each cable must comply with design materials.

Article 7-22. Prohibition of installing cables in the same vertical plane

It is prohibited to install cable in parallel above or under a pipe in the same vertical plane

Section4 Cable installation inside culvert, canal and production area

Article 7-23. Cable installation in the culvert, canal and production area

For cable installation inside culvert, canal and production area, it is prohibited to use un-flatted cover. For exceptional cases, such kind of cable shall be used in wet condition, extremely wet area and with special environment condition, which may cause chemical erosion to cables metal cover.

Article 7-24. Clearance between cable shelves

Normally, on the vertical straight section, the distance between cable shelves shall be 0.8-1m or in accordance with design standard applicable to all kinds of cable.

Article 7-25. Cable installation on the shelf (None-steel-hoop cables)

For the cable without steel hoop, aluminum or lead covered, there must be soft pad when installed on the shelf.

Article 7-26. Clearance between cable and brick wall

If aluminum unarmored cable go along the brick wall with mortar plastering or concrete wall, there must be a gap between wall and cable. It is permitted to install the cable close to the wall in case the wall is oil painted.

Article 7-27. Cable installation inside foundation

When the cable is installed inside foundation or inlaid floor, the cable must be inserted into pipe or canal. It is prohibited to install cable directly into construction structures.

Article 7-28. Clearance between cable and floor

When the cable is installed on ground or un-plastering wooden structure, there must be a gap of at least 50mm at least between cable and floor. In compartments with wooden ceiling, cable without steel hoop must be inserted into pipe or box made by inflammable material.

Article 7-29. Notice points when cables go through wall

When the cable goes though wooden floor and wall, the cable must be inserted into pipe and the pipe head must expose at least 50mm at each side. The gap between cable and pipe must be tightly filled by inflammable material such as concrete, mortar. If the exposed section of the pipe is 100mm from wall or floor edge, it is not necessary to fill but the cable must not be close to the wall with distance of less than 50mm.

Article 7-30. Cable installation inside cable canal

Inside the cable canal, the cable must be placed on shelf. If depth of the canal is not over 0.5m, it is permitted to install cable on the canal bed.

1. If there are cable shelf on both sides of the pipe and canal, the testing cable and power cable under 1KV should be installed at one side and cable above 1KV at other side.
2. In-operation cable and redundant cable above 1KV for generator, transformer etc which supplying power for consumer class 1 should be installed on different 2 shelves.

Article 7-31. Clearance between cables when cables are installed on the canal bed

If all the cables are installed on canal bed, the distance between power cable group above 1KV and testing cable group must be 100mm at least or there must be an inflammable partition between them.

The minimum allowable distance between each cable is described in the below table:

Table 7.31.1 Minimum distance for cable installation

Item	Minimum distance for cable installation (mm)	
	- Inside pipe Similar cables in a system	- Inside cable canal
- Height	1800	Not applicable
Horizontal distance between two shelves when laying into 2 rows (there's a path in the middle) The distance from shelf to wall when arranged in 1 row (a path is arranged)	1000 900	100 300
+ For power cable, when the number of cable on shelf is from 2 to 4 and when cable voltage is: - Up to 10KV - 20-35KV - Over 35kV	 200 250 Necessary distance prescribed in the design materials or guarantied by manufacturers	 150 200
Distance between testing cable and communication cable	Not applicable	

Notes: The above distance is also applicable to cable installation inside cable pit.

Article 7-32. Prohibition of sand used as covering cables

It is prohibited to use sand for filling power cable line installed inside canal, except in explosive room.

Article 7-33. Cable layout (culvert, canal)

Cable installation inside culvert, canal as well as in other rooms must meet the following requirements:

1. Normally, testing cable must be installed under power cable. As for power cable under 1KV, it is permitted to install in similar level with testing cable.

Article 7-34. Dimension of the cable installation structure

Size of the cable installation structure, the structure's height, corridor's width and distance between cable and other structures must not be smaller than numeric value in the above Table 7.31.1. At narrow areas, it is permitted to reduce the corridor's width to 0.6m over a length of 0.5m.

Section5 Cable installation inside block and pipe

Article 7-35. Progress inspection for block and pipe

Before filling soil into cable-inserted block, it has to be carefully inspected.

