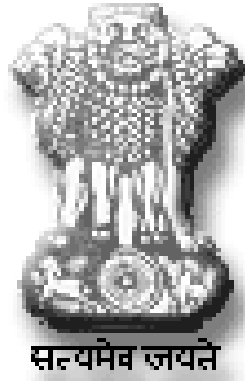


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Government of India- Ministry of Railways

**CODE OF PRACTICE
FOR
EARTHING AND BONDING SYSTEM
FOR SIGNALLING EQUIPMENTS**

(TENTATIVE)

SPECIFICATION NO. RDSO/SPN/197

Version 1.0

Number of pages – 21

Issued by

SIGNAL DIRECTORATE

RESEARCH, DESIGNS & STANDARDS ORGANISATION

MANAK NAGAR, LUCKNOW - 226011

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DOCUMENT DATA SHEET	
Designation	RDSO/SPN/197, Version 1.0
Title of Document	Specification for Code of practice for Earthing& Bonding system for signaling equipments
Authors:	Name: Hari Om Kushwaha Designation: Director/Signal, RDSO/Lko.
Approved by	Name: Shri Sandeep Mathur, Designation: Executive Director/Signal, RDSO/Lko
Abstract This document defines specification for Code of practice for Earthing& Bonding system for signaling equipments	

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DOCUMENT CONTROL SHEET

NAME	ORGANISATION	FUNCTION	LEVEL
Silas Minz, DD/SIG	RDSO	Member	Prepare
Hari Om Kushwaha, DSIG-VI	RDSO	Member	Prepare
Sandeep Mathur, ED/SIG	RDSO	Approving Authority	Approve

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Specification No.	Version	Amendment	Amendment Details	Issued On
RDSO/SPN/197/2008	---	---	---	2008
RDSO/SPN/197	1.0	---	Clauses amended:- Cl. 2, 6, 8.1, 8.2, 8.4.1, 8.4.2, 8.4.3, 8.4.4, 8.5.1, 8.5.4, 10, Drg. No. SDO/RDSO/E&B/001 Clauses included:- Cl. 2.1, 12, Drg. No. SDO/RDSO/E&B/003, Annexure-I & II	2016

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1. Scope

This document covers earthing& bonding system to be adopted for signalling equipments with solid state components which are more susceptible to damage due to surges, transients and over voltages being encountered in the system due to lightning, sub-station switching etc. These signalling equipments include Electronic Interlocking, Integrated Power supply equipment, Digital Axle counter, Data logger etc.

2. References

IS 3043	Code of practice for earthing
ANSI/UL 467	Safety for Grounding & bonding equipment
IEC 62561-2	Requirement for conductors and earth electrodes
IEC 62561-7	Requirement for earthing enhancing compounds
IEC 60068-2-52	Salt Mist Test and Humid sulphur Atmosphere Test
ASTM G 59-97	Potentiodynamic polarization resistance methods
CET/TS 14997	Leaching behaviours principles and methods
IRS:S:103 /2004	welding material for track circuit applications
IEC 62561-5	Load test for inspection chamber
IEEE Std 837 TM - 2002	Standard for qualifying permanent connections used in substation grounding.

- 2.1 Wherever, in this specification, any of the above mentioned specifications is referred by number only without mentioning the year of issue, the latest issue of that specification is implied.

3. Importance of Earthing

The installation and maintenance of an effective low resistance earthing system is essential due to the following -

- Efficiently dissipate heavy fault currents and electrical surges, both in magnitude and duration, to protect equipment being damaged so as to minimize down time, service interruption and replacement cost.
- Provide a stable reference for electrical and RF circuits at the installation to minimize noise during normal operation.
- Protection of personnel who work within the area from dangerous electric shock caused due to “step potential” or “touch potential”.

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4. Characteristics of good Earthing system

a. Excellent electrical conductivity

- i) Low resistance and electrical impedance.
- ii) Conductors of sufficient dimensions capable of withstanding high fault currents with no evidence of fusing or mechanical deterioration.
- iii) Lower earth resistance ensures that energy is dissipated into the ground in the safest possible manner.
- iv) Lower the earth circuit impedance, the more likely that high frequency lightning impulses will flow through the ground electrode path, in preference to any other path.

b. High corrosion resistance

The choice of the material for grounding conductors, electrodes and connections is vital as most of the grounding system will be buried in the earth mass for many years. Copper is by far the most common material used. In addition to its inherent high conductivity, copper is usually cathodic with respect to other metals in association with grounding sites, which means that it is less likely to corrode in most environments.

c. Mechanically robust and reliable.

5. Location for Earthing

- a. Low lying areas close to the building or equipment are good for locating Earth Electrodes.
- b. The location can be close to any existing water bodies or water points but not naturally well-drained.
- c. Dry sand, lime stone, granite and any stony ground should be avoided.
- d. Earthing electrode should not be installed on high bank or made-up soil.

