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**Code for construction and acceptance of grounding
connection electric equipment installation engineering**

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1 General provisions

1.0.1 To ensure the construction quality of grounding connection electric equipment installation engineering, promote the improvement of technical level of engineering construction, and to ensure the safe operation of grounding connection, this Code is developed.

1.0.2 This Code is applicable to the construction and acceptance of grounding connection electric equipment installation engineering, and not to the construction and acceptance of high voltage DC power transmission grounding electrode.

1.0.3 The construction and acceptance of grounding connection shall, in addition to complying with this Code, comply with the current relevant national standards.

2 Terms

2.0.1 Grounding electrode

Metal conductors buried in the ground and in direct contact with the earth are called grounding electrodes. They are classified into horizontal grounding electrodes and vertical grounding electrodes.

2.0.2 Natural grounding electrode

Various metal components, metal well pipes, foundations of reinforced concrete buildings, metal pipelines and equipment in direct contact with the earth which can be utilized for grounding.

2.0.3 Air-termination system

The generic term of devices for accepting lightning stroke, including lightning rod, lightning belt, lightning conductor, lightning protection net, metal roofing, and metal components, etc..

2.0.4 Grounding conductor

A metal conductor which is used to connect the grounding terminal of electric equipment and air-termination system to the grounding electrode and does not carry current under normal conditions.

2.0.5 Grounding connection

The sum of grounding electrode and grounding conductor.

2.0.6 Grounded

USE grounding conductor to connect the electric equipment, facilities, overvoltage protective devices of power systems or structures to the grounding electrode.

2.0.7 Grounding impedance

The impedance between a given point and a reference point of systems, devices, or equipment at a given frequency.

2.0.8 Ground resistance

The resistive component of grounding impedance, which is power frequency ground resistance at the power frequency.

2.0.9 Neutral line

3 Basic requirements

3.0.1 The installation of grounding connection shall be carried out by the engineering construction organization in accordance with the approved design documents.

3.0.2 When adopting new techniques, new technologies, and new materials, they shall be tested and verified with national qualification.

3.0.3 The installation of grounding connection shall be in accordance with the construction of the construction engineering. Before covering concealed portions, related organizations shall make inspections and acceptances and form records.

3.0.4 The following metal parts of electric equipment must be grounded:

1 Metal base, framework, shell, and transmission of electric equipment.

2 Metal base and shell for portable or mobile electric equipment.

3 Metal boxes of box-type substation.

4 Secondary winding of mutual inductor.

5 The panel (cabinet, box) for power distribution, control, and protection, and the metal framework and base of console.

6 Metal jacket, connector box, terminals, and metal protection tube of power cable, and shielding layer of secondary cable.

7 Cable bridges, bearers, and derricks.

8 Substation (converter station) framework, bracket.

9 Power line pole and tower with overhead ground wire or electric equipment.

10 Metal barriers of power distribution equipment.

11 Metal shell for electric heating equipment.

3.0.5 The DC system grounding connection which needs to be grounded shall meet the following requirements:

1 The grounding conductor which can form a closed loop with the ground and often flows through current shall be laid along the insulating padding plate; and shall not be metal-connected with metal pipelines, structures,

4 Grounding of electric equipment

4.1 Selection of grounding connection

4.1.1 Various grounding connections utilize natural grounding electrodes directly buried in the ground or in the water. The following natural grounding electrodes can be utilized:

- 1** Metal pipelines buried in the ground, but do not include pipelines which transport combustible or explosive materials.
- 2** Metal well pipes.
- 3** The metal structure of a building which has a reliable join to the earth.
- 4** Metal pipes, piles, and foundation layer rebar meshes for hydraulic structures and other structures located in water or moist soil environments.

4.1.2 The grounding conductor of the AC electric equipment can be grounded using the following grounding electrodes:

- 1** Metal structure, beams, and columns of buildings.
- 2** The runway, corridors, platforms of production cranes, framework of cranes and lifts, steel beams for transporting belt, framework of electric precipitators, and other metal structures.