At the inspection, the following should be checked:

1. Designed cable line
2. Depth of cable installation
3. Water-proofing work for cable
4. Distance between cable block surface and ground level

Article 7-36. Smoothness at the connecting points for blocks and pipes

At connection of blocks or connection between pipes, heads of pipe and block must be make smooth to avoid harm on cable when pull the cable or put cable into operation.

Article 7-37. Cable size limitation

The outer diameter of cable must be at least smaller than 85% of the inner diameter of the duct.

Article 7-38. Clearance between duct and other structures

When install cable-inserted pipe into ground, the distance between the cable-inserted pipe and other structure shall be similar to those when install cable directly into the ground

Article 7-39. Cable installation on the shelf in the cable pit

In cable pit, cable and cable box must be placed on shelf or platform

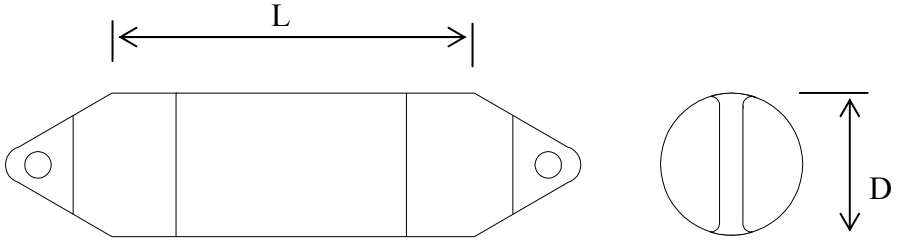
Article 7-40. Treatment of neutral line

Apply neuter baseline before inserting cable into block or pipe.

Article 7-41. Ducts inspection with mandrill before cable installation

Before new cables are installed, it should be confirmed that mandrill can pass through the ducts smoothly. The active length of mandrill, 600mm, is determined based on the condition that the minimum bending radius of ducts is 10m and allowable bended angle is 2 degrees. Therefore individual study is needed if ducts of smaller bending radius than 8m are adopted.

(Regular Size of Mandrill)



< Regular Size of Mandrill Depends on Duct Size>

Inner Size of Ducts (mm)	φ100	φ125	φ150	φ175	φ200
Outer Size of Mandrill: D(mm)	90	115	140	165	190
The Active Length of Mandrill: L (mm)	600	300	300	300	300

Article 7-42. Visual inspection with video camera

When mandrill does not pass through the ducts smoothly before the cable installation, visual inspection with video camera is essential to prevent new cables from damage due to duct defect. When huge water leakage from the ducts is detected, there is high possibility of duct defect. In this case, visual inspection with video camera shall be conducted. This inspection shall be conducted to prevent the second accident like cave of road near the duct defect. The purpose is duct defect detection and early restoration.

Section6 Cable installation at swamp, muddy region and under water

Article 7-43. Cable installation in the alluvial sand

When the cable intersects streamline, alluvial sand, and water gutter… the cable must be inserted into pipes.

Article 7-44. Cleaning of bed of canal and river before cable installation

Bed of canal, river... where the cable shall be installed, must be smooth, without any sharp place, which may cause damage to cable or cause mechanical force on cable. If there is any obstacle (carved stone etc….) the cable line must go around, clearance of obstacle or install the cable though it.

Article 7-45. Intersection of cable and river

When the cable line intersects river, canal etc. the cable must be installed as follows:

1. Minimum clearance of 0.8m for inshore and water shallow area.
2. Minimum clearance of 0.5m for the area with frequent ship traffic
3. At area with frequent ship traffic, where the riverbed is frequently dredged, the depth of cable installation must be agreed by functional waterway management agency. The distance between 2 cables installed at riverbed must not be smaller than 0.25m.

Article 7-46. Necessary cable length

The distance between cable lines must not be smaller than 10% of the river's width and not smaller than 20m. At the place where cable coming out from water, the cable must be installed deep into the ground or inserted into pipe for protection.

Article 7-47. Cable protection at bank of river

At bank of streamline, river where collapse often happened, cable protection method by construction of stone embankment, small surrounding dike, and stake… is necessary.

Article 7-48. Prohibition of cable intersection in the water

It is prohibited for cables to intersect each other under the water.

Article 7-49. Compliance with regulations of waterway transportation

At intersection points between cable and river, canal there must be notice sign in accordance with regulations of waterway transportation.

Section7 Cable connection and cable head making

Article 7-50. Cable head of oil soaked paper insulated cable

Head of cable insulated by paper soaked in oil, voltage up to 10KV can be made without using cable funnel (insert cable core through lead, rubber, plastic pipe…) and can use corrugated iron (steel).

