

SECTION: 2.12

PROTECTIVE EARTHING

1.0 **Scope**

1.1 The scope of work shall cover earthing stations, laying aluminium/ copper earth strips and connecting the power panels, DBs and switch boards.

2.0 **Standards**

2.1 The following standards and roles shall be applicable:

- 1) IS:3043 - 1966 Code of Practice for earthing.
- 2) Indian Electricity Act and Rules

2.2 All codes and standards mean the latest.

3.0 **Earthing Station**

3.1 **Maintenance free Earthing System**

Earthing system should meet the requirements according to IS 3043, IEC 60364-5-54, IEC62305 as well as UL 467. Components used should conform to IEC 62561- 1 to 7. Earth rods as well as Earth enhancing compounds should be tested and certified confirming to IEC 62561- 1 to 7. Earthing system should offer resistance less than 1 ohms throughout the year. For this purpose, earthing system vendor should do the soil testing and provide the necessary recommendation. In places where Soil resistivity is more, multiple earth electrodes are to be installed to get the required value. In case of multiple earth rods, vendor should provide possible resistance value of each earth pit. This value remains without any change for at least one year. In places where resistance of each pit is more than 10 ohms, special care needs to be taken. Earth Enhancing compound need to be used for the vertical rods as well as horizontal conductors, where ever specified.

Earthing shall be of TNS / TT category with separate neutral & safety conductors laid throughout the installation. A combination of earth conductors and earth electrodes / earth mats shall be laid out for efficient earthing. The same shall be interconnected to the main earth grid of the base building as well as to the steel reinforcement of the building if special provisions are provided. The earth conductors shall be laid at a depth of not less than 600mm from finished ground level. The entire earthing shall be interconnected to the base building earth grid.

Due to high safety and reliability, earthing shall be carried out using copper strips unless otherwise specified. Size of the earth strip shall be indicated in the drawing. All joints should be made of exothermic welding. Neutral earthing shall be carried out using copper earth electrodes and copper earth mats. All joints in the run of the copper earth conductor shall be

exothermically welded. Earth conductors of the power and lightning protection systems shall be interconnected in ground to equalize the potential as well as bonded to a common equipotential bonding bar.

The minimum thickness of the earth strips shall be 3mm & the minimum diameter of wires shall not be less than 10mm. The minimum cross sectional area shall not be less than 50 sq.mm for bare GI / copper conductor respectively

All riveted joints / joints with bolt and nut as well as spot welded areas should be protected against corrosion with black bituminous paint and corrosion protection tape. Corrosion protection is not necessary for exothermically welded joints.

3.2 Type of earth pits and application: Neutral Earthing of Transformer and DG:

EC grade Copper plate of size 600mm x 600 mm x 3 mm at a depth of 2000 mm shall be installed in an excavated area of 700 x 700 x 2500 mm. The surroundings of the copper plate electrode shall be filled with a mixture of earth enhancing compound tested according to IEC 62561-7 mixed with excavated soil in the ratio of 1:2. Approximately 150 Kgs of earth enhancing compound need to be used. Two copper strips of 50*6 mm exothermically welded to the copper plate electrode is used to connect plate electrode with the bonding bar in the chamber. Bus bar of 400x50x6mm is used as the bonding bar between earth electrode and external connections. All connections from the bonding bar to the plate electrode shall be strictly exothermically welded. Additional CI pipe for watering through a funnel shall be provided with a bolted connection to the bonding bar. Exothermic weld must comply to the requirements of IEEE 837 and UL approved. Earth chamber should be strong enough to withstand heavy loads depending upon the civil requirements.

