सत्यमेव जयते

भारत सरकार
रेल मंत्रालय
(रेलवे बोर्ड)

भारतीय रेल
ए सी कर्षण नियमावली

अनुरक्षण एंव परिचालन

जिल्द - 2 (भाग - 2)

स्थिर संस्थापनायें (परिशिष्टों की सूचियां)

नवंबर, 2022

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RAILWAY BOARD

INDIAN RAILWAYS
MANUAL OF AC TRACTION

MAINTENANCE AND OPERATION

VOLUME II (PART II)

FIXED INSTALLATIONS (LIST OF APPENDICES)

NOVEMBER, 2022

INDEX

APPENDIX-1
PRINCIPLES FOR LAYOUT PLANS AND SECTIONING DIAGRAMS FOR 25kV AC TRACTION

1.0 INTRODUCTION

1.1 These principles for preparation, checking and finalization of overhead equipment lay out plans, have been framed for standardization and guidance of Railways/Railway Electrification Projects. In some cases, the principles are obligatory and should be followed. In other cases, principles have been evolved to standardize designs and to speed up the work. The principles could be relaxed in special cases, after studying individually the implications to arrive at the best solution both from economical and technical points of view. The fundamental aim of design of overhead equipment is to install all the contact wire at the requisite height and to keep it within the working range of the pantograph under all circumstances.

2.0 DEFINITIONS

The technical and other terms used in this book, shall have the same meaning as defined in General and Subsidiary Rules/ac Traction Manual, unless, there is any thing repugnant to the subject or context:

2.1 BOND

An electrical connection across a joint in or between adjacent lengths of rail:

1. Bond, continuity – A rail bond used for maintaining continuity of the rail circuit at crossings and junctions.
2. Bond, cross – A rail bond used for connecting together two rails of a track or rails of adjacent tracks.
3. Bond impedance – A special rail bond used to bridge an insulated rail joint in ac track circuited sections in areas equipped for electric traction.
4. Bond rail – An electrical connection across a joint between two adjacent lengths of rail as part of the track return.
5. Bond, Structure – An electrical connection between the steel work of track structures, bridge or station building, to which the traction overhead equipment is attached and the track returns.

2.2 Cantilever (assembly)

It is an insulated swivelling type structural member, comprising of different sizes of steel tubes, to support and to keep the overhead catenary system in position so as to facilitate current collection by the pantograph at all speed without infringing the structural members. It consists of the following structural members.

1. Stay arm – It comprises of dia 28.4/33/7 mm (Small) size tube and an adjuster at the end to keep the bracket tube in position. It is insulated from mast by stay arm insulator.
2. Bracket tube – It comprises of dia 40/49 mm (Large) or dia. 30/38 mm (standard) bracket tube and insulated by bracket insulator. Catenary is supported from this member by catenary suspension bracket and catenary suspension clamp.

3. Register Arm – It comprises of dia 28.4x33.7 mm tube to register the contract wire in the desired position with the help of steady arm.
4. Steady arm assembly – It is 32 x 31 mm BFB section made of aluminum- alloy to register the contact wire to the required stagger and to take the push up of contact wire. It is always in tension.

2.3 Crossings

The electrically live member/conductor passing over another electrically live member/conductor, without physical contact.

1. Power line crossing – An electrical overhead transmission or distribution line or underground cable placed across railway track(s) whether electrified or not for transmission of electrical energy.
2. Crossing OHE – Crossing of two conductors of OHE crossing without physical contact.

2.4 Dropper

A fitting used in overhead equipment construction for supporting the contact wire from catenary.

2.5 Electrical Clearance

The distance in air between live equipment and the nearest earthed part.

2.6 Encumbrance

The axial distance on vertical plane between the catenary and the contact wire at support.

2.7 Height of contact wire

The distance from rail level to the under side of contact wire.

2.8 Feeder

A conductor connecting (a) a substation with a feeding post, or (b) a feeding post with the OHE.

2.9 Interruptor

It is a single phase Vacuum circuit breaker used as load switch to close the circuit on fault but does not open on fault. It is operated either by remote or manually at site. Different methods of connection of interruptors are:

1. Bridging Interruptor – An interruptor which is provided at the neutral section to extend the feed from one substation to the overhead equipment normally fed by the other substation in emergencies or when the latter is out of use. This normally remains in the open position.
2. Sectioning Interruptor – An interruptor which connects adjacent sub-sectors together to maintain continuity of supply. This normally remains in closed position.
3. Paralleling Interruptor – An interruptor which connects overhead equipments of two different tracks. This normally remains in closed position to reduce the voltage drop.

2.10 Jumper

A conductor or an arrangement of conductors for electrical continuity not under tension, which forms electrical connection between two conductors or equipments.

2.11 Mast

A single vertical post embedded in the foundation or otherwise rigidly fixed in vertical position to support the overhead equipment with cantilever assembly. It may be rolled section or fabricated. The uprights of portals , head spans, and TTCs are also called mast.

2.12 Neutral Section

A short section of insulated dead overhead equipment which separates the sectors fed by two adjacent substations which are normally connected to different phases.

2.13 Overhead Equipment (OHE)

The electrical conductors over the track together with their associated fittings, insulators and other attachments by means of which they are suspended and registered in position.

All overhead electrical equipment, distribution lines, transmission lines, and feeders may be collectively referred to as overhead lines.

2.14 Overlap

An arrangement of overhead equipment over a track where two sets of traction conductors are run parallel to each other for short distance over span(s) providing a smooth passage for the pantograph of an electric rolling stock. In the un-insulated overlaps two sets of conductors are separated by 200 mm and connected by a jumper. In insulated overlaps the two sets of conductors are separated by 500 mm in air. Electrical continuity is provided by an isolator or an Interruptor.

2.15 Over line structures

Any fixed structure provided over the track. The prescribed clearance is normally provided as laid down in the Schedule of Dimensions for unrestricted movement of rolling stock.

2.16 Pantograph

A collapsible device mounted on an insulated base from the roof of an electric engine or motor coach for collecting current from the overhead equipment.

2.17 Return Conductor

A conductor which carries return current from the tracks to the substation in the booster transformer system.

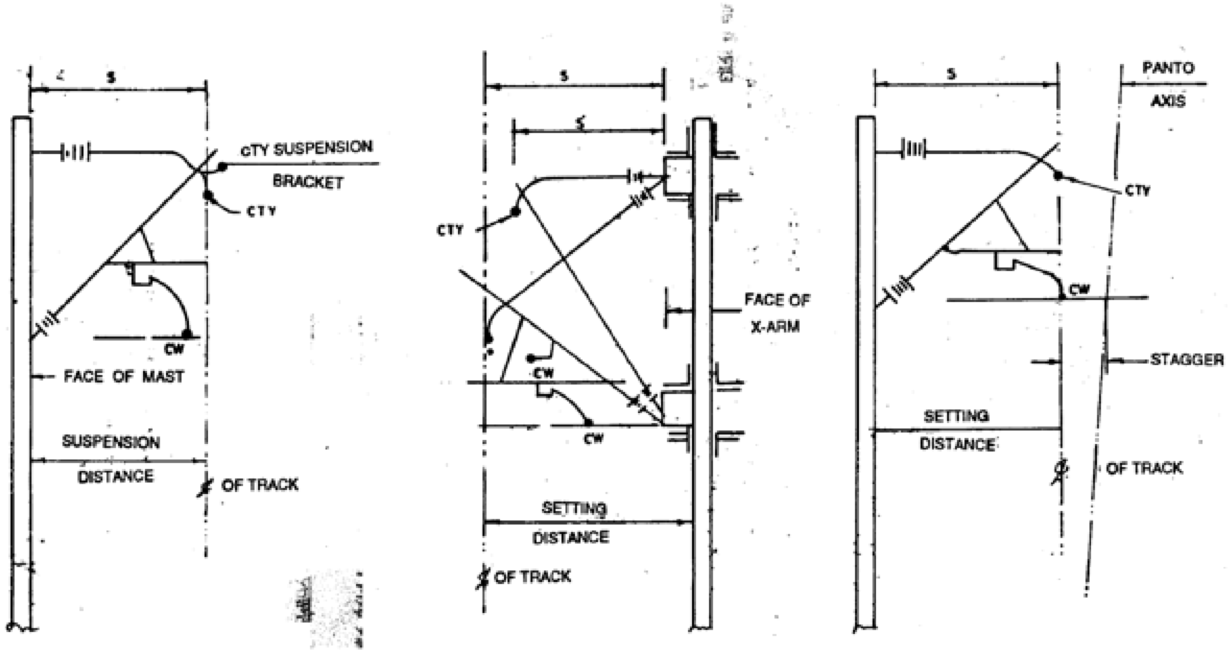
2.18 Regulating Equipment

A device for maintaining the tension of OHE conductors constant under all ambient temperature conditions.

Note: Such OHE is called regulated OHE.

2.19 Setting Distance (Implantation)

The horizontal distance from the nearest face of traction mast to the centre line of the track.



(i) For Single Bracket

(ii) For Multiple Bracket

(iii) For Single Bracket on out side curve

FIG. A 101

2.20 Suspension Distance

The horizontal distance from the centre of the eye of catenary suspension bracket to the face of the mast for a single cantilever assembly or to the face of cross arm channel in case of multiple cantilever assembly (Ref. Fig A.1.01)

2.21 Span

The distance between the centre lines of the adjacent supporting masts for overhead equipment/lines.

Clear span in case of portal structure, is the distance between the inner faces of portal uprights.

2.22 Stagger

Stagger of the contact wire is the horizontal distance of the contact wire from the vertical plane through the centre of pantograph plan at the contact surface.

The stagger of the catenary is the horizontal distance of the eye of the catenary suspension bracket from the vertical plane through the centre of the track.

2.23 Section Insulator

A device installed in the contact wire for insulating two elementary electrical sections from each other while providing a continuous path for the pantograph without break of current.

2.24 Supply Control Post

It is general term which refers to an outdoor assembly of control gear, such as interruptors, isolators, potential transformers, auxiliary transformers, etc. including remote control equipment installed in a cubicle, for controlling power supply to overhead equipment.

1. Feeding Post (FP) – It is a supply post where the incoming 25 kV feeder lines from the substation are terminated, and connected to the overhead equipment through interruptors.
2. Sectioning and Paralleling Post (SP) – It is a supply control post situated mid-way between two feeding posts at the neutral section and provided with bridging and paralleling interruptors.
3. Sub-sectioning and paralleling post (SSP) – It is a supply control post where a sectioning and paralleling interruptor is provided.
4. Sub-sectioning Post (SSP)- (For single line section) it is a supply control post where a sectioning interruptor is provided.

2.25 Sector

A section of overhead equipment of a track which can be energized by closing a feeder circuit breaker at the sub-station.

1. Sub-sector - The smallest section of overhead equipment which can be isolated remotely by opening of interruptors.
2. Elementary Section – The smallest section of overhead equipment which can be isolated from the rest of the system by manual operations.

2.26 Tension Length

Length of conductor which is stretched between the two anchor points.

2.27 Versine

The versine is the maximum offset of the rail on which spans have been measured (Para 5.1) of the curved track from the chord connecting two points, each opposite adjacent masts.

3.0 Electrical Clearance

3.1 Clearance

The clearances between 25 kV live parts and earthed parts of fixed structures or moving loads shall be as large as possible. The minimum electrical clearances (vertical and horizontal) to be maintained under the worst condition of temperature, wind, etc. between any live parts of the overhead equipment or pantograph and parts of any fixed structures (earthed or otherwise) or moving loads shall be as below:

1. Long duration 250 mm
2. Short duration 200mm

(ACS 10 of IRSOD (BG) Rev 2004.)

Note:

1. The powers delegated to Principal Chief Electrical Engineers vide Board's letter no.76/RE/240/1 dated 27.03.1980 are withdrawn.
2. A clearance study should be made for every over line-structure/tunnel and, if required should be referred to RDSO for advice.

   Long duration clearance 250 mm does not include track maintenance allowance, tilting allowance etc. It includes 200mm short time clearance and 50mm only for pushup/oscillation.

   (Clarified as in ACS 21 of IRSOD(BG)-Revised 2004, track maintenance allowance of 50 mm & tilting allowance of 57 mm added.)

3.2 Working clearance

Minimum clearance between live conductor/equipments and such earthed structure/live parts of different elementary sections where men are required to work shall be 2 m. Where the clearance is not obtained the structure shall be protected by earthed metallic screens or prescribed warning boards (refer para 22.2 and 22.3)

4.0 Wind Pressure

4.1 Wind Load

Wind pressures for design of all masts and determination of spans are based on Wind loads as per IS:875(Part-3)-2015 "Design Loads (Other than Earthquake) for Buildings and Structures — Code of Practice" .The standard wind pressures adopted are as follows for all new works for different zones as indicated in the specification.

i)	Navy Blue	-	73 kgf/m²
ii)	Yellow	-	105 kgf/m²
iii)	Blue	-	136 kgf/m²
iv)	Green	-	155 kgf/m²
v)	Red	-	178 kgf/m²
vi)	Hatched Red	-	216 kgf/m²

4.2 Loading calculation

For working out the wind loading the 190% of projected area for the rolled and fabricated sections and 3/4th of the projected area for conductors and other circular member is taken into account.

Note: The safety of masts and portals is checked for two conditions.

1. At 35 degree C temperature and full wind pressure.
2. At 4 degree C temperature and 20% of the governing wind pressure.

5.0 Spans

5.1 Measurement

Spans shall be accurately measured by means of a steel tape. On curves, these measurement shall be taken on the outer rail of the middle track in the case of an odd number of tracks and in the case of an even number of tracks on the inner rail of the first outside track (from the centre of the formation). On single track, measurements shall be made on the outer rail.

5.2 Standard Span

Standard spars shall be determined in accordance with:

1. Standard spans in accordance with Employment Schedule for Conventional OHE given in clause no. 6.1.2.
2. Drg. No. ETI/OHE/G/04201 for regulated tramway OHE and
3. Drg. No. ETI/OHE/SK/375 for composite OHE (Aluminum- alloy catenary and copper contact wire)

5.3 The spans shall be as large as practicable, but should enable the contact wire to be erected with permissible stagger. For a stipulated maximum stagger, the length of the span is governed by curvature, blow off of overhead equipment, and sway of pantograph and deflection of the mast under wind condition. Standard spans shall be used to maximum extent possible.

5.4 Mid span stagger

Where the two adjacent spans are located on curves of different radius or when the two versines are in opposite directions, the spans shall be determined so as to keep the mid span stagger in the two spans within the limit given in the span and stagger chart (ETI/OHE/G/00202), taking into account the stagger at the common support and the stagger at the extreme supports (see para 8)

5.5 Restrictions

The following restrictions are applicable.

1. On main tracks, the lengths of two consecutive spans shall not normally differ by more than 18 m.
2. The length of spans with unequal encumbrances shall be such that the axial distance between the catenary and the contact wire at the minimum dropper is not less than 150 mm. For example the length of the span with 1.4 m and 0.9 m encumbrances at the two ends shall not exceed 67.5 m. This restriction is applicable to the two spans on each side of the structure, equipping a turnout for the main OHE.
3. Spans in the vicinity of over line structures with restricted head room shall be determined with reference to the electrical clearances available (See para 3)
4. The lengths of spans loaded with section insulators may require to be restricted (See para 11)
5. Non-standard spans may be adopted in difficult locations, e.g. in rocky cuttings, on through girder bridges, for locations of masts on bridge piers and within station limits.
6. With crossed type equipment with actual crossings of OHEs at facing turnouts, the anchor spans shall be restricted to 54 m.
7. Where earth wire is provided, the maximum span over level crossings should be 58.5m.

5.6 Overlaps

The spans at insulated and un-insulated overlaps should be designed in accordance with Drg. Nos. ETI/OHE/G/02131/Sheet 1 and RE/33/G/02121 Sh. 1 respectively.

Note: If feasible, overlap shall be avoided under overhead power line crossings. Insulated overlap should be avoided within 120 m in front of stop signal.

5.7 Neutral sections

The spans at neutral sections should confirm to Drg. No. ETI/OHE/G/02161 sheet No. 1 and no deviations are normally permissible.

6.0 Masts, Portals, Head Spans and Foundations.

6.1 Types of masts

OHE conductors are suspended from swivelling cantilever assembly generally erected on individual masts.

6.1.1 Nine types of masts are used. These are designated as 150x150 BFB, 200x150 RSJ, K/B-100, K/B-125, K/B-150, K/B-175, K/B-200, K/B-225 and K/B-250. The first two are rolled sections and remaining seven are fabricated masts. B-series (Drg. No. ETI/C/0071) masts can be used in lieu of K-series masts.

(K- series and B-series OHE fabricated OHE mast are equally considered in Max. Permissible Bending Moment capacity.)

Note: Sometimes 200x200 (8"x8") BFB have been imported. These are used in lieu of 200x150 RSJ as specified in mast employment schedules.

6.1.2 Selection of masts

The masts for standard applications viz. masts for single OHE, anti-creep and overlaps should be selected from the mast employment schedules. Separate mast employment schedules have been made for each wind pressure zone as under:

1. Conventional OHE (65mm2 Cd-Cu catenary and 107 mm2 copper contact wire)

Navy Blue Zone (73 kg/m2)	TI/DRG/CIV/ES/RDSO/00001/18/0 (Sheet-1)
Yellow Zone (105 kg/m2)	TI/DRG/CIV/ES/RDSO/00001/18/0 (Sheet-2)
Blue Zone (136 kg/m2)	TI/DRG/CIV/ES/RDSO/00001/18/0 (Sheet-3)
Green Zone (155 kg/m2)	TI/DRG/CIV/ES/RDSO/00001/18/0 (Sheet-4)
Red Zone (178 kg/m2)	TI/DRG/CIV/ES/RDSO/00001/18/0 (Sheet-5)

These drawing are suitable for implantation up to 2.8m from the centre line of the nearest track. For implantation other than this, see drawing nos. in appendix ix.

(Due to revision of Wind Zone as per IS:875(Part-3)-2015)

The mast employment schedules are prepared only for standard setting distance as given in Drg. No. ETI.OHE/G/00111 Sheet-1For higher implantations and other locations like masts for turnouts, diamond crossings, umbrella type OHE etc, the load on the mast should be calculated separately for every locations and safety of the mast checked in accordance with Drg. No. ETI/OHE/G/00141 sheet 3. The permissible bending moments of the mast are given in Drg. No. ETI/SK/C/122

6.2 Two Track Cantilever

In the yards and sidings when the mast cannot be erected near the track to be equipped, it may be erected spanning one or two tracks using a two track cantilever (Drg. No. ETI/C/009/69, Sheet 1). This is generally used for supporting OHE near turnouts and X-overs. This arrangement should not be used for supporting OHE of two main lines. The OHE can be supported upto a distance of 10.5 m from the upright with this arrangement.

Two Track Cantilever Structure TTC-17 (Drg. No. – ETI/C/0077 SH-3A) with 10 m Boom, can be used along the track on Bridge approaches.

6.3 Portals

On multiple track sections, where adequate track centres are not available and tracks cannot be slewed, portals are used. Each portal consists of two fabricated uprights and one fabricated boom consisting of with or without one central piece and two end pieces.

6.3.1 Three types of portals have been standardized. "N " type portal is used for clear spans of 10 m-20m (4 track maximum), 'O" type portal is for clear span of 20m-30m (for 6 tracks maximum) and 'R' type portal with span of 30m-40m (for 8 tracks maximum).For more than 8 tracks, special type portal uprights with boom may be adopted.

6.3.2 Where the upright of standard portals cannot be erected due to limited track centres, 'P' type portal may be used in place of 'N' type and 'G' type may be used in place of 'O' type. The width of upright of these portals is 300 mm and 250 mm as against 450 mm of 'N' type and 550 mm of 'O' type respectively. In exceptional cases, BFB uprights of 152 mm width (Drg. No. ETI/C/0026 Sheet 1) may also be used with 'N' type portal boom. Special BFB portals with 3 legs (Drg. No. ETI/C/0027 Sheet) may also be used in exceptional cases where N type portal can not be used.

6.3.3 The cantilevers for the extreme track are provided on the uprights of the portals in accordance with para 19. The cantilevers for the intermediate tracks are provided on the drop arms suspended from the boom (ref. Para 19.6)

6.4 Head spans

In yards where un-regulated/regulated OHE is used head span may also be used to cover more than 6 tracks. Standard head span arrangement is given in Drg. No. ETI/OHE/G/03201. The head span arrangements are not used normally.

6.5 Foundations

6.5.1 Volume charts

The foundation bending moment codes (FBM) for each location are obtained from the mast employment schedules or by actual calculation (Para 6.1.2) Bearing capacity of the soil is determined at the outer toe of the bottom of foundation at a representative number of locations. Where foundations are placed on the slope of banks due to increase in setting distance, the bearing capacity of the soil should be determined on the slope. Bearing capacities determined thus would be considerably less than those determined on the top of formation.

Selection of the type and size of foundation is done from the volume chart. (Drg. No TI/DRG/CIV/FND/RDSO/00001/04/0) on the basis of FBM code, type and bearing capacity of soil/shoulder width and the extent of projection above ground level.

6.5.2 Type of foundations.

The following types of foundations are for OHE mast and portals:

1. For Masts:

i. (A) Side bearing (Type B)	TI/DRG/CIV/FND/RDSO/00001/04/0 (Sheet-1) “MOD-B”
(B) Side gravity (type : BG)	TI/DRG/CIV/FND/RDSO/00001/04/0 (Sheet-1) “MOD-B”
(C) Pure gravity (Type: G)	-do-
(D) Pure gravity for black cotton soil (Type: WBC)	TI/DRG/CIV/FND/RDSO/00001/04/0 (Sheet-1) “MOD-B”
ii. New Pure gravity (Type : NG)	TI/DRG/CIV/FND/RDSO/00001/04/0 (Sheet-2) “MOD-B”
iii. NBC type foundation for dry black cotton soil (16500 & 11000 kgf/m^2) 3.0 m depth.	TI/DRG/CIV/FND/RDSO/00001/04/0 (Sheet-3) “MOD-B”
iv. New pure gravity for different soil and site conditions (500 mm exposed) (Type-. NG or SPL)	TI/DRG/CIV/FND/RDSO/00001/04/0 (Sheet-4) “MOD-B”
v. New pure gravity for black cotton soil (for 8000 kgf/m2 soil pressure. 2.5 m depth. (Type : NBC)	TI/DRG/CIV/FND/RDSO/00001/04/0 (Sheet-5) “MOD-B”
vi. Foundations in soft rock (bearing capacity 45000 Kgf/m^2)	Drg. No. ETI/C/0059 “MOD-C”.
vii. Foundations in hard rock (bearing capacity 90,000 kgf/m^2)	Drg. No. ETI/C/0060 “MOD-D”.
viii. Bolted Foundation in hard Rock (Bearing Capacity-90000 kgf/m^2)	Drg No TI/Drg/CIV/ANCH-FDN/00001/17/0/ MOD-C

(Due to revision of Foundation Drawings in view of increased minimum standard implantation from 2.5m to 2.8m.Rly.Bd letter No.2002/RE/161/11 dated 14.11.2006.)

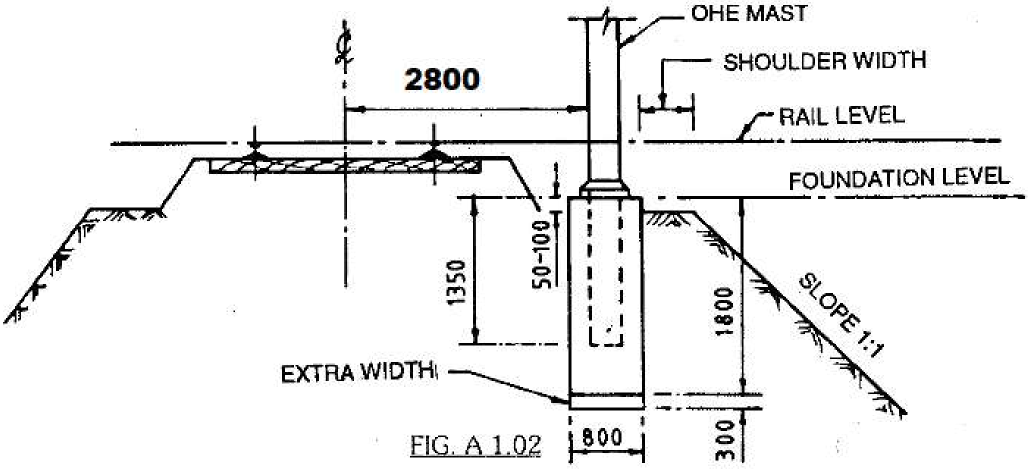


FIG. A 1.02

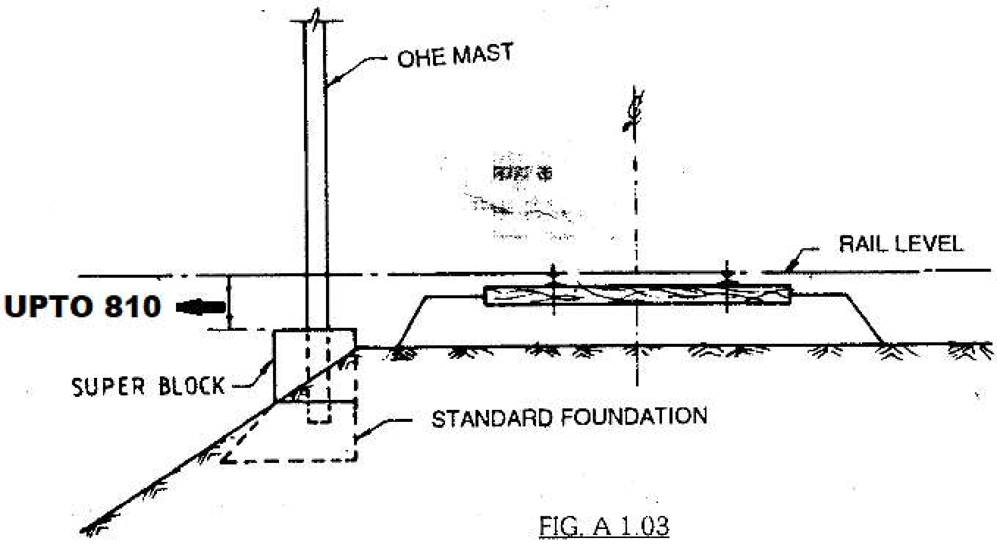


FIG. A 1.03

2) For portals

   a. In ordinary soil — Drg. No.ETI/C/0005/68

   b. In dry black cotton soil — Drg. No. ETI/C/0063

6.5.2.1 In the case of OHE foundations in deep rock cutting the foundation should be below the drain.

6.5.2.2 For all future constructions of pure gravity foundation Drg. No. ETI/C/0058 sheet 2A only shall be followed.

6.5.3 Selection of foundations

Side bearing foundations are used for masts where the soil bearing capacity is 11,000 or 21,500 Kgf./m^2 and 300 mm wide shoulder is available on the bank. However for overlap inter masts and masts on the inside of curves, 550 mm wide shoulder is necessary (Drg. No. ETI/C/0023) . (Ref. Fig. A1.02).

6.5.4 New pure gravity foundations may be used for masts where soil bearing capacity is 5500, 8000 and 11000 Kgf./m^2 or where adequate shoulder width as mentioned in para 6.5.3 is not available. In such cases, it should be ensured that foundation is not exposed.

6.5.5 Side gravity foundations may be used for masts where soil bearing capacity is 8000 and 11000 Kgf./m^2, or adequate shoulder width is not available. No portion of the foundation should be exposed.

6.5.6 Pure gravity foundations (type G) are used for independent masts where soil surrounding the foundations is loose and cannot exert passive pressure on the foundations. G type foundation have been designed for soil bearing capacity of 5500 , 8000 and 11000 kgf./m^2. Pure gravity foundations (Type P) are used for portals and are designed for soil bearing capacity of 8250 and 11000 Kgf./m^2.

6.5.7 Foundations in black cotton soil

6.5.7.1 The foundation of the black cotton should be done preferably in dry season i.e. from November to May. Excavations should be avoided as far as possible in case of unexpected rains in dry season also.

6.5.7.2 In black cotton soils. WBC and NBC type of foundations are used. Primarily WBC foundations are to be adopted where swelling/shrinkage is not expected to take place at the founding level and NBC foundations have to be provided where swelling/shrinkage is expected to occur.

6.5.7.3 The safe bearing capacity should be determined in accordance with IS: 6403

6.5.7.4 When in doubt regarding classification of BC soil as to dry or wet, it is preferable to make NBC type foundation.

6.5.8 Where foundations are constructed on the slope of banks, the foundations should be so located that generally no part of it is exposed. The top of foundation may then be brought to the desire level (rail level- 500 mm) by providing a super block of length and breadth equal to the top dimension of foundations. The increase in bending moment due to increased setting distance should be calculated and the designation of foundation to allow for this BM should be selected. The arrangement is shown in the Fig. No. A.1.03

6.5.9 The top of foundation should be 50-100 mm above the surrounding ground level. The length of mast below rail level should be minimum 1850 mm for regulated OHE and 1750 mm for un-regulated OHE. A 1350 mm embedment of mast in concrete is necessary. Concrete cushion of 150 mm below the bottom of mast is also necessary. Wherever necessary, these may be achieved by providing a super block of length and width equal to the top dimension of foundation.

However portion of existing pure gravity foundations to Drg. No. TI/DRG/CIV/FND/ RDSO/ 00001/04/0 sheet -2 corresponding to a depth of 500 mm of embankment having slope of 1:2 may be exposed.

(Due to revision of Foundation Drawings in view of increased minimum standard implantation from 2.5m to 2.8m.Rly.Bd letter No.2002/RE/161/11 dated 14.11.2006.)

6.5.10 Giving due consideration to the above, the most economical type of foundation should be adopted.

7.0 Contact Wire Height.

7.1 Standard height

Normally the height of contact wire (under side surface) above the track plane shall not be less than 5.50 m at any point in the span under the worst temperature conditions. To ensure this, the normal height at the suspension point shall be as under:

Type of OHE Normal height of contact wire at the support point.

1. Regulated
   a. Normal with 10 cm pre-sag 5.60 m
   b. Normal with 5 cm pre-sag 5.55 m
2. Unregulated
   a. Unregulated OHE designed 5.75 m
      for areas with a temp range of
      4 degree Centigrade to 65 degree Centigrade
   b. Unregulated OHE designed 5.65 m
      for areas with a temp range
      of 15 degree Centigrade to 65 degree Centigrade

7.2 The height may be reduced under over line structures after a clearance study. The minimum height shall be 4.92 m for the broad gauge and 4.02 m for the meter gauge to permit movement of "C" class ODC without physical lifting of wires. In case "C" class ODC movement is not required, the height could be reduced to 4.80 m (BG) Ref. Fig. A1.04)

Height may be further reduced to 4.54m if rolling stock of height higher than 4.27m are not allowed on such lines in case of restricted height of overline structure after clearance study.

7.2.1 At electric locomotive sheds and loco inspection pits, the minimum height shall be 5.80 m for the metre gauge.

7.2.2 At level crossings, the minimum height shall be 5.50 m for both broad and metre gauges.

7.3 Erection tolerance

A tolerance of +/- 20 mm is permissible on the height of contact wire as measured at a point of support except on either side of an over bridge, here a tolerance of +/- 10 mm will be allowed. But the difference between the heights of contact wire at two adjacent supports shall not exceed 20 mm. In spans with gradient of contact wire, this difference of 20 mm is measured over and above the approved gradient.

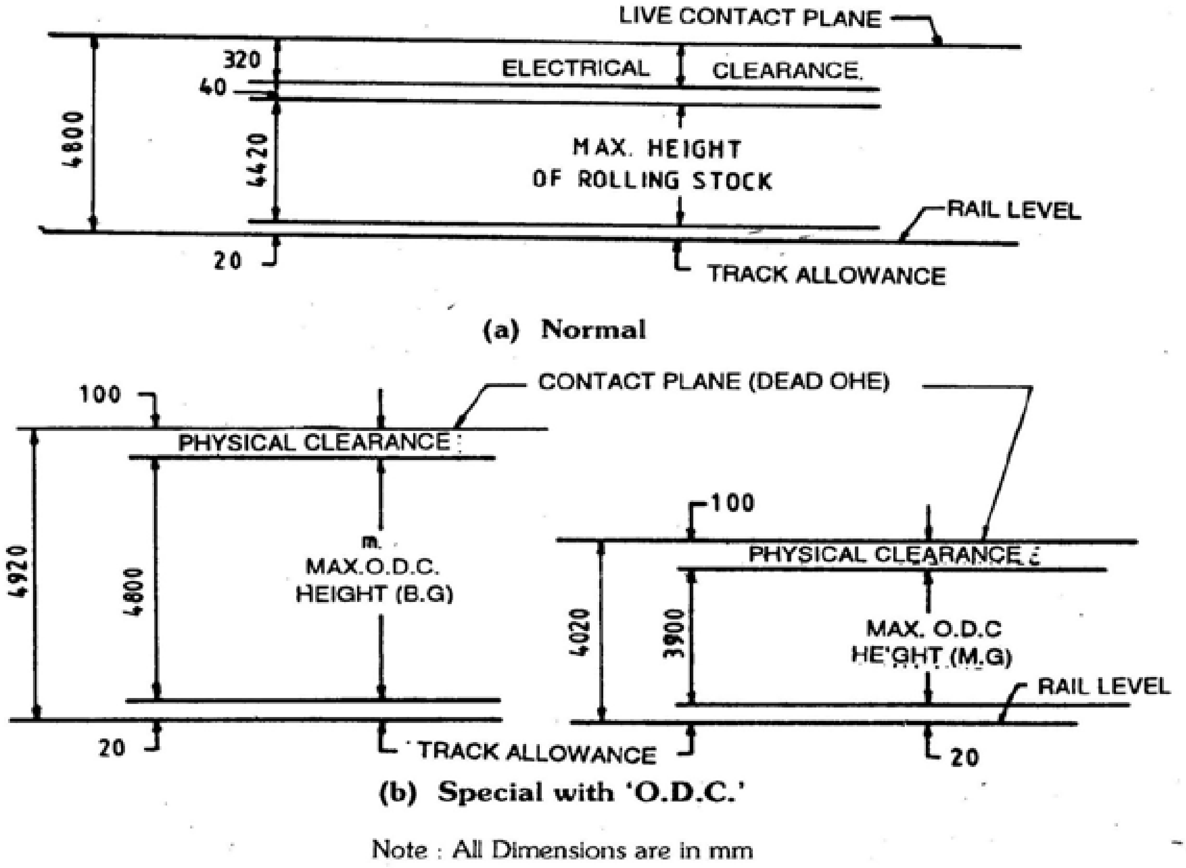


FIG. A 1.04

7.4 Contact Wire gradient

Any change in the height of the contact wire should be made gradually and the slope should not normally exceed 3 mm/m on main lines and 10 mm/m on sidings. In no case shall the relative gradient of the contact wire in two adjacent spans be greater than 1.5 mm/m on main lines and 5 mm/m on sidings. Railway Board vide letter no 2001Elect(G)/170/1 dated 22.11.16 revised the contact wire gradient and relative gradient to 2mm/m and 1mm/m respectively for new electrification works.

7.5 Provision for future track raising

The rail level may go up in future by 275 mm (max) due to use of concrete sleepers and strengthening of track structure. Provision should be made for possible lifting of track by 275 mm (max.) (Correction Slip No. 10, Schedule of Dimension, (BG/Metric), 1973). OHE arrangement indicated in Drg. No. ETI/OHE/G/02102,Sheet 3 (Rev B)should be used for the areas where track raising is contemplated. The areas where track is proposed to be raised may be ascertained before commencement of works. No track raising is normally contemplated near over-line structures unless additional head room has been provided.

