



N. E. Railway

Office of

General Manager /Electrical

NE Railway Gorakhpur

Date:- 13/07/2009

No. - L/252/CEE Specification/Part-VII/560

Sr. DEE/IZN, LJN, BSB,

Dy. CEE/Colony/GKP,

Dy. CEE/Workshop/GKP, IZN

Dy. CEE/BG/Con./GKP

Dy. CEE/Works/LJN

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Subject : Specification for Maintenance Free Earthing.

A approved copy of the Specification for Maintenance Free Earthing is enclosed, for information & necessary action please. If there is any suggestion about specification then please inform to HQ for inclusion of the same.

Encl: 10 pages of Specification.

(B. Rai)

Chief Electrical Engineer/HQ
For General Manager/Electrical

Approved Head
11/23

North Eastern Railway
Electrical Department
Specification No. CEE/Maintenance Free Earthing/July 2009

1.0 Scope of Work:

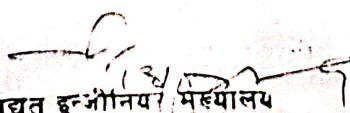
This Specification covers Installation, Testing and Commissioning of Maintenance Free Earth Electrode and its component, to achieve earth resistance less than 1 Ohm. The purpose of this specification is to provide guide lines for latest and long lasting earthing system for various application to meet Rules 51 & 61 of Indian Electricity Rule – 1956. This specification covers in detail the component to be used and the procedure for constructing the pit for maintenance free earthing system. The main purpose of using this new technology is to ensure that the resistance between the earth electrode and the equipment is nearly zero, consistently throughout the year. The earth electrode shall not rise the temperature, deforms the chemical characteristic of Earth enhancing material and soil under normal and during faulty currents flow. It is also required that the earth resistance shall not vary during the flow of faulty current and allow to drain the faulty/leakage current.

2.0 Reference : This Specification requires the reference to the following documents.

- IS 3043 -1947 : Code of practice for earthing.
- IE Rule 1956 With Latest Amendments.

3.0 Objective : Earthing is a essential part of any electrical installation which provides safety to human as well as electrical machines/equipment.

At present conventional type earthing system are provided for various application. Due to presence of salts and acidic media, corrosion is comparatively much faster and conductor gets corroded very fast, further increased soil resistivity & fluctuating earth resistance, also hamper the


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performance of earthing system. So there is need to develop maintenance free, corrosion free, fluctuation free & less ohmic value earthing system.

The purpose of this is to ensure that in general, all parts of apparatus other than live parts, shall be at earth potential as well as to ensure that operators and users shall be at earth potential at all times. Thus the purpose of the earthing is to save human being from electrical shock and safe working in Electrical installation in any fault condition due to leakage of currents.

4.0 Application :

- ❖ Transmission and distribution System.
- ❖ Substation & Generators.
- ❖ Transformer Neutral Earthing.
- ❖ Pumping Installation.
- ❖ Lightning Arrester Earthing.
- ❖ Computers & data processing centres etc.

5.0 Earth Resistance :

The value of Earth resistance at earth BUS Bar should be less than 0.5Ω .

6.0 System Earthing And Equipment Earthing:

Earthing associated with current carrying conductor is normally essential to the security of the system and is generally known as system earthing. While earthing of non current carrying metal work and conductor is essential to the safety of human life, animal and property and is generally known as equipment earthing.

7.0 Technical features of Earthing Installation:

7.1 The Value of Earth Resistance should be less than 1Ω for single earth installation.

7.2 Electrode & Chemicals should be corrosion free.

- 7.3 Least fluctuation of ohmic value.
- 7.4 Galvanization should be adequate i.e. thickness 80 to 100 micron.
- 7.5 Practically no need to maintain i.e. maintenance free (Fit & Forget).
- 7.6 The system should be of "Dual Pipe Technology".
- 7.7 Pit size should be of the order of 5 feet \times 5 feet \times 10 feet.
- 7.8 The electrode shall be of 3 meter in length with the outer pipe of 80 mm diameter & inner pipe of 50 mm diameter dully tested & certified by CPRI.
- 7.9 The chemical earth electrode should be tested in CPRI for Peak & RMS Currents.
- 7.10 The chemical earth electrode shall be surrounded by resistance lowering grounding minerals to increase the overall conductive surface area in order to lower the ohmic value and also to minimize the corrosion process.
- 7.11 The Earth electrode should be able to carry the peak short circuit withstand current of minimum 50 kA and dully tested & certified by CPRI.
- 7.12 Resistance lowering grounding material should be electrolytic gel of highly conductive. It should be made of natural components (graphite, minerals etc.), it absorbs the moisture from surrounding soil & is non corrosive.
- 7.13 To improve the overall efficiency of the earthing system, 5 litres of Enhancer liquid should be added at appropriate intervals during the time of installation.
- 7.14 The packing material for one pit should be 75 Kg.

8.0 Earth Electrode: The earth electrode is the component of the earthing system, which is in direct contact with the ground and thus provides a means of releasing or collecting any earth leakage currents. The material should

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have good electrical conductivity and should not corrode in a wide range of soil conditions. Copper or Galvanised steel is generally the preferred material.

