East Central Railway
Signal & Telecommunication Department

TECHNICAL CIRCULAR NO. 14

Sub: Provision of Earthing system for signaling equipments.

1. Earthing of cables, equipments is done for one or more of the following purposes-
   a) To ensure effective and rapid operation of protective equipment in the event of earth fault currents in an electrical supply system which might otherwise cause fire; and to protect against danger to life through shock due to non-current carrying equipment and metal work being maintained at a dangerous potential relative to earth.
   b) To provide an earth for telephone systems employing an earth return signaling circuit.
   c) To provide a means for the earthing of metal screens of telecommunication cables and equipment for the purpose of reducing interference.
   d) To provide direct connection with earth for discharge tubes, lighting protectors, etc.
   e) To provide an earth to block instrument working on earth return.

2. **Signalling Installations to be earthed**- Separate earthing shall be provided for the following cases-
   a) The lever frame and other metallic frames of the cabin shall be connected together to a separate earthing.
   b) Every location box where cables terminated.
   c) All types of Block Instruments block circuits working on earth return through the respective block filters & the surge arrestors provided in block.
   d) All type of chargers & transformers for feeding signals.
   e) Operating panel of relay/electronic interlocking, IPS, Data Logger, Evaluators of Axle Counters, relay and cable termination rack, EI equipment rack etc.
   f) In case of signals falling within 2 meters from the electrified track, the protective screen shall be connected to an earth.
   g) All signal posts in RE area.

3. **Limits of Earth Resistance** – The maximum earth resistance specified as-

S.N.	Items	Earth Value	Reference
a)	Earth for equipment	less than 10 ohms.	SEM Part-II, Para-22.14.2.3
b)	Earth for Block Instruments	less than 10 ohms.	-do-
c)	Earth for lightening discharger	less than 10 ohms.	-do-
d)	Axle counter cable screen in AC electrified area	less than 1 ohm.	-do-
e)	Signaling equipment with solid state components like Electronic Interlocking, Integrated Power supply, Data Logger & Digital & Analog Axle counter	less than 1 ohm.	RDSO Specification No. - RDSO/SPN/197/2008

4. **Methods of Earthing** - Following methods are used to obtain appropriate value of earth resistance -
   - Conventional Method – for 3(a), (b) & (c) - To obtain Earth Resistance less 10 ohms.
   - Low resistance Earthing & bonding system – for 3(d) & (e) - To obtain Earth Resistance less than 1 ohm.

4.1 At station where Signaling equipment with solid state components like Electronic Interlocking, Integrated Power supply, Data Logger, Digital & Analog Axle counter is/are provided, low resistance earthing & bonding system must be installed and all the indoor signalling equipment of that station building/complex must be connected to this earth by using earth busbar except block instruments for which separate conventional earth shall be provided.

4.2 Low resistance earthing & bonding system shall also be provided for electromechanical/mechanical signaling station if any Signaling equipment with solid state components is installed at the station.

5. **Location for earth-**

a) The preferable location for earth are-

- Low lying areas close to the building or equipment are good for locating earth electrode.
- The location can be close to any existing water bodies or water points but not naturally well-drained.

b) The locations to be avoided for providing earth are

- Dry sand, lime stone, granite and any stony ground.
- High bank or made up soil.

6. **Low Maintenance Earthing & Bonding system-** Earthing and bonding system shall be generally in accordance with RDSO/SPN/197/2008 (Draft) – Brief description of the system are as given below-

6.1 **Main components of low maintenance Earthing & Bonding are –**

1) Earth Electrode
2) Earth Enhancement material
3) Earth Pit
4) Equi-potential earth busbar
5) Connecting cable & tape/strip

6.1.1 **Earth Electrode-** It shall have following characteristics-

1) The earth electrode shall be made of high tensile low carbon steel circular rods, molecularly bonded with copper on outer surface.
2) The earth electrode shall be 17.0 mm diameter & 3.0 meter long and listed in Underwriter Laboratories (UL) 467-2007 or latest.
3) The minimum copper bonding thickness shall be of 250 microns.
4) The earth electrode shall be marked with UL Marking, Manufacturer's name or trade name, length, diameter; catalogue number must be punched on every earth electrode.
5) The earth electrode can be visually inspected, checked for dimensions and thickness of copper coating using micron gauge.

