पूर्व मध्य रेलवे

महाप्रबंधक
(संकेत एवं दूर संचार)
पू. म. रे., हाजीपुर

No.ECR-HQ0SnT(OTH)/7/2024
(Computer no-279747)

Dated: 16.01.2025

Sr.DSTEs
East Central Railway
DHN, DNR, DDU,SEE & SPJ

Sub: RDSO Guideline on Earthing, Bonding, Surge & Lightening Protection System for S&T Installation & TAN 3006 ver 3.0.
Ref: RDSO-SIG0SPD(PROJ)/1/2020, Dtd.-01.01.2025 & Dtd.-08.01.2025.

Vide above referred letter Guide line & TAN have been issued by RDSO for Earthing, Bonding, Surge & Lightening Protection System for S&T Installation.

As directed by RB during CSE's Conference held on 13th Jan'14, please nominate an Officer from your division to go through the above referred guideline & TAN on the subject who will outspread the Technical details down below upto SIMs level by holding meeting/seminar or other Audio/Video mediums.

Report of the meeting/seminar or other efforts may be communicated to this office for record.

DA: Above referred letters

16.1.25
(Rajiva Shekhar)
ASTE/D&D-II
For GM (S&T)/ECR/HJP

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सत्यमेव जयते

Government of India - Ministry of Railways
Research Designs & Standards Organisation
LUCKNOW – 226011
Room No. 206, II floor,
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Manak Nagar, LUCKNOW – 226011

No- RDSO-SIG0SPD(PROJ)/1/2020 Date- 08.01.2025

महाप्रबंधक (सि० दू० सं०)	सि० दू०सं० (निर्माण)	**GM** S&T S&T/CONST.
1. मध्य रेलवे, मुम्बई (सीएसटी)–01		Central Railway, Mumbai, CST- 400 001
2. पूर्व रेलवे फेयरली प्लेस, कोलकाता–01		Eastern Railway, Fairlie Place, Kolkata -700 001
3. उत्तर रेलवे, बडौदा हाउस, नई दिल्ली–01		Northern Railway, Baroda House, New Delhi – 110 001
4. पूर्वोत्तर रेलवे, गोरखपुर–12		N.E. Railway, Gorakhpur – 273 012
5. उत्तर सीमान्त रेलवे, मालीगांव, गुवाहाटी–11		N.F. Railway, Maligaon, Guwahati -781 011
6. दक्षिण रेलवे, पार्क टाउन, चेन्नई–03		Southern Railway, Park Town, Chennai-03
7. दक्षिण मध्य रेलवे, सिकन्दराबाद–500 071		S.C. Railway, Secunderabad – 500 071
8. दक्षिण पूर्व रेलवे, गार्डन रीच, कोलकाता–43		S.E. Railway, Garden Reach, Kolkata -700 043
9. पष्चिम रेलवे, चर्चगेट, मुम्बई–20		Western Railway, Churchgate, Mumbai – 400 020
10. पूर्वीतट रेलवे, भुवनेष्वर–01		East Coast Railway, Bhubneshwar – 751 001
11. उत्तर मध्य रेलवे, इलाहाबाद–01		North Central Railway, Allahabad – 211 001
12. दक्षिण पूर्व मध्य रेलवे, बिलासपुर–01		South East Central Railway, Bilaspur – 492 001
13. दक्षिण पष्चिम रेलवे, हुबली–20		South West Railway,Club Road, Keshavpur, Hubali-580020
14. पष्चिम मध्य रेलवे, जबलपुर–01		West Central Railway, Jabalpur – 482 001
15. उत्तर पष्चिम रेलवे, जयपुर–01		North West Railway, Jaipur – 302 001
16. पूर्व मध्य रेलवे, हाजीपुर–01		East Central Railway, Hajipur – 844 101

Sub: TAN 3006 ver 3.0 on Earthing , Bonding, Surge & Lightning Protection System for S&T Installation. Reg.

A Technical Advisory Note (TAN 3006 ver 3.0) on Earthing, Bonding, Surge & Lightning Protection System for S&T Installation has been prepared and issued for use of Zonal Railways. The same is attached herewith.

This has approval of competent authority.

DA: As above (13 pages)

YOGENDRA PRATAP SINGH
2025.01.08 15:49:39 +05'30'

(Y.P.Singh)
Dir/Signal III
For DG/S&T

SN.	Description
	Effective protection of signaling equipment from lightning and surge-induced damages is crucial for ensuring safe and reliable railway operations. To address this, RDSO has issued specifications, Technical Advisory Notes (TANs), guidelines etc. on Earthing, bonding, surge and lightning Protection. The initial TAN, STS/E/TAN/3006 Ver 1.0, was released on 02.11.2012 for the Earthing and Bonding scheme of Electronic Interlocking systems. Subsequently, RDSO, in collaboration with IISc Bangalore, developed a comprehensive scheme for the Lightning and Surge Protection of signaling equipment, leading to the issuance of TAN STS/E/TAN/3006 Ver 2.3, currently under trial in various zones. However, audits of S&T installations by RDSO have revealed deviations from specifications, a lack of adherence to TAN instructions and inadequate knowledge. Therefore, a revised TAN STS/E/TAN/3006 Ver 3.0 is being issued to ensure proper implementation of Earthing, Bonding, Surge, and Lightning Protection measures at field sites. This revised TAN is based on RDSO Specifications RDSO/SPN/197 Ver 1.0, RDSO/SPN/144/2006 Rev 2, IEC Standard 62305, the National Building Code of India 2016, Guidelines for "Earthing, Bonding, Surge, and Lightning Protection" issued on 01.01.2025 etc. It aims to ensure the proper implementation of protective measures at field sites.
1.	**Earthing and Bonding System**
1.1	**Components of Earthing and Bonding System:**
	The components of Earthing & Bonding system are: a) Earth electrode b) Earth enhancement material c) Earth pit d) Equi-potential earth busbar e) Connecting cable f) Exothermic Weld Material & Mould g) Copper or GI tape/strip and other associated accessories. The list of components to be procured for the Earthing and Bonding system is attached as **Annexure-I** and must be strictly adhered to.
1.2	**Location for Earthing**
	a) A flat area on natural soil close to the building or equipment is ideal for locating earth electrodes. b) Dry sand, lime stone, granite and any stony ground should be avoided. c) Earthing electrode should not be installed on high bank or made-up soil.

1.3 Installation of Earthing & Bonding System

a) The installation of the earth system shall be carried out as per the drawing attached in **Annexure-II**, ensuring the following:
   i. No hammering shall be done on the earth electrode during installation.
   ii. All materials used for the installation of the earth system shall be anti-corrosive.
   iii. The earth pits shall be interlinked using a 25 x 2 mm copper conductor with proper exothermic welding.
   iv. As per Para 8.4.2 (d) of RDSO/SPN/197 V1.0, the interconnecting conductor shall be buried at a depth of not less than 500 mm below the ground level. This conductor shall also be covered with approximately 30 kg of earth enhancement compound for every 3 meters of its length.

b) The installation of Earthing and Bonding for **all S&T installations** (EI, PI, RRI, Auto Hut, IBS, LC, Telecom hut etc.) shall be as per **Annexure-III (a) or (b)**. Separate earth is applicable for only those equipment's which work on earth return such as SGE Block Instrument.

c) The procedure of Exothermic welding, as outlined in **Annexure-IV shall be followed**.

d) The **OEM shall be responsible** for complete supply, installation & commissioning of the Earthing & Bonding system.

e) The **Pre-commissioning checklist** shall be followed during installation. This has been reiterated by this office letter no. RDSO-SIG0EnB(GEN)/1/2020 dt. 18.07.2024 and also included in guidelines for earthing, bonding, surge and lightning protection issued on 01.01.2025.

f) **OEM Certificate** shall be obtained from OEM, after the installation of Earthing & Bonding system. Warranty of such system shall be **60 months from date of commissioning**.

g) The **Earthing & Bonding plan** should be available at the Station.

h) The overall Earth resistance value for the earth connected with MEEB shall be less than 1 ohm. If necessary multiple earth shall be provided in loop to achieve earth resistance less than 1 Ohm.

i) The distance between two successive earth electrode shall be not **less than 3 meter and more than 6 meter**.

j) It is recommended that, multiple earth pits shall be installed around the perimeter of the building. However, at some locations, it may not be possible to form a perimetric earth around the Relay room, Power supply room and Station master room. In such cases, ring earthing arrangements consisting of interconnected multiple earth electrodes may be installed in the available free space as close as possible to the station building. A Sample drawing is attached as **Annexure III** for reference.

k) Earth pits shall be installed at least one meter away from building wall.

l) Minimum 20 meter distance should be maintained between electrical and S&T earth.

1.4	**Measurement of Earth Resistance**
	a) The individual earth resistance value shall be measured and recorded before equipotential bonding. b) After installation of the Earthing & Bonding system, the final earth resistance value shall be measured at the MEEB or Equipment end. c) The earth value shall preferably be measured with Clamp meter.
1.5	**Other Important Points for Earthing and Bonding**
	a) PVC insulated multi-strand single core 4 X 35 sq. mm copper cable or 2 nos of 25 X 2 mm copper tape to be used for connecting MEEB to nearest earth electrode. b) PVC insulated multi strand single core copper cable as per IS:694 shall be used and connected using tinned copper lugs with stainless steel nut and bolts as: i. For individual equipment earthing to SEEB/ BRC -**10 sq.mm** ii. For connecting SEEB/BRC to MEEB or CTR to BRC - **16 sq.mm** iii. For connecting Surge protection devices (SPD) to MEEB - **16 sq.mm** c) **Main equi-potential earth bus bar (MEEB)** Copper strip size of 300X25X6 mm and **Sub equi-potential earth bus bar (SEEB)** Copper strip size of 150X25X6 mm minimum shall be used. d) Main Equipotential Earth Busbar (MEEB) shall be installed not more than 0.5 m from LPD/SPD Box and preferably near the SMR rack of IPS. **(Annexure V)** e) The Bonding Ring Conductor (BRC)/ Common Bonding Network (CBN) has the objective of maintaining the same reference potential. Hence, all equipment shall be connected to the nearest point on the BRC using bonding wires routed through the floor of the room. Routing through the floor ensures the shortest path and prevents the earth wire from running parallel to any power/data cables. It is mandatory that a complete close loop has to be formed for BRC. f) There should not be any loose connection between any earth conductors connected for earthing and bonding system. g) There should not be any Loop in earthing bonding conductor. h) The exothermic material used for exothermic welding must be UL-listed and consumed in the quantity specified by the OEM. i) Armour of all cables to be properly earthed at both ends. j) The Earth & Bonding system shall preferably be safeguarded with suitable fencing. k) The checklist for earthing & bonding, surge and lightning protection sytem shall be completed before commissioning to ensure proper installation. **(Annexure VII)** l) The maintenance of the earthing system shall be carried out as per the schedule mentioned in IRSEM.

2.	**Lightning and Surge Protection System**
2.1	**External Lightning protection / Class A protection**
	a) Latest guidelines issued by the RDSO/Railway Board shall be followed for Class A protection. As per NBC 2016, radioactive terminals, such as dissipation systems, ESE, or CSE air terminals, are not permitted. b) The down conductor shall consist of a 50 sq mm copper-bonded steel conductor, securely connected to the air terminal and the earth pit. c) The down conductor/ earth bonds/ Cables/ Wires shall be connected to the earth using the shortest possible path.
2.2	**Surge Protection**
	1. The appropriate rating of the SPD shall be provided as specified in the RDSO specifications and the Guidelines issued for Earthing, Bonding, Surge, and Lightning Protection dated 01.01.2025 or latest. 2. If power supply /data / signaling lines (AC/DC) are carried through overhead wires or cables above ground to any nearby building or any location outside the equipment room, additional protection of Stage 2 (Class C) type shall be used at such locations for power supply lines and Stage 3 protection for signal / data lines. 3. **Indicative type pluggable SPDs with PFC contact** Type I/Type II and **Indicative type pluggable/modular SPDs** with PFC contact Type III shall be used. 4. Ensure the wiring of the Available PFC contact of SPD in Datalogger. 5. The SPD/LPD box shall be installed in such a manner that the power cable serving as input to the IPS does not cross any other cable. 6. The SPD and equipment shall be connected in the **shortest possible path**. Additional SPD (Type II) is provided in the equipment rack if the distance between SPD and Equipment is more than 10 meter. 7. Test report of SPD's as per IEC standard shall be shall be ensured.
3	**Segregation of electrically Dirty and clean wiring:**
3.1	Conductors entering the building could be carrying lighting currents or voltage transients and hence are considered to be "dirty". Internal conductors after the earth bonding point, and SPDs, are considered "clean". All such cables/conductors should be classified as" clean "or "dirty" and segregated accordingly.
3.2	All earth bonds, cables and wires classified as "dirty" must not run through cable trays carrying "clean "signaling and "clean" Power circuits.
3.3	The wires of all circuits including power circuits as applicable shall be twisted or at least bundled ensuring that for every B (+ve) there is the complementary N (-ve) in the twist or bundle and for every BX there is the complementary NX in the twist or bundle. All wiring must be twisted wherever possible so opposite poles are always in close proximity.

Annexure-I

Part List

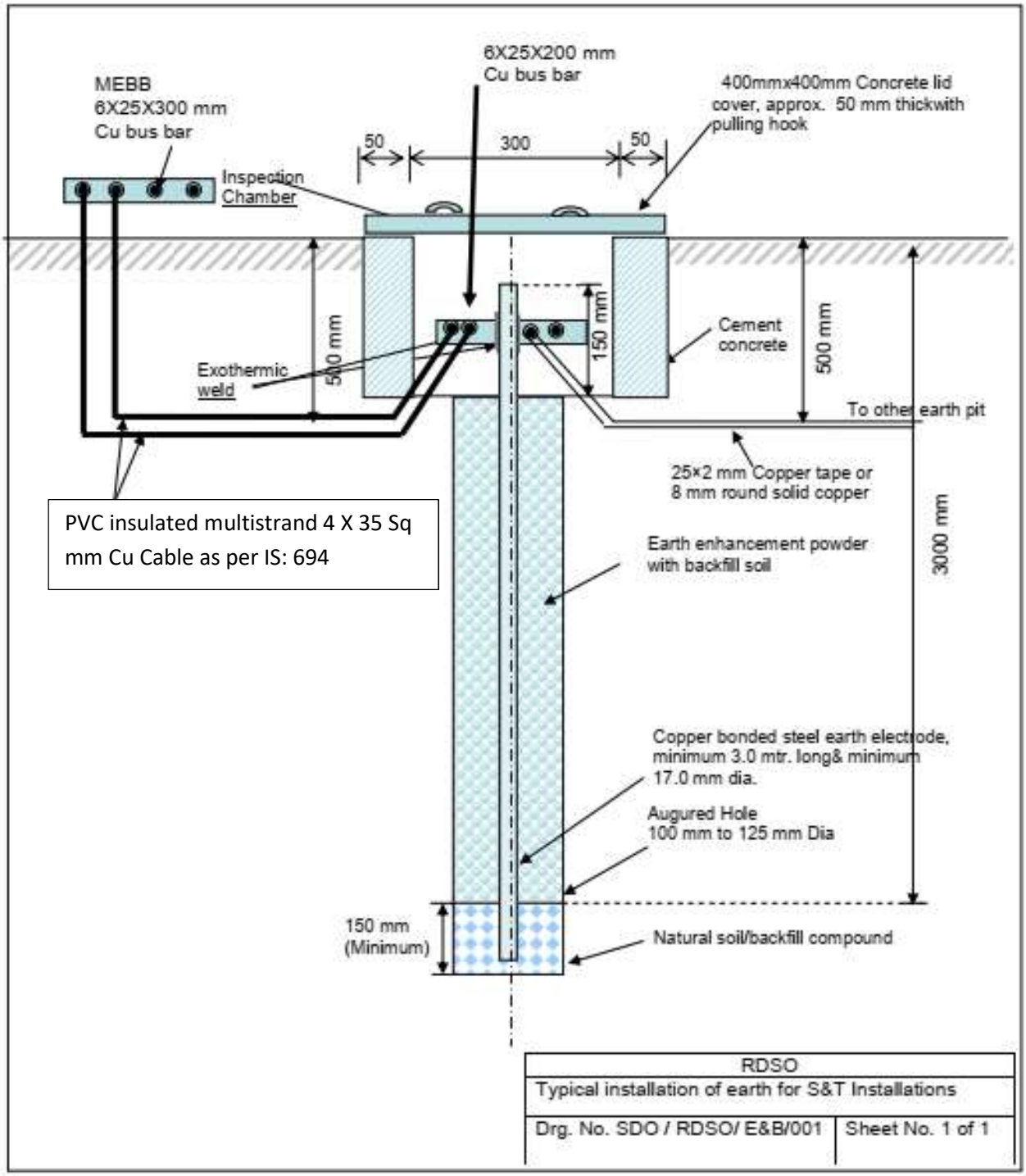
(**Ref:** Annexure I of Guidelines for Earthing, Bonding, Surge and Lightning Protection System)

