Template for submitting comments/inputs on Draft New GR on "MAINTENANCE FREE EARTHING SYSTEM FOR TELECOM EQUIPMENT" (TEC XXXX: 2026)"-

Name of Manufacturer/Stakeholder:

Organization:

Contact details:

Clause No.	Clause Description	Comments, if any	Remarks, if any

Note: The comments/inputs on the draft New GR (Standard No. TEC XXXX: 2026) may be furnished in the above format through email to adgfa-tec-dot@gov.in with copy to dirfa.tec@gov.in and ddgfla.tec@gov.in at the earliest and within prescribed time period.

सत्यमेव जयते

वर्गीय आवश्यकताओं के लिए मानक

टीईसी XXXX: २०२६

(सं: टीईसी xxxx :xxxx को अधिक्रमित करता है)

STANDARD FOR GENERIC REQUIREMENTS

TEC XXXX: 2026

(Supersedes No. TEC XXXX:XXXX)

दूरसंचार उपकरणों हेतु अनुरक्षण-मुक्त अर्थिंग प्रणाली

MAINTENANCE FREE EARTHING SYSTEM FOR TELECOM EQUIPMENT

ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र

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FOREWORD

Telecommunication Engineering Centre (TEC) is the technical arm of the Department of Telecommunications (DOT), Government of India. Its activities include:

- Framing of Standards for Generic Requirements for a Product/Equipment, Standards for Interface Requirements for a Product/Equipment, Standards for Service Requirements
- Formulation of Essential Requirements (ERs) under Mandatory Testing and Certification of Telecom Equipment (MTCTE) Policy
- Field evaluation of Telecom Products and Systems
- Designation of Conformity Assessment Bodies (CABs)/Testing facilities
- Testing & Certification of Telecom products
- Adoption of Standards
- Support to DoT on technical/technology issues

For the purpose of testing, four Regional Telecom Engineering Centres (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata.

ABSTRACT

This document specifies the generic requirements for Maintenance Free Earthing Systems used in telecommunication networks, electrical and electronic installations, industrial facilities, and lightning protection applications. The system shall provide a reliable, low-resistance, corrosion-resistant, and long-life earthing solution for the safe dissipation of fault, lightning, surge, and leakage currents, while maintaining acceptable earth resistance throughout its service life without periodic watering, chemical treatment, or frequent maintenance.

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HISTORY SHEET

S. No.	Standard / document No.	Title	Remarks
1	TEC XXXX:2026	Maintenance Free Earthing System For Telecom Equipment	First Issue

REFERENCES

S. No.	Document No.	Title/Document Name
1.	~~BS 7430:2011+A1:2015~~	~~British standard - Code of Practice for Earthing~~
2.	IEC 62561-2:~~2018~~ 2025/ IS 18925-2: 2025	Lightning protection system components (LPSC) - Part 2: Requirements for conductors and earth electrodes
3.	IEC 62561-5:2023 / IS 18925-5: 2025	Lightning protection system components (LPSC) - Part 5: Requirements for earth electrode inspection housings and earth electrode seals
4.	IEC 62561-7:~~2018~~ 2024 IS 18925-7: 2025	Lightning protection system components (LPSC) - Part 7: Requirements for earthing enhancing compounds
5.	IEEE 80:2013	IEEE guide for safety in AC Substation Grounding
6.	IEEE 1100 - 2005	IEEE Recommended Practice for Powering and Grounding Electronic Equipment
7.	IEEE 837:2024	Standard for qualifying permanent connections used in substation grounding
8.	IS 3043:2018	Indian standard Code of Practice for Earthing
9.	IS/IEC 62368-1:2023	Audio/video, information and communication technology equipment - Part 1: Safety requirements
10.	NBCS: ~~2016~~2026	National Building ~~Code~~ Construction Standard
11.	UL 467: 2022	Standard for Grounding and Bonding Equipment
12.	TEC 66130:2025	Lightning and Surge Protection of Telecom Sites
13.	TEC 10009:2024	Safety Requirements of Telecommunication Equipment
14.	ITU-T K.27: 2015	Bonding configurations and earthing inside a telecommunication building
15.	ISO 9001:2015	Quality management systems

Note:

Unless otherwise explicitly stated, the latest approved issue of the standard/GR/IR, with all amendments in force, listed in references, on the issuance date of this GR/IR are applicable".

CHAPTER 1

1.0 INTRODUCTION

1.1 This document covers the generic requirements of "Maintenance Free Earthing System for Telecom Equipment" intended for use in Telecommunication Networks, electrical installations, electronic systems, industrial facilities and lightning protection applications. Earthing systems are used to provide a safe, low resistance and reliable path for dissipation of fault currents, lightning currents, surge currents and leakage currents into the earth, thereby ensuring protection of equipment and safety of personnel.

1.2 The Maintenance Free Earthing System for Telecom Equipment is required to maintain a uniform earth potential under and around the installation so that all non-current carrying metallic parts remain at earth potential under normal and fault conditions.

1.3 The system shall be designed to minimize dangerous touch and step voltages and to ensure safe operation during short circuits, electrical surges and other abnormal operating conditions in accordance with IEEE 1100: 2005.

1.4 The System shall be capable of providing stable and acceptable earth resistance values throughout its operational life without requiring periodic watering, chemical treatment or frequent maintenance.

1.5 The system shall be designed using suitable earthing electrodes, earthing conductors, earth enhancement compounds and ~~permanent~~ intact bonding arrangements to ensure reliable long-term earthing performance with minimum downtime, service interruption and equipment damage.

2.0 DESCRIPTION

A typical schematic arrangement of the Maintenance Free Earthing System, demonstrating the integration of the earth pit, copper-bonded electrode, earth enhancement material, and equipotential busbars, is illustrated in Annexure-1. The Maintenance Free Earthing System comprises the following major components:

2.1 Earth Electrode (Rod):

2.1.1 The earth electrode/rod is the primary component of the earthing system. It shall be in direct contact with the ~~ground~~ Earth Enhancement Material to provide an effective path for dissipation and collection of fault current, leakage current, surge current and lightning current.

2.1.2 The earth electrode shall possess high electrical conductivity to ensure efficient earthing performance and low earth resistance during normal and fault operating conditions.