6.1.2 **Earth Enhancement material** - Shall be supplied in sealed moisture proof bags marked with manufacturer name or trade name, quantity etc.

6.1.3 **Backfill Material** – Sand, salt, coke breeze, cinders and ash shall not be used as a back fill material because of its acidic & corrosive nature. Only excavated soil after sieved & removing any large stone shall be placed around electrode and well compacted.

6.1.4 **Earth Pit** – Shall be prepared as per RDSO Drg.No. - SDO/RDSO/E&B/001. (Annexure-A)

6.1.4 (a) Construction of Earth Pit –

1) A hole of 100mm to 125mm dia & about 2.8 meters depth shall be augured/dug.
2) The earth electrode shall be placed into this hole.
3) It will be penetrated into the natural soil available into the bottom at about 150 mm by gently driving on the top of the rod.
4) Minimum 30-35 Kg (approx) Earth enhancement material shall be filled into the augured/dug hole in slurry form and allowed to set. After the material gets set, the diameter of the composite structure shall be minimum 100mm dia covering entire length of hole.
5) Remaining portion of the hole shall be covered by backfill soil.
6) A copper strip of 150mmx25mmx6mm shall be exothermically welded to main earth electrode for taking the connection to the main equi-potential earth bus bar in the equipment room and to other earth pits, if any. The exothermic weld material shall be UL listed and tested as per provisions of IEEE 837 by NABL/ILAC member labs.

7) The main earth pit shall be located as near to the main equi-potential earth bus bar in the equipment room as possible.

6.1.4 (b) Construction of loop earth by providing multiple earth pits-

1) At certain locations, it may not be possible to achieve earth resistance of less than 1 ohm with one earth electrode/pit due to higher soil resistivity. In such cases, provision of loop earth consisting of more than one earth pit shall be done. The number of pit required shall be decided based on the resistance achieved for the earth pit already installed.
2) The distance between two successive earth electrodes shall be minimum 3 mtrs. and maxm. upto twice the length of earth electrode i.e. 6 mtrs. approx.
3) These earth pit shall then be interlinked using 25x2 mm. copper tape to form a loop using exothermic welding technique.
4) The interconnecting tape shall be buried at depth not less than 500mm below the ground level. This interconnecting tape shall also be covered with earth enhancing compound.

6.1.4 (c) Inspection Chamber-

1) A 300x300x300mm (inside dimension) concrete box with smooth cement plaster finish shall be provided on the top of the pit. A concrete lid, painted black, approx. 50mm thick with pulling hooks, shall be provided to cover the earth pit.
2) On back side of cover, date of testing and average resistance value shall be written with yellow paint on black background.

6.1.5 Equipotential Earth Busbar and its connection to equipments & Surge protection device of equipment room- Shall be done as per RDSO Drg.No. - SDO/RDSO/E&B/002 (Annexure-B)

- The EEBs shall be installed at the height of 0.5 m from the room roof insulated from the building walls for ease of installation & maintenance. Each EEB shall be installed on the wall with low voltage insulator spacers of height 60mm.
- The insulators shall have suitable insulating and fire resistant properties.
- The equi-potential earth bus bar (EEB) shall have pre-drilled holes of suitable size for termination of bonding conductors.
- There shall be one equi-potential earth bus bar for each of the equipment room i.e. IPS/Battery charger room and EL/Relay Room and termed as Sub equi-potential earth bus bar (SEEB).
- All termination on the EEBs shall be using copper lugs with spring washers.

