



## SECTION – 2.13

### EARTHING & LIGHTNING PROTECTION SYSTEM

#### 1.0.0 INTRODUCTION

This section covers the requirements of earthing and lightning protection system for BESS yard and GIPCL switchyard & substation with associated buildings and structures.

#### 2.0.0 SCOPE OF WORK

The scope of work shall include the following:

- The existing earthing and lightning protection system of the 132 kV switchyard of GIPCL, switchyard of remote end (GETCO/GSS) and 70 MVA transformer yard may be utilized, subject to due validation. However, for any new or relocated equipment where the existing earthing system is not available or is found to be inadequate, a new earthing system shall be provided.  
The size, type, and design of the earthing and lightning protection system for these switchyards shall be in line with the existing system. The bidder shall refer to the available earthing system documents attached with this tender
- Buried earth mat with mild steel rod for entire BESS yard, existing 132 kV switchyards of GIPCL and GETCO end (limited bullet no 1 of clause no 2.0.0) and control buildings
- Neutral earthing of 70 MVA power transformers (limited bullet no 1 of clause no 2.0.0)
- Service transformers and auxiliary transformers.
- Equipment earthing of all the equipment in the BESS yard, 132 kV GIPCL switchyard (limited bullet no 1 of clause no 2.0.0) and Control building
- Earthing of all the electrical equipment in various buildings
- Lightning protection of BESS yard, switchyards (limited bullet no 1 of clause no 2.0.0), and control building
- Electronic earthing for UPS, SCADA & Computers/Servers.

#### 3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant IS / IEC/ IEEE standards including amendments, if any, except where modified and /or supplemented by this specification. Some of the applicable standards are listed below:

IS 3043	Code of practice for earthing
IS 2633	Methods of testing uniformity of coating on zinc coated articles
IS 6005	Code of practice for phosphating iron and steel
IS 2629	Recommended practice for hot dip galvanizing on iron and steel
IS 2309	Code of practice for the protection of buildings and allied structures against lightning
IS 4759	Hot-dip zinc coatings on structural steel and other allied products



IEC 62561-7	Requirements for earthing enhancing. Compounds & Lightning protection system components (LPSC)
IEEE: 837	Standard for qualifying permanent connections used in substation grounding
ANSI/IEEE: 80	Guide for safety in AC Substation Grounding
UL-467	Grounding and Bonding Equipment
CBIP Publication: 223	Design of Earthing Mat for High Voltage substation
CEA regulations for electrical safety	
Indian Electricity Rules/ Indian Electricity Act.	

#### **4.0.0 TECHNICAL REQUIREMENTS FOR EARTHING SYSTEMS**

##### **4.1.0 Substation Earthing System (limited bullet no 1 of clause no 2.0.0)**

- 4.1.1 The earth mat design shall be done by the Vendor as per IEEE 80. The main earth mat shall be laid in the Substation area in accordance with the approved design requirements. The scope of earthing system shall include the earthing of all the equipment in the Substation and Substation control building.
- 4.1.2 Earthing Conductor Sizing including Step & Touch potential shall be carried out for Substation in accordance IEEE-80 using grounding software.
- 4.1.3 The earthing system of Substation shall meet the following requirements:
- Ensure adequate earth fault current for operation of earth fault protection
  - Limit step and touch voltages to acceptable limits during earth fault
  - Earthing conductors and connections shall withstand earth fault current for the duration of the fault
- 4.1.4 The earth mat shall be designed with grid spacing such that safe voltage gradients are maintained. Bare mild steel (MS) to be installed below grade shall be spaced in a grid pattern to provide the earthing mesh grid throughout the site. Substation earth mat shall be interconnected with main power plant earth mat by a minimum of two parallel conductors.
- 4.1.5 The mild steel earth grid shall be designed to withstand 25 years of corrosion and still retain safe touch and step potentials in accordance with IEEE 80.
- 4.1.6 Buried earthing conductors shall have at least 600mm of earth cover unless stated otherwise. After installation, the trench shall be backfilled and firmly re-compacted to maintain structural integrity of the compacted fill materials.