SN	Item/ Component	Size	Quantity
1	Earth Electrode	Dia- 17 mm Length- 3 mtr	1
2	Earth Enhancement Material	30- 35 Kg	1
3	Main equipotential earth busbar (MEEB)	300X25X6 mm (min.)	1
4	Sub equipotential earth busbar (SEEB)	150X25X6 mm (min.)	1
5	Multi-strand single core PVC insulated copper cable as per IS:694 used to connect individual equipment to SEEB	10 Sq mm	As per site requirement
6	Multi-strand single core PVC insulated copper cable as per IS:694 used to connect SPD to MEEB	16 Sq mm	
7	Multi-strand single core PVC insulated copper cable as per IS:694 (4 Nos) used to connect MEEB to Main earth electrode	35 Sq mm	
8	Copper tape or solid copper round conductor used to connect Main earth pit to other earth pit in case of loop earth	25 X 2 mm or 8 mm dia	
9	Copper strip to be exothermically welded to earth electrode	2000X25X6 mm (min.)	1
10	Exothermic Weld Material & Mould	-	As per site requirement

Annexure-II

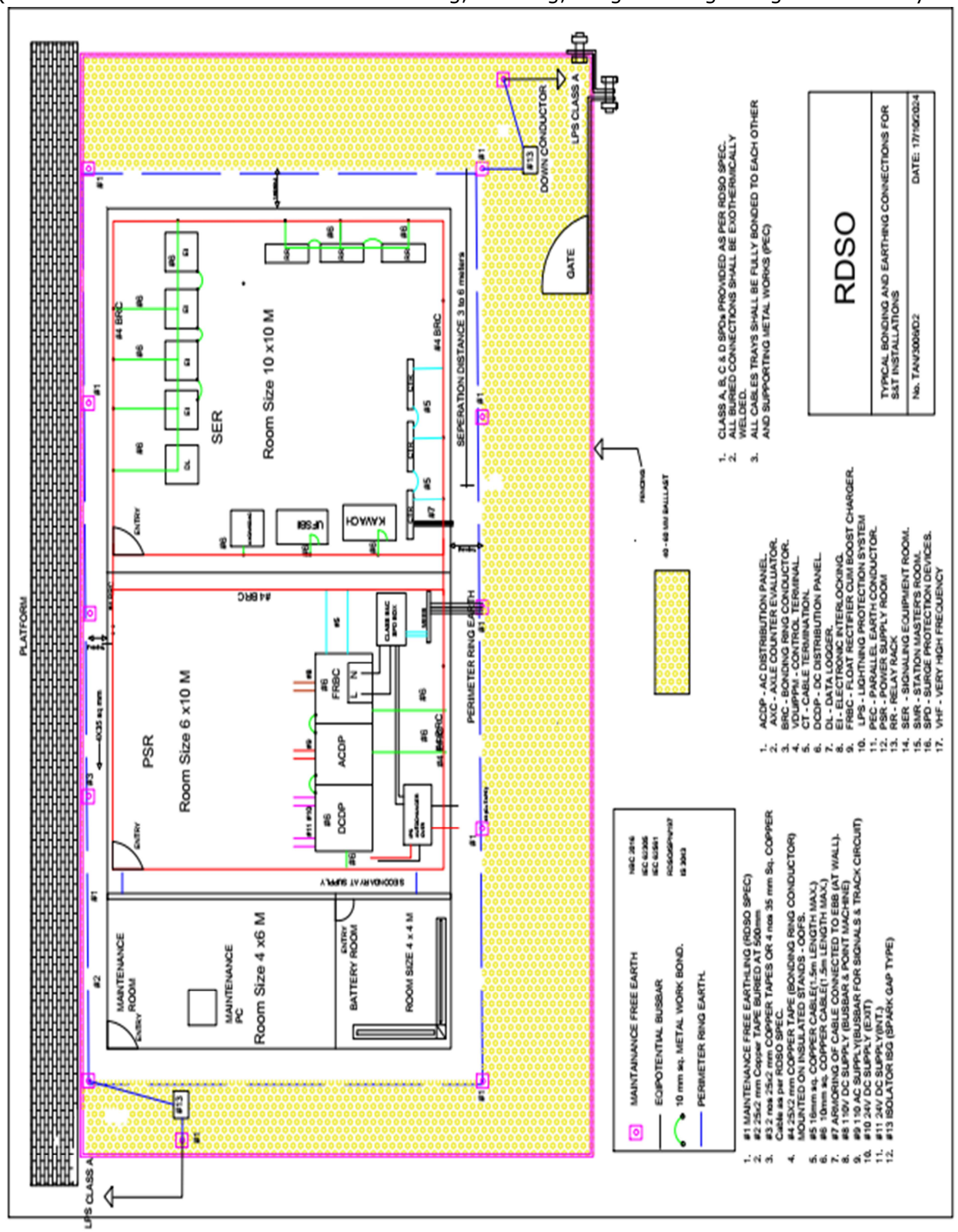
Drawing for Typical Installation of Earth

(**Ref:** RDSO/SPN/197 Ver 1.0)



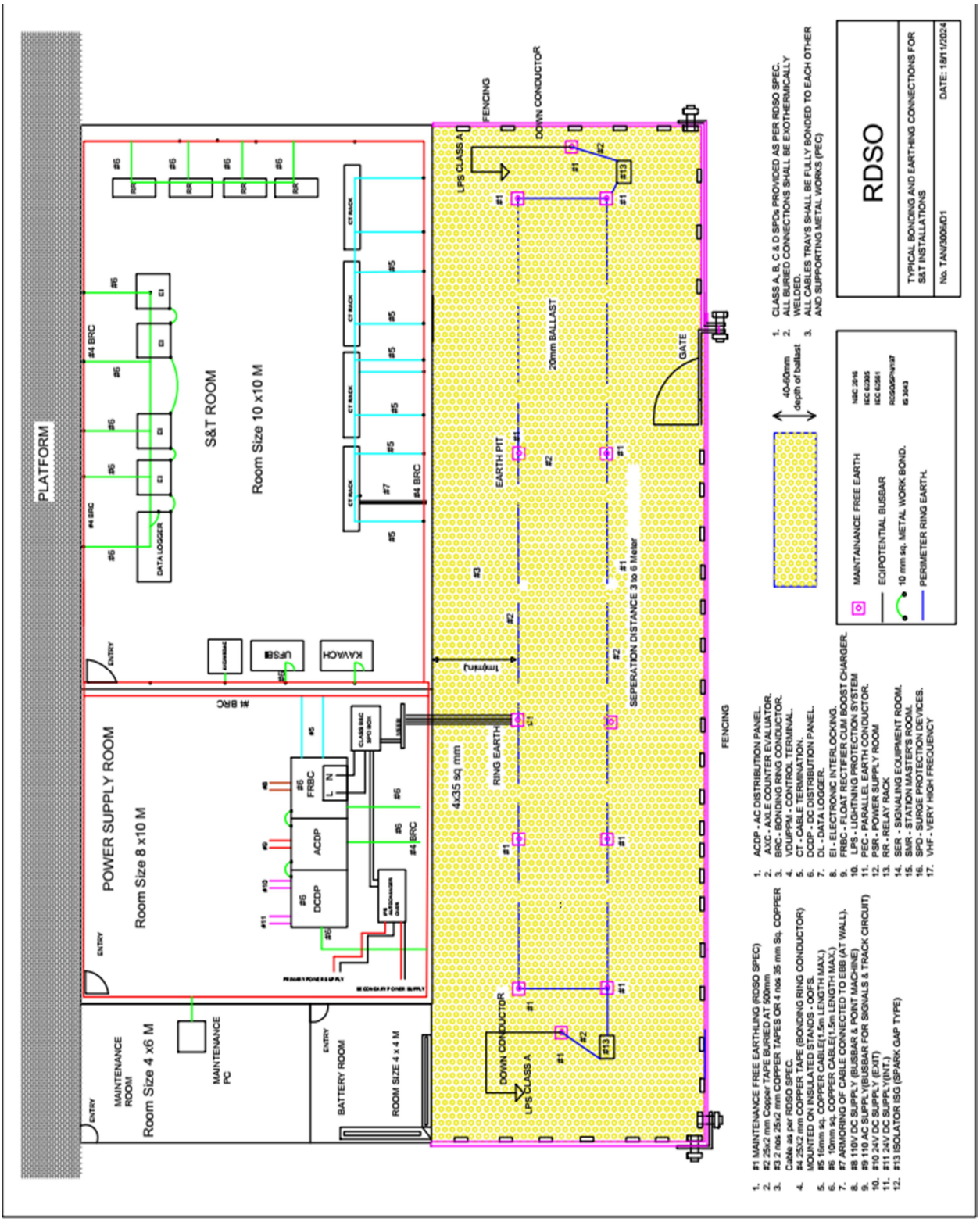
Annexure-III (a)

(**Ref:** Annexure III of Guidelines for Earthing, Bonding, Surge and Lightning Protection System)



Annexure-III (b)

(**Ref:** Annexure III of Guidelines for Earthing, Bonding, Surge and Lightning Protection System)



Annexure-IV

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

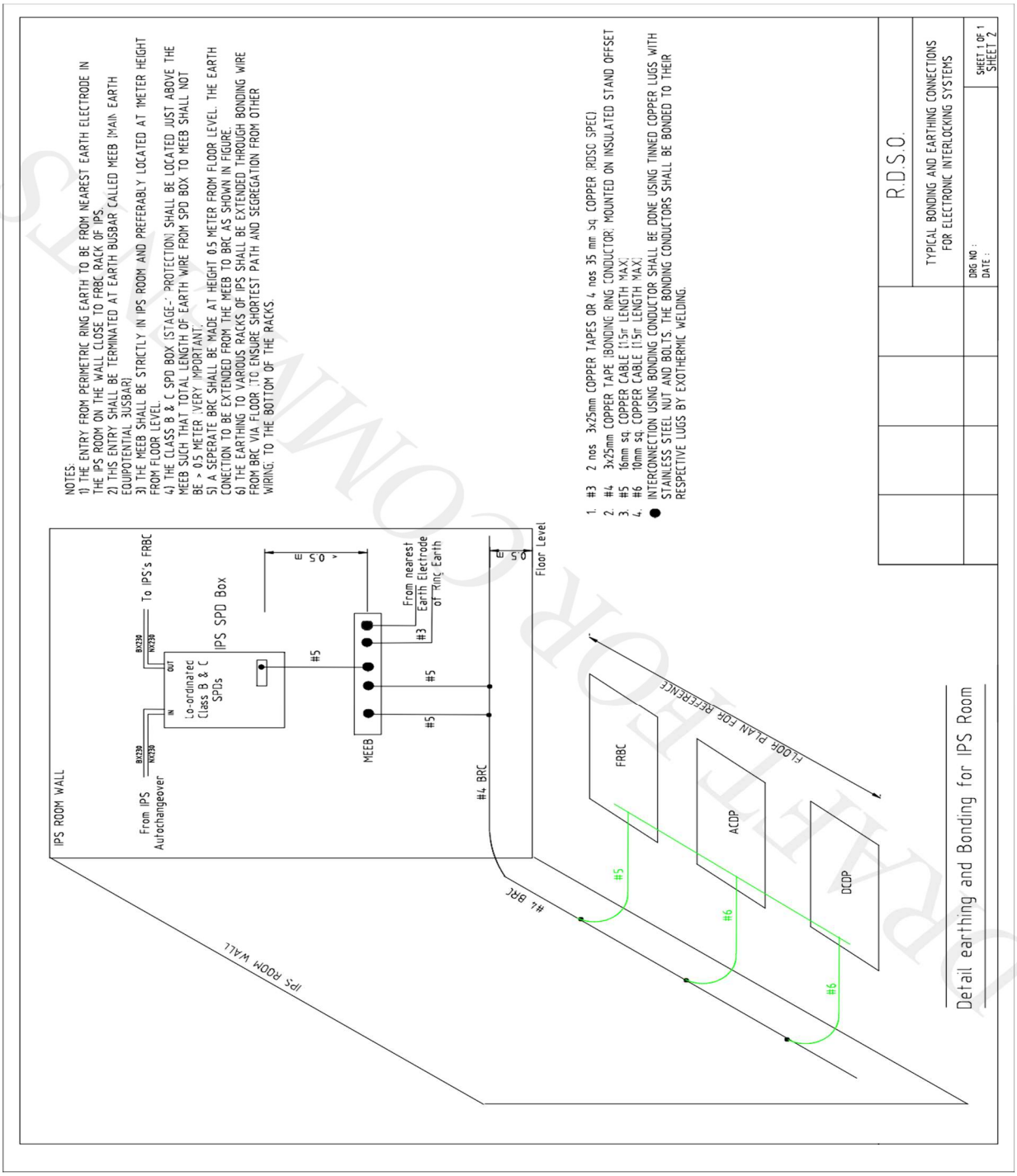
(Ref: Annexure-II of RDSO/SPN/197 Ver 1.0**)**

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.

Annexure V

SPD arrangement at Input of IPS

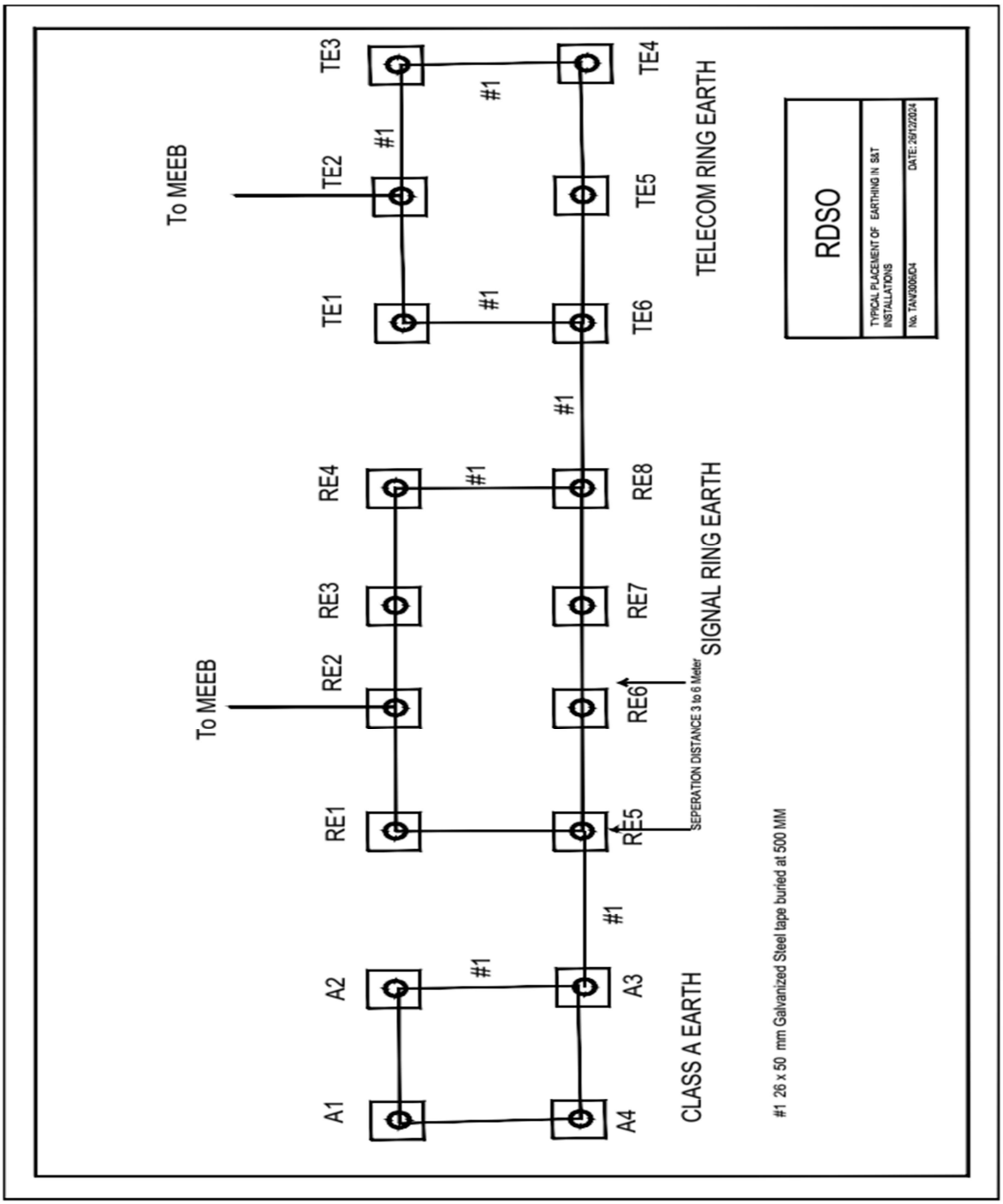
(**Ref:** Annexure VI of Guidelines for Earthing, Bonding, Surge and Lightning Protection System)



Annexure VI

Placement of Earthing at S&T Installation

(**Ref:** Annexure VIII of Guidelines for Earthing, Bonding, Surge and Lightning Protection System)



Annexure VII

Checklist for Earthing & Bonding and Lightning Protection System

(**Ref:** Annexure IX of Guidelines for Earthing, Bonding, Surge and Lightning Protection System)

SN.	Description	Status (Yes/No)
1.	Earth is installed as per drawing mentioned in RDSO/SPN/197/2016 Ver.1	
2.	The material is procured as per the part list issued by RDSO for Earthing and Bonding system (Annexure I).	
3.	Only NABL/ILAC-tested exothermic materials are used for exothermic welding in Earthing and Bonding system.	
4.	The installation of Earthing and Bonding system is carried out by the OEM or an OEM authorized representative.	
5.	The Pre-commissioning checklist is jointly signed with OEM.	
6.	The OEM installation certificate for Earthing and Bonding is obtained from the OEM.	
7.	The drawing for Earthing and Bonding is painted on the outside wall of building for easy identification.	
8.	The Earthing and Bonding Plan of station are made available at Station.	
9.	The Earth is installed at least 1 meter away from the wall.	
10.	The copper or GI strip provided for interconnecting earth electrode is buried at a depth not less than 500 mm.	
11.	It is ensured that, no knot and coils are present in the conductors used for Earthing and Bonding.	
12.	Only one Entry is ensured for the building for the connection of MEEB and Earth.	
13.	The MEEB is provided only in IPS Room for S&T installation and in Telecom room for Telecom installation.	
14.	All electronic equipment in the S&T room is connected to the BRC via a shortest path.	
15.	Indicative type SPDs with PFC contact are provided for the electronic equipments.	
16.	Available PFC contact of SPDs are wired in the Datalogger.	