2.1.3 The material used for the earth electrode shall exhibit high corrosion resistance and shall be suitable for installation in varying soil and environmental conditions without degradation of electrical or mechanical performance throughout the operational life of the earthing system.

2.2 Earth Enhancement Compound:

2.2.1 A highly conductive and non-corrosive backfill material used to improve earthing performance and maintain low earth resistance, particularly in high soil resistivity conditions.

2.2.2 The Earth Enhancement Material shall be installed around the earth electrode in an augured hole or around earthing conductors in a trench to improve conductivity and earthing effectiveness.

2.2.3 The material shall be completely free from bentonite and suitable for installation either in dry form or in premixed slurry form, as specified in the earthing system design and installation procedures by "manufacturer/supplier". The installation shall ensure effective contact between the electrode, conductor ~~and surrounding soil~~, and shall be carried out in accordance with ~~IEEE 80:2013~~ Annexure-1.

2.2.4 An augured hole of 100 mm to 250 mm diameter shall be prepared with a minimum clearance of 150 mm maintained at the bottom of the earth electrode, to allow for an adequate base layer of the Earth Enhancement Material and ensure complete encapsulation, in accordance with the dimensional guidelines of IEEE 80:2013 and the earth enhancement practices of IS 3043:2018.

2.3 ~~Earth Mesh/Mat~~ Interconnecting Conductor for Multiple Earth Pit Connections:

2.3.1 The earth mat shall comprise a 25 mm × 2 mm solid copper tape, an 8 mm solid copper round conductor or an 8 mm diameter Copper Bonded Steel (CBS) round conductor, to provide an effective and reliable earthing network for the safe dissipation of fault, surge, and lightning currents, in compliance with the material, configuration, and cross-sectional area requirements of IEC 62561-2:~~2018~~ 2025 / IS 18925-2: 2025.

2.3.2 The copper-coated/bonded steel conductor shall consist of a high-tensile, low-carbon mild steel core molecularly bonded with a minimum of 99.9% pure electrolytic grade copper on the outer surface, to ensure high conductivity, mechanical strength, and long-term corrosion resistance, in accordance with IEC 62561-2:~~2018~~ 2025 / IS 18925-2: 2025.

2.4 Exothermic Welding System:

2.4.1 A permanent molecular bonding arrangement used for buried earthing joints to ensure reliable electrical continuity, high fault current withstand capability and corrosion resistant connections throughout the operational life of the earthing system.

2.4.2 The Exothermic (Thermic) Welding System shall be utilized to create permanent, molecularly bonded electrical connections strictly for copper-to-copper and copper-to-steel applications (including structural bonding), to ensure joint integrity, in accordance with the permanent connection standards of IEEE 837:2024 and IS 3043:2018.

2.4.3 The welded joints shall be suitable for direct burial in earth or concrete and shall maintain electrical and mechanical integrity throughout the operational life of the earthing system without deterioration under normal service conditions.

2.5 Equipotential Earth Busbar (EEB):

2.5.1 The Equipotential Earth Busbar (EEB) shall provide a common bonding point to maintain equipotential conditions among all metallic parts and earthing conductors, ensuring effective dissipation of fault, surge, and lightning currents for personnel safety and equipment protection.

2.5.2 The system shall utilize copper busbars for reliable equipotential bonding and long-term electrical performance.

2.5.3 The Main Equipotential Earth Busbar (MEEB) shall be constructed of high-conductivity copper with a minimum cross-sectional area of 25 mm × 6 mm for fault current upto 30 KA and 50 mm × 6 mm for fault current upto 45 KA and an overall physical length determined by site-specific requirements with at least 20% spare capacity for future expansion, to function as the Main Earthing Terminal (MET) and satisfy the earth fault thermal limits, in accordance with IS 3043:2018.

2.5.4 The Sub Equipotential Earth Busbar (SEEB) shall be constructed of high-conductivity copper with a minimum cross-sectional area of 25 mm × 6 mm and a physical length dictated by site-specific layout requirements, to function as the local equipotential bonding bar and accommodate all local physical cable terminations without overlapping lugs, to satisfy the local bonding thermal requirements of IS 3043:2018.

2.5.5 A dedicated Outdoor Grounding Busbar shall be provided on the outward-facing wall where installation includes an external gantry, tower, or equipment bay. It shall serve as the bonding point for external grounding conductors, including tower down conductors, waveguide earthing conductors, and lightning protection conductors, before their connection to the internal grounding system.

2.5.6 The internal Main Equipotential Earth Busbar (MEEB) shall serve as the primary earth distribution point and shall provide interconnection between the grounding electrodes, equipment earthing conductors, surge protection devices, and other equipotential bonding conductors within the installation. For above-ground joints, either exothermic welding or mechanical/pressure clamps may be used for interconnection.

2.6 Earth Pit / Inspection Chamber:

2.6.1 A dedicated earth pit or inspection chamber shall be provided over the earth electrode, to protect the connection and ensure accessibility for periodic testing and maintenance. It shall be tested as per IEC 62561-5:2023 / IS 18925-5: 2025.

2.6.2 The inspection chamber shall be constructed of PVC/RCC (Reinforced Cement Concrete) providing a minimum internal clear working space of 300 mm × 300 mm × 300 mm (or a minimum 300 mm internal diameter if cylindrical), ~~to permit unrestricted physical access for a technician's hands~~

~~and tools to safely unbolt the disconnecting test link and attach earth resistance testing clamps, consistent with the earth pit accessibility and periodic testing provisions of~~ in accordance with IS 3043:2018. ~~and BS 7430:2011+A1:2015 (or latest)~~.

~~2.6.3A removable disconnecting bolted test link shall be provided within the inspection chamber, to allow the earth electrode to be temporarily isolated from the main earthing network to facilitate accurate periodic earth resistance measurements, in accordance with the testing provisions of IS 3043:2018 and BS 7430:2011+A1:2015 (or latest)~~.

2.6.3 The inspection chamber and its cover shall possess sufficient mechanical strength, capable of withstanding a minimum of 15 kN vertical load applied through a 130 mm diameter steel plate of 20 mm thickness, to prevent collapse or damage, in accordance with the inspection housing requirements of IEC 62561-5:2023 / IS 18925-5: 2025.