3.3 RMG, HT PANEL, MAIN PANEL , TRANSFORMER BODY:

EC Grade solid copper conductor or copper coated steel conductor with a min coating thickness of 250 microns and with a cross sectional area of 300 sq mm (50x6mm flat or 20mm dia round) interconnected in the form of a mesh buried at a depth of 1500mm as per the drawing need to be used. Only exothermic welding is permitted for interconnections. The grid size is 3000mmx 2000mm with a spacing of 500mm. Both 100mm below and above the mesh shall be treated with earth enhancing compound mixed with excavated soil of 1:4 ratio. Approximately 150 KGs of earth enhancing compound need to be used. Two distinct connections each from both side of the mesh shall be taken from the mesh to the chamber and exothermically welded to a bonding bus bar. Bus bar of 400x50x6mm is used as the bonding bar between earth electrode and external connections. All connections from the bonding bar to the plate electrode shall be strictly exothermically welded. Additional CI pipe for watering through a funnel shall be provided with a bolted connection to the bonding bar. Exothermic weld must comply to the

requirements of IEEE 837 and UL approved. Earth chamber should be strong enough to withstand heavy loads depending upon the civil requirements.

3.4 Earthing of Individual panels:

Earth pits using copper bonded solid rods need to be used. Rod of suitable diameter need to be selected as per the below chart.

Short circuit current selection of copper bonded solid rods

Sl no	Diameter of Rod (including copper coating)	Short circuit capacity		Purpose/ For Body earthing of panel boards with rated current.
		I_{pk} (10 ms)	I_{rms} (1 s)	
1	14.2 mm	31	13	Lightning protection / Up to 250A
2	17.2 mm	50	18	250A - 400A
3	20 mm	70	25	400A – 630 A
4	25 mm	105	40	630A and above

3.5 Earth electrode and installation:

High-grade solid steel rods molecularly bonded with 99.9% pure electrolytic copper with minimum coating thickness of 250 microns should be used as earth electrode. The rods must be UL listed as well as tested according to IEC62561-2 and comply to the requirements of IEC 60364-5-54. The rods also should withstand short circuit currents as per the chart above. All fasteners used should confirm to the requirements of the above standards. Earth enhancing compound (Soil conductivity improver) used should be tested according to IEC62561 – 7 from an NABL accredited laboratory. Exothermic welding material used shall be tested as per IEEE 837