8.0 Stagger

8.1 Tangent track

On tangent track, the contact wire is normally given a stagger of 200 mm at each support alternately on either side of the centre of the track. This is relaxed in special cases for ensuring requisite clearances in difficult locations such as in the vicinity of signals, subject to stagger at mid-span not exceeding the permissible values given in Drg. No. ETI/OHE/G/00202.

8.2 On tangent track, the catenary stagger is zero for masts supporting a single equipment. The catenary is fixed vertically over the contact wire at all supports at which more than one equipment is supported, at flexible head spans and at supports with reduced encumbrance, on tangent as well as curved tracks.

8.3 Curved track

On curves, the stagger of the contact wire at supports should not exceed 300 mm. The stagger of the catenary on curved track shall be determined with reference to Drg. No. ETI/OHE/G/00202. The standard values adopted are 0, +200 and – 200

Note: For maximum permissible stagger refer para 4 of Chapter V-A of Schedule I, BG Metric Schedules of Dimensions – 1973.

8.4 Turnouts and diamond crossing

At turnouts, the stagger of the contact wire on the main running line shall be in accordance with Drg. No. ETI/OHE/G/00202. The stagger of contact wire of the branching line shall not exceed 300 mm at any point in the span. This is achieved by selecting a suitable location for the mast near the centre of the turnout in the case of overlap type equipment, or by suitably adjusting the point of crossing of the two contact wires in the case of crossing type equipment.

8.5 Un-insulated overlaps

At un-insulated overlaps, the stagger should confirm to Drg. No. RE/33/G/02121 sheet 1. On non-uniform curves or at other locations where staggers different from those indicated in these drawings are adopted, the following points should be observed.

1. The stagger of the in-running contact wire does not exceed 200 mm on tangent track and 300 mm on curved track at any support, at which only one contact wire is in-running.
2. In any span at the centre of which only one of the contact wires is in-running (as in a 4-span overlap), the mid-span stagger of the in-running contact wire does not exceed the values given in Drg. No ETI/OHE/G/00202
3. The two contact wires run parallel to each other between the intermediate supports at a distance of 200 mm from each other.

8.6 Insulated overlap

At insulated overlaps, stagger should conform to Drg. No. ETI/OHE/G/02131 Sheet 1. On non-uniform curves and at other locations where stagger different from those shown in this drawing are adopted, the points mentioned against un-insulated overlap spans also apply, with the difference that between the intermediate masts the two contact wires run parallel at a distance of 500 mm from each other.

8.7 Neutral Sections

The stagger at overlap type neutral sections should conform to Drg. No. ETI/OHE/G/02161, Sheet No. 1.

8.7.1 The stagger at section insulator type neutral section should be so adopted that the stagger at the section insulator assembly is within the limit of +/- 100 mm (see para 11.1(iii).

8.7.2 PTFE type neutral section shall be erected on tangent track only. The stagger shall be zero at support.

9.0 Encumbrance

9.1 Normal

The encumbrance shall normally be 1.40 m.

9.2 Reduced encumbrance

The preferred values of reduced encumbrance for erection of overhead equipment under over-line structure are:

Span under Over-line Structure (m)	Recommended encumbrances for span under over-line Structure (m)	Largest permissible adjacent Spans (m)
1	2	3
63.0	0.9	67.5
58.5	0.9	67.5
54.0	0.75	67.5#
49.5	0.6	63.0
45.0	0.6	63.0
40.5	0.5	58.5
36.0	0.40	54.0*
31.5	0.40	49.5
27.0	0.30	45.0

Applicable where the encumbrance cannot be increased to 1.40 m in a single span from the value given in column 2. The normal encumbrance of 1.40 m should be provided in subsequent spans. In such cases, the encumbrance may be adjusted in such a way that the lowest point of the catenary does not fall between first dropper and the support.

* See para 5.5 (1)

Note i) The above values are applicable only to regulated OHE with 10 cm nominal pre-sag of contact wire.

ii) Special droppers may be required in spans under and adjacent to over-line structures.

9.3 Minimum Encumbrance

Normally, the axial distance between the catenary and the contact wire at the minimum dropper should not be less than 150 mm. Smaller droppers may be adopted in exceptional cases. If the shortest dropper is loop type and more than 150 mm, no speed restriction is called for. But it the dropper is without loop or of rigid type or less than 150 mm, the overhead equipment is deemed suitable upto 90 km/h speed.

9.4 If section insulators are to be installed in spans under over-line structures, special designs will have to be evolved.

10.0 Droppers

10.1 The standard arrangement of droppers assembly shall be as per drawing No. ETI/OHE/P/1190

10.2 The general distribution of droppers on an OHE span shall be as per drawing No. ETI/OHE/G/00161. The arrangement of OHE span should be designed in such a way that standard droppers are used.

10.3 Special droppers arrangement.

The special arrangement of dropper as shown in Drg. No. ETI/OHE/P/1400 may be followed in exceptional cases wherever unavoidable.

10.3.1 The arrangement of the dropper to be adopted on the through girder bridges as shown in Drg. No. ETI/OHE/P/1410, where the OHE is supported on member of girder bridge.

10.4 Rigid dropper

Adoption of rigid dropper (made of contact wire only) should be avoided as far as practicable. It should not be adopted, at all on main running lines.

11.0 Section Insulators

11.1 Location

Sectional insulators should be so located that the following conditions are fulfilled.

1. At location of section insulator, the axial distance between the catenary and contact wire shall not be less than 450 mm in the case of single-wire section insulator and 600 mm in the case of a double wire section insulator without increasing the encumbrance at the supports beyond 1.40 m.
2. The section insulator is to be located beyond the point where the centre distance between the two tracks is equal to or more than 1.65 m. If the section insulator is erected with the free ends of the runners away from the centre of the turn out this distance may be reduced to 1.45 m.
3. The stagger of the contact wire at the location of the section insulator should normally be zero, but in no case should it exceed + 100 mm.
4. On loops, the section insulator shall, as far as possible, be located close to the first support of the overhead equipment for the loop.
5. The preferred location of section insulator on main running track is 2 to 10 m from the support in the direction of traffic, though its provision on the main line should be avoided.
6. In double line section, the runners should be in the trailing direction.

7. Light Weight Section Insulator Assembly:

   Light Weight Section Insulator Assembly (LWSI) as per RDSO specification TI/SPC/OHE/LWTSI/0060(Revision-1) with A & C-1 may also be used as it is advantageous to conventional type section insulator assembly in terms of lesser weight and fitness for higher speed hence the Light Weight Section Insulator Assembly can be installed in main line fit for high speed train operation. For more details ACTM Vol-II Part-I Para 20311 may be referred.

   (Vide rb letter no2003/RE/161/1 dated 03.03.2005. RB has recommended for trial of LWTSI on specified route for 150 KMPh)

11.2 Permissible Speeds

11.2.1 On double line sections, with runners trailing, the section insulator assembly using porcelain sectioning insulators are fit for speeds upto 120km/h provided it is installed within the first one-tenth and one-third of the span.

11.2.2 In case the runners of the section insulator are facing or it is not installed within first 1 /3rd of the span the speed should be restricted to 80km/h. (Ref. Fig. A1.05).

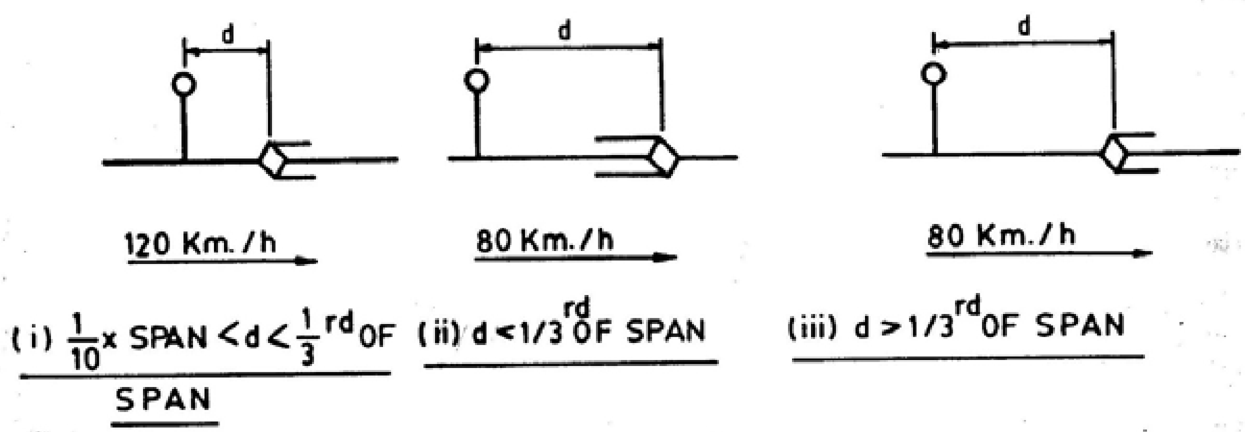


FIG. A 1.05

12.0 Arrangement of Jumpers

12.1 In span jumpers

In span jumpers between the contact and catenary wires are provided at suitable equi-distant intervals as indicated in Drg. No. ETI/OHE/G/05101.

12.2 Turnout jumpers

The arrangement of connections at turnouts and at diamond crossings is indicated in Drg Nos. ET1/OHE/G/ 05103 and 05106 respectively.

12.3 G-Jumpers

The arrangement of jumpers at un-insulated overlaps is indicated in Drg No. ETI/OHE/G/05102.

12.4 Potential equalizing jumpers

The arrangement of potential equalizer jumpers is indicated in Drg. No. ETI/OHE/G/05104.

12.5 Anti-theft jumpers

The arrangement of anti-theft jumpers should be as indicated in Drg. No ETI/OHE/SK/432.

13.0 Tension Lengths

13.1 Regulated equipment

With regulated overhead equipment every tension length is equipped with an automatic tensioning device at each end and an anticreep located approximately midway between the tensioning devices. The distance between the anticreep and the anchor mast/structures on either side should not exceed 750 m or 15 supporting masts.

13.2 Half tension lengths

Half tension lengths of regulated overhead equipment, not greater than 750 m between anchorages, may be adopted where necessary. The equipment is fixed at one end and provided with an automatic tensioning device at the other, the fixed end being determined to suit convenience of erection. The half tension-length on either side of the neutral section should not exceed 600 m when the whole or a part of it is located on a curve. The distance of the axis of a 4 span insulated overlap from the anti-creeps/ fixed terminations on either side shall not exceed 600 mtrs.

13.3 Bridges and tunnels

Where the catenary is anchored on the face of an over line structure, the anchor shall be the anti creep point. Termination of overhead equipment or provision of an anticreep, should be avoided , as far as possible, inside the tunnels and on the mast set on bridge piers.

13.4 Masts with three brackets

In the case of masts with three brackets supporting regulated equipment, anticreeps or fixed terminations of the overhead equipment should be arranged so as to keep the relative movement between brackets as low as possible so that the brackets do not foul with each other.

13.5 Unregulated equipment

With unregulated equipment tension-lengths of upto 2000 m. between anchors may be adopted on tangent as well as curved track.

13.5.1 Unregulated OHE shall not take off from main running lines

13.6 Linkage of wire-runs

Wire-runs linking two or more main line wire-runs shall be as short as possible. For example, the same wire run may not ordinarily be used for equipping an emergency cross –over and a loop line.

13.7 Anti-creep

Anticreep arrangement: Anticreep is located approximately in the centre of a tension length. The standard arrangement should be in accordance with Drg. No. .TI/DRG/OHE/GENL/RDSO/0001/12/0.

13.7.1 Boom type anticreep arrangement (Drg. No ETI/OHE/G/02113) may be provided on multiple track sections or in other areas where portals have been provided on account of other design considerations. Portals should not be provided specifically for provision of boom type anticreep.

14.0 Anchor Height

14.1 Crossing of anchoring spans

Crossing of equipment of different elementary electrical sections in the anchoring span should be avoided as far as possible-

14.2 Crossing of regulated and unregulated equipments should be avoided. This may, however, be permitted if there is sufficient mechanical clearance between the crossing contact wires under all conditions.

14.3 Anchoring near signals

Anchoring spans in the vicinity of signals, water columns and other fixed structures should be avoided as far as possible.

14.4 Back to Back anchors :- Back to Back anchoring of two equipments on the same mast may be adopted if both the terminations are of the fixed type (without counter weight).

14.5 Anchor near buffers

In order to equip the full length of a buffer end siding, the scheme of anchoring as indicated in Fig. A1.06 may be adopted.

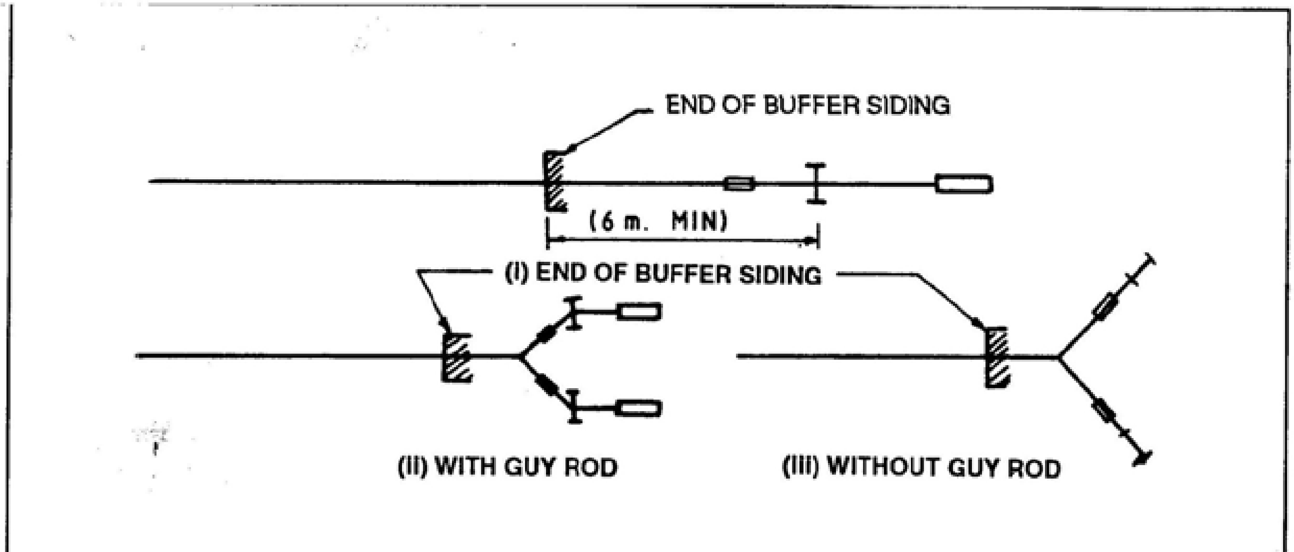


FIG. A 1.06

14.6 Anchor height

Where the contact wire is of unregulated equipment and raised from the contact plane and anchored in a single span, the anchor height shall be fixed within limits decided on considerations indicated below. The maximum height shall be such that with the contact wire tension at its maximum, the contact wire of the anchor OHE does not leave the contact plane in the one where it is required to be in-running. The minimum height shall be such that with the contact wire tension as its minimum, there is no possibility of the contact wire sagging too much below the contact plane where it is out of running and getting entangled with the pantograph. In both cases, the anchor height is to be determined with respect to the anchor span if there is no crossing of the two contact wires, and with respect to the distance between the anchor mast and the point of crossing if there is crossing of the wires.

14.7 In case of regulated equipment, when the equipments to be anchored on a single span, anchor height shall be the standard one to get the regulation of the overhead equipment within the limit travel zone of counter weight assembly. However, single span anchoring should be avoided as far as possible.

14.8 Anchor near buildings

No live anchor or equipment shall be provided near or over any hut/goomty and building, In such cases the overhead equipment should be isolated by providing cut-in-insulator and earthed by connecting it metallically to the anchor mast without providing the insulator in the anchor assembly.

14.9 Termination

The anchoring arrangement of OHE are given in Drg. No. RE/33/G/03121. In polluted areas, e.g. tunnels, areas near sea-coast, neighborhood of chemical/fertilizer/cement plants, near loco sheds, ash pits, water columns, etc long creepage path (1050 mm/1600 mm) insulator should be used on the anchoring arrangement.

15.0 Location of overlap

15.1 Platform lines

Overlaps serving platform lines should not be located opposite platform to avoid location of tensioning devices on the platforms. If it is unavoidable, half tension length may be adopted to avoid the provision of the regulating equipment on the platform

15.2 Protection by signals

In the station area insulated overlaps on main running lines should be located after the stop signals. (Refer to sectioning arrangement of OHE – para 30.)

15.3 Cross over

In the case of emergency cross-overs insulated overlaps in the direction of the trailing end should permit the longest train to be accommodated between the lock bar of the cross over switch and the first intermediate mast of the overlap with a minimum margin of 50m. This distance may be taken as 850 m. the overlap in the rear should be located as close as possible (Refer to sectioning arrangement of OHE – para 30.)

15.4 Span

Location of insulated and uninsulated overlaps should be decided in such way that the maximum span can be adopted to achieve parallel path of not less than 3 m for smooth change over by the pantograph.

15.5 The arrangement of overlaps should be as per standard drawings (see para 5.6).

15.6 Feeders to overlaps

Feeding overlaps should be sufficiently away (see para 16.2) from the stop signals to facilitate coasting of trains (with pantograph lowered in the event of extension of feed from either side. Feeders may be run, if required, from the substation which is usually located in the station areas.

16.0 Neutral Section

16.1 Overlap type

The conventional overlap type neutral section (Drg. No. ETI/OHE/G/02161, Sheet-1) shall be used except in suburban and heavily graded sections.

16.2 Short Neutral Section of Section Insulator Assembly type

In heavily graded section and suburban section where adoption of overlap type neutral section is not feasible, short neutral section of 5 m length, comprising of conventional section insulator assembly may be adopted. The arrangement is shown in the Drg. No. ETI/OHE/G/02161, Sheet 2. Speed under such neutral sections shall be restricted to 100 km/h if the runners are in trailing direction, otherwise to 70 km/h (Para 11.2.1).

Note: Short neutral section should be provided on half tension length not exceeding 500 m.

16.2.1 Adoption of short neutral section with section insulators assembly should be avoided on main running lines due to heavy weight, restricted speed and frequent maintenance requirement.

16.3 Short Neutral section of PTFE type

Short neutral section assembly of PTFE type as per RDSO specification no TI/SPC/OHE/SNS/0000(Rev-1) A&C No-01 may be provided on main line as it is lighter and is considered fit for speeds upto 200 Km/h. For more details ACTM Vol-II Part-I Para 20312 may be referred.

16.4 Neutral section shall be located away from stop signals, level crossing and shall be on tangent track and on level to the possible extent.

16.4.1 If neutral section is provided after a stop signal, the distance* between signal and neutral section shall be such that after stopping, the train shall be able to pick up enough speed to coast the neutral section without any risk of stalling.

16.4.2 If neutral section is provided before a stop signal, the distance* between neutral section and signal shall be such that the train shall not cross the signal in an effort to coast the neutral section.

*Note: The distance should be preferably 1600 m away on section with gradient upto 1 in 300 and 2500 m with higher gradient upto 1 in 200, if unavoidable.

16.5 The PTFE type short neutral section shall be located on level tangent track at least 400 m after the stop signal and 200 m before the stop signal. Where, however, modifications require to comply with these guide lines are difficult or entail heavy investment, the Principal Chief Electrical Engineer of the Railway may direct any other arrangement to be followed consistent with safety and reliability, and for location on graded section according to para 16.4.1 and 16.4.2. (Ref. Fig. A1.07). Similarly, for section where 12/16 coach EMU/MEMU are proposed to be introduce, the distance (200 m) between NS and stop signal should be increased in such a way that if signal is red the complete EMU/MEMU should be able to get accommodated between NS and signal with sufficient distance left between NS and signal

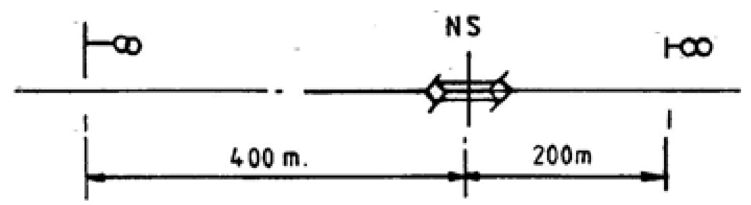


FIG. A 1.07

16.6 Location of 'OPEN DJ' and 'CLOSE DJ' boards.

The indication boards to indicate the approaching neutral section and 'OPEN DJ' , 'CLOSE DJ' boards shall be provided according to drawing No. ETI.OHE/G/02161 Sheet 3.

16.6.1 Separate 'CLOSE DJ' boards are required for EMUs and loco hauled trains.

17.0 Points and Crossings.

17.1 General arrangement

The equipment at points and crossings should preferably be of the overlap type. In unavoidable circumstances it may be of crossed type.

17.1.1 The general arrangement of regulated overhead equipment at turnouts and cross overs is shown in Drg. Nos. ETI/OHE/G/02141 and 02151. For high speed running, the overlap type should be provided.

17.1.2 The general arrangement of unregulated overhead equipment at turnouts and cross overs is shown in Drg. No. ETI/OHE/G/03151 and 03152, Sheet 1 & 2.

17.1.3 The leading dimensions of standard turnouts and crossings are given Drg. Nos. RE/33/G/01104, sheet 1 and 01105, Sheet 1 for the broad gauge and in Drg. Nos. RE/33/G/01104, Sheet 2 and 01105, sheet 2 for the metre gauge.

17.2 Overlap type

In the case of turnouts for high-speed running a mast is located near the centre of the turnout and the contact wire of the secondary track is raised in one or more spans (exclusive of the anchor span) after the centre of the turnouts, before it is anchored. A cross over is equipped in the same manner as two ordinary turnouts.

Note: Overlap type overhead equipment at turn outs taking off from main line shall be provided.

17.2.1 A diamond crossing with or without slips is equipped as two turnouts, the turnout centres being coincident. The mast located near the common centre is, therefore, equipped with three bracket assemblies (See Drg. No. ETI/OHE/G/02151).

17.3 Crossed type

The crossed type equipment for turnouts is normally adopted on secondary tracks but may be used on main tracks, where speeds are less than 100 km/h. The overhead equipment of the secondary track normally crosses the overhead equipment of the main track or does not have any overlapping span before anchorage. The two contact wires are clamped together to prevent relative vertical displacement. For this type of equipment, no support is necessary near the centre of turnout.

17.3.1 In case of diamond crossings with double slips, if crossed type of equipment is provided, doubling of contact wire is necessary (See Drg. No. ETI/OHE/G/03152, sheet 2). Doubling of contact wire is, however, not essential in the case of diamond crossings with single slip. In either case, no mast is necessary at the centre of the crossings.

18.0 Arrangement of Masts

18.1 Location of masts

Masts should generally be arranged as far as possible in the same line parallel to the track and in the same line transverse to the track. Normally, no masts should be located between any two main running tracks.

18.2 Umbrella type

Masts may be fitted with bracket assemblies on each side to serve adjacent tracks if the overhead equipment of the tracks belong to the same elementary electrical section.

18.3 Restrictions

18.3.1 Masts serving track of different elementary sections should not normally be located between them and in the same line. If two masts serve tracks belonging to two different elementary electrical sections and are located between them, the masts should normally be staggered by 9 m, though a minimum stagger of 4.5 m is permissible in exceptional cases (Ref. fig. A1.08 (i).

18.3.2 If one of the masts mentioned is an anchor mast, and the anchor falls between the two masts, they should be staggered by 13.5 m minimum (Ref. Fig. A1.08(ii).

18.3.3 If both the masts mentioned are anchor masts and both anchors fall between the masts, they should be staggered by 18 m (Ref. Fig. A1.08(iii).

18.3.4 If one of the masts is an anchor mast and the anchor falls away from the masts and the out-of-run equipment runs close to the second mast, the spacing of masts should be such that sufficient working clearance is available between the overhead equipment and the second mast. (See para 3.2). Cut in insulators or special anchor arrangements may be adopted in special cases (Ref. Fig. A1.08(iv)).

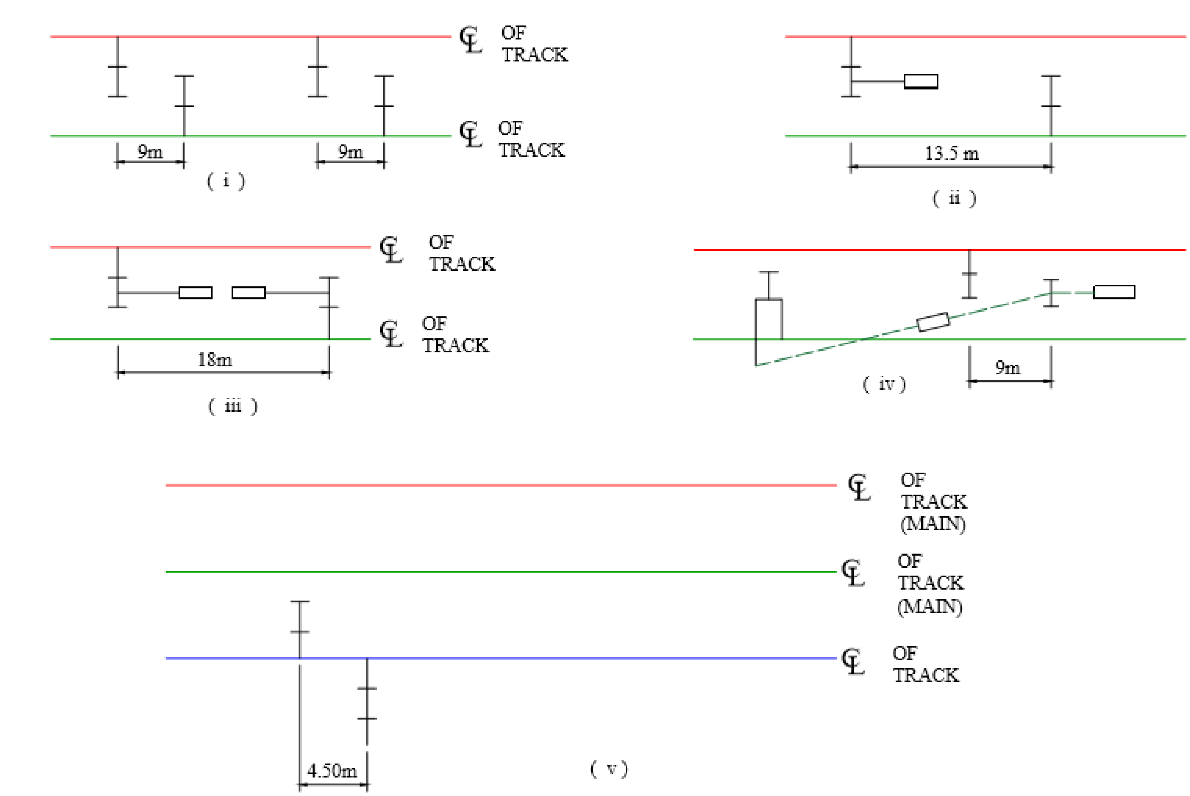


FIG.A 1.08

18.4 If masts are located on both sides of a track, they shall be staggered by 4.5 m (Ref: Fig. A1 .08(v)).

18.5 Masts for turnouts and diamond crossing should be located at the theoretical centre. If unavoidable, 2 metres is the permissible displacement on either side of the theoretical centre of turnout.

18.6 Wiring of loops In future

Masts should generally be located and designed to permit wiring of unwired loops and extension of electrification in yards and sidings, in future, conveniently. Wherever such provisions Is made, future wire-runs should be shown In dotted lines on the layout plans to ensure selection of correct type of masts and foundations.

18.7 Masts with counterweights should be avoided on platforms. In unavoidable circumstances, safety cage around counter weights to be provided to avoid injury to passengers at platform in the event of SS rope breakage.

18.8 Ash-pits & water columns

Masts should not be located within 15 m of ash-pits and water columns! Steam engines standing at water columns and ash-pits blow off steam which may cause flash-over of insulators.

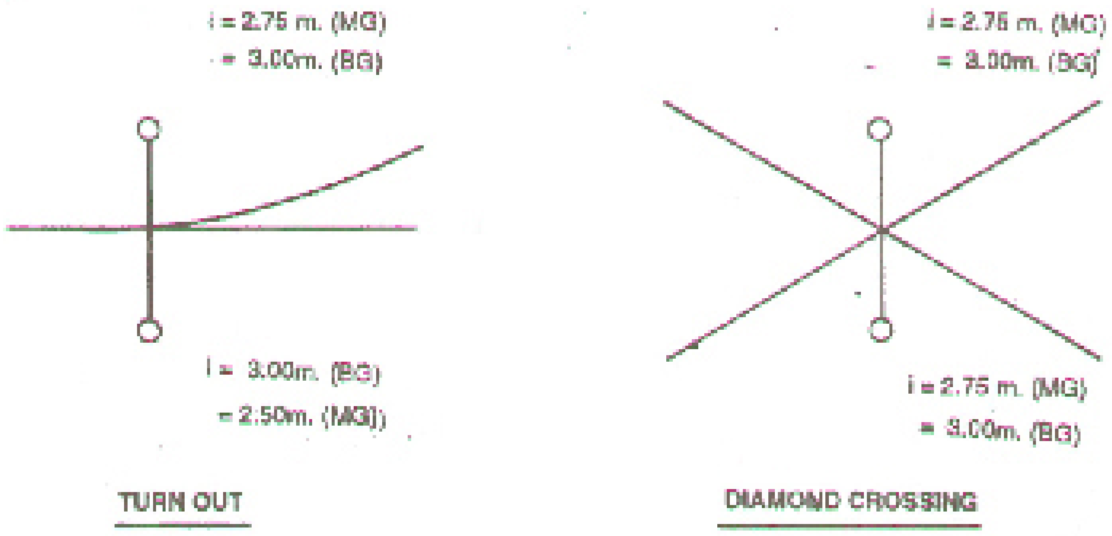


FIG. A 1.09

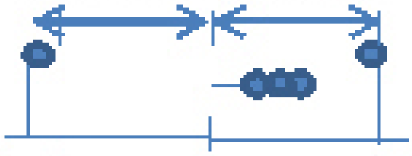


FIG. A 1.10

18.9 Masts shall not be located in front of station entrances

18.10 Masts shall not be located opposite to trolley refuges, close to culverts, subways and on bridges of length less than 50 m.

18.11 No mast shall be located beyond a signal post at a distance less than 10 m. In case the OHE mast is located in the front of the signal the distance between the OHE mast and signal post should not be less than 30 m (Ref. Fig. A1.10)

As per Railway Board letter No. 2017/Sig/3/85th/SSC dated 03.07.2018 and leter no. 2013/RE/161/22 pt/dtd. 24/26/7/2018:

1. Layout plan (LOP) showing placement of traction mast and signal shall be approved by PCSTE (or his authorised representative) with concerned Electrical officer.
2. PCEEs/PCSTEs are empowered to give dispensation for reduction in the distance for placing mast in front of signal on straight track from 30m upto 10 meters after ensuring staggering for proper visibility of signal as per provisions of ACTM & SEM.
3. In case of OHE Mast in rear of the signal post, the minimum distance may continue as already prescribed in SEM & ACTM.)

18.12 Masts should be located sufficiently far away from level crossings and back of abutments of bridges. The distance between the mast and the end of the level crossing/abutment shall not normally be less than 10 m. The distance between the mast and the end of the abutment may be reduced to minimum 5m by PCEE on case specific basis after getting approval of CBE subject to the following conditions:

i. The reduction of distance upto 5 m shall result in avoidance of OHE Mast over the pier of the bridge.

ii. The mast at abutment shall carry single cantilever assembly, and must not be used for ATD provision or Anti-creep anchor.

iii. The implantation of OHE mast may be suitably increased as per side condition.

iv. Cost of strengthening the approaches due to this modification to be borne by Electrical Department.

18.13 The sections having more than two tracks, independent masts should be provided if adequate track centres are available or if the tracks can be slewed. Where adequate track centres are not available portals will normally be adopted and they should be located in such a way as to facilitate provision of drop arm/s and bracket assembly.

18.14 In case of bad formations, if it is possible to locate the masts on either side of a track, preference should be given to the side with better stability.

18.15 Support for OHE in tunnels.

In the lined tunnels, stubs for supporting OHE cantilever assembly should be provided on both sides of the tunnel, opposite each other. This would facilitate restoration of OHE in the event of damage to stubs on one side.

18.16 Masts on bridges

Core holes for erecting masts on bridges should be provided as per Drg. No. RE/31/0590/63 on both sides of all the piers. Holes on piers which are not used for foundation should be filled with dry sand covered with a concrete slab. Similarly holding down bolts (Ragged Type) are to be grouted in core holes on piers with epoxy for holding standard base plate of future mast on spare piers.

18.17 In case of wiring a petroleum siding special precaution shall be adopted as laid down

19.0 Cantilever Arrangement

19.1 Overhead equipment is supported from the masts by cantilever bracket assembly made of galvanized steel tubes. The bracket assembly shall be of the swiveling type.

19.2 Cantilever arrangement

The arrangement of cantilever depends upon the height of contact wire, encumbrance, suspension distance, stagger and super elevations. Standard cantilever arrangements are given in Drg. No. ETI/OHE/G/02106, Sheet 1 & 3.

19.2.1 Platform location

The arrangement of cantilever on platform shall be as per Drg. No. ETI/.OHE/G/-2104, Sheet 2.

19.3 Allowance for adjustment

The bracket assembly shall be such as to permit easy adjustment of the whole equipment after erection to cater for displacement of track during maintenance to the extent of 100 mm on either side of the track centre.

19.3.1 Adjustment on bracket tube

It shall be ensured at the time of selection of bracket assembly that the free length of the bracket tube beyond the catenary suspension bracket fittings is atleast 150 mm to facilitate future adjustment.

19.3.2 Adjustment on stay tube

The selection of stay tube at any location shall be such that its adjuster is free for adjustment of minimum 90 mm in either direction.

19.3.3 In case of curve track when the rail level is raised or the super elevation is changed due to strengthening of track structure, the pantograph axis will be shifted. If this shift is not within the possible adjustment limit of bracket assembly as specified in Clause 19.3.1 and 19.3.2 above, new cantilever may have to be provided taking care that at no stage the contact wire is beyond the specified stagger.

19.4 Size of tubes

The size of stay tube and register arm tube is 28.4/33/7 mm dia. for all cantilever arrangements. The size of bracket tube is either 30/38 mm or 40/49 mm designated as standard or large respectively depending upon the location (See Drg. No. ETI/OHE/G/00158 sheet 1,2 and 3 and 00159 sheet 1,2 & 3).

19.5 Back to back arrangement

More than one cantilevers (on the same side) are provided on the masts for overlap, turnouts, cross over and diamond crossings. The cantilever may be symmetrical (50 cm on either side of the mast) or asymmetrical (65 cm on one side and 35 cm on the other side of the mast).

Note:
- i. Adoption of more than three bracket assembly is not possible on a single cross arm.
- ii. Cantilever assemblies can be provided on both sides of the masts, if the OHE of the two tracks are of the same elementary section. This is called 'Umbrella' construction.

19.6 Bracket assembly on drop-arm

On portals, bracket assembly for the intermediate track/s is erected on drop arms. Wherever the track centre is inadequate (i.e. suspension distance less than 1.60 m), the equipment should be supported on drop arm of reduced length so that the bracket assembly does not infringe with the swept zone of pantographs. The arrangement is shown in Drg. No. ETI/OHE/G/02108.

19.7 Bridge & Tunnels

Bracket assembly of special design may be adopted on bridges and tunnels after making clearance study.

19.8 Bracket chair

Bracket assembly can be designed up to suspension distance of 3.5 m only. If the suspension distance is more, bracket chair to drawing No. ETI/OHE/P/3050 and RE/33/P/3100 shall be used.

