



RAICHUR POWER CORPORATION LIMITED

VERAMARUS TPS - 2x800 MW

ELECTRICAL EQUIPMENT INSTALLATION WORK

SECTION: D2.19

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1.0 GUIDELINES FOR INSTALLATION OF ELECTRICAL EQUIPMENT

1.1 All electrical equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, squat and properly aligned and oriented. Tolerances shall be as established in the Manufacturer's drawings.

1.2 Transformers

Care shall be taken during handling of insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulating, filtering or otherwise handling of oil, rubber hoses shall not be used. Circulation and filtering of oil, heating of oil by regulated short circuit current during drying runs and sampling and testing of oil shall be in accordance with the Manufacturer's instructions and specified Code of Practice.

1.3 Switchgear, Control/Relay Panels

1.3.1 Switchgears and control relay panels/desks shall be installed in accordance with specified code of practice and the Manufacturer's instructions.

1.3.2 In joining shipping sections of the switchgear/panels/control centres together, adjacent housing or panel sections provided shall be bolted together after alignment has been completed.

1.4 Motors

The installation, commissioning of the motors shall be as per the applicable code of practice and the Manufacturer's instructions.

1.5 Battery and chargers

Each cell of the battery bank shall be inspected for breakage and condition of cover seals as soon as received at site. Each cell shall be filled with electrolyte in accordance with the Manufacturers instructions. Battery shall be set up on racks as soon as possible after receipt, utilising lifting devices supplied by the MANUFACTURER. The cells shall not be lifted by the terminals.

1.6 Switchyard

1.6.1 Switchyard equipment installation shall be carried out as required in the approved drawing/plan and elevation drawings of switchyard showing bus bar configurations, sizes, tensions, insulator details etc.

1.6.2 The above shall include installation of complete set of bus bars and all bays, conductors, complete with tension/suspension insulator strings, bus post insulators, equipment connections, bus bar connections to equipment, lightning shield wires including down comers where they shall be connected to the test links. Tube type conductor lengths shall be joined by welding procedure.

1.6.3 Installation work of breakers shall also include compressors with accessories whenever applicable and necessary adjustments/alignments for





proper operation of circuit breakers and their operating mechanisms. All insulators and bushings shall be protected against damage during installation.

2.0 TESTING AND COMMISSIONING

2.1 All checks and tests as per the Manufacturer's drawings/manuals, relevant code of installation and commissioning check lists for various electrical equipment e.g. Transformers, breakers, isolators, CTs, PTs, motors, switchgear, relays, meters etc. shall be carried out.

2.2 The CONTRACTOR shall perform operating tests on all switchgear and panels to verify operation of switchgear/panels and correctness of the interconnections between various items of the equipment. This shall be done by applying normal AC or DC voltage to the circuits and operating the equipment for functional checking of all control circuits, e.g., closing, tripping, control interlock, supervision and alarm circuits. All connections in the switchgear shall be tested from point to point for possible grounds or short circuit.

2.3 Insulation resistance tests shall be carried out by following rating meggers :

- | | | | |
|-----|---|---|---------------------------------|
| (a) | Control circuits upto 220V | : | by 500 V megger |
| (b) | Power circuits, bus bars, connections upto 11kV | : | 1000V megger |
| (c) | Power circuits, bus bars, connections above 11 kV | : | by 5000 V motor operated megger |

2.4 The applicable standards for installation and testing of equipment are indicated in the table below :

Applicable Standards

- | | | | |
|-----|--|---|----------|
| (a) | Installation and Maintenance of Transformers | : | IS:10028 |
| (b) | Installation and Maintenance of Switchgear | : | IS:10118 |
| (c) | Installation and Maintenance of Induction Motors | : | IS:900 |
| (d) | Guide for safety procedures and Practices in Electrical work | : | IS:5216 |
| (e) | Hot dip galvanising | : | IS:2629 |
| (f) | Electrical wiring installations for voltages > 650V | : | IS:732 |
| (g) | Fire safety of buildings (General) – Electrical Installation | : | IS:1646 |

3.0 In order to avoid hazards to personnel moving around the equipment such as switchgear etc. which is kept charged after installation before commissioning, such equipment shall be suitably cordoned off to prevent anyone accidentally going near it.

