

## EARTHING SYSTEM

### PART 1 – GENERAL

#### 1.1 WORK DESCRIPTION

- A. This section specifies the engineering, supply, installation, testing, commissioning and setting to work of the complete earthing network for individual earthing systems, circuit protective conductors and bonding conductors. A complete earthing network comprising cables, copper tapes, electrodes and earth bonding of all relevant necessary non-current carrying metal parts of equipments/ apparatus shall have connected as required.
- B. The system shall have a common earthing system as described in the Specification and as shown on the Drawings. Individual earthing systems shall be provided as follows as per drawing. Earth main MV/LV/Generator Electrical Earthing shall have 2 connection to the earthing system:
1. MV Electrical Earthing
  2. LV Electrical Earthing
  3. Generator Earthing
  4. ELV Earthing
  5. Data Communication Earthing
- C. Sufficient numbers of electrodes interconnected by Cooper/ GI (as per BOQ) to form earthing mat so that the overall earth resistance shall be less than 1 ohm for each individual earthing mat.
- D. The number of earth electrodes of the earthing mat are indicated on the drawings as minimum. The Contractor shall test the resistivity of soil at site. Exact number of earth electrodes shall be determined by the Contractor to achieve the earth resistance value subject to Engineer approval. The complete earthing installation include earth plate, earth mat detail to achieve the earth resistance value shall be included in the Contract.
- E. The Contractor shall inform the Engineer or his representative before driving Plate/ pipe earthing into the ground so that he may supervise the operation. Driving shall be carried out only in the presence of the Engineer or the representative and all earthing plates/ pipes shall be submitted for the examination before use.

#### 1.2 STANDARDS

- A. Complete earthing system shall be engineering and constructed in accordance with the latest revision of the following standards and the appropriate BS/IEC:
1. IS: 3043 : Earthing
  2. BS6651 : Lightning Protection System
  3. IEC 61024-1-2 : Lightning Protection System
- B. The detail of the Earthing System shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.

#### 1.3 SUBMISSION

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.
- B. As minimum requirement, the submission shall include the following:
1. Shop Drawings and Sample Submission;
  2. Builder's work requirements;
  3. Testing procedures and report format for testing of the earth electrodes and/or earth strips;

4. Soil resisting test report with calculation report for the details of the earthing system detail including quantity and layout of earth electrodes and/or earth strips to achieve the required earth resistance. The report shall be endorsed by the Contractor's Installation Engineer who supervise and endorse the installation upon completion;
5. Proposed details of earthing system including quantity and layout of the earth electrodes and/or earth strips according to the calculation result.

## **PART 2 – PRODUCT**

### **2.1 GENERAL**

- A. The resistance between earthing system and the general mass of earth shall not be greater than 1 ohm.
- B. The earth loop resistance to any point in the electrical system shall not be in excess of 0.5 ohms in order to ensure satisfactory operation of protective devices.
- C. The resistance to earth shall be measured at the following:-
  1. At each electrical system ground or system neutral ground.
  2. At one point on each grounding system used to ground electrical equipment enclosures.
  3. At one point on each grounding system used to ground wiring system enclosures such as metal conduits and cable sheaths or armoured.
- D. All earthing conductors shall be of high conductivity copper/ G.I. as per B.O.Q. and shall protected against mechanical damage. The cross-sectional area of earth conductors shall not be smaller than half that of the largest current carrying conductor. However, the contractor shall use the sizes specified in the bill of quantities of the Tender. Common earth mats of resistivity of less than one (1) ohm, shall be constructed below the lowest floor structure prior to any ground work construction. The earth mats shall comprise the complete earth electrodes, earth strips/grids, earth inspection chambers, earth leads, main earth terminals, earth test link boxes at ground level, etc. Each individual earthing system shall have earth leads connecting its main earth terminal directly to an earth electrode underground as specified.
- E. All earthing products/accessories shall be according to IS standards.
- F. The mating surface of all tapes at joints etc shall be cleaned before clamping and all joints shall be riveted, joint with proper connector or exothermic welded. All connections to electrical apparatus shall be made by a bolted connection in a visible and accessible position

### **2.2 PIPE EARTH ELECTRODE**

- A. G.I. pipe shall be of medium class 100mm dia and 3m in length.
- B. G.I. Pipe electrode shall be cut tapered at bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other upto 2m of length from bottom.
- C. The electrode shall be buried in the ground vertically with its top not less than 20cm below ground level.
- D. Clamping of the earth leads to the earth rod shall be made by earth clamp. The clamps shall be capable of providing a high pressure contact between the earth rod and the earth leads to achieve a low contact resistance.
- E. When two or more electrodes are driven to form a group, the heads of the electrodes in the group shall be bonded to each other by means of a 25 mm x 3mm GI/ Copper strip, laid at a depth of at least 600 mm in soil.

