



TI/PSI/DRG/TSS-SPC/POLICY/11

Dated, the 3rd April, 2013

To,
The Chief Electrical Engineer,
All Zonal Railways.

Sub: Special Maintenance Instruction No. TI/SMI/0031, for setting up Earthing Station at Switching Posts (SSP & SP)

Ref: Item No. 337 of 58th ESC meeting held at Jaipur

Augmentation of Earthing & Bonding Practices (Item No. 337) was discussed & deliberated in the 58th Electrical Standards Committee Meeting held at North Western Railway, Jaipur on 28 & 29.09.2012. It was decided to strengthen the Earthing system.

2. In existing Earthing system, there are no direct earth connections between rail and earth, except at the Feeding posts. The design philosophy assumes that the Rails are naturally at ground potential and the structures get earthed by connecting to Rails.

Present connection at Feeding Post has been described in the RDSO's Drawing No. ETI/PSI/203 for 'Typical Earthing Layout of a Feeding Station'.

The immediate concerns arising out of this arrangement are the rising of Rail potentials which affect efficacy of existing protection scheme leading to unsafe Rail system.

It was decided to create Earthing Stations at about 10 km separation to create positive, strong and deliberate 'maintenance free Earth connection' to improve system resilience.

3. Accordingly a trial was conducted at Lucknow SSP in Lucknow Division of Northern Railway with maintenance free Earth Electrodes, Earth conductivity enhancement material (non-leachable, non-corrosive, environmentally benign), Special fastening system. The Bond between Buried Rail and Earth Electrodes have been made using exothermic weld for achieving better rail to earth connectivity.

4. Special Maintenance Instruction No. TI/SMI/0031, covering methodology to create Earth Station, at Switching Posts (SSP & SP) has been prepared and is being issued for the use of Zonal Railways as well as Electrification Projects.

5. It is advised to implement the subject 'Special Maintenance Instruction', in a time bound manner, as it is essentially required for the safety of OHE Equipment and human being working near the electrified track.

Encl. As stated above.

Subal
3.4.2013
(J. N. Lal)
Director General (TI)

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Government of India
Ministry of Railways

SPECIAL MAINTENANCE INSTRUCTION

No. TI/SMI/0031

SETTING UP EARTHING STATION

AT

SWITCHING POSTS

(SSP & SP)

Research Designs & Standards Organisation
Manak Nagar,
Lucknow – 226011.

April, 2013

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SPECIAL MAINTENANCE INSTRUCTION
FOR
SETTING UP EARTHING STATION
AT
SWITCHING POSTS (SSP & SP)

1.0 INTRODUCTION

With advances in track technology the Rail is no longer at ground potential which has been the assumption of existing Earthing Code ETI/PSI/120 & ETI/OHE/71. The structures have been conventionally bonded to the Rail with belief that the structure would be grounded through the Rail. Whereas, now Rail sees earth through the structures many-a-times with increasing rail-formation insulation.

The immediate concerns which arise are the rising of Rail potentials, affect on the efficacy of existing protection scheme and safety of Rail vehicles.

Thus, it was decided to create Earthing stations at about 10 km separation (for sake of convenience, this can be sited close to Switching Posts). Idea is to create positive, strong and deliberate maintenance free earth connection to improve system resilience.

58th Electrical Standards Committee Meeting held at North Western Railway, Jaipur. Item No. 337 on the subject 'Augmentation of Earthing & Bonding Practices' identified need of strengthening the Earthing system. It was deliberated in length.

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Accordingly, a trial was conducted at Lucknow SSP in Lucknow Division of Northern Railway (during January, 2013) with standard maintenance free components to create the Earthing Station, to verify the practicality of instructions. Drawings prepared at RDSO by the Traction Installations Directorate, using components, extant practices and documents.