19.9 Insulator for Bracket Assembly

In polluted areas e.g. tunnels, areas near sea coast, neighborhood of chemical/ fertilizer/cement plants, near steam loco sheds, ash pits, water columns etc. long creepage path (1050 mm /1600 mm) insulators should be used on the cantilever assemblies.

(Railway Board letter No. 2002/EEM/161/21/Vol-II dated 30.9.20)

20.0 Setting of Masts

20.1 Tangent Track

The standard setting i.e. the normal distance of the nearest part of the traction mast from the centre line of tangent track shall be 2.50 m for the broad gauge and 2.35 m for the metre gauge. The setting may be reduced to a minimum of 2.36 m for the broad gauge and 2.14 for the metre gauge only in special circumstances such as yards, cuttings and bridges etc. with the approval of the Chief Electrical Engineer of railway concerned. In case of portal uprights, masts carrying more than one OHE and head span masts, the setting should not normally be less than 3.00 m which may be relaxed to 2.80 m, with the personal approval of PCEE (open line) who may prescribe by special precaution as may be consider necessary.

20.2 Curved track

The minimum setting distance of masts including portals, head span masts etc. on curves is obtained by adding the curve allowance and 150 mm slewing allowance to the setting distance specified for tangent track in para 20.1. For trunk routes and main lines where the speed may be increased in near future, curve allowance should be taken as per table-III. For other routes, branch lines and yards where there is no prospect of increase in above 105 km/h in near future, the curve allowance should be taken as per table-I for Broad gauge and Table-II for metre gauge. Normally, the standard setting distance on broad gauge main lines on curves should not be less than the values given below:

	Standard setting (m)
a. On outside curves	
i. Radius of curvature greater than or equal to 875m.	2.50
ii. Radius of curvature less than 875m.	2.65
b. On side Curves	
i. Radius of curvature greater than or equal to 3500m.	2.90
ii. Radius of curvature greater than or equal to 2350m. but less than 3500m.	3.05
iii. Radius of curvature greater than or equal to 1150m but less than 1150m.	3.25
iv. Radius of curvature greater than or equal to 300m. but less than 1150m.	3.30

Table-I Curve Allowance for maximum speed upto 105km/h Broad Gauge

Degree of curvature	Radius of curvature (meter)	Max. permissible speed (Km/h)	Super elevation (mm)	Extra clearance between adjacent track (mm)	
				Inside curve	Outside curve
1°	1747	105	50	130	-
1 ½°	1164	105	75	220	-
2°	875	105	100	310	10
3°	583	96	120	390	30
4°	438	80	125	420	40
5°	350	72	120	420	60
6°	292	65	105	390	80
7°	250	56	125	470	90
8°	219	48	140	540	110
9°	194	48	140	550	130
10°	175	40	120	500	140

Note: See Drg. No. ETI/OHE/G/00111 Sheet 1, also for this reference.

TABLE-II Curve allowance for Metre Gauge

Degree of curvature	Radius of curvature (meter)	Max. permissible speed (Km/h)	Super elevation (mm)	Extra clearance between adjacent track (mm)	
				Inside curve	Outside curve
1°	1747	72	15	50	-
2°	875	72	30	120	-
3°	583	72	45	200	20
4°	438	72	55	250	30
5°	350	72	70	320	40
6°	292	65	65	320	60
7°	250	56	75	370	70
8°	219	48	85	420	80
9°	194	48	90	460	100
10°	175	40	75	410	110
11°	159	40	80	440	120
12°	146	32	55	360	140
13°	134	32	60	390	150
14°	125	32	65	420	160
15°	116	25	40	340	180
16°	109	25	40	350	190

Note: See Drg. No. ETI/OHE/G/00111 Sheet 2, also for this reference.

Table-III Curve allowance for maximum speed 200 km/h – Broad Gauge

Degree of curvature	Radius of curvature (metre)	Max. per- missible speed (Km/h)	Super elevation (mm)	Extra clearance between adjacent track (mm)	
				Inside curve	Outside curve
1°	3492	200 (160)	71 (40)	191 (89)	-
3/4°	2328	200 (160)	133 (60)	400 (159)	-
1°	1747	190 (160)	185 (100)	575 (295)	-
1 ½°	1164	155	185	585	-
2°	875	135	185	590	10
3°	583	110	185	605	30
4°	438	95	185	620	40
5°	350	85	185	640	60
6°	292	80	185	655	80

Note: i. Figures in bracket indicates super elevation and curve allowance for 160 Km/h speed.

ii. See Drg. No. ETI/OHE/G/00111 Sheet 1, for other reference.

- Reproduced from Railway Board's letter No. 68/WDO/SC/1 dated 15.4.1968.

20.2.1 In yards, where there is no super-elevation of track on curves, the extra clearance indicated may be reduced suitably in locating masts between tracks.

20.3 Masts with counter weights

In the case of masts with counterweights, the term "Setting" refers to the minimum distance of the counter-weight from the track centre in the worst condition. For this purpose, the displacement of the counter-weight due to wind transverse to the track may be taken +/- 50 mm.

20.4 Platform masts

The setting of masts on platforms shall not be less than 4.75 m on the broad gauge and 4.0 m on the metre gauge. As far as possible, masts shall be located In line with other masts or obstructions on platform and shall be of minimum possible dimensions and fit in with the architectural pattern prevailing in the vicinity. Locations of masts opposite to public entrances, exits, staircases, gang ways shall be avoided. No live conductor should be run over platforms.

20.5 Masts near signals

The visibility of signals should be kept in mind while deciding the setting up masts in their vicinity. The following principles should be observed for deciding the setting of masts near signals.

20.5.1 Colour light signals located outside all tracks.

1. Colour light signals without route indicators.
   i. Where no approach signal is provided

      The minimum setting of mast before signal should be 3.55, 3.40 ,3.35 , 3.20, 3.05 m for distance upto 80 m, beyond and upto 110 m ,beyond and upto 190 m, beyond and upto 270 m and beyond and upto 400 m respectively.

   ii. Where approach signal is provided and for signals other than distant signals.

      The minimum setting of masts before the signal should be 3.55 ,3.40 ,3.35 , 3.20, 3.05 m for distance upto 50 m. beyond and upto 70 m beyond and upto 115 m, beyond and upto 160 m and beyond and upto 240 m respectively.

2. Colour light signal with route indicators.
   i. With horizontal route indicator

      The minimum setting of masts before the signal should be4.02, 3.80, 3.55, 3.35, 3.20, 3.05 m for distances upto 60 m, beyond and upto 125 m beyond and upto 170 m, beyond and upto 215 m, beyond and upto 250 m, beyond and upto 310 m, respectively.

   ii. With other than horizontal route indicator

      The minimum setting of masts before the signal be ,3.80 ,3.55 ,3.35 , 3.20, 3.05 m for distances upto 70 m, beyond and upto 130 m, beyond and upto 170m, beyond and upto 215 m, and beyond and upto 280 m respectively.

Note : 1 See Drg. No. ETI/OHE/G/00112 REV1 also. The setting may be reduced in special cases, conforming to Figs. 6 to 9. Setting distance may be reduced for starter signals of loop lines and yard lines

(Increased in view of change in OHE mast Implantation from 2.5m to 2.8m)

20.5.2 Colour light signals located between tracks:

1. Signals without route indicators:

No OHE mast should, as far as possible be located in the same lane as the signal for a distance of at least 600 m before a signal. Drop arms of portals should also not normally be located in the lane where signals are located, at least for a distance of 600 m before the signal.

Where this is not possible, for any reason, the signal should be mounted on an off-set bracket, In addition, a special study should be made in each such case in respect of three drop arms before the signal, to see whether the drop arms can be off-set from the centre line of the lane in a direction opposite to the off-set of the signal or alternatively, whether it is possible to shorten the drop arms. Reduction in the signals height may also be examined.

2. Signals with route indicators:

   The principles mentioned under para 20.5 (a) should be observed in these cases also.

Note: 1. No part of a colour light signal without a route indicator should, as far as possible, be higher than 5.2 m above all level. Great care should be exercised in deciding the locations of colour light signals with route indicators so that the necessary minimum clearances are available between the signals and live out of run conductors, or pantograph sway zone.

2. On single-line sections, signals (colour light as well as semaphore) should, as far as possible, be located on the side of the track opposite to the OHE masts.

20.5.3 For semaphore signals located outside the track:

The minimum setting of masts before the signal should be 3.35, 3.20, 3.05 m for the first second and next three masts respectively.

Note : For details, See Drg. No. ETI/OHE/G/00112REV-1

(Increased in view of change in OHE mast Implantation from 2.5m to 2.8m)

20.6 Masts on bridge piers

The setting of masts on piers of bridges will be as large as possible and indicated by the Railway.

20.7 Turnouts

The setting of masts located near theoretical centres of turnouts and diamond crossings should be 3.0 m from the nearest track for the broad gauge and 2.75 m for the metre gauge (Ref. Fig. A1.09)

20.8 Portals

Wherever portals are proposed to be used, they shall be selected with standard clear spans (distance between face of the uprights) indicated in the tables IV and V. For this purpose the clear span for any location obtained by adding the proposed setting of the two columns to the centre-to-centre distances of the tracks spanned by the portal shall be rounded off to the next higher standard span indicated in the tables. The setting of the uprights of the portal shall then be adjusted to suit the standard span selected with a minimum setting distance as specified in para 20.2.

20.9 Minimum horizontal distance from centre line of track to face of foundation of OHE Mast/Portal

For facilitating working of track machines, following dimensions may also be ensured in the new electrification works either connected with new lines/work of laying multiple lines/RE/ Gauge conversion:

Minimum horizontal distance from centre line of track to face of foundation of OHE Mast/Portal:

1. Below the rail level upto the formation level of the track on straight line and curves upto radius of 875 m – 2575 mm
2. Below the rail level upto the formation level of the track on curves with radious less than 875 m- 2725 mm

Table- IV Standard Clear Spans for 'N' type portals (Spans in metres)

Nominal range: 10.0 m to 20.0 m

9.91	9.96	10.01	10.06	10.11				
10.41	10.46	10.51	10.56	10.61				
10.91	10.96	11.01	11.06	11.11				
11.41	11.46	11.51	11.56	11.61	11.66	11.71	11.76	11.81
11.91	11.96	12.01	12.06	12.11	12.16	12.21	12.26	12.31
12.41	12.46	12.51	12.56	12.61	12.66	12.71	12.76	12.81
12.91	12.96	13.01	13.06	13.11	13.16	13.21	13.26	13.31

13.41	13.46	13.51	13.56	13.61	13.66	13.71	13.76	13.81
13.91	13.96	14.01	14.06	14.11	14.16	14.21	14.26	14.31
14.41	14.46	14.51	14.56	14.61	14.66	14.71	14.76	14.81
14.91	14.96	15.01	15.06	15.11	15.16	15.21	15.26	15.31
15.41	15.46	15.51	15.56	15.61	15.66	15.71	15.76	15.81
15.91	15.96	16.01	16.06	16.11	16.16	16.21	16.26	16.31
16.41	16.46	16.51	16.56	16.61	16.66	16.71	16.76	16.81
16.91	16.96	17.01	17.06	17.11	17.16	17.21	17.26	17.31
17.41	17.46	17.51	17.56	17.61	17.66	17.71	17.76	17.81
17.91	17.96	18.01	18.06	18.11	18.16	18.21	18.26	18.31
18.41	18.46	18.51	18.56	18.61	18.66	18.71	18.76	18.81
18.91	18.96	19.01	19.06	19.11	19.16	19.21	19.26	19.31
19.41	19.46	19.51	19.56	19.61	19.66	19.71	19.76	19.81
19.91	19.96	20.01	20.06	20.11	20.16	20.21	20.26	20.31

TABLE - V Standard Clear Span for 'O' and 'G' type Portal

Nominal range: 20.0 m to 30.0 m

20.05	20.1	20.15	20.2	20.25				
20.55	20.6	20.65	20.7	20.75				
21.05	21.1	21.15	21.2	21.25				
21.55	21.6	21.65	21.7	21.75	21.8	21.85	21.9	21.95
22.05	22.1	22.15	22.2	22.25	22.3	22.35	22.4	22.45
22.55	22.6	22.65	22.7	22.75	22.8	22.85	22.9	22.95
23.05	23.1	23.15	23.2	23.25	23.3	23.35	23.4	23.45
23.55	23.6	23.65	23.7	23.75	23.8	23.85	23.9	23.95
24.05	24.1	24.15	24.2	24.25	24.3	24.35	24.4	24.45
24.55	24.6	24.65	24.7	24.75	24.8	24.85	24.9	24.95
25.05	25.1	25.15	25.2	25.25	25.3	25.35	25.4	25.45
25.55	25.6	25.65	25.7	25.75	25.8	25.85	25.9	25.95
26.05	26.1	26.15	26.2	26.25	26.3	26.35	26.4	26.45
26.55	26.6	26.65	26.7	26.75	26.8	26.85	26.9	26.95
27.05	27.1	27.15	27.2	27.25	27.3	27.35	27.4	27.45
27.55	27.6	27.65	27.7	27.75	27.8	27.85	27.9	27.95
28.05	28.1	28.15	28.2	28.25	28.3	28.35	28.4	28.45
28.55	28.6	28.65	28.7	28.75	28.8	28.85	28.9	28.95
29.05	29.1	29.15	29.2	29.25	29.3	29.35	29.4	29.45
29.55	29.6	29.65	29.7	29.75	29.8	29.85	29.9	29.95
30.05	30.1	30.15	30.2	30.25	30.3	30.35	30.4	30.45

21.0 Over-line Structure

21.1 Clearance

The requisite minimum electrical clearances (See para 3) should be maintained under over-line structures such as over-bridges , signal gantries, platform sheds and tunnels. The location of structures and spans under these structures is, therefore, determined to suit the clearances. A clearance study shall be made for all existing over line structures. Efforts should be made to provide as large clearance as possible.

21.2 Where adequate clearance is available, the catenary should be erected so as to have maximum clearance from the over-line structure to reduce the possibility of birds perching on the catenary wire and coming in contact with earthed parts.

21.3 The catenary is normally passed freely under over-line structures. Where this is not possible on account of restricted clearances, the following alternatives may be adopted.

1. The catenary may be suspended from the two-faces of the over-line structures.
2. Suspension from over-line structure

The catenary may be suspended from the over-line structure at an intermediate point.

3. The catenary may be anchored on to the over-line structure on either side or on to special anchor structures. The anchor point should normally be the anticreep.
4. Special designs may be adopted inside covered station areas and on through girder bridges, employing even regulated tramway type equipment (contact wire only), where it is feasible.

Note: At over-line structures, the span should preferably be centrally located as far possible and generally should not exceed 54.0 m.

21.4 Polluted zone

Double insulation or insulator for polluted zones shall be used in the following cases:

1. In tunnels (see para 19.9)
2. For insulators located on the axis of the track in areas where steam traction would be in extensive use or where smoke is likely to accumulate.

22.0 25 kV Feeders

22.1 Suspension

Where a 25 kV feeder is run longitudinally on traction masts, it shall be carried on the masts as shown in Drg. No. ETI/OHE/G/05143. The feeder may be run on either side of a mast. Two 25 kV feeders, or one return conductor and one 25 kV feeder, may be carried on a single mast, if necessary, with one feeder on each side of the mast.

Note: If the 25 kV feeder and OHE are of different elementary sections, 'Restricted clearance' board shall be provided.

22.2 Clearances from over head equipment

Where a 25 kV feeder crosses overhead equipment belonging to a different elementary electrical section, the clearance between the feeder and the overhead equipment shall not be less than two meters under any conditions.

22.3 Clearance from line side structures

Normally, no feeder should be erected over huts, cabins, goomties, platforms shed or other covered structures. If unavoidable the clearance between the highest point of a covered structure and a 25 kV feeder passing over it shall be 2 m under all conditions. In the case of a 25 kV feeder passing over an over-line structures which is not covered, a suitable metallic screen shall be provided on the structure underneath the feeder. The clearance between the feeder and the highest point of the screen shall be adequate. A clearance of 2 m is desirable between the 25 kV feeder and any part of an earthed structure for facilitating maintenance work on the structure.

23.0 Cross-Spans at Switching Stations

23.1 Cross span arrangement

All the switching stations have gantry with two or more main vertical supports. Cross span wires/ feeders are provided on the gantry to connect the various sections of overhead equipment by jumper connections. The general arrangement is shown in Drg. No. ETI/OHE/G/05124

23.2 Setting distance

The minimum setting distance of the gantry upright which is normally aligned parallel to the track shall be 4.30 m.

23.3 Multiple track

The general arrangement of connections at the switching stations on double track and multiple track section are shown in Drg. No. ETI/OHE/G/05125 and 05126 respectively.

24.0 Tramway type overhead equipment

24.1 Regulated Equipment

In tramway type equipment only contact wire is provided and is auto-tensioned at the anchor by weight. The contact wire is supported by swiveling type of brackets on individual masts as indicated in Drg. No. ETI/OHE/G/04204. Generally the principles applicable to normal overhead equipment are also applicable to regulated tramway equipment except as specified below:

24.1.1 Usage

The regulated tramway type equipment is to be adopted for loop lines, sidings, yards and spur lines excluding the main running line and first loop or lines taking-off from the main running line.

24.1.2 Span

The maximum span is restricted to 63 m. The general arrangement is shown in Drg. No. ETI/ OHE/G/04203.

24.1.3 Section Insulators

Where a section insulator assembly is to be provided, the provision of a structure to support the assembly is obligatory. The arrangement is shown in Drg. No. ETI/OHE/G/04207 sheet 1 & 2.

24.1.4 The arrangement of tramway equipment at anti creep and points and crossings are shown in Drg. No. ETI/OHE/G/04205 and 04208 respectively.

24.2 Unregulated equipment

The general arrangement of tramway equipment to be adopted for head span and cantilever type construction is shown in Drg. No. ETI/OHE/G/04101. The principles applicable to normal OHE are applicable to this type of unregulated equipment except as specified below.

24.2.1 The maximum span is restricted to 30m. In station areas, where this type runs side by side with conventional equipment with contact and catenary wires, the maximum span may be increased to 31.5 m.

24.2.2 Where a section insulator is to be provided the provision of a structure becomes obligatory.

25.0 Booster Transformers

25.1 100 kVA Booster Transformer wherever necessary for suppression of inductive interference of P&T communication lines running in close vicinity and parallel to 25 kV OHE may be provided separately for each running tracks. The primary winding of the booster transformer is connected in series with the OHE at insulated overlaps. The arrangement of mounting and connection is shown in RDSO Drg No. ETI/PSI/115

25.2 The Booster transformers are located at an approximate spacing of 2.66 km between each other.

25.3 The location of the booster transformer should be decided considering the following aspects:

1. At feeding posts and sectioning and paralleling posts the booster transformers should be located equi-distant on either side so that the mid-point falls in front of these switching stations
2. In exceptional circumstances where the booster transformers are not placed equi-distant from the feeding post or sectioning post, it must be ensured that the distance of the booster transformer from FP or SP does not exceed 1.33 km
3. The booster transformer should not be located:
   a. in the vicinity of the stop signals to avoid bridging of insulated overlap by locomotives pantograph
   b. within the station limits except for very big stations

26.0 Return Conductors

26.1 Route

In deciding the route of return conductors the obstructions en-route should be taken into consideration. Besides adequate physical and electrical clearances should be maintained from fixed structures.

The general objectives is to run the return conductor as close as possible to the associated overhead equipment so as to secure maximum compensation. Subsidiary lines such as sidings, loops etc. are not provided with return conductors

The return conductor will be normally run on the traction masts on the same side as the overhead equipment The arrangement is shown in Drg. No. ETIVOHE/G/05307. The clearance between the return conductor and the overhead equipment should not be less than 400 mm under the worst conditions

26.2 Clearance

The static and dynamic clearance to any part of the return conductor from an earthed structure should be 150 mm and 80 mm respectively.

26.3 Return conductors at over-bridges

At over-bridges return conductors may be run straight through, if possible, as on normal structures

26.4 Return conductors in complicated areas

In station areas having complicated track layout, it may not be practicable to position the return conductor sufficiently close to the associated overhead equipment to secure the required compensation.

In such cases, the route of the return conductor should be decided on the merits of each case. Care being taken to avoid running of return conductor over platforms.

26.5 Tension lengths of return conductors

Return conductors are normally terminated at the masts where the return conductors are connected to the rail. They may be anchored back-to-back at such masts

26.6 Connections to booster transformers

At all booster stations, the return conductors for each track should be provided with a cut-in-insulator. The return conductor is connected in series with the secondary winding of the booster transfomer and the connections of the return conductor to the booster transformer should be carried out in accordance with Drg. No. ETI/OHE/ G/05413.

26.7 1. The mid-point of return conductor shall be connected to the buried rail as per RDSO's Drg. No. ETI OHE/G/05306 and ETI/PSI/611. The mid-point is defined as a mid-point between two consecutive booster transformers

2. Mid-point of the return conductor before feeding posts shall be connected to the buried rail on either side of the insulated overlap and in case of sectioning posts shall be connected on either side of the neutral section.
3. In exceptional circumstances, where mid-point does not fall in front of feeding posts and sectioning posts, the two rail links between return conductor and rail should be provided in front of feeding post and sectioning post on either side of the insulated overlap/neutral section. In these cases, mid-point should not be connected to rail

27.0 LT Supply Transformer

27.1 Low tension power supply

230 V single phase power supply required for operation of sub-station equipment e.g. circuit breakers, interruptors, etc. lighting of the station yard, tunnels and working of colour light signals, is obtained through 25 kV 230 V , 10 kVA 50Hz. single phase LT supply transformer. It is provided at substations feeding and switching posts, stations, block-huts and at other outdoor locations e.g. level crossings with gate signals.

27.2 Capacity

LT supply transformers are of 5/10/25/50 kVA capacity. More than one transformer are provided at large station, yard etc.

27.3 Protection

1. LT supply transformers are protected only by a 25 kV, Amp. Dropout fuse on the primary side and 63 A fuse (rewireable d.c. type with 20 SWG tinned copper wire (vary according to AT capacity)) on the secondary side
2. Arching Horn Arrangement as per RDSO Drg No TISK/PSI/ARCHON/00001/08/0 is to be provided across 9-tonne insulator on incoming side of auxiliary transformer with horn gap maintained at 165 mm.

27.4 Mounting Arrangement

The LT supply transformer is mounted on steel platform erected on the OHE mast and connected to the 25 kV OHE through 50 mm2 copper jumper wire. The general arrangement of mounting and connection is shown in Drg. No. ETI/PSI/036

27.5 Substation L T supply.

At substation, in order to provide power to single phase transformer oil centrifuging /filtration plant, 100 KVA, 25 KV/230V 50 Hz. single phase transformers are provided. The general arrangement of mounting and connection is shown in Drg. No. ETI/PSI/0312.

28.0 Mast and Rail Bonds

28.1 Structure Bonds

All traction masts shall be bonded to a non-track-circuited rail as shown in Drg. No. ETI/OHE/P/7000 (see para 27.1). In the case of portals, both uprights of the portals, and in the case of head spans, both masts of the head spans, shall be bonded to non-track-circuited rails.

28.2 Rail Bonds

The Rail bonds to connect the running rails longitudinally across a rail joint shall be in accordance with Drg. No. ETI/OHE/P/7030.

28.3 The cross bonds connecting two rails of track of rails of track or rails of adjacent track shall be in accordance with Drg No. ETI/OHE/G/05251

29.0 Earth Wires

29.1 Sectioning and earthing

In sections where a non-track circuited rail is not available, as in double-rail track-circuited sections, all traction masts shall be connected together by a continuous aerial earth wire supported by the traction masts. The earth wire shall be divided into electrical sections not exceeding 1000 m in length by means of cut-in-insulators. Each section of earth wire shall be bonded to traction mast which should be connected to an earthing station (Drg. No. ETI/OHE/P/7020). With two separate earth electrodes in such a way that the interval between the earthed structures does not normally exceed 500 m as shown in Drg. No. ETI/OHE/G/05201.

29.2 In Tunnels

In case of tunnels, all the traction support structures shall be connected together by a continuous earth wire, which may be supported from tunnel surface. The earth wire shall be made into discontinuous sections not exceeding 1000 m and shall be connected to earth electrodes provided not more than 500 m apart and traction rail at both ends of the tunnel.

29.3 Layout

No earth wire shall cross any track. Where masts required to be connected to an earth wire are located on opposite sides of a track, separate wire-runs shall be used for connecting the masts. In complicated areas, masts may be connected to individual earthing stations.

29.4 Anchoring

Earth wires need be anchored only at termination of wire-runs.

30.0 Sectioning Arrangement

30.1 Necessity of sectioning

OHE is divided into electrically isolated sections by provision of interruptors or isolators at overlaps and with section-insulators at turnouts and with PTFE type short neutral section at TSS/SP. Sectioning is provided to permit isolation of OHE in small sections for maintenance or to isolate damaged OHE in case of breakdown/accident and to permit diversion of trains from up line to down line and vice-versa. However, the sectioning should be kept to the minimum consistent with operational requirement.

30.2 Protection of isolated sections'

Protection by signal of the isolated sections:

Normally a stop signal is provided before the insulated overlap, i.e. isolator so that approaching train is stopped from entering the isolated section. Although the distance between the stop signal and the sectioning points has not been specified in the rules, it is desirable to provide 120 m between the stop signal and the centre line of the insulated overlap/section insulators, i.e., the sectioning point.

30.3 Sectioning arrangements for different types of stations: Double line section

30.3.1 Stations having no emergency cross-over:

The isolation is provided to take a block. The trains are stopped by the stop signal. The sectioning point should be provided 120m away from the starting signal. This arrangement enables the trains to be received at the station. Fig.A1, 11 shows the layout.

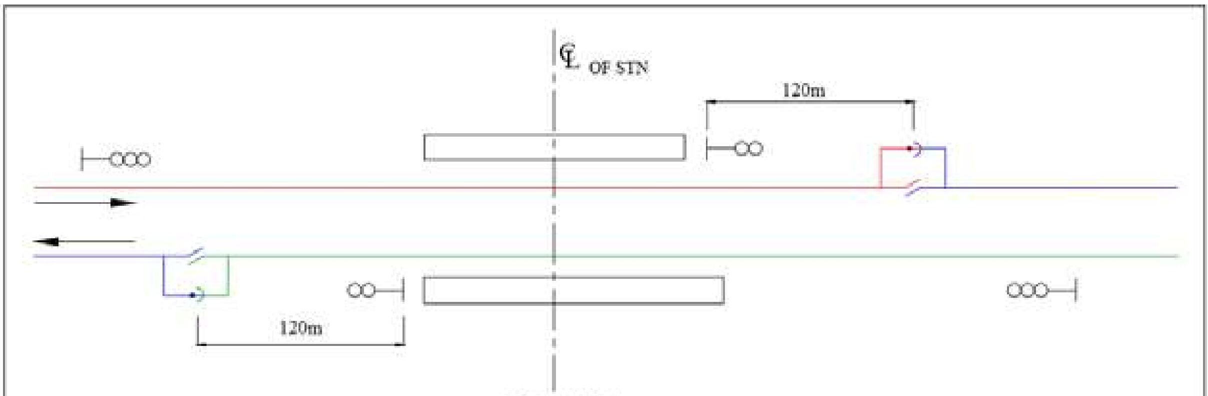


FIG. A 1.11

30.3.2 The first loop line adjacent to the main is normally provided in the same elementary section as that of the main line. No sectioning is, therefore, required between the main line and the loop line. Only where there are group lines comprising of 2 loops or more, sectioning should be provided to include the loop lines in an independent elementary section. In case of large number of loop lines, the chances of damage to the OHE being more, they should be isolated to keep the main line operative. The arrangement is shown in Fig.A1.12.

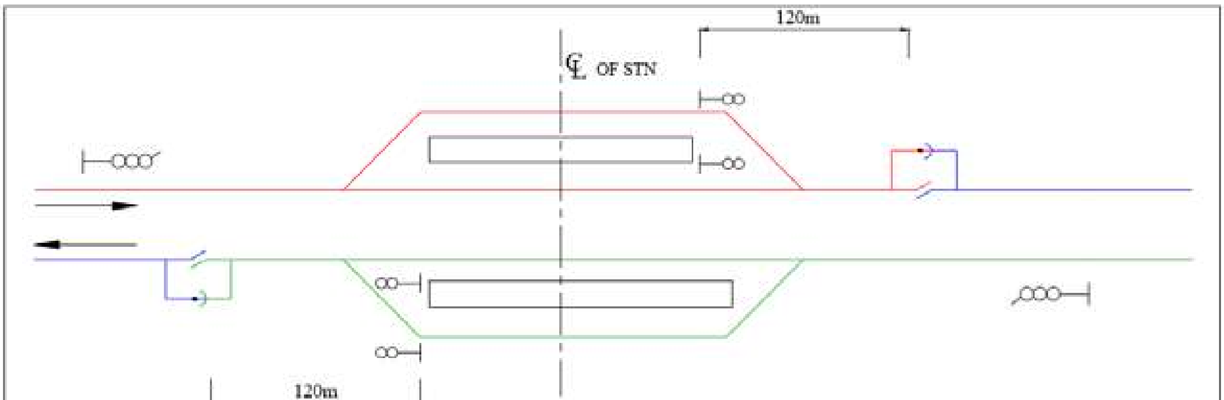


FIG. A 1.12

30.3.3 Stations provided with emergency cross-overs:

At the stations provided with emergency cross-overs, the diversion of trains from up-track to down-track and vice versa and also the diversion of trains coming on the wrong track to the correct track is possible. Isolation at such stations should be provided in accordance with Fig.A1.13 so that the longest train can be pulled beyond the crossover before backing. It is advisable to keep the advance starter sufficiently away from the cross-over so that the longest train length can be accommodated between the cross-over and the advance starter. Otherwise, provision should be made in the station working rules for shunting of the trains beyond advance starter.

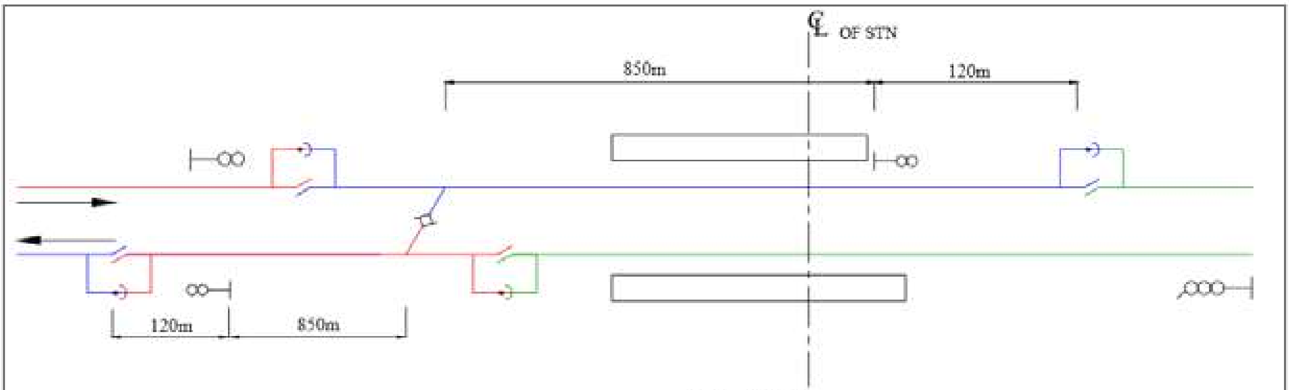


FIG. A 1.13

30.3.4 Stations provided with emergency cross-over and loop lines:

At stations having loop lines the isolation arrangement as shown in Fig: A1.14 & A1.15 should be adopted. Where space is available, the insulated over-tap and the isolator should be provided between the points, A & B as shown in Fig: A 1.14. Otherwise, the insulated overlap should be provided before the point and a section insulator provided in the loop line as shown in Fig:A1.15.

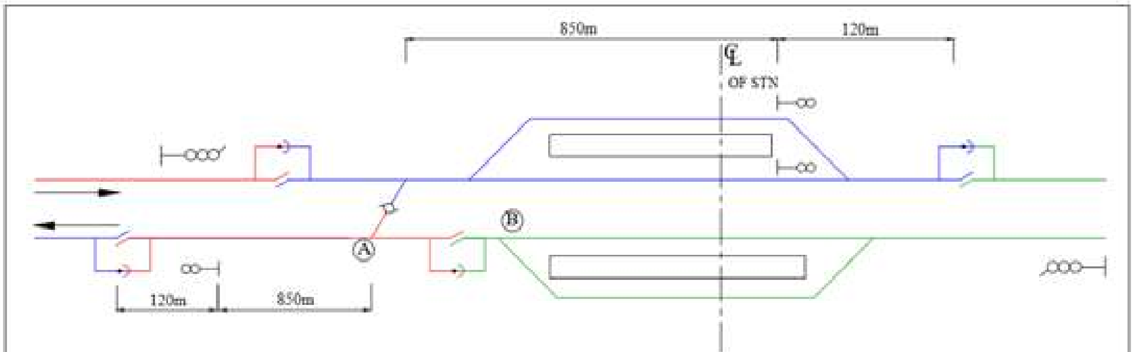


FIG. A 1.14

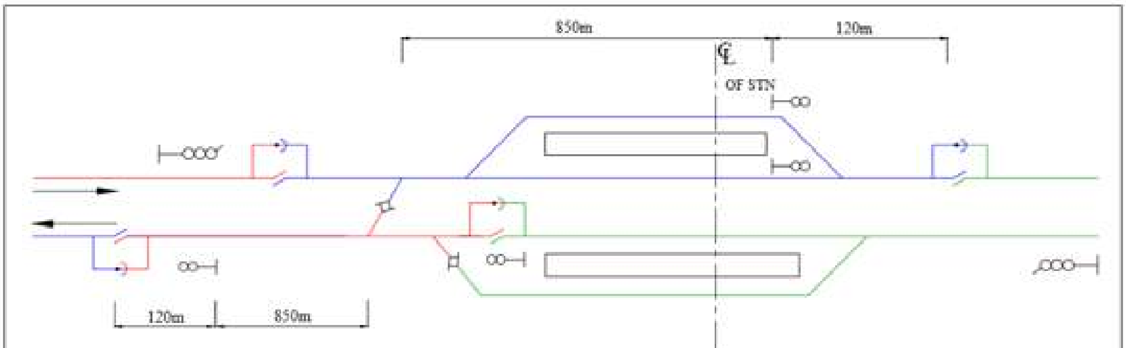


FIG. A 1.15

30.3.5 Sections having one or more common loops situated on one side of the track:

Generally the common loop is situated on one side of the main track. Such common loop can be electrically connected only to the adjoining main line. Stations with such a common loop also have a facing cross-over which can be beneficially used for diversion of trains from one line to the other without reversing. The sectioning should permit diversion of trains from one line to the other in both the directions. The sectioning given in Fig: A1.16 would meet these requirements.