4.0 It will be the responsibility of the Contractor to obtain necessary License / Authorisation permit for work from the Licensing board of the locality/state/ State Electricity Authority/Inspectorate where the installation is to be carried out. The persons deputed by the Contractor's firm shall also hold valid





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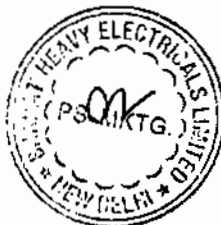
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permits issued or recognised by the Licensing Board of the locality/state/
State Electricity Authority/Inspectorate where the work is to be carried out.

5.0

The approval of all drawings and inspection of all installations complete, by the Govt. approved Electrical inspector, shall be the responsibility of the Contractor. All necessary fees towards the same shall be paid by the contractor. Also any modification work, if required/ advised by the Electrical inspector, shall be carried out by the Contractor free of cost.



**RAICHUR POWER CORPORATION LIMITED****YERAMARUS TPS - 2x800 MW****CABLING SYSTEM**

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1.0 CABLES**1.1 H T Cables**

MV system (11kV & 3.3kV system) cables shall be unearthed grade suitable for use in medium resistance earthed system, with stranded & compacted aluminium conductors, extruded semi-conducting compound screen, extruded XLPE insulated, Dry/Gas/Steam/Sioplas extruded semi-conducting compound with a layer of non-magnetic metallic tape for insulation screen, extruded PVC (Type ST - 2) inner sheath, Aluminium / galvanised steel strip/wire armoured, extruded PVC (Type ST - 2) outer sheathed, single / multicore conforming to IS 7098 (Part II) for constructional details and tests. Single core cables shall be without inner sheath.

1.2 L T Power Cables

LV Power Cable shall be 1100 V grade, single / multicore, stranded aluminium conductor, XLPE insulated, Dry/Gas/Steam/Sioplas, with extruded PVC inner sheath, Type ST - 2 and outer sheath made of FRLS PVC, Type ST-2 compound. The armoring shall be of Aluminium / galvanised steel strip/wire. The cable used for DC system shall be of single core type. All other details shall be as applicable. Minimum conductor cross section of power cables shall be 10 sq. mm for aluminium conductor and 2.5 sq. mm for copper conductor.

1.3 Control Cables

Control cables shall be 1100V grade, multicore, minimum 2.5 sq.mm cross section, stranded copper conductor having 7 strands, PVC insulated, inner PVC sheathed, galvanised steel wire armoured and outer sheath made of FRLS PVC compound conforming to IS-1554. In situations where accuracy of measurement or voltage drop in control circuit warrants, higher cross sections as required shall be used. Min 2.5 sq.mm copper conductor cables shall be used for CT circuits all other specifications remaining same.

1.4 Instrumentation Cables

Instrumentation cables shall be 225V grade with stranded high conductivity copper, twisted pair extruded PVC insulated with overall and / or individual screening, extruded PVC inner sheathed, extruded outer sheathed with FRLS PVC compound and aluminium/galvanised steel wire armoured complying VDE standard. The conductor size shall be minimum 0.5 sq. mm.

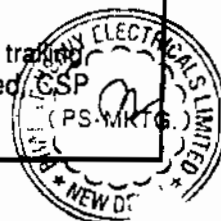
Triplex cables similar to instrumentation cables can be used for RTDs.

1.5 Lighting Wires

1100V grade, single core, stranded, copper conductor, PVC insulated wires conforming to IS-694-1990 /. Minimum cross section of copper wires shall be 2.5 sq. mm for lighting circuits and 4 sq. mm for single phase receptacle circuits.