17.	The SPD/LPD Box are installed close to IPS (preferably near FRBC panel of IPS).	
18.	The distance between the MEEB and SPD box is not more than 0.5 meters	
19.	The SPD and equipment are connected in the shortest path. Additional SPD (Type II) is provided in the equipment rack if the distance between SPD and Equipment is more than 10 meter.	
20.	Test report of SPD's installed as per IEC standard is ensured.	
21.	Physical connections and wiring of SPDs are ensured.	
22.	The Dirty and Clean wires are properly segregated.	
23.	The down conductor of Class A is connected with the shortest path to earth.	
24.	The earth for Class A and Perimeter /Ring Earth are equipotential bonded.	

Signature of Railway Representative

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सत्यमेव जयते

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No- RDSO-SIG0SPD(PROJ)/1/2020 Date- 01.01.2025

महाप्रबंधक	(सि० एवं दू० सं०)	सि० एवं दू०सं० (निर्माण)	**GM**	S&T	S&T/CONST.

1. मध्य रेलवे, मुम्बई (सीएसटी)–01 Central Railway, Mumbai, CST- 400 001
2. पूर्व रेलवे फेयरली प्लेस, कोलकाता–01 Eastern Railway, Fairlie Place, Kolkata -700 001
3. उत्तर रेलवे, बडौदा हाउस, नई दिल्ली–01 Northern Railway, Baroda House, New Delhi – 110 001
4. पूर्वोत्तर रेलवे, गोरखपुर–12 N.E. Railway, Gorakhpur – 273 012
5. उत्तर सीमान्त रेलवे, मालीगांव, गुवाहाटी–11 N.F. Railway, Maligaon, Guwahati -781 011
6. दक्षिण रेलवे, पार्क टाउन, चेन्नई–03 Southern Railway, Park Town, Chennai-03
7. दक्षिण मध्य रेलवे, सिकन्दराबाद–500 071 S.C. Railway, Secunderabad – 500 071
8. दक्षिण पूर्व रेलवे, गार्डन रीच, कोलकाता–43 S.E. Railway, Garden Reach, Kolkata -700 043
9. पष्चिम रेलवे, चर्चगेट, मुम्बई–20 Western Railway, Churchgate, Mumbai – 400 020
10. पूर्वीतट रेलवे, भुवनेष्वर–01 East Coast Railway, Bhubneshwar – 751 001
11. उत्तर मध्य रेलवे, इलाहाबाद–01 North Central Railway, Allahabad – 211 001
12. दक्षिण पूर्व मध्य रेलवे, बिलासपुर–01 South East Central Railway, Bilaspur – 492 001
13. दक्षिण पष्चिम रेलवे, हुबली–20 South West Railway,Club Road, Keshavpur, Hubali-580020
14. पष्चिम मध्य रेलवे, जबलपुर–01 West Central Railway, Jabalpur – 482 001
15. उत्तर पष्चिम रेलवे, जयपुर–01 North West Railway, Jaipur – 302 001
16. पूर्व मध्य रेलवे, हाजीपुर–01 East Central Railway, Hajipur – 844 101

Sub: Guidelines on Earthing , Bonding, Surge & Lightning Protection System for S&T Installation

A Comprehensive guideline on Earthing, Bonding, Surge & Lightning Protection System for S&T Installation is prepared and issued for use of Zonal Railways. The same is attached herewith.

This has approval of competent authority.

YOGENDRA PRATAP SINGH
2025.01.01 19:13:13 +05'30'

DA: As above (52 pages)

(Y.P.Singh)
Dir/Signal III
For DG/S&T

Subject	Guidelines on Earthing, Bonding, Surge and Lightning Protection System		
Document Number	RDSO-SIG0SPD(PROJ)/1/2020	Version	0.0
Dated	01/01/2025	Pages 52	1

Guidelines on Earthing, Bonding, Surge And Lightning Protection System For S&T Installations

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SN.	Description
1.	**Earthing and Bonding System**
	An effective low-resistance and equipotential earthing system is essential for safely dissipating fault currents, protecting equipment, minimizing downtime, ensuring improved reliability of all Electronic Signalling & Telecom System (EI, PI, RRI, Auto Hut, IBS, LC, Telecom hut etc.) and safeguarding personnel from electric shocks.
1.1	**Components of Earthing and Bonding System:**
	The components of Earthing & Bonding system are: a) Earth electrode b) Earth enhancement material c) Earth pit d) Equi-potential earth busbar e) Connecting cable f) Exothermic Weld Material & Mould g) Copper or GI tape/strip and other associated accessories. The list of components to be procured for the Earthing and Bonding system is attached as **Annexure-I** and must be strictly adhered to.
1.2	**Location for Earthing**
	a) A flat area on natural soil close to the building or equipment is ideal for locating earth electrodes. b) Dry sand, lime stone, granite and any stony ground should be avoided. c) Earthing electrode should not be installed on high bank or made-up soil.
1.3	**Installation of Earthing & Bonding System**
	a) The installation of the Earth shall be carried out as per Drawing attached as **Annexure-II**. b) The installation of Earthing and Bonding for **all S&T installations** (EI, PI, RRI, Auto Hut, IBS, LC, Telecom hut etc.) shall be as per **Annexure-III (a) or (b)**. Separate earth is applicable for only those equipment's which work on earth return such as SGE Block Instrument. c) The procedure of Exothermic welding is attached as **Annexure-IV**. d) The **OEM shall be responsible** for complete supply, installation & commissioning of the Earthing & Bonding system. e) The **Pre-commissioning checklist** attached as **Annexure-V** shall be followed during installation. f) **OEM Certificate** shall be obtained from OEM, after the installation of Earthing & Bonding system. g) The **Earthing & Bonding plan** should be available at the Station and it should be as per Annexure III a, b

1.4	**Measurement of Earth Resistance**
	a) The individual earth resistance value shall be measured and recorded before equipotential bonding. **b)** After installation of the Earthing & Bonding system, the final earth resistance value shall be measured at the MEEB or Equipment end. **c)** The earth value shall preferably be measured with Clamp meter.
1.5	**Warranty of Earthing & Bonding System**
	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. **(Para 10 of RDSO/SPN/197 Ver 1.0)**
1.6	**Maintenance Schedule**
	The maintenance of the earth shall be carried out as per the schedule mentioned in IRSEM. During maintenance, earth connections shall be carefully examined and kept intact and joints soldered. The wire between each earth and the connected equipment shall be electrically isolated. The exothermic welding termination on maintenance free earth rod shall be checked and cleaned as per **Annexure VII**
1.7	**Other Important Points**
	a) The overall Earth resistance value for the earth connected with MEEB shall be less than 1 ohm. If necessary multiple earth shall be provided in loop to achieve earth resistance less than 1 Ohm. b) The distance between two successive earth electrode shall be not **less than 3 meter and more than 6 meter**. c) Multiple earth pits shall be installed around the perimeter of the building. However, at some locations, it may not be possible to form a perimetric ring earth around the Relay room, Power supply room and Station master room. In such cases, parallel earthing arrangements consisting of interconnected multiple earth electrodes may be installed in the available free space as close as possible to the station building. A Sample drawing is attached as Annexure III for reference. d) Main Equipotential Earth Busbar (MEEB) shall be installed not more than 0.5 m from LPD/SPD Box. **(As per Annexure VI)** e) The Bonding Ring Conductor (BRC)/ Common Bonding Network (CBN) has the objective of maintaining the same reference potential. Hence, all equipment shall be connected to the nearest point on the BRC using bonding wires routed through the floor of the room. Routing through the floor ensures the shortest path and prevents the earth wire from running parallel to any power/data cables. It is mandatory that a complete close loop has to be formed for BRC.

2.	**Lightning/Surge Protection System**
	Lightning and surge protection is crucial for safeguarding railway signalling systems, which are essential for safe and efficient train operations. These devices protect critical equipment like interlocking systems and track circuits from voltage surges caused by lightning strikes, ensuring reliable performance and preventing signal failures or delays. By shielding sensitive electronics, they reduce repair costs, prolong equipment lifespan, and enhance operational safety. Given the exposure of railway infrastructure to outdoor environments, these protections are indispensable for maintaining system reliability and ensuring seamless train movement.
2.1	**External Lightning protection / Class A protection**
	• This is provided with an external lightning conductor on top of the building connected through a down conductor to ground (EARTH). This is known as class 'A' protection. Standard Franklin rods made of copper shall be provided as Air Terminals or the latest policies issued by RDSO/Railway Board shall be followed for Class A protection. As per NBC 2016, the radioactive terminal such as dissipation system/ESE/CSE air terminal are not allowed. The size of down conductor shall 50 sq mm copper bonded steel conductor connected to air terminal and earth pit. • The down conductor/ earth bonds/ Cables/ Wires should be connected with the shortest path to earth.
2.2	**Function of SPD**
	Surge protection devices should ideally operate instantaneously to divert a surge current to ground with no residual common-mode voltage presented at the equipment terminals. Once the surge current has subsided, the SPD should automatically restore normal operation and reset to a state ready to receive the next surge.
2.3	**Features of SPD**
	• Rapid operation, • Accurate voltage control • Automatic resetting once the over-voltage has ceased.
2.4	**Types of SPDs**
	▪ Air or Carbon Sparks Gaps ▪ Gas discharge tubes (GDTs), ▪ Transient Voltage Suppression Diode ▪ Metal-oxide Varistors (MOVs)

2.5 SPD Rating for Various Voltage Source

a) Stage 1 Protection: Type I/Class B SPD : This provides the first stage of protection at the mains distribution panel before the equipment. This type of protection shall be provided against Lightning Electromagnetic Pulse (LEMP) and other high surges at the power distribution panel The parameter of Type I SPD are as under :

SN	Parameters	Limits	
		Line & Neutral	Neutral & Earth
1	Nominal Voltage (Un)	230V	230V
2	Maximum Continuous Operating Voltage (Uc)	≥ 255V	≥ 255V
3	Lightning Impulse current (I_{imp}) -10/350µs	≥ 25KA	≥ 50KA
4	Response Time (Tr)	≤ 100 ñs	≤ 100 ñs
5	Voltage Protection Level (Up)	≤1.5 KV	≤1.5 KV
6	Short circuit withstand and follow up current extinguishing capacity without back up fuse (Isc & Ifi)	≥ 10 KA	≥100A
7	Temporary Over Voltage (U_{Tov}) withstands for 120 minutes (LV system faults in distribution system and loss of neutral in TT system	438V	438V
8	Temporary Over Voltage (U_T) (LV system faults in consumer installation TT system)	334V min. for 05 secs.	1200V min. for 200ms
9	Operating temperature / RH	- 25ºC to +80ºC/ 95%	
10	Mounted on	Din Rail	
11	Indication	Mandatory	
12	Plugability	Mandatory	
13	Potential free contact for remote monitoring	Mandatory	

14	Encapsulation	Encapsulated
15	Degree of protection	IP20
16	Housing	Fire retardant as per UL 94
17	Approvals as per IEC- 61643-11-2011	National/ International Labs like KEMA,VDE etc. or any other accredited test lab (Details of accreditation shall be submitted)

b) Stage 2 Protection: Type II/ Class C SPD : The (Type-1)/ Class B SPD will be followed by (Type-2) / Class C SPD adjacent to it and connected between Line & Neutral. The Type II SPD's are also provided at the output modules of IPS. The device shall be a single compact varistor of proper rating and in no case a number of varistors shall be provided in parallel. It shall be voltage clamping device, thermal disconnecting type and shall be tested as per IEC 61643-11 (latest) with the following characteristics and features:-

SN	Parameters	Limits (between Line & neutral)
1	Nominal Voltage (Un)	230V
2	Maximum Continuous Operating Voltage (Uc)	≥ 253 V
3	Temporary Over Voltage (U_{Tov}) withstands for 120 minutes	438V
4	Nominal discharge current 8/20µs (In)	≥ 10KA
5	Maximum discharge current 8/20µs (Imax)	≥ 40KA
6	Response time (Tr)	≤ 25 ñs
7	Voltage Protection Level (Up)	≤ 1.5 KV
8	Operating Temperature / RH	- 25°C to +80°C/ 95%
10	Mounted on	Din rail

11	Indication	Mandatory
12	Plug ability	Mandatory
13	Potential free contact for remote monitoring	Mandatory
14	Degree of protection	IP20
15	Housing	Fire retardant as per UL 94
16	Approvals as per IEC- 61643-11-2011	National/ International Labs like KEMA,VDE etc. or any other accredited test lab (Details of accreditation shall be submitted)

Type II SPD for the various output power supply of IPS

SN	Parameters	Limits (between L & N, L & E , N & E)		
1	Nominal Voltage (U_0)	60V-110V AC/DC	24V-60V AC/DC	110-150V AC/DC
2	Maximum Continuous Operating Voltage (U_c)	≥ 150 (AC) ≥ 200 (DC)	≥ 75 (AC) ≥ 100 (DC)	≥ 150 (DC)
3	Nominal Discharge Current 8/20µs (I_n)	≥ 10KA	≥ 10KA	≥ 10KA
4	Maximum Discharge Current 8/20µs (I_{max})	≥ 40KA	≥ 40KA	≥ 40KA
5	Response Time (Tr)	≤ 25 ñs	≤ 25 ñs	≤ 25 ñs
6	Voltage Protection Level (U_p)	≤ 1.0 KV	≤ 0.5 KV	≤ 0.8 KV
7	Operating temperature / RH	- 25°C to +80°C/ 95%		
8	Mounted on	Din Rail		

9	Indication	Mandatory
10	Pluggability	Mandatory
11	Potential free contact for remote monitoring	Mandatory
12	Degree of protection	IP20
13	Housing	Fire retardant as per UL 94
14	Approvals as per IEC 61643-11-2011	National/ International Labs like KEMA,VDE etc. or any other accredited test lab (Details of accreditation shall be submitted)

c) Stage 3 Protection: Type III/ Class D SPD : All external Power/signaling/data lines (AC/DC) shall be protected by using preferably pluggable stage 3 surge protection devices which consists of a combination of varistors/suppressor diodes and GD tube with voltage and current limiting facilities.