- F. All earth electrode penetrations through basement water proofing membranes shall be provided with manufacturer's recommended water seal insert sleeve approved by Engineer. The installation of the water seal insert sleeve shall be under the supervision and endorsed by the manufacturer's representative to ensure the installation comply with the manufacturer installation detail.

## 2.3 PLATE EARTH ELECTRODE

- A. The plate earth electrode shall consist of copper plate or G.I. plate as per item of work. The plate electrode shall be buried in ground with its faces vertical and top not less than 4.5m below Ground level. The plate shall be filled with charcoal dust and common salt filling, extending 15cm around it's on all sides.
- B. A watering pipe of 50mm dia of medium class G.I pipe shall be provided.
- C. The top of the pipe shall be provided with a funnel and a G.I. mesh screen for watering the earth. In the case of pipe electrode a removable plug shall be provided.
- D. The earthing lead from electrode onwards shall be suitably protected from mechanical injury by a suitable dia medium class G.I. pipe in case of wire and size according to strip size.
- E. The overlapping of strips at joints shall done in approved manner
- G.I strips shall be riveted with rivets/ bolted and welded.
  - Copper strips shall be riveted with rivets/ bolted brass nuts, bolts and washers and brazed.
- F. The protection pipe within ground shall be buried at least 30 cm deep (to be increased to 60cm in case of road crossing and pavements).
- G. The portion within the building shall be recessed in walls and floors to adequate depth.
- H. In the case of plate earth electrode the earthing lead shall be securely bolted to the plate with two bolts, nuts, check nuts and washers.
- I. In case of pipe electrode, it shall be connected by means of a through bolt, nuts and washers and cable socket.
- J. Main earthing conductor is taken from the earth electrode with which the connection is to be made.
- K. No earth pit shall be fixed within 1.5 M of a wall of foundation. The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. Effort shall be made to locate them in grass lawns or near flower beds or water taps.

## 2.4 EARTH INSPECTION CHAMBER

- A. Earth electrode shall be fitted with a heavy-duty precast concrete inspection chamber/pit complete with heavy-duty cover as specified on drawings.
- B. For earth electrodes located outside or on the apron of the building, earth inspection chambers shall extend to a depth of not less than 300 mm below finished ground level and kept free of soil. For earth electrodes located inside building, earth electrodes shall be buried not less than 100 mm below the floor slab structure. Each earth electrode shall be clearly marked 'SAFETY ELECTRICAL EARTH CONNECTION – DO NOT REMOVE.
- C. The chamber and cover shall be heavy duty detail to consider the traffic load at the location of installation. The cover shall be recessed cover to receive the Architectural floor finish at the location of installation.

## 2.5 EARTH STRIP

- A. Earth strips/grids shall be of bare GI/ Copper strips of 25 mm x 3 mm as specified.
- B. Earth strips shall be riveted or joint with proper connector to earth electrodes underground below the floor slab structure, and shall be buried not less than 300 mm below the floor slab structure.
- C. In order to minimise the mutual inductance between strips, earth strips shall be positioned at a distance not less than 6m apart unless otherwise specified.

### **PART 3 – EARTH BONDING**

#### **3.1 CIRCUIT PROTECTIVE CONDUCTOR**

- A. Circuit protective conductor (CPC) is a system of conductors joining together all exposed conductive parts and connecting them to the main earth terminal.
- B. The purpose of circuit protective conductor is to provide a path for earth fault circuit so that the protective device will operate to remove dangerous potential differences during a fault condition.
- C. The circuit protective conductors shall take the form of separate cable with a sheath in green/yellow color or copper tape of minimum size 25mm x 3mm.
- D. All exposed non-current carrying metal parts of light fittings, switchgears, motors, enclosures, etc. shall be effectively earthed by circuit protective conductors for earth continuity protection.
- E. For equipment where an earth terminal is provided, the earth continuity wire shall be firmly clamped. Where no earth terminal is provided, the exposed metal part shall be cleaned of paint and surface rust before welding the earth continuity lead.
- F. The minimum size of the principal protective conductors shall be in accordance with the current edition of IS: 3043/ BS7671 and BS7430.
- G. The external earth terminal on the outside of the end panel of any switchboard shall be connected to the main earth bar provided in two independent points.
- H. Circuit protective conductors shall be provided in electrical and mechanical rooms and along the routes for the bonding of all exposed conductive parts and extraneous conductive parts. A suitably sized earth terminal shall be provided at each zone of the building for this purpose.
- I. All exposed conductive parts shall be effectively connected in an approved manner to the principal protective conductors. The circuit protective conductors shall be single core copper cables or high conductivity annealed copper tapes specified. Unless otherwise specified, the minimum cross-sectional area of the circuit protective conductors shall be selected in accordance with IS:3043/ BS7671:

**END OF SECTION**