In necessary cases, if the design requires, use special cable box made by cast iron, non-ferrous metals with insulator (porcelain).

Article 7-51. Joint of cable with lead or aluminum jacket

For cable with voltage from 3KV up with lead or aluminum cover, it is necessary to use connection box made by epoxies, lead, copper or bronze.

For cable with voltage less than 1KV with lead or aluminum cover, in case of direct installation in the ground, it is permitted to use cast iron connection box. For uncovered cable installation, it is permitted to use epoxide or lead connection box.

Article 7-52. Distance between edge of joint and cable

If there is a joint on cable which directly installed in the ground, the distance between edge of connection box and the cable must be 250mm at least. If the above distance is not guaranteed, there must be several protection methods applicable for connection boxes close to other cables (brick laying, installing the cable connection box deeper).

The connection box must be installed so that the cable core will not cause mechanical stretch to the connection pipe and damage to the joint (by sand filling, balancing stretch force)

Connection box placed at locations where cable lines installed vertically or at canal with water erosion is prohibited. When installation at such location is really necessary, a horizontal plane must be made for the connection box.

Article 7-53. Place for cable joints

Connection of cable in blocks must be carried out in the connection box inside cable pit.

Article 7-54. Cable joint method

For cable with voltage from 2KV up, with rubber covered and inserted into soft rubber pipe, the connection must be made by heat vulcanization, then added coating damp-proof bitumen.

Article 7-55. Temperature tolerance of bitumen or pine resin

Temperature of cable with bitumen or pine resin when pouring into cable box must not exceed below numeric value:

1. 190^{o} C for cable insulated by paper
2. 110^{o} C for cable insulated by rubber

3. 130^{o} C for cable insulated by plastic.

For cable box with porcelain, temperature of pouring bitumen must not exceed 130^{o} –140^{o}C. Before pouring, cable box and porcelain must be heated until 60^{o}C.

Article 7-56. Cable head of rubber insulated cable

Head of cable insulated by rubber can be made by steel or plastic funnel filled with paraffin. Dry cable head wrapped by plastic or fabric tape can be used for indoor cable head.

Article 7-57. Joint of rubber insulated cable

Connection, distribution of cable insulated by rubber must use connection box made by lead or cast iron filled with paraffin.

In case of indoor installation, it is permitted that dry junction is made by electrical insulation tape, then painted. Connection box is not required if there is no risk of mechanical damage.

Article 7-58. Cable head of paper insulated cable

For cable core insulated by paper, ends of funnel must be wrapped by plastic tape or damp-proof painted fabric tape or vulcanized rubber pipe or light and heat resistance plastic pipe.

Article 7-59. End wrapping of cable head (rubber insulated cable)

For cable core insulated by rubber, the same method of end wrapping is applicable.

Section8 Cable installation in explosive room and explosive outdoors equipment

Article 7-60. Scope of application

Requirements in this article are applicable for installation of all types of unidirectional and alternating current power cable in explosive room and explosive outdoor installations.

Article 7-61. Prohibited places for cable joints setup

It is prohibited to place cable connection box and branch distribution box in explosive room, near technology equipment of explosive outdoors installation.

Article 7-62. Clearance between cable and other equipment

Cable must be installed far away from valves; condenser and other equipment in accordance with design materials instruction but should not smaller than 100mm.

It is prohibited to cover cable with flammable material (jute, bitumen etc.)

Article 7-63. Intersection between cable and corrosive chemical pipe

At intersection between cable and corrosive chemical pipe, the cable must be inserted into steel pipe and tightly fixed.

Article 7-64. Treatment at hole that cable path

Hole in floor to insert the cable and pipe must be filled with inflammable material.

Article 7-65. Cable installation in explosive room

In rooms where gas and hot air with specific weight 0.8 higher than air, cable canal must be filled with sand.

If cable is installed in a canal close to the wall of explosive room, it is requested to fill the canal with sand over the length of 1.5m from the point where cable inserted into canal.

Article 7-66. Approach to erosive chemical material

For part where cable goes from component of the house to static equipment where during its operation erosive chemical can touch the cable, uninflammable materials must cover part of cable. Size of that cover box must be suitable to any changing of cable part leading to equipment and easy connection for the part leading to the wall.