2.7 Connecting ~~Cables~~ Conductor and Hardware

2.7.1 The connection from the Main Equipotential Earth Busbar (MEEB) to the main earth pit shall be made using a multi-strand bare copper conductor or ~~PVC-insulated copper cable conforming to IS 694:2010~~ bare copper-bonded steel round conductor as per IEC 62561-2: 2025 / IS 18925-2: 2025, with the minimum cross-sectional area calculated based on the maximum fault current and operating time, to safely carry the fault current, in accordance with the formula of IS 3043:2018, as detailed in Annexure-2 (Section 1).

2.7.2 The connections from the Sub Equipotential Earth Busbars (SEEB) to the MEEB shall be made using, ~~a multi-strand PVC-insulated copper cable conforming to IS 694:2010~~ a copper-coated (bonded) steel round conductor, sized as per the fault current requirement, to ensure adequate current-carrying capacity for the fault loop, with the cross-sectional area determined by calculation per IS 3043:2018.

2.7.3 All cable terminations on the busbars shall be made using heavy-duty tinned copper lugs secured with stainless steel nuts, bolts, and spring washers, to protect against mechanical deterioration, electrodynamic forces, and electrolytic corrosion, in compliance with IS 3043:2018.

2.7.4 The connections from individual equipment racks to the local SEEB shall be made using a ~~multi-strand single-core PVC-insulated copper cable conforming to IS 694:2010, with a cross-sectional area of not less than 4 sq. mm~~ copper-coated (bonded) steel round conductor, sized as per the fault current requirement to ensure adequate protection, complying with the minimum limits of IS 3043:2018.

2.7.5 The connections from Surge Protection Devices (SPDs) to the MEEB shall be made using multi-stranded single-core PVC-insulated copper conductors conforming to IS 694:2010 maintained as short and straight as practicable, to minimize inductive impedance, executed in compliance with the cross-sectional sizing and routing path requirements of the TEC Generic Requirement for Low Voltage SPDs (TEC 66130:2025).

3.0 FUNCTIONAL REQUIREMENTS

3.1 The earth electrode shall be a driven rod comprised of round copper, steel-cored copper, or galvanized steel with a standard diameter of 14.2 mm, 17.2 mm, or 19 mm and a length between ~~1220 mm and 2440 mm~~ 1500 mm and 3000 mm (which may be coupled to achieve greater depths), and where impenetrable strata prevent deep vertical driving, rods shall be driven at an approximately 30º angle to the horizontal or installed in parallel, to ensure effective earth resistance, in compliance with the minimum dimensional mandates of ~~NBC: 2016~~ NBCS: 2026 and IS 3043:2018.

3.2 The earth electrode shall possess a loading capacity adequate for the system, to safely dissipate expected fault energy into the earth without experiencing failure caused by excessive temperature rise at the electrode surface, in accordance with the thermal and current density parameters of IS 3043:2018.

3.3 The outer surface of the steel core shall feature a copper cladding with a minimum radial thickness of 0.25 mm (250 µm), to prevent corrosion and ensure longevity, as mandated by ~~BS 7430:2011+A1:2015 (or latest)~~ IS 3043:2018.

3.4 The cladding material shall consist of 99.9% purity electrolytic copper that is molecularly bonded directly to the steel core, to ensure structural and electrical integrity, ~~as required by BS 7430:2011+A1:2015 (or latest)~~ in accordance with IS 3043:2018.

3.5 Earth rods shall be mechanically robust and the material shall be sufficiently malleable, to ensure that no cracking of the rod takes place during the installation process, in compliance with the physical installation requirements of IEC 62561-2:~~2018~~ 2025/IS 18925-2: 2025.

3.6 Each earth electrode shall be permanently marked with the following information:

i. Manufacturer’s name or trade name

~~ii. Electrode length~~

~~iii. Electrode diameter~~

~~iv. Relevant standard compliance/certification mark~~

~~v~~ii. Catalogue number / Batch number / Lot number

The marking shall be punched or permanently embossed on every rod in a manner that ensures legibility throughout the operational life of the electrode and ensure traceability and compliance, in accordance with the marking requirements of IEC 62561-2: ~~2018~~ 2025/IS 18925-2: 2025 ~~and UL 467:2022~~.

3.7 The Earth Enhancement Material shall be supplied in appropriate packing units with clear marking on the packing unit, to ensure the preservation of its characteristics and allow representative samples to be taken directly from the package, in accordance with IEC 62561-7:~~2018~~ 2024 / IS 18925-7: 2025.

3.8 The enhancement material shall be permanent, non-leaching over time, and explicitly prohibit the use of bentonite or highly corrosive coke breeze, to prevent degradation of the earthing system, complying with the earth resistivity enhancement guidelines of IS 3043:2018.

3.9 The Earth Enhancement Material shall possess low resistivity characteristics with a value of less than 0.12 Ω m, to effectively lower the earth resistance, tested and verified using the four-electrode method in compliance with IEC 62561-7:~~2018~~ 2024 / IS 18925-7: 2025 and IS 3043:2018.

3.10 The exothermic welded connection shall provide a permanent joint ensuring long-term electrical conductivity, corrosion resistance, current carrying capacity, and mechanical strength, to satisfy the criteria for underground connections, as outlined in IEEE 80:2013.

3.11 The exothermic welded joints shall be structurally solid, to be suitable for underground connections including direct burial in earth or concrete without degradation, in accordance with the application parameters of IEEE 80:2013.

3.12 The exothermic welded joint shall successfully endure sequential tests including current-temperature cycling and repeated fault-current surges, to prove it is capable of withstanding repeated electrical discharges and system fault currents, as mandated by IEEE 837:2024.

3.13 The exothermic welded connection shall be in compliance with ~~tested with a symmetrical rms fault current applied at 90% of the fusing current for the specific conductor's cross-sectional area, to ensure it successfully withstands a short-time fault current for a minimum duration of 10 seconds, in compliance with the fault-current test parameters of~~ IEEE 837:2024.

3.14 Following the completion of the fault-current test, the connection shall not melt, separate, or move in relation to the conductor, and its final electrical resistance shall not exceed 1.5 times the initial resistance value, to verify the joint's absolute survivability, complying with the fault-current and resistance criteria of IEEE 837:2024.

4.0 ELECTRICAL REQUIREMENTS

4.1 The earthing system shall be established as a global earthing system integrating both power equipment and sensitive electronic networks into an interconnected local earthing system, to satisfy equipotential bonding requirements and maintain the earth return path resistance as low as possible (in no case greater than 1 Ω), in accordance with IS 3043:2018.