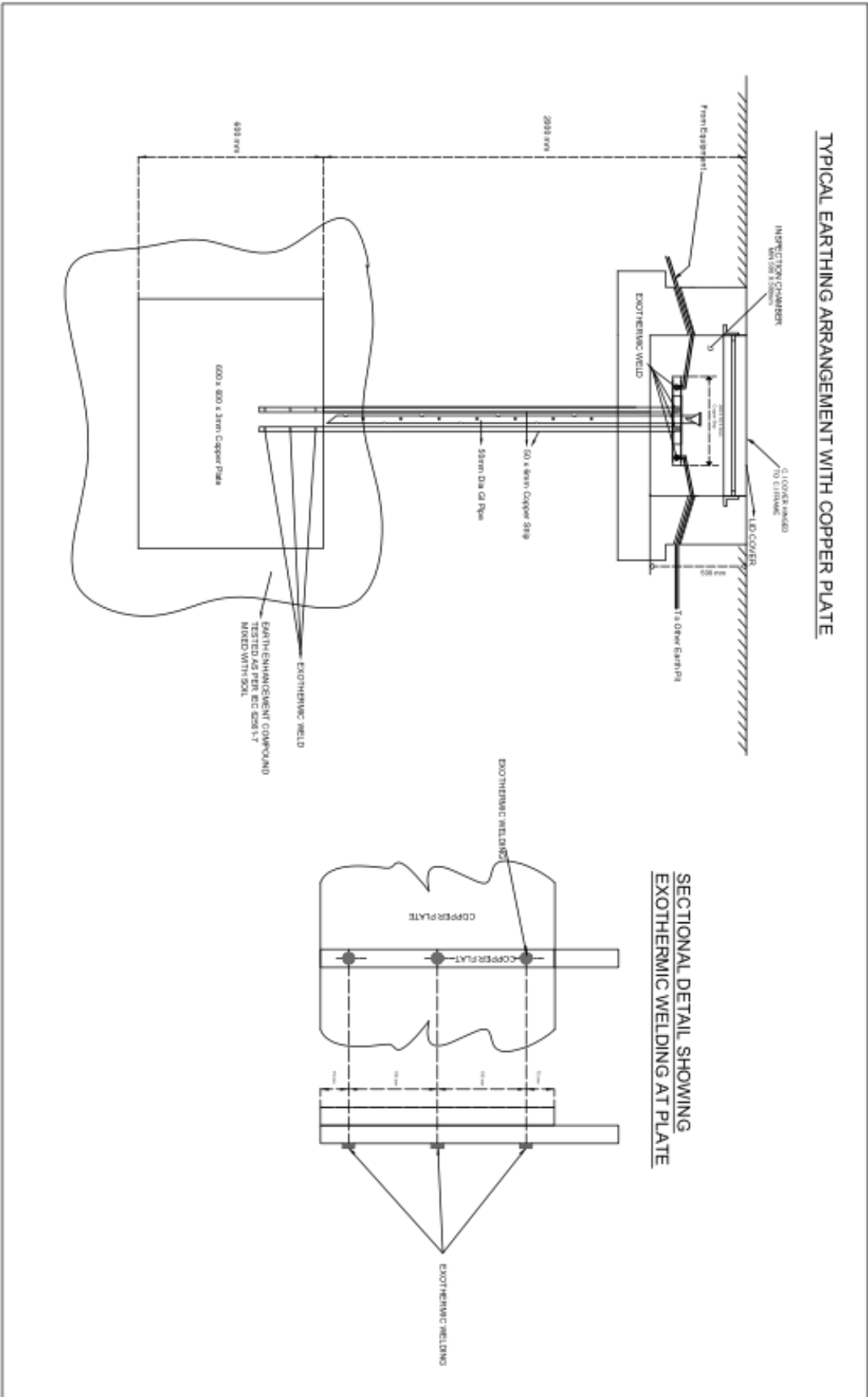
Construction of Earth Pit

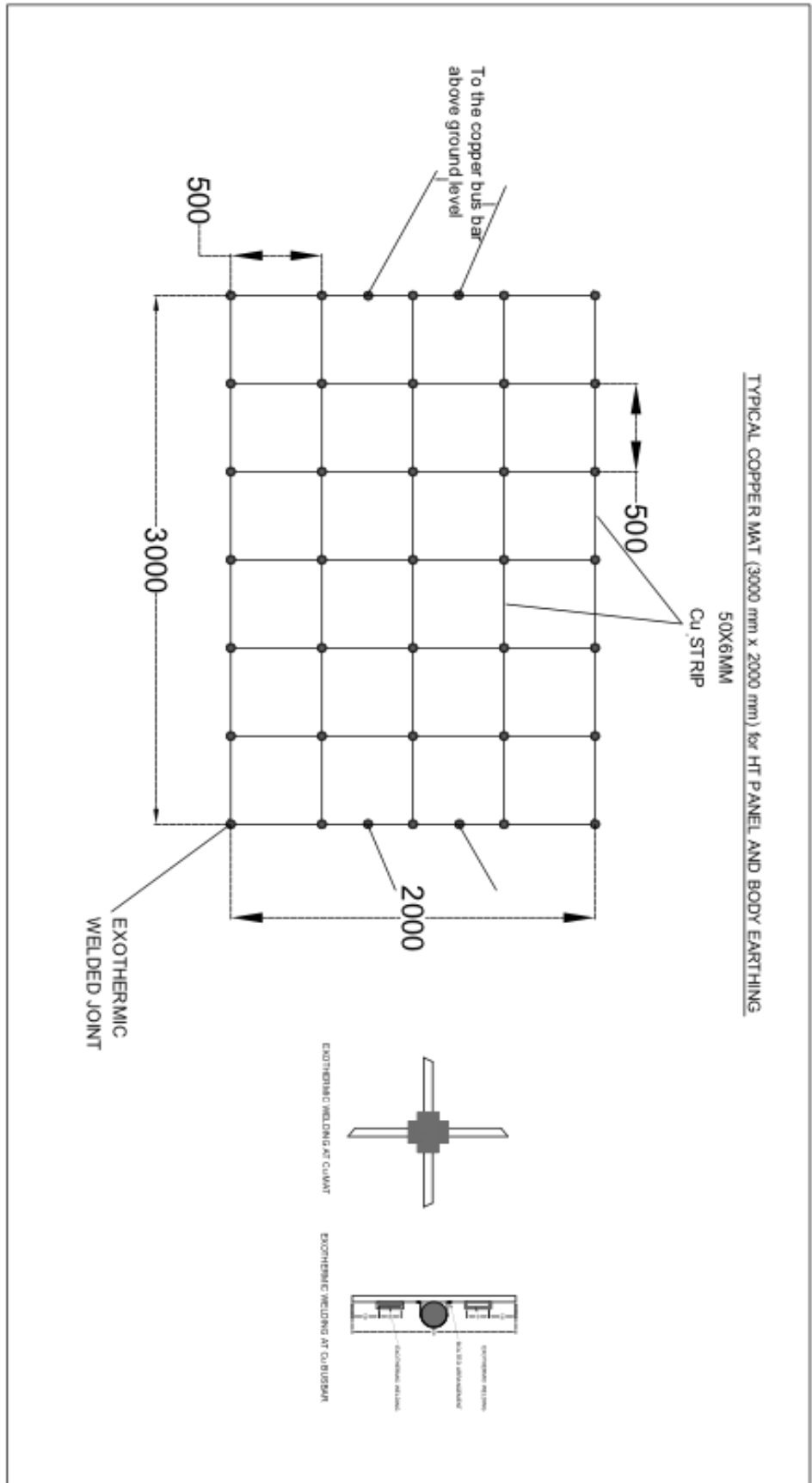
- A hole of 100 to 125 mm dia. shall be augured / dug to a depth of about 2.8 meters.
- Earth electrode of minimum 3 meters length shall be placed into this hole.
- It will be penetrated into the soil by gently driving on the top of the rod. Here natural soil is assumed to be available at the bottom of the electrode so that min 150 mm of the electrode shall be inserted in the natural soil.
- Earth Enhancing material (min 30 KG) shall be filled in to the augured /dug hole in slurry form and allowed to set. After the material gets set, the diameter of the composite structure (earth electrode + Earth Enhancing material) shall be of minimum 100 mm dia. covering entire length of the hole.
- Remaining portion of the hole is filled with backfill soil which is taken out during auguring / digging
- Connectors in the earth chamber made of Aluminum Bronze / Silicon Bronze material need to be used to connect this rod with the round / flat conductors from outside. In places where short-circuit level is more than 15 KA, (eg all panel boards, body) a copper strip of 25 mm * 6 mm with a minimum length of 150mm

- exothermically welded to the solid rod ne dot be used for bonding earth electrode with the round / flat conductors from outside. All further connections need to be done to this copper flat.