6. Acceptable Earth Resistance value

The acceptable Earth Resistance at earth MEEBbusbar shall not be more than 1 ohm. For achieving this value more than one earth pits can be installed if necessary depending upon the soil resistivity.

7. Components of Earthing& Bonding system

The components of Earthing& Bonding system are-

Earth electrode, Earth enhancement material, Earth pit, Equi-potential earth busbar, connecting cable & tape/strip and other associated accessories.

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8. Design of Earthing& Bonding system

8.1 Earth Electrode

- a. The earth electrode shall be made of high tensile low carbon steel circular rods, molecularly bonded with copper on outer surface to meet the requirements of Underwriters Laboratories (UL) 467-2007 or latest as well as IEC 62561. Such copper bonded steel cored rod is preferred due to its overall combination of strength, corrosion resistance, low resistance path to earth and cost effectiveness.
- b. The earth electrode shall be UL listed and of minimum 17.0mm diameter and minimum 3 Meter long.
- c. In rocky area, a set of 3 electrodes of 1 Meter each of 17.0mm dia in grid form shall be installed in grid form.
- d. The minimum copper bonding thickness shall be of 250 microns of 99.9% electrolyte grade copper.
- e. Marking: UL marking as per UL 467 scheme, Manufacturer's name or trade name, length, diameter, catalogue number must be punched on every earth electrode.
- f. Earth electrode can be visually inspected, checked for dimensions and thickness of copper coating using micron gauge. The supplier shall arrange for such inspection at the time of supply, if so desired.

8.2 Earth Enhancement material

Earth enhancement material is a superior conductive material that improves earthing effectiveness, especially in areas of poor conductivity (rocky ground, areas of moisture variation, sandy soils etc.). It improves conductivity of the earth electrode and ground contact area. It shall be tested and confirm to the requirements of IEC 62561-7 having following characteristics:-

- a. shall be carbon based with min 95% of fixed carbon content premixed with corrosion resistant cement to have set properties. Cement shall not mix separately & shall not have Bentonite.
- b. shall have high conductivity, improves earth's absorbing power and humidity retention capability.
- c. shall be non-corrosive in nature having low water solubility but highly hygroscopic.
- d. shall have resistivity of less than 0.2 ohms -meter.
- e. shall be suitable for installation in dry form or in a slurry form.
- f. shall not depend on the continuous presence of water to maintain its conductivity.
- g. shall be permanent & maintenance free and in its "set form", maintains constant earth resistance with time.
- h. shall be thermally stable between -10⁰ C to +60⁰ C ambient temperatures.
- i. shall not dissolve, decompose or leach out with time.
- j. shall not require periodic charging treatment nor replacement and maintenance.
- k. shall be suitable for soils of different resistivity.

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- l. shall not pollute the soil or local water table and meets environmental friendly requirements for landfill, shall not be explosive & shall not cause burns, irritation to eye, skin etc. In this regard "Safety Data Sheets" shall be submitted by the manufacturers.
- m. Marking: 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 etc.

8.3 Backfill material

The excavated soil is suitable as a backfill but should be sieved to remove any large stones and placed around the electrode taking care to ensure that it is well compacted. Material like sand, salt, coke breeze, cinders and ash shall not be used because of its acidic and corrosive nature.

8.4 Earth Pit

8.4.1 Construction of unit earth pit: Refer typical installation drawing no. SDO/RDSO/E&B/001.

- a. A hole of 100mm to 125mm dia shall be augured /dug to a depth of about 3.0 meters.
- b. The earth electrode shall be placed into this hole.
- c. 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.
- d. Earth enhancement material (minimum approx. 30-35 kg) 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 (earth electrode + earth enhancement material) shall be of minimum 100mm dia covering entire length of the hole.
- e. Remaining portion of the hole shall be covered by backfill soil, which is taken out during auguring /digging.
- f. A copper strip of 200mmX25mmX6mm shall be exothermically welded to main earth electrode for taking the connection to the main equi-potential earth busbar in the equipment room and to other earth pits, if any.
- g. Exothermic weld material shall be tested as per provisions of IEEE 837 by NABL/ILAC member labs.
- h. The main earth pit shall be located as near to the main equi-potential earth busbar in the equipment room as possible.

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8.4.2 Construction of loop Earth by providing multiple earth pits

- At certain locations, it may not be possible to achieve earth resistance of $\leq 1\Omega$ 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 pits required shall be decided based on the resistance achieved for the earth pits already installed. The procedure mentioned above for one earth pit shall be repeated for other earth pits.
- The distance between two successive earth electrodes shall be min. 3mtrs. and max. up to twice the length of the earth electrode i.e. 6 mtrs. approx.
- These earth pits shall then be inter linked using 25X2mm. copper tape or 8mm round solid copper conductor to form a loop using exothermic welding technique.
- The interconnecting conductor shall be buried at depth not less than 500mm below the ground level. This interconnecting conductor shall also be covered with approximately 30 Kg of earth enhancing compound for each 3 meters length.