4.2 The earthing arrangement shall be designed to provide a low earth fault loop impedance, to facilitate automatic disconnection of the supply and limit the rise of potential under fault conditions (minimizing earth potential rise and maintaining safe touch and step voltages), directly aligning with the fundamental safety objectives of IS 3043:2018 and IEEE 80:2013.

4.3 ~~A~~ Multiple number of rods ~~or pipes~~ shall be installed and connected in parallel in locations where high soil resistivity prevents achieving the required earth resistance using a single electrode, to effectively lower the combined earth resistance, in accordance with the multiple-electrode practices of IS 3043:2018.

4.4 The exact number, arrangement, and configuration of earth electrodes shall be definitively based on site-specific soil resistivity measurements, to ensure the design achieves the optimum resistance needed for proper protective system operation. Verifying local values is required by IS 3043:2018 and the estimated earth resistance shall be calculated using the mathematical guidelines provided in Annexure-2 (Sections 3, 4, and 5).

4.5 Interconnected earth electrodes shall be installed at an adequate distance from one another so each is situated outside the resistance area of any other, to prevent mutual interference and ensure effective performance, as dictated by IS 3043:2018.

4.6 The physical mutual separation between adjacent parallel earth electrodes shall be at least equal to their driven depth (with separations up to twice the driven depth yielding little additional reduction), to optimize the reduction in resistance, in accordance with the spacing laws of IS 3043:2018.

4.7 Perimeter earth electrodes shall be buried immediately adjacent to the building plinth or increased to a distance of ~~0.5~~ 1 meters from the foundation if the structure/enclosure is metallic, to prevent unsafe step and touch potentials, in compliance with ~~BS 7430:2011+A1:2015 (or latest)~~ IS 3043: 2018.

4.8 All earthing systems within the installation (including the tower, building, lightning protection, equipment, power plant, and engine alternator earths) along with coordinated Stage-I and Stage-II surge protection devices in a TT configuration, shall be intentionally interconnected into a single equipotential bonding network terminated at the Main Earthing Terminal (MET), to prevent dangerous potential differences during a fault or lightning strike (expressly prohibiting isolated earth systems), in compliance with the equipotential bonding mandates of IS 3043:2018, BS 7430:2011+A1:2015 (or latest), and TEC 66130:2025.

5.0 SAFETY REQUIREMENTS

5.1 The earth enhancing compound shall be designed and formulated to be safe during handling, storage, and installation, to ensure it performs reliably without posing any danger to personnel or the surrounding environment, in compliance with the general safety mandates of IEC 62561-7:2018.

5.2 All telecommunication equipment and associated indoor/outdoor installations shall conform to the safety requirements of IS/IEC 62368-1:2023 (including

Annex Y for outdoor enclosures), to ensure comprehensive protection against electrical, thermal, mechanical, and environmental hazards, as explicitly prescribed in Table 1 of TEC 10009:2024 (or latest).

5.3 All personnel engaged in or assisting with the exothermic welding connections shall use appropriate Personal Protective Equipment (PPE) including eye/face protection and heat-resistant clothing, to protect against splashing materials and extreme thermal hazards associated with the molten metal reactions, in compliance with the ~~NBC: 2016~~ NBCS: 2026.

5.4 All inspection and testing of the earthing system shall be carried out by competent personnel utilizing insulated footwear, fire-retardant clothing, and voltage-rated gloves alongside Installation Category IV test equipment, to ensure protection against impressed voltages or remote earth faults since a substation grounding system cannot be guaranteed 'dead', in accordance with ~~BS 7430:2011+A1:2015 (or latest)~~ IS 3043: 2018.

6.0 ENVIRONMENTAL REQUIREMENTS

6.1 The earthing enhancing compound shall be chemically inert to the subsoil and provide a stable environment in terms of physical and chemical properties, to ensure it does not pollute the surrounding environment or contaminate the local water table, in compliance with the material requirements of IEC 62561-7:~~2018~~ 2024 / IS 18925-7.

6.2 The Earth Enhancement Material shall undergo a leaching test to determine the concentration of specific leachable heavy metal ions (Fe, Cu, Zn, Ni, Cd, Co, Pb), to ensure ecological safety and verify that the material does not leach hazardous or toxic substances into the soil over its operational life, in accordance with IEC 62561-7:~~2018~~ 2024 / IS 18925-7.

6.3 The manufacturer shall provide comprehensive safety literature, including Safety Data Sheets (SDS), to demonstrate compliance with health and environmental safety requirements and ensure the installer can select, handle, and install the materials in a safe manner, fulfilling the documentation mandates of IEC 62561-7:~~2018~~ 2024 / IS 18925-7.

6.4 The Earth Enhancement Material shall be verified by an accredited laboratory to have all measured sulphur values strictly less than 2% utilizing combustion/infrared methods or adapted analyses instrumentation (ICP-OES, ICP-AES), to prove it is free of highly corrosive elements, in accordance with the sulphur determination and passing criteria of IEC 62561-7:~~2018~~ 2024 / IS 18925-7.

6.5 The earthing enhancing compound shall successfully pass the potentiodynamic polarization resistance tests, to ensure it is not chemically corrosive to the earth electrodes being used and maintains the long-term structural and electrical integrity of the buried grounding system, in accordance with IEC 62561-7:~~2018~~ 2024 / IS 18925-7.

6.6 The Earth Enhancement Material shall maintain continuous and intimate physical contact with the earth electrode without shrinking, swelling, or cracking away from the conductor after drying out, to prevent the formation of highly resistive air gaps during dry weather conditions, in accordance with the material stability and installation mandates of IS 3043:2018 and IEC 62561-7:~~2018~~ 2024 / IS 18925-7.

7.0 QUALITY REQUIREMENTS

7.1 The components of the earthing system shall be manufactured following the ISO 9001: 2015 Quality Management System, for which the manufacturer shall be duly accredited. A quality plan describing the quality assurance system followed by the manufacturer shall be submitted, in accordance with the quality and workmanship mandates of TEC.

7.2 The manufacturer shall submit detailed conductor sizing calculations for the earth conductor and earth mesh design, to demonstrate the absolute adequacy of the conductor size for the specified fault current and fault duration without fusing or degrading, in accordance with the calculation methodologies of IEEE 80:2013, utilizing the ampacity formula detailed in Annexure-2 (Section 2).