4.1.3 Grounding connections such as power plants and substations, in addition to natural grounding electrodes, shall also be laid with a grounding grid which consists mainly of horizontal artificial grounding electrodes. A measuring well which separates the natural grounding electrode from the artificial grounding electrode shall also be provided. For substations and power distribution stations of 3kV ~ 10kV, when the rebar mesh in the structure foundation is used as the grounding electrode and the ground resistance meets the specified value, no artificial grounding is required.

4.1.4 The selection of grounding connection material shall meet the following requirements:

- 1** Except for temporary grounding connections, the grounding connection, when using steel, shall be hot dip galvanizing. The horizontally laid connection shall be round steel and flat steel of hot dip galvanizing. The vertically laid connection shall be angle steel, steel pipe, or round steel of hot dip galvanizing.
- 2** When flat copper strip, copper stranded conductor, copper rod, copper

existing building (structure), steel pipes or other solid protective sheaths shall be installed. Anti-corrosion measures shall be taken for chemically corroded parts. At places where the grounding conductor passes through the newly-built structure, it can bypass the foundation or pass underneath; and shall not be broken or poured into the concrete.

4.2.4 When the grounding connection is composed of a plurality of sub-grounding connection parts, according to the design requirements, the disconnecting clip for easy separation shall be set. The joints of natural grounding electrodes and artificial grounding electrodes, the grounding conductor of incoming-outgoing line framework, etc. shall be provided with disconnecting clips. The disconnecting clip shall be protected. When the grounding grid is expanded, the join of the new and old grounding grids shall be done through multiple points of grounding well.

4.2.5 The backfill of grounding connection shall meet the following requirements:

- 1 There shall be no stones and construction waste, etc. in the backfill. The soil taken outside shall not be highly corrosive. When backfilling, it shall be compacted in layers. For backfilling of outdoor grounding trench, an anti-setting layer with a height of 100mm ~ 300mm shall be provided.
- 2 When laying grounding electrodes in mountainous rocky areas or in the earth ditch of earthy sections with high resistivity, the backfill shall not be less than 100mm thick pure soil cushion; and pure soil shall be compacted in layers for backfilling.

4.2.6 The installation of exposed laying grounding conductor shall be in accordance with the following requirements:

- 1 The installation position of the grounding conductor shall be reasonable, easy to check, and shall not hinder equipment maintenance and operation inspection.
- 2 The join of the grounding conductor shall be reliable. There shall be no problems such as reduced cross section of grounding conductor, weakened strength, or rust due to processing.
- 3 The distance between the grounding conductor supports shall be 0.5m ~ 1.5m in horizontal straight-line part, 1.5m ~ 3m in vertical part, and 0.3m ~ 0.5m in the turning part.
- 4 The grounding conductor shall be laid horizontally or vertically; or can be laid in parallel with the inclined structure of building. In the straight-line segment, there shall be no ups and downs and bending.

- 6) Grounding busbar and grounding terminal of gas-insulated metal enclosed switchgear.
 - 7) Grounding terminal of lightning arrester, lightning rod, and lightning conductor.
- 2 When the electric equipment is not grounded by a specially laid grounding conductor, the following provisions shall be complied with:
- 1) The grounding conductor of electric equipment shall utilize metal components, steel bars of ordinary reinforced concrete components, threaded steel pipes, etc.;
 - 2) Grounding conductors for low voltage electric equipment for operation, measurement, and signaling can utilize permanent metal pipelines, but metal pipelines of combustible liquids, combustible or explosive gases shall not be utilized;
 - 3) When using the materials listed in Items 1) and 2) of this Clause as grounding conductors, it shall ensure that the full length is an intact electric pathway. When using the metal components in series as grounding conductors, the metal components shall be welded with steel with a cross-sectional area of not less than 100mm².
- 3 The neutral point with a voltage class of 110kV and above and required for direct grounding for operation shall have two grounding conductors connected to different grounding points of grounding grid. The specification for each of them shall meet the design requirements.
- 4 The iron core, clamp of transformer shall be reliably connected to the grounding grid; and shall be easy to operate to monitor the circulation in the grounding conductor.
- 5 Important electric equipment and equipment framework of 110kV and above shall be provided with two grounding conductors. Each shall meet the design requirements. The erection for connecting lead shall be convenient for regular inspection and testing.
- 6 The basic steel of row-by-row installation plates and cabinets and the grounding busbar of row-by-row switch cabinets shall have a clear and reliable grounding of not less than two points.
- 7 The mechanism case, control cabinet (box), junction box, terminal box, etc. of electric equipment, as well as the cable metal protection tube (tray), shall be grounded clearly and reliably.

between them.