8.4.3 Measurement of Earth resistance

The earth resistance shall be measured at the Main Equip-potential Earth Busbar (MEEB) with all the earth pits interconnected using Fall of Potential method. The typical connection diagram used for measurement of earth resistance is as per figure no. SDO/RDSO/E&B/003.

The basic procedure of fall of potential method using four terminal equipments is as under:-

- Connect the C1 & P1 on the test set to the earth electrode as per figure no. SDO/RDSO/E&B/ 003.
- Drive a probe into the earth 30 to 60metre from the centre of the electrode and connect to terminal C2. This probe should be driven to a depth of 15 to 30cms.
- Drive another probe into the earth midway between the electrodes and probe C2 and connect to terminal P2. This probe should be driven to a depth of 6 to 12 inches.
- Measure the resistance.
- Move the potential probe 3metre farther away from the electrode and make the second measurement.
- Move the potential probe 3metre closure to the electrode and make the third measurement.
- All the three measurements shall be within a few percent of their average. The average of the three measurements may be used as the electrode/earth resistance.

8.4.4 Inspection Chamber

- Inspection chamber should be as per IEC 62561-5 or latest.

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- b. The dimension of the chamber will be of 300 x 300 x 300 mm (inside dimension) of RCC with 50mm thick and fine finish.
- c. The marking space should be present an RCC cover.
- d. The date of testing and earth resistance value shall be written on the cover with black base with yellow paint.

8.5 Equi-potential Earth Busbar and its connection to equipments & Surge protection devices in the Equipment room: Refer typical bonding connections drawing no.SDO/RDSO/E&B/002.

8.5.1 Equi-potential earth busbars

- a. There shall be one equi-potential earth busbar for each of the equipment room i.e. IPS/Battery charger room and EI/Relay room. The equi-potential earth busbars located in individual rooms shall be termed as Sub equi-potential busbars (SEEB). The equi-potential earth busbar located in the IPS /Battery charger room and directly connected to Class 'B' SPDs and the main earth pit shall be termed as Main equi-potential earth busbar (MEEB).
- b. The EEBs shall have pre-drilled holes of suitable size for termination of bonding conductors. The EEBs shall be insulated from the building walls. Each EEB shall be installed on the wall with low voltage insulator spacers of height 60mm. The insulators used shall have suitable insulating and fire resistant properties for this application. The EEBs shall be installed at the height of 0.5m from the room floor surface for ease of installation & maintenance. All terminations on the EEBs shall be by using tinned copper lugs with spring washers.

8.5.2 Bonding Connections

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 be directly connected to its SEEB. The bonding conductors shall be bonded to their respective lugs by exothermic welding.

- 8.5.3** All connections i.e routing of bonding conductors from equipments to SEEB & from SEEBs to MEEB shall be as short and as direct as possible with min. bends and separated from other wiring. However, connection from SPD to MEEB shall be as short as possible and preferably without any bend.

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8.5.4 Materials and dimensions of bonding components for connection of individual equipments with equipotential bus bar and earth electrode shall be as given below:

Component/Bonding	Material	Size
Main equipotential earth busbar (MEEB)	Copper	300X25X6 mm (min.)
Sub equipotential earth busbar (SEEB)	Copper	150X25X6 mm (min.)
Individual equipments to SEEB using tinned copper lugs with stainless steel nut and bolts.	Multi-strand single core PVC insulated copper cable as per IS:694	10 sq.mm
SEEB to MEEB using tinned copper lugs with stainless steel nut and bolts.	Multi-strand single core PVC insulated copper cable as per IS:694	16 sq.mm
Surge protection devices (SPD) to MEEB using tinned copper lugs with stainless steel nut and bolts.	Multi-strand single core PVC insulated copper cable as per IS:694	16 sq.mm
MEEB to main earth electrode	Multi-strand single core PVC insulated copper cable as per IS:694 (Duplicated)	35sq.mm
Main earth pit to other earth pit in case of loop earth	Copper tape OR solid copper round conductor	25X2 mm or 8mm dia

9. Drawing of earthing & bonding system

The complete layout with dimensions of the earthing& bonding system shall be submitted by the supplier after commissioning.

10. Warranty

The OEM shall be responsible for complete supply, installation & commissioning of the earthing& bonding system. The warranty of such system shall be 60 months from date of commissioning. During this period, any failure of earthing system due to improper materials & bad workmanship shall be attended free of cost by the OEM.

11. Maintenance of earthing & bonding system

The maintenance schedule should cover verification of earthing system conductors and components, verification of electrical continuity, measurement of earth resistance, re-fastening of components and conductors etc.