1. **Power Line Protection (Class D):** The device for power line protection shall be of Class D type. This shall have an indication function to indicate the prospective life and failure mode to facilitate the replacement of failed SPDs. This shall be thermal disconnecting type and equipped with potential free contact for remote monitoring. This protection shall be complying to IEC 61643 with following characteristics:

Nominal Voltage (U_0)	**24V**	**48V**	**60V**	**110V**	**230V**
Max. continuous operating Voltage (U_c)	30V	60V	75V	150V	253V
Rated load current (I_L)	16A				
Nominal discharge current (I_n) 8/20µs	>=700A			>=2.0KA	>=2.5KA
Max discharge current (I_{max}) 8/20 µs	>=2KA			>=5 KA	
Voltage protection level (U_p)	<=200V	<=350V	<=500V	<=700V	<=1100V
Response time (T_r)	<=25 ns				

2. **Signaling/Data line protection :** These devices shall preferably have an indication function to indicate the prospective life and failure mode to facilitate the replacement of failed SPDs. If the device has any component which comes in series with data/ signaling lines, the module shall have "make before break" feature so that taking out of pluggable modules does not disconnect the line. This protection shall be complying to IEC 61643-21 & VDE 0845 Pt. 3 with the following characteristics

Nominal Voltage (U_o)	5V	12V	24V	48V
Arrester Rated Voltage (U_c)	6V	13V	28V	50V
Rated load current (I_L)	>=250mA			
Total discharge current, 8/20 µs (I_n)	>=20KA			
Lightning test current 10/350 µs	>=2.5KA			
Voltage protection level (U_p)	<=10V	<=18V	<=30V	<=70V

2.4 Other Important Points

1. The **Stage-I protection shall be provided in the IPS room** where power is coming from outside (AT supply of OHE and SEB local supply). There is a high probability of a surge coming from the input supply line. The coordinated class Type 1 & Type 2 SPD in a separate Box is to be provided in the IPS room.The coordination between Type 1 & Type 2 SPD shall be provided using a coordination module to ensure proper functionality of this Integrated SPD.
2. The Type 1 SPD diverts a high amount of surge to earth which due to lead inductances and earthing impedance, leads to transient potential rise. To minimize the inductive voltage rise in the earth wire, its length may be kept minimal (ref: IEC- 62305). Hence it is very essential to install **Type I SPD close to MEEB** (Main Equipotential Earth Bus bar) in the IPS room as per RDSO/SPN/197 Ver 1.0. The MEEB located in the building must be closest to the main earth pit of the building.
3. Unwanted surge currents entering equipment room must be dissipated to the earth electrode as close as possible to their point of entry.
4. The **length of all cable connections** from the input supply and earth busbar to the SPDs **shall be kept as short as possible**. This should be ensured during installation.
5. If power supply /data / signaling lines (AC/DC) are carried through overhead wires or cables above ground to any nearby building or any location outside the equipment room, additional protection of Stage 2 (Class C) type shall be used at such locations for power supply lines and Stage 3 protection for signal / data lines.
6. For ease of maintenance and testing, **Indicative type pluggable SPDs with PFC contact** (Type I/Type II) and **Indicative type pluggable/modular SPDs** with PFC contact (Type III) shall be used.
7. Ensure the **wiring of the Available PFC contact of SPD in Datalogger**.
8. Physical connections and indication of the SPD shall be checked quarterly.
9. The SPD/LPD box shall be installed in such a manner that the power cable serving as input to the IPS does not cross any other cable.
10. The distance between SPD and equipment to be protected shall be as minimal as feasible, but in any case, it shall not exceed 10 meters. In case of length more than 10 meter, additional SPD (Type II) shall be provided inside the equipment rack.
11. Batch test report of SPD from National/International Labs like NABL, KEMA, VDE etc. shall be asked by the Railways.

Dos and Don'ts

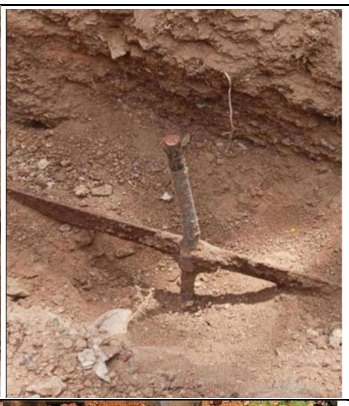
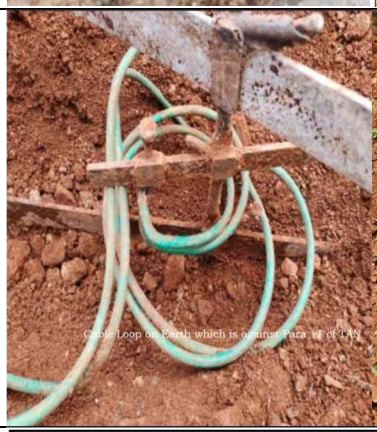
A.	**Do's for Lightning Protection System**
	1. Proper Installation : Install SPDs at strategic points such as power distribution panels and equipment input levels to protect against high and low voltage surges **2. Use Coordinated Protection :** Implement coordinated Class B & C arrestors in a separate enclosure adjacent to each other **3. Ensure Grounding :** Properly ground all non-current carrying metal parts and ensure the maximum earth resistance of 1 ohm **4. Use Pluggable Devices :** Preferably use pluggable type SPDs for easy replacement **5. Indication Function :** Use SPDs with an indication function to show the prospective life and failure mode for easy monitoring and replacement **6. Potential-free contact :** Ensure SPDs are thermal disconnecting type and equipped with potential-free contact for remote monitoring **7. Minimize Cable Length :** Keep the length of all cable connections from input supply and earth busbar to SPDs as short as possible
	Don'ts for Lightning Protection System
	1. Do Not Ignore Environmental Factors: Do not neglect the effects of environmental factors such as spikes in the power supply system and stray fields caused by traction vehicles or standby diesel generator sets. **2. Avoid Improper Shielding :** Do not neglect the need for shielding at both the card level and chassis/rack level to protect against electromagnetic interference. **3. Do Not Use Non-Compliant Devices :** Avoid using SPDs that do not comply with IEC 61643-1, VDE -0675 Pt. 6, IEC 61643-21, and VDE 0845 Pt. 3 standards. **4. Do Not Ignore Indications :** Do not ignore the indication functions of SPDs that show the prospective life and failure mode. **5. Avoid Parallel Varistors :** Do not use multiple varistors in parallel for Class C type protection; use a single compact varistor of proper rating. **6. Avoid Inadequate Marking :** Ensure all markings and indications are easily legible, durable, and placed in the vicinity of the components they refer to

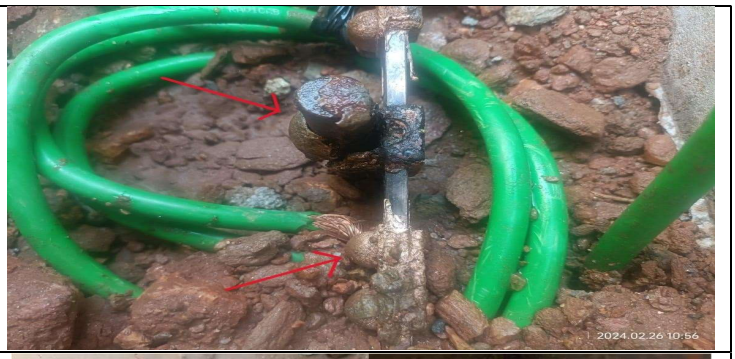
B.	Do's for Earthing & Bonding

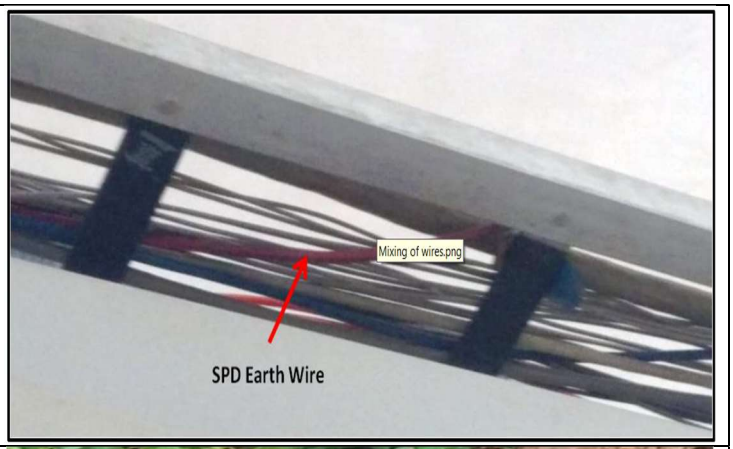
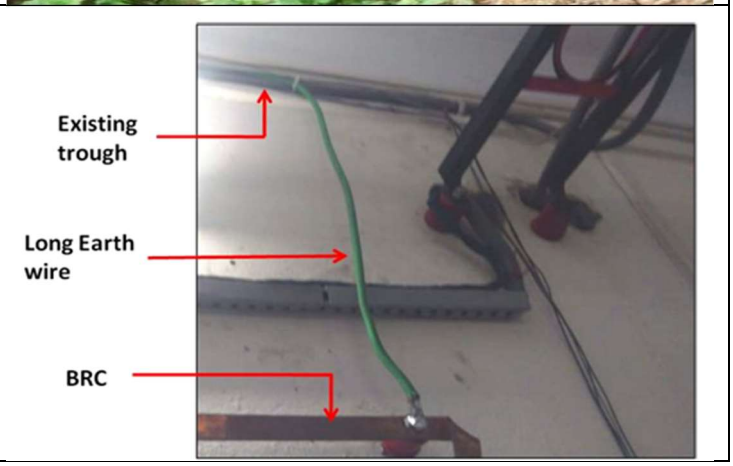
1. **Adhere to Guidelines:** Earthing and bonding should be done as per the Technical Advisory Notes (TAN) issued by RDSO from time to time.
2. **Follow Approved Drawings:** Earth should be installed as per drawing mentioned in RDSO/SPN/197/2016 Ver.1.
3. **Installation:** Earth should be installed only by OEMs or OEM authorized firm.
4. **No Hammering :** No hammering should be done on earth electrode during installation.
5. **Optimal Location:** Earth should be installed in natural soil.
6. **Anti-Corrosive Materials:** Material used for the installation of earth should be anti-corrosive.
7. **Proper Bonding:** All bonding should be done with appropriate size conductors as recommended by RDSO.
8. **Equipotential Bonding:** All earths of the equipment should be bonded to achieve equipotential bonding.
9. **Shortest Path Connectivity:** The connectivity between the BRC to equipment and the MEEB to earth should be connected in the shortest path.
10. **Proximity of MEEB and SPD:** The distance between the MEEB and SPD box should not be more than 0.5 meters and preferably near the SMR rack of IPS
11. **Quality Exothermic Welding:** The exothermic material used for exothermic welding should be UL listed and used insufficient quantity as recommended by OEMs.
12. **Adequate Earth Points:** Sufficient number of earth points should be provided in case of high resistance.
13. **Equipment Resistance:** The earth resistance of electronics equipment should not be more than 1 ohm.
14. **Protection of Earth Installation:** All earths installed as a ring earth or perimeter earth should be protected through tie-bar fencing or boundaries with ballast over the area. If it is not feasible to make boundaries, the area should be properly concreted to avoid any damage to the earth installed.
15. **Configuration Display:** The installed earth configuration should be painted on the wall for better identification of the earthing pit.
16. **Regular Inspection:** Earth pits should be regularly checked for any damage or deterioration. TheEarth Pit should be cleaned regularly.
17. **Tools for Testing :** Wenner's method of earth testing is effective for the measurement of individual disconnected earth electrodes. However, for measuring the earth resistance at the equipment end, such as the MEEB end, using a clamp-type meter is more effective.
18. **Proper Training :** The staff should be trained regularly for the installation practices of earthing and Bonding system.

	Don'ts of Earthing & Bonding
	1. **Avoid Unsuitable Grounds:** Dry sand, limestone, granite, and any stony ground should be avoided for the installation of earth. 2. **No High Banks or Made-Up Soil:** Earthing electrodes should not be installed on high banks or made- up soil. 3. **Maintain Distance from Buildings:** Earth should not be installed less than 1 meter from the building wall. 4. **Distance from the Electrical Earth:** Minimum 20 meter distance should be maintained between electrical and S&T earth. 5. **Follow Pre-Commissioning Check list:** Never deviate from the pre-commissioning checklist issued by RDSO. 6. **Equipotential Bonding of Class A and Ring Earth:** Class A earth should not be connected via two paths to achieve equipotential between Class A and ring earth/perimeter earth. 7. **No Loose Connections:** There should be no loose connection between any earth conductors connected for earthing and bonding system. 8. **No Loop conductors:** There should not be any loop in the earthing conductor

Deviations at Site

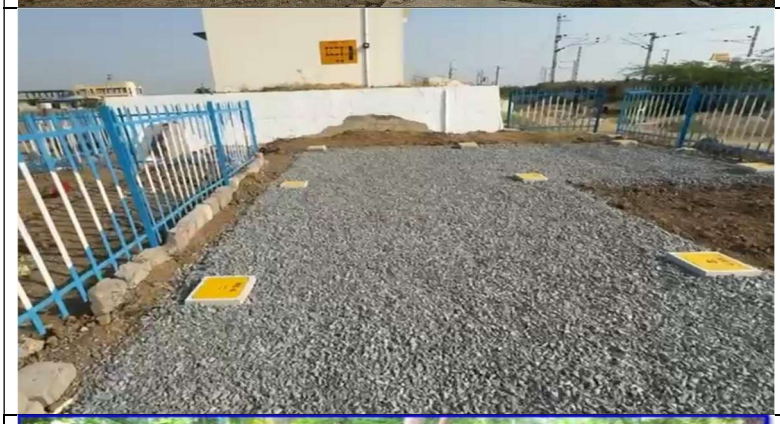
SN.	Description	Pictures
1.	Deviation from the drawing mentioned in the standard drawing for the RDSO Specification No. RDSO/SPN/197 Ver.1.0.	 
2.	Knot and coils to be avoided in the earth cable between MEEB and Earth Electrode. This will create large Potential (and high impedance path) during surge dissipation and the surge may find a low impedance path through equipment.	  
3.	The interconnecting conductor shall be buried at Depth not less than 500 mm below the ground level. The interconnecting conductor shall also be covered with approximately 30 Kg of earth enhancing compound for each 3 meters length.	

4.	Exothermic compounds from the local market are used for exothermic welding. As per Para 8.4.1 (g) of RDSO Specification No. RDSO/SPN/197 Ver. 1.0, only NABL/ILAC-tested exothermic materials shall be used for exothermic welding.	 
5.	As per **Para 11 of TAN STS/E/TAN/3006:** The down conductor/ earth bonds/ Cables/ Wires should be connected with the shortest path to earth.	
6.	As per **STS/E/TAN/3006,** the Earth installed should be at minimum distance of 1 meter away from the wall of building.	 

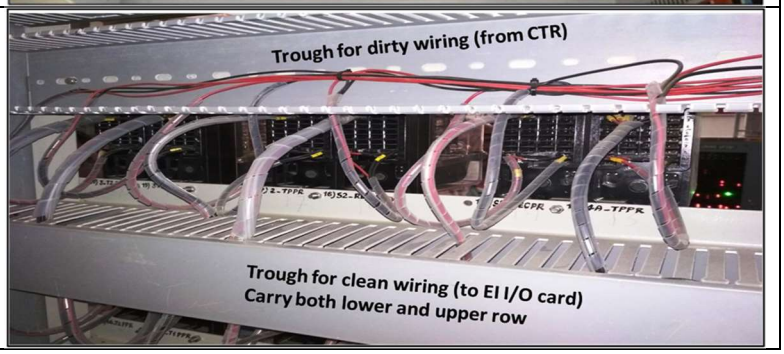
7.	As per RDSO TAN No. STS/E/TAN/3006 dt.2.11.2012, Para 14, All earth bonds, cables and wires are classified as “dirty” and must not run through cable trays carrying “clean” signalling and “clean” power circuits.	
8.	Regular maintenance should be carried out as per the IRSEM guidelines to identify any damaged earth connections or earth bondings.	
9.	At some locations, BRC is installed higher on the wall to avoid windows and doors. To achieve the shortest path from SPD to BRC, the earth wire is routed with internal wires on existing troughs or ladders (Figure 13). However, this results in a longer earth wire and mixing with internal clean wiring, which is undesirable.	

10.	Electrical cable and S&T Cable with same entry.	

Good Installation Practices

SN.	Description	Pictures
1.	The earth is installed as per the specifications with proper protection.	  

2.	Inter distance between SPD and MEEB is <0.5 meter.	
3.	The earth connections on the wall are painted for easy identification.	
4.	The cables are laid in the RCC duct with a proper chamber for the coil, ensuring isolation from any nearby earth, such as Class A or VHF Tower earth.	
5.	As per RDSO Specification no. RDSO/SPN/197 Para 8.5.1 (b) The Equi-potential Bus Bars (EEBs) shall be installed at the height of 0.5m from the room floor surface for ease of installation & maintenance.	