4.1.7 Neutrals of 132kV systems, 11kV system and 415 V System are solidly earthed. Each neutral of transformer should be solidly connected to the grid by duplicate earth connections, one going directly to earth electrodes and other going to the common earth bus. The size of the neutral earthing conductor should in no case be less than that of the size of the main earthing conductor. System earth fault currents of 40kA for 132kV system shall be considered for earthing design. The earthing design shall be carried out as per IEEE-80 and shall consider the following:

- Soil resistivity in Substation area: Vendor shall measure actual values at site and carry out the design accordingly
- Earth fault current duration for conductor sizing : 1 sec
- Shock duration for mesh sizing : 0.5 sec
- Type of buried earthing conductor : Mild steel rod
- Type of joint for below ground earth mat : Welded
- Rate of corrosion of steel : To be decided based on soil data
- Design life for earthing grid : 25 years
- Ambient earth temperature : 40°C
- Human body weight for step / touch voltage calculation : 50kg/70kg
- Surface material : Gravel
- Resistivity of gravel : 1000 ohm

Earthing conductors or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding / cleating at intervals of 750mm. Wherever it passes through walls, floors etc., galvanized iron sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed with silicon or, PU Foam material to prevent the passage of water through the sleeves.

4.1.8 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.

4.1.9 Earthing conductors crossing the road shall be laid 300mm below road or at greater depth to suit site conditions.

4.1.10 Earthing pads shall be provided for the apparatus / equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices.

4.1.11 Steel / RCC structures & columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different sections of handrails and metallic stairs.

4.1.12 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

4.1.13 Metallic conduits shall not be used as earth continuity conductor.

4.1.14 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.

4.1.15 Light poles, junction boxes on the poles, cable and cable boxes / glands, lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which in turn shall be connected to earthing grid conductor at a minimum two points.



- 4.1.16 Earthing conductor shall be buried 2000mm outside the Substation fence. All the gates and every alternate post of the fence shall be connected to earthing grid.
- 4.1.17 Flexible earthing connectors shall be provided for moving parts.
- 4.1.18 A continuous earth conductor of 16 SWG GS wire shall be run all along each conduit run. The conductor shall be connected to each panel earth bus. All junction boxes, receptacles, switches, lighting fixtures etc. shall be connected to this 16 SWG earth conductor.
- 4.1.19 50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further, this flat shall be earthed at both ends and at an interval of 30m. The MS flat shall be finally painted with two coats of red oxide primer and two coats of post office red enamel paint.
- 4.1.20 Chemical earth pit with earth electrode shall be provided as per IS:3043 to connect down conductor of lightning mast and towers with peak.
- 4.1.21 Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making earth connection. Equipment bolted connections, after being checked and tested, shall be painted with anti-corrosive paint / compound.
- 4.1.22 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protection, the welds shall be treated with red lead and afterwards coated with two layers bitumen compound to prevent corrosion.
- 4.1.23 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
- 4.1.24 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.
- 4.1.25 All ground connections shall be made by electric arc welding. Welding shall be done with welding rod of low halogen content (7018 as per AWS/SFA-5.1 or, equivalent of IS: 814). All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
- 4.1.26 Bending of earthing rod shall be done preferably by gas heating.
- 4.1.27 Metallic sheaths and armour of all multi-core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.
- 4.1.28 Earthing terminal of each lightning arrester and capacitor voltage transformer shall be directly connected to rod earth electrode which in turn, shall be connected to station earthing grid.
- 4.1.29 All earth pits shall be chemical earth pit only.
- 4.1.30 Copper bonded earth electrode (with minimum 250 micron copper uniform coating, the copper used shall be type DHP alloy No 122 CDA, 99.5% copper) having required diameter and 3000 mm length OR Pipe in pipe type earth electrode shall be galvanized iron of minimum 40mm diameter.
- 4.1.31 Inside dimension of the earth pit shall not be less than 600x600 mm.
- 4.1.32 Top cover of Earth Pit shall be of heavy duty cast iron (600x600mm) of reputed make. Cover shall be hinged type. (HDPE/Pre cast covers are not permitted).