12. Tests & Requirements

Conditions of tests – Unless otherwise specified, all tests shall be carried out at ambient atmospheric conditions.

12.1 For inspection of material, relevant clauses of this specification shall also apply.

12.2 Type tests: The type test may be done in firm's premises or at NTH/NABL approved laboratory/ Internationally recognized test laboratory. The following shall comprise type tests and shall be carried out once in five years in the given sequence:-

12.2.1 Type test on earth electrode:-

The type test shall be conducted on six samples

SN	Test	Clause
a)	Visual inspection	(Cl. 12.6.1)
b)	Adherence of coating Test	(Cl. 12.6.2)
c)	Tensile strength test	(Cl. 12.6.3)
d)	Bending test	(Cl. 12.6.4)

12.2.2 Type test on earth enhancement compound:-

SN	Test	Clause
a)	Leaching test	(Cl. 12.6.7)
b)	Sulphur content	(Cl. 12.6.8)
c)	Corrosion test	(Cl. 12.6.9)
d)	Resistivity test	(Cl.12.6.10)

12.2.3 Type test on Exothermic welding connection :-

SN	Test	Clause
a)	Short time current test	Cl. 12.6.11)

12.2.4 Type test on exothermic Joints of earth electrode:-

The test shall be conducted on six earth electrode of 500mm length each and having three joints of each type in line with Annexure H of IEC 62561-2.

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SN	Test	Clause
a)	Compression test	(Cl. 12.6.12)
b)	Salt mist test	(Cl. 12.6.5)
c)	Humid sulphur Atmosphere Test	(Cl. 12.6.6)

12.3 The type test shall be carried out on 6 samples of the lot offered. The earth electrode shall successfully pass all the type tests for proving conformity with this specification. If the sample fails in any of the type tests, the purchaser or his nominee at his discretion may call for other samples of the same type and subject it to all tests or to the test (s) in which failure(s) occurred. No failure shall be permitted in the repeat test (s). At the end of the validity period or earlier if necessary, the testing authority may call for fresh samples for type testing.

12.4 Acceptance tests - The test facility should be available at manufacturers premises. The following shall comprise acceptance tests.

SN	Test	Clause
a)	Visual inspection	(Cl. 12.6.1)
b)	Adherence of coating Test	(Cl. 12.6.2)
c)	Bending test	(Cl. 12.6.4)
d)	Tensile strength test	(Cl. 12.6.3)
e)	Resistivity test (on earth enhancement compound)	(Cl. 12.6.10)

12.5 Routine test:-

SN	Test	Clause
a)	Visual inspection	(Cl. 12.6.1)
b)	Dimensional Check on earth electrode	(Cl. 8.1)
c)	Copper bonding thickness test	Cl. 8.1 (d)
d)	Weight check of earth enhancement compound	

12.6 Test Procedure:

12.6.1 Visual Inspection;- Earth electrode and earth enhancement compound shall be examined in reference to clause 8.1 and 8.2 marking and UL listing.

12.6.2 Adherence of coating Test on earth electrode;- The test shall be carried out as per clause no.9.7.1 of UL- 467. A 457mm (18in) length of rod with one end cut to a 45° shall be driven between two clamping plates or jaws of a vise set 1.02mm (0.04in) less than the diameter of the rod, so as to shear off sufficient metal to expose the bonds between the coating & rod. There shall be no Separation of the coating from steel.

12.6.3 Tensile strength test as per IEC 62561-2:- The tensile strength for a copper clad solid round steel rod shall be between 600 to 770 N/mm².

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12.6.4 Bending test on earth electrode:- The test shall be carried out as per clause no.9.7.2 of UL-467. A length of rod shall be rigidly held in a clamp or vise. A force shall be applied normal to the free end of the rod at a distance from the clamping device equal to 40 times the rod diameter. The application of the force shall be such that the rod is permanently bent through a 30° angle. There shall be no cracking of the coating when subjected to bend through a 30° angle.

12.6.5 Salt mist test as per Ann-A of IEC 62561-2:- The test shall be carried out as per clause 9.3 of IEC 60068-2-52:1996, severity 2. Three spray periods of two hrs each at a temp between 15°C to 35°C with a humidity storage period between 20h and 22h after each. The storage test in humidity chamber at 40°C ± 2°C & 90 ± 2 % RH. There should not be any visual corrosive deterioration when inspected with normal or corrective vision without magnification. 100mm from both ends of the specimen are excluded from inspection. White rust is not considered as corrosive deterioration.

12.6.6 Humid sulphur Atmosphere Test as per Ann-A of IEC 62561-2:- The test shall be carried out as per ISO 6988:1985 regarding Metallic and other non organic coatings -- Sulfur dioxide test with general condensation of moisture. There should not be any visual corrosive deterioration when inspected with normal or corrective vision without magnification. 100mm from both ends of the specimen are excluded from inspection. White rust is not considered as corrosive deterioration.