7.3 All components used in the earthing system shall be certified by recognized National/International Institutions and shall possess valid type test certificates issued by a NABL accredited laboratory or ILAC MRA Signatories ~~accredited laboratory~~, with a validity not exceeding five years from the date of testing.

7.4 The type test reports for the Earth Enhancement Material shall explicitly demonstrate compliance with the leaching, sulphur, and resistivity mandates of IEC 62561-7:~~2018~~ 2024/ IS 18925-7:2025, and the corrosion characteristics shall be evaluated using the potentiodynamic polarization resistance method with resistance values strictly greater than 4 $\Omega \cdot m^2$ for non-aggressive environments and greater than 8 $\Omega \cdot m^2$ for aggressive environments, to ensure baseline material quality and environmental safety, in accordance with ~~ASTM G59-97:2020~~ and IEC 62561-7:~~2018~~ 2024 / IS 18925-7:2025.

7.5 The type test reports for exothermic welded connections shall explicitly demonstrate successful completion of the full sequential qualification program (Current-Temperature Cycling, Freeze-Thaw, Corrosion, and Fault-Current) alongside the Electromagnetic Force (EMF) test, where the Short-Time Fault Current Test is strictly calculated as 90% of the fusing current for a 10-second duration, to guarantee long-term mechanical and electrical integrity, in accordance with the qualification test sequence of IEEE 837:2024.

7.6 The copper-bonded steel earth electrodes shall possess valid type test certificates demonstrating successful completion of conditioning/ageing, environmental, mechanical, and electrical tests, including a minimum radial copper coating thickness of 250 μm (with 99.9% copper content) and the mechanical capability of withstanding a 90° bend without cracking, peeling, or separation of the copper coating from the steel core, to guarantee reliability in harsh underground conditions, in accordance with the type test mandates of IEC 62561-2:~~2018~~ 2025 / IS 18925-2: 2025.

7.7 The earth electrode inspection housings (earth pits) shall possess valid type test certificates demonstrating successful completion of a load test utilizing a minimum 15 kN vertical load applied through a 130 mm diameter steel plate of 20 mm thickness, to ensure they can withstand designated mechanical loads and environmental conditions without deformation, in accordance with the testing and requirement mandates of IEC 62561-5:2023 / IS 18925-5: 2025.

7.8 Each lot of earthing components supplied against a specific order (following type approval) shall be physically inspected and tested prior to dispatch by the Quality Assurance (QA) wing or designated inspecting authority, to ensure that the requirements of this document have been met, in compliance with the approved Test Guide document and the Quality Assurance Tests mandates of TEC.

7.9 All supplied earthing components (including earth electrode inspection housings and Earth Enhancement Material packaging, in addition to the earth electrodes as per Clause 3.6) shall be permanently and legibly marked with the manufacturer's name or trademark, identifying symbol, ~~batch/lot traceability,~~ and the explicitly displayed tested resistivity value on the EEM packaging, to ensure field traceability and prevent counterfeit substitution at the site, in compliance with the marking mandates of IEC 62561-7:~~2018~~ 2024 / IS 18925-7: 2025, IEC 62561-5:2023 / IS 18925-5: 2025.

8.0 Installation and Execution Precautions

8.1 A hole of 100 mm to 250 mm in diameter shall be augured to the specified depth for the vertical earth electrode, to allow for adequate volumetric placement of the Earth Enhancement Material and prevent the predominance of auxiliary electrodes in dissipating fault current, in accordance with the installation methods of IEEE 80:2013.

8.2 The Earth Enhancement Material shall be poured around the electrode in a premixed slurry form rather than dry, to ensure immediate, void-free, and effective soil contact resistance around the entire length of the electrode, in accordance with the artificial treatment and installation mandates of IS 3043:2018.

8.3 All conductor surfaces shall be pre-heated and thoroughly cleaned with a wire brush to remove moisture, grease, and oxidation prior to exothermic welding, to prevent porous joints or explosive reactions caused by trapped moisture expanding during the molten metal reaction, in alignment with the jointing preparation principles of ~~BS 7430:2011+A1:2015 (or latest)~~ IS 3043: 2018.

8.4 The Earth Enhancement Material shall be applied directly around the conductors and topped with imported good quality, non-corrosive earth in rocky, hard, or hostile soil conditions (such as black cotton or hard murrum) where excavated hostile material shall not be reused as backfill, to prevent electrode damage and guarantee a low-resistance contact, in accordance with IS 3043:2018~~ and BS 7430:2011+A1:2015 (or latest)~~.

8.5 The equipotential bonding of equipment rooms shall be implemented as a "Star-IBN" (Isolated Bonding Network) topology where each Sub Equipotential Earth Busbar (SEEB) is connected directly to the Main Equipotential Earth Busbar (MEEB/SPCB) via independent, single-point conductors, to eliminate the risk of circulating earth loops and unwanted common-mode coupling, in accordance with ITU-T K.27: 2015.

8.6 Earth connections to surge diverters and critical equipment shall be routed as direct, short, and straight as possible, and shall expressly not pass through iron pipes or closed metallic conduits, to prevent a dangerous increase in the surge impedance (inductive choke) during high-frequency lightning discharges, in strict accordance with IS 3043:2018 ~~and BS 7430:2011+A1:2015 (or latest)~~.

8.7 Earthing conductors routed along structures shall be secured using insulated clips or non-magnetic/PVC fasteners spaced no more than 1 meter apart (avoiding encircling magnetic metallic clamps or galvanized clips), to prevent electrolytic action and inductive choking during fault surges, in compliance with IS 3043:2018 ~~and BS 7430:2011+A1:2015 (or latest)~~.

8.8 The installation and coordination of protective conductor tracks shall strictly maintain a combined conductor length of $a + b \leq 0.50$ meters where the earthing system integrates with Stage-I and Stage-II Surge Protection Devices (SPDs), to ensure the voltage protection level remains effective across the site, in compliance with the technical layout and installation mandates of TEC 66130:2025.

8.9 All buried bare conductors forming the horizontal earthing grid/mesh shall be laid at a minimum depth of 600 mm below ground level, to ensure protection against mechanical damage, seasonal soil resistivity variations, and frost, in accordance with the laying conductor mandates of IS 3043:2018~~ and BS 7430:2011+A1:2015 (or latest)~~.