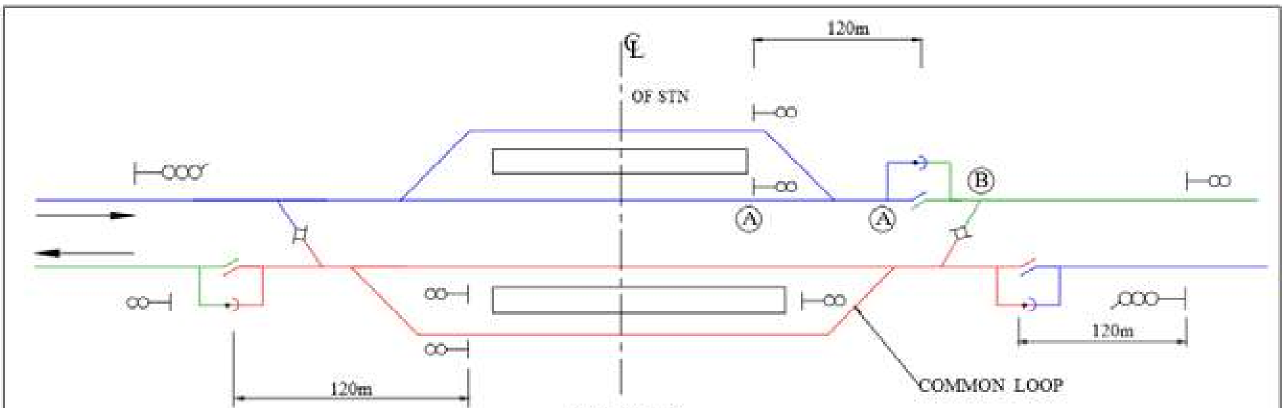


FIG. A 1.16

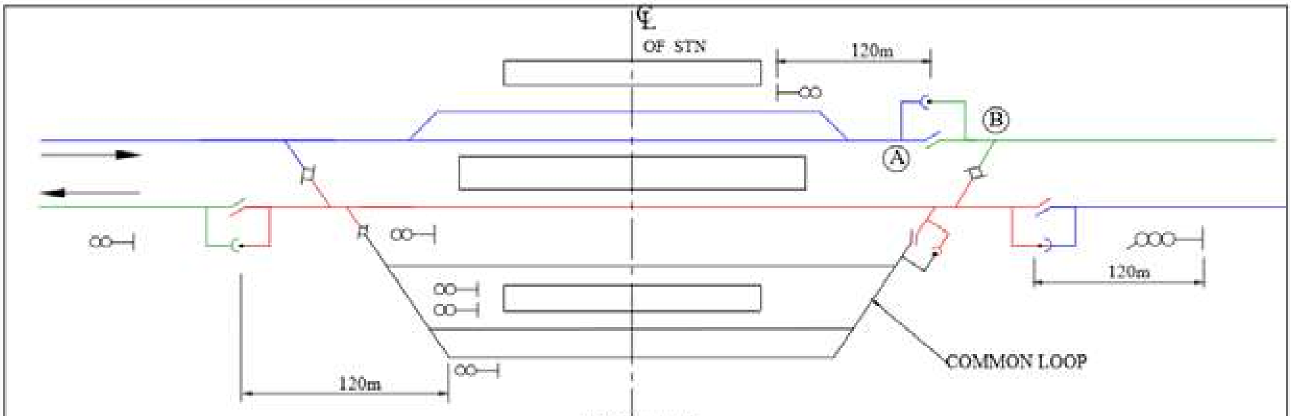


FIG. A 1.17

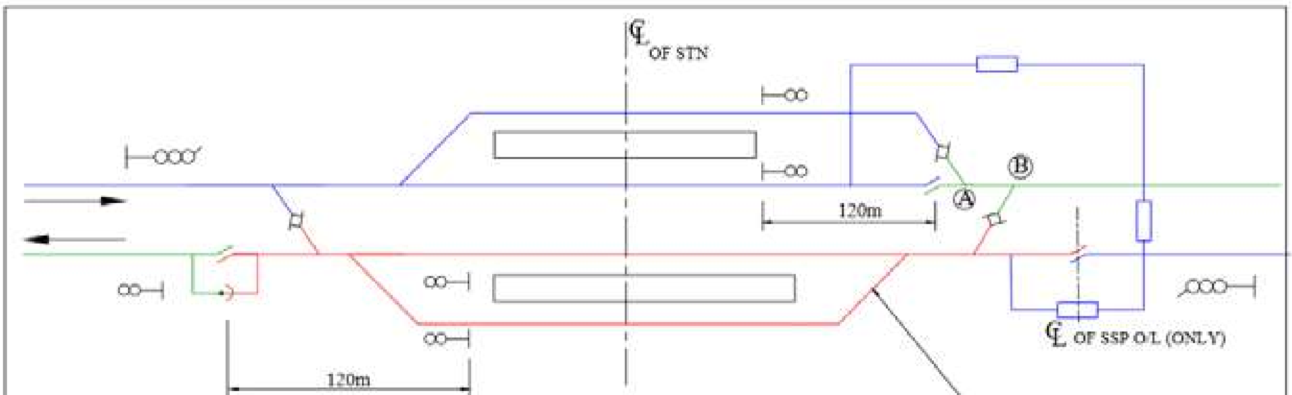


FIG. A 1.18

Note:Where space is available the insulated overlap and isolator should preferably be provided between (A) &(B).

Note : For layouts having a group of (common) loops on one side, sectioning arrangement shown in Fig. A1.17 should be followed.

Where an SSP is located the sectioning arrangement as shown in Fig. A1.18 could be adopted. However, this arrangement cannot be adopted at feeding posts because in that case the cross-over would be connected to two different sectors and in case of extension of feed, the section-insulator would be connected to two different phases and subjected to 44 kV. Passage of electric locos in such condition would result in bridging of 2 phases which may damage the section insulator assembly.

30.3.6 Common loop situated in between the two main lines:

At some stations, the common loop is provided in between the two main lines. Such stations provided ideal arrangements for sectioning, as the common loop can be connected to either up or down main lines through a set of inter-locked isolators. The sectioning arrangement is indicated in Fig:A1. 19.

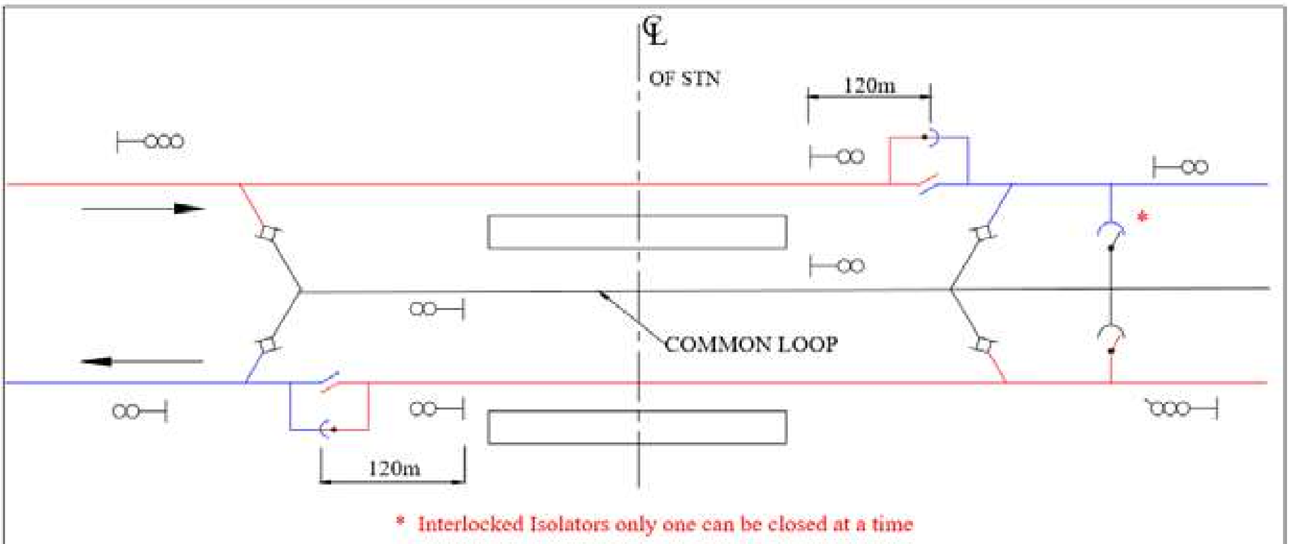


FIG. A 1.19

30.3.7 Sectioning for the loco sheds and major yards:

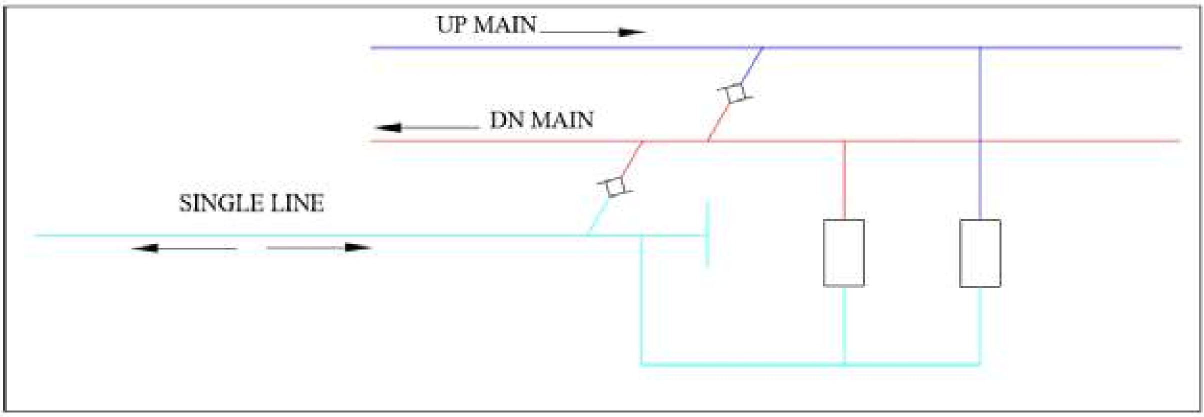
30.3.7.1 Loco sheds and major yards are prone to frequent flash-over of insulators due to pollution caused by steam/diesel shunting locomotives and also due to switching surges from the loco transformer and sparking of rod-gap which result in tripping of feeder breaker affecting power supply to the main line. It is, therefore, advisable to provide a separate feeder with a circuit breaker and required protection for all major yards and electric loco sheds. If the yard/shed is within 4 km from the traction sub-station, a separate feeder can be economically run. If the yard/shed is beyond 4 km the power supply may be given by an interrupter located in the SSP with provision to supply from either UP or DOWN line. In case the circuit breaker or interrupter is out of service for maintenance, alternative arrangement is made to tap the OHE, directly through an inter-locked isolator. These arrangements are shown in drawing No. ETI/PSI/704.

30.3.7.2 Major yards are normally separated in Up and Down yards. Each yard is again sub-divided as Reception yard, Despatch yard, Sorting yard, Marshalling yard etc. These yards, if electrified, should be electrically independent of each other. Each yard, if it consists of more than four lines, shall be divided into two or more elementary sections consisting of group of 3 to 4 lines each. Each elementary section should be fed by an isolator from a bus connected to the yard interrupter in such a way that interruption to any elementary section should cause minimum upset to the yard working.

30.3.8 Sectioning arrangement for different type of stations – single line section

If it is a single line taking off from a main running lines, the following procedure may be adopted in consistent with operation requirement.

Take off from main line: The power supply from single line section at the take off point (from main running line) must be made with duplicate source. This would provide power supply all along as shown below



If at take-off point any switching station exists, the power supply in such cases may be ensured by provided an interrupter at switching station for the single section.

Station with single/ double loop lines: The loop lines/ lines is/are to be isolated by providing an insulated overlap on the main line and a section insulator assembly on the loop line keeping the provisions mentioned earlier for protection of the isolated section by a stop signal. The arrangements are shown in the following two Fig. 1 & 2.

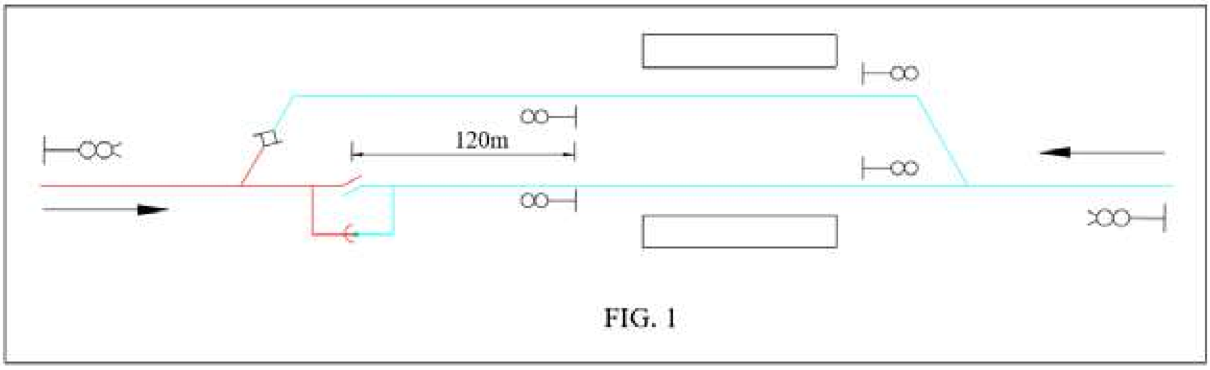


FIG. 1

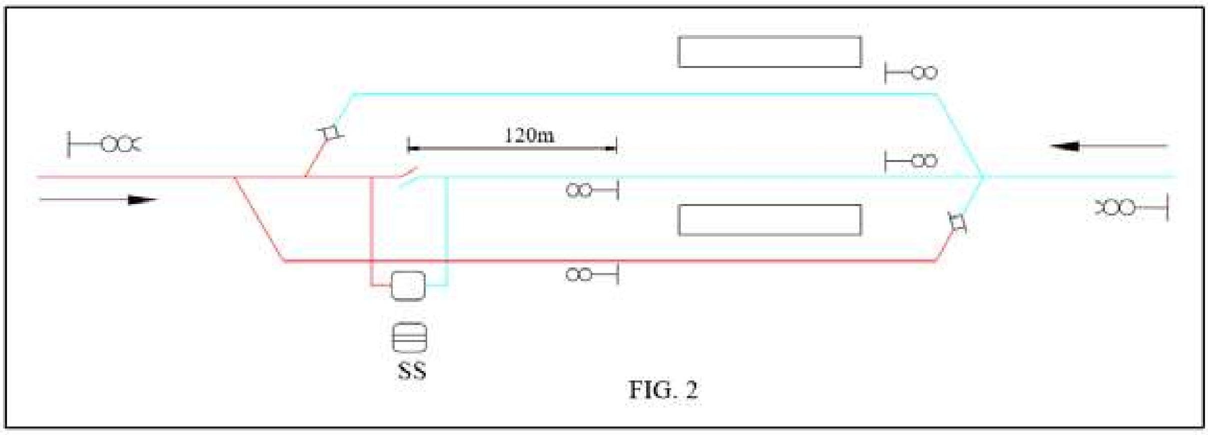


FIG. 2

*OTHER THAN SWITCHING STATION SINGLE POLE ISOLATOR IS TO BE PROVIDED

Station with goods platform: In such a station isolation facilities should be provided for the goods platform as shown in Fig. 3

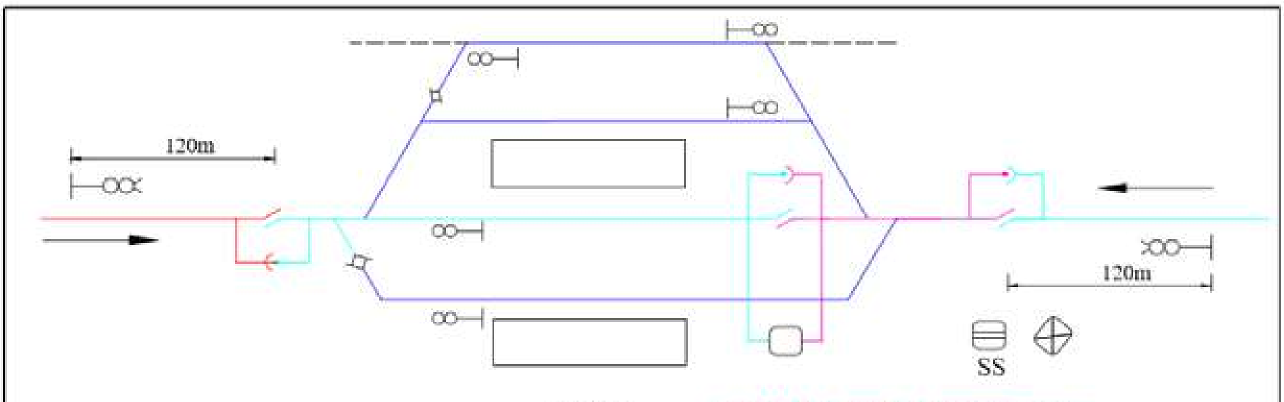


FIG. 3

(Added as per ACS 3 of ETI/OHE/53)

31.0 Numbering of OHE Masts

31.1 Necessity

As the P&T overhead telegraph lines on the 25 kV ac electrified routes are replaced by under-ground screened cable, the OHE masts are used to indicate the kilometer-age of the track. The mast number is also used for identification of the section of overhead equipment (OHE) and the line to which it belongs. There are normally 15 to 18 masts in one kilometer and each mast is given a number in serial order starting from kilometer post. The number is scribed in two parts, the kilometer being shown above the line and the mast serial number below the line. For example, (70/1) indicates the first mast from the kilometer post No. 70 on the Up line.

31.2 Single line section

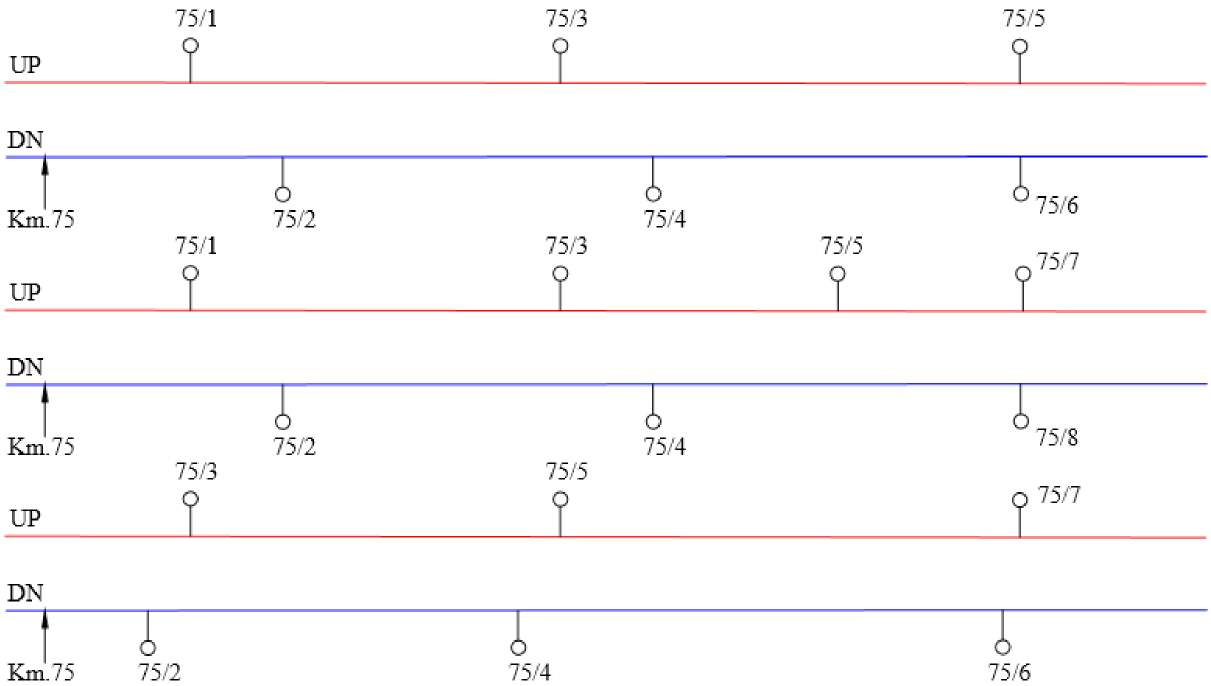
In single line section where there is no chance of future doubling, numbering is done progressively in the direction of increase of kilometer-age, i.e. 70/1, 70/2,etc. In case where doubling is anticipated in future the system of numbering will be according to para 31.3.

31.3 Double line section

All traction masts on Up track shall be given odd numbers, i.e. 75/1,75/3, 75/5 etc. and that on Down track even numbers as 75/2, 75/4, 75/6,etc. 1 and 2 are the serial number of the masts immediately after every kilometer post. Numbering is done progressively in the direction of increase of kilometer-age.

31.3.1 Since the OHE masts on Up and Down tracks are normally located opposite each other, the mast numbers 1 & 2 would be in one line, and mast numbers 3 & 4 would be in in one line and so on.

31.3.2 In case the spans on the Up and down lines are not equal and the masts are not in one line, the masts shall be numbered in such a way that higher serial number does not occur at a lower kilometer-age (see Fig:A1 .20).



Numbering of Masts of loop and siding in station yards

FIG. A 1.20

31.4 Multiple section

In multiple track section, suffix 'A' is to be given to the multiple track mast. For instance in case of a section consisting of Up main, Down main and Up slow and Down slow track the slow track masts shall be numbered as 75/1A, 75/3A, etc. for Up slow line and 75/2A, 75/4A etc. for Down slow line. Uprights of portals, erected in multiple track sections shall be numbered with reference to main line only i.e. 75/1, 75/2 etc.

31.5 Numbering of masts of loops and sidings in station yards

31.5.1 Individual masts

Single cantilever and double cantilever mast supporting OHEs of tracks on either side (umbrella type) for loops and sidings shall bear the station code and serial number in one thousands series (1000). The station code shall be given on above the horizontal line and the serial number below it. Masts of Up loops and siding on Up line side shall be given odd number of 1001.1003,1005 etc. in the order of progressive chainage, irrespective of the number of loops and the masts on the Down loops and sidings on the Down line side shall be given even numbers 1002, 1004, 1006 etc.

In case several independent cantilever masts for different loops are located at the same chainage, loop mast nearest to the main track should bear the lowest number in the series (see Fig A1.21). This system of numbering is applied from one end of a yard in the kilometer-age of the starting point and progressively higher numbers is given in the direction of increase in chainage whether it is Up or Down yard. The numbering does not indicate the kilometer-age.

31.5.2 1. In case a portal is provided, the upright of the portal nearest to the main track shall be given a number in 2000 series, the other upright of the portal shall be given a number in 3000 series. In case of 3 leg portals, the farthest leg from the main track shall be given a number in 4000 series.

31.5.2 2. In case a portal is covering both Up and Down main lines as well as loops and siding, the numbering shall be as for the main line tracks, irrespective of the fact that it also covers loops.

31.5.2 3. In case of a portal covering Up main line and a number of Up side secondary tracks, the upright which is located near the main track and service the main line shall be numbered with respect to the main track. Other upright shall be given the same number with suffix 'A'.

31.5.2 4. The upright of portals in Up yard shall have odd numbers i.e. 2001-3001, 2003-3003 etc. and the upright in Down yard shall have even numbers i.e. 2002-3002, 2004-3004 etc.

31.6 Head span mast

Procedure of numbering the mast of a head span shall be the same as that for portals detailed in 31.5.2 except that the mast of the head span shall be given numbers in 5000, 6000 and 7000 series as detailed in 31.5.2 (a).

31.7 Branch line masts

All masts on branch lines taking off from the main line are to be given a prefix letter indicative of the branch line, mast e.g. Pradhankanta-Pathardih which takes off from the main line at Pradhankanta is given a prefix letter 'P' which is indicating of Pathardih viz. 70/14 P.

31.8 Alternative numbering

Mast on loop/yard lines may also be numbered with a letter/word prefixed indicating the nomenclature of the line e.g. the mast numbers on a goods line in passenger station area may be numbered as G1, G2 etc. below the station code. The mast numbers on engine run-round line may be numbered as EL1, EL2 etc. This method may be adopted when additional lines are provided or wired subsequently.

31.9 Switching station masts

Mast at the switching station are numbered with the station code of the switching station for example KGP/1 which means Kharagpur Switching Station, mast No. 1.

32.0 Numbering of Equipment

32.1 Abbreviation of equipments

To identify the location of the equipments covering OHE and Switching stations a code for identifying the type of equipment followed by a S.No. is given.

AT: 25 KV/230V Auxiliary Transformers

BT: Booster Transformers

BM: Interruptor for main lines

BS: Interruptor for yard lines

BX: Bus coupler interruptor

BC: Bus coupler isolator

CB: Circuit Breakers

CT: Current Transformers
DP: Double pole isolators
LA: Lightening arrestor
PT: Potential transformer
SF: Single pole isolator at Switching Station
SP: Single pole isolator at sub-station
SM: Isolator for main lines
SS: Isolator for secondary lines loops and yards
TR: Power transformer.

32.2 Numbering circuit breakers

Each power transformer, current transformer, potential transformer is given a serial number in a Railway starting from 01 except 25 kV circuit breakers which shall be according to para 32.2.2.

32.2.1 High voltage (132/110/66KV) circuit breakers are given two digit numbers progressively increasing in the direction of increasing kilometerage starting from 01. For example, the first high voltage circuit breaker will be numbered as CB/01,02,03

32.2.2 25 kV circuit breakers are given three digit numbers - odd nos. e.g. CB/101, 103, 105 etc. for feeder breakers and even nos. CB/100,102,104 etc. for transformers circuit breakers.

32.3 The serial number of transformers and circuit breakers also follow geographical sequence within a substation/feeding post. Lower number is given for the equipment connecting at less kilometerage and higher number of for the equipment connected to higher kilometerage.

32.4 Interruptors

The main line 25 kV interruptors numbered serial wise progressively increasing from a datum point on railway. e.g. BM/01, 02, 03 etc.

32.5 Yard interruptors. The yard line interruptors are numbered serial wise on a railway i.e., BS 01, 02, 03 etc. Where there are different yards for Up and Down direction, the interruptor for Up yard is given odd number and that for Down yard is given even number

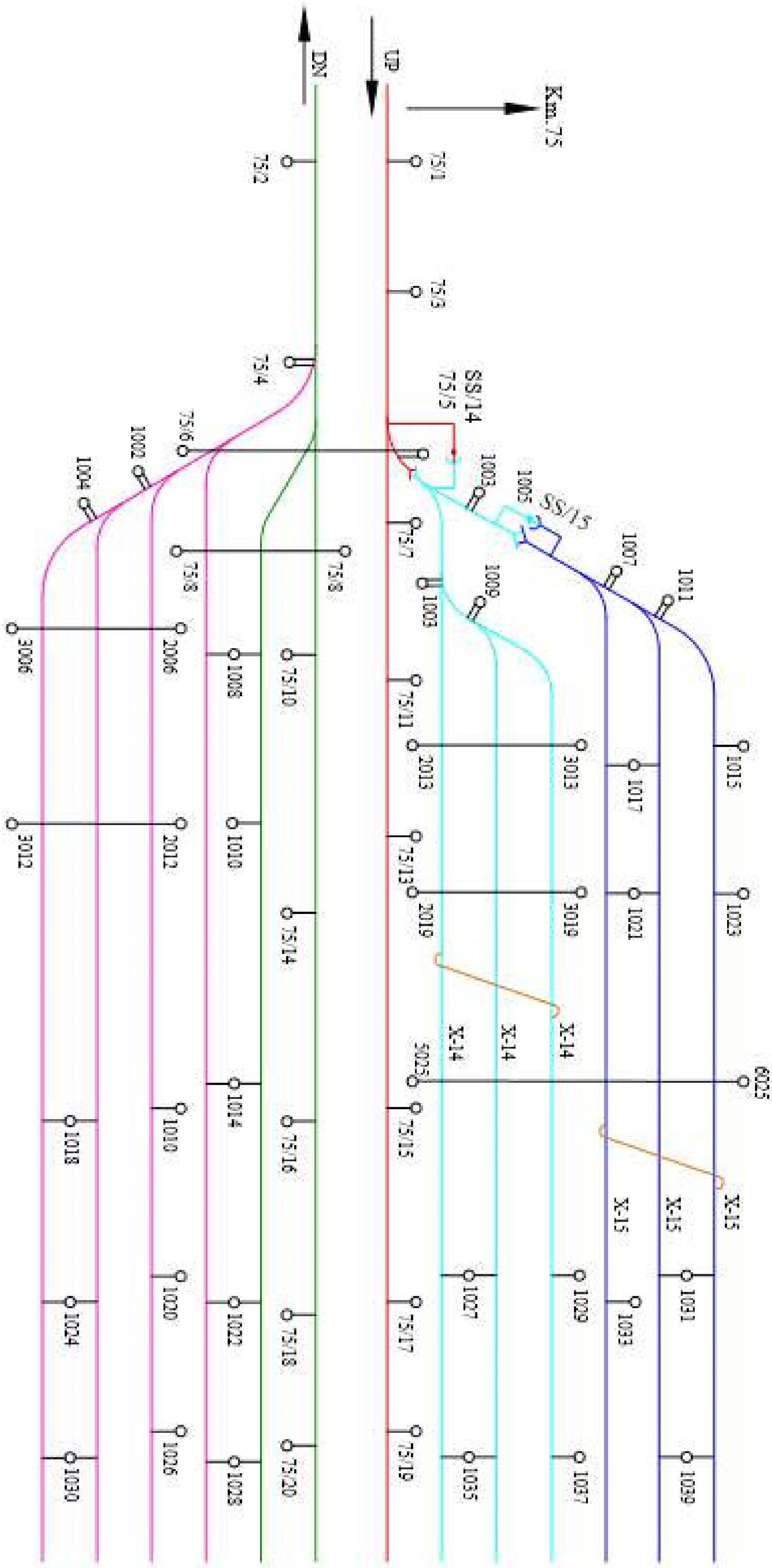

DN
UP
Km.75
75/1
75/2
75/3
75/4
SS/14
75/5
75/6
1002
1004
1003
1005
SS/15
1007
1011
75/7
75/8
75/8
1009
3006
2006
1008
75/10
75/11
2013
3013
1017
1015
3012
2012
1010
75/13
2019
3019
1021
1023
75/14
X-14
X-14
X-14
3025
6025
1014
1018
1016
75/16
75/15
X-15
X-15
X-15
1027
1029
1033
1031
1024
1020
1022
75/18
75/17
1030
1026
1028
75/20
75/19
1035
1037
1039

FIG. A 1.21

32.6 Other equipment

The number of other equipments is serial wise progressively increasing irrespective of up or down line on a railway preferably according to increasing chainage.

32.7 Numbering of elementary section

Elementary section for main line are given a number beginning with the number of interruptor which feeds it (see Fig. A1.21)

32.7.1 The first two/three digits of the number for an elementary section indicate the governing interruptor and last two digit indicate the progressive serial numbers. The progressive serial number for Up line are odd number starting with 01 for example 3401, 3403 etc. and even number for Down line starting with 02 such as 3502, 3504 etc.

32.7.2 Yard elementary sections

The elementary section number of yard lines shall be provided with the number of the isolator which controls the feed of the line/s with a prefix 'X' For example, if an isolator, no. 118 controls the feed of the lines of the receiving yard the elementary section number of the lines is X 118.

32.7.3 Elementary section for two sides

If the line/s are fed by an inter-locked isolator numbering of the elementary section should corresponds to the isolator number which normally feeds the line/s.

32.7.4 Type of number plates

The number plates shall be in accordance with drawing No. RE/33/P/7501.Retro reflective number plates shall be provided as per Railway Board letter no. 2001/Elect(G)/170/1/Pt dt. 21.02.2012.

32.7.5 Design deviations permissible for 1500 volt DC OHE converted to 25 kV AC OHE in Mumbai and Pune divisions of Central Railway and Mumbai division of Western Railway:-(As per ACS 25)

1. Overlap: In converted OHE the overlap spans are single span as against 3-4 spans in 25 kV AC OHE, laid down in ACTM para 5.6.
2. Obligatory Mast: In 25 kV AC OHE, obligatory masts is provided on turnouts, whereas in converted OHE obligatory mast may not be provided where there is constraint of space availabilty for locating the obligatory mast. Moreover, in converted OHE from DC to AC, Scissor type of turnout may be provided without obligatory structure but with Knuckles.
3. Regulated OHE: The tension length and regulation of 25 kV AC OHE is as per Para 13.0 whereasthe converted OHE shall continue to be unregulated.
4. Span length of OHE:. In 25 kV AC OHE the maximum permissible span is 72m as per dropper schedule for regulated OHE with equal encumbrance 1.40m/1.40m, where as in converted OHE maximum permissible span as existed previously in 1500 V DC will continue.
5. Contact wire gradient: The contact wire gradient in 25 kV AC OHE is to be maintained as per para 7.4 of ACTM Vol. II, Pt. II, Appendix I. For 1500 V DC OHE converted to 25 kV AC OHE, the gradient and relative gradient may be maintained as 10 mm/m and 5 mm/m respectively.
6. Cantilever assembly/ Catenary assembly: In 25 kV AC OHE the arrangement of cantilever assembly is as per Para 19.0, whereas in converted OHE the arrangement of cantilever assembly as existed previously in 1500 Volt DC will continue.
7. Size of catenary and contact wire for converted OHE: In 25 kV AC OHE, catenary wire of 65 sq. mm and contact wire of 107 sq mm is provided as per table given under characteristics of

conductors for 25 KV. In converted OHE, catenary wire of size 323/242/129 sq mm and contact wire of size 193/150 sq mm, may also be used.

8. Droppers and Jumpers: The droppers and jumpers in 25 kV AC OHE is governed by Para 10.0 and Para 12.0, whereas in converted OHE, the standard shedule of droppers and jumpers may not be followed depending upon the requirement at specific locations.

*****

CODE FOR BONDING AND EARTHING FOR25 kV a.c. 50 Hz. SINGLE PHASE TRACTION SYSTEM

PART-I

1.0 Scope

This Code shall apply to 25 kV, a.c. 50 Hz single phase traction system and covers the requirements for bonding and earthing of overhead equipment masts, structures and associated rails of railway track. The bonding and earthing at traction substation including feeding posts, switching stations, booster transformer stations, 25kV/240V auxiliary transformer stations and switching station gantry as well as signaling and Telecommunication equipment are beyond the scope of the CODE.

2.0 Definitions

The following terms wherever appearing in this Code shall, unless excluded by or repugnant to the context, have the meaning attributed there to and apply as follows:

2.1 "Bond" means an electrical connection between two or more conductors or non-currents carrying metallic parts of traction masts or structures or supports and rails.

2.2 "Cross-bond" means a bond between two rails of a track or two rails of adjacent tracks. It is also called a transverse bond.

2.3 "Earth wire" means a conductor run on traction masts or structures or supports and bonded to their metallic parts/supports and connected to earth.

2.4 "Earth" means a connection to the general mass of earth by means of an earth electrode. An object is said to be earthed when it is electrically connected to an earth electrode, and the object is said to be solidly earthed when it is electrically connected to an earth electrode without intentional addition of resistance or impedance in the earth connection. The resistance of the earth electrode shall not exceed 10-ohms.

2.5 "Earth electrode" means a metal plate or pipe or any other conductor electrically connected to the general mass of the earth.

2.6 "Impedance-bond" is a bond, installed by the Signal and Telecommunication Department, which provides a low impedance path for the traction return current and a relatively high impedance path for track circuit current.

2.7 "Rail-bond" mean an electrical connection across a rail joint between consecutive lengths of rails. It is also called a "Longitudinal bond".

2.8 "Rail length" means a continuous length of rail with or without welded joints but with no fish plate joints.

2.9 "Structure- bond" means a bond connecting the non current carrying metallic parts of traction mast or structure or support to the traction rail.

2.10 "Signal bond" means an electrical connection across a rail joint, provided by the Signaling & Telecommunication Department, to facilitate flow of track circuit current.

2.11 "Short direct connection" means a connection for electrical continuity, which shall be of the shortest possible length with minimum bends.

2.12 "Traction rail" means a non-track-circuited rail of a wired track, not required for signaling purposes and which may be earthed. In non-track-circuited sections, both the rails of a wired track are traction rails and in single rail-track-circuited sections, the traction rail is the non track circuited rail.

2.13 "Welded bond" means a bond which is made of standard copper conductors with M.S. ferrules at either end, pressed on the conductors and bent to shape.

2.14 "Wired track" means a track provided with 25 kV, a.c. 50 Hz single phase overhead equipment.