12.6.7 Leaching test on earth enhancement compound as per clause no.5.2 of IEC 62561-7;- As per Cl 2.3.1.3 of CEN/TS14997 in line with EN12457-2, Various test portions are put in contact during 48 hrs at a L/S ratio of 10ml/g with leachants the PH of which is adjusted and controlled at predetermined PH values. PH value shall be > 10.

12.6.8 Sulphur content on earth enhancement compound as per clause no. 5.3.1 & 5.3.2 of IEC 62561-7:- The test for determination of sulphur content shall be performed according to ISO 14869-1 regarding Soil quality -- Dissolution for the determination of total element content. The material is deemed to have passed the test if all measured values are less than 2%.

12.6.9 Corrosion test on earth enhancement compound as per clause no.5.5.1 & 5.5.5 of IEC 62561-7:- The corrosion rate is determined by using potentiodynamic polarization resistance methods as outlined in ASTM G59-97 and ASTM G102-89. For Cu plated earth electrode, the polarization resistance shall be >4 Ohm m² for non aggressive environment and >8 Ohm m² for aggressive environments.

12.6.10 Resistivity test on earth enhancement compound:- An earth tester with four electrode shall be used for measurement of soil resistivity. The four electrode soil box shall be made of an inert non-conductive material with four permanently mounted manufactured of mild or stainless steel.

The four-electrode method is used to measure the resistivity of earthing enhancing Compounds. Three samples of the earthing enhancement material shall be tested in a

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four-electrode soil box. With the four-electrode method, a voltage is impressed on the outer electrodes which causes current to flow. The resulting voltage drop between the inner electrodes is measured using a voltmeter and the resulting resistance is calculated.

The resistance of each earthing enhancing compound sample shall be converted to the resistivity value using the following formula: $\rho = (R \times A)/a$

Where

ρ -is the sample resistivity (Ω cm);

R -is the resistance (Ω);

$A(\text{cm}^2)$ -is the cross sectional area of the container perpendicular to the current flow

a (cm).-is the inner electrode spacing, measured from inner edges of electrodes

Sample preparation:- The sample should be reasonably large and thoroughly mixed so that it will be representative. The measured will be dependent on the degree of compaction, moisture content, constituent solubility and temperature. The effect of variation in compaction & moisture content may be reduced by fully saturating the sample before placing it into the box. This will be done by preparing stiff slurry of the sample, by adding only sufficient water to produce a slight amount of water surface, which should be allowed to evaporate before the slurry is remixed and placed in the box. Let the sample be saturated for at least 24 hours. The saturated measurement will provide an approaching minimum resistivity, and can be usefully compared with "as received" resistivity measurements.

12.6.11 Short time current test on exothermic welding connection systems as per Ann-D

of UL-467:- Exothermic welding connection systems using applicable connections & electrode shall be subjected to short time current test of 5.0KA for 10 sec. Exothermic welding connection system consisting of all type of joints shall be subjected to Short time current of 5.0KA for 10 sec duration". The grounding or bonding system shall not crack, break or melt. After the test, the continuity shall be maintained on the test sample. The continuity shall be maintained between the conductors as measured at a connection point 6.4mm (1/4 in) from the device.

12.6.12 Compression test:- As per clause 5.4.2 of IEC 62561-2:- Each specimen shall be assembled from two parts of the rods each 500mm long. The top of the specimen shall be impacted with a vibration hammer defined with the following parameters, for duration of 2 minutes:-

(a) Percussion rate $(2000 \pm 1000)\text{min}^{-1}$

(b) Single stroke impact energy (50 ± 10) Nm

The specimens are deemed to have passed the tests if their joints are not broken or do not show any crack to normal or corrected vision without magnification.