1.6 Trailing Power and Control cables for Mobile Equipment.

11kV / 3.3 kV (UE) and 1100V (E) grade power & control flexible trailing annealed tinned copper conductor, EPR insulated, EPR inner sheathed





outer sheathed and shall have conductor screen of rubber. Cables shall conform to IS requirements and any other applicable standards.

2.0 CABLE PROPERTIES

2.1 All power, control and Instrumentation cable will be with armour. MV cables will be with PVC inner and outer sheath and other type of cables are with FRLS PVC, Outer sheath.

All single core power cables will have wire armouring of aluminium, whereas multicore cables will have galvanised steel wire /strip armouring.

2.2 The outer sheath of all cables shall be of extruded layer of suitable synthetic material compatible with specified ambient and operating temperature of the cables. The sheath shall be resistant to water, UV radiation, fungus, termite and rodent attack.

2.3 The outer sheath of FRLS PVC compound shall meet the following performance requirements:

- (a) The critical oxygen index value shall be minimum 29 when tested at $27 \pm 2^\circ\text{C}$ as per ASTM-D-2863-77. and the temperature index will be minimum 250°C at oxygen index value of 21 when tested as per ASTM D 2863.
- (b) The maximum acid gas generation as determined by titration shall be less than 20% by weight when tested as per IEC-60754-1 (1994).
- (c) The smoke generation under fire shall have maximum smoke density rating of 60% when tested as per ASTM-D-2843-7 (1988).
- (d) The cables will pass the hydraulic stability and ultraviolet tests as per DIN 53387.

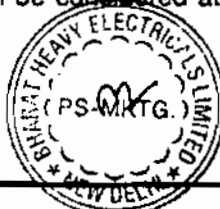
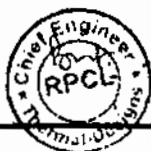
2.4 The finished cable shall pass the flammability test as per IEC- 60332-1 (1993) and IEEE-60383. In addition, it shall also pass flammability test as per Class F3 of Swedish Standard SS-424-1475 (1978).

3.0 DESIGN CRITERIA FOR CABLE SIZING

3.1 Power cables

Power cable sizes shall be selected on the basis of current carrying capacity, short circuit rating, permissible voltage drop and standardization of cable sizes.

3.1.1 Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like Thermal resistivity of soil, ambient air/ground temperature, grouping, method of laying, etc. The design ambient air and ground temperatures shall be considered at 50°C & 30°C respectively.



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- 3.1.2 Power cables shall withstand the fault current of the circuit for the duration not less than the maximum time taken by the primary protective system to isolate the fault. Fault clearing times for Power cables shall be considered in line with IS. The short circuit withstand capacity of screen in case of HT cables shall be 300 amps for 2(two) seconds per core.
- 3.1.3 For 11000V / 3300V motors controlled by vacuum contactors with back-up HRC fuses, the minimum cross-section of cables shall be based on the cut-off current of the fuses and their fusing time.
- 3.1.4 For the cables to 415V motors and feeders protected by fuses, the cross section shall be chosen according to the cut-off current of the fuse and its fusing time.
- 3.1.5 Voltage dip at motor terminals during starting of motors will be limited to the following values:
(ii) For LV motors – 15% of the rated voltage.
(iii) For HT motors – 20% of the rated voltage.
- 3.1.6 Voltage drop in LV feeder cables between PCC & MCC, for full load current, shall be limited to 3 %. Further, the Voltage drop in feeder cables between PCC/MCC to Motor terminals shall be limited to 3% during full load running condition.
- 3.1.7 For power supply to valve actuator motors, actuators of various isolating and regulating dampers and exhaust fans, 3 core 2.5 sq. mm stranded copper conductor cable may be used in view of ease of termination. These cables shall be in other respects similar to cables described in Clause 1.2 above.