- 4.1.33 For earth electrode CPRI type test report shall be submitted.
- 4.1.34 Earthing system calculations / results shall consider scenario of disconnection of one of the earth conductor from the Main Earthing Grid.
- 4.1.35 Detail Bill of Material (BOM) shall be submitted during details engineering stage.
- 4.1.36 All bolt joints must be protected from corrosion by applying suitable paste / grease / petroleum jelly etc. at the time of installation. Same shall be included in the notes of all relevant drawings.
- 4.1.37 SS 304 bolts, nuts with plain and spring washer (on both sides) shall be provided for petty clamp of earth electrode.
- 4.1.38 For entry of earth wire / earth strip / earth cable to earth chamber, 75 mm PVC/HDPE pipe shall be provided at least on two sides or as required.
- 4.1.39 Each earth pit shall have permanent identification with engraved plate fixed on OR near to Earth pit. The engraving shall have sufficient depth and letter size shall be not less than 25 mm. Material of engraving plate may be aluminum / aluminum alloy / SS 304.
- 4.1.40 Date of testing, value of earth resistance measured and next date of testing shall be provided on each earth pit either by painting or by weather proof vinyl sticker. Letter size shall be not less than 25 mm.
- 4.1.41 Patty clamp shall be designed for connection of minimum 4 nos of earth wire/flat/ rod.
- 4.1.42 Petty clamp and earth conductor shall be designed so as to facilitate easy disconnection of for testing of earth resistance of earth electrode.
- 4.1.43 Top of earth rod / patty clamp shall be 75 mm below the top cover.
- 4.1.44 Earth pit shall be 50 mm above FGL
- 4.1.45 Pre galvanised GI Strip with GI coating not less than 126 micron shall be used. Sufficient documentary evidence shall furnish to verify make of GI Flat/ strip / rod used by the contractor. NO Negative tolerance on size / dimensions (Width and thickness individually) / cross sectional area of earth strip / rod etc. is permitted.
- 4.1.46 Chemical Compound (Backfill material)

The backfill material shall be highly conductive. The backfill Material shall be carbon based and of low resistance, non-corrosive, highly conductive carbon based powdered material that improves grounding effectiveness, especially in areas of high soil resistivity such as rocky and sandy areas. This material shall be suitable to be installed in either slurry or dry form. The material shall attain the hardening characteristics of cement when mixed with water or exposed to moisture while retaining its' properties. The backfill material shall confirm to the following specifications:

- Shall be highly electrically conductive and non-soluble.
- Shall not leach into ground.
- Shall have a resistivity less than 0.1 ohm meter as per clause 14.5 (d) of IEEE 80
- Shall be compatible with all copper grounding systems
- Shall contain a corrosion inhibitor to mitigate corrosion of copper
- Shall not contain hazardous chemicals
- Shall not be affected by drought and shall be stable between -10° to + 50° C temperature.
- Shall not depend on presence of moisture for conductivity but shall be electronically Conductive like metals.
- Shall be suitable for any kind of soil



- The compound should have been tested in a reputed laboratory for not containing any hazardous chemicals as per EPA Chapter 7.
- 4.1.47 For EMS/SCADA & UPS electronic earth pit shall be provided as recommended by the system supplier. The system supplier shall provide the requirements in writing for the electronic earth pit.
- 4.1.48 Auxiliary earthing mat comprising of MS rods closely spaced (300mm x 300mm) conductors shall be provided at depth of 300mm from ground level below the operating handles of the operating mechanism box of the isolators. Operating mechanism boxes shall be directly connected to the auxiliary earthing mat. Auxiliary earthmat shall be interconnected with main earth mat by welding.
- 4.1.49 All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.
- 4.1.50 Earth pits shall be located avoiding interference with road, building foundation, column, equipment foundation etc. The disconnect facility shall be provided for individual earth pits to check their earth resistance periodically. Proper symmetry and distance between earth pits shall be maintained as per applicable standards and procedures. Treated earth pits shall conform to relevant standard.
- 4.1.51 Construction of trench for earthing conductor shall include excavation, laying of conductor, back filling and compacting. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150mm. Minimum earth coverage of 300mm shall be provided between earth conductor and the bottom of trench / foundation / underground pipes at crossings.
- 4.1.52 On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured in presence of Owner's representatives. Equipment required for testing shall be furnished by Vendor.
- 4.1.53 Measurement of Ground Resistance
- 4.1.54 After completion of grounding system installation, the measurement of ground resistance shall be performed by the Vendor. Before measurement, the overhead ground wires shall be disconnected from the Substation / substation. The method of measurement shall be as per relevant standards / codes. The ground resistance of Substation grounding system shall be not more than 1 ohm.