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12. Sampling plan

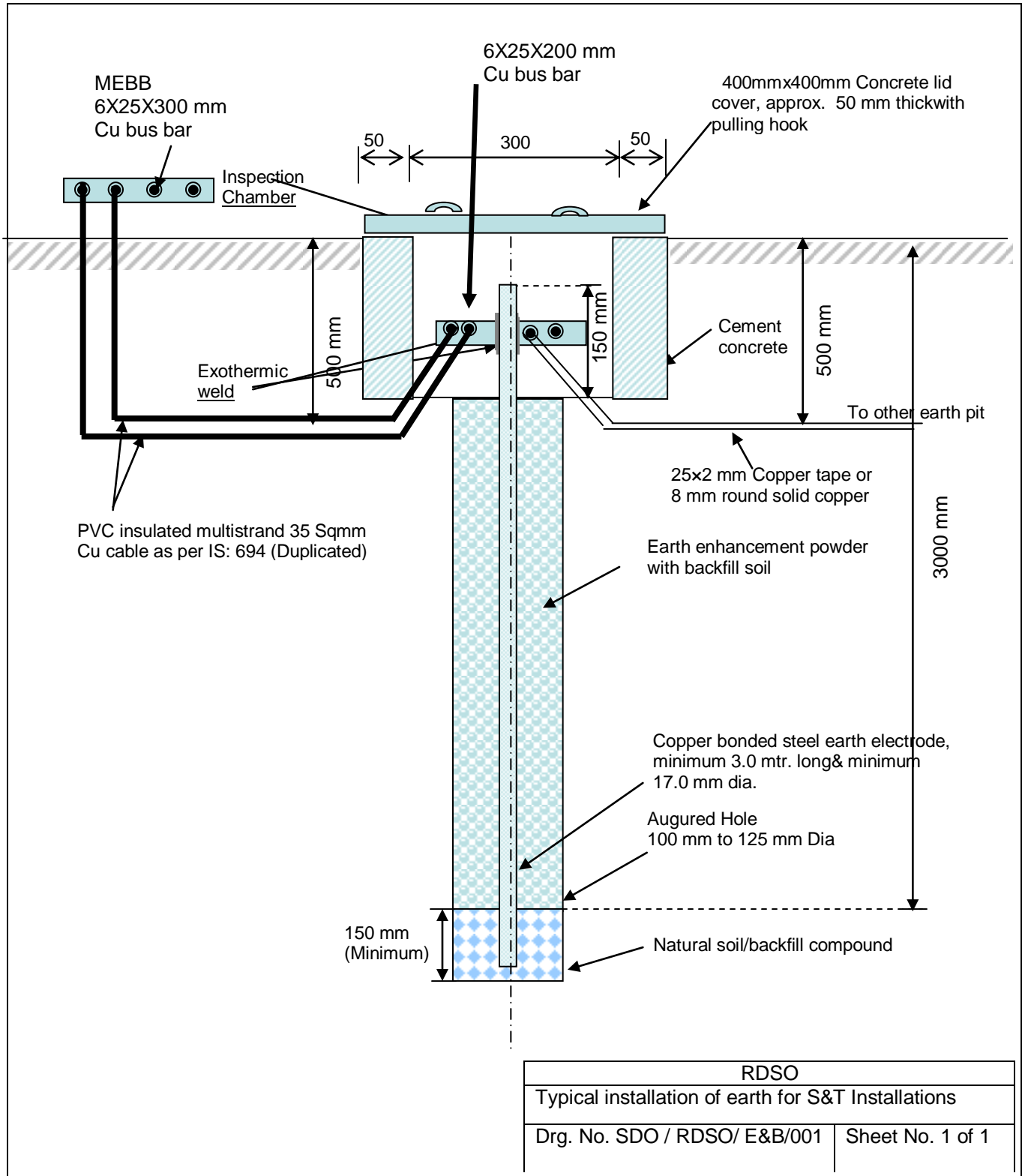
12.7 The following sampling plan for earth electrode shall be adopted for acceptance tests.