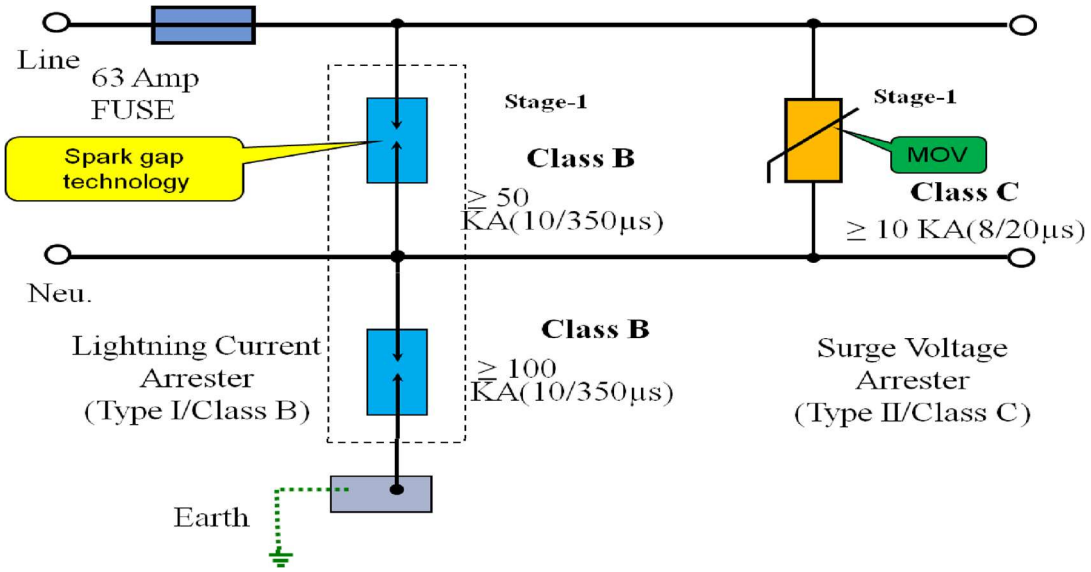
6.	Segregation of dirty and clean wires using 3 tier ladder and routing dirty and clean wires through separate troughs	 

Facts to Know

The specifications or policies issued by RDSO are formulated based on established standards or research and incorporate feedback from Zonal Railways. However, deviations are sometimes observed at sites, arising from misconceptions or differing interpretations of existing practices. To address this, the following facts are provided to facilitate informed decision-making at higher levels.

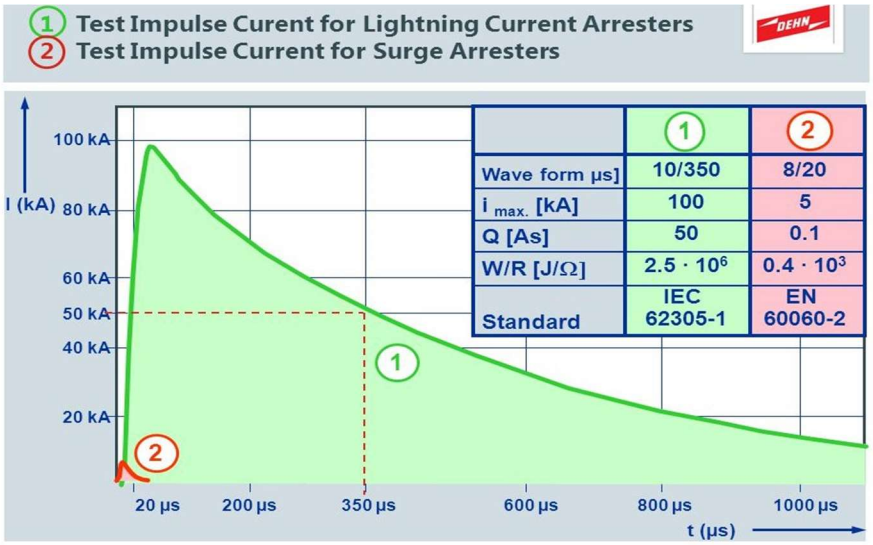
1. Understanding the characteristics of SPD and Surge protection:

a. The typical configuration drawing of an SPD installed as a Type I SPD is shown below:

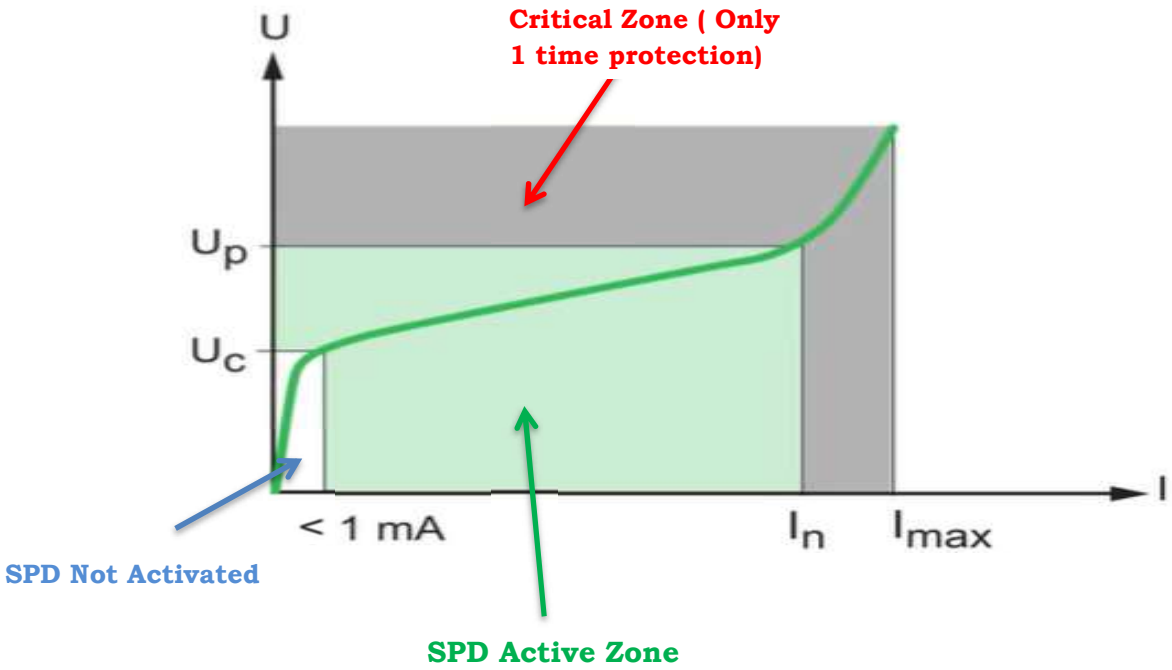


b. **10/350 µs & 8/20 µs waveforms :** This are standardized surge waveforms used in testing and evaluating the performance of surge protection devices (SPDs) and systems. 10/350 µs waveform represents the energy and current associated with direct lightning strikes and 8/20 µs with indirect lightning strikes or switching surges. Both waveforms are critical for ensuring the reliability and safety of surge protection systems in different scenarios.

The 10/350 µs waveform describes two parameters of an impulse of energy. The "10" denotes the amount of time, in micro seconds, it takes to achieve 90% of its rise to peak amplitude. The "350" refers to the duration, in micro seconds, it takes for the trailing edge to diminish down to 50% of that peak. Same applies for 8/20 µs waveform.

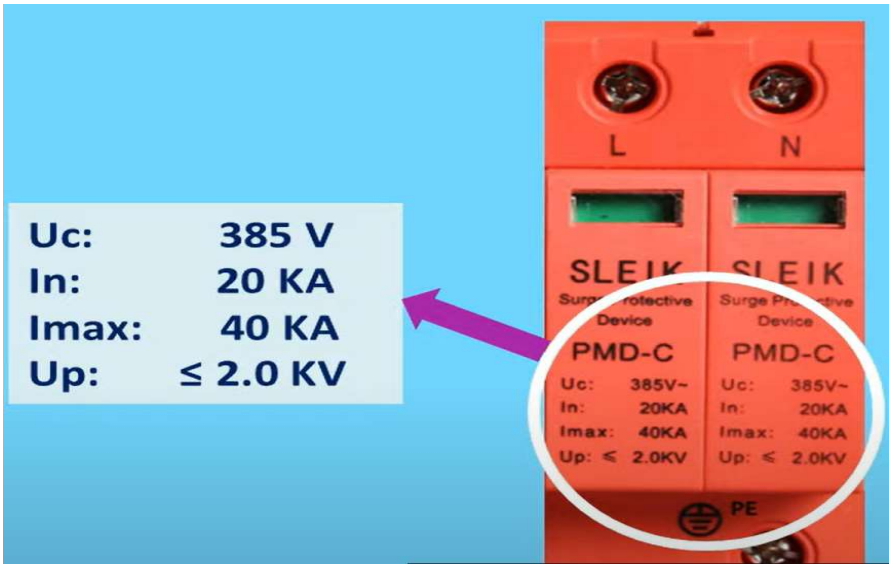


c. **SPD Zone and Configuration :** The range of protection is depicted in the graph shown below:



SPD Zones

2. Understanding the Specifications of SPD:



a. **Maximum Continuous Voltage (U_c) :** The maximum continuous voltage beyond which any sudden spike will trigger the SPD to operate, diverting the resulting current to the ground instantly.

b. **Voltage Protection Level (Up)** : This is the maximum voltage across the terminals of the SPD when it is active. The voltage protection level chosen must be below the overvoltage withstand capacity of the loads. In the event of lightning strokes, the voltage across the terminals of the SPD generally remains less than Up. As soon as voltage spike generated across SPD (transient) crosses Up value, SPD will be triggered and it will dissipate the current through itself.

c. **Nominal Discharge Current (In) :** I_n refers to the peak current an SPD can safely discharge multiple times (15 to 19 times) without degradation. This parameter indicates the SPD's durability under repeated surge events. This is called I_{imp} for the SPD handling in-direct lightning.

d. **Maximum Discharge Current (I_{max}):** I_{max} is the peak current an SPD can discharge once without being damaged. It represents the SPD's absolute capacity to handle high-energy surges.

e. **Impulse withstand voltage (Uw)** : Impulse withstand voltage is a measure of the ability of an equipment to withstand a high-voltage surge without failure. It is expressed in KV peak and depends on the type and design of the equipment. It is tested under prescribed conditions of voltage waveform, polarity and duration.

3. **Effect of increasing the length of connecting wires for SPD:** From the past experiences it has been observed that even if correct type of SPD is provided, if the method of connection or installation is not correct, then it may fail to protect the connected equipment. Some factors are to be considered for achieving best results of SPD which are given in following examples:

- When an SPD is connected to the equipment to be protected, the inductive voltage drop ΔU of the connecting conductors will add to the protection level U_p of the SPD. (Ref.: IEC 62305-4)

- Internal systems are protected if there Impulse Withstand Voltage U_w is greater than or equal to the voltage protection level U_p of the SPD plus a margin necessary to take into account the voltage drop of the connecting conductors. (Ref.: IEC 62305-4).

- A simple example is given in Figure 1 below:

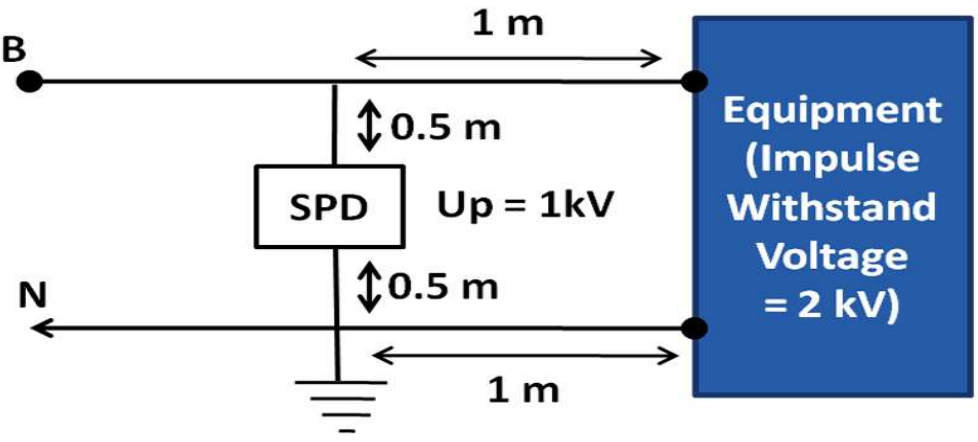


Figure 1 : Connection between SPD and equipment

- Suppose the immunity level (Impulse Withstand Voltage) of equipment to be protected is 2 KV and U_p of SPD is 1 KV.

- If the length of connecting wires is 0.5 m +0.5 m =1 m as shown in Fig. then In the event of lightning strike, the voltage across the terminals of the SPD is assumed to be Up i.e. 1 KV.

- The voltage reaching across the ports of the equipment

  = Up + 1K V (assuming 1 KV per meter voltage drop)
  = 1KV + 1 KV = 2KV

- Now suppose the length of connecting wires is increased to 3 m then the voltage reaching across the ports of the equipment

  = Up + 3K V (assuming 1 KV per meter voltage drop)
  = 1KV + 3 KV = 4KV

It can be seen from above that if the length of connecting wires is increased, the voltage reaching the ports of the equipment can reach up to a value which is more than the tested immunity level of the equipment. In that case there are likely chances that the equipment may fail. **Hence the length of connecting wires between the SPD and equipment to be protected should be kept minimal to limit the voltage produced due to surge across the equipment below its immunity level.**

4. Why is the management of connecting wires between the SPD and equipment required?

To reduce the length of connecting wires, SPD is to be provided in the same rack in which the equipment to be protected is installed. A local earth bus bar is installed in the equipment rack and SPD is to be connected to the local earth bus bar with connecting cable upto maximum 0.5 meter. As per RDSO specification no. RDSO/SPN/165 /2023.

- **Length of all cable connection from SPDs to earth equi-potential busbar shall be kept less than 0.5mtrs. For this, a sub earth equi-potential busbar shall be installed at approx. 20cm from the SPD box.**

The effect of connecting the SPD through sub earth equi-potential busbar in the equipment rack is explained with the help of figures below. As shown in Figure 2 the SPD and the equipment earth are connected to sub earth Equi-potential busbar provided close to the equipment. Which in turn is connected to Main Equi-Potential Bonding bar and earth. During lightning strike, the surge potential developed at the ports of the equipment will be with respect to sub earth equi-potential busbar. This potential developed will be within the Impulse withstand voltage of the equipment.

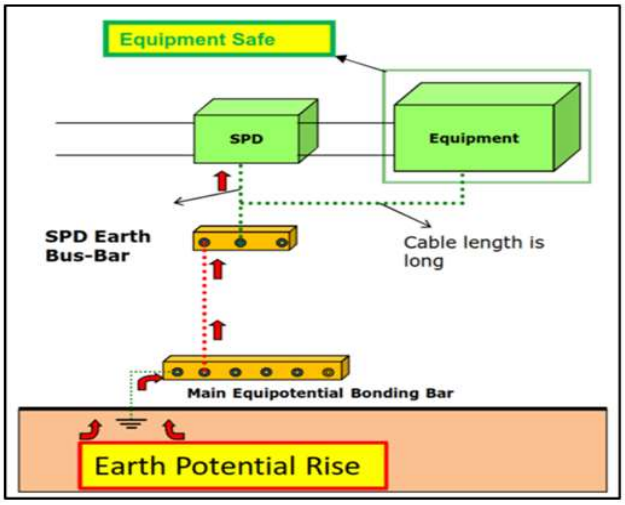


Figure 2 : SPD & Equipment earths connected to same Sub-equipotential bus bar (Recommended)

In the Fig. the earthing of SPD is done through sub earth equi-potential busbar and the equipment is connected to earth separately though Main Equi-potential bonding bar. Here the surge potential developed at the ports of the equipment will be with respect of main Main Equi Potential Bonding bar which will be much higher due to longer length of cables. Hence there are likely chances of equipment failure due to surge.

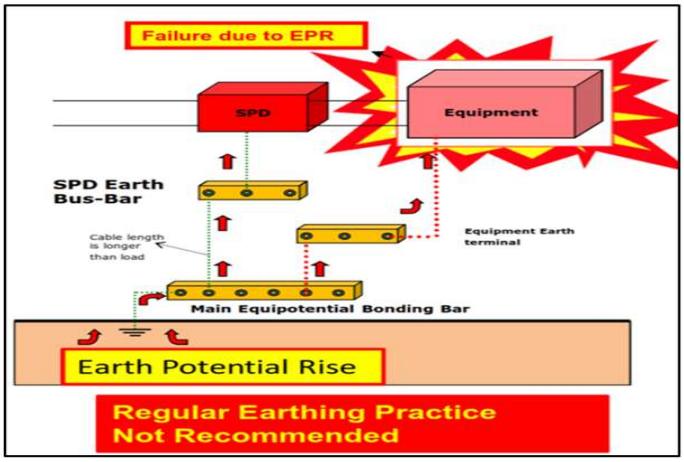


Figure 3 : Equipment earth connected separately (longer path -Not Recommended)

5. What are the effects of Separate earth for two different equipment in same building ?

In Fig below separate earths are provided for IPS and EI installations. Now if there is a lightning strike of magnitude 100kA nearby. The surge current dissipates in the earth and the earth potential of that area rises abruptly. Different earth potentials will be developed at earth pits of IPS and EI say 6 kV and 3 kV

respectively. This results in the development of potential difference of 3 kV between IPS and EI. If the SPD is good enough it may protect the equipments from damage which depends upon the bonding and earthing between the equipments. In this arrangement, the lightning hazard very easily finds entry inside the equipments and there are more likely chances of damage to equipments.