8.10 Multiple vertical earth electrodes (rods) installed in parallel to achieve the target ground resistance shall be separated by a mutual distance not less than the driven depth of the rod (e.g., separated by a minimum of 2.8 meters for a 2.8-meter rod), to ensure their individual resistance areas do not overlap and mathematically degrade dissipation efficiency, in accordance with the parallel connection mandates of IS 3043:2018~~ and BS 7430:2011+A1:2015 (or latest).~~

8.11 The main earth electrode shall be terminated in a sunken inspection housing (earth pit) equipped with a bolted test link with all finished mechanical joints within this housing actively protected against moisture ingress and galvanic corrosion using bitumastic paint, grease-impregnated tape, or suitable protective wrapping, to facilitate periodic measurement and verification of earth resistance, in accordance with the jointing and testing mandates of ~~BS 7430:2011+A1:2015 (or latest) and~~ IS 3043:2018.

8.12 Connections bonding copper earthing conductors to galvanized steel structures (such as telecom towers or equipment frames) shall utilize bimetallic connectors or tinned copper interfaces with all underground or moisture-exposed joints completely encapsulated using mastic compound or bitumastic paint, to prevent severe galvanic corrosion of the steel, in accordance with the bimetallic jointing and corrosion prevention mandates of ~~BS 7430:2011+A1:2015 (or latest) and~~ IS 3043:2018.

8.13 The routing of all earthing conductors shall avoid sharp 90-degree corners with any required changes in direction made using gentle, sweeping curves with a wide bending radius, to prevent inductive choking, flashovers, and arc-overs during high-frequency lightning strikes, in compliance with the surge impedance minimization mandates of IS 3043:2018.

9.0 DOCUMENTATION

9.1 Two copies of the Installation, Operation, and Maintenance Manual—in both hard copy and soft copy (URL link / QR code / PDF) - shall be supplied in English and Hindi along with each earthing system.

9.2 The manual shall include the following:

i. Dimensioned layout and schematic drawings of the earthing system, including the earth pit, inspection chamber, and mesh/mat architecture.

ii. Step-by-step instructions for initial site preparation, installation, and commissioning procedures, specifically covering exothermic welding procedures and the correct application method for the Earth Enhancement Material (EEM).

iii. Safety measures to be observed during the handling of materials, particularly the exothermic welding powder and EEM.

iv. Precautions at the time of installation, operation, and maintenance.

v. Detailed routine health-check procedures (e.g., periodic earth resistance measurement using the disconnecting test link) to be carried out by the user to monitor the electrical integrity of the earthing system without requiring physical excavation or chemical treatment.

vi. A recommended periodic inspection schedule (e.g., Half-Yearly/Yearly) limited to visually checking the physical integrity of the surface inspection chamber, busbar, and bolted connections for accidental damage or severe environmental corrosion.

vii. The test results obtained in the factory (Acceptance Test reports) and a feedback format.

viii. The exact address and telephone numbers of the established maintenance and support centre, to ensure immediate access to troubleshooting and repair services.

ix. Systematic trouble-shooting charts (fault-tree) detailing probable faults, their diagnostic procedures, and immediate remedial actions.

9.3 The hard copy of the Installation & Maintenance Manual shall be prepared using good quality paper with clear and crisp printing. All drawings shall be attached to the handbook. The handbook shall be in proper binding so as to make it presentable and durable.

10.0 MAINTENANCE AND SUPPORT REQUIREMENTS

10.1 The supplier/manufacturer shall have an established maintenance and support facility in India.

10.2 The supplier shall guarantee the availability of system spares (such as exothermic welding powder, molds, and earth enhancement compound) for at least 10 years from the date of supply. In the event that the supplier intends to close down the production of the offered equipment or materials, the supplier shall be legally obligated to provide a minimum of two years' advanced notice to the purchaser to facilitate the stocking of lifetime spares.

10.3 To guarantee the 25-year service life, the manufacturer/supplier shall execute the end-to-end supply, installation, and commissioning of the earthing system. Furthermore, the system shall carry a minimum warranty of 60 months from the commissioning date. Within this timeframe, the supplier shall rectify any system failures arising from defective materials or poor workmanship at no additional cost.

10.4 Along with the equipment supply, the manufacturer/supplier shall furnish a comprehensive list of recommended spares required for three years of standard maintenance, to enable advanced procurement planning by the purchaser.

10.5 All special tools, fixtures, and accessories essential for the installation, operation, and maintenance of the earthing system (including exothermic welding molds, clamps, and igniters) shall be clearly indicated in the manual and supplied alongside the equipment.

CHAPTER 2

11.0 GUIDELINES FOR THE PURCHASER/USER

This chapter describes the requirements which may be included in the tender by the purchaser as per its needs. The following items need to be specified by the ordering authority depending upon the actual requirements:

11.1 The purchaser must provide a site-specific Soil Resistivity Report to the manufacturer. This report is mandatory for the manufacturer to accurately perform the conductor sizing and earth mesh design calculations in accordance with IEEE 80:2013.

11.2 The purchaser shall specify the general soil topography of the installation site (e.g., normal, sandy, or rocky). This determines whether the vendor must supply the standard vertical coupled earth electrodes or provide alternative parallel/angled rod configurations tailored for rocky/high-resistivity soil, in accordance with Clause 3.1.

11.3 The purchaser shall verify and specify the bonding architecture required by the equipment manufacturer—either Mesh Bonding Network or Isolated Bonding Network (Star-IBN). Equipment belonging to two separate Isolated Bonding Networks, or equipment from an Isolated Bonding Network and a Mesh Bonding Network, shall not be permitted to make physical contact with each other.

11.4 The purchaser should clearly specify the packing and transportation requirements. It is critical that the Earth Enhancement Material (EEM) is shipped in moisture-proof packaging, and that the copper-bonded earth electrodes are physically protected during transit to prevent deep mechanical abrasions that could compromise the 250 μm copper cladding.

11.5 The purchaser shall explicitly specify the required warranty period and any Annual Maintenance Contract (AMC) conditions, particularly regarding the vendor's liability to maintain the target earth resistance value over the specified service life.