6.1.6 Bonding Connection-

1) To minimize the effect of circulating earth loops and to provide equi-potential bonding "star type" bonding connection is required. As such, each of the SEEBs installed in the rooms shall be directly connected to MEEB using bonding conductors. Also equipment/racks in the room shall directly connect to its SEEB. The bonding conductor shall be bonded to their respective lugs by welding.
2) All connections of bonding conductors from equipments to SEEB & from SEEBs to MEEB shall be as short as direct as possible with minimum bends and separated from other wiring.

6.1.6 (a) Material & dimensions of bonding components- For connection of individual equipments with equi-potential bus bar and earth electrode shall be as given below-

Component/Bonding	Material	Size
Main equi-potential earth busbar (MEEB)	Copper	300x25x6mm (min.)
Sub equi-potential earth busbar (SEEB)	Copper	150x25x6mm (min.)
Individual equipments to SEEB using copper lugs with stainless steel nut and bolts.	Multi-strand single core PVC insulated copper cable as per IS:264	10Sq.mm
SEEB to MEEB using copper	Multi-strand single core PVC insulated	16 Sq.mm

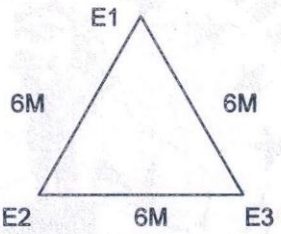
lugs with stainless steel nut and bolts.	copper cable as per IS:264	
Surge protection devices (SPD) to MEEB using copper lugs with stainless steel nut and bolts.	Multi-strand single core PVC insulated copper cable as per IS:264	16 Sq.mm
MEEB to main earth electrode.	Multi-strand single core PVC insulated copper cable as per IS:264(Duplicated)	35 Sq.mm
Main earth pit to other earth pit in case of loop earth.	Copper tape	25x2 mm

7. **Drawing of Earthing & bonding system**-The drawing of complete layout with dimensions of the earthing & bonding system shall be maintained.
(Refrence-Drg.No.-SDO/RDSO/E&B/001 & 002, Annexure-A & B)

8. **Measurement of Earth resistance** – The earth resistance shall be measured at the Main Equi-potential Earth Bus bar (MEEB) with all the pits interconnected as per SEM Part-II Para-18.44 Annexure-27.

8.1 Earths shall be tested by means of a Wheatstone bridge or a G.P.O. detector or a megger Earth tester. Two iron bars with terminals fixed on them and suitable length of wire shall be used as temporary earths.

8.2 To test an earth, iron bars shall be driven about 6m from the earth to be tested and 6m from each other as per diagram given below-



Where, E1 represents the Earth under test, E2 and E3 represents temporary earths.

Taking R1= Resistance between E1 and E2
Taking R2= Resistance between E1 and E3
Taking R3= Resistance between E2 and E3