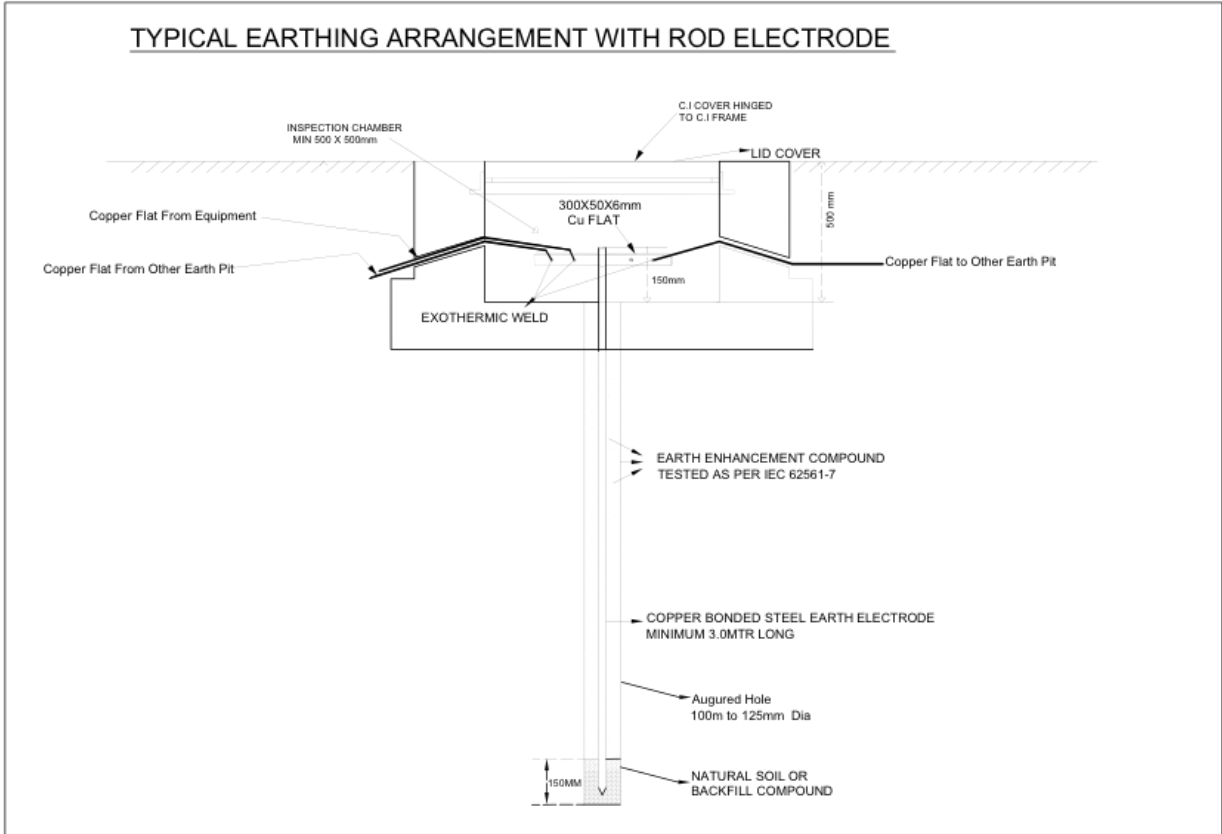
For interconnection of earth pits, SOLID copper conductors with a size of 25* 3 mm flat or 10 mm round are to be used for Lightning Protection/ General purpose. In places where high short circuit currents of more than 10 KA are expected, copper flats of 25 *6mm or 50 * 6 mm need to be used depending upon the expected short circuit level. In places where short circuit current requirements are more than 10 KA, Exothermic / Aluminothermic welding are only allowed for jointing earth electrode with round / Flat conductor. Connections with nut and bolt need to be completely avoided in applications under ground level, instead exothermic / aluminothermic welding need to be performed.

Vendor should submit test certificates of components for approval before execution of the job. Vendor should offer a guarantee of 1 year. Earthing system should offer a minimum life of 30 years





TYPICAL EARTHING ARRANGEMENT WITH ROD ELECTRODE



4.0 **Earth leads and connections**

4.1 Earth lead shall be bare copper or aluminium or galvanised steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 percent. Aluminium and galvanised steel buried in ground shall be protected with bitumen and Hessian wrap or polythene faced hessian and bitumen coating. At road crossings necessary hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles on wall so that the strip is atleast 6mm away from the wall surface.