4.1.55 Size of the earthing conductor shall be as follows:

SI.No.	Equipment	Size/ type of Earthing material
1.	Main earthing conductor	Mild steel rod of adequate size
2.	Earth risers	Mild steel rod
3.	Rod earth electrode	Copper bonded or GI pipe as per requirement
4.	Earth conductor embedded in concrete	50X6 mm MS flat
5.	Chemical earth pit	As per IS 3043 and Earthing Calculation
6.	Electronic earthing	Chemical earth pit
7.	132kV Equipment	
	a) Equipment Earth pad to structure, Structure to earth mat	2 nos. 75X8mm GS flat
	b) Control cubicle, Mechanism box	2 Nos. 50X6mm GS flat
	c) Lightning arrester Insulating base to surge counter	Min. 50mm <sup>2</sup> copper cable
	d) Lightning arrester Surge counter to earth (without touching structure)	75X8mm GS flat
	e) CVT, Wave trap, Current Transformer neutral to earth electrode	75X8mm GS flat
	f) Earth switch rod to isolator frame	2 nos. copper flexibles
8.	Tower with peak/lightning mast	
	a) Tower peak to test link	7/3.66mm galvanized steel shield wire
	b) Test link to main earth mat	50X6mm GS flat
	c) Structure to earth mat	75X8mm GS flat
9.	Bay marshalling kiosk	50X6mm GS flat
10.	11kV Switchgear	50X6mm GS flat
11.	415 V Switchgear	50X6mm GS flat
12.	415 V PDB / DCDB / Emergency DB	50X6mm GS flat
13.	LT Transformer	50X6mm GS flat
14.	Charger / UPS	50X6mm GS flat
15.	Lighting panels	25X6mm GS flat
16.	Relay panels / SAS panel	25X6mm copper flat



Sl.No.	Equipment	Size/ type of Earthing material
17.	Cable trays	50X6mm GS flat
18.	Cable trays (along each side of trench)	50X6mm GS flat
19.	CT junction box / PT junction box/ Lighting junction box (if any)	50X6mm GS flat

Note: Above specified earth materials (size & type) are minimum requirements and the earth materials shall be finalized during detailed engineering as per the project requirements.

#### 4.2.0 BESS yard Earthing System

4.2.1 Every equipment shall be effectively earthed by two separate and distinct connections to earthing system. Earthing system shall consist of interconnected earth pits electrodes connected by GS flat or Copper Clad Steel (CCS) earthing. DC-AC earthing shall be connected through test link wherever it is required.

4.2.2 Minimum size of riser conductor to connect the structures to buried earthing conductor and structure to structure in the BESS farm shall be GS Flat or CCS of Min. 80 x 6 Sq.mm size.

4.2.3 Periphery fencing wherever provided shall be earthed at every 50-meter interval with GS flat connected with DC or AC side nearest buried earthing conductor.

4.2.4 The Bidder shall furnish the detailed design and calculations for Owner/Purchaser approval as per IEEE 80 to determine the number of earth pit and size of earth conductor.

4.2.5 All the earth electrodes shall be interconnected in single network/mesh and no electrode or group of electrodes shall be isolated/islanded. These electrodes shall be uniformly distributed in the plant at maximum practical extent and location of earth electrode shall be approved during detail engineering. A continuous earth path is to be maintained throughout the plant.

4.2.6 Connection of DC earthing system and AC earthing system with location and manner of connection shall be approved during detail engineering. Bidder shall submit the design calculation of earthing system of AC and DC side as standalone (no interconnection) system.

4.2.7 Connection of riser to the structures shall be bolted or welded type. Portion of galvanized structure which undergoes welding at site shall be coated with two coats of cold galvanizing and anti-corrosion paint afterwards.