2.0 REFERRED DOCUMENTS

2.1 Signal Specification for maintenance free Earthing System: RDSO/SPN/197 2008.

2.2 Specification for Exothermic Welding of Traction Installation Directorate: TI/PSI/OHE/EXOTHRMBOND/0100 (04/10)

2.3 Earthing and Bonding Code No. ETI/PSI/120 & ETI/OHE/71.

2.4 RDSO Drawing No: ETI/PSI/0212-1 for buried rail.

2.5 Existing Arrangement for Earthing the Tracks

There are no direct earth connections except at the Feeding posts. The design philosophy *assumes* that the Rails are naturally at ground potential and the structures get earthed by connection to the Rails.

Present connection at Feeding Post has been described in ETI/PSI/203. It is seen that following are main components of the present Feeding Post Earthing Station.

2.5.1 BURIED RAIL

Acts as maintenance free Earth Bus.

2.5.2 EARTHGRID

Connects various ground Electrodes and reduces the possibility of higher Step Potential.

2.5.3 EARTH ELECTRODES

Couple the Buried Rail to parent earth and hence bring it to earth potential.

It may be noted that in conventional electrification which uses a running Rail for return circuit, one end of Transformer's secondary is connected to this Earthing system, thereby making full traction current flow through this system. It may be further noted that full load current would not necessarily take:

Running Rail>Buried Rail>Transformer.

Some current can as well get to the transformer from Earth Electrode>Earth Grid>Transformer.

For Single Wire Earth Return Circuits (SWER), to which conventional electrification deployed on IR belongs, good galvanic coupling with parent earth is a pre-requisite. Unfortunately, the continued dependence on mild-steel Electrodes, even though galvanised, places infrastructure in precarious position, as life of conventional Electrode is usually below ten years. It is hence imperative to move to solutions which are inherently maintenance free. Further, salt/charcoal mix leaches out easily, reducing soil conductivity drastically with passage of time. Thus it can be noted that Electrode corrodes fast and conductivity enhancement material also leaches out after some time.

It is hence imperative to use Electrode system which can last for 40-50 years and earth conductivity enhancement material which does not leach and is environmentally benign.

Thus, all new works must veer towards maintenance free components which meet practical operating and ambient conditions.

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3.0 DESIGN OF THE EARTHING STATION

Two Earthing Stations in front of Switching Station, one either side of the UP and Dn track, shall be provided for. This has been done to reduce the length of the flats connecting the running Rails to Buried Rail.

3.1 GENERAL ARRANGEMENT

13 meters Long released Rail is used to create an Earth station.

Two maintenance free Earth Electrodes with Earth conductivity enhancement material (non-leachable, non-corrosive, environmentally benign) shall be provided at each end of the Rail. Thus the Buried Rail would be configured as Earth Bus.

3.2 DESIGN

It is noted that -

- Conventional MS Fasteners fail to provide maintenance free and low resistance, durable connections and are prone to relatively faster corrosion.
- Special fastening systems which use Tinned Copper Bush are maintenance free, with low contact resistance, corrosion resistant, lesser prone to loosening due to vibration, higher productivity and ease of use, are now widely used in advanced Railways like German National Railways (Deutsche Bahn) and SNCF (French Railways), besides Bangalore Metro and other major Railroads & Metros. Such systems have already been adopted by Signal Department on Indian Railways for about 2-3 years (can be studied on AFTC Project being executed by IRPMU and North Central Railway).

It is, hence, decided to use such fastening systems for design of maintenance free Earth Stations.

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3.2.1. A trench, of size about 0.6 m x 15 m, with a depth of about 1 m from the ground level is dug on the track side.

3.2.2. At a distance of about 1.5 meters from either ends of the Buried Rail, two holes are drilled.

3.2.3. At a distance of approximately 200 mm, Earth pits are dug on either end, Maintenance Free Earthing is provided as described in RDSO's Drawing No. TI/DRG/PSI/E.STN/00001/13/0.

3.2.4 Preparation of Earth Bus

Holes are drilled in the Rail (to be used as Buried Rail) using Rail drilling machine (as mentioned in the Railway Board letter no. 2006/RE/220/1 dated 28.04.2008 for High Productivity Tools). A tinned Copper Bush (one end with Flange) is inserted in these holes. After insertion of the Bush, with appropriate tool, free end of the Bush is swaged so that the Bush takes shape of a hollow Rivet and gets in permanent electrical contact.