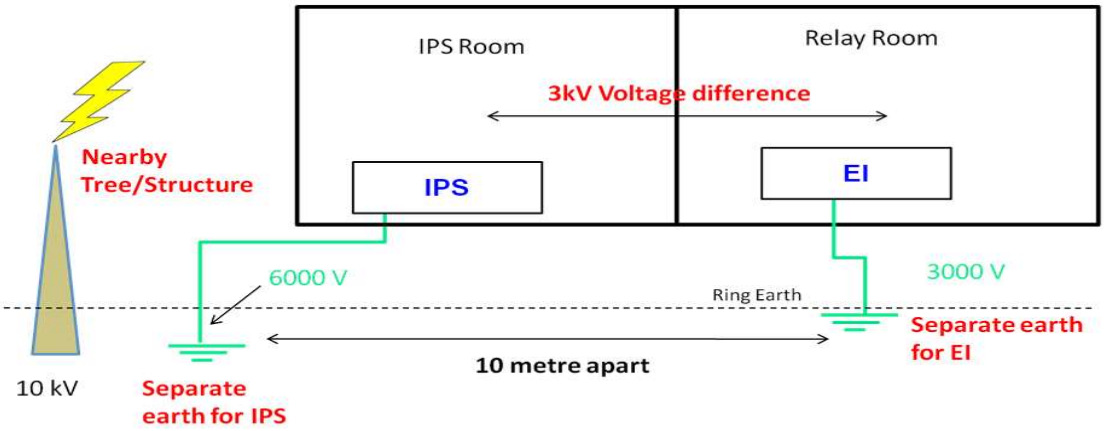


Figure 5 : Provision of separate earths for IPS & EI installations

Hence Equi-potential earthing and bonding is provided to ensure that in the event of lightning, the surge potential developed at the connected equipments is within limits.

6. What are the effects of changing the location of earth entry point ?

In the Figure 4 given below, if a surge comes on power line (24 V DC) it is supposed to get earthed through earth pit. When the surge current flows, it gets shortest path to earth through SPD and returns to the source as shown in the figure.

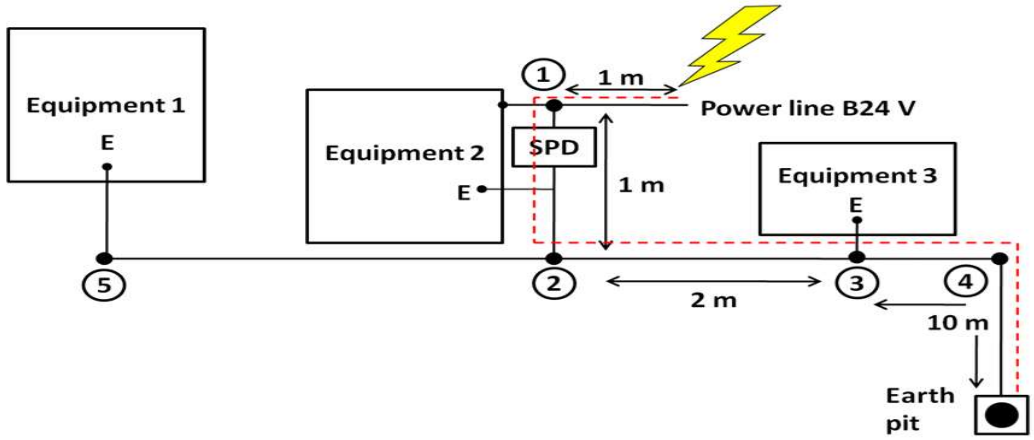


Figure 4 : Connection of earth pit

- Reference potential at source is taken as 0 V. Considering 1 kV drop per meter:
- Potential developed at junction 1 = 1 kV X 1 m =1 kV
- Potential developed at junction 2 = 1 kV+ (1 kV X 1 m) = 2 kV
- Potential developed at junction 3 = 2 kV + (1 kV X 2 m) = 4 kV
- Potential developed at junction 4 = 4 kV + (1 kV X 10 m) = 14 kV

The voltage developed at the earth pit may be as high as 14 kV. The main aim is to ensure that if there is interconnection between equipment's then no potential should develop between them. It can be seen that junction 5 is at same potential as that of junction 2 as current does not flow towards Equipment 1. Thus no potential is developed between Equipment 1 & 2.

- As Equipment 2 & 3 are interconnected through 2 & 3, the potential developed between them is 4 – 2 = 2 kV.

If earth pit is connected to junction 5 instead of junction 3 then the scenario will be different. In this case, now the surge current will not flow towards junction 3 hence there will be no potential developed between Equipment 2 & 3. The current will flow towards earth pit through junction 2 & 5 and the potential developed between Equipment 1 & 2 can be calculated as above.

As per RDSO Para 9 of STS/E/TAN/3006 dated 02.11.2012 Internal earthing network must be of very low inductance to pass high unwanted surge currents, without developing high voltages at any point in equipment/power room and so prevent damage to persons and equipment.

Hence the method of connection of earth pit to equipments is important. Even if the SPD is of proper specification, it will fail if its connection is not properly done. The connection to earth pit shall be such that internal equipment's should be equipotential, so that the potential developed between them is within limits.

7. Why Single Earth Entry ?

The Lightning Protection Zone (LPZ) concept is used to design effective protection systems against lightning strikes. It divides a structure or area into zones with varying levels of protection to minimize lightning-related damage.

i. **LPZ 0:** The external zone exposed to direct lightning strikes and full electromagnetic fields. The building structure comes in this zone. This zone is protected against direct lightning strikes by air terminals (Class A protection).

ii. **LPZ 1:** The internal zone protected from direct strikes but still exposed to partial electromagnetic fields. Example : IPS with Class B SPD (Stage I protection)

iii. **LPZ 2 and beyond:** Further internal zones with increasing levels of protection, where sensitive equipment is shielded from surges and electromagnetic interference. Example : Relay Room, EI, Class C SPDs should come in LPZ2.

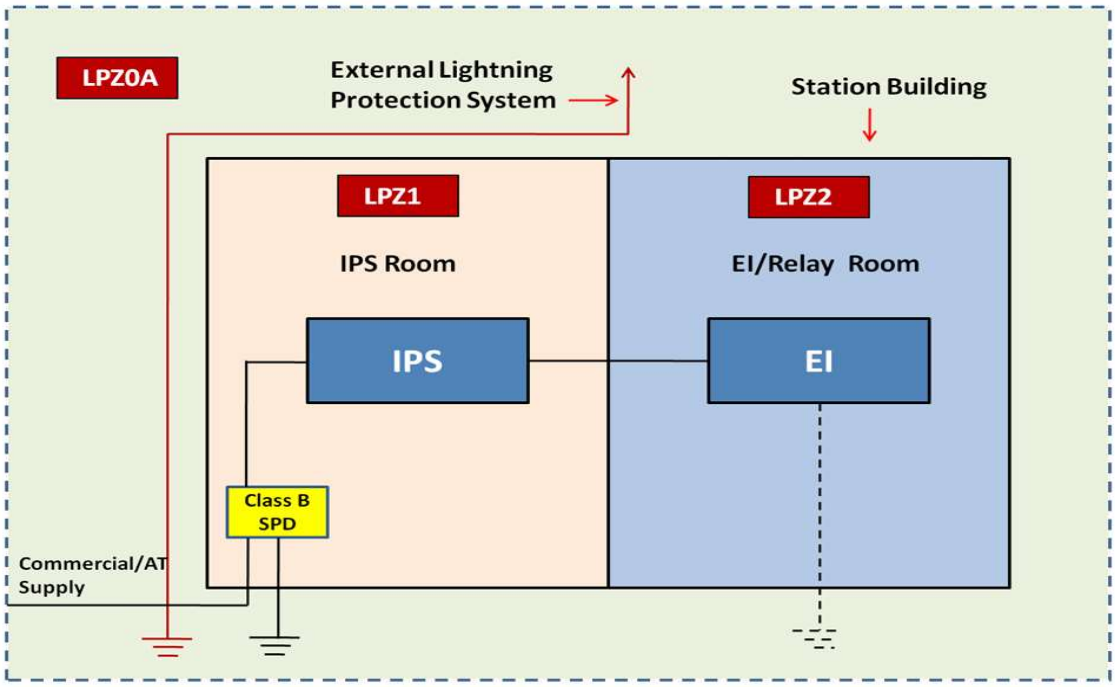


Figure 6 : Provision of Earth entry in LPZ1

If earthing entry is provided in LPZ1: Then in the event of surge, the surge current dissipates from LP0 to LPZ1 & LPZ2. The magnitude of surge current is reduced till it reaches the equipments in LPZ2.

If earthing entry is provided in LPZ2: The equipments in LPZ2 (EI, Relay room) are exposed to higher surge currents as these equipments of LPZ2 come first in the path instead of LPZ1.

Hence in any signalling installation the recommended practice is to provide single earthing entry through LPZ1 .

8. Why Equipotential Bonding of Class A and Ring Earth ?

When separate earths are provided to Class A LPS and Ring earth system, there are two cases:

Case I : Earth of Class A LPS not connected to that of Ring earth system (Ref.: Figure 7) Suppose 10 KA current is generated at Class A LPS due to lightning strike. A far earth is taken for reference with potential as 0 Volts. Earth potential rise in Class A LPS will be 10 KV. The same current will flow through down conductor ignoring the voltage drop due to inductance. There will be capacitive coupling between down conductor and the building wall (due to RCC structure and iron lanterns in the wall). The surge voltage will appear on the walls due to capacitive coupling. Since resistivity of earth (soil) is high, there will be a large potential difference between Class A LPS Earth to the Earth of Ring earth system. Suppose the potential drop at the Earth of Ring earth system is 3 KV. This voltage will flow through the BRC of ring earth system. Due to large potential difference between the building wall and BRC, the surge current will enter the building and may result in damage to equipment's.

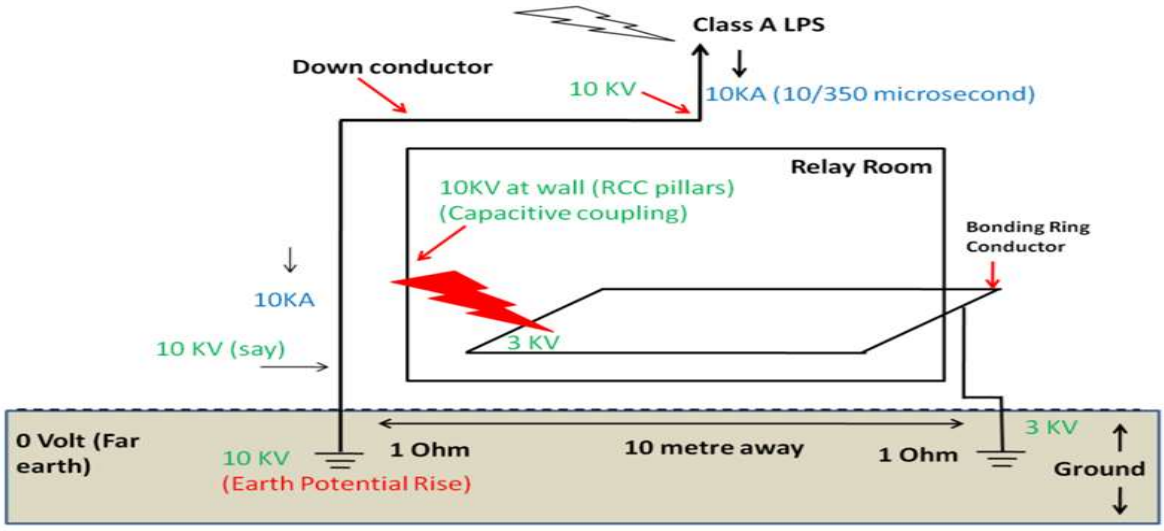


Figure 7 : Class A LPS Earth not connected to Ring Earth

Case II : Earth of Class A LPS connected to that of Ring earth system (Ref.: Figure 8) In this case since resistivity of copper is much lower than that of earth (soil) there will be no potential difference between two earth points. Hence there is no possibility of potential difference between the building wall and BRC.

Hence it is recommended to connect Earth of Class A LPS connected to that of Ring earth system

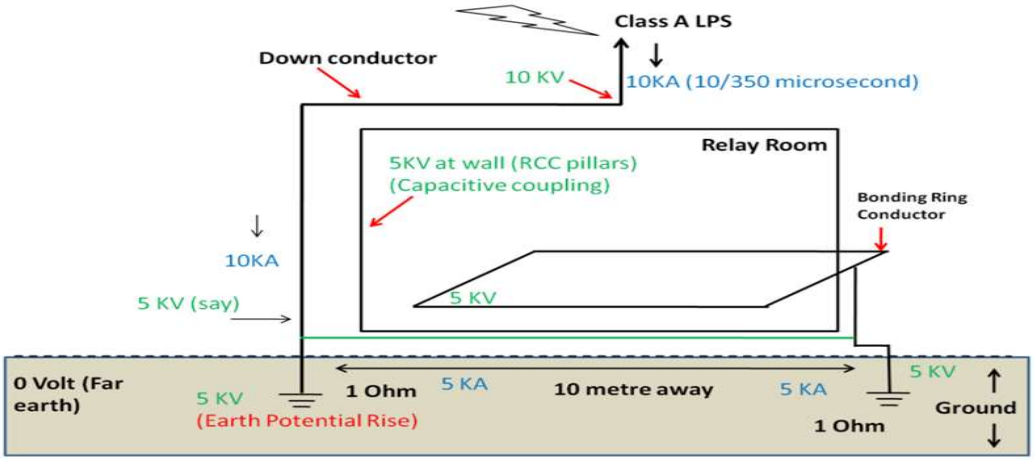


Figure 8 : Class A LPS Earth connected to Ring Earth

9. Why Separation between Clean and Dirty wires ?

Dirty wires: All earth wires, Voltage monitoring cables to the data logger, Cables from/to external locations. Power supply to points, end goomties, etc.

Clean wires: Wiring for EI power after dc-dc convertors, Wiring from EI cards to interface relay, etc. (directly connected to electronics). Clean wire is directly connected to electronics like I/O card, CPU etc.

• Even highest quality electronic equipment complying to EN-50121-4 have EMI immunity for surge of 1-2KV for 50 microseconds at I/O port (line to line).

• When any surge goes through dirty wire, it can induce current surge in clean wire and hence a Surge voltage to electronics. **Hence dirty wires and clean wires should not be mixed.**

10. Whether Down Conductor should be insulated from the wall of Building?

Separation distance is the distance required between air terminals/Lightning down conductors and any conductive/metallic/electrical/electronic part of the building to avoid uncontrolled flashover. Separation distance (S), in m should be calculated as per the following formula:

$$S = \frac{K_i \times K_c \times \ell}{K_m}$$

Where

K_i = depends on the selected LPL (Lightning Protection Level)

K_m = depends on the electrical insulation material

K_c = depends on the partial lightning current flowing on the air-termination and the down- conductor

ℓ = length, in m along the air-termination and the down-conductor from the point where the separation distance is to be considered, to the nearest equipotential bonding point or the earth-termination.