3.2 Control Cables

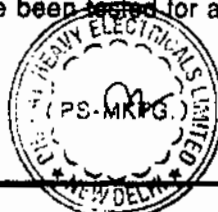
- 3.2.1 Current transformers leads shall be checked for the lead burden vis-a-vis the current transformer VA capacity and 2.5 sq mm cables shall be used for connection of CT to loads. In case 2.5 sq mm conductor impose unacceptable high burden on CTs, higher cross section of conductor shall be used.
- 3.2.2 Voltage transformer leads shall be checked for voltage drop, which shall be limited to within 1% for all cases other than tariff metering. For tariff metering the voltage drop shall be limited to 0.2%. In case the voltage drop with 4 sq. mm Cu conductors exceed this value, higher conductor sizes shall be used.

3.3 Instrumentation Cables

Instrumentation cables shall comply with the Electrical Properties suitable for the Digital and Analogue signals.

4.0 CABLE TERMINATIONS

- 4.1 All 11000V / 3300V termination kits shall be of heat shrinkable type and suitable for XLPE insulation and the same shall have been tested for a short circuit current as per relevant Standards





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- 4.2 All 1100V termination for XLPE/PVC power cables and control cables shall be by crimping type tinned copper / aluminum lugs.

5.0 **CABLE JOINTS**

Cable joints shall be avoided to the extent possible. If joints are unavoidable due to circuit length, in excess of permissible maximum drum length, they shall be heat shrinkable type having a short circuit with stand capacity as per IS 13573.

6.0 **CABLE CARRIER SYSTEM**

- 6.1 The cable carrier system shall be designed considering the following:

- (a) Facility for easy laying of cables.
- (b) Access to maintenance.
- (c) Neat and aesthetic appearance.
- (d) Safety of equipment & personnel.
- (e) Ground water seepage.

- 6.2 Cables shall be laid in prefabricated ladder/ Perforated type trays and in conduits. Direct burial of cable shall be avoided as far as possible. In case cables are buried, length of burial shall be limited to about 10 M and depth of burial shall be about 750 mm. Cable route markers shall be provided at every 15 m intervals and at bends. Also joint markers shall be provided at each joint.

- 6.3 Cable tunnels are not acceptable. Cables shall necessarily be run in overhead racks.

7.0 **CABLE INSTALLATION AND ACCESSORIES**

- 7.1 All material and accessories required for cable installation like cable trays, tray covers, support steel, etc., shall be hot dip galvanised and conduits/pipes shall also be hot dip galvanised. Cable trays in horizontal formation in boiler area shall be provided with cable tray cover.

The racks/trays, conduits/pipes, trenches required to route the cables to individual equipments shall be supplied and installed by the CONTRACTOR.

- 7.2 Separate trays shall be provided for HV Power/LV Power (AC&DC)/Control & Instrumentation cables.

8.0 **CABLE TRAYS AND COVERS**

- 8.1 Cable trays shall be of ladder / perforated type complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories. Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows, etc., shall be fabricated from 12 gauge (2 mm thick) mild steel sheets cable tray covers shall be fabricated from 16 gauge (1.6 mm thick) MS sheets. All the sheet steel shall be hot dip galvanised as per relevant standards.



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Cable trays shall be ladder type for power & control cables and perforated type for Instrumentation cables.

- 8.2 Cables of sizes 120 sq.mm and above shall be laid in single layer. Single core cables used for 3 phase AC power circuits shall be laid in Trefoil form.

9.0 **FIRE-PROOF SEALING OF CABLE PENETRATION**

Cables / cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another, between the units and within the same unit, shall be sealed by a fire-proof sealing system. The fireproof sealing system (FPSS) shall effectively prevent the spread of fire from the flaming to the non-flaming side, in the event of a fire. The FPSS shall conform to relevant standard in addition to the following requirements:

- (a) FPSS shall have a fire rating of one hour.
- (b) The FPSS shall be subjected to fire endurance test, hose stream test as per ASTM-E-814/BS:476
- (c) Under fire condition, the FPSS material shall not emit excessive smoke or any corrosive or toxic fumes.