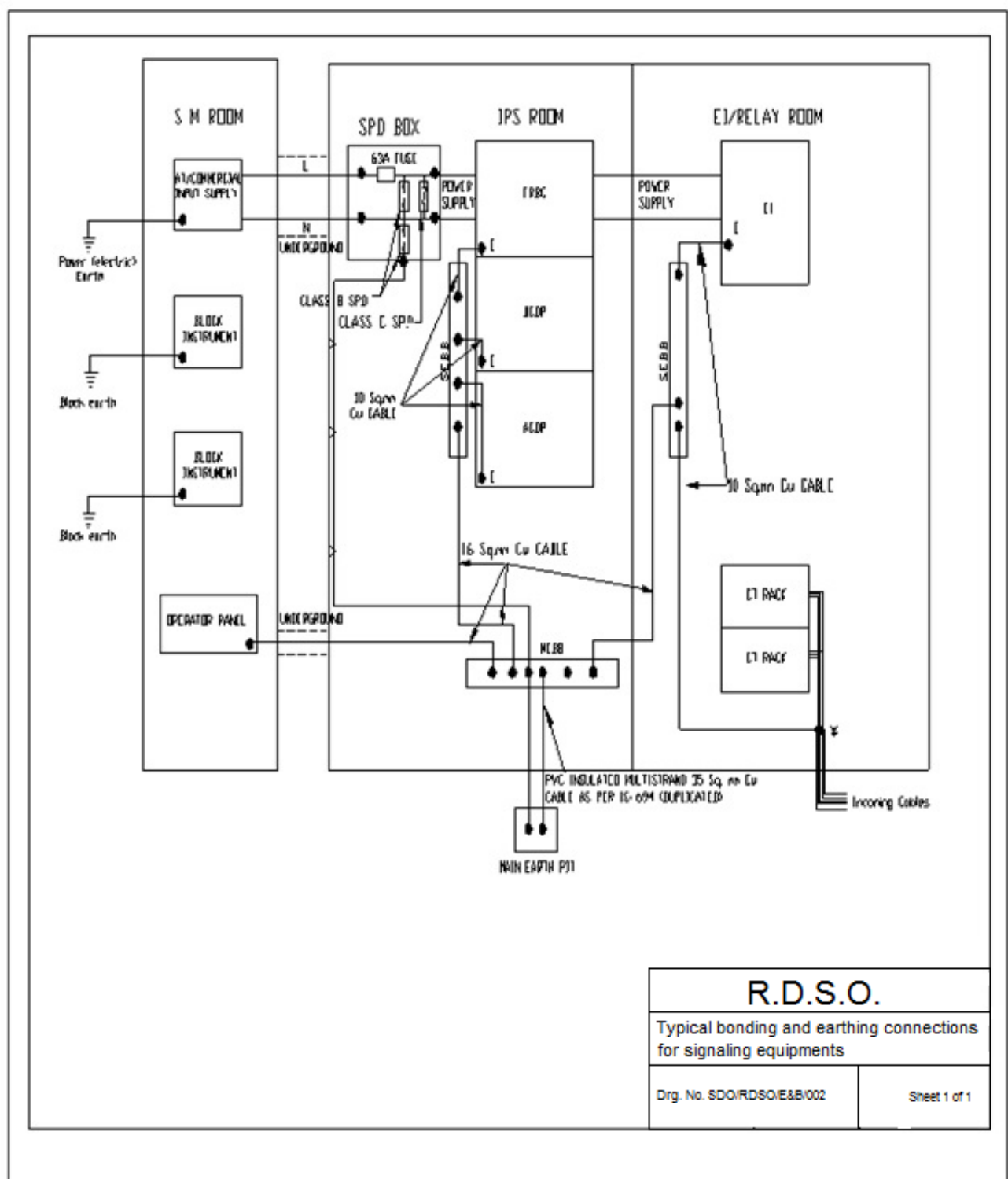
Lot size	Visual inspection/ Dimension	Adherence to coating	Bend test	Tensile strength
2-8	2	1	1	1
9-15	3	1	1	1
16-25	5	1	1	1
26-50	8	2	2	2
51-100	13	3	3	3
101-150	20	3	3	3
151-200	32	4	4	4
Above 200	15%	2%	2%	2%

12.7.2 For resistivity test min two samples shall be selected.

12.7.3 If any of the sample fails during acceptance test the complete lot will be rejected.

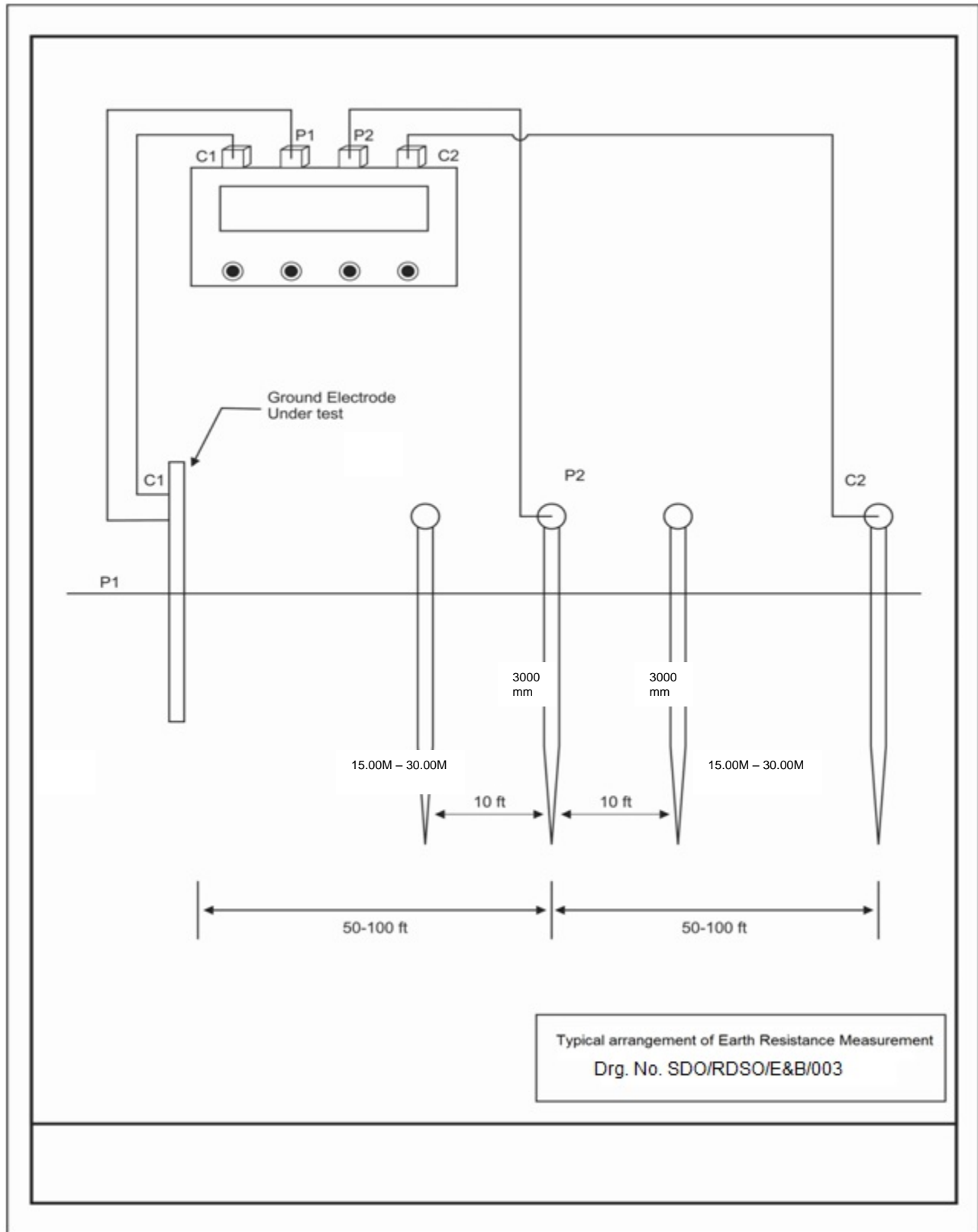
12.4.4 For load test on inspection chamber minimum 1 sample shall be selected.