12.0 ORDERING INFORMATION

The following items need to be specified while ordering by the Tendering Authority depending on the requirements:

I. Application of the earthing system (e.g., Main Earth Mat for Power Equipment, Clean Earth for Electronic Equipment, or Lightning/Surge Protection System).

II. Target acceptance earth resistance value required for the site (e.g., < 1 ohm).

III. The specific volumetric quantity of Earth Enhancement Material (EEM) required per pit, based on the approved augered hole dimensions for the specific site.

IV. Requirement of extra maintenance spares (e.g., additional Exothermic Welding molds, extra weld powder cartridges, or spare disconnecting test links).

V. If the dimensions of the RCC earth pit/inspection chamber need to be modified based on specific infrastructural constraints at the site.

VI. The requirement of the Installation & Maintenance Manual (in terms of the specific number of hard copies and preferred soft copy format, e.g., QR Code/PDF).

VII. The specific diameter (e.g., 14.2 mm, 17.2 mm) and total driven length of the copper-bonded earth electrode required.

VIII. The specific dimensions and material profile of the horizontal earth conductor/mesh (e.g., 25 mm × 2 mm solid copper tape or 8 mm solid copper round conductor).

13.0 SPECIFIC ITEMS TO BE MENTIONED IN THE CERTIFICATE

Following details of the product shall be explicitly mentioned on the Type Approval Certificate (TAC):

1. MAKE AND Model number of the major parts:
    - a. Earth Electrode (Rod)
    - b. Earth Enhancement Compound (EEM)
    - c. Exothermic Welding System (including powder and molds)
    - d. Earth Inspection Housing (Earth Pit)

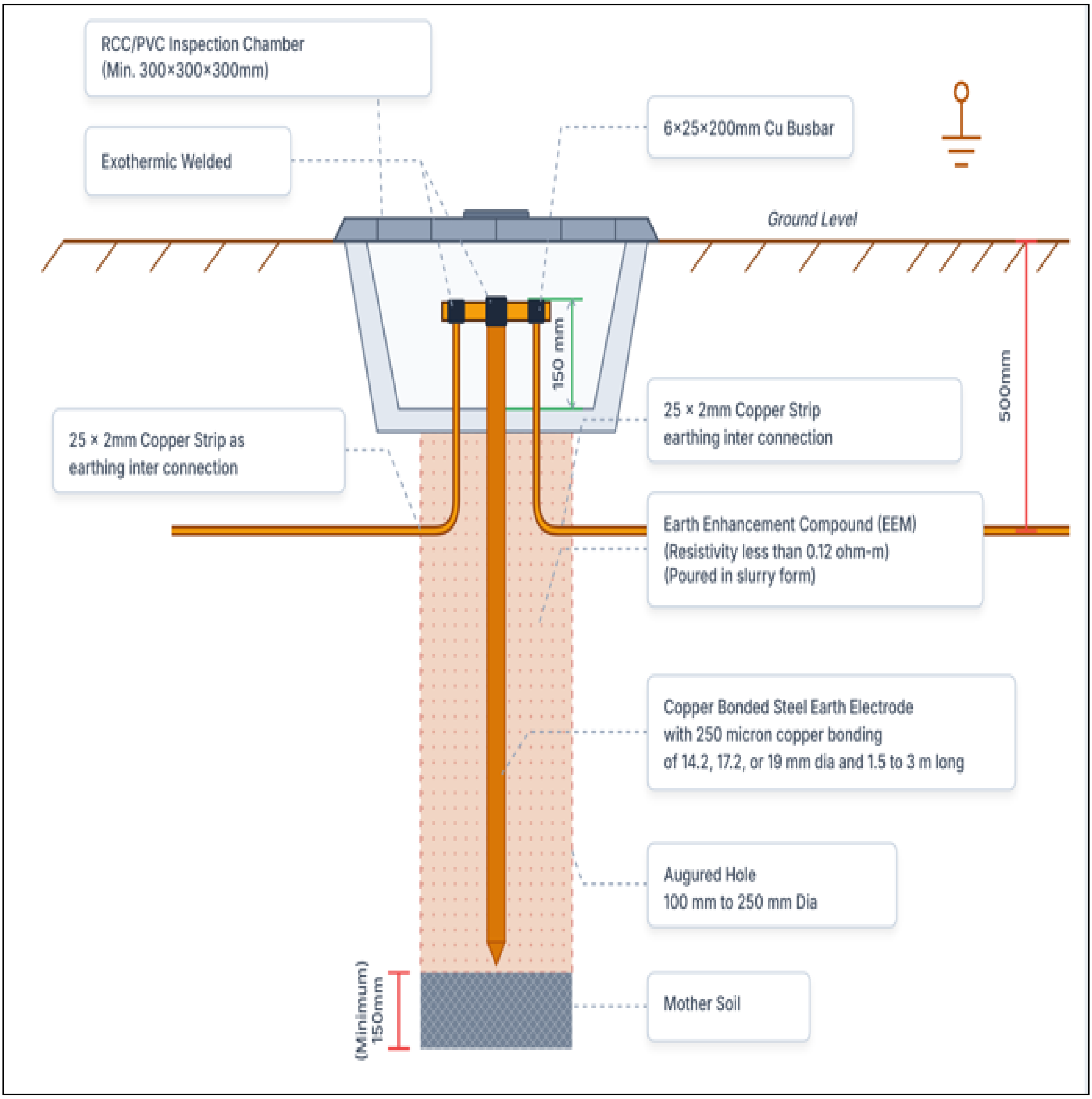
ABBREVIATIONS

S. No.	Abbreviation	Definition
1.	°C	Degrees Celsius
2.	AC	Alternating Current
3.	ASTM	American Society for Testing and Materials
4.	BS	British Standard
5.	CAB	Conformity Assessment Body
6.	cm	Centimetre
7.	DoT	Department of Telecommunications
8.	EEB	Equipotential Earth Busbar
9.	EEM	Earth Enhancement Material
10.	EMF	Electromagnetic Force
11.	EPR	Earth Potential Rise
12.	ER	Essential Requirements
13.	GR	Generic Requirements
14.	IBN	Isolated Bonding Network
15.	ICP-AES	Inductively Coupled Plasma Atomic Emission Spectrometry
16.	ICP-OES	Inductively Coupled Plasma Optical Emission Spectrometry
17.	IEC	International Electrotechnical Commission
18.	IEEE	Institute of Electrical and Electronics Engineers
19.	ILAC MRA	International Laboratory Accreditation Cooperation Mutual Recognition Arrangement
20.	IR	Interface Requirements
21.	IS	Indian Standard
22.	ISO	International Organization for Standardization
23.	ITU-T	International Telecommunication Union - Telecommunication Standardization Sector
24.	J	Joule
25.	kA	Kiloampere