10.0 **FIRE BREAK**

- 10.1 Firebreak shall be provided by applying a suitable fire-resistant coating on cables for the required length to meet the fire rating of thirty minutes.

- 10.2 Firebreak shall be provided at an interval of 15 metres in the straight portion of each of the cable tray above ground, at intervals of 30 metres in cable trenches and at 5M for all vertical trays. All cable inter section and tee offs shall be provided with firebreaks.

11.0 **TESTS**

All routine tests shall be carried out as per relevant standards and approved GTP/QAP. For type tests, certificates for tests carried out earlier shall be furnished.



**1.0 EARTHING SYSTEM**

Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons.

2.0 DESIGN CRITERIA**2.1 Fault Current & Duration**

For earth mat design, the size of earthing conductor shall be calculated considering maximum fault current of 50 kA for duration of 1 second.

2.2 Conductor Material

The earthing system conductors and accessories as proposed are to be as follows:

- (a) Conductors above ground level and in trenches : Galvanised steel
- (b) Conductors buried in ground or embedded : Mild Steel
concrete
- (c) Electrodes : GS Rod
GS pipe for treated pits
- (d) Lightning protection air termination and down : GS Flat
conductors for buildings
- (e) Exposed lightning protection air termination : Lead coated copper
chimney top

The CONTRACTOR shall undertake the soil resistivity measurements at site and select suitable type of conductors.

2.3 Size of Conductors**(i) Main Earthing Conductors**

The earthing conductor sizes shall be calculated as per IS- 3043 and shall comply with IE rules and IEEE-80.

- (ii) The earth conductor dimension shall be calculated taking into account the corrosion effect of steel at a rate of 0.12mm/yr for a plant life of 30years

(iii) Rod Electrodes

Mild steel rod electrodes of suitable diameter and length shall be used as per the recommendation of IS-3043. For test pits electrodes shall be heavy duty type (Class - C) GI pipe of suitable diameter with perforations. Electrodes installed in the test pits will have disconnecting facilities.



**(iv) Equipment Earthing Leads**

The size of the earthing leads shall be decided based on the type of equipment and structure to be earthed and shall be provided generally as per IS-3043 and also with a view to minimise the number of sizes.

(iv) Conductors for lightning protection system

The size of conductors for lightning protection system shall be decided based on mechanical strength.

3.0 EARTHING SYSTEM LAYOUT

3.1 The earthing system design and installation shall generally comply with the following standards.

- (a) IS-3043 : Code of practice for Safety Earthing
- (b) IEEE-80 : Guide for safety in Alternating current sub-station grounding
- (c) Indian Electricity Rules

3.2 General

3.2.1 Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system. Two earthing leads shall be used if rated voltage of equipment is above 250V. If the rated voltage is 250V or below, one earth lead shall be provided. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead. Main earthing in switchyard, Transformer yard, TG and boiler area, switchgear rooms, buildings shall be in form of grids.

3.2.2 Earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm.

3.2.3 All cable trays in the plant buildings as well as inside the trenches shall be connected to earth grid at an interval of about 30m.

3.3 Earthing Conductor Layout In Switchyard

3.3.1 Main earthing conductors shall be laid in the form of a grid. Spacing between conductors, number of parallel conductors, etc., shall be decided such that step and touch potential are within safe limits.

3.3.2 The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80. The detailed design / engineering calculations be furnished.

3.3.3 Earthing conductors shall be provided around the outside edge of fence at a distance of approximately 2000 mm. This shall be connected to the switchyard earthing grid.





3.3.4 An earthing mat comprising closely spaced (about 150 mm) conductors shall be provided below the operating handles of disconnecting switches and breaker operating kiosk for the additional safety of the operating personnel.

3.3.5 Each earth leads of transformer neutral, lightning arrester earth leads, CVT's earth leads shall be directly connected to two separate treated earth pits. Lightning protection down conductor shall be directly connected to a separate earth electrode and Inturn connected to earth grid.