Article 7-67. Use of cable joints

Where cable entering electric equipment, electrical instrument, it is required to use cable connection box, firmly chocked. It is not necessary to fill the gap between the cable and the box.

Article 7-68. Use of cable pit in explosive rooms

In rooms for high capacity machine without entering box can use cable funnel or dry pit for cable inserting which is put into dust resistance box placed at a location where only authorized person can reach.

Article 7-69. Cable installation in explosive rooms

For outdoors installation, where cable-inserted steel pipe and steel fastening belt placed on the same connector with other technology pipe, the following cases are permitted:

1. Installation on the same side with inflammable technology pipe.
2. Installation under pipes of gas or hot air with specific weight under 0.8.
3. Installation above pipes of gas or hot air with specific weight over 0.8.

Section9 Painting and marking

Article 7-70. Painting for cables and ancillary equipment

When install unexposed cable with lead or aluminum cover, without steel fastening belt or with steel fastening belt but without cover, all cable structure, cable box and cable funnel must be painted with:

1. Oil or bitumen paint when install indoor in normal environment conditions.
2. Proper paint with chemical impact resistance when install indoors with aluminum, lead, steel erosive environment.
3. Bitumen or similar material when install outdoors.

Cable connection box and other structures of cable chocking in the ground or under water must be coated with bitumen or hot bitumen.

Article 7-71. Display of cable information

Each power cable from 2KV up should have its number sign or name. For cable lines with many parallel cables, each cable should have the same number sign but different supplemental notation such as A, B, C etc.

Uncovered cables and all cable boxes, cable funnel must have small sign clearly mentionihg: voltage, section, number sign or name.

As for connection box and funnel, the sign must clearly mention: number sign, date of execution, and name of maker.

As for pit for cable inserting, the sign must mention: number sign, sign of beginning and ending of cable. The sign must be durable in the surrounding environment.

Article 7-72. Display of cable information in the canal, culvert and inside the house

The sign of cable installed inside canal, culvert underground or indoor must be installed at the place where the cable changes its direction, on both sides where the cable goes though floor, wall, where the cable entering the canal, at cable pit, on connection box, cable funnel etc.

The sign must be made of following materials:

1. Plastic, aluminum, painted corrugated iron if installed in house with conditioned environment.
2. Plastic, aluminum or carefully painted with corrugated iron if installed in a wet house or outdoors.
3. Plastic if installed in steel erosion characteristic house and in the ground.

Numeral on the sign shall be written by good paint in the normal condition or cast in special condition.

Article 7-73. Fixing plate with cable information

The sign must be tied to galvanized wire with diameter from 1 to 2mm except for special cases where particular regulation is applicable.

Steel wire tie must be tightened and then coated with anti-rust bitumen.

Article 7-74. Protection of plate with cable information

The sign of cable and connection box installed in the ground must be wrapped with 2-3 layers of plastic tapes to avoid damage.

Chapter 8 Overhead Power Transmission Lines

Section1 General

Article 8-1. Norm for installation of overhead transmission lines

For installation of overhead power transmission lines, this norm and also related norms shall be strictly observed. Electrifying traffic network and other type of specialized power network must be in compliance with norms stipulated separately.

Article 8-2. Implementation of installation

Installation of overhead power transmission lines should be carried out in accordance with design materials; state construction standards, norms on electrical equipment, norms on technology and safety.

Any variation works other than design, specified cases shall be subject to consent of the owner.

Article 8-3. Principal works

For a effective implementation of principal works of overhead power transmission lines the following requirements shall be observed:

1. To set up execution plan
2. To proper prepare materials, technology and manpower
3. To prepare appropriate execution organization.

Article 8-4. Arrangement of execution schedule

Arrangement of execution schedule for overhead power transmission lines shall include the contents concerning to management of execution schedule, quality and safety.

Article 8-5. Adoption of standard methods of construction

For the installation of overhead power transmission lines with voltage 35 KV without complicated technical characteristic, a simpler execution method shall be applicable but all necessary dossiers for the execution should be prepared for an effective performance. As for the lines with voltage 110kV and over, the methods of

construction shall be considered from the aspect of site and cost condition comprehensively including the methods stipulated in this chapter.

Article 8-6. Preparation at the onset of works

The owner should provide to construction and installation unit the followings dossiers:

1. Approved design materials (including design and execution schedule)
2. Land using permit
3. Other legal dossiers with approval of project relevant functional authorities.
4. The land area requisition for the execution on site.
5. Permit relating to work that needs cutting trees on the area.