4.3.10 The grounding of GIS in power plants and substations shall comply with the requirements of design and manufacturer, and shall comply with the following provisions:

- 1** Each grounding busbar on the GIS base shall, by means of not less than 4 grounding conductors separately set at both ends thereof, be connected to the grounding connection of the power plant or substation. The grounding conductor shall be connected to the ring grounding busbar of the GIS area. When the grounding busbar is long, another grounding conductor shall be provided in the middle part and connected to the grounding grid.
- 2** The grounding conductor and GIS grounding busbar shall be bolt-connected.
- 3** When the GIS is installed in the open air or installed on the indoor ground which is in direct contact with the soil, the joints between the grounding switch, the special grounding terminal of metal oxide arrester and the GIS grounding busbar shall be equipped with concentrated grounding connection.
- 4** The ring grounding busbar shall be laid in the GIS room. The parts of the indoor equipment to be grounded shall, in the shortest path, be connected to the ring grounding busbar. When the GIS is placed on indoor floor, the rebars in the reinforced concrete floor under its base shall be welded into a net and connected to the ring grounding busbar.
- 5** Jumper connections shall be made between flange pieces; and a good electric pathway shall be guaranteed. When the manufacturer uses basin-type insulator and flange joint with metal grounding connection to ensure electric conduction, there is no need for jumper connections between the flange pieces.

4.3.11 The grounding of motor shall comply with the following requirements:

- 1** When the cross-sectional area of motor phase line is less than 25mm^2 , the cross-sectional area of grounding conductor shall be equal to that of the phase line. When the cross-sectional area of motor phase line is $25\text{mm}^2 \sim 50\text{mm}^2$, the cross-sectional area of grounding conductor shall be 25mm^2 . When the cross-sectional area of motor phase line is greater than 50mm^2 , the cross-sectional area of grounding conductor shall be 50% of the cross-sectional area of the phase line.
- 2** The protective ground terminal, except for protection, shall not be used for

2 When multiple deep-drilling grounding electrodes have been used to reduce the ground resistance, the horizontal grounding grid can be buried normally.

3 When the thickness of seasonal high-resistivity layer is deep, the horizontal grounding grid can be buried normally. Short vertical grounding electrodes are arranged around the grounding grid and at the cross nodes of internal grounding electrodes. The length shall be 2m below the seasonal high-resistivity layer.

4.4.4 The selection and construction of resistance-reducing materials shall meet the design requirements, and shall comply with the following requirements:

1 The content of heavy metals and radioactive substances in resistance-reducing materials shall comply with the provisions of primary standard in the current national standard GB 15618 "Environmental quality standard for soils".

2 The electric and physical and chemical properties of resistance-reducing materials used shall comply with the current national standard DL/T 380 "Technical condition of material for reduced ground resistance".

3 The resistance-reducing materials used shall be constructed in accordance with the requirements of product technical documents.

4.5 Grounding of wind turbines and photovoltaic power station

4.5.1 The grounding of wind turbines, in addition to complying with the relevant provisions of this Code, shall also comply with the following provisions:

1 The system grounding of boosting transformer of wind turbines shall comply with the following regulations:

1) When the low-voltage side of boosting transformer of low-voltage wind turbines is star-connected, the neutral point shall be directly grounded.

2) The neutral point of high-voltage wind turbines can be resonant-grounded or low-resistance grounded.

2 The protective ground of wind turbines shall meet the following requirements:

1) The ground resistance of a single wind turbine in low-resistance grounding system shall meet the design requirements.

2) When the ground resistance of a single wind turbine does not meet the design requirements, the grounding connections of multiple units can

connection and the entrance-exit of roads or structures shall be greater than 3m. When less than 3m, voltage-sharing measures shall be taken, or pebble or asphalt floor shall be laid.