4.2 All earth strip shall be jointed as follows:

Copper : Copper riveting with 80mm bimetallic fish plate and brazing

Aluminium : Riveting with 2Nos 100mm long bimetal fish plates

Galvanised Steel : Lap welding with 50mm minimum lap

4.3 All strips shall be run on walls/beams with 6mm thick galvanised steel earth saddles at 500mm centre to centre as shown on drawings.

5.0 **Equipment earthing**

5.1 All apparatus and equipment transmitting or utilising power shall be earthed in the following manner:

<i>Size of phase conductor</i>	<i>Copper</i>	<i>Aluminium</i>	<i>Galvanised steel</i>
Upto 16	<	Same	> 1.55
Over 16 to 35	<	16	> 32
Over 35	<	As shown on drgs.	>
Minimum (base)	2.5	4.0	6
Minimum (enclosed)	2.5	2.5	-

The protective earth continuity conductor may be drawn inside the conduit in which case, it should be insulated.

Copper earth wires shall be used where copper wires are specified. Aluminium wires may be used where aluminium phase wires are specified unless otherwise indicated in the schedule of work and drawings.

- 5.2 Metallic conduit shall not be accepted as an earth continuity conductor. A separate insulated/bare earth continuity conductor of size related to phase conductor shall be provided. Non-metallic conduit shall have an insulated earth continuity conductor of the same size as above. All metal junction and switch boxes shall have an inside earth stud to which the earth conductor shall be connected. The earth conductor shall be distinctly coloured (green) for easy identification.
- 5.3 Armoured cables shall be bonded to the earth by 2 distinct earth connections to the armouring at both the ends and the size of connection being as above. In multiple cables entering a panel/DB, the cable joints shall be bonded together using a bonding wire selected on the basis of the largest size of cable in the group. In the case of unarmoured cable, an earth continuity conductor shall either be run outside along the cable or should form a separate insulated core of the cable. 3 Ph. power panels and distribution boards shall have 2 distinct earth connections of the size correlated to the incoming cable size. In case of 1 Ph. DB's a single earth connection is adequate. Similarly for 3 Ph and 1 Ph. isolating switches there shall be 2 and 1 earth connections respectively, sizes being correlated to the incoming cable.
- 5.4 3 Ph. motors and other 3 Ph. apparatus shall have 2 distinct earth connections of size equal to incoming feeder size. For 1 Ph motor and 1 Ph apparatus, the single earth connections shall be provided of the above size.

6.0 **Earthing Installation**

- 6.1 All work shall be carried out in accordance with local Electrical Inspectorate, and IS Code of Practice 732. Reference to above codes, specifications and regulations shall mean the latest.
- 6.2 All materials used on the installation shall be new and of approved make. Tenderer should indicate makes of materials proposed to be used on the job.

7.0 **Testing**

- 7.1 The following earth resistance values shall be measured with an approved earth meggar and recorded.
- 1) Each earthing station
 - 2) System as a whole
 - 3) Earth continuity

8.0 **Mode of measurements**

8.1 Providing earthing station complete with excavation, electrode, watering pipe, soil treatment, masonry chamber with cast iron cover etc. shall be treated as one unit of measurement.

8.2 The following items of work shall be measured and paid per unit length covering the cost of the earth wires/strips clamps, labour etc.

(a) Main protective earth terminal and connections to the earthing stations

(b) Connections to the switchboard, power panels, distribution boards etc.

8.3 The cost of earthing the following items shall become part of the cost of the item itself and no separate payment for earthing shall be made.

a) Motors - earthing forming part of the cabling/wiring for the motors.

b) Isolating switches and starters should form part of mounting frame, switch starter etc.

c) Light fittings - form part of installation of the light fittings.

d) Conduit wiring - should form part of the wiring

e) Cable armouring - should form part of the cable termination.

f) Street lighting - should form part of the external cable which shall incorporate a protective earth-conductor which shall be used for earthing of the pole etc.