Article 8-7. Hand over centerline and benchmarks of overhead transmission line

The owner should make constructor to submit report concerning centerline and benchmarks of overhead power transmission lines not less than 1 month prior to commencement. The owner shall check site clearance and definition of foundation based on the report.

Article 8-8. Checking for concrete pole and pier

It should be checked if concrete pole, pier and reinforced piles satisfie the required specifications based on manufacture or purchase specification, or data documents in factory.

Article 8-9. Anti-rust

All metal accessories of wooden poles and reinforced concrete poles should be painted or galvanized to anti-rust in accordance with design materials.

Article 8-10. Re-bar structure

The fabrication and installation of re-bar structure shall be in compliance with design materials by proper procedure.

Article 8-11. Acceptance inspection of insulators and wiring accessories

Upon receiving insulators and wiring accessories, it should be checked it satisfy required specification by exterior inspection or document inspection based on purchase specification, manufacture specification, or quality-testing dossiers for each lot of insulators, which is issued by manufacturer.

Article 8-12. Stockyard for material of structure

All structure of steel pole, reinforced concrete poles, foundation piers, reinforced concrete piles for foundation gathering at stockyards must be in good quality maintenance method.

Article 8-13. Procedure of overhead line crossing over

When the execution is carried out at the location as: nearby running power network, crossing river, crossing power and communication cable, crossing railways network, crossing roadway etc. work schedule, security plan and related documents shall be submitted to the agencies concerned.

Section2 Foundation works

Article 8-14. Implementation of excavation work

Excavation work of foundation should be done in compliance with regulation on excavation and technology outline setting up on execution schedule. Prior to excavation, the foundation location should be exactly defined.

Article 8-15. Checking of foundation bottom

Foundation bottom after being excavated should be cleaned; leveled and proper elevation of foundation bottom comparing with axis of pole should be checked. It is necessary to adjust foundation bottom by soil straight cutting method aiming not to affect to natural structure of foundation bottom. It is allowable to embank foundation bottom in case the difference with the design is less than 100 mm and then well compacted.

Article 8-16. The error of slope

Foundation bottom for tensile poles should be cleaned and leveled in accordance with design materials. The error of slope is not allowed over 10%.

Article 8-17. Excavation by drill

The cylinder shaped foundation uses for concrete centrifugal poles, which directly erect should be excavated by driller; in case of manual excavation, the foundation dimensions and strengthening method should be in compliance with design materials.

Article 8-18. Application for exploding

The performance of the above mentioned mine exploding method should be subject to approval of and under strict supervision of relevant agencies.

Article 8-19. Method for exploding work

It is allowable to do finishing works for foundation at the location with mixture of stone and soil by mine exploding method; safety limitation of the exploding area shall be in accordance with norms on mine exploding safety.

Article 8-20. Qualification for exploding work

Mine exploding workers should get through technical test and qualified.

Article 8-21. Limitation of exploding working time

The mine exploding works should be carried out on daytime; it is prohibited to carry out at nighttime or in rainy and stormy weather conditions.

Article 8-22. Management and control for exploding work

The mine exploding should be carefully carried out under an exactly and unique control of a sole person in charge.

Article 8-23. Countermeasure of submergence

In case foundation is filled by water prior to installation; casting foundation; backfilling works, the water should be pumped out.

Article 8-24. Checking of depth

The depth of foundation must be in compliance with design materials. In case it is impossible to reach design requirements, those should be reported for the owner's approval.

Article 8-25. Welding joint of foundation pier

. All welding joints or jointing bolts of foundation piers shall be painted with anti-rust coating layer. Prior to welding works, rust at welding points should be cleaned. The protective method shall be applied to ready cast

reinforced concrete foundation with thickness of protective concrete coating less than 30 mm and those foundations are located at the places with possibility of environment violence.

Article 8-26. Prevention for water and soil pollution

In case there is possibility of water and soil pollution, the concrete shall be tested by relative agency and by chemical experiments. Appropriate countermeasure shall be taken based on the result of test.

Article 8-27. Checking before backfilling

After the foundation casting and installation in compliance with design materials , the minutes on inspection and acceptance should be made and then foundation backfilling works carried out.