Resistance of E1= $\frac{R1+R2+R3}{2}$

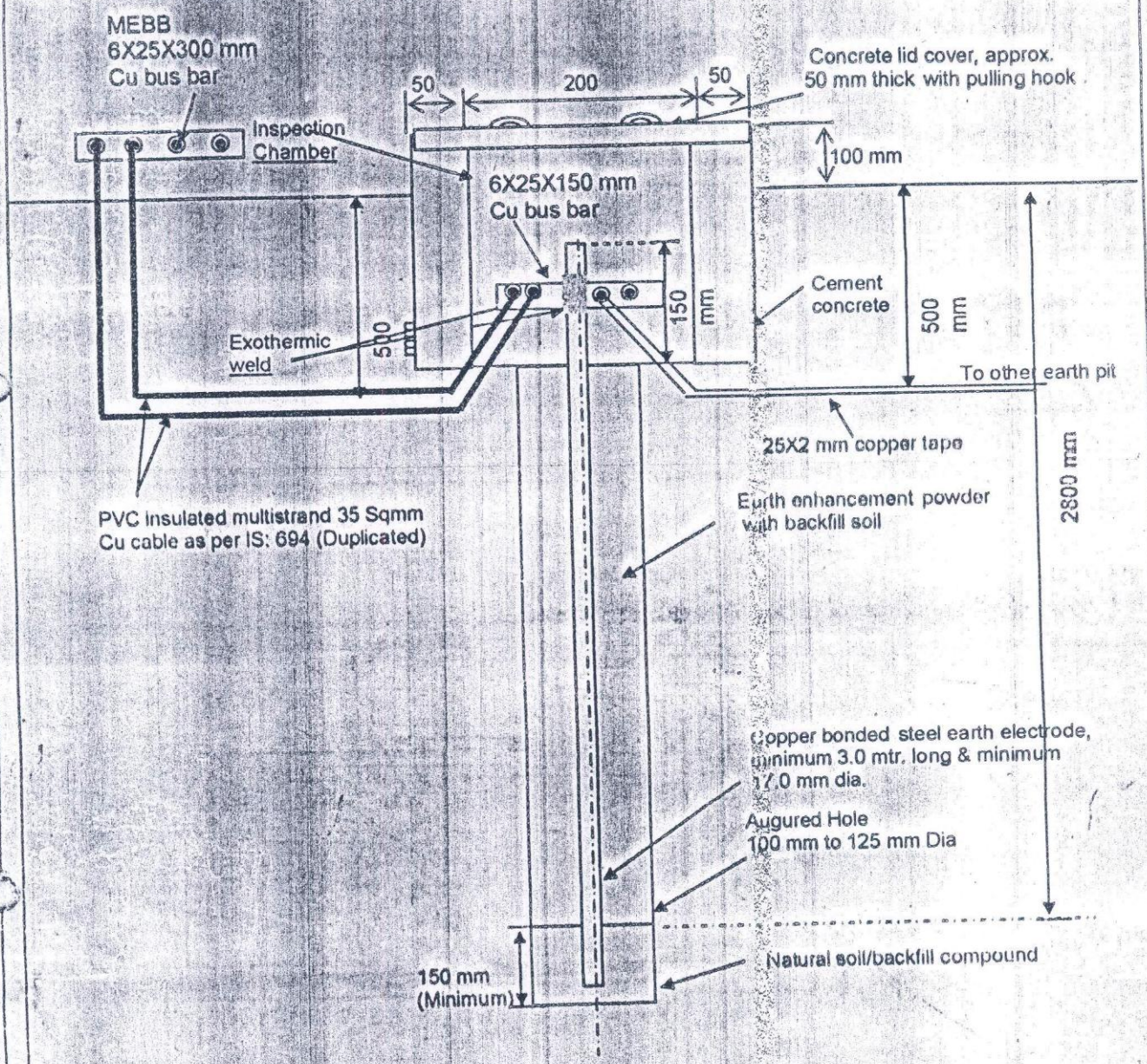
The bars shall be used as temporary earths and driven in the ground for 1m, at a time 0.25m, then pull backwards and forwards so as to leave a space for watering. Salt water shall be used to ensure that the bars make a good connection with the earth, if salt water not available, a weak solution of salamoniac in water may be used.

This issue with the approval of CSTE.