3.3.6 The earthing conductors of switchyard equipments shall be directly connected to earth grid. Equipment supports (structures/Pipe supports) will not be used as earth continuity conductors. All earth electrodes in turn shall be connected to station earthing system. The earth grids of different areas of the plant shall be interconnected through, test pits to enable measurement of earth resistance for each area separately.

3.3.7 Earthing grid design shall be done in such a manner that the grid resistance is less than 0.5(zero point five) ohm.

3.4 Earthing Conductors Inside Building

3.4.1 Main earthing conductors shall be buried in earth around the building. Minimum two taps-off from this earthing loop shall be taken inside the building and connected to the earthing grid embedded in the floor slab with approximately 50 mm concrete cover. The earthing within the building shall be in form of grids.

3.4.2 In case, the building has more than one floor, each floor shall be provided with earth grid as discussed earlier. Floor earthing grids shall be interconnected.

3.4.3 Each RCC / Steel column of the building shall be interconnected to the floor earthing grid in the ground floor.

3.4.4 Cable trays, steel pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.

3.4.5 Instrumentation system and computer system shall be provided with a dedicated earthing system suitable for the equipment.

3.4.6 Earthing grids of all the buildings, outdoor yards shall be interconnected to form a single grid for the plant.

3.4.7 Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.

Above-ground earthing system comprises of risers drawn in continuation with the conductors protruding above the ground level from the buried earthing system, equipment earth continuity conductors and run-away conductors for cable tray earthing. For above-ground earthing, conductors of galvanised iron (GI) flats/GI wire are provided. All equipment are generally earthed at two points for reliability.





- 3.4.8 Earthing connections to equipment are bolted type while at the other end they are welded type. For system earthing, neutral points are grounded at two points through test-pit

For electronic system earthing, all cable screens are brought at one point (preferably at 24V DCDB) and connected to station earth through a separate dedicated riser.

4.0 **EARTHING SYSTEM INSTALLATION**

- 4.1 The spacing between two electrodes shall be at least equivalent to twice the length of the electrode.
- 4.2 Earthing conductor running exposed on column, walls, etc., shall be supported by suitable cleating, at intervals of 1000 mm
- 4.3 The earthing conductor crossing the road / track shall be laid in hume pipe or laid at a greater depth to avoid damage.
- 4.4 When earth conductor passes through floors, walls, etc., suitable pipe sleeves shall be provided and the same shall sealed after installation.
- 4.5 The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices.
- 4.6 Metallic conduits and pipes shall not be used as earth continuity conductor.
- 4.7 Street lightning poles, flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.
- 4.8 Flexible earth conductors shall be provided at expansion joints for earthing the gates, operating handles, etc..
- 4.9 Equipment bolted connection after being checked and tested shall be painted with anti-corrosive paint / compound.
- 4.10 Connection between the equipment earth lead and the grid conductor shall be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.
- 4.11 The cable sheaths, screens armour shall be earthed at both ends for multi-core cables. For single core cables the same shall be done at one end (switchgear end) only.
- 4.12 All bimetallic connections shall be treated with suitable compound to prevent moisture ingress.
- 4.13 The contractor shall demonstrate the effectiveness of earthing system by measurement of earth resistance, step & touch potentials at different locations.



**5.0 LIGHTNING PROTECTION SYSTEM**

Lightning protection system shall consist of vertical air termination rods, horizontal roof conductors, down comers, and pipe electrodes.

5.1 Need for Protection

The need for providing the lightning protection system shall be established by calculating risk index value for each building structure, etc., as per procedure given in IS-2309.

5.2 Lightning Protection System Layout

5.2.1 The lightning systems design and installation shall generally comply with IS:2309 code of practice for the protection of building and allied structure against lightning.

5.2.2 For switchyard, lightning protection masts shall be provided and the down comers from the masts shall be run along the tower connected to rod / electrode. Calculations for sizing and determining topography and number of lightning masts shall be furnished for approval by OWNER.