Article 8-28. Backfilling

The soil use for foundation backfilling should be in compliance with design materials and tightly compacted per layers.

Article 8-29. Removal of supporting equipment

The maintenance for installation of foundation pier using installation method should be uninstalled after backfilling works has reached to the elevation equal to ½ foundation elevation.

Article 8-30. Leveling after backfilling

The leveling after backfilling should be inclusive of settlement possibility of backfilling soil.

Article 8-31. On-site concrete foundation

On site concrete foundation casting shall be in accordance with norms on construction of concrete structures.

Section3 Installation and poles erection

Article 8-32. Checking site condition

Site condition at each pole foundation should be suitable for erection of accessories. Moreover, route equipment for transportation during installation period should be considered. The installation of poles shall be carried out in proper steps and in compliance with technology outline setting up on execution schedule.

Article 8-33. Installation of wooden pole

The installation of wooden poles shall be in compliance with requirements on design materials. Dimension and standard of bolts shall be in compliance with design requirements.

Article 8-34. Checking the condition of reinforced concrete pole

Prior to installation of reinforced concrete poles, the pole should be checked carefully to ensure that there is no break, no crack or no over limited size break.

Article 8-35. Checking of welding joint quality

Checking of welding joint quality of steel poles on site, as usual those shall be done visually, or measurement of welding joint by knocking, or check acoustically. Allowable errors value during installation of steel poles shall be referred to norms on manufacturer's installation of steel structure.

Article 8-36. Anti-rust for steel cable

Steel cable to be use for poles tensile wiring should have an anti-rust coating layer; cable should be fabricated and recorded number sign on each poles location on site and transport to respective places.

Article 8-37. Terminal treatment

For steel cable using for execution, the cable ends should be compacted round with proper calculation in accordance with technical requirements.

Article 8-38. The insertion for centrifugal concrete poles

The insertion for centrifugal concrete poles for cylinder shaped foundation shall be filled directly after erecting and adjusting poles in compliance with design location. The insertion layer shall be in compliance with design materials and tightly compacted by professional tool. The insertion of reinforced concrete poles, wooden poles, steel poles into glassed shaped foundation shall be done after erecting and adjusting poles in compliance with design location then checking poles by inserting ready cast concrete supporters, mortar to be filled into pole’s foot should be in compliance with design materials and done on the same day when mortal is filled.

Article 8-39. Erection of pole according to hinge rotation method

Prior to erection of pole according to hinge rotation method, mushroom shaped foundation piers and foundation piles; diagonal support against propulsive force of foundation during the erection should be prepared. Poles are

prohibited to erect prior to completion of foundation formation, foundation filling and the installation of above diagonal support.

Article 8-40. Checking step prior to pole erection

In case the site records on execution of foundation and poles erection has satisfied technical requirements and foundation has been inspected and accepted, to start poles erection into foundation is allowed. Prior to poles erection into foundation, the followings checking steps shall be carried out:

1. To check foundation, to re-measure and check position of bolt for foundation, poles foot whether there is any difference from design materials; screw of bolts for foundation is clean and has no or break; is it smooth to screw up and vice versa.
2. To check quality and condition of welding joints or bolts' tightening.

Article 8-41. The weight for design at erection

Poles erection technical plans should be inclusive of force bearing capacity of poles and other structure details in compliance with execution force in order to prevent damage and deformation of poles during execution.

Article 8-42. Poles erected into reinforced concrete foundation

For poles erected into reinforced concrete foundation or foundation piles, bolts shall tightly fix those poles' foot over its limitation in order to prevent self-loosen phenomenon.

Footing bolts for all kind of poles shall be fixed with 02 screw nuts and those shall be covered by concrete in accordance with design materials.

When fixing poles with its foundation, it is requested to put between base and poles foot and foundation pier plane, elevation errors value should not be over 4 mm. Dimension and outside figure of pad shall be determined in accordance with poles' base structure design.

Article 8-43. Pole without tensile wire

In case of poles without tensile wire, the pole shall be checked vertically and in case of Π shaped poles, checking by plumb is the most popular method, in case of steel tower shaped, checking by theodolite shall be applicable.

Article 8-44. Grounding Wire

Lightning equipment, ground wire shall be carried out in accordance with installation requirements of lightning equipment stated in this norm.

Section4 Installation of Insulator and wiring accessories

Article 8-45. Installation of insulator

As usual the installation of beam shall be carried out during erecting period of poles and insulators shall be installed during erecting period of poles or wiring tension.