3.0 Bonding

3.1 In the case of 25 kV, a.c. 50 Hz single phase traction system, the traction current is drawn from the overhead equipment by the electric rolling stock, operating in a section and passes through the traction rail. The return current flows mostly through the earth leaving the traction rail except in a zone extending over a few hundred metres on both sides of the electric rolling stock in operation in the section or in the vicinity of a feeding station and returns to the traction sub-station. Bonding of all rails is, therefore, not absolutely essential unlike in the case d.c. traction where practically the whole traction return current flows through the rail and hence bonding of rails is essential. However bonding of rail facilitates passage of the traction return current from rail to earth and vice versa and is, therefore, provided in the vicinity of traction sub-station/feeding posts where the traction return current has to flow back from the earth to the traction rails which are connected to the earthed leg of the traction transformer at the sub-station, through a buried rail opposite the feeling post. Bonding of rails also ensures the spread of flow of return current into the earth and, therefore, reduces the voltage between rail and earth. So bonding of rails is done wherever it is essential to keep the rail voltage low to ensure safety of personnel.

3.2 The traction rail of a wired track when bonded or laid on metallic sleepers provides generally an earth better than an earthing station with earth electrode. If, therefore, any non-current carrying part of an equipment or metallic structure is required to be earthed, it shall ordinarily be connected to a traction rail.

3.3 Track Circuited Sections

3.3.1 In sections equipped with single rail-track-circuits, the traction rail shall be bonded to ensure that:

1. The a.c. voltage along its length is reduced so as to minimize the risk of a.c. voltage being applied to the track relay;
2. As low a resistance path as possible is provided both for traction return as well as signaling currents as fish plate joints can not be relied upon for low resistance.

3.3.2 In sections with double rail-track-circuits, both rails are longitudinally bonded to ensure a low resistance path for traction return and signaling currents; and also to distribute the return current more evenly in both the rails. Impedance bonds are installed at insulated joints to provide a continuous path to the traction return current. All track-circuited-rails are, in addition, provided with signal bonds.

3.4 Structure Bond

All non-current carrying metallic parts of traction masts or structures or supports or metallic parts of concrete/wooden masts, supporting the traction overhead equipment shall be connected by means of the structure-bond to the nearest traction rail or to an earth wire run on the traction mast /structures/

supports or to an earth. In the case of a portal structure, both legs of the portal shall be provided with the structure bond, whereas for head span masts, each mast of the head span shall be bonded to the traction rail nearest to it. Alternatively flexible stranded steel structure bonds can also be used in theft prone areas.

Where traction masts or structures or supports are located on railway platforms and are bonded to the nearest traction rail, a cross-bond shall be provided at the location of the structure-bond to connect the rail to the adjacent traction rail.

To avoid inconvenience to passengers at PF area & damage to PF floors for providing structure bonds, earth wire may be provided in station platform area with the approval of PCEE. Earth wire is to be connected to all the structures of the same track and when the earth wire exceeds 1000 metres, it shall be made electrically discontinuous by providing a cut-in-insulator so that no section of the earth wire is greater than 1000 metres electrically. Each such section of the earth wire shall be connected to an earth at two traction masts or structures or supports at a distance not exceeding 500m apart. Earth wire shall be provided for each track separately.

3.5 Track Bonding

In station yards or elsewhere, where a track is not wired for its entire length, it shall be deemed to be wired for a distance of upto 50m beyond the traction mast at which the overhead equipment has been terminated. Rail-bonds and one cross-bond shall be provided for a distance of upto 50m beyond the last traction mast.

3.6 Mode of Connection of Bond

3.6.1 All types of bonds i.e. rail-bond, cross-bond and structure bond shall be of mild steel of not less than 200 sq.mm cross sectional area.

3.6.2 A structure-bond shall be rigidly connected by means of galvanized steel fasteners to the traction rail and the metallic part of traction mast or structure or support.

3.6.3 A rail-bond shall be rigidly connected by means of galvanized steel fasteners longitudinally across the fish-plate joint of the traction rail and the track-circuited-rail in a track circuited section except at the insulated joint of the track circuited rail.

3.6.4 A cross-bond shall be rigidly connected by means of galvanized steel fasteners between two traction rails of a track or non-track-circuited rails of an adjacent track.

3.6.5 Hole drilled in the web of rail should be concentric with neutral axis of rail section and bond hole should be chamfered. Procedure for making holes in Rails for 'fixing Structure Bond' is given in Drawing No. ETI/OHE/P/7000(Mod-F). The dimension below the hole in both 50 kg and 60 kg rails (i.e. 75.59mm and 80.95 mm) to be complied and minimum distance between neutral axis of holes to be minimum 170mm.

3.6.6 The bond for connecting return conductor to the traction rail through the buried rail shall normally be made with GI/Galvanised steel nuts and bolts with spring washer and check nuts.

3.6.7 The cross-section of an earth wire used for bonding traction masts or structures or supports or the metallic parts supporting the traction overhead equipment in a tunnel or in double rail-track-circuited section shall be not less than 50 sq.mm copper equivalent.

3.6.8 During maintenance of bonds, rail and bond contact surfaces should be cleaned and refitted with graphite grease. Greasing should be carried out with periodicity of six months.

3.7 Bonding in single Rail-Track-Circuited Sections

3.7.1 The traction rail in a single rail-track-circuited Sections shall be provided with rail-bonds not only over the entire length upto which the track circuited rail exists but also for a distance of 50m on both sides of the track circuited length. In addition, the traction rail shall be cross-bonded to the traction rails, if any, of adjacent tracks wherever they exist at intervals of not more than 100m. The traction rails of such adjacent tracks shall also be provided with rail-bonds over the entire length of the track circuits and for a further 50m on both sides. In case the length of a track-circuited rail is not more than 350m, a cross-bond shall be provided between the rails of the track immediately outside the track circuited length at both of its end.

3.7.2 In single line section, whether or not doubling of the section is foreseen in the future, provided with single rail-track-circuit, the non-track-circuited rail shall be provided with rail-bonds over the entire length and for a further 50m on both sides. It shall also be connected to an earth at distances not exceeding 100m from each other. The connection of the non-track-circuited rail to each of the earths shall be made by two separate mild steel strips/flats each of cross-section not less than 200 mm2. The need for providing an earth wire is thus obviated.

3.8 Bonding in Double Rail Track-Circuited Sections

In a double rail-track-circuited section, both the rails shall be provided with rail-bonds. At insulated joints of the double rail-track-circuit an impedance bond shall be provided. Since no traction rail is available for structure bonding, an earth wire shall be run on the traction mast or structure or support. In case, the length of the earth wire exceeds 1000m it shall be made electrically discontinuous by providing a cut-in-insulator so that no section of the earth wire is greater than 1000m electrically. Each such section of the earth wire shall be connected to an earth at two traction masts or structures or supports at a distance not exceeding 500m apart.

No cross-bond shall be provided between the rails of the same track or between the rails of different tracks in a double rail-track-circuited section.

3.9 Bonding adjacent to Traction sub-station/Feeding Post

3.9.1 Commencing opposite to a traction sub-station/feeding post, all the traction rails shall be provided with rail-bonds for a distance of 1000m on either side of the traction sub-station/feeding post. In addition, these traction rail shall be cross-bonded at approximate distances of 300, 500, 700 and 1000m from the traction sub-station/feeding post on both sides of the traction-station/feeding post.

3.10 Bonding of Rails on Wooden/Concrete Sleepers

A wired track shall be deemed to be on wooden or concrete sleepers if there are not more than six metallic sleepers in any length of track not exceeding 350m. The traction rail of such a track shall be provided with cross-bonds at distances of not more than 350m apart. No rail-bonds shall be provided.

3.11 Bonding of Tracks in Loco Sheds and Loco/EMU Stabling Sidings

All traction rails of loco sheds and loco/EMU stabling siding shall be provide with cross-bonds at distances of not more than 100m apart. Further, all sidings and /or dead ends, whether wired or not, shall be connected by rail bonds. The rails on wooden or concrete sleepers/supports in loco/EMU inspection pits shall be provided with rail bonds for the entire length of the pit and also upto a length of 50m on both sides and connected to an earth.

3.12 Bonding of Rails on a Weigh-Bridge

Both the rails of a wired track on weigh-bridge shall be provided with rail-bonds for a length of upto 50m on both sides of the weigh-bridge. If the rails are on wooden or concrete sleepers/supports, they shall be connected to an earth.

3.13 Bonding at a Level Crossing

All the traction rails shall be provided with cross-bonds at only one location which shall be within five meters from either of the transverse edges of the level crossing.

3.14 Bonding at Oil Depot Sidings

3.14.1 Unwired sidings leading to a oil depot or installation shall be provided with duplicate insulated block joints as near as possible to the turn-out from the main track from which they take-off and before entry into the oil depot or installation.

3.14.2 Where a siding or a secondary loop line is to be wired to serve the purpose of loading and unloading of petroleum products, the arrangements to be made and precautions to be taken are:

1. A neutral zone shall be set up at either end of the length of the siding or secondary loop line over which the vehicles containing the petroleum products are to be berthed and loaded/unloaded. The neutral zone is created both in the track as well as in the traction overhead equipment (OHE) by provision of insulating joints and section insulators with isolators as done for locomotive inspection pits respectively. The neutral zone is to ensure that the rest of the railway network is kept isolated when the loading/unloading operations are in progress so as to avoid propagation of stray currents.
2. Both the rails of the siding or secondary loop line shall be provided with longitudinal-bonds. Besides transverse-bonds shall be provided between the rails at distances not exceeding 30m apart.
3. The rails of the siding or secondary loop line shall be connected to an earth at both ends immediately outside neutral zone.
4. An equi-potential link/switch shall be provided between the metallic portions of the petroleum installations i.e. the earth and the rails of the siding or the secondary loop line. This equi-potential link/switch is to be kept closed during the loading/unloading operations.
5. Each and every non-current carrying part of a traction mast or structure or support and other metallic structures in the vicinity of the siding or secondary loop line shall be provided with structure-bonds. Only copper rivets shall be used for connection between the non-current carrying metallic part or rail and the bond.
6. During the time the loading and unloading of a petroleum product is taking place, proper electrical continuity shall be maintained between the petroleum installations, the rails on which the vehicles containing the petroleum products are berthed and the OHE which has already been made dead and connected to the rails.

3.15 Bonding of Exposed Metallic Parts

All exposed metallic parts such as platform structures sheds, metallic fencing, wires, pipes and such other items, not likely to come into direct contact with the 25 kV a.c. overhead equipment and located within a distance of 20 m from the nearest electrified track and running parallel to it for a distance of more than 20 m but less than 350 m shall be connected to an earth or traction rail. If parallelism with the nearest electrified track exceeds 350 m, all such exposed metallic parts shall be connected to a separate earth with two GS flat at distances not exceeding 350 m apart.

No special precaution is required in case such metallic parts are fitted on metallic supports direct buried in the ground if the natural earth resistance of such metallic support is less than 10 ohm.

3.16 Bonding of Earthing Heel of Isolator Switch

The earthing heel of an isolator switch shall be connected by two mild steel flats of cross-section not less than 200 sq.mm each to the supporting metallic traction mast or structure or support. The connection shall be as short and as direct as possible. Such a traction mast or structure or support shall, in turn, be connected to a traction rail or an earth wire and, in addition, to an earth.

3.17 Bonding of Over Line Structure

The metallic parts of foot or road over-bridges or other over-line structures over wired tracks shall be connected either to a traction rail or to an earth by means of two mild steel strips/flats of cross-section not less than 200 mm2 each.

Touch and accessible voltages shall not exceed those stated in IEC-62128-1 -2013

4.0 Drawings:

The drawing issued by RDSO in connection with the practices prescribed in this CODE are listed below:

S. No.	Description	Drawing Number
i.	General arrangement of earth wire on mast	ETI/OHE/G/05201-1
ii.	Arrangement of transverse bonds.	ETI/OHE/G/05251 Rev A
iii.	Structure bonds.	ETI/OHE/P/7000 Rev F
iv.	Earthing station	ETI/OHE/P/7020 Rev B
v.	Longitudinal rail bond	TI/OHE/P/7030Rev F

5.0 Guidelines:

1. Guidelines for provisions of OHE Mast for Electrification at New and Existing Bridge Pier/ Abutment (RDSO Report No. BS-121)
2. Instruction no. TI/IN/0038 for making connections/welding/drilling holes on steel bridges structure

PART-II

Earthing & Bonding in Tunnels and Bridges

1.0 Bonding of Rails in a Tunnel in non track circuited section

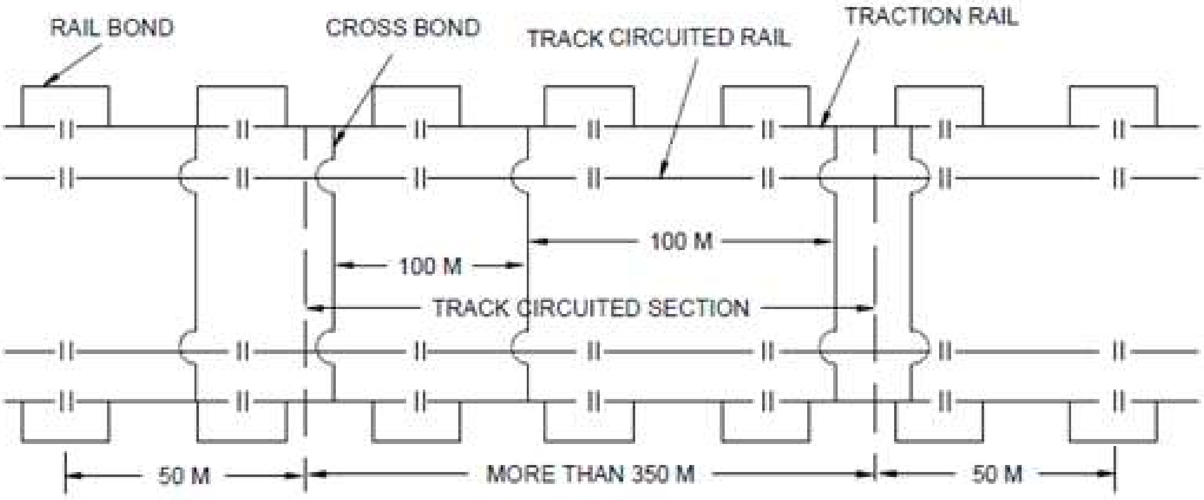
In a tunnel all the traction rails shall be provided with rail-bonds not only over the entire length inside the tunnel but also for a length of upto 50m on both sides outside the tunnel. Besides, a cross-bond shall be provided between the traction rails at every 100m inside the tunnel and at both ends of the tunnel.

The cross-section of an earth wire used for bonding traction masts or structures or supports or the metallic parts supporting the traction overhead equipment in a tunnel or in double rail-track-circuited section shall be not less than 50 mm^2 copper equivalent.

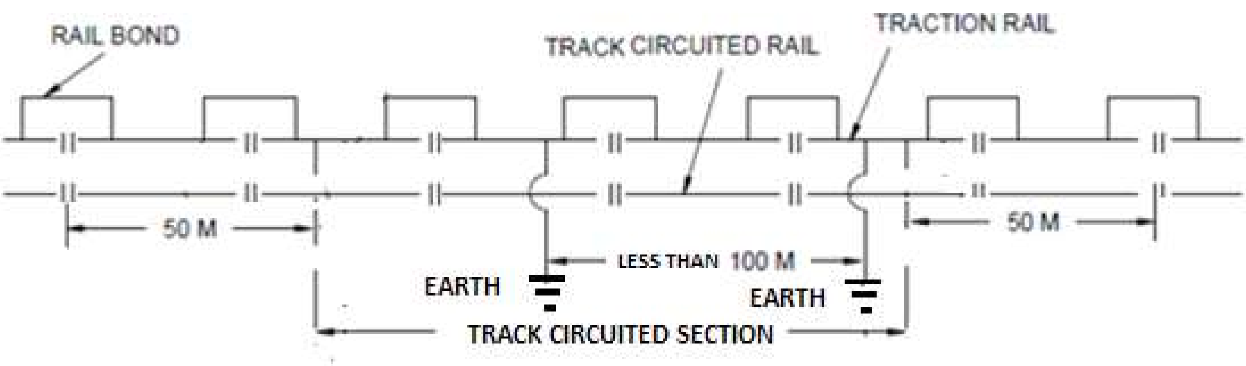
If the tracks in a tunnel are track-circuited, the procedure in clause 1.1 & 1.2 shall be followed.

1.1 Bonding in single Rail-Track-Circuited Sections

1.1.1 The traction rail in single rail-track-circuited Sections shall be provided with rail-bonds not only over the entire length up to which the track circuited rail exists but also for a distance of 50m on both sides of the track circuited length. In addition, the traction rail shall be cross-bonded to the traction rails, if any, of adjacent tracks wherever they exist at intervals of not more than 100m. The traction rails of such adjacent tracks shall also be provided with rail-bonds over the entire length of the track circuits and for a further 50m on both sides. In case the length of a track-circuited rail is not more than 350m, a cross-bond shall be provide between the rails of the track immediately outside the track circuited length at both of its end.



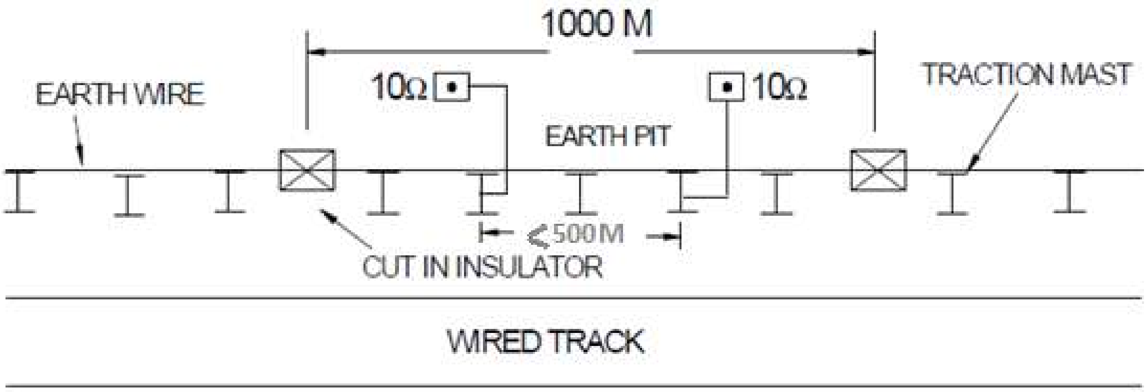
1.1.2 In single line section, whether or not doubling of the section is foreseen in the future, provided with single rail-track-circuit, the non-track-circuited rail shall be provided with rail-bonds over the entire length and for a further 50m on both sides. It shall also be connected to an earth at distances not exceeding 100m from each other. The connection of the non-track-circuited rail to each of the earths shall be made by two separate mild steel strips/flats each of cross-section not less than 200 mm2.



1.2 Bonding in Double Rail Track-Circuited Sections

In a double rail-track-circuited section, both the rails shall be provided with rail-bonds. At insulated joints of the double rail-track-circuit an impedance bond shall be provided. Since no traction rail is available for structure bonding, an earth wire shall be run on the traction mast or structure or support. In case, the length of the earth wire exceeds 1000m it shall be made electrically discontinuous by providing a cut-in-insulator so that no section of the earth wire is greater than 1000m electrically. Each such section of the earth wire shall be connected to an earth at two traction masts or structures or supports at a distance not exceeding 500m apart.

No cross-bond shall be provided between the rails of the same track or between the rails of different tracks in a double rail-track-circuited section.



1.3 Bonding and Earthing of Rail &Metallic Parts in a Tunnel

1.3.1 Earthing of Metallic Parts inside a Tunnel

For Bonding in Non-track circuited section, Single & Double track circuited section, procedure given in para 1.0, 1.1 & 1.2 shall be followed. For each track, an earth wire connecting all non-current carrying metallic parts which form parts of the supports for the overhead equipment, shall be run inside the tunnel. The earth wire shall be connected to an earth as well as to the traction rails at both ends just outside the tunnel. In case, all the rails are track circuited, the earth wire shall be connected to an earth at both ends Just outside the tunnel. If the length of the earth wire exceeds 1000 m, the stipulation in regard to making it electrically discontinuous may be examined if the earth wire is local and not a part of the return current circuit.

If the length of the earth wire exceeds 1000 m, it shall be made electrically discontinuous by providing a cut-in-insulator so that no section of the earth wire is greater than 1000m electrically. Each such section of the earth wire shall be connected to an earth at two traction masts or structures or **supports at a distance not exceeding 500m apart.**

1.3.2 In a tunnel, in case of single rail track circuit a cross bond shall be provided between the traction rails at every 100 m and at both ends of the tunnel and provided with a local earth. The traction rail shall be cross-bonded to the traction rails, if any, of adjacent tracks wherever they exist at intervals of not more than 100m. If the tracks in a tunnel are single track-circuited, the typical drawing is given in **Annexure-I**.

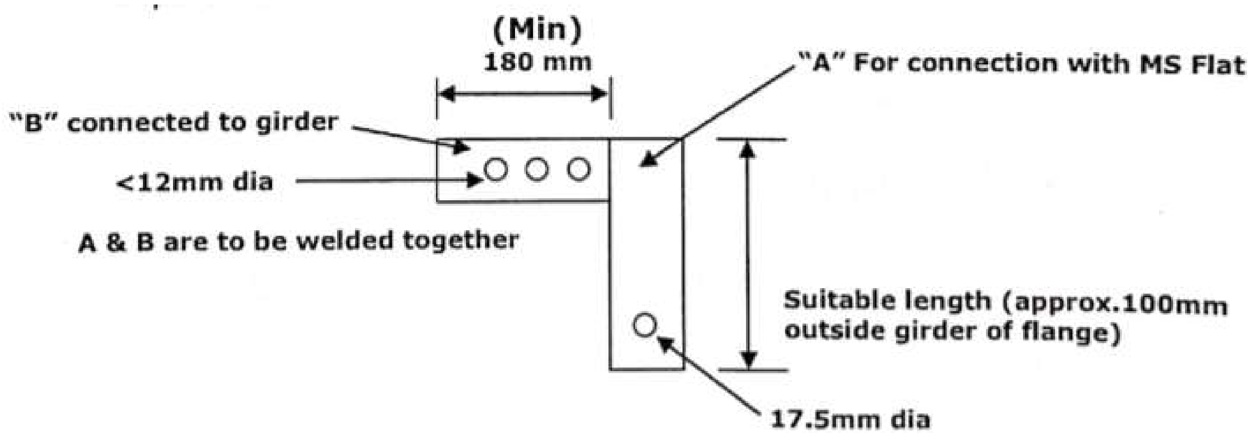
2.0 Bonding of Girder Bridge

2.1 Steel structures of a girder bridge shall be connected to a traction rail or to an earth by means of two mild steel strips/flats of cross-section not less than 200mm2 each. The traction rails (where there are two or more such rails) on the bridge shall be connected by cross-bonds at distances not exceeding 100 metres apart.

2.2 In a single rail-track-circuited section, the non-track-circuited rail which is the traction rail shall be provided with rail-bonds (refer clause 1.1 Part - II) and connected to an earth at both ends of the bridge. The connection of the non-track-circuited rail to each of the earths shall be made by two separate mild steel strips/flats each of cross-section not less than 200 mm2. The steel structures of the girders should be interconnected with each other with 2 nos. GS flats. Guard rails/check rails & running rails of traction rails shall be interconnected by GS flats at every 100 m.

2.3 Following guidelines as per Instruction no. TI/IN/0038 for making connections/welding/drilling holes on steel bridges structure for earthing and bonding shall be followed.

1. No holes by gas cutting shall be made in steel parts of any type of bridges.
2. No holes by any means shall be made in the web of the steel girder of any type of bridges.
3. Following process can be done over steel parts of the bridges with the permission of competent authority of engineering department by submitting proposal with sketch:
   a. Circular Holes (not more than 12mm in diameter) by **drilling.**
   b. L–shape steel Part shall be used for weld joint to the steel part of bridges. Welded part shall be painted as per the guidelines of engineering department.



   c. The attachment through welding or drilling of holes (hole diameter less than 12mm) shall be done in the End-portion of the bridge span beyond the support bearings i.e. the connection/ attachment shall not be done within the effective-span of the bridge.
   d. Provisions available in the Bridge drawing for Earthling & Bonding connections shall for welding/bolting.

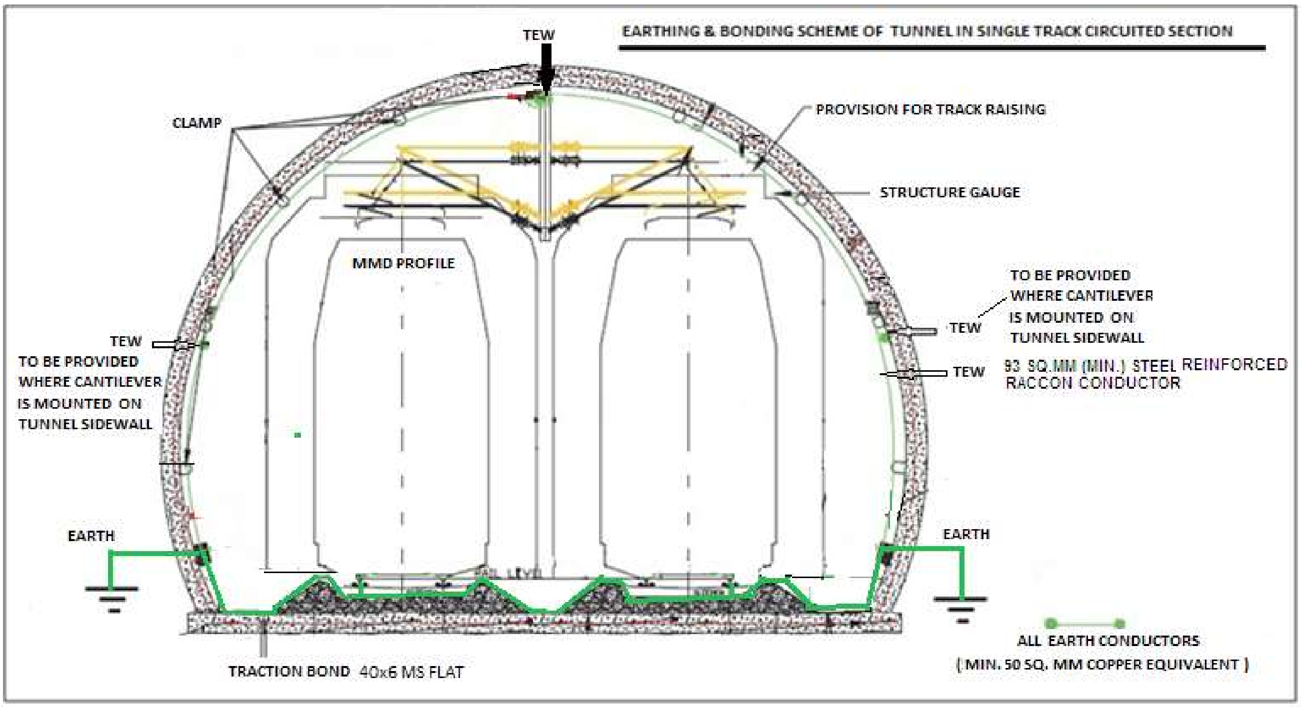
3.0 Bonding of Rail & Structures on Bridges

3.1 Bridge mast/structures shall be connected to a traction rail or to an earth by means of two mild steel strips/flats of cross-section not less than 200mm2 each. The traction rails (where there are two or more such rails) on the bridge shall be connected by cross-bonds at distances not exceeding 100 metres apart.

3.2 In a single rail-track-circuited section, the non-track-circuited rail which is the traction rail shall be provided with rail-bonds (refer clause 1.1-Part II) and connected to an earth at both ends of the bridge. The connection of the non-track-circuited rail to each of the earths shall be made by two separate mild steel strips/flats each of cross-section not less than 200 mm2. Bonding of Rail & Mast/structure on Bridges on Single Track circuited section is shown in drawing at Annexure-II.

3.3 For Bonding in Double track circuited section, procedure given in para 1.2 (Part-II) shall be followed.

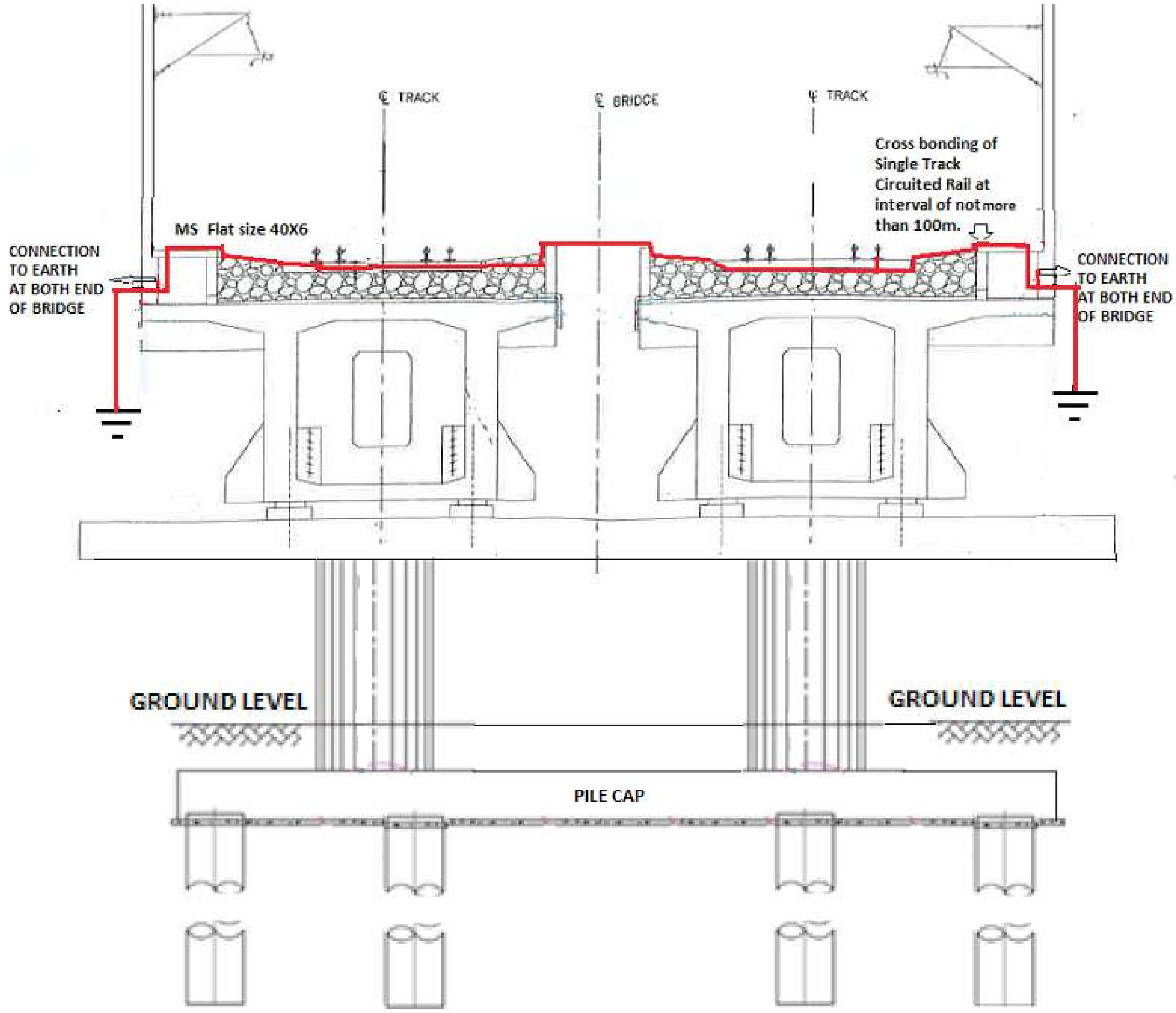
ANNEXURE-I



NOTE:

1. PROVISION OF CONNECTION OF TRACTION BOND FROM RAIL TO EARTH.
2. CROSSBONDING OF TRACTION RAILS AT INTERVALS OF NOT MORE THAN 100M.
3. PROVISION OF TUNNEL EARTH WIRE (TEW) CONNECTING AT EACH SUPPORT & CONNECTION OF TEW TO RAIL THROUGH MS FLAT OF SIZE 40MM X 6MM.
4. PROVISION OF EARTH AT BOTH ENDS OF TUNNEL.
5. PROVISION OF TUNNEL EARTH WIRE ON BOTH SIDE OF TUNNEL ALONG THE TRACK IF CANTILEVER /SUPPORT IS PROVIDED ON SIDE WALLS OF TUNNEL.
6. THE SCHEME IS NOT APPLICABLE FOR TUNNELS WITH SYNTHETIC INSULATING SHEETS FOR WATERPROOFING.

Annexure-II



Bonding of Rails & Structures in Single Track Circuited Section on Bridges

NOTE:

1. PROVISION OF CONNECTION OF TRACTION BOND FROM MAST TO RAIL.
2. CROSSBONDING OF TRACTION RAILS AT INTERVALS OF NOT MORE THAN 100M.
3. PROVISION OF EARTH AT BOTH END OF BRIDGE & PROVISION OF CONNECTION OF RAIL TO EARTH AT BOTH END OF THE BRIDGE.

*****

APPENDIX-3
CODE OF PRACTICE FOR EARTHING OF POWER SUPPLY INSTALLATIONS

1.0 SCOPE

1.1 This specification supersedes the specification no. ETI/PSI/120(02/91) with A&C slip no. 01.

1.2 This specification caters for general arrangements of earthing system and equipment earthing at Traction Sub-Stations, Switching stations and Auxiliary transformer stations of 25kV as well as 2X25kV system. Low voltage (LT) electrical power distribution system, 25 kV overhead equipment system as well as signal and telecommunication equipment do not come within the purview of this specification.

1.3 It is to be noted that "The Make in India Policy of Government of India shall be applicable."

2.0 TERMINOLOGY

The following terms wherever occurring in this specification shall, unless excluded or repugnant to the context, have the meaning attributed thereto as follows:-

2.1 Combined Earth resistance: The resistance of an earth electrode (s) with respect to earth, with the earth electrode (s) connected in the metal work of electrical equipment other than parts which are normally live or carry current and the masts/ structures but without connection with the traction rail(s).

2.2 Earth: The conductive mass of the earth, whose electrical potential at any point is conventionally taken as zero.

2.3 Earth Electrode: A conductor (mild steel (MS) pipe) or group of conductors in intimate contact with and providing an electrical connection to earth.

2.4 Earthing Grid: A system of a number of interconnected, horizontal bare conductors buried in the earth, providing a common ground for electrical devices and metallic structures, usually in one specific location.

2.5 Equipment Earthing: Earthing of all metal work of electrical equipments other than parts which are normally live or current carrying. This is done to ensure effective operation of the protective gear in the event of leakage through such metal work, the potential of which with respect to neighboring objects may attain a value which would cause danger to life or risk of fire.

2.6 Mesh Voltage (E mesh): The maximum touch voltage to be found within a mesh of an earthing grid.

2.7 System Earthing: Earthing done to limit the potential of live conductors with respect to earth to values which the insulation of the system is designed to withstand and thus to ensure the security of the system.

2.8 Step Voltage (E step): The potential difference between two points on the earth's surface separated by distance of one pace that will be assumed to be one metre in the direction of maximum potential gradient.

2.9 Power Supply Installation: The electrical equipments and associated structures provided at a Railway Traction Substation or Switching Station or Auxiliary transformer station on the 25 kV & 2X25kV overhead equipment.

2.10 Traction Rail – Traction Rail means a non-track circulated rail of a wired track, not required for signaling purposes and which may be earthed. In non-track circulated sections, both the rails of a wired track are traction rails and in single rail track circulated sections, the traction rail is the non-track circulated rail

2.11 Touch Voltage (E touch): The potential difference between a grounded metallic structure and a point on the earth's surface separated by a distance equal to the normal maximum horizontal reach of a person, approximately one metre.