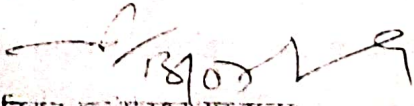
8.1 Primary conductor diameter 25/40 mm pipe ISI marked as per IS 1239 with addition of 15 micron galvanization and length of pipe not less than 3000 mm. The surface area of Primary conductor pipe should not be less than 23500 Square mm.

8.2 Secondary Conductor diameter 50/60/80 mm pipe ISI Marked as per IS 1239 with addition of 15 micron galvanization and length of pipe not less than 3000 mm. The surface area of Primary conductor pipe should not be less than 470000 Square mm. An additional coating of 30 to 40 micron EC grade copper should be applied on the outer surface for better corrosion protection and enhancing the life of earthing system.

8.3 Crystalline Conductive mixture: To be filled between the annular space between two co-axial pipe and inside inner pipe as well. Crystalline Conductive mixture to be injected in the electrode assembly. It is a combination of high conductivity material alloys such as copper & aluminium powder, conductive carbon and bonding materials etc. mixed in different proportion. The mixture is forced (Pressurized) filled inside the earth electrode in the paste form and after solidification of the same, the cap is placed. The metal alloys helps in conducting the current and conductive carbon gives anti corrosive property.

8.4 X-Ray quality welds : For all joints the welds should be X-Ray quality.

8.5 Its surface shall be clean and free from any visible oxide layer or foreign material.


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8.6 Current Carrying capacity : The design of the electrode should be such that it is able to carry minimum 20 kA (for 10 sec) current with test certificate from Central Power Research Institute or any Govt. Laboratory.

8.7 Corrosion test : It should be as per IS 2119. Salt spray test for analysis of effect of corrosion for the specific design be done through reputed testing lab, preferably 500 Hrs of salt spray test or more is required.

8.8 Life cycle analysis : Life cycle analysis against corrosion protection for the design should be done through reputed test lab & copy of test report to be enclosed with the tender.

9.0 Earthing Conductor :

9.1 A copper bus bar of size 200mm×25mm×5mm to be installed in the equipment room and with preferably a copper conductor of 25mm×3mm or 6 mm² suitable length bare copper wire from instrument to the BUS BAR. The connecting terminal of the earth electrode to the BUS BAR must be connected by copper strip of 25mm×3mm />6mm² bare solid copper conductor of suitable length buried inside a trench of 300mm width × 600mm depth (from the earth pit to the nearest well). However, it shall be ensured that only minimum required length is used and any extra length is cut away to keep the earth impedance minimum.

9.2 It shall be highly conductivity copper. The maximum specific resistance of the copper strip earthing conductor shall be 17.241×10^{-7} Ohm-cm at 20°C.


9.3 It shall be connected to earth electrode with the help of two rivets or nut bolt as suitable and to earth BUS BAR with welding.

10.0 Packing / Backfill Material/ Soil Enhancer Earthing Compound:

10.1 It should have low resistivity preferably below 10 ohm meter.

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- 10.2 It should be a little alkaline in nature with pH value >07 but <10 , test certificate be provided for composition so designed.
- 10.3 It should have better hygroscopic properties to absorb moisture.
- 10.4 It should have capacity to have $>10\%$ moisture at 105°C . Test certificate from reputed labs to be submitted for the composition so designed.
- 10.5 It should have water solubility less than 5% , test certificate from reputed labs to be submitted for the composition so designed.
- 10.6 It should be Eco-friendly and containing natural curing clays.
- 10.7 The Soil enhancer Earthing compound shall be in fine powder form free from lumps and moisture.
- 10.8 It shall contain minimum 70% carbon.
- 10.9 Its maximum specific resistance shall be 30×10^{-6} Ohm -cm.
- 10.10 Its bulk density shall be $1.3 - 1.95 \text{ gm/cm}^3$.
- 10.11 In all cases back fill medium must be non corrosive, be of a relatively small particle size and should, if possible, help to retain the moisture. The soil should have a pH value between 6.0 (acidic) and 10 (alkaline). Normal, stiff clay is not a suitable backfill as, if heavily compacted, it may become almost impervious to water and could remain relatively dry. It may also form large lumps, which do not consolidate around the rod. Material, which should not be used as back fill, includes sand, coke - breeze, cinders and powder - station ash, many of which are acidic and corrosive. Normally the excavated soil shall be used if it free from sand gravel and stones. In cases the excavated soil contains sand gravel and stones lines be removed by appropriate methods such as hand picking sieving etc. small proportion of sand in the soil may be permissible. If the excavated soil contains sand,


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gravel and stones in large proportion and it is not feasible to remove these economically, good quality soil from other place may be used for backfilling. While back filling the soil shall be thoroughly compacted with at least 5 Kg compactor. In case the soil is dry, small quantity of water may make the soil muddy which is not suitable for compacting and after drying the soil may contain voids which may permanently increase earth resistance.