4.2.8 Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection, welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.

4.2.9 Each battery container shall be earthed in accordance with battery manufacturer guidelines.

4.2.10 Inverter functional earthing (Negative earthing, Anti PID Earthing) shall be carried out as per guideline of OEM. Bidder shall submit complete detail of such earthing from OEM and implement the earthing accordingly.

4.2.11 For Negative earthing of Inverter only copper conductor shall be used.

4.2.12 Individual Components

4.2.13 GI Earth Strip:



- GI Strip of suitable size & quantity for Main grid & structure to structure Earthing shall be selected based for the fault levels & ERT Values. Usage of GI rods for BESS Plant earth grid shall not be acceptable.
- Recommended practice for hot dip galvanized of Iron Earthing Strips - IS: 2629(1966).
- Methods of testing weight, thickness & uniformity of coating on hot dip galvanized articles – IS: 2633(1972).
- Specification for hot dip galvanized coating on fastness – IS: 5358(1969)
- Specification for Electroplating – IS:3203.
- Specification for hot dip Zinc coating on structural & other allied products - IS: 4759(1968).
- The zinc required for galvanizing shall be quality Zn-98 & shall confirm to IS: 209- 1966 and its latest amendments.
- Fully galvanized Iron strips shall be used in the Plant Area for Earthing. Galvanized Iron strips shall confirm to IS: 2629 (1966). The zinc deposition should not be less than 80 microns
- The standard length of Galvanized Iron Earthing Strip shall be minimum 7 Mtrs and not exceeding 10 Mtrs.
- The depth of the strip may be selected appropriately considering the Land condition & suitable clamping arrangement shall be selected

#### 4.2.14 Rod earth electrode

- High tensile-low carbon steel rod having diameter not less than 17mm complying with requirements of BS 4360 Grade 43A or EN10025:2-004 S275JR, molecularly bonded by 99.99% pure high conductivity copper on outer surface with copper coating thickness 250 micron or more, Length 3000 mm (minimum). Length of the electrode may be increased in multiple of 1 meter to reduce earth resistance if required. To increase the length, pieces of similar rod shall be either exothermally welded to basic 3-meter electrode or connected using socket of suitable size. These sockets shall also be molecularly bonded by 99.99% pure high conductivity copper on inner & outer surface with copper coating thickness 250 micron or more. The resistivity of each rod shall be less than 0.12 ohm as per IS 62561. The Rods shall be UL Certified.
- Gunmetal Clamps (bimetallic) ensuring solid conductivity between Earth Rod & Earth Flat shall be provided.

#### 4.2.15 Earth enhancement material:

Earth enhancement material should be a superior conductive material that improves earthing effectiveness, especially in areas of poor conductivity (rocky ground, areas of moisture variation, sandy soils etc.). It may contain conductive cement, graphite, hydrous aluminum silicate, sodium montmorillonite etc. and shall not contain bentonite. It improves conductivity of the earth electrode and ground contact area. It shall have following characteristics-

- It should have low resistivity preferably below 0.12 Ohm-meters. Resistivity shall be tested by making a 20cm. cube of the material and checking resistance across the opposite face of the cube.
- It shall not depend on the continuous presence of water to maintain its conductivity.
- It should be a little alkaline in nature with pH value >7 but <9, test certificate from NABL approved laboratory to be provided for the composition so designed.
- It should have better hygroscopic properties to absorb moisture. It should absorb and release the moisture in dry weather condition and help in maintaining the moisture around the earth electrode.
- It should have capacity to retain >10% moisture at 105°C. Test certificate from NABL approved lab to be submitted for the composition so designed.
- It should have water solubility < 5%. Test certificate from NABL approved lab be submitted for the composition so designed.
- It should be granular with granule size 0.1 mm to 3 mm.
- It should be nontoxic, non-reactive, non-explosive & non corrosive.