(ii) The Rail, duly prepared, is lowered in to the trench.

(iii) The Electrodes are exothermically welded to the Rail as described in RDSO's Drawing No. TI/DRG/PSI/E.STN/00001/13/0.

(iv) 19 mm holes are drilled on the web of running Rail and tinned Copper Bushes provided as on the Buried Rail.

(v) Connections between the running Rail and the Buried Rail are made with two GI Flats of size 50 x 6mm. interconnecting between the main running rail and a 13 m. section of Buried Rail on the track side, as per RDSO's Drawing no. TI/DRG/PSI/E. STN/00001/13/0.

The connection between the Buried Rail and Earth Electrodes of respective Earth Pits on both sides is done through 50 x 6 mm GI flat by using Exothermic weld.

3.3 RESULTS

3.3.1 TRACK NORTH SIDE

Soil resistivity 33.96 Ω meter.

Sl.No.	Description	Earth resistance value
1.	Resistance of Running track without Earthing station	2.47 Ω
2	Resistance of Earth Pit	2.69 Ω
3.	Resistance of Running track with connection of the Buried Rail	1.36 Ω
4.	Resistance of Running track with connection of both end Buried Rail	1.36 Ω

3.3.2 TRACK SOUTH SIDE

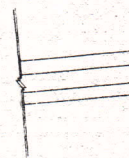
Soil Resistivity 23.55 Ω meter.

Sl.No.	Description	Earth Resistance value
1.	Resistance of Running track without connection Earthing station	1.55 Ω
2.	Resistance of Earth Pit	2.48 Ω
3.	Resistance of Running track with connection of the Buried Rail	1.09 Ω

4.	Resistance of Running track with connection of both end Buried Rail	1.04 Ω
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Equipment used for measurement of Earth resistance
M/s FLUKE make Advance Earth/ Ground Tester Model 1625 (Calibration status: valid up to 17.12.2013).