3.0 OBJECT OF EARTHING

The object of an earthing system is to provide as nearly as possible a surface under and around a station which shall be at a uniform potential and as nearly zero or absolute earth potential as possible. The purpose is to ensure that generally all parts of the equipment other than live parts are at earth potential and that attending personnel are at earth potential at all times. Also by providing such an earth surface of uniform potential under and surrounding the station, there can exist no difference of potential in a short distance big enough to shock or injure an attendant when short circuits or other abnormal occurrences take place. The primary requirements of a good earthing system are:

1. It should stabilize circuit potentials with respect to ground and limit the overall potential rise.
2. It should protect men and materials from injury or damage due to over voltage.
3. It should provide low impedance path to fault current to ensure prompt and consistent operation of protective devices during ground faults.
4. It should keep the maximum voltage gradient along the surface inside and around the substation within safe limits during earth faults.

4.0 GOVERNING SPECIFICATIONS

Assistance has been taken from the following standards/specifications in the preparation of this code of practice:

1. IS: 3043- 2018 code of practice for earthing (latest edition).
2. IEEE Guide for safety in AC substation grounding, IEEE standard 80- 2013.

5.0 TYPICAL VALUE OF EARTH RESISTANCE

At each power supply installation, an earthing system as specified in this specification shall be provided. The combined resistance of the earthing system (with the connection to the running rail(s) disconnected) shall be not more than the following values:-

SN	Name of the Station	The limit of combined earth resistance in ohms
1.	Traction substation	0.5
2.	Switching station	2.0
4.	Auxiliary transformer station	10.0

6.0 EARTH ELECTRODES

The earth electrode shall normally be of mild steel galvanized perforated pipe of not less than 40 mm nominal bore, of about 4 m length provided with a spike at one end and welded lug suitable for taking directly MS flat of required size at the other end. The pipe shall be embedded as far as possible vertically into the ground, except when hard rock is encountered, where it may be buried inclined to the vertical, the inclination being limited to 30 degree from the vertical. The connection of MS flat to each electrode shall be made through MS links by bolted joints to enable isolation of the electrode for testing purposes. A typical arrangement of an earth electrode shall be as per Drawing number ETI/PSI/222-1 (Annexure-VI).

6.2 Earth electrodes shall be embedded as far apart as possible from each other. Mutual separation between them shall usually be not less than 8.0 m (which is twice the length of the electrode).

6.3 If the value of earth resistance specified in clause 5.0 cannot be achieved with a reasonable number of electrodes connected in parallel such as in rocky soil or soil of high resistivity, the earth surrounding the electrodes shall be chemically treated. The earth electrode shall be surrounded in an earth pit by alternate layers of finely divided coke, crushed coal or charcoal and salt at least 150 mm all round. Though substantial reduction in earth resistance can be achieved by coke treated electrode, yet as this method results in rapid corrosion not only of electrode but also of steel frame work to which it is bonded, coke treatment shall be used only where absolutely necessary and such electrodes shall not be situated within 8.0 m of other metal work.

6.4 In high embankments, it may be difficult to achieve earth resistance specified in clause 5.0 even after chemical treatment of electrodes. In those locations, use of electrodes longer than 4 m so as to reach the parent soil is recommended. Mutual separation between them shall usually be twice the length of the electrode.

6.5 As far as possible, earth electrodes for Traction Sub-Stations/ Switching Stations shall be installed within and adjacent to perimeter fence. At large sites, apart from securing a sufficiently low resistance and adequate current carrying capacity a reasonable distribution of electrodes is also necessary.

7.0 EARTHING ARRANGEMENT AT TRACTION SUBSTATION for 25kV & 2X25kV System (160kmph).

7.1 Earthing Grid.

7.1.1 An earthing grid is formed by means of bare mild steel rod of appropriate size as indicated in clause 7.1.2 buried at a depth of about 600 mm below the ground level and connected to earth electrodes. The connection between the earth electrode and the grid shall be by means of two separate and distinct connections made with 75 mm x 8 mm MS flat. The connection between the MS flat and the MS rod shall be made by welding, while that between the earth electrode and the MS flats through MS links by bolted joints. The earth electrodes shall be provided at the outer periphery of the grid as shown in Annexure-II. As far as possible the earthing grid conductors shall not pass through the foundation block of the equipments. All crossings between longitudinal conductors and transverse conductors shall be jointed by welding. The transverse and longitudinal conductors of the earthing grid shall be suitably spaced so as to keep the step and touch potentials within acceptable limits; the overall length of the earthing grid conductors shall not be less than the calculated length (refer Annexure- I & XI).

7.1.2 The size of the earthing grid conductor shall be decided based on the incoming system voltage and fault level (refer Annexure I & XI). The fault level considered shall take into account the anticipated increase in fault current during the lifespan of the station. The size shall be as given below.

SN	System voltage (kV)	Fault level (MVA)	Diameter of the grid conductor (MS rod) in mm (For 25kV and 2X25kV TSS)
1.	66	Upto 4000 above 4000 upto 5000 above 5000 upto 6000	32 36 40
2.	110	Upto 6000 above 6000 upto 8000 Above 8000 upto 10000	32 36 40
3.	132	Upto 7000 Above 7000 upto 10000	32 36
4.	220	Upto 12000 Above 12000 upto 16000 Above 16000 upto 20000	32 36 40
5.	For earthing grid at SP & SSP of 2X25kV System 32 mm Diameter of the grid conductor (MS rod) is to be used.		

7.2 Buried rail.

7.2.1 A steel rail of section 52 kg/m (the one used for the railway track) and length about 13m shall be buried near the track at the traction substation at a depth of about one metre to form part of the earthing system. Two separate and distinct connections shall be made by means of 75 mm x 8 mm MS flat between the earthing grid and the buried rail. The buried rail shall also be connected by means of two separate and distinct connections made with 75mm x 8 mm MS flat to the traction rail(s) in a single - rail track circuited section and to the neutral point (s) of the impedance bond(s) in a double - rail track circuited section.

7.2.2 In cases where the feeding post is located separately away from the traction substation, the buried rail shall be provided at feeding post (where one terminal of the secondary winding of the traction power transformer of the substation is grounded).

7.3 System earthing.

7.3.1 For Traction Power Transformers

1. In case of25kV Traction System
   One terminal of the secondary winding (25 kV winding) of each traction power transformer shall be earthed directly by connecting it to the earthing grid by means of one 75mmX8mm MS flat, and to the buried rail by means of another 75mmX8mm MS flat in case of 21.6/30.24MVA transformer. In case of 30/42MVA Transformer, two numbers 75mmX8mm MS flat to be directly connected to earthing grid, and to the buried rail by means of another two numbers 75mmX8mm MS flat.

2. In case of 2X25kV Traction System with 38/53/63MVA Single Phase Dual LV Winding Traction Power Transformer at TSS:
   In these transformers there are two secondary windings. The inner terminals of these two secondary windings are to be solidly connected to each other. This connection is to be connected with two no. 75X8mm MS Flats. One MS flat is to be connected with Buried Rail & another with the Earthing grid (Annexure-VIII).

3. In case of 2X25kV Traction System with 60/84/100MVA Scott Connected Transformer at TSS: At these TSSs, the autotransformer has been used. The neutral Bushing of this Autotransformer is to be connected with two no. 75X8mm MS Flats. One MS flat is to be connected with Buried Rail & another with the Earthing grid. (Annexure-IX)

7.3.2 One designated terminal of the secondary of each potential, current and auxiliary transformer shall be connected to the earthing grid by means of two separate and distinct earth connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system.

7.4 Equipment earthing.

The metallic frame work of all outdoor equipments such as transformers, circuit breakers, interrupters and isolators as well as steel structures shall be connected to the earthing grid by means of two separate and distinct connections made with MS flat of size as indicated below; One connection shall be made with the nearest longitudinal conductor, while the other shall be made to the nearest transverse conductor of the grid.

SN	Equipment	System Voltage and fault level	Size of MS flat	
			For 25kV system	For 2X25kV system
1.	Equipment on the primary side of traction power transformer.	66 kV, upto 3000 MVA 110 kV, upto 5000 MVA 132 kV, upto 6000 MVA 220 kV, upto 10,000 MVA	50 mm x 6 mm	75 mm x 8 mm
		66 kV, above 3000 upto 6000 MVA 110 kV, above 5000 upto 10000 MVA 132 kV, above 6000 upto 12000 MVA 220 kV, above 10000 upto 20000 MVA	75 mm x 8 mm	75 mm x 8 mm
2.	Equipments on the secondary side of traction power transformer.		50 mm x 6 mm	75 mm x 8 mm
3.	Fencing uprights / steel structures		50 mm x 6 mm	75 mm x 8 mm
4.	Door/fencing panels		SWG G. I. Wires.	

7.5 Earthing inside control room.

An earthing ring shall be provided inside the control room by means of 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system. This earthing ring shall be run along the wall on teak wood blocks fixed to the wall at a height of about 300 mm from the floor level. The earthing ring shall be connected to the main earthing grid by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system. The earthing ring shall also be connected to an independent earth electrode by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system. The metallic framework of control and relay panels, LT AC and DC distributions boards, battery chargers and such other equipments shall be connected to the earthing ring by means of two separate and distinct connections made with 8 SWG galvanized iron wire. The connections shall be taken along the wall and in recesses in the floor. All recesses shall be covered with cement plaster after finishing the work. Connections between the MS flats shall be made by welding.

7.6 Earthing of SCADA/RTU Equipments

A separate earth electrode shall be provided as per clause 6.1 & 6.2 of this specification. The RTU body/frame shall be suitably connected to this earth electrode using two no. 8SWG bare copper wires.

The earth Resistance of this electrode shall be between 2 ohm to 10 ohm or better, depending upon the soil resistivity. This earth electrode shall not be connected to any other earthing arrangement.

7.7 Earthing of lightning arrester.

In addition to the earth electrodes provided for the main earthing grid, an independent earth electrode shall be provided for each lightning arrester. This earth electrode shall be connected to the ground terminal of the lightning arrester as well as to the main earthing grid by means of two separate and distinct connections made with 50mm x 6mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system, for the LV side lightning arresters, and with 75 mm x 8 mm MS flat for the HV side lightning arresters. The earth electrode shall be provided as close as possible to the lightning arrester and the connections shall be as short and straight as possible avoiding unnecessary bends. For lightning arresters provided for the traction power transformers, there shall also be a connection as direct as possible from the ground terminal of the lightning arrester to the frame of the transformer being protected; this connection shall also be made by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system, for LV side arresters, and with 75mm x 8mm MS flat for HV side lightning arrester.

7.8 Earth Screen.

The area covered by outdoor substation equipments shall be shielded against direct strokes of lightning by an overhead earth screen comprising 19/2.5 mm galvanized steel stranded wire strung across the pinnacles of the metallic structures. The earth screen wires shall be strung at a height as indicated in the approved traction substation layouts (not less than 2.5 m above the live conductors) and shall be solidly connected to the traction substation earthing grid at each termination by means of 50mm x 6mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system.

7.9 Earthing of fencing uprights and panels

Each metallic fencing upright shall be connected to the traction substation main earthing grid by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system. In addition, all metallic fencing panels shall be connected to the uprights by means of two separate and distinct connections made with 6 SWG G. I. wire. All the metallic door panels shall also be connected to the supporting uprights by means of two separate and distinct connections made with 6 SWG G. I. wire.

7.10 Earthing at the point of 240 V ac 50 Hz supply for oil filtration plant.

The 240 V ac 50 Hz distribution board for power supply to oil filtration plant shall be connected to the main earthing grid by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system.

8.0 EARTHING ARRANGEMENT AT SWITCHING POST

8.1 For 25kV System:

1. A minimum number of three earth electrodes (excluding the earth electrode provided separately for control room and RTU equipments (refer clause 8.5 & 8.6) shall be provided at each switching station, and they shall be interconnected by means of 50 mm x 6 mm MS flat forming a closed loop main earthing ring. This ring shall be connected by two separate and distinct connections made with 50 mm x 6 mm MS flat, to the traction rail in a single rail track circuited section and to the neutral point of the impedance bond in a double-rail track circuited section of the nearest track, so

as to limit the potential gradient developing in the vicinity of the switching station in the event of a fault.

2. In addition to above earthing, separate earthing station of Buried Rail, near the switching posts is to be provided as per the SMI No. TI/SMI/0032 Rev.02. (Annexure-X)

8.2 For 2X25kV System (Transformer capacity at TSSs: 38/53/63MVA or 60/84/100MVA):

1. Earthing Grid at the SP/SSP is also to be prepared by taking the fault current of 12kA and duration of 3 seconds. The Formula for the calculation is at Annexure-I and sample calculation at annexure-XII. The Buried rail as mentioned in Para 7.2.1, is required to be provided at the SP/SSP.
2. Neutral of the Autotransformer installed at the SP/SSP also to be connected with two no. 75X8mm MS Flats. One MS flat is to be connected with Buried Rail & another with the Earthing grid. The reference for the connection arrangement can be taken from Annexure-IX.

8.3 System earthing.

One designated terminal of the secondary of each potential, current and auxiliary transformer shall be connected to the main earthing ring/earthing grid by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV System .

8.4 Equipment earthing.

8.4.1 All masts, structures, fencing uprights and all outdoor equipment pedestals including auxiliary transformer tank shall be connected to the earthing ring by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system. All fencing panels shall be connected to the supporting uprights by means of two separate and distinct connections made with 6 SWG G. I. wire. All the metallic door panels shall be connected to the supporting uprights by means of two separate and distinct connections made with 6 SWG G. I. wire.

8.4.2 The metal casing of potential and current transformers shall be connected to the mast/ structures by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system.

8.4.3 The ground terminal of lightning arrester shall be connected directly to the earth electrode by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system. The earth electrode shall be so placed that the earthing leads from the lightning arrester may be brought to the earth electrode by as short and straight a path as possible.

8.5 Earthing inside remote control cubicle.

An earthing ring shall be provided inside the remote control cubicle by means of 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system. The earthing ring shall be run along the wall on teak wood blocks fixed to the wall at a height of 300 mm from the floor level. The earthing ring shall be connected to an independent earth electrode by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system. The metal casing of LT, AC and DC distribution board, battery chargers, terminal board and other such equipments shall be connected to the earthing ring by means of two separate and distinct connections made with 8 SWG GI wire. The connections shall be taken along the wall and in recesses in the floor. All recesses shall be covered with cement plaster after finishing the work. Connections of earth strips to each other shall be made by welding.

8.6 Earthing of SCADA/RTU Equipments

A separate earth electrode shall be provided as per clause 6.1 & 6.2 of this specification. The RTU body/frame shall be suitably connected to this earth electrode using two no. 8SWG bare copper wires. The earth Resistance of this electrode shall be between 2 ohm to 10 ohm or better, depending upon the soil resistivity. This earth electrode shall not be connected to any other earthing arrangement.

9.0 EARTHING OF NEUTRAL OF LOCAL POWER SUPPLY SYSTEM

At traction substations and switching stations where power supply at 415 V/ 240 V, ac 50 Hz is taken from the local supply authority and having neutral earth at some distant point in the premises of the supply authority, the neutral of such supply shall also be earthed by means of two separate and distinct connections made with 6 SWG GI wire by connecting to an independent earth electrode.

10.0 EARTHING ARRANGEMENT AT AUXILIARY TRANSFORMER STATION

10.1 The combined earth resistance at an auxiliary transformer station shall not be more than 10.0 ohms. Normally, one earth electrode is sufficient at each auxiliary transformer station. The earth electrode shall be connected to the mast on which the auxiliary transformer is mounted by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system. In addition, the mast shall be connected to the nearest traction rail or to the neutral point of the impedance bond in a double rail track circuited section by means of 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system.

10.2 The earthing terminal on the transformer tank shall be connected to the mast on which the transformer is mounted by means of two separate and distinct connections made with 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system. One terminal of the secondary winding of the auxiliary transformer shall be connected to the earthing terminal on the transformer tank and as well as to the mast by means of 50 mm x 6 mm MS flat in case of 25kV system and with 75mm X 8mm MS Flat in case of 2X25kV system. These connections shall be as short and straight as possible and avoiding unnecessary bends.

11.0 METHOD OF JOINTING

All the joints between the MS flats, MS rods or between MS flat and MS rod shall be made by welding only. No soldering shall be permitted. For protection against corrosion. All the welded joints shall be treated with red lead and afterwards thickly coated with bitumen compound.

12.0 PAINTING OF MS FLATS

For protection against corrosion, all the exposed surface of earthing connections (MS flats) above ground level shall be given all around two coats of painting to colour grass green, shade 218 of IS:5.

13.0 CRUSHED ROCK SURFACE LAYER

At the traction substations and switching stations, a surface layer of crushed rock shall be provided to a thickness of about 100mm. If considered necessary from the point of view of containing the step and touch voltages within the acceptable limits, higher thicknesses may be provided depending on calculation based on site conditions.

14.0 STEP AND TOUCH VOLTAGES

14.1 The formulae for calculating the tolerable touch and step voltages, estimated mesh and step voltages, earth resistance, earth potential rise, size of earthing grid conductor and length of buried grid conductor are given in Annexure-I & XI.

14.2 The design for earthing grid shall be done separately for each location depending on the conditions obtaining and those foreseen.

15.0 REFERENCE DRAWINGS

The following drawings (latest versions) issued by RDSO in connection with this specification may be used for reference:

SN	Description	Drawing No.	Enclosed at
1.	Typical return current connection of buried rail at traction substation	ETI/PSI/0212-1	ANNEXURE-III
2.	Typical earthing layout of sub sectioning and paralleling station	ETI/PSI/201-1	ANNEXURE-IV
3.	Typical earthing layout of sectioning and paralleling station	ETI/PSI/202-1	ANNEXURE-V
4.	Typical arrangement of an earth electrode	ETI/PSI/222-1	ANNEXURE-VI
5.	Typical earthing arrangement of an auxiliary Transformer station	ETI/PSI/708	ANNEXURE-VII

Note: Drawings as per the revision at the time of issue of specification are enclosed. The latest version of the drawings should be followed.

ANNEXURE-I

FORMULAE FOR CALCULATION OF EARTHING GRID BASED ON IEEE GUIDE FOR SAFETY IN AC SUBSTATION GROUNDING, NO. IEEE 80-2013 & IS: 3043-2018

1.0 Tolerable Touch and Step Voltage

1.1

$$E_{touch} = (1000 + 1.5C_s\rho_s)\frac{0.116}{\sqrt{t_s}} \quad \text{V} \quad \text{(for 50 kg body)}$$

1.2

$$E_{step} = (1000 + 6C_s\rho_s)\frac{0.116}{\sqrt{t_s}} \quad \text{V} \quad \text{(for 50 kg body)}$$

Where,

Symbol	Representation
Cs	$1 - \dfrac{0.09 \times \left(1 - \dfrac{\rho}{\rho_s}\right)}{2 \times h_s + 0.09}$
ρs	Resistivity of surface material (crushed rock) in Ω-m
ρ	Resistivity of earth (Soil) in Ω-m
tS	Duration of shock current in seconds (to be taken as 0.5 seconds)
hS	Thickness of the crushed rock surface layer in m

2.0 Estimated mesh and step voltage

2.1 E mesh $= \dfrac{\rho . K_m . K_i . I_G}{L}$ Volt

2.2 E step $= \dfrac{\rho . K_s . K_i . I_G}{L}$ Volt

Where,

Symbol	Representation
Ki	Correction factor for grid geometry, which accounts for the increase in current density in the grid extremities, = 0.644+ 0.148 X n
IG/L	Average current per unit length of buried conductor in amperes / metre
Km	$Km = \dfrac{1}{2\pi}\left[\ln\left(\dfrac{D^2}{16hd} + \dfrac{(D+2h)^2}{8Dd} - \dfrac{h}{4d}\right) + \dfrac{Kii}{Kh}\ln\dfrac{8}{\pi(2n-1)}\right]$

Symbol	Representation
Kii	1, for grids with earth electrodes along the perimeter, or for grids with earth electrodes in the grid corners, as well as both along the perimeter and throughout the grid area.
	1/ {(2n)(2/n)}, for grids without earth electrodes or grids with only a few earth electrodes, none located in the corners or on the perimeter.
Kh	$\sqrt{1+h/b}$
Ks	$\frac{1}{\pi}\left[\frac{1}{2h}+\frac{1}{D+h}+\frac{1}{D}\left(1-0.5^{n-2}\right)\right]$ for values of h between 0.25 and 2.5m
ho	1 metre (reference depth of grid)
D	Spacing between parallel conductors of grid in m (same spacing in both directions)
n	$n_a \times n_b \times n_c \times n_d$ $n_a = \frac{2.L_c}{L_p}$ $n_b = 1$ for square grids $n_c = 1$ for square and rectangular grids $n_d = 1$ for square, rectangular and L-shaped grids Otherwise $n_b = \sqrt{\frac{L_P}{4\times\sqrt{A}}}$ (Since in Indian Railways, there are square or rectangular grids, other formulas of IEEE-80 are not mentioned here)
h	Depth of earthing grid conductors in metres
d	Diameter of earthing grid conductor in metres
L	Total length of earthing system conductor
	Lc + Lr for grids without earth electrodes or with only a few electrodes located within the grid but away from perimeter
	Lc + 1.15 Lr for grids with earth electrodes along the perimeter
Lc	Total grid conductor length in m
Lr	Total earth electrode length in m
Lp	Peripheral length of grid in m
ρ	Resistivity of earth in Ω-m
A	Area of the grid in m2
I_G	As defined in para 4.1 below.

Note: The estimated values of mesh and step voltage should be less than the tolerable touch and step voltages respectively.

3.0 Earth resistance:

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

Where,

Symbol	Representation
L	Total length of buried conductors in m
A	Area occupied by the earthing grid in m2
Rg	Station ground resistance in ohms
ρ	Resistivity of earth (soil) in Ω-m

4.0 Earth Potential rise:

4.1 Earth potential rise = Rg X I_G

Where,

Symbol	Representation
Rg	Station earth resistances in ohms
I_G	Cp x Df x Ig
Cp	Corrective projection factors accounting for the relative increase of fault currents during the station lifespan: for a zero future system growth Cp = 1
Ig	r.m.s. value of symmetrical grid fault current in amperes.
Df	Decrement factor for the entire duration of faults (to allow for the effects of asymmetry of the fault current wave).
	1.0 for fault current duration of 0.5 second or more.

5.0 Size of earthing grid conductor

$$A = \frac{I\sqrt{t}}{80}$$

Where

Symbol	Representation
A	Cross sectional area of earthing grid conductor in square millimeters.
I	r.m.s value of fault current in amperes.
t	Duration of fault current in second 1. To be taken as 01 second for the calculation of grid conductor size on the basis of HV side Fault MVA. 2. To be taken as 03 second for the calculation of grid conductor size on the basis of LV side fault current, which is 6kA for 25kV System and 12kA for 2X25kV System.

Note: -

1. To allow for the effects of corrosion, the size of the grid conductor selected shall be such that its cross section area is nearly twice that calculated above.
2. The earthing grid conductor size to be calculated on the basis of both primary and secondary side fault current and the higher between them should be selected for designing the grid.

6.0 Minimum length of buried grid conductor

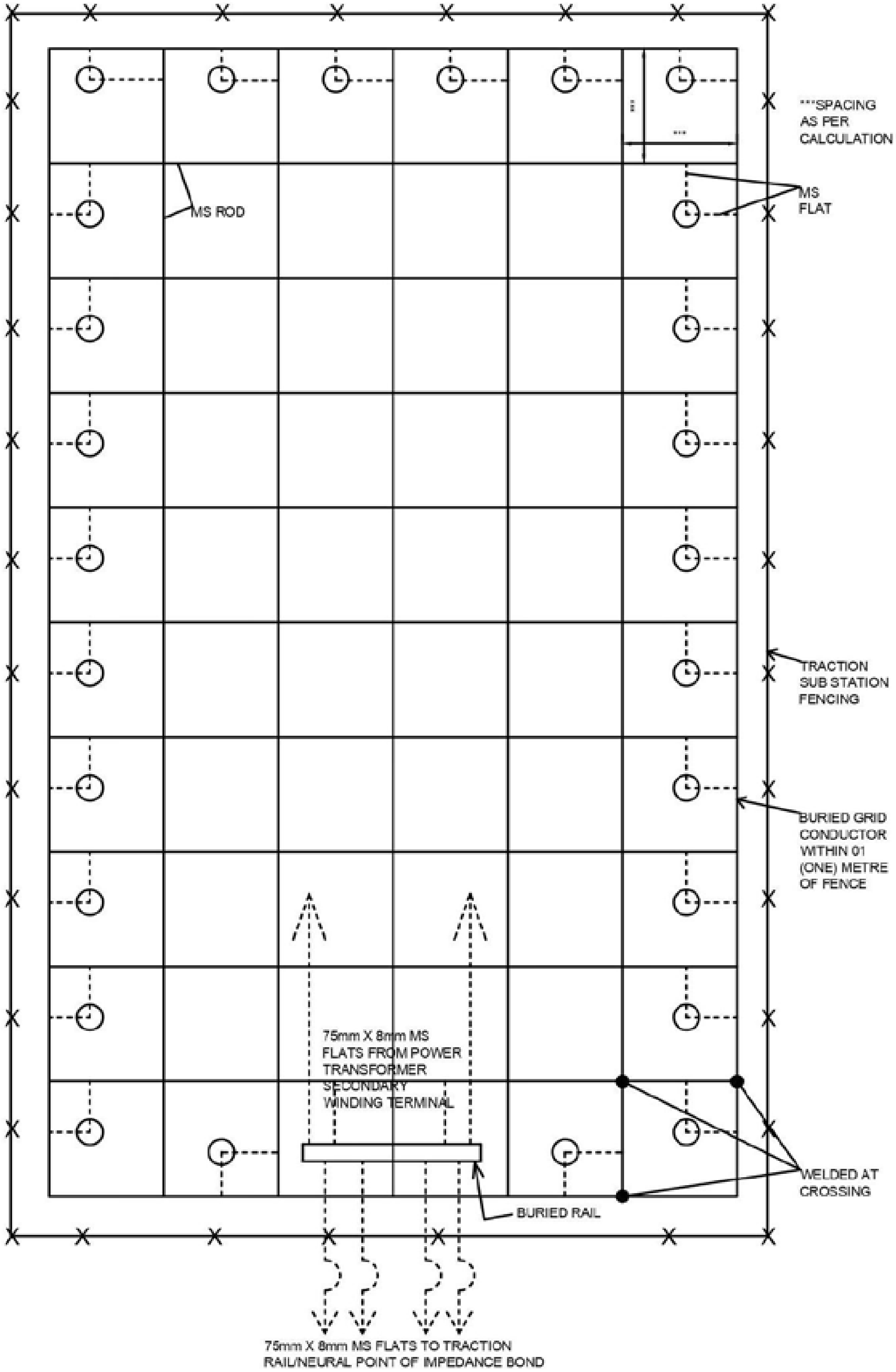
$$\mathbf{L >} \frac{Km \ X \ Ki \ X \ \rho \ X \ IG\sqrt{ts}}{\{116 + 0.174 \ Cs \ X \ \rho s\}} \quad \text{for E mesh < E touch}$$

Where,

Symbol	Representation
L	Minimum length of buried grid conductor including earth electrodes in metres.
ts	0.5 second (assumed maximum duration of shock).
Cs, Km, Ki, ρ, I_G and ρs have been defined earlier.	

Annexure–II

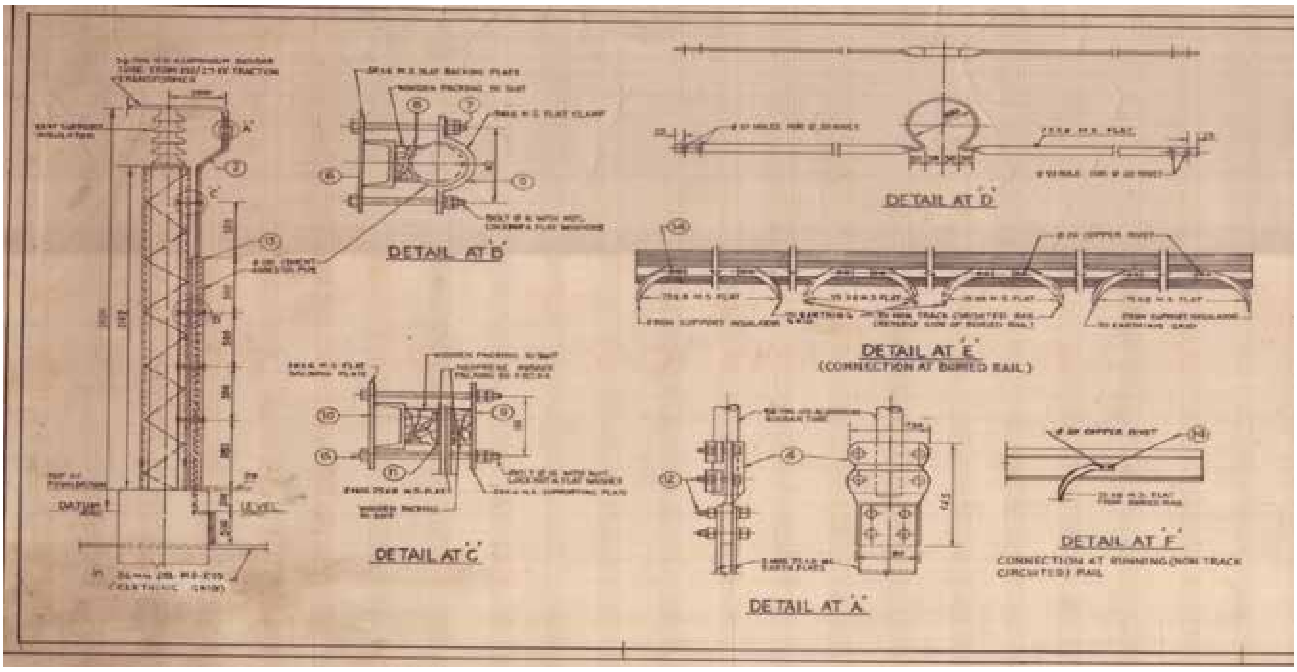
TYPICAL EARTHING GRID (MS ROD)

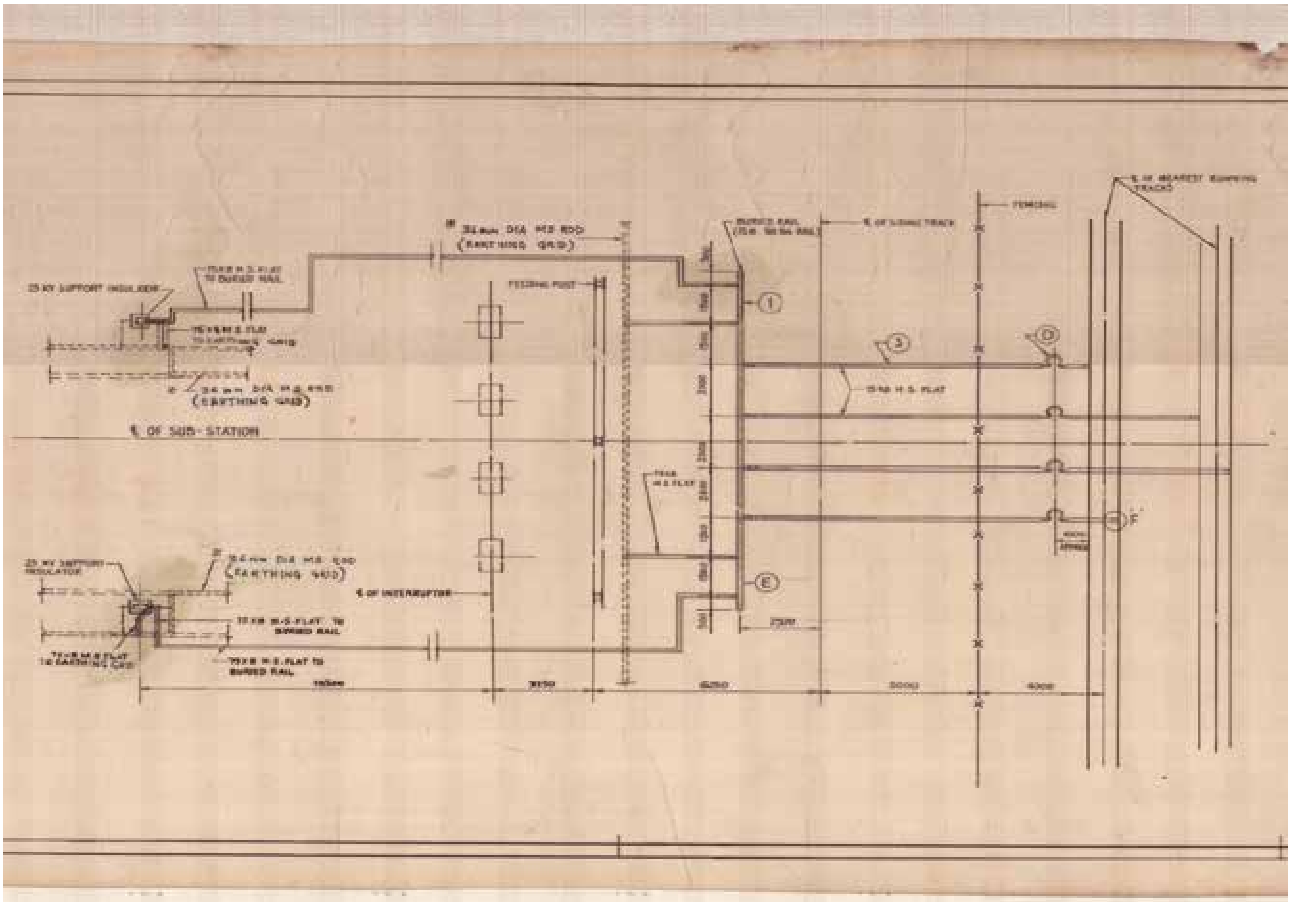


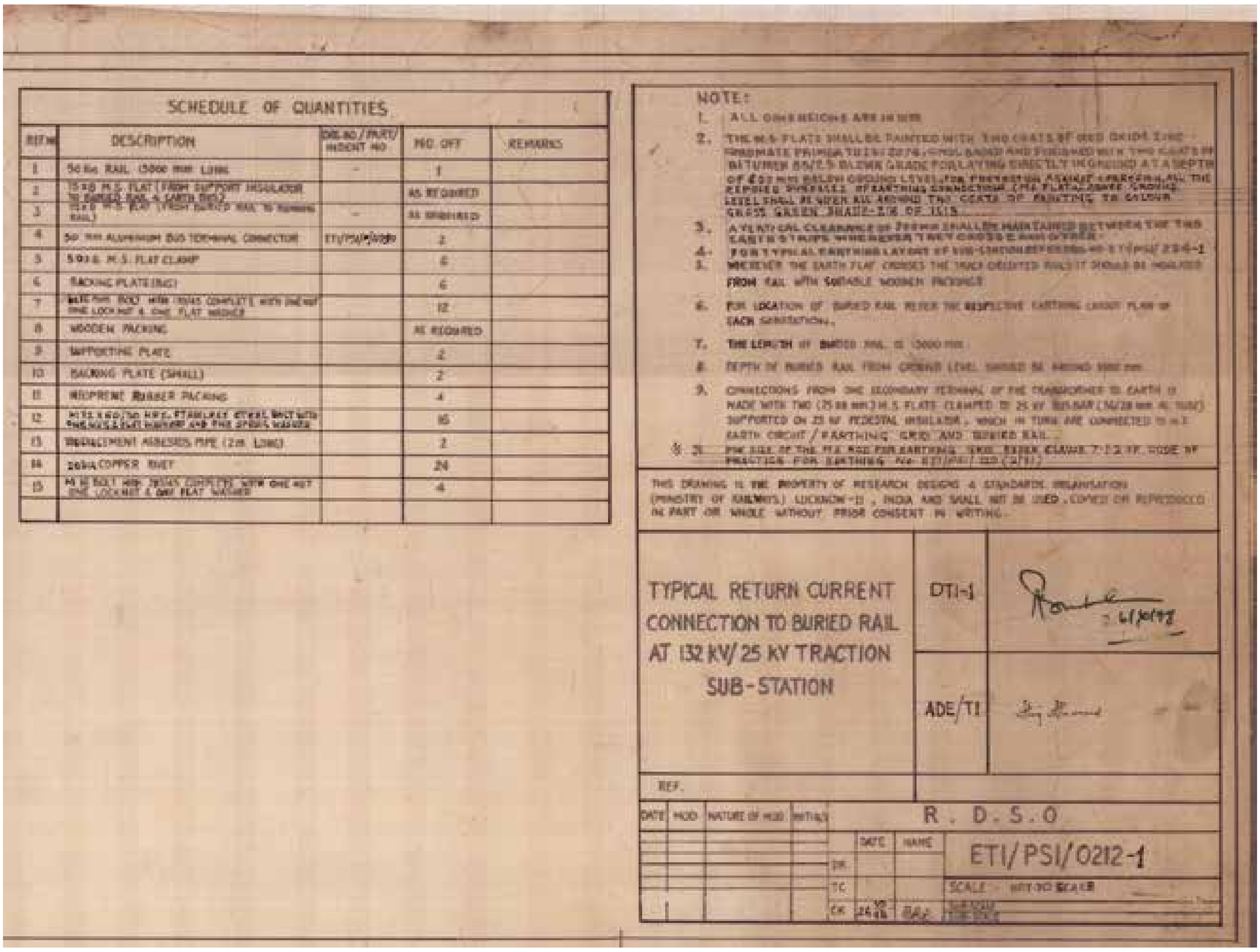
TYPICAL EARTHING GRID (MS ROD)