Standing insulators should be installed firmly to beams or poles, to make sure that all standing insulators on beams and poles shall be straight, and fixed appropriately.

Section5 Installation of conduction wire and lighting system

Article 8-46. Protection of wire

When install cable with supporting lock or tensile (bolt lock or supporter) aluminum wires and aluminum wires with steel conductor, which is made of aluminum shall be used to protect or made of copper in case of copper wires.

In is necessary to tie wire with standing insulators in accordance with technology outline on installation in design materials.

Article 8-47. Requirements for specification of wire

Code and wire section and supporting wire shall be in accordance with design materials. Aluminum wire or aluminum wire with steel core shall be compressed and connected with same material.

Article 8-48. Connection of wire

For one section, there should be not over one connection.

It is not allowable to connect wire and lightning wiring within the same section-crossing high users density roadway. In case of cable with voltage of not over 1.000 voltages; communication wiring network, roadways network, railways network, and etc. wire with section less than 240 mm^2 shall be applicable.

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Minimum distance from jointing point to supporting bolts should be not less than 25m. The difference on dimension with connecting pipe shall not be over allowable errors value regulated by the manufacturer. After being pressed or twisted if on jointing pipe appears cracks, those should be omitted.

Article 8-49. Jointing pipe

Jointing pipe and tensile bolts as well as joint sleeve should match with wire code. The ends of two joint pipes should be of the same code, diameter of the jointing sleeve should be in compliance with the circulation of wire changes, Allowable error value applicable for joint sleeve should be not over manufacturer specification.

Article 8-50. Fever welding battery method

Welding by heat welding battery method applicable to wiring connection shall be done in accordance with technical process. The following is not acceptable:

1. Holes at the position of welding joint with depth 1/3 diameter of conducting-wire
2. Bent of conducting-wire at the position of welding joint.

Article 8-51. Protection during wiring work

When arrange conducting-wire, those should be put on pulley hanging on poles, protection method is applied in order to protect conducting-wire from being damaged by soil, stone and other obstacle on site at its touching surface.

When arrange conducting-wire at the roadway crossing position, those shall be put on scaffolding with specified elevation..

Article 8-52. Verticality

Installation of conducting-wire and lightning wire shall be in accordance with design materials. The difference of insulator string along wiring line and with vertical line should not be observed strictly.

Article 8-53. The distance from conducting wire to ground

The distance from conducting-wire to ground lever and other constructions should satisfy requirements of norms on electrical equipment. The distance form conducting-wire to poles as well as with other conducting-wire on poles at the phase switching position or transposition should be not smaller than design dimension by10%.

Section6 Installation of tube lightning arrester

Article 8-54. Installation of tube lightning arrester

The installation of tube lightning arrester on electric poles should be in accordance with design materials and manufacturer's technology outline, and the electric discharging part should be arranged at the position that can be visually checked from the ground level.

Article 8-55. Checking item

During installation of tube lightning arrester the followings shall be checked:

1. Tube's inside diameter
2. There should be no crack on lightning wire
3. Supporting part and electric discharging part should be covered with anti-rust protective coating layer.
4. Exterior electric discharge slot should be correctly adjusted and not exceed by 10% specifications in design materials.
5. Gas distribution area of tube lightning arrester shall not be at the same elevation of other parts belonging to pole and wiring system.
6. The steel plate aiming to detect lightning signal shall be put at the head of lightning tube and this part should not hang down.

Section7 Numbering and painting

Article 8-56. Procedure of painting for anti-rust

Steel poles, steel beams, other metal parts of foundation pier and foundation of reinforced concrete shall be mainly covered with anti-rust coating layer at the factory. Only amendment is allowed to be carried out on site.

The welding and connection of steel poles should be repainted after being welded.

It is unacceptable to paint the connection point between poles and ground wire. It is unacceptable to paint unexposed parts buried in concrete structure, which is used for jointing.

The surface of jointing details between parts of poles shall not be painted.

It is prohibited to re-paint the area which anti-rust coatings are damaged and metal parts on line under raining conditions and on wet and dirty metal's surface.

Section8 Inspection and put of project into operation

Article 8-57. Standards for inspection

Inspection for overhead transmission lines should be carried out based on inspection regulation that is technical standards Vol.5 Chapter 5 Section 2.