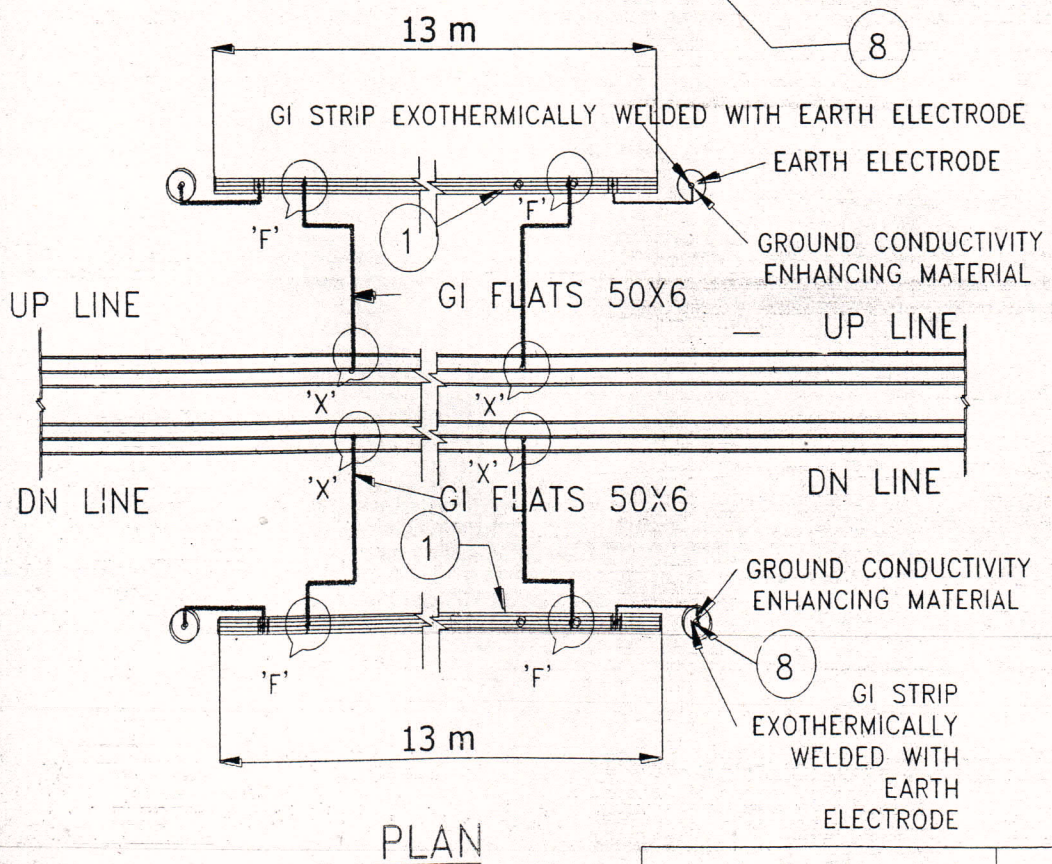
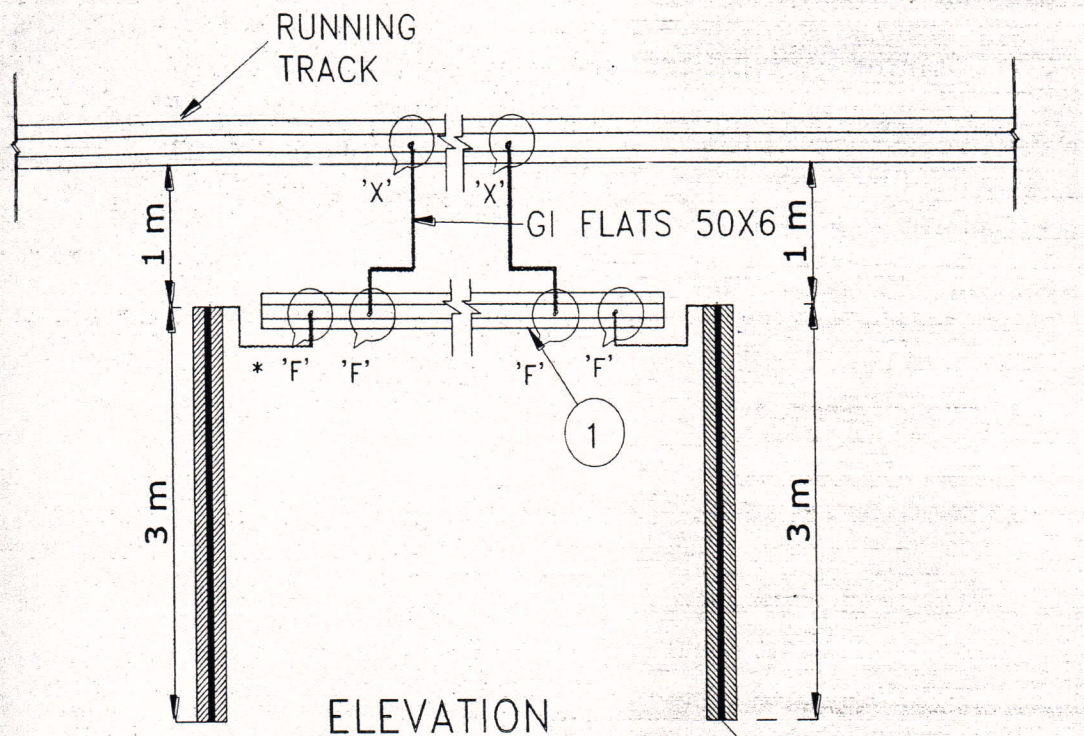
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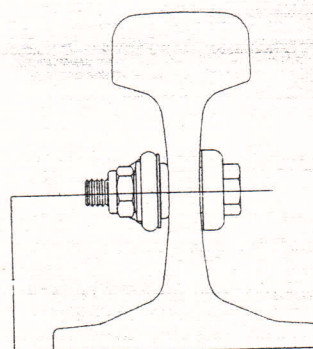
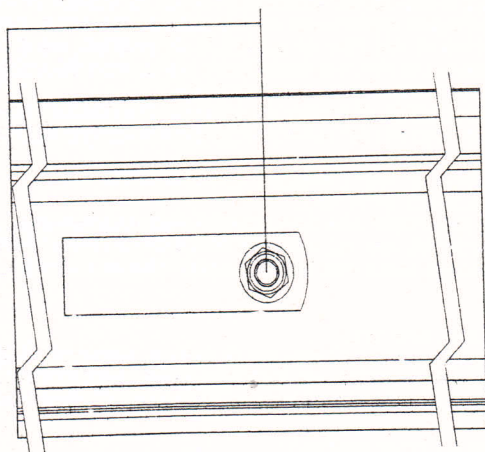
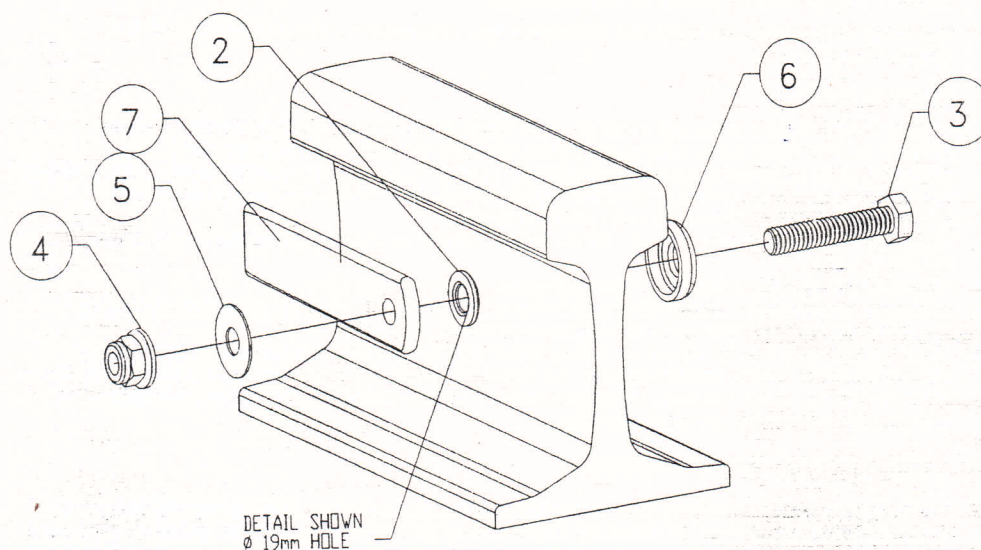