Annexure-III

Typical return current connection of buried rail at traction substation, drawing no. ETI/PSI/0212-1







SCHEDULE OF QUANTITIES

REF NO	DESCRIPTION	DRG.NO./PART/ INDENT NO	NO. OFF	REMARKS
1	50 Kg RAIL (5000 mm LONG)	-	1	
2	75x8 M.S. FLAT (FROM SUPPORT INSULATOR TO BURIED RAIL & EARTH BUS)		AS REQUIRED	
3	75x8 M.S. FLAT (FROM BURIED RAIL TO RUNNING RAIL)	-	AS REQUIRED	
4	50 mm ALUMINIUM BUS TERMINAL CONNECTOR	ETI/PSI/[illegible]	2	
5	50x16 M.S. FLAT CLAMP		6	
6	BACKING PLATE (BIG)		6	
7	M16 mm BOLT WITH [illegible] COMPLETE WITH ONE NUT ONE LOCKNUT & ONE FLAT WASHER		12	
8	WOODEN PACKING		AS REQUIRED	
9	SUPPORTING PLATE		2	
10	BACKING PLATE (SMALL)		2	
11	NEOPRENE RUBBER PACKING		4	
12	[illegible] STAINLESS STEEL BOLT WITH [illegible] AND [illegible] SPRING WASHER		16	
13	[illegible] ASBESTOS PIPE (2 m LONG)		2	
14	[illegible] COPPER RIVET		24	
15	M 16 BOLT WITH [illegible] COMPLETE WITH ONE NUT ONE LOCKNUT & ONE FLAT WASHER		4	

NOTE:

1. ALL DIMENSIONS ARE IN mm
2. THE M.S. FLATS SHALL BE PAINTED WITH TWO COATS OF RED OXIDE ZINC CHROMATE PRIMER TO IS: 2074, [illegible] AND FINISHED WITH TWO COATS OF BITUMEN [illegible] GRADE FOR LAYING DIRECTLY IN GROUND AT A DEPTH OF 600 mm BELOW GROUND LEVEL FOR PROTECTION AGAINST CORROSION. ALL THE EXPOSED SURFACES OF EARTHING CONNECTIONS (M.S. FLATS) ABOVE GROUND LEVEL SHALL BE GIVEN ALL AROUND TWO COATS OF PAINTING TO COLOUR GRASS GREEN SHADE [illegible] OF IS:[illegible]
3. A VERTICAL CLEARANCE OF [illegible] mm SHALL BE MAINTAINED BETWEEN THE TWO EARTH STRIPS WHEREVER THEY CROSS EACH OTHER.
4. FOR TYPICAL EARTHING LAYOUT OF SUB-STATION REFER DRG. NO. ETI/PSI/[illegible]
5. WHEREVER THE EARTH FLAT CROSSES THE TRACK CIRCUITED RAILS IT SHOULD BE INSULATED FROM RAIL WITH SUITABLE WOODEN PACKINGS.
6. FOR LOCATION OF BURIED RAIL REFER THE RESPECTIVE EARTHING LAYOUT PLAN OF EACH SUBSTATION.
7. THE LENGTH OF BURIED RAIL IS 5000 mm
8. DEPTH OF BURIED RAIL FROM GROUND LEVEL SHOULD BE AROUND [illegible] mm
9. CONNECTIONS FROM ONE SECONDARY TERMINAL OF THE TRANSFORMER TO EARTH IS MADE WITH TWO (75x8 mm) M.S. FLATS CLAMPED TO 25 kV BUS-BAR ([illegible] mm AL TUBE) SUPPORTED ON 25 kV PEDESTAL INSULATOR, WHICH IN TURN ARE CONNECTED TO H.T. EARTH CIRCUIT / EARTHING GRID AND BURIED RAIL.
10. FOR SIZE OF THE M.S. ROD FOR EARTHING [illegible] REFER CLAUSE [illegible] OF CODE OF PRACTICE FOR EARTHING No. ETI/PSI/[illegible]

THIS DRAWING IS THE PROPERTY OF RESEARCH DESIGNS & STANDARDS ORGANISATION (MINISTRY OF RAILWAYS) LUCKNOW-11, INDIA AND SHALL NOT BE USED, COPIED OR REPRODUCED IN PART OR WHOLE WITHOUT PRIOR CONSENT IN WRITING.

TYPICAL RETURN CURRENT CONNECTION TO BURIED RAIL AT 132 KV/25 KV TRACTION SUB-STATION

DTI-1

ADE/TI

REF.

DATE	MOD	NATURE OF MOD	INITIALS

R. D. S. O

	DATE	NAME
DR.		
TC		
CK		

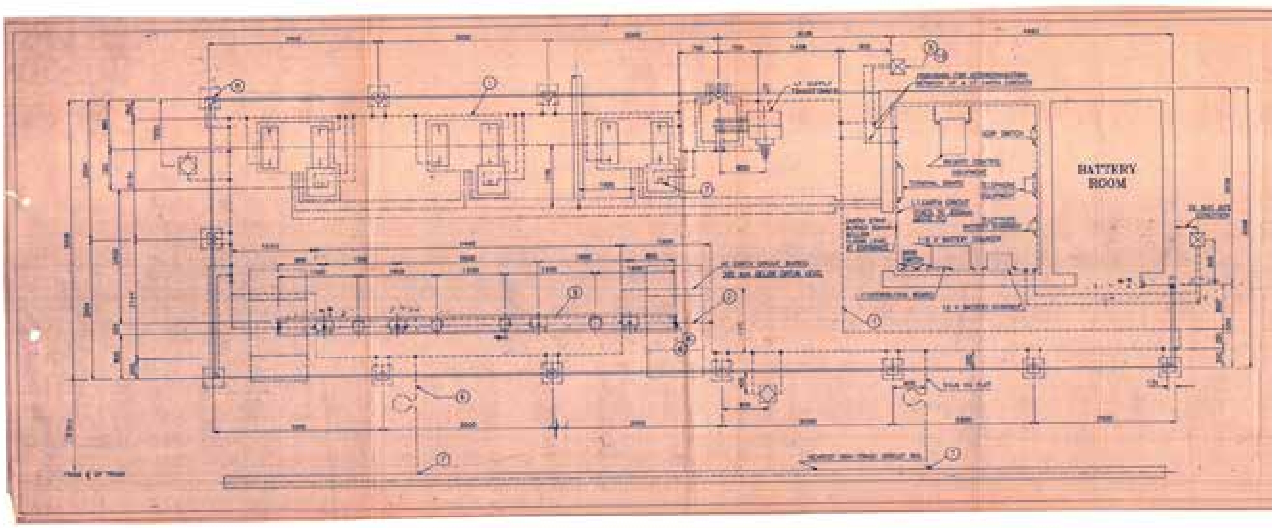
ETI/PSI/0212-1

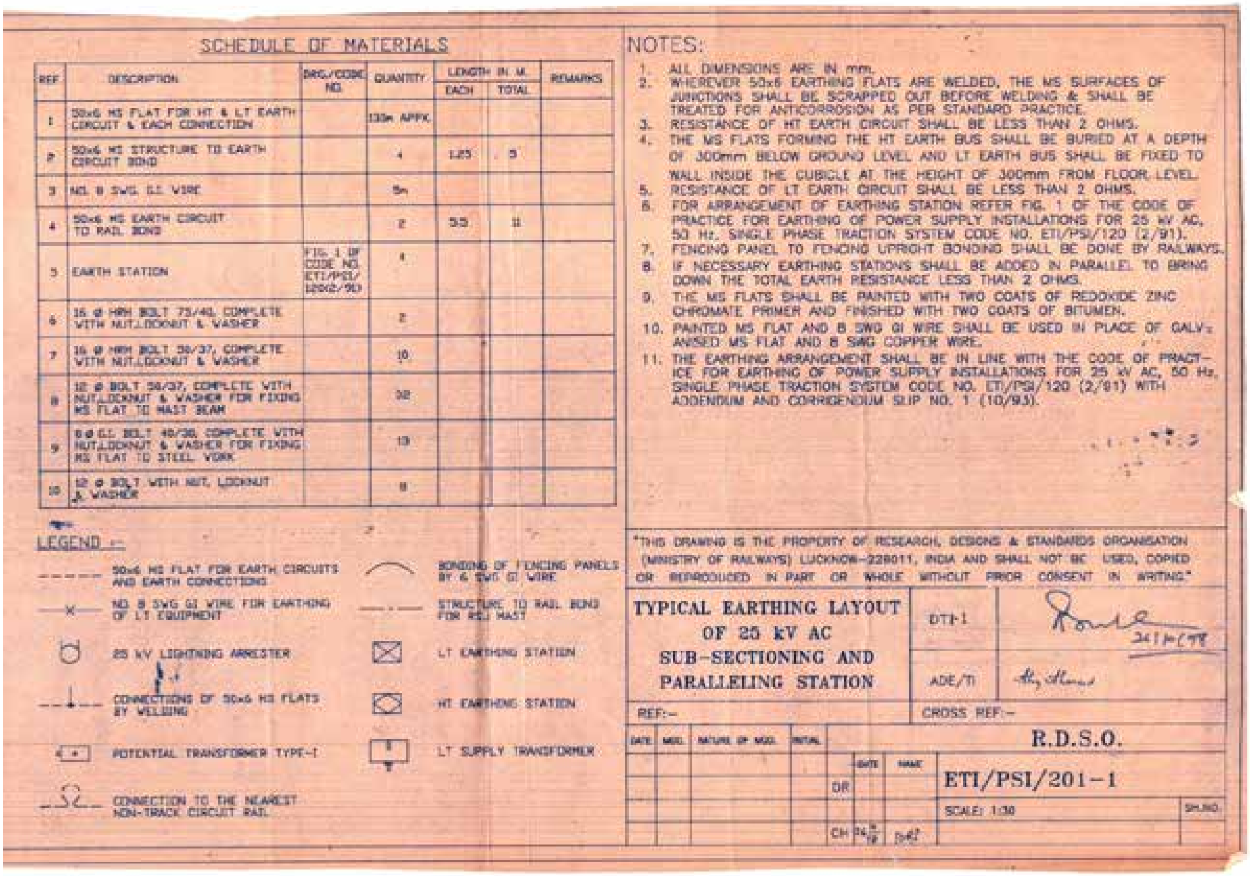
SCALE - NOT TO SCALE

Typical return current connection of buried rail at traction substation, drawing no. ETI/PSI/0212-1

Annexure-IV

Typical Earthing layout of sub sectioning and paralleling station Drawing No. ETI/PSI/201-1





SCHEDULE OF MATERIALS

REF	DESCRIPTION	DRG./CODE NO.	QUANTITY	LENGTH IN M. EACH	LENGTH IN M. TOTAL	REMARKS
1	50x6 MS FLAT FOR HT & LT EARTH CIRCUIT & EACH CONNECTION		130m APPX.			
2	50x6 MS STRUCTURE TO EARTH CIRCUIT BOND		4	1.25	5	
3	NO. 8 SWG G.I. WIRE		5m			
4	50x6 MS EARTH CIRCUIT TO RAIL BOND		2	5.5	11	
5	EARTH STATION	FIG. 1 OF CODE NO. ETI/PSI/12002/90	4			
6	16 Ø HRH BOLT 75/40, COMPLETE WITH NUT,LOCKNUT & WASHER		2			
7	16 Ø HRH BOLT 50/37, COMPLETE WITH NUT,LOCKNUT & WASHER		10			
8	12 Ø BOLT 50/37, COMPLETE WITH NUT,LOCKNUT & WASHER FOR FIXING MS FLAT TO MAST BEAM		32			
9	8 Ø G.I. BOLT 40/30, COMPLETE WITH NUT,LOCKNUT & WASHER FOR FIXING MS FLAT TO STEEL WORK		13			
10	12 Ø BOLT WITH NUT, LOCKNUT & WASHER		8			

NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. WHEREVER 50x6 EARTHING FLATS ARE WELDED, THE MS SURFACES OF JUNCTIONS SHALL BE SCRAPPED OUT BEFORE WELDING & SHALL BE TREATED FOR ANTICORROSION AS PER STANDARD PRACTICE.
3. RESISTANCE OF HT EARTH CIRCUIT SHALL BE LESS THAN 2 OHMS.
4. THE MS FLATS FORMING THE HT EARTH BUS SHALL BE BURIED AT A DEPTH OF 300mm BELOW GROUND LEVEL AND LT EARTH BUS SHALL BE FIXED TO WALL INSIDE THE CUBICLE AT THE HEIGHT OF 300mm FROM FLOOR LEVEL.
5. RESISTANCE OF LT EARTH CIRCUIT SHALL BE LESS THAN 2 OHMS.
6. FOR ARRANGEMENT OF EARTHING STATION REFER FIG. 1 OF THE CODE OF PRACTICE FOR EARTHING OF POWER SUPPLY INSTALLATIONS FOR 25 kV AC, 50 Hz, SINGLE PHASE TRACTION SYSTEM CODE NO. ETI/PSI/120 (2/91).
7. FENCING PANEL TO FENCING UPRIGHT BONDING SHALL BE DONE BY RAILWAYS.
8. IF NECESSARY EARTHING STATIONS SHALL BE ADDED IN PARALLEL TO BRING DOWN THE TOTAL EARTH RESISTANCE LESS THAN 2 OHMS.
9. THE MS FLATS SHALL BE PAINTED WITH TWO COATS OF REDOXIDE ZINC CHROMATE PRIMER AND FINISHED WITH TWO COATS OF BITUMEN.
10. PAINTED MS FLAT AND 8 SWG GI WIRE SHALL BE USED IN PLACE OF GALVANISED MS FLAT AND 8 SWG COPPER WIRE.
11. THE EARTHING ARRANGEMENT SHALL BE IN LINE WITH THE CODE OF PRACTICE FOR EARTHING OF POWER SUPPLY INSTALLATIONS FOR 25 kV AC, 50 Hz, SINGLE PHASE TRACTION SYSTEM CODE NO. ETI/PSI/120 (2/91) WITH ADDENDUM AND CORRIGENDUM SLIP NO. 1 (10/93).

LEGEND :-

- 50x6 MS FLAT FOR EARTH CIRCUITS AND EARTH CONNECTIONS
- NO. 8 SWG GI WIRE FOR EARTHING OF LT EQUIPMENT
- 25 kV LIGHTNING ARRESTER
- CONNECTIONS OF 50x6 MS FLATS BY WELDING
- POTENTIAL TRANSFORMER TYPE-I
- CONNECTION TO THE NEAREST NON-TRACK CIRCUIT RAIL
- BONDING OF FENCING PANELS BY 6 SWG GI WIRE
- STRUCTURE TO RAIL BOND FOR RSJ MAST
- LT EARTHING STATION
- HT EARTHING STATION
- LT SUPPLY TRANSFORMER

"THIS DRAWING IS THE PROPERTY OF RESEARCH, DESIGNS & STANDARDS ORGANISATION (MINISTRY OF RAILWAYS) LUCKNOW-226011, INDIA AND SHALL NOT BE USED, COPIED OR REPRODUCED IN PART OR WHOLE WITHOUT PRIOR CONSENT IN WRITING."

TYPICAL EARTHING LAYOUT OF 25 kV AC SUB-SECTIONING AND PARALLELING STATION

DTI-1

ADE/TI

REF:-

CROSS REF:-

DATE	MOD.	NATURE OF MOD.	INITIAL

R.D.S.O.

DR

CH

DATE NAME

ETI/PSI/201-1

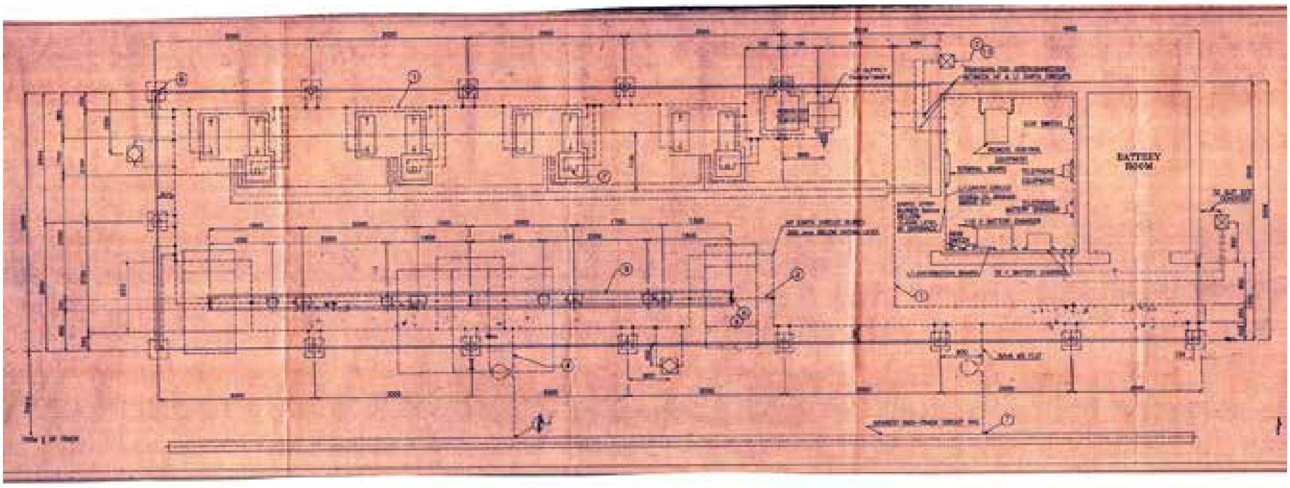
SCALE: 1:30

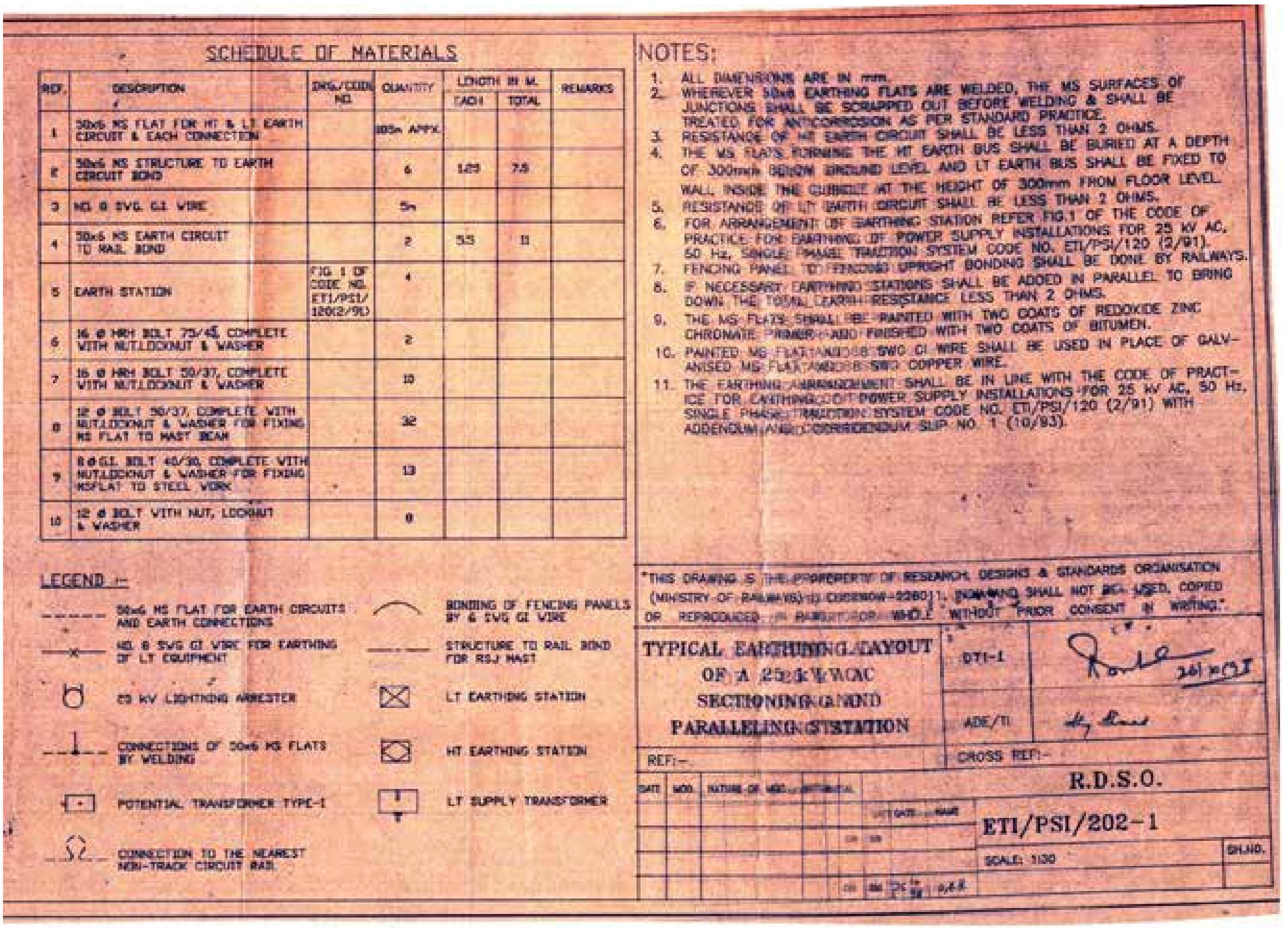
SH.NO.

Typical Earthing layout of sub sectioning and paralleling station Drawing No. ETI/PSI/201-1

Annexure-V

Typical Earthing layout of sectioning and paralleling station, drawing No. ETI/PSI/202-1





SCHEDULE OF MATERIALS

REF.	DESCRIPTION	DWG./CODE NO.	QUANTITY	LENGTH IN M. EACH	LENGTH IN M. TOTAL	REMARKS
1	50x6 MS FLAT FOR HT & LT EARTH CIRCUIT & EACH CONNECTION		105m APPX.			
2	50x6 MS STRUCTURE TO EARTH CIRCUIT BOND		6	1.25	7.5	
3	NO. 8 SWG. G.I. WIRE		5m			
4	50x6 MS EARTH CIRCUIT TO RAIL BOND		2	5.5	11	
5	EARTH STATION	FIG. 1 OF CODE NO. ETI/PSI/120(2/91)	4			
6	16 Ø HRH BOLT 75/45, COMPLETE WITH NUT,LOCKNUT & WASHER		2			
7	16 Ø HRH BOLT 50/37, COMPLETE WITH NUT,LOCKNUT & WASHER		10			
8	12 Ø BOLT 50/37, COMPLETE WITH NUT,LOCKNUT & WASHER FOR FIXING MS FLAT TO MAST BEAM		32			
9	8 Ø G.I. BOLT 40/30, COMPLETE WITH NUT,LOCKNUT & WASHER FOR FIXING MSFLAT TO STEEL WORK		13			
10	12 Ø BOLT WITH NUT, LOCKNUT & WASHER		8			

NOTES:

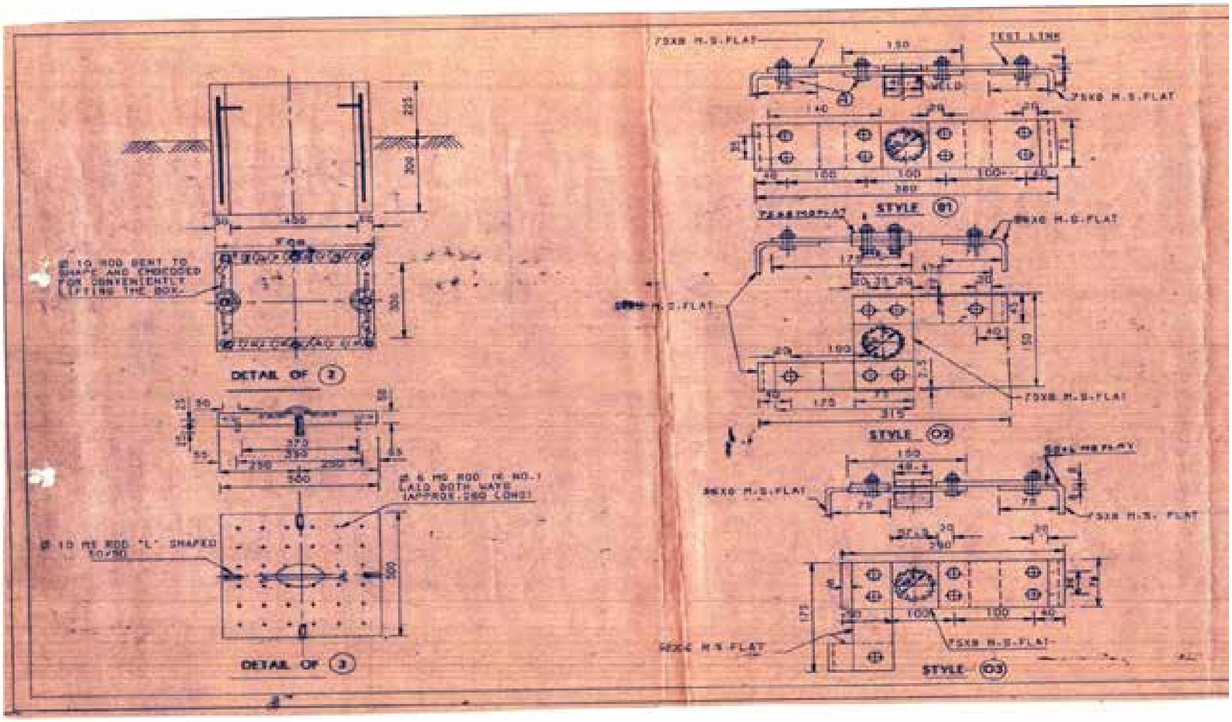
1. ALL DIMENSIONS ARE IN mm.
2. WHEREVER 50x6 EARTHING FLATS ARE WELDED, THE MS SURFACES OF JUNCTIONS SHALL BE SCRAPPED OUT BEFORE WELDING & SHALL BE TREATED FOR ANTICORROSION AS PER STANDARD PRACTICE.
3. RESISTANCE OF HT EARTH CIRCUIT SHALL BE LESS THAN 2 OHMS.
4. THE MS FLATS FORMING THE HT EARTH BUS SHALL BE BURIED AT A DEPTH OF 300mm BELOW GROUND LEVEL AND LT EARTH BUS SHALL BE FIXED TO WALL INSIDE THE CUBICLE AT THE HEIGHT OF 300mm FROM FLOOR LEVEL.
5. RESISTANCE OF LT EARTH CIRCUIT SHALL BE LESS THAN 2 OHMS.
6. FOR ARRANGEMENT OF EARTHING STATION REFER FIG.1 OF THE CODE OF PRACTICE FOR EARTHING OF POWER SUPPLY INSTALLATIONS FOR 25 kV AC, 50 Hz, SINGLE PHASE TRACTION SYSTEM CODE NO. ETI/PSI/120 (2/91).
7. FENCING PANEL TO FENCING UPRIGHT BONDING SHALL BE DONE BY RAILWAYS.
8. IF NECESSARY EARTHING STATIONS SHALL BE ADDED IN PARALLEL TO BRING DOWN THE TOTAL EARTH RESISTANCE LESS THAN 2 OHMS.
9. THE MS FLATS SHALL BE PAINTED WITH TWO COATS OF REDOXIDE ZINC CHROMATE PRIMER AND FINISHED WITH TWO COATS OF BITUMEN.
10. PAINTED MS FLAT AND 8 SWG GI WIRE SHALL BE USED IN PLACE OF GALVANISED MS FLAT AND 8 SWG COPPER WIRE.
11. THE EARTHING ARRANGEMENT SHALL BE IN LINE WITH THE CODE OF PRACTICE FOR EARTHING OF POWER SUPPLY INSTALLATIONS FOR 25 kV AC, 50 Hz, SINGLE PHASE TRACTION SYSTEM CODE NO. ETI/PSI/120 (2/91) WITH ADDENDUM AND CORRIGENDUM SLIP NO. 1 (10/93).

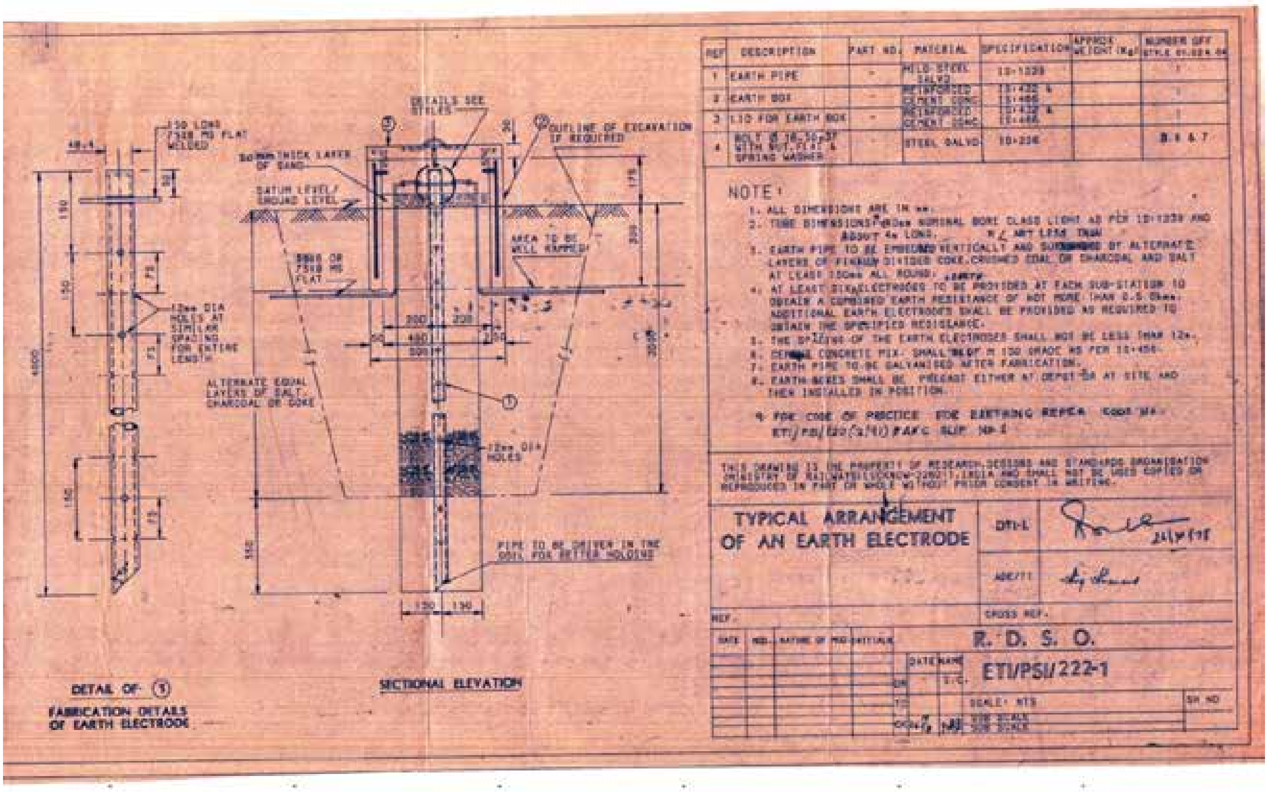
LEGEND :-

Typical Earthing layout of sectioning and paralleling station, drawing No. ETI/PSI/202-1