26.	kg	Kilogram
27.	kN	Kilonewton
28.	LP	Lightning Protection
29.	m	Metre
30.	MEEB	Main Equipotential Earth Busbar
31.	MET	Main Earthing Terminal
32.	mm	Millimetre
33.	MTCTE	Mandatory Testing and Certification of Telecom Equipment
34.	NABL	National Accreditation Board for Testing and Calibration Laboratories
35.	NBC	National Building Code
36.	O&M	Operation and Maintenance
37.	PVC	Polyvinyl Chloride
38.	QA	Quality Assurance
39.	RCC	Reinforced Cement Concrete
40.	rms	Root Mean Square
41.	RTEC	Regional Telecom Engineering Centre
42.	SDS	Safety Data Sheet
43.	SEEB	Sub Equipotential Earth Busbar
44.	SPCB	Single Point Connection Bar
45.	SPD	Surge Protection Device
46.	sq. mm	Square Millimetre
47.	TAC	Type Approval Certificate
48.	TCAP	Thermal Capacity Factor
49.	TEC	Telecommunication Engineering Centre
50.	TT	Terre-Terre (Protective Earth Configuration)
51.	UL	Underwriters Laboratories
52.	μm	Micrometre
53.	Ω	Ohm
54.	Ω m	Ohm Metre

ANNEXURE-1

Typical Arrangement View of Maintenance Free Earthing System



ANNEXURE-2

CALCULATION GUIDELINES FOR EARTHING SYSTEM

The manufacturer and purchaser, to determine the proper sizing of the earth conductors and to calculate the estimated earth resistance of the system, taking into account the use of Earth Enhancement Material (EEM), shall use the following mathematical guidelines.

1. Connecting Cable Sizing Calculation:

To ensure the connecting earthing conductors (such as those from the MEEB to the earth pit) can safely dissipate the maximum fault current without melting the insulation, the minimum cross-sectional area shall be calculated. In accordance with IS 3043:2018, the sizing is determined using the following formula:

$$S = I\sqrt{t}/k$$

Where:

- S = cross-sectional area, in square millimetres
- I = value (ac, rms) of fault current for a fault of negligible impedance, which can flow through the protective device, in amperes
- t = operating time of the disconnecting device, in seconds
- k = factor dependent on the material of the protective conductor, the insulation and other parts, and the initial and final temperatures (values as per **IS 3043, Tables 11A to 11D**)

2. Earth Grid Conductor Ampacity Calculation:

To ensure the buried bare earthing conductors and electrodes can safely dissipate the maximum fault current without melting the metal itself, the minimum cross-sectional area shall be calculated. According to IEEE 80:2013, the root mean square (rms) current capacity of a conductor can be determined using the following formula:

$$I = A\sqrt{\left(\frac{TCAP \times 10^{-4}}{t_c \times \alpha_r \times \rho_r}\right) \ln\left(\frac{K_0 + T_m}{K_0 + T_a}\right)}$$

Where:

- I is the root mean square (rms) fault current in kA.
- A is the conductor cross-section in mm^2.
- T_m is the maximum allowable temperature in °C (fusing temperature of the metal).
- T_a is the ambient (initial) conductor temperature in °C.
- T_r is the reference temperature for material constants in °C.
- α_r is the thermal coefficient of resistivity at reference temperature T_r in 1/°C.
- ρ_r is the resistivity of the ground conductor at reference temperature T_r in $\mu\Omega$-cm.
- K_0 is equal to $(1/\alpha_r) - T_r$ in °C.
- t_c is the time of current flow (fault duration) in seconds.
- $TCAP$ is the thermal capacity factor in $J/(cm^3 \cdot ^\circ C)$.

3. Earth Resistance of a Single Driven Rod:

If an earth electrode is driven directly into homogenous soil without any enhancement material, its resistance to earth shall be estimated using the following equation in accordance with IS 3043:2018:

$$R = \frac{100\rho}{2\pi l} \log_e \left(\frac{4l}{d} \right)$$

Where:

- R = resistance of the pipe or rod (Ω)
- ρ = resistivity of the soil ($\Omega \cdot m$)
- l = length of the rod or pipe (cm)
- d = diameter of the rod or pipe (cm)

(Note: IS 3043 uses centimeters for the rod dimensions in this specific clause, which is why the 100 multiplier is present in the numerator).

4. Earth Resistance of an Electrode Encased in Earth Enhancement Material:

In a Maintenance Free Earthing System, the earth electrode is encased in a low-resistivity Earth Enhancement Material (EEM). This effectively increases the diameter of the electrode, lowering the overall earth resistance. The combined resistance of the backfilled electrode shall be calculated using the following dual-medium formula as per IS 3043:2018:

$$R_b = \frac{1}{2\pi L} \left\{ (\rho - \rho_c) \left[\ln\left(\frac{8L}{D}\right) - 1 \right] + \rho_c \left[\ln\left(\frac{8L}{d}\right) - 1 \right] \right\}$$

Where:

- R_b is the resistance of the backfilled electrode in ohms (Ω).
- ρ is the resistivity of the native soil in ohm-meters ($\Omega \cdot m$).
- ρ_c is the resistivity of the conducting enhancement material used for the backfill in ohm-meters ($\Omega \cdot m$).
- L is the length of the rod in meters (m).
- d is the diameter of the rod in meters (m).
- D is the diameter of the augured hole (the concrete/EEM shell) in meters (m).

5. Earth Resistance of a Grid/Mesh:

For an earthing system formed by a grid of horizontally buried conductors (Earth Mat), the resistance of the mesh (Rm) shall be calculated in accordance with IS 3043:2018 using the following formula:

$$R_m = \frac{0.443\rho}{\sqrt{A}} + \frac{\rho}{L}$$

Where:

- R_m = resistance of the mesh/grid (Ω)
- ρ = resistivity of the soil ($\Omega \cdot m$)
- A = actual area covered by the mesh (m^2)
- L = total length of strip/conductor used in the mesh (m)