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(* FOR DETAILS 'X' KINDLY REFER SH 2/4 (PAGE 9/11) OF SMI No. TI/SMI/0031)

(* FOR DETAILS 'F' KINDLY REFER RDSO DRAWING No. ETI/PSI/0212-1)





DETAIL OF X

NOTES:-

THE SYSTEM HAVE FOLLOWING BROAD COMPONENTS

1.0 RAIL CONTACT SYSTEM (FASTENING)

- 1.1 RAIL CONTACT SYSTEM SHALL BE IN LINE WITH THE DRAWING; VARIATIONS NEEDED TO MEET SPECIFIC REQUIREMENTS ARE ACCEPTABLE AS LONG AS DESIGN PHILOSOPHY REMAINS THE SAME.
- 1.2 ALL COMPONENT OF RAIL CONTACT SYSTEM SHALL BE PROCURED FROM THE SAME VENDOR. RAIL CONTACT SYSTEM SHOULD HAVE BEEN USED SUCCESSFULLY FOR SIGNAL OR TRACTION APPLICATIONS ON A RAILWAY AND CERTIFICATE TO BE AVAILABLE.
- 1.3 RAIL CONTACT SYSTEM SHOULD HAVE BEEN EVALUATED FOR USE IN HIGH VIBRATION CONDITIONS.
- 1.4 CONTACT TO HAVE BEEN TESTED FOR SHORT CIRCUIT WITHSTAND ABILITY OF AT LEAST 6000 A AVERAGE CURRENT FOR 10 CYCLES (200 MS).
- 1.5 CONTACT RESISTANCE REQUIRED IS 5 MICRO OHMS.
- 1.6 SALT MIST TEST AS PER APPROPRIATE INTERNATIONAL STANDARD TO BE CARRIED ON THE RAIL CONTACT SYSTEM