6 Independent lightning rods and lightning conductors shall be provided with independent concentrated grounding connections. The underground distance between them and the grounding grid shall not be less than 3m. When less than 3m, if the length along the grounding electrode BETWEEN the underground join point of lightning rod and main grounding grid AND the underground join point of equipment of 35kV and below and main grounding grid is not less than 15m, the grounding connection can be connected to the grounding grid.

7 The framework of power distribution equipment of power plants and substations, or the framework of lightning rod and suspension lightning conductor on the roof shall, at the grounding conductor, be provided with concentrated grounding connection, and shall be connected to the grounding grid.

4.6.2 The lightning rod or lightning protection metal mesh on buildings (structures) for production shall be connected to other metal objects on the top of the buildings (structures) into a whole.

4.6.3 The power lines of lighting lamps on the framework provided with lightning rod and lightning conductor, which are connected to the power line, and the grounding grid of low-voltage power distribution equipment or power distribution equipment, shall be cables with metal jackets or conductors pierced into metal pipes. The metal jacket or metal pipe of the cable shall be grounded. The length buried in the soil shall not be less than 10m.

4.6.4 There shall be no joints in the lightning conductors of power plants and substations.

4.6.5 The air-termination system and its grounding connection shall adopt a bottom-up construction procedure. The concentrated grounding connection shall be installed first, then the ground conductor, and finally, the air-termination system shall be installed.

4.7 Grounding of transmission poles and towers

4.7.1 The soil resistivity and the buried depth and ground resistance of grounding connection shall comply with the requirements of Table 4.7.1:

data handover, the actual laying diagram of grounding connection shall be drawn in the construction quality acceptance record and the relative position and size shall be marked. When the previous design is closed loop such as a square, the construction shall be in accordance with the design.

4.7.9 When laying horizontal grounding electrode on sloped terrains such as a hillside, it shall excavate along the contour line. The grounding trench shall be flat at the bottom. The trench depth shall not have a negative error. Backfill shall remove debris which affects the contact between the grounding electrode and the soil; and shall be compacted. The horizontal grounding electrode shall be laid flat.

4.7.10 The join between grounding conductor and pole and tower shall be reliable and in good contact. The weld length of grounding electrode shall be carried out in accordance with the provisions of Section 4.3 of this Code; and it shall be easily opened to measure the ground resistance.

4.7.11 Each tower leg of overhead line poles and towers shall be connected to the grounding conductor and grounded through multiple points.

4.7.12 The introduction of overhead ground wire of overhead line poles and towers into substation shall be reliably connected with the substation grounding grid by using parallel groove clamp. The discharge gap on both sides of insulator shall not be tied.

4.7.13 The concrete pole may be led down directly through the overhead ground wire or grounded through a metal ladder. When the grounding conductor is directly led down from the overhead ground wire, the grounding conductor shall be close to the pole body; and shall be fixed once to the pole at a distance of no more than 2m.

4.7.14 For the grounding conductor of prestressed reinforced concrete pole ground wire, it shall connect the open wire to the grounding electrode and set the break contact which is easily open to measure the ground resistance.

4.8 Grounding of main control building, dispatching building and communication station

4.8.1 The main control building, dispatching building, and communication station shall share a grounding grid with the electric equipment, building lightning protection devices, and shielding devices in the building.

4.8.2 In the communication machine room, the ring grounding busbar shall be laid around the machine room. The cross-sectional area of copper bar shall not be less than 90mm². The cross-sectional area of galvanized flat steel shall not be less than 120mm². Around the communication machine room building,

be laid in a closed loop around the outdoor box-type transformer, ring main unit, and pole-mounted distribution transformer.

4.11.2 The laying and join of the grounding connection shall comply with the provisions of Section 4.2 and Section 4.3 of this Code.

4.11.3 The join between the grounding conductor and the neutral point of the transformer shall be firm. The parts such as lock washer shall be complete.

4.11.4 The grounding conductor, connected to the exposed conductive part of electric equipment such as outdoor box-type transformer, ring main unit, and pole-mounted distribution transformer, shall be connected to the grounding connection.

4.11.5 The grounding conductor of the arrester installed on each overhead line leading into power distribution room shall be connected to the grounding connection of the distribution room. At the place where it enters the ground, a concentrated grounding connection shall be laid.