Approx. Coefficient value Kc		**Approx. Coefficient value K_i**		**Approx. Coefficient value K_m**	
Number of Down Conductors	***K_c***	**Class of LPS**	**K_i**	**Material**	**K_m**
1	1	I	0.08	Air	1
2	0.66	II	0.06	Concrete, Bricks & wood	0.5
3 and more	0.44	III & IV	0.04		

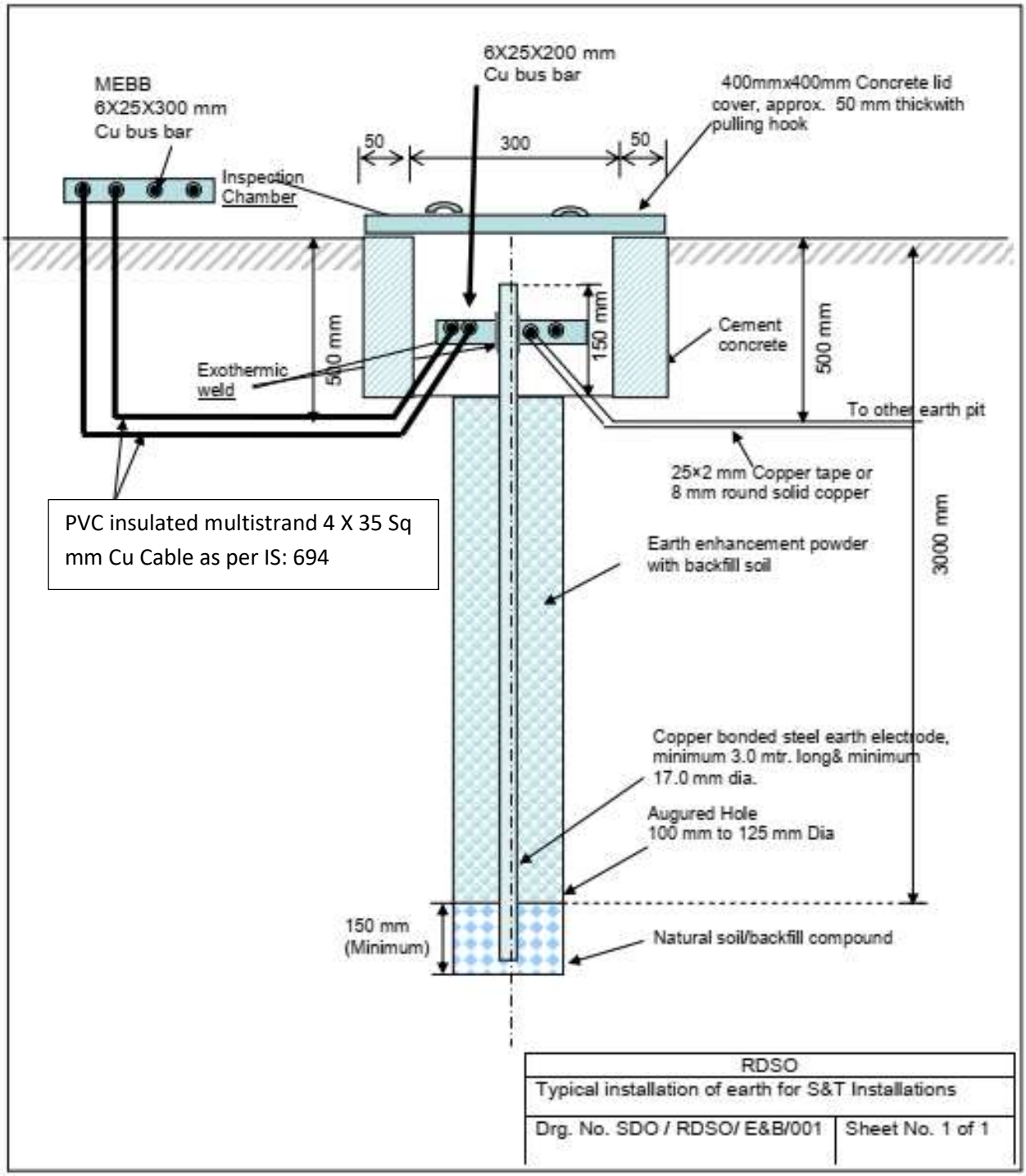
Annexure-I

Part List

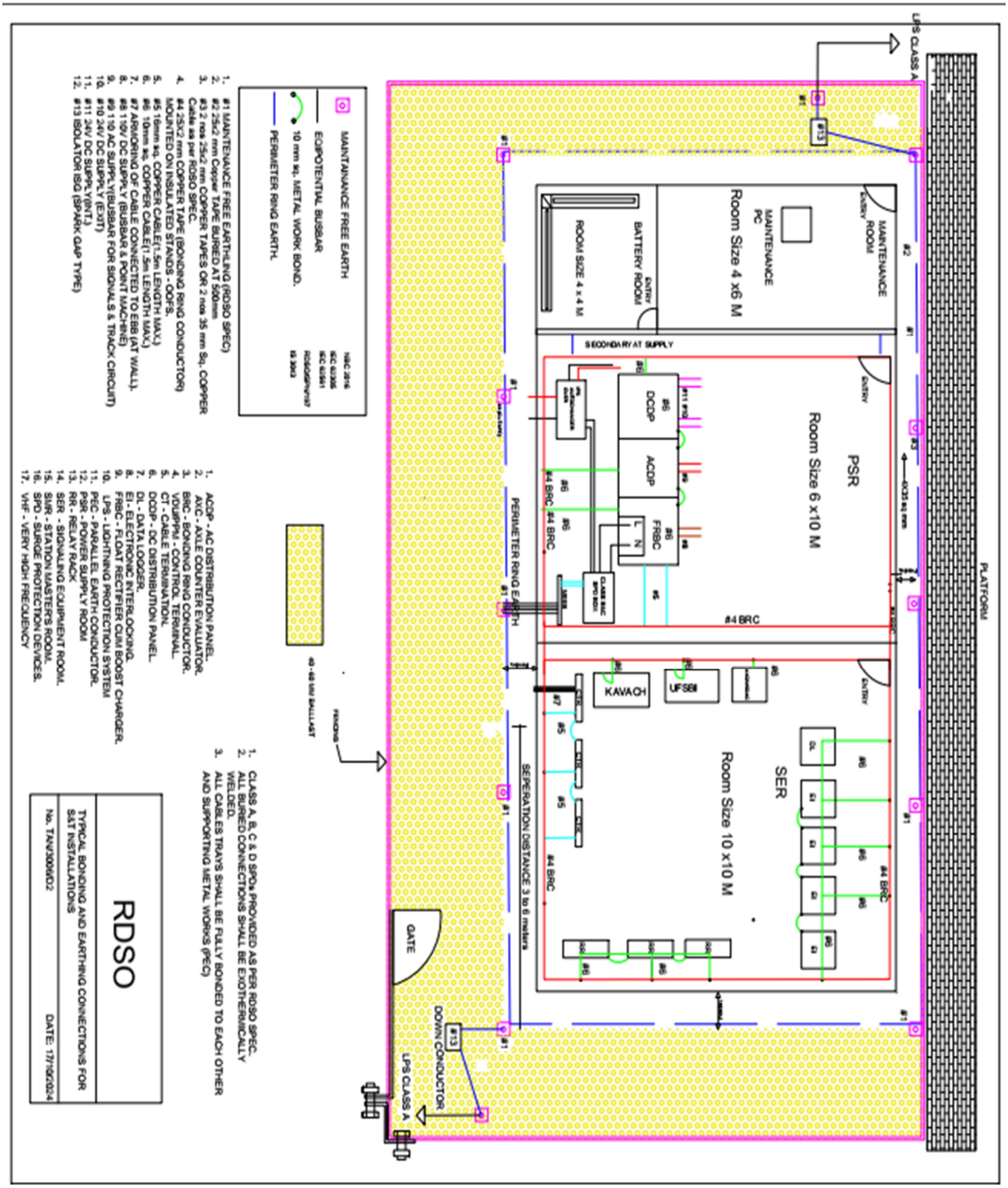
SN	Item/ Component	Size	Quantity
1	Earth Electrode	Dia- 17 mm Length- 3 mtr	1
2	Earth Enhancement Material	30- 35 Kg	1
3	Main equipotential earth busbar (MEEB)	300X25X6 mm (min.)	1
4	Sub equipotential earth busbar (SEEB)	150X25X6 mm (min.)	1
5	Multi-strand single core PVC insulated copper cable as per IS:694 used to connect individual equipment to SEEB	10 Sq mm	As per site requirement
6	Multi-strand single core PVC insulated copper cable as per IS:694 used to connect SPD to MEEB	16 Sq mm	
7	Multi-strand single core PVC insulated copper cable as per IS:694 (4 Nos) used to connect MEEB to Main earth electrode	35 Sq mm	
8	Copper tape or solid copper round conductor used to connect Main earth pit to other earth pit in case of loop earth	25 X 2 mm or 8 mm dia	
9	Copper strip to be exothermically welded to earth electrode	2000X25X6 mm (min.)	1
10	Exothermic Weld Material & Mould	-	As per site requirement

Annexure-II

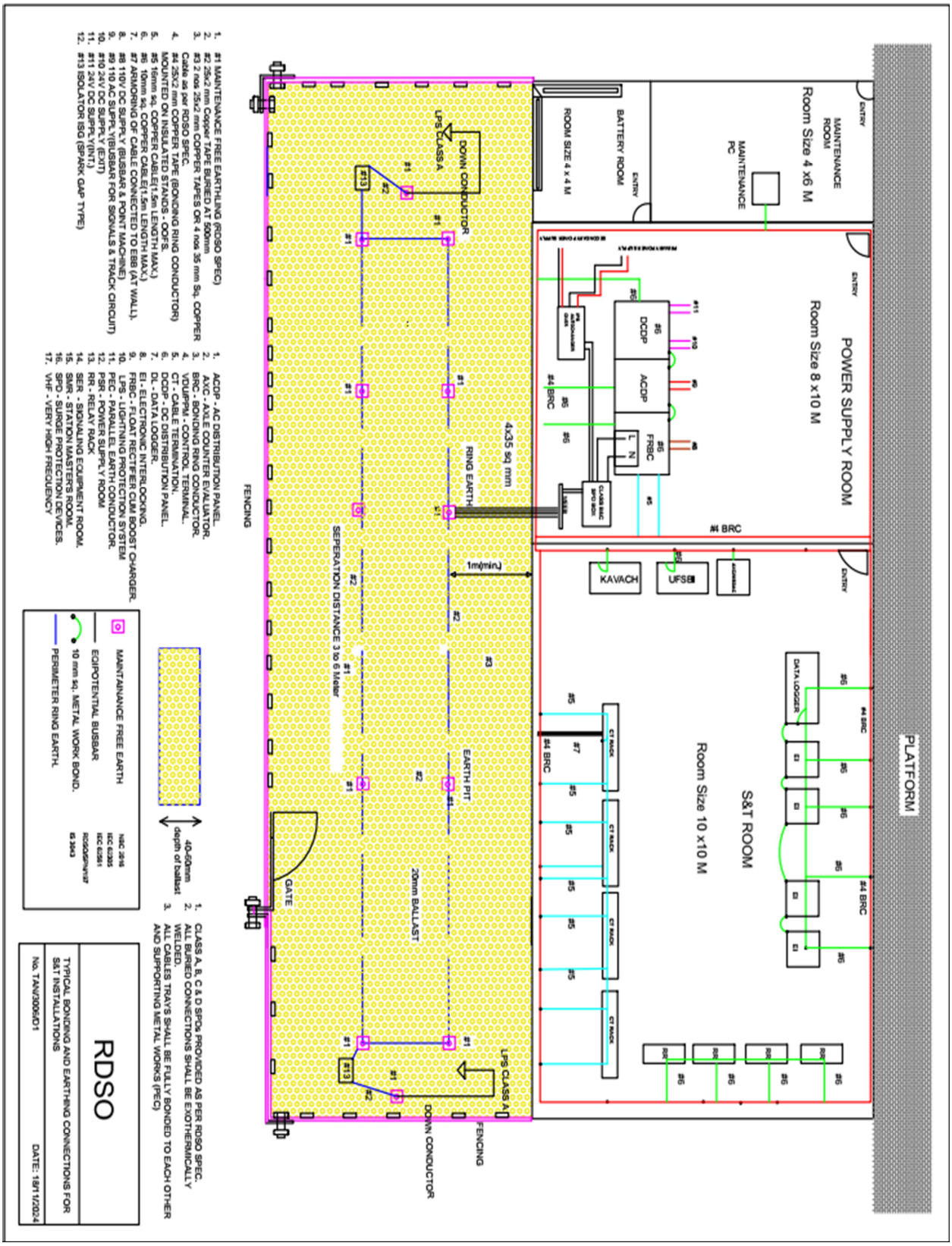
Drawing for Typical Installation of Earth



Annexure-III (a)

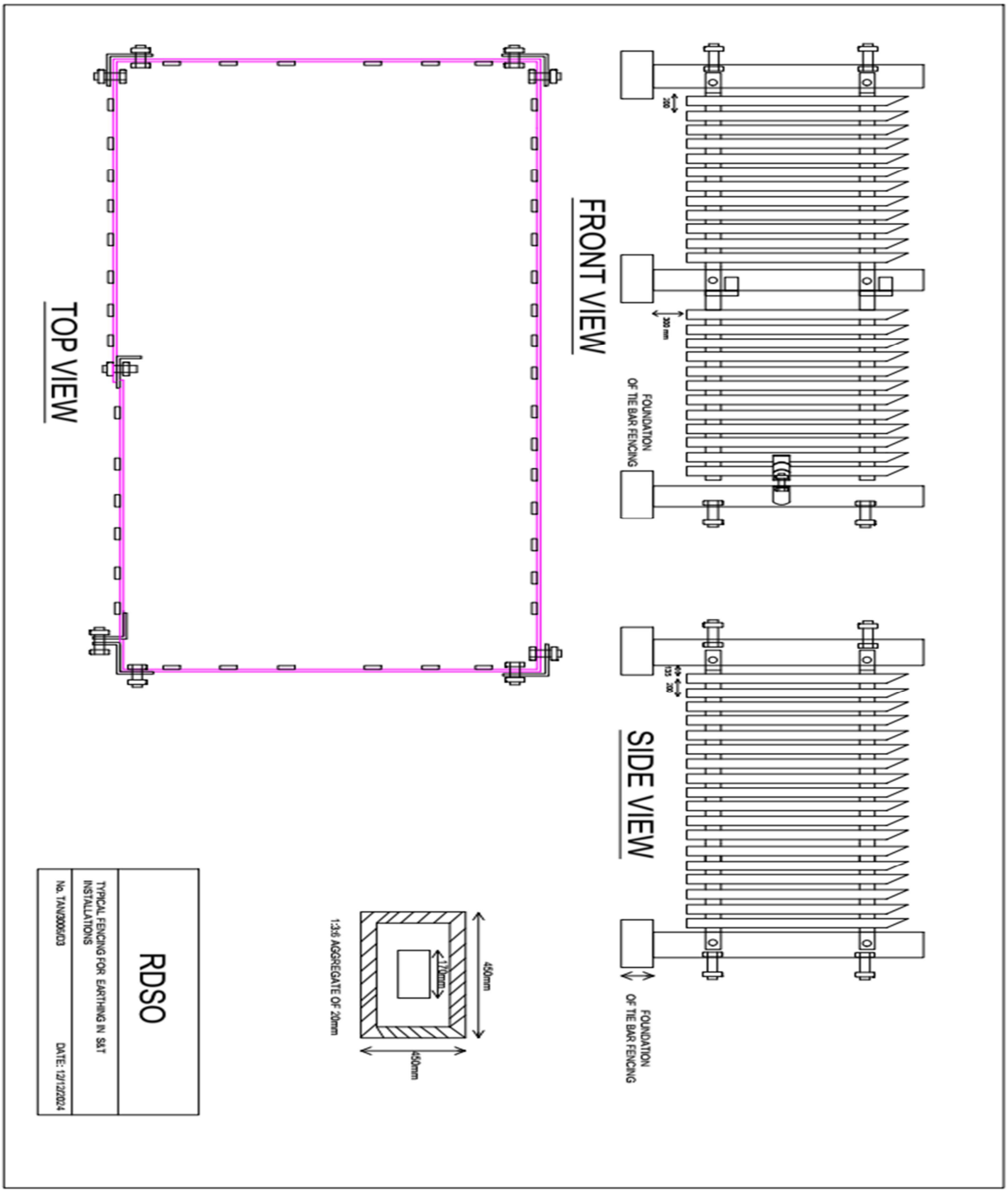


Annexure-III (b)



Annexure-III (c)

Typical Fencing for Earthing S&T installation



Annexure-IV

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.