R.D.S.O.	
Typical bonding and earthing connections for signaling equipments	
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Annexure-I

Precautions to be followed for execution of earthing work

1. All the material supplied for the earthing work should be inspected by RDSO.
2. Site location for earthing-
 - i) Low line areas close to the building are good for locating earth electrode.
 - ii) Dry sand, lime stone, granite and any stony ground should be avoided.
 - iii) Earth electrode should not be installed on high bank or made-up soil.
3. The copper coating on earth electrode should not be cracked due to damage during storage /transport and should be free of corrosion.
4. The packing bags of earth enhancement compound should be in sealed condition.
5. For the earth pit, a hole of 100mm-125mm dia should be augured to a depth of approx. 3m and the earth electrode is placed in the hole with about 150mm of bottom part inserted in the natural soil.
6. Earth enhancement material (minimum 30-35Kg) shall be filled into the augured hole in a slurry form such that it spreads evenly around the electrode covering entire length of the hole.
7. In order to achieve earth resistance of less than or equal to 1 ohm, multiple earth pits should be provided depending upon soil resistivity if required.
8. The distance between two earth electrodes shall be minimum 3m and maximum upto 6m (approx.).
9. The 25 x 2copper strip or 8mm round solid copper interconnecting the earth electrode shall be buried at a depth not less than 500mm below ground level and this copper strip should also be covered with earth enhancement compound.
10. Proper size of cable should be used for connection of equipments to equi-potential busbar, SPDs to equi-potential busbar, equi-potential busbar to earth electrode as indicated in the specification.
11. The length of cable connection between SPDs and equi-potential busbar and between equipment and equi-potential busbar should be as short and as direct as possible and preferably without/ minimum bends.
12. Authorized representative of the RDSO approved OEM should supervise each installation and certify that the installation is complying the requirements of the specification

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Annexure-II

Precautions to be followed for Exothermic welding of connections for Earthing& Bonding System for signalling equipments

1. Clean the surfaces of the various components i.e. earth electrode, cable, copper bus bar, copper tape and mould etc. with the help of card cloth brush before performing exothermic welding to ensure that surface is free from oil & dust.
2. Pre heat the welding surfaces of various components to ensure that the surface is free from moisture.
3. Mould used should be correct for the component size and application. Do not use worn out or broken moulds which could result in leakage of molten weld metal.
4. Ensure that handle clamp is attached to the mould and properly adjusted.
5. Ensure that all the components to be jointed properly fit into the mould and the mould is in level position.
6. Place the correct size of steel disc into the mould crucible and make sure the disc sits well at the base of the weld metal cavity.
7. Pour recommended size of weld metal powder into the mould crucible.
8. Check for leaks, make sure that weld metal do not enter into the weld cavity.
9. Ignite the weld powder at the lid opening. Use only firm's recommended igniter. Make sure that no inflammable items are around the mould.
10. Once welding is completed, wait for two minutes before opening mould to allow metal to cool.
11. Gently scrap off the un- wanted slag from the crucible with a mould scraper.
12. Clean the crucible and the weld cavity with a mould cleaning brush.
13. Welding should be carried out only by the well trained staff of the supplier.

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