11.0 Construction of Unit Earth :

11.1 Make 5feet \times 5feet \times 10feet earth pit (except in Rocky soil).

11.2 Sieve the soil digged and remove the gravells and stones. If soil quitly is good (without murum and rocks) then add some quantity of packing material in the soil for using as back fill.

11.3 If the soil seems unusable (containing large quantity of gravel, stones, murum, sand etc.) then replace the soil with black cotton soil.

11.4 insert the electrode at the center of the earth pit and arrange to keep it vertical in the pit.

11.5 Arrange for water supply for the earth pit.

11.6 Fill the pit with the back fill and keep on adding the packing material surrounding the electrode and simultaneously watering the pit.

11.7 The procedure to be repeated till completion of the filling of the earth pit along with the packing material and sufficient watering adequate ramming.

11.8 The pit should be very compactly rammed and watering for 2-3 days and addition of soil if required be done.

11.9 Make trench of 600mm depth \times 300mm wide from the earth pit to the nearest point of the connection.

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11.10 Connect the copper tape / bare copper solid conductor (06mm thickness) to the connection terminal of the electrode and lay the copper tape and fill up the trench properly. Connect to the BUS bar.

11.11 Construct earth pit with cover for the installation.

11.12 Measure the earth resistance as per IS 3043/1987 Code of practice.

11.13 If less resistance is required Then multiple earth can be constructed and interconnect. Distance between earthing electrode should not be less than the length of earth electrode. Combined earth resistance can be calculated as :

$$\frac{1}{R_{eq.}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

where Req.=Equivalent Earth Resistance.

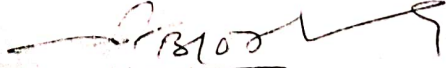
R1, R2, R3, = Individual Earth Resistance.

12.0 Earth pit Chamber & Cover :

This shall be square shaped frame of 450 (±10) mm × 450 (±10) mm size made from 25 (±3) mm × 25 (±3) mm × 3 (±0.5) mm mild steel angles welded at corners and with 4(±1) mm dia ribbed mild steel rods. Welding shall be sufficiently strong. The welded mild steel angle frame with rods shall be supplied in the set and masonry work shall be done during installation by installation agency.

12.0 Marking: Following information shall be legibly marked on the earth pit. The marking shall be clear, distinct and visible to the naked eyes from a distance of about one meter, the size of marking shall be minimum 25 mm.

- Specification No.
- Earth Resistance Values with dates.


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14.0 Test report & drawings : The tenderer will submit the documents shown in clause No. 10 and CPRI test report of earthing electrode and chemical used with this. The tenderer will also submit the essential drawings of earthing system complete.

15.0 FREE SERVICE:- Supplier shall agree to do free servicing of Earthing electrode & chemical used during guarantee / warrantee period. Any fault occurring in it during guarantee period shall be attended and rectified within the time frame given by the Railways.

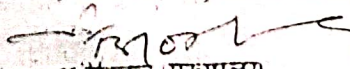
16.0 DEVIATION:-

Deviation from any of the clauses of the above specification shall be clearly indicated in the offer, otherwise it will be presumed that the offer is strictly as per this specification.

17.0 WARRANTY: The manufacturer shall warranty the material covered by this specification to be free from defects in design, material and workmanship under ordinary use and service this obligation under this warranty being limited to replace free of cost those parts which part shall be found defective within 05 year after installation & commissioning. This warranty shall not apply to any component which shall have been repaired are altered in any way by any one other than the manufacturer or its representative. The tenderer has to give the earthing system's expected life minimum 15 to 20 years.

18.0 Earthing Electrode of following manufacturer/supplier or of The firm having experience in the field of maintenance free earthing electrode of minimum eight years or more only shall be acceptable.

- Sanbros Spares Pvt. Ltd. – Nagpur.
- Galaxy Earthing Electrodes Pvt. Ltd. – Chennai.
- BBN Trading Company, Plot No. 1555, Sector-7, Ext. Gurgaon.


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19.0 Questionnaire

(To be filled by tenderer)

	DESCRIPTION	TENDER SPECIFICATION	TENDERER's OFFER
19.0	Earthing Electrode type	GI or Copper	
19.1	Length of electrode	3000 mm	
19.2.0	Outer pipe.	Galvanisation 80 to 100 micron.	
19.2.1	Outer pipe.	Thickness of pipe- 3.25 mm to 3.65 mm or more.	
19.2.2	Outer pipe.	Outer shell diameter- 50 mm to 80 mm or more.	
19.3.0	Inner pipe.	Galvanisation 200 to 300 micron.	
19.3.1	Inner pipe.	Thickness of pipe- 3.25 mm or more.	
19.3.2	Inner pipe.	Inner shell diameter-25 mm.	
19.4	Value of probable Earth resistance per electrode.	Tenderer to be specify.	
19.0	Brand, Name & Quantity of Chemical used as moisture booster around the outer shell pipe.	Quantity should not less than 50 Kg and Tenderer to be specify Brand, Name & Quantity.	
19.1	Quantity of Chemical used as moisture conductive compound in between both pipes.	Tenderer to be specify Brand & Name.	

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