- It shall be thermally stable between -10 degree centigrade to +60-degree centigrade ambient temperature.
- It shall not decompose or leach out with time.
- It shall not pollute the soil or local water table and meets environmentally friendly requirement for landfill.
- It should expand & swell considerably and removes entrapped air to create strong connection between earth electrode and soil.
- It should be diffusing into soil pores and creates conductive roots enlarging conductive zone of earth pit.
- It shall be permanent & maintenance free and in its "set form", maintains constant earth resistance with time.
- It shall not require periodic charging treatment or replacement.
- It shall be suitable for any kind of electrode and all kinds of soils of different resistivity.
- It shall not cause burns, irritation to eye, skin etc.
- The Earth enhancement material shall be supplied in sealed, moisture proof bags. These bags shall be marked with Manufacturer's name or trade name, quantity, batch no & date of manufacture.

#### 4.2.16 Inspection Chamber

- 230mm Brick masonry with 450x450mm chamber & CI Cover with hinges & locking arrangement. Its construction shall be in line with IS 3043.
- Care shall be taken regarding the level of the floor surrounding the earth so that the connector is not too deep in the masonry or projecting out of it.
- Separate marker for earth pit needs to provide with date of the testing, pit number and average resistance value shall be written with yellow paint on black background.

## 5.0.0 TECHNICAL REQUIREMENT FOR LIGHTNING SYSTEMS



**5.1.0 Substation Lightning Protection System (limited bullet no 1 of clause no 2.0.0)**

- 5.1.1 Direct stroke lightning protection (DSLPL) shall be provided in the Substation by lightning masts and shield wires including connections, earth pits etc. to make the lightning protection complete for the outdoor Substation. The arrangement shall be based on DSLP calculations. Vendor shall furnish necessary design calculation for approval by Owner.
- 5.1.2 Lightning protection shall be provided for various buildings as per IS:2309.
- 5.1.3 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.
- 5.1.4 Down conductors shall be cleated on the structures at 1000mm interval.
- 5.1.5 Connection between each down conductor and rod electrodes shall be made via test joint (pad type compression clamp) located approximately 1500mm above ground level.
- 5.1.6 Lightning conductors shall not pass through or run inside galvanized iron (GI) conduits.
- 5.1.7 For the building, lightning protection system shall comprise air terminations, down conductors, test links, earth terminations and earth electrodes.
- 5.1.8 Materials for lightning protection system shall be as follows:
- 25x6mm galvanized steel strip for horizontal air termination and down conductors
  - 20mm diameter 1000mm long galvanized steel rod for vertical air termination
- 5.1.9 Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided for the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor the BESS Power plant shall be provided with Lightning Protection System (LPS) covering BESS containers, Inverter Duty Transformer (IDT), control room and balance of plant.
- 5.1.10 The lightning protection system must be completed prior to start-up of commissioning activities of the project.
- 5.1.11 The main aim of Lightning Protection System is to protect BESS components, Outdoor Electrical Equipment and buildings from any over voltage surge before it reaches the above equipment.
- 5.1.12 The minimum level of protection shall be Level IV; however, bidder shall design as per protection level based on Risk assessment.
- 5.1.13 Hot dip galvanization thickness of the materials which are applicable shall have minimum 80 microns thickness as average.
- 5.1.14 The mounting pole and supports shall be securely fixed with the brackets and PVC insulated metallic guy wires to withstand the maximum wind velocity (39m/s) of that area.

**5.2.0 Lightning Protection of BESS Yard**



- a) The BESS Yard and the other sub-system components shall be protected against lightning using Lightning arrestor and shall be as per IEC standards.
- b) The lightning system shall include lightning terminal, lightning mast, a Supporting pipe and separate Earthing arrangement with down conductor, test links and Earth pits etc.
- c) Each of the Down Conductor shall be connected to the respective Earth Electrodes in the Earth Pit. Both Earth Electrodes shall be interconnected to achieve Earth Resistance not more than 10  $\Omega$ .
- d) The structures of mounting support shall be designed considering the design wind speed, seismic zone, and maintenance requirement at site.