5.2.3 Each down conductor shall be connected to a rod electrode, which in turn shall be connected to the station earthing system through test links.

5.2.4 Lightning protection shall also be provided for Boiler and station building as well as other buildings as required by the relevant codes and subject to OWNER's approval.

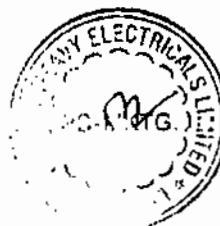
5.3 Lightning Protection System Installation

5.3.1 Conductors of lightning protection system shall not be connected with conductors of safety earthing system above ground level.

5.3.2 The down conductors shall be welded to steel structures at 1000 mm interval or cleated to wall at 1000mm interval. Wherever welded, the weld locations shall be treated to provide rust protection.

5.3.3 Each down conductor shall be provided with a test link at a height of about 1000 mm above ground level.

5.3.3 All the metallic structures within a vicinity of 2000 mm shall be connected to the lightning protection conductors. However, this requirement shall be complied with in line with relevant IS.





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1.0 MINIMUM SIZE AND MATERIAL OF MAIN EARTHING CONDUCTORS

SLNO SYSTEMS	SIZE IN Sq.mm	RECOMMENDED SIZE	
		Buried in earth	Above ground or embedded in concrete
1	MAIN EARTHING CONDUCTOR		
a. 400KV system		40mm dia	50x10 mm GS flat
b. MV system		32 mm dia	-Do-
c. LV system		32 mm dia	-Do-
2.	EARTH ELECTRODES		
a. Rod Electrodes	32 mm dia, 3000mm long		
b. Pipe Electrodes	40 mm dia, 3000mm long galvanised steel, class 'C' pipe		
3.	MATERIAL		
a. Above ground	Galvanised steel-Galvanizing as per IS 2629-1985		
b. Below ground & Embedded in concrete	Mild steel		

2.0 MINIMUM SIZES OF EQUIPMENT EARTHING LEADS:-

SL.No	Equipment/Structure	Earth Lead Size
1	Equipment of HV/MV/LV system	50 x 10 mm flat
2	LT switch gears and Motor Control Centres	50 x 10 mm flat
3	LT Motors	
	a. Fractional HP	8 SWG GI wire
	b. Up to 40 KW	25 x 3 mm flat
	c. 41 to 70 KW	25 x 6 mm flat
	d. 71 KW and above	50 x 10 mm flat
4.	Isolated phase bus duct and accessories	50 x 10 mm flat
5.	Generator and accessories	50 x 10 mm flat
6.	Transformer and accessories	50 x 10 mm flat
7.	Control Desks, Control/relay panels, LDBs, PDBs, Lighting Panels, Power receptacles, Lighting Masts, Lighting Poles	25 x 6 mm flat
8	LPB stations, Limit/Pressure switches, Starters, CT/PT terminal Boxes	08 SWG GI wires
9	Columns, Fence, Gates, Cable trays etc	25 x 6mm flat
10	LT bus ducts	50 x 10 flat
11	Switchyard structure	50 x 10mm flat
12.	MATERIALS	
	a. Above Ground	Galvanized steel-Galvanizing as per IS 2629-1985
	b. Below ground & Embedded in concrete	Mild Steel





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3.0 MINIMUM SIZES AND MATERIALS OF LIGHTNING SYSTEM CONDUCTORS:

SL No.	Description	Sizes
1	Roof Conductors and down conductors building and boiler areas	25 x 6 mm GI flat
2	Horizontal Air termination for Chimney	25X6 lead coated copper conductor.
3	Vertical air termination for chimney	20mm dia copper rod coated with lead, approx. 2000mm long
4	Down Conductor for Chimney/Cooling Towers	25 x 6 mm galvanised steel conductor OR mild steel embedded in concrete
Galvanizing as per IS 2629-1985		