4.11.6 When the low voltage system adopts the TT and IT grounding types, the electric equipment shall be provided with an independent grounding connection; and shall not share the grounding connection with the system grounding at the power supply. The protective ground conductor of the exposed conductive part of electric equipment shall be connected to the grounding connection.

4.12 Grounding of structures electric equipment

4.12.1 The setting of the grounding connection shall meet the design requirements.

4.12.2 The same grounding connection is used for system grounding and protective ground of electric equipment, and lightning protective ground of structures, etc.. The ground resistance of the grounding connection shall meet the minimum requirements.

4.12.3 When the total equipotential mode is adopted, the grounding conductor leading from the grounding connection to the total equipotential terminal box shall not be less than 2.

4.12.4 The ring grounding busbar installed in the converter room or transformer room shall be connected to the grounding connection or total equipotential terminal box. The grounding conductors for the join shall be no less than 2.

4.12.5 The join between the grounding conductor and the neutral point of transformer shall be firm and reliable. The parts such as lock washer shall be complete.

be less than 2.5mm^2 . The cross-sectional area of grounding conductor of portable appliances shall not be less than 1.5mm^2 .

4.13.2 The metal shell or base of mobile appliances powered by fixed power source or by mobile power generation equipment shall have a reliable electric join to the grounding connection of these power supplies. In the IT system, a grounding connection can be installed near mobile appliances instead of laying the grounding conductor. The nearby natural grounding electrode shall be utilized. Its electric join and thermal stability shall be guaranteed. Its ground resistance shall comply with the relevant regulations.

4.13.3 The system grounding of mobile generator shall comply with the requirements for system grounding of power transformer. In the following cases, no additional protective ground is required:

- 1** When the mobile generator and appliances are fixed on the same metal bracket and do not provide electricity to other equipment.
- 2** No more than 2 appliances are powered by specialized mobile generators. The spacing between the power supply equipment and appliances is not more than 50m. There is a reliable electric join between the metal shells of power supply equipment and appliances.

4.14 Grounding against lightning induction and static electricity

4.14.1 Power plants and substations have explosion hazard and, after the explosion, the main equipment in power plants and substations may be affected, or the buildings (structures) for power generation and supply may be seriously affected. Independent lightning rod protection shall be adopted. Measures to prevent lightning induction shall also be adopted. The following provisions shall be met:

- 1** A closed ring grounding connection shall be installed around the open-air storage tank. The ground resistance shall not exceed 30Ω . Open-air storage tanks without independent lightning rod protection shall not exceed 10Ω . The grounding points shall not be less than 2. The grounding point spacing shall not exceed 30m.
- 2** The overhead pipeline shall be grounded once every 20m ~ 25m. The ground resistance shall not exceed 30Ω .
- 3** The breather valve of combustible oil storage tank and the thermo-technical measuring equipment of combustible oil and natural gas storage tank shall, by using metal conductors, be connected to the grounding connection of the corresponding storage tank. Pipeline joints such as valves, flanges, elbows, etc. which cannot maintain good electric contact

5 Engineering succession and acceptance

5.0.1 The acceptance of grounding connection electric equipment installation engineering shall comply with the following requirements:

- 1** The construction shall be completed according to the design requirements. The grounding construction quality shall comply with the provisions of this Code.
- 2** The join of the exposed part of the whole grounding grid shall be reliable. The specifications of grounding conductor shall be correct. The anti-corrosion layer shall be intact. The marking shall be complete and clear.
- 3** The installation position and height of lightning rods, lightning conductors, lightning belts, and lightning protection nets shall meet the design requirements.
- 4** The number and location of connecting plates for connecting temporary grounding conductors shall meet the design requirements.
- 5** The grounding impedance, ground resistance, and other test parameters shall be in accordance with the design provisions.

5.0.2 During succession and acceptance, the following information and documents shall be submitted:

- 1** Drawings which match the actual construction.
- 2** Proof documents of design change.
- 3** Test reports and quality certificates of grounding equipment, resistance-reducing materials, and new grounding connection.
- 4** Installation technical records, the content of which shall include concealed engineering records.
- 5** Grounding test records and reports, the contents of which shall include ground resistance test, grounding conduction test, etc..

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