2.0 EARTHING SYSTEM

THE EARTH ELECTRODE SHALL BE MADE OF HIGH TENSILE LOW CARBON STEEL CIRCULAR RODS, MOLECULARLY BONDED WITH COPPER ON OUTER SURFACE TO MEET THE REQUIREMENTS OF UNDERWRITERS LABORATORIES (UL) 467-2007 OR LATEST. SUCH COPPER BONDED STEEL CORED ROD IS PREFERRED DUE TO ITS OVERALL COMBINATION OF STRENGTH, CORROSION RESISTANCE, LOW RESISTANCE PATH TO EARTH AND COST EFFECTIVENESS.

- 2.1 THE EARTH ELECTRODE SHALL BE UL LISTED AND OF MINIMUM 17.0 MM DIAMETER AND MINIMUM 3.0 MTRS. LONG.
- 2.2 THE MINIMUM COPPER BONDING THICKNESS SHALL BE OF 250 MICRONS.
- 2.3 MARKING: UL MARKING, MANUFACTURER'S NAME OR TRADE NAME, LENGTH, DIAMETER, CATALOGUE NUMBER MUST BE PUNCHED ON EVERY EARTH ELECTRODE.
- 2.4 EARTH ELECTRODE CAN BE VISUALLY INSPECTED, CHECKED FOR DIMENSIONS AND THICKNESS OF COPPER COATING USING MICRON GAUGE. THE SUPPLIER SHALL ARRANGE FOR SUCH INSPECTION AT THE TIME OF SUPPLY, IF SO DESIRED. (SPECIFICATION OF SIGNAL DIRECTORATE, RDSO'S SPECIFICATION No. RDSO/SPN197 2008 CAN BE REFERRED)

3.0 CONDUCTIVITY ENHANCEMENT MATERIAL

EARTH ENHANCEMENT MATERIAL IS A SUPERIOR CONDUCTIVE MATERIAL THAT IMPROVES EARTHING EFFECTIVENESS, ESPECIALLY IN AREAS OF POOR CONDUCTIVITY (ROCKY GROUND, AREAS OF MOISTURE VARIATION, SANDY SOILS ETC.). IT IMPROVES CONDUCTIVITY OF THE EARTH ELECTRODE AND GROUND CONTACT AREA. IT SHALL HAVE FOLLOWING CHARACTERISTICS-