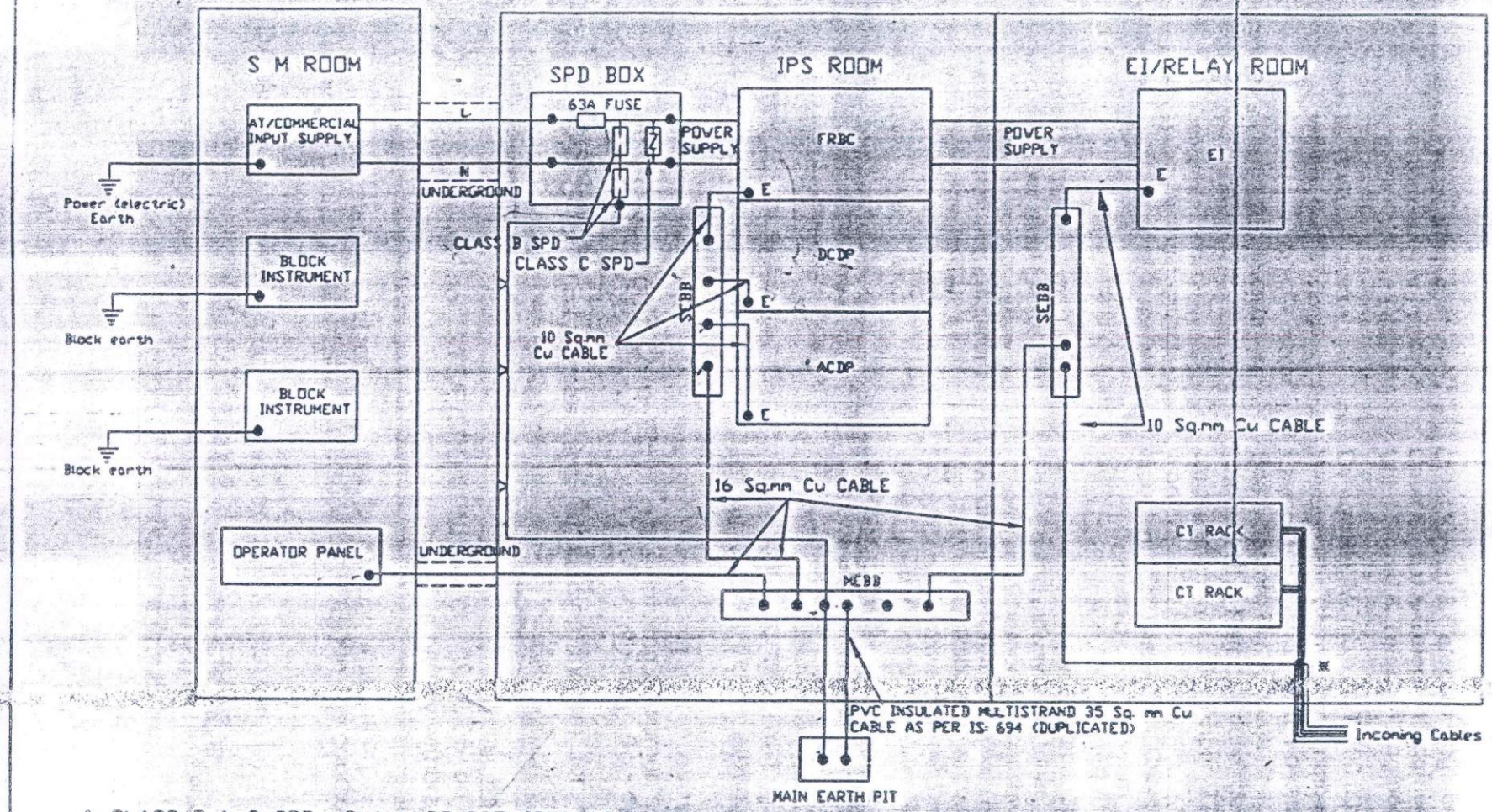
(Arun Kumar) 28/01/09
Chief Signal Engineer
for General Manager(S&T)

Docket No. - ECR/S&T/Technical Circular/185 Date – 28-01.2009

Annexure-A



JE/SE/ Sig	ADE/Sig	For DG/Sig	RDSO Typical installation of earth for S&T Installations	
			Drg. No. SDO / RDSO/ E&B/001 Date: 19.09.08	Sheet No. 1 of 1



1. CLASS B & C SPDs SHALL BE PROVIDED AS PER RDSO GUIDELINES AND FROM RDSO RECOMMENDED SOURCES.
2. * ALL THE ARMOURING OF THE CABLES SHALL BE CONNECTED TO SEBB.
3. ALL DIMENSIONS ARE IN MILLIMETER.

			R.D.S.O.	
			Typical bonding and earthing connections for signalling equipments	
JE/SE/Sig.	ADE/Sig.	For DG/Sig.	Drg. No. SDO/RDSO/E&B/002 Date : 19.09.08	Sheet 1 of 1

Annexure-B