#### 5.2.1 Specific Requirements

#### 5.2.2 Down Conductor

- a) Down conductor shall be straight and follow a direct path to the earth electrode. Length of the conductor shall be minimized. Any joints to the down conductor shall be welded type only.
- b) The Down conductor shall be of copper in accordance with latest IS 2633 & IS 4759 standards and of minimum size 25 X 3 mm.
- c) Test link shall be provided to the down conductor at a height of one meter above the ground and there shall not be any other connection below the test link except connection to the earth electrode.
- d) Each down conductor shall be provided with a test link at 1000 mm above ground level for testing, but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.
- e) All joints in the down conductors shall be welded type.
- f) Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.
- g) Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.
- h) All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.
- i) Lightning conductors shall not pass through or run inside GI Conduits. Testing link shall be made of galvanized steel of size 25x 6mm.
- j) Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earth's oxide layer or foreign material.

#### 5.2.3 Lightning event counter

- a) The lightning event counter shall be connected in series to the down conductor which uses the current induced in a secondary circuit to activate the electromechanical counter.
- b) The lightning event counter shall be of non-electronic and non-resettable (Not require any external power supply) type lightning event counter to count the lightning stroke.
- c) The lightning event counter having display with IP-67 enclosure including all accessories and connection (6/7 digits).



#### 5.2.4 Earth Pit

- a) Each earth pit shall be provided with an earth electrode of 3m length copper bonded steel rod of diameter not less than 14 mm including accessories and masonry enclosure with cover plate as per IS 3043.
- b) The pit around the electrode shall be treated with carbon-based earth enhancement compound as required as per provisions of IS 3043.
- c) Requirements for earthing enhancing compounds shall conform to IEC 62561-7. The minimum quantity of earth enhancement compound to be used with each earth-pit shall be 25 Kg.
- d) Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance. For each earth pit, necessary Test Point shall be provided. The distance between earth pits shall be more than 3 meters.
- e) 230mm the Brick masonry with 450x450mm chamber & CI Cover with hinges & locking arrangement. Its construction shall be in line with IS 3043.
- f) Care shall be taken regarding the level of the floor surrounding the earth so that the connector is not too deep in the masonry or projecting out of it.
- g) Separate marker for earth pit needs to provide with date of the testing, pit number and average resistance value shall be written with yellow paint on black background.

### 6.0.0 DRAWINGS, DATA AND MANUAL

#### 6.1.0 To Be Submitted After Award of Contract:

- Technical data sheet
- General arrangement drawings
- Earthing layout drawing
- Earthing design calculations
- Lightning protection design calculations
- Lightning protection layouts
- Earthing installation details
- Lightning protection installation details.
- Earthing layout, earth pit drawings, and lightning protection as-built drawings for the existing 132 kV switchyard shall be prepared, incorporating both new and existing earthing systems.

Any other drawings required for statutory approvals shall also be prepared and submitted by the bidder

### 7.0.0 TESTS

#### 7.1.0 Type Test

- a) The equipment offered shall be of type tested and proven type. Type test report of latest versions shall be submitted for review.

#### 7.2.0 Routine Test

- b) The lightning protection system and its components shall be subjected to routine test in accordance with IEC standard.

#### 7.3.0 Test Witness

- c) Tests shall be performed in presence of Owner representative if so desired. The Bidder shall give at least seven (07) days' advance notice of the date when the tests are to be carried out.



**7.4.0 Test Certificates**

- d) Certified reports of all the tests carried out at the works shall be furnished in four (4) copies for approval of the Owner.
- e) The equipment shall be dispatched from works only after receipt of Owner written approval of the test reports.
- f) Type test certificate on any equipment, if so desired by the Owner, shall be furnished. Otherwise, the equipment shall have to be type tested, free of charge, to prove the design.

**8.0.0 PACKING AND DELIVERY**

The Vendor shall arrange transportation of all equipment from the point of manufacture to Owner Site. The arrangements shall include, but not be limited to, hiring adequate capacity of space, determination of routes, determination of required permits, payment of required taxes and duties, and notification to Owner.

**9.0.0 WARRANTY**

All the equipment included in the scope shall satisfy the warranty of 12 months from the date of Commissioning, or 18 months from the delivery at site whichever later.

**10.0.0 QUALITY CONTROL**

Bidder shall submit the MQAP & FAT for the Air Terminal, Lightning mast, Down Conductor, Lightning Event Counter, Support Pipe, Earthing Strips, Structures and other accessories for Lightning Protection System.