- 3.1 SHALL MAINLY CONSIST OF GRAPHITE AND PORTLAND CEMENT. BENTONITE CONTENT SHALL BE NEGLIGIBLE.
- 3.2 SHALL HAVE HIGH CONDUCTIVITY, IMPROVES EARTH'S ABSORBING POWER AND HUMIDITY RETENTION CAPABILITY.
- 3.3 SHALL BE NON-CORROSIVE IN NATURE HAVING LOW WATER SOLUBILITY BUT HIGHLY HYGROSCOPIC.
- 3.4 SHALL HAVE RESISTIVITY OF LESS THAN 0.2 OHMS-METER. RESISTIVITY SHALL BE TESTED BY MAKING A 20 CM. CUBE OF THE MATERIAL AND CHECKING RESISTANCE OF THE CUBE AT THE ENDS. THE SUPPLIER SHALL ARRANGE FOR SUCH TESTING AT THE TIME OF SUPPLY, IF SO DESIRED. NECESSARY CERTIFICATE FROM NATIONAL/INTERNATIONAL LAB FOR THE RESISTIVITY SHALL ALSO BE SUBMITTED.
- 3.5 SHALL BE SUITABLE FOR INSTALLATION IN DRY FORM OR IN A SLURRY FORM.
- 3.6 SHALL NOT DEPEND ON THE CONTINUOUS PRESENCE OF WATER TO MAINTAIN ITS CONDUCTIVITY.
- 3.7 SHALL BE PERMANENT & MAINTENANCE FREE AND IN ITS "SET FORM", MAINTAINS CONSTANT EARTH RESISTANCE WITH TIME.
- 3.8 SHALL BE THERMALLY STABLE BETWEEN -10° C TO +60° C AMBIENT TEMPERATURES.
- 3.9 SHALL NOT DISSOLVE, DECOMPOSE OR LEACH OUT WITH TIME.
- 3.10 SHALL NOT REQUIRE PERIODIC CHARGING TREATMENT NOR REPLACEMENT AND MAINTENANCE.
- 3.11 SHALL BE SUITABLE FOR ANY KIND OF ELECTRODE AND ALL KINDS OF SOILS OF DIFFERENT RESISTIVITY.
- 3.12 SHALL NOT POLLUTE THE SOIL OR LOCAL WATER TABLE AND MEETS ENVIRONMENTAL FRIENDLY REQUIREMENTS FOR LANDFILL.
- 3.13 SHALL NOT BE EXPLOSIVE.
- 3.14 SHALL NOT CAUSE BURNS, IRRITATION TO EYE, SKIN ETC.
- 3.15 MARKING: THE EARTH ENHANCEMENT MATERIAL SHALL BE SUPPLIED IN SEALED, MOISTURE PROOFS BAGS. THESE BAGS SHALL BE MARKED WITH MANUFACTURER'S NAME OR TRADE NAME, QUANTITY ETC. (SPECIFICATION OF SIGNAL DIRECTORATE, RDSO'S SPECIFICATION No. RDSO/SPN197 2008 CAN BE REFERRED).
- 4.0 FOR BURIED RAIL DRAWING No. ETI/PSI/0212-1 TO BE REFERRED.
- 5.0 EXOTHERMIC WELDING TO BE DONE ACCORDANCE WITH TI/PSI/OHE/EXOTHRMBOND/0100(04/10). IT IS PREPARED TO USE REMOTE IGNITION SYSTEM FOR PERSONNEL SAFETY.
- 6.0 COMPONENTS FOR ITEMS AT 2.0, 3.0 AND 5.0 TO BE PROCURED FROM SAME VENDOR TO ENSURE CONSISTENCY IN QUALITY.

REF.	DESCRIPTION	QUANTITY	REMARKS
1.	13M LONG RAIL (52kg OR 60kg AS AVAILABLE)	2 Nos.	
2.	TIN PLATED COPPER BUSHES	4 Nos.	
3.	M-12 BOLTS (STAINLESS STEEL)	4 Nos.	
4.	NUTS	4 Nos.	
5.	PLAIN WASHER	4 Nos.	
6.	LOCK WASHER (SPRING STEEL)	4 Nos.	
7.	GALVANIZED IRON FLAT SIZE OF 50X6 MM	28 m	
8.	COPPER BONDED CARBON STEEL EARTH ELECTRODE Ø 17.2 mm, 3 m LONG	4 Nos.	

SCHEDULE OF MATERIAL FOR MARKED 'F' (REFER RDSO DRAWING No. ETI/PSI/0212-1)

REF.	DESCRIPTION	QUANTITY	REMARKS
1.	20 Ø COPPER RIVET	16 Nos.	
2.	M-16 BOLTS HRH 210/45 COMPLETE WITH 1 NUT, 1 LOCK NUT AND 1 FLAT WASHER	8 Nos.	

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DRAWING FOR TYPICAL EARTHING STATION AT SWITCHING POST (SSP AND SP)	DTI/PSI	<i>h'n</i> 3.4.13
	ADE/PSI	<i>h'n</i> 03.04.2013

REF:-				CROSS REF:-			
DATE	MOD.	NATURE OF MOD.	INITIAL	R. D. S. O.			
				DATE	NAME	TI/DRG/PSI/E.STN/00001/13/0	
				DR.	<i>g.h. 10/13</i>		
				TC.		SCALE:- N.T.S	
				CK.		SUB SCALE:-	
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SH 4/4