Annexure V

PRE-COMMISSIONING CHECK LIST

OF

CODE OF PRACTICE

FOR

EARTHING AND BONDING SYSTEM

FOR SIGNALLING EQUIPMENTS

REFERENCE: SPECIFICATION NO. RDSO/SPN/197, Version- 1.0

FORMAT NO. SIG 0625

Number of pages - 08

RESEARCH, DESIGNS & STANDARDS ORGANISATION

MINISTRY OF RAILWAYS

MANAK NAGAR

LUCKNOW - 226011

11/07/19

Signature of Manufacturer Representative

Signature Of Railway supervisor

DOCUMENT DATA SHEET	
Designation	**SIG 0625**
Title of Document	**Pre-Commissioning Checklist of Code of practice for Earthing& Bonding system for signaling equipments**
Authors:	**Name: Hari Om Kushwaha** **Designation: Director/Signal, RDSO Lucknow**
Approved by	**Name: Shri Anurag Goyal,** **Designation: Executive Director/Signal, RDSO Lucknow**
Abstract **This document defines Pre-Commissioning Checklist for "Code of practice for Earthing& Bonding system for signaling equipments"**	

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DOCUMENT CONTROL SHEET

NAME	ORGANISATION	FUNCTION	LEVEL
Pradeep ADE/SIGNAL	RDSO	Member	Prepare
Hari Om Kushwaha, DSIG-VI	RDSO	Member	Prepare
Anurag Goyal, Executive Director/Signal	RDSO	Approving Authority	Approve

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Signature Of Railway supervisor

PRE-COMMISSIONING CHECKLIST FOR EARTHING AND BONDING SYSTEM FOR SIGNALLING EQUIPMENTS

1. STATION DETAILS

Zonal Railway	
Division	
Station Name	
Name of OEM/Manufacturer	
Date of Installation	

2. Part /Components for Earthing & Bonding System as per Spec. No. RDSO/SPN/197, Ver. 1.0

S. No.	Item/Component	Size/Diamention (Minimum)	Size/Diamention of Installed items	Remark (OK/Not OK)
1.	Earth Electrode	Dia.- 17.0 mm Length- 3.0 meter		
2.	Earth Enhancement Material	10 Kg./Bag (Min. approx. 30-35 Kg/Earth Electrode)		
3.	Main equipotential earth busbar (MEEB)	300X25X6 mm (min.)		
4.	Sub equipotential earth busbar (SEEB)	150X25X6 mm (min.)		
5.	Multi-strand single core PVC insulated Copper Cable as per IS:694 used to connect individual equipment to SEEB	10 sq.mm		
6.	Multi-strand single core PVC insulated Copper Cable as per IS:694 used to connect SEEB to MEEB	16 sq.mm		
7.	Multi-strand single core PVC insulated Copper Cable as per IS:694 used to connect SPD to MEEB	16 sq.mm		
8.	Multi-strand single core PVC insulated Copper Cable as per IS:694 (Duplicated) used to	35 sq.mm		

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	connect MEEB to main earth electrode			
9.	Copper tape or solid copper round conductor used to connect Main earth pit to other earth pit in case of loop earth	25X2 mm or 8mm dia.		
10	Copper strip to be exothermically welded on earth electrode	200mmX25mmX6mm		
11.	Exothermic Weld Material & Mould	–		
12.	Inspection Chamber (RCC) (Prepared at site during installation)	300X300X300 mm (inside dia.) with 50 mm thickness		

Note: *Length of copper cables, Copper Tape/solid copper round conductor should be minimum as much as possible.*

3. PRE-COMMISSIONING REQUIREMENTS

S.N.	ITEM	Specified Value/provision	Measured Value / Observation	Remark (OK/Not OK)
1.	Parts/Components of Earthing & bonding system	Ensure that all the materials provided for eatthing work is pre-inspected by RDSO.		
7.	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.		
8.	Construction of unit earth pit:	a. Earth Pit shall be as per typical installation drawing **no. SDO/RDSO/E&B/001.** b. A hole of 100mm to 125mm dia shall be augured /dug to a depth of about 3.0 meters.		

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		c. The earth electrode shall be placed into this hole. d. Min. 150 mm of the electrode shall be inserted in the natural soil. e. Earth enhancement material (minimum approx. 30-35 kg) shall be filled into the augured/dug hole in slurry form and allowed to set. f. 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. g. A copper strip of 200mmX25mmX6mm shall be exothermically welded to main earth electrode. h. The main earth pit shall be located as near to the main equi-potential earth busbar in the equipment room as possible. i. Earth resistance shall be measured.		
9.	Construction of loop Earth by providing multiple earth pits	a. If earth resistance is >1 ohm with one earth electrode /pit due to higher soil resistivity, 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. b. The distance between two successive earth electrodes shall be min. 3 mtrs. and max. up to 6 mtrs. approx. c. These earth pits shall then be inter linked using 25X2mm. copper tape or 8 mm round solid copper conductor to form a loop using exothermic welding technique. d. The interconnecting conductor shall be buried at depth not less than 500 mm below the ground		

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		level. This interconnecting conductor shall also be covered with approximately 30 Kg of earth enhancing compound for each 3 meters length.		
10.	No. of Earth Pit Provided	The number of pits required shall be decided based on the resistance achieved for the earth pits already installed.		
11.	Measurement of Earth resistance	The earth resistance shall be measured at the Main Equi-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.**		
12.	Equi-potential Earth Busbar and its connection	Equi-potential Earth Busbar and its connection to equipments & Surge protection devices in the Equipment room shall be as per typical bonding connections drawing no.**SDO/RDSO/E&B/002**		
13.	Inspection Chamber	a. Inspection chamber should be as per IEC 62561-5 or latest. b. The dimension of the chamber will be of 300 x 300 x 300 mm (inside dimension) of RCC with 50 mm thick and fine finish. c. The size of RCC cover of Inspection Chamber shall be 400×400×50 mm. with pulling hooks. d. The marking space should be present an RCC cover. The date of testing and earth resistance value shall be written on the cover with black base with yellow paint.		
14.	User Manual	Two sets of User Manual consisting of Layout drgs., of RDSO/SPN/197, Ver. 1.0) shall be submitted.		
15.	Precautions are to be followed for execution of Earthing works & Exothermic Welding connections as per Annexture-1 & 2 of the specification.			

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Page 8 of 8	Date of issue 11.07.2019	Pre-Commissioning Checklist for Earthing & Bonding System (RDSO/SPN/197, Ver. 1.0)	Format No SIG 0625	Version 1.0

	a. The cable routing should be done as such that the length of used is cable minimum. b. Proper sadding of cable should be done at every 1 mtr. so as to avoid any cable sagging. c. there should not be any coiling of cable of any point. d. Jointing of any two cables should be avoided and if required then the jointing must be properly done and installed well. e. The clean wires and dirty wires should be kept separate.		

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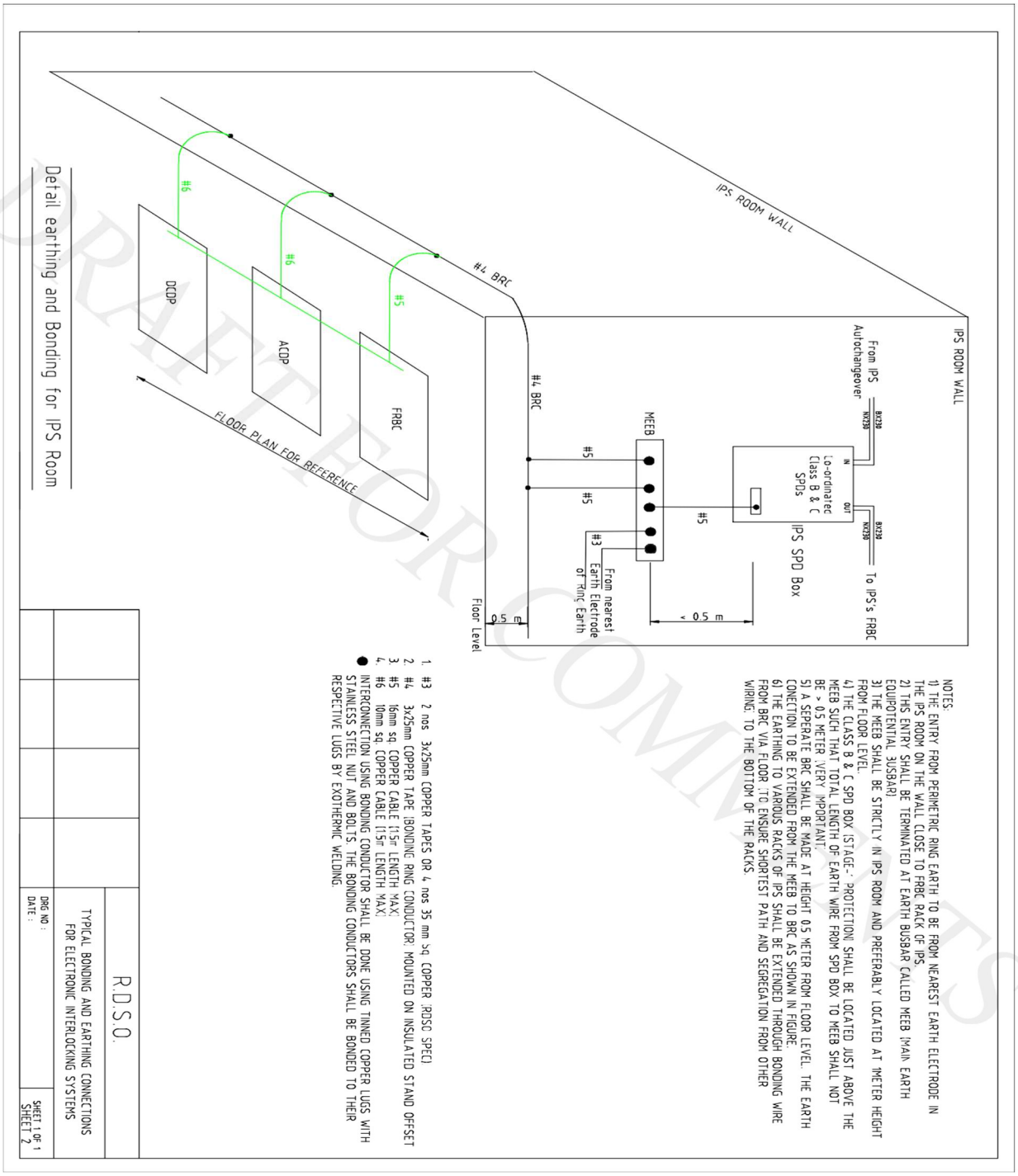
Annexure VI

SPD arrangement at Input of IPS



Annexure VII

Maintenance Schedule of Earthing as per IRSEM

Para No. 19.11.9 — Annexure: 19-MS6

Maintenance Schedule of Earthing (Conventional & Maintenance Free) and Lightning Protection

Index

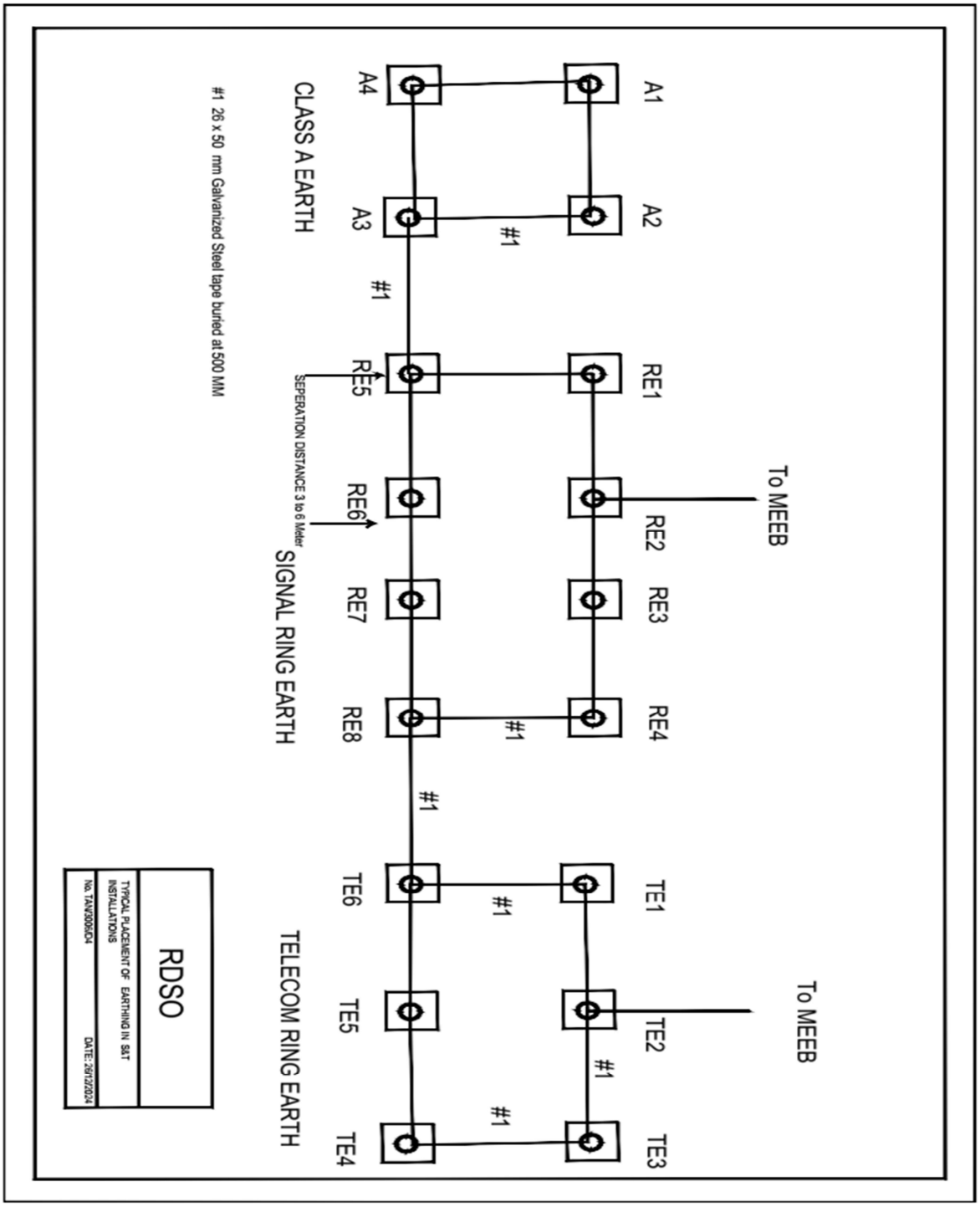
Periodicity	Schedule Code
Monthly	E1
Quarterly	E1
Half Yearly	E1, E2
Yearly	E2, E3

	Schedule Code: E1 *Periodicity: Technician(Signal): Monthly* *Sectional SSE/JE(Signal): Quarterly* *SSE(Signal)/Incharge: Half-yearly*
S.No.	Check the following:
1.	All earth connections of block earth, Axle counter, MUX and other equipment earth are intact.
2.	Earth wire lead is not corroded and is well protected.
3.	Nut connecting earth wires to electrode are not corroded.
4.	SPD (B & C type at 230 V entry stage) indications are OK.
5.	Connections to SPD are intact.
	Schedule Code: E2 *Periodicity: Sectional SSE/JE(Signal): Half-yearly* *SSE(Signal)/Incharge: Yearly*
S.No.	Check the following:
1.	SPD (C type at the output side of DC supply) indications are OK. Before onset of monsoon and after every lightning it has to be verified.
2.	Connections to SPD are intact.
	Schedule Code: E3 *Periodicity:* Sectional SSE/JE : Yearly SSE(Signal)/Incharge: Yearly *(Note: They shall do in alternate Six months)*
S.No.	Check the following:
1.	Proper rating and type of SPD used.
2.	Available potential free contacts are wired.
3.	Separate earth exists for each block.
4.	Different earthing conductors are insulated from each other.
5.	Measuring the value of earth resistance of the earthing provided for signaling circuit, improving earth resistance if found more than beyond specified limit of installed equipment, take steps to reduce it further.
6.	Keeping records of the earth resistance measurement and painting its value on earth enclosures/nearest wall.

Note: There should not be any other earth or system earth of electrical, placed less than 20 meters away from the equipment earth.

Annexure VIII

Placement of Earthing at S&T Installation



Annexure IX

Checklist for Earthing & Bonding and Lightning Protection System

SN.	Description	Status (Yes/No)
1.	Earth is installed as per drawing mentioned in RDSO/SPN/197/2016 Ver.1	
2.	The material is procured as per the part list issued by RDSO for Earthing and Bonding system (Annexure I).	
3.	Only NABL/ILAC-tested exothermic materials are used for exothermic welding in Earthing and Bonding system.	
4.	The installation of Earthing and Bonding system is carried out by the OEM or an OEM authorized representative.	
5.	The Pre-commissioning checklist is jointly signed with OEM.	
6.	The OEM installation certificate for Earthing and Bonding is obtained from the OEM.	
7.	The drawing for Earthing and Bonding is painted on the outside wall of building for easy identification.	
8.	The Earthing and Bonding Plan of station are made available at Station.	
9.	The Earth is installed atleast 1 meter away from the wall.	
10.	The copper or GI strip provided for interconnecting earth electrode is buried at a depth not less than 500 mm.	
11.	It is ensured that, no knot and coils are present in the conductors used for Earthing and Bonding.	
12.	Only one Entry is ensured for the building for the connection of MEEB and Earth.	
13.	The MEEB is provided only in IPS Room for S&T installation and in Telecom room for Telecom installation.	
14.	All electronic equipment in the S&T room is connected to the BRC via a shortest path.	
15.	Indicative type SPDs with PFC contact are provided for the electronic equipments.	
16.	Available PFC contact of SPDs are wired in the Datalogger.	
17.	The SPD/LPD Box are installed close to IPS (preferably near FRBC panel of IPS).	

18.	The distance between the MEEB and SPD box is not more than 0.5 meters	
19.	The SPD and equipment are connected in the shortest path. Additional SPD (Type II) is provided in the equipment rack if the distance between SPD and Equipment is more than 10 meter.	
20.	Test report of SPD's installed as per IEC standard is ensured.	
21.	Physical connections and wiring of SPDs are ensured.	
22.	The Dirty and Clean wires are properly segregated.	
23.	The down conductor of Class A is connected with the shortest path to earth.	
24.	The earth for Class A and Perimeter /Ring Earth are equipotential bonded.	

Signature of Railway Representative