Annexure-VI

Typical arrangement of an earth electrode Drawing No. ETI/PSI/222-1

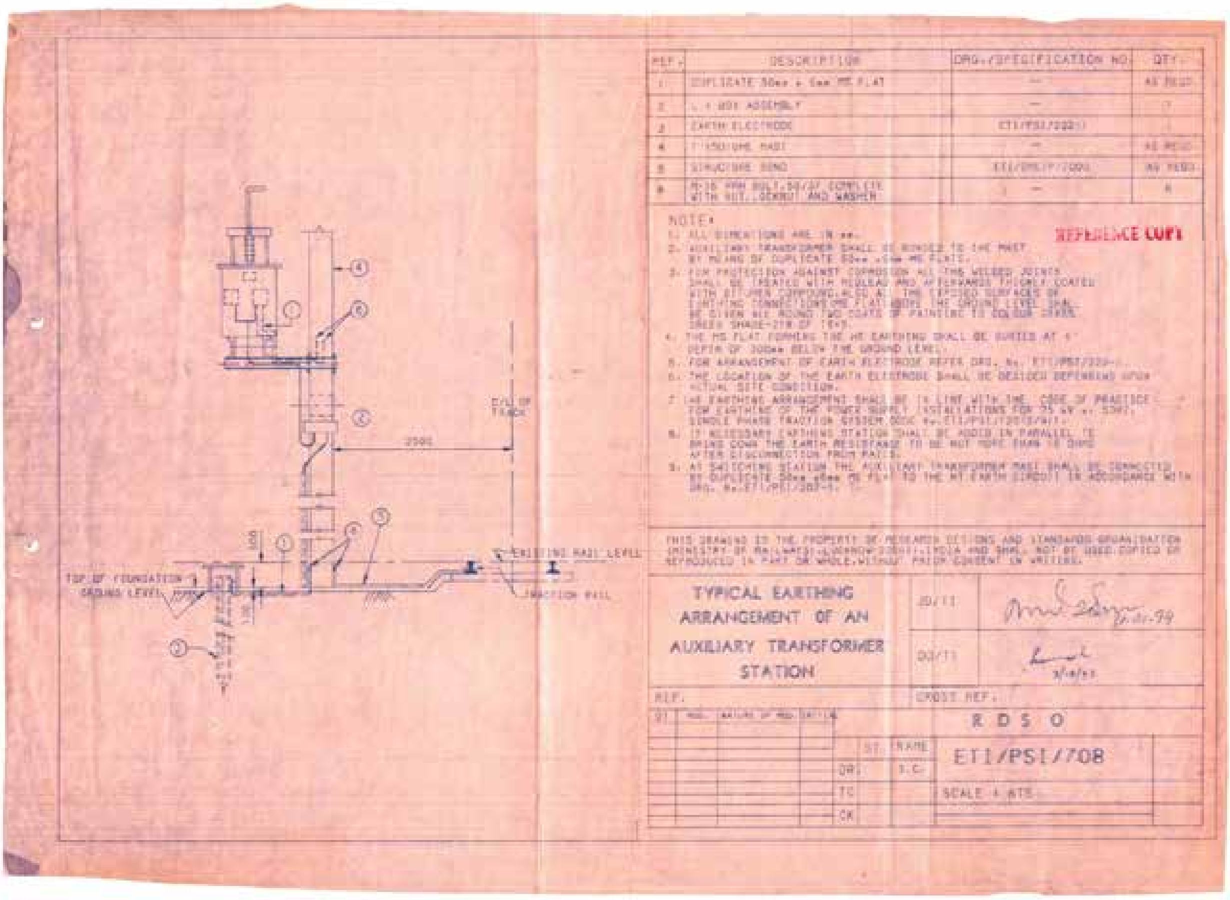




Typical arrangement of an earth electrode Drawing No. ETI/PSI/222-1

Annexure- VII

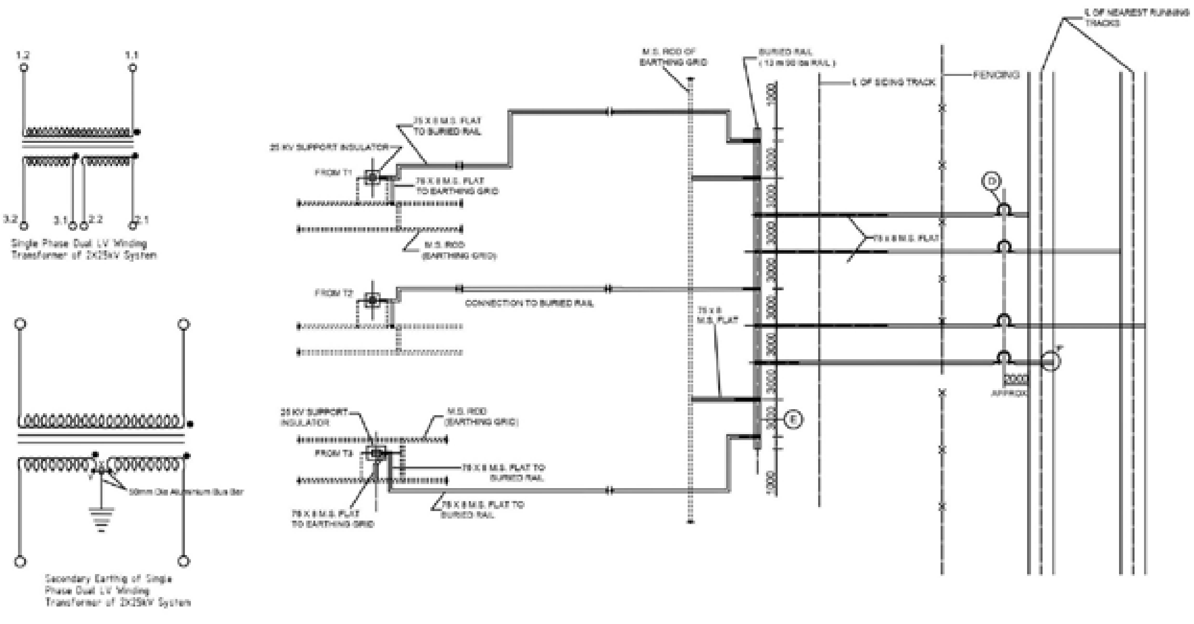
Typical Earthing arrangement of an Auxiliary Transformer station, Drawing No. ETI/PSI/708



Typical Earthing arrangement of an Auxiliary Transformer station, Drawing No. ETI/PSI/708

Annexure-VIII

Connection arrangement to Buried Rail in TSS of V Connected Transformer

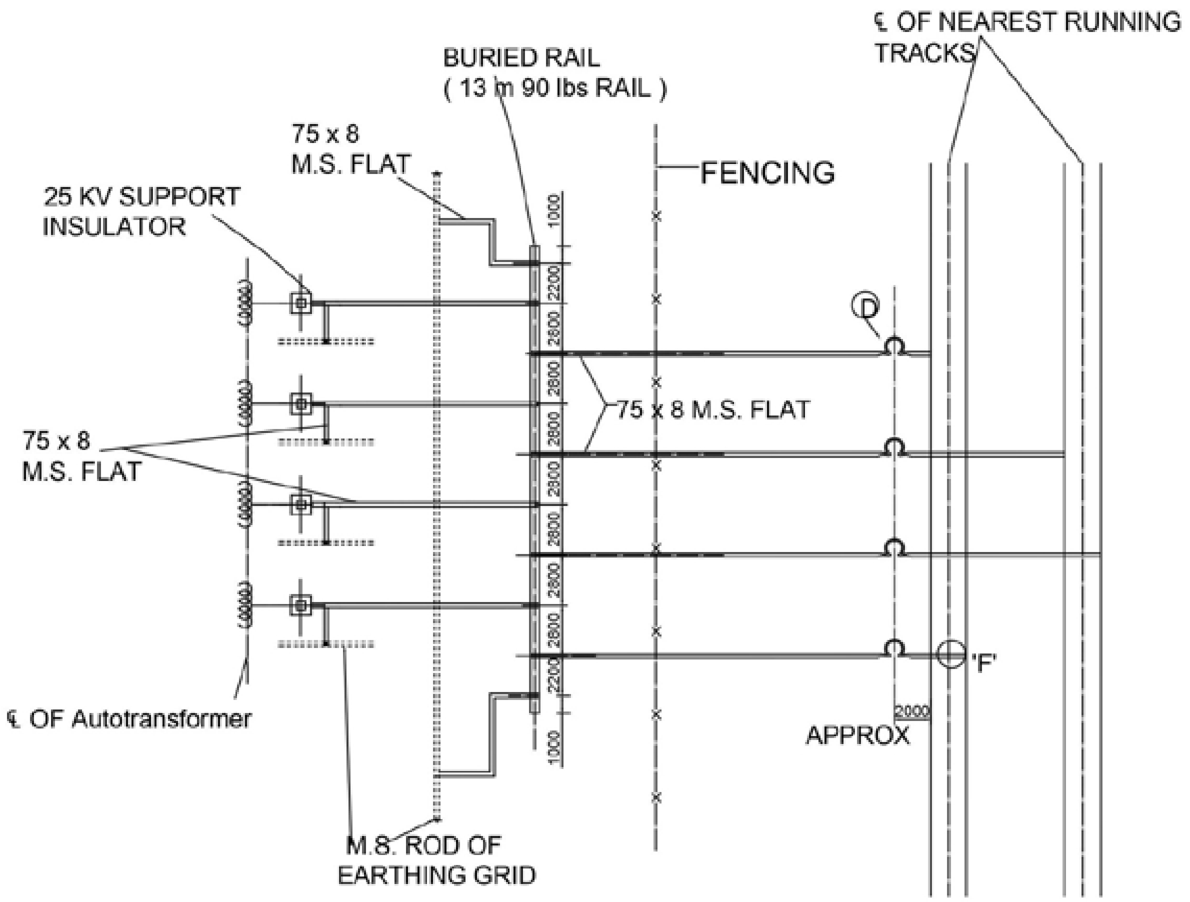


NOTE :

1. Connection arrangement of the Secondary Mid Point Earthing of the Single Phase, Dual LV winding Transformer of 2X25kV System to the Buried Rail and Earthing Grid.
2. This layout is for showing the connection arrangement of MS Flats. The dimension, orientation & locations of MS flats to be decided as per TSS layout of the site, since there are different type of layouts as per the site conditions.
3. For the details of 'D' and 'F' and other general details drawing no. ETI/PSI/0212-1 to be referred.

Annexure-IX

Connection arrangement to Buried Rail of Autotransformer at Scott Connected TSS and at SP/SSP of 2X25kV system



NOTE :

1. Connection arrangement of the Autotransformer of 2X25kV System to the Buried Rail and Earthing Grid.

2. This layout is for showing the connection arrangement of MS Flats. The dimension, orientation & locations of MS flats to be decided as per TSS layout of the site, since there are different type of layouts as per the site conditions.

3. For the details of 'D' and 'F' and other general details drawing no. ETI/PSI/0212-1 to be referred.

Annexure-X

1.0 INTRODUCTION

1.1 This SMI supersedes the SMI No. TI/SMI/0032 Rev.01 issued by RDSO vide letter no. TI/PSI/Earthing/Policy/14 dated 01.04.2014.

1.2 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.

1.3 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 is decided to create Earthing stations at a place near the Switching Posts (SP/SSP). Idea is to create a positive, strong and deliberate earth connection to improve system resilience.

1.4 The SMI No. TI/SMI/0031 Rev.01 was discussed in the 30th MSG (TRD) held at Mount Abu on 13th & 14th April 2018 and 31st MSG (TRD) held at Somnath on 08th & 09th November 2019. The group deliberated for the revision of SMI.

2.0 REFERRED DOCUMENTS

SN	Document	Description	Number
1.	Specification	Code for Bonding and Earthing for 25 kV, a.c., 50 Hz Single Phase Traction System.	ETI/OHE/71
2.	Specification	Code of Practice for Earthing of Power Supply Installations for 25 kv, ac, 50Hz, Single Phase traction System.	ETI/PSI/120
3.	Specification	Specification for Exothermic Welding (Connection for Bonding, Earthing /Grounding)	TI/SPC/OHE/EXOTHR MBOND/0100 (04/10)
4.	Specification	Specification for Stainless Steel fasteners for 25kV AC Traction Overhead equipment	TI/SPC/OHE/FASTNE RS/0120 rev.01
5.	Drawing	Earthing Station	ETI/OHE/P/7020
6.	Drawing	Typical Earthing Layout at Feeding Station	ETI/PSI/203
7.	Drawing	Typical return Current connection to Buried Rail at 132/25 kV Traction Sub Station	ETI/PSI/0212-1
8.	Drawing	Return Current Connection to the Sub Sectioning and Paralleling Post.	ETI/PSI/0201-1
9.	Drawing	Return Current Connection to the Sectioning and Paralleling Post.	ETI/PSI/0202-1

3.0 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.

4.0 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 RDSO Drawing No. ETI/PSI/203. The following are main components of the present Feeding Post Earthing Station:-

4.1 BURIED RAIL: Acts as maintenance free Earth Bus.

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

4.3 EARTH ELECTRODES: Couples the Buried Rail to parent earth and hence bringing down the Earth potential.

5.0 DESIGN OF THE EARTHING STATION

Two Earthing Stations near the Switching Station, one on either side of the UP and DN track, shall be provided. For multi track system [i.e. Block Sections having more than two tracks (UP & DN track)], separate Earthing Station for each track shall be provided.

5.1 GENERAL ARRANGEMENT

Preferably Rail or TRD mast (all type) of length more than 9 m shall be used to create an Earth station. The released Rails/TRD Masts should always be preferred. Two Earth Electrodes shall be provided at each end of the Buried Rail as per RDSO Drawing No. ETI/OHE/P/7020. Thus the Buried Rail would be configured as Earth Bus.

5.2 DESIGN

A trench, of size about 0.6 m x 'X' m, with a depth of about 1 m from the ground level shall be dug on the track side. ('X' should be more than 2 m of the length of the Rail/TRD mast used)

5.2.1 At a distance of about 1.5m ± 0.5 m, from either ends of the Buried Rail, two 19 mm Φ holes are drilled for connection to earth pits. 02 more holes at 1.5m ± 0.5 m from the above holes to be drilled for connection to track.

5.2.2 Two electrodes shall be provided as per RDSO Drawing No. ETI/OHE/P/7020 at a distance of 1.5m±1.0m on both ends. Earthing shall be provided as described in RDSO Drawing No. ETI/PSI/0212-1 and mentioned at page no. 4 & 5 of this SMI. GI flats are preferably to be used for earthing, in view of longer life, but in case of non-availability of GI Flats, standard MS Flats can be used after painting them with two coats of Aluminium paint. Subsequently the word GI Flat will mean both the above methods.

5.2.3 Preparation of Earth Bus (Buried Rail)

5.2.3.1 The Rail (this nomenclature includes masts as mentioned in Para 5.1), duly prepared, shall be lowered in to the trench.

5.2.3.2 The connection between the Buried Rail and Earth Electrodes of respective Earth Pits on both sides shall be done through 75 x 8 mm GI Flats, by using 20 mm Φ Stainless Steel bolts as mentioned at page no. 4&5 of this SMI.

5.2.4 Preparation of Running Rail

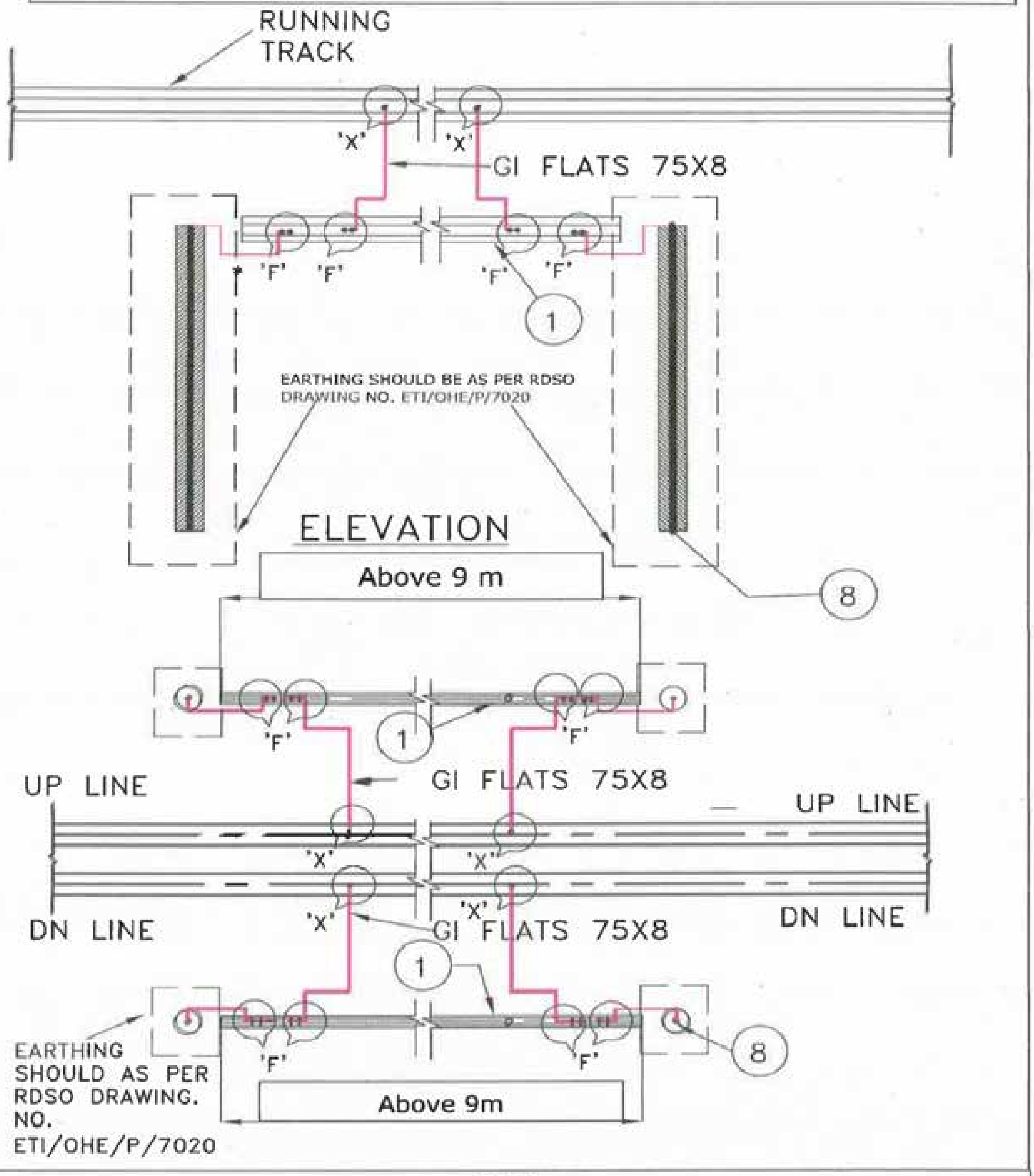
Holes are drilled on the web of running Rail and connection to be made as mentioned on page no. 4&5 of this SMI.

5.2.5 Connection between the Running Rail and Buried Rail

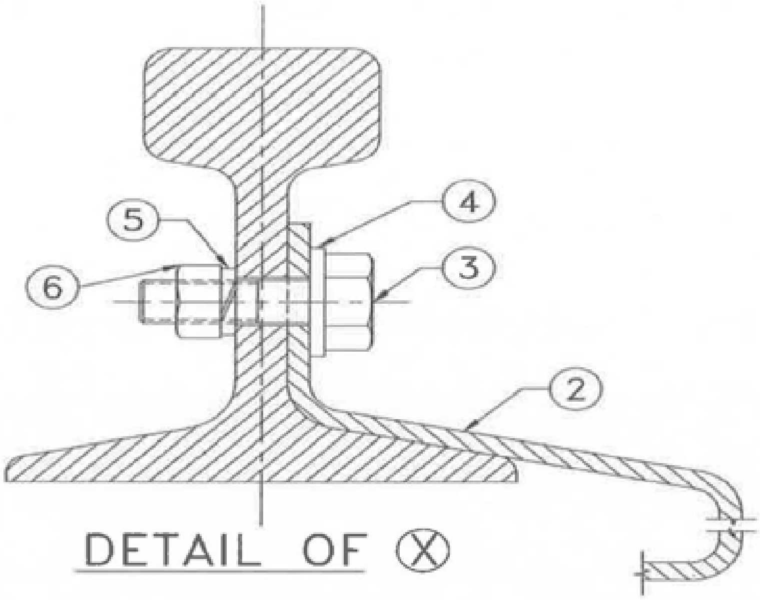
Connections between the Running Rail and the Buried Rail are made with two GI Flats of size 75 x 8 mm, connected with Buried Rail with 20 mm Stainless steel bolts, as per RDSO Drawing No. ETI/PSI/0212-1 and to the Running Rail with M-12 Bolt, as mentioned at page no. 4&5 of this SMI.

6.0 Connection arrangement of the Running Rail – Buried Rail – Earth Electrodes

* For detail of 'X' refer page no. 05 of this SMI.
* For detail of 'F' refer RDSO Drawing no. ETI/PSI/0212-1



PLAN



7.0 The Earth electrode shall be made as per Drawing No. ETI/OHE/P/7020.

8.0 For Buried Rail Drawing No. ETI/PSI/0212-1 to be referred.

9.0 Schedule of materials:

Ref:	Description	Quantity
1.	Above 9 m long rails or TRD masts.	02 Nos.
2.	Galvanised Iron Flats of 75mm X8 mm	as required
3.	M-12 Bolts (Stainless steel)	04 Nos
4.	Plain washer	04 Nos
5.	Lock washer (Spring steel)	04 Nos
6.	Nuts	04 Nos
7.	M-20 Bolts (Stainless steel) (for connection of GI flat to buried rail)	16 Nos
8.	Earth electrode as per RDSO Drawing no. ETI/OHE/P/7020	04 Nos

****

Annexure-XI

Sample Calculation for the Design of Earthing Mat for a TSS

(**Note:** This calculations is for example with assumed values, actual site values are to be taken for the actual calculations)

Data assumed for calculations:

1.	Resistivity of earth (Soil) in (ρ)	40 Ω-m
2.	Incoming Voltage	132kV
3.	Fault Level at incoming side (i.e. 132kV side)	7000 MVA
4.	Fault Current on primary side, Ig	(7000)/(√3 X 132) = 30618A
5.	Grid Dimensions	100m X 50m, Area = 5000m2
6.	Resistivity of surface material (crushed rock), ρs	3000 Ω-m
7.	Thickness of the crushed rock surface layer , hS	0.1 m
8.	Depth of Earth mat, h	0.6 m
9.	Reference depth of grid , ho	1.0m

Standard Values to be taken:

1.	Duration of Fault current, t	1. To be taken as 01 second for the calculation of grid conductor size on the basis of HV side fault current. 2. To be taken as 03 second for the calculation of grid conductor size on the basis of LV side fault current.
		0.5 second for determining the Tolerable touch and step potential
2.	Resistance of the Main Earthing Mat	0.5 Ω (maximum) for TSS

Step 1: Diameter of the grid MS rod size calculation (d):

i. On the basis of HV side fault current i.e. 30618A for 01 second,

$$A = \frac{I\sqrt{t}}{80} = (30618 \text{ x } \sqrt{1})/\ 80 = 382.724 \text{ mm}^2$$

By taking 100% margin factor due to corrosion, required area = 2 x 382.724 = 765.44 mm^2

So, required conductor dia= √(765.44/3.14) x 2 = 31.22 mm

ii. On the basis of LV side fault current i.e. 6kA for 3 seconds,

$$A = \frac{I\sqrt{t}}{80} = (6000 \text{ x } \sqrt{3})/\ 80 = 129.9 \text{ mm}^2$$

By taking 100% margin factor due to corrosion, required area = 2 x 129.9 = 259.8 mm2

So, required conductor dia= √(259.8/3.14) x 2 = 18.19mm

Higher between (i) & (ii) above is 31.22 mm. Now, considering the Para 7.1.2 of the specification, 32mm Diameter grid conductor is to be used.

Step 2: Tolerable Step & Touch Potential

$$E_{touch} = (1000 + 1.5C_s\rho_s)\frac{0.116}{\sqrt{t_s}}$$

Where, Cs = $$1 - \frac{0.09 \times \left(1 - \frac{\rho}{\rho_s}\right)}{2 \times h_s + 0.09}$$ = 0.694

E_{touch} = {(1000+ 1.5 x 0.694 x 3000)} x {(0.116) /(√0.5)}

= 676.220V

$$E_{step} = (1000 + 6C_s\rho_s)\frac{0.116}{\sqrt{t_s}}$$

E_{step} = {(1000+ 6 x 0.694 x 3000)} x {(0.116) /(√0.5)}

= 2212.735V

Step 3: Design of Grid

Grid layout = 100m X 50m

Assumed spacing between earth grid conductors (D) = 5m

So, No. of Vertical rods in earth mat Nx = (100/5) = taken as 20 and No. of Horizontal rods in earth mat Ny = (50/5) = Taken as 10

Total length of earthing system conductor (L)

= Lc + 1.15 Lr for grids with earth electrodes along the perimeter

Lc = 100 x 10 + 50 x 20 = 2000m

Assuming no. of earth electrodes = 70

So, Lr = 4 X 70 = 280m (4m length of earth electrode)

Total length of Earth conductor = 2000 + 1.15 x 280 = 2320m

Step 4: Grid resistance:

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

Rg = {0.443 x (40/√5000)} + (40/2320)

= 0.268 Ω

Step 5: Maximum Grid Current (IG)

I_G = Cp x Df x Ig

= 1 x 1 x 30618 = 30618A

Step 6: Earth Potential rise

= Rg x IG

= 0.268 x 30618 = 8200V

Step 7: Estimated mesh and step voltage

Estimated mesh voltage

E mesh = $\dfrac{\rho.K_m.K_i.I_G}{L}$

Ki = 0.644+ (0.148 X n)

$n = n_a \times n_b \times n_c \times n_d$

= 13.33 X 1.02 x 1 x 1 = 13.73

Ki = 0.644 + (0.148 x 13.73)

Ki = 2.676

$$Km = \frac{1}{2\pi}\left[\ln\left(\frac{D^2}{16hd}+\frac{(D+2h)^2}{8Dd}-\frac{h}{4d}\right)+\frac{Kii}{Kh}\ln\frac{8}{\pi(2n-1)}\right]$$

Kh = $\sqrt{1 + h/b}$ = 1.2649, Kii = 1, n= 13.73, D = 5m, d = .032m, h= 0.6m

Thus, Km = 0.409607

Now, E mesh = (40 x 0.409607 x 2.676 x 30618)/(2320)
= 578 V (Which is less than 676.22 V, tolerable mesh voltage)

Estimated step voltage

E step = $\dfrac{\rho.K_s.K_i.I_G}{L}$ V

.Ks = $\dfrac{1}{\pi}\left[\dfrac{1}{2h}+\dfrac{1}{D+h}+\dfrac{1}{D}\left(1-0.5^{n-2}\right)\right]$ = 0.385938

Estep = (40 x 0.3859 x 2.676 x 30618)/(2320)
= 545V (Which is less than 2212.735 V, tolerable step voltage)

Estimated Touch Voltage is less than Tolerable Touch Voltage and Estimated Step Potential is less than Tolerable Step Potential, Thus design is safe.

Annexure-XII

Sample Calculation for the Design of Earthing Mat for TSS, SP & SSP of 2X25kV System

(**Note:** This calculations is for example with assumed values, actual site values are to be taken for the actual calculations)

Data assumed for calculations for TSS:

1.	Resistivity of earth (Soil) in (ρ)	40 Ω-m
2.	Incoming Voltage	132kV
3.	Fault Level at incoming side (i.e. 132kV side)	7000 MVA
4.	Fault Current on primary side, I_g	(7000)/(√3 X 132) = 30618A
5.	Grid Dimensions	100m X 50 m, Area = 5000 m^2
6.	Resistivity of surface material (crushed rock), ρs	3000 Ω-m
7.	Thickness of the crushed rock surface layer, hs	0.1 m
8.	Depth of Earth mat, h	0.6 m
9.	Reference depth of grid , ho	1.0 m

Data assumed for calculations for SP &SSP:

1.	Resistivity of earth (Soil) in (ρ)	40 Ω-m
2.	Fault Current to be taken	12000A
3.	Grid Dimensions	50m X 30m, Area = 1500m2
4.	Resistivity of surface material (crushed rock), ρs	3000 Ω-m
5.	Thickness of the crushed rock surface layer , hs	0.1 m
6.	Depth of Earth mat, h	0.6 m
7.	Reference depth of grid , ho	1.0 m

Standard Values to be taken:

1.	Duration of Fault current , t	1. To be taken as 01 second for the calculation of grid conductor size on the basis of HV side fault current. 2. To be taken as 03 second for the calculation of grid conductor size on the basis of LV side fault current.
		0.5 second for determining the Tolerable touch and step potential
2.	Resistance of the Main Earthing Mat	0.5 Ω (maximum) for TSS 2.0 Ω (maximum) for SP & SSP

Step 1: Diameter of the grid MS rod size calculation (d):

1. On the basis of HV side fault current i.e. 30618A for 01 second, (by assuming Fault MVA 7000MVA at primary side)

$$A = \frac{I\sqrt{t}}{80} = (30618 \times \sqrt{1})/\ 80 = 382.72 \text{ mm}^2$$

By taking 100% margin factor due to corrosion, required area = 2 x 382.72 = 765.44 mm^2
So, required conductor dia= √(765.44/3.14) x 2 = 31.22mm

2. On the basis of LV side fault current i.e. 12kA for 3 seconds,

Diameter of the grid MS rod size calculation (d):

A = $\dfrac{I\sqrt{t}}{80}$ = (12000 x √3)/80 = 259.8 mm²

By taking 100% margin factor due to corrosion, required area = 2 x 259.8 = 519.6 mm2

So, required conductor Dia= √(903.68/3.14) x 2 = 25.73mm

Higher between (i) & (ii) above is 31.22 mm. Now, considering the Para 7.1.2 of the specification, 32mm Diameter grid conductor is to be used at the TSS. Considering the uniformity in the size of the buried grid conductor, at the SP & SSP of 2X25kV system also 32mm Diameter grid conductor is to be used.

A Sample calculation for the TSS is already given at Annexure-XII. Therefore, for the SP &SSP the calculation is mentioned below:

Sample calculation for SP & SSP of 2X25kV is given as below:

Step 2: Tolerable Step & Touch Potential

$$E_{touch} = (1000 + 1.5C_s\rho_s)\frac{0.116}{\sqrt{t_s}}$$

Where, Cs = $1 - \dfrac{0.09 \times \left(1 - \dfrac{\rho}{\rho_s}\right)}{2 \times h_s + 0.09}$ = 0.694

E_{touch} = {(1000+ 1.5 x 0.694 x 3000)} x {(0.116) /(√0.5)}
= 676.220V

$$E_{step} = (1000 + 6C_s\rho_s)\frac{0.116}{\sqrt{t_s}}$$

E_{step} = {(1000+ 6 x 0.694 x 3000)} x {(0.116) /(√0.5)}
= 2212.735V

Step 3: Design of Earthing Grid

Grid layout = 50m X 30m

Assumed spacing between earth grid conductors (D) = 5m

So, No. of Vertical rods in earth mat Nx = (50/5) = 10

and No. of Horizontal rods in earth mat Ny = (30/5) = 6

Total length of earthing system conductor (L)

= Lc + 1.15 Lr for grids with earth electrodes along the perimeter

Now, Lc = 50x 6 + 30 x 10 = 600m

Assuming no. of earth electrodes = 10

So, Lr = 4 X 10 = 40m (4m length of earth electrode)

Total length of Earth conductor = 600 + 1.15 x 40 = 646m

Step 4: Grid resistance

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

R_g = {0.443 x (40/√1500)} + (40/637)
= 0.52Ω

Step 5: Maximum Grid Current (I_G)

I_G = Cp x Df x Ig
= 1 x 1 x 12000 = 12000A

Step 6: Earth Potential rise

= Rg X IG
= 0.52 x 12000 = 6240 V

Step 7: Estimated mesh and step voltage

Estimated mesh voltage

$$E\ mesh = \frac{\rho.K_m.K_i.I_G}{L}$$

Ki = 0.644+ (0.148 X n)

$$n = n_a \times n_b \times n_c \times n_d$$

= 7.5 X 1.01 x 1 x 1 = 7.6

Ki = 0.644 + (0.148 x 7.6) = 1.77

$$Km = \frac{1}{2\pi}\left[\ln\left(\frac{D^2}{16hd} + \frac{(D+2h)^2}{8Dd} - \frac{h}{4d}\right) + \frac{Kii}{Kh}\ln\frac{8}{\pi(2n-1)}\right]$$

$Kh = \sqrt{1 + h/ho}$ = 1.2649, Kii = 1, n= 7.6, D = 5m,
d = .032m, h= 0.6m

Thus, Km = 0.49

Now, E mesh = (40 x 0.49 x 1.77 x 12000)/(646)
= 644V (Which is less than 676.22 V, tolerable mesh voltage)

Estimated step voltage

$$E\ step = \frac{\rho.K_s.K_i.I_G}{L}\ V$$

$$Ks = \frac{1}{\pi}\left[\frac{1}{2h} + \frac{1}{D+h} + \frac{1}{D}\left(1 - 0.5^{n-2}\right)\right] = 0.38$$

Now Estep = (40 x 0.38 x 1.77 x 12000)/(646)
= 500V (Which is less than 2212.735 V, tolerable step voltage)

Estimated Touch Voltage is less than Tolerable Touch Voltage and Estimated Step Potential is less than Tolerable Step Potential, Thus design is safe.

*****

APPENDIX-4
REGULATIONS FOR POWER LINE CROSSINGS OF RAILWAY TRACKS

I. GENERAL

1.0 Definitions

1.1 The following terms wherever occurring in the Regulations shall, unless excluded by or repugnant to the context, have the meaning attributed thereto as under:

"Principal Chief Electrical Engineer " means the officer designated as such by the Zonal Railway or his successors in office or on whom his duties devolve.

"Power line crossing" means an electrical overhead line or under ground cable placed across railway track(s) for the transmission and/or distribution of electrical energy. It may also be referred to as a "Crossing " in these Regulations.

"Electrical Inspector" means the officer appointed by the appropriate Government under Section 36 of the Indian Electricity Act, 1910, to exercise the powers and perform the functions under the said Act. On the Zonal Railway, the Principal Chief Electrical Engineer is the Electrical Inspector.

"Owner" means the owner of an electrical crossing.

"Railway" means the Zonal Railway administration in whose territorial jurisdiction the electrical crossing is located or proposed to be located and includes the Principal Chief Electrical Engineer, the Divisional Railway Manager (Electrical) of the Zonal Railway Administration.

"Writing" includes all matters written, typewritten or printed either in whole or in part.

2.0 Scope

2.1 The regulations apply to electrical overhead lines and/or underground cables crossing railway tracks operated by the Indian Railways, Railway Companies and Port Commissioner's Railways, including assisted and private sidings on which rolling stock of Indian Railways may work, unless any special section or railway tracks are exempted from these Regulations by specific written orders of the Electrical Inspector.

2.2 Regulations for Electrical crossings of Railway Tracks, 1987 need not be applicable to the electrical crossings which were already in existence and were nearing completion prior to the issue of 1987 regulations. Ref Board letter no; 87/electricalElec.1/112/1 dated 26.10.87.(ACS -5)

Notes:

1. If any existing crossing infringes the provisions of the Regulations at the time of its issue, the infringement(s) shall be treated as permissible infringement(s) provided that necessary relaxation has been granted in respect of the clearances under clause 21 thereof.
2. The Regulations do not apply to crossing(s) of railway track(s) laid underground/inside tubes and tunnels.
3. The Regulations do not also apply to Railway Traction systems (1500 V d.c. and 25 kV, 50 Hz. A.c. Single phase) whose feeders/conductors/wires run along or across the tracks for traction purposes.

4. On sections proposed to be electrified on or to be converted to suit 25 kV , 50 Hz. Ac single phase traction system, the crossing existing at the time of electrification/conversion proposed shall be specially studied with a view to avoiding modifications to the extent possible without jeopardising safety. If any modifications are considered essential to obtain the minimum clearances, specified in clause 21 thereof, they shall be carried out.
5. In special cases, where the Electrical Inspector has specifically permitted reduction in clearances under clause 21 thereof, a clear declaration to this effect shall be recorded in the CERTIFICATE OF COMPLIANCE (in the form at Annexure II) to these regulations.

3.0 Approval of Works by the Railway:

3.1 1. Designs, Drawing etc.

Before the Owner commences any work on a crossing, he shall obtain the approval in writing, of the Railway for the proposed location, the detailed design and the method of execution of the crossing. For this purpose, the data designs, calculations and drawing(s) relating to the crossing shall be furnished by the owner to the Railway as stipulated in Annexure A 4.01 to these Regulations. On receipt of written approval from the Railway, the owner shall execute an Agreement in the Form at Annexure A.4.02 to these Regulations.

2. Construction

The owner shall notify the Railway in writing at least 15 days in advance of the date on which he will commence the work of construction of the crossing. The Principal Chief Electrical Engineer, or his representative, may, if he so desires, inspect the site/work of the crossing during its construction to ensure that it is being constructed in accordance with the approved designs and drawings. Only good quality of materials shall be used in the construction of the crossing which shall be executed in a workman-like manner.

3. Bringing crossing into use.

Prior to bringing the crossing into use, the owner shall:

a. Notify the Railway in writing at least 15 days in advance of the date the crossing is intended to be brought into use.
b. Submit to the Railway a CERTIFICATE OF COMPLIANCE, (In the form at Annexure A 4.03 to the Regulations) to the effect that the works have been constructed in compliance with the Recalculations and in conformity with the design(s) and drawing(s) approved by the Railway. Only on receipt of written approval from the Railway, the crossing shall be energised and brought into use.

4.0 Compliance with Indian Electricity Act 1910 and Indian Railway Act ,1890 and Rules made thereunder etc.

4.1 Except as otherwise provided for in the Regulations the contents of relevant section of the Indian Electricity Act 1910 the Indian Railway Act ,1890 and the rules made under these Acts and as amended from time to time and the relevant provisions of Indian Railways Schedule of Dimensions for Broad Metre and Narrow gauges together with the latest amendments thereto shall apply to the crossing.

5.0 Compliance with Indian Standard Specifications:

All materials used in the construction of the crossing shall comply with the latest Indian Standard specification(s) relevant and where these are not available, with the latest British standard specification(s) relevant.

6.0 Works to be executed by the Railway:

6.1 The disturbance of any rail, road or ground or any attachment to any railway structure as may be necessary for the placing and/or maintenance of the crossing shall be effected by or under the direct supervision of the Railway and any conduit, culvert or similar work passing under Railway premises shall be constructed by the Railway in such manner and of such materials as it may approve of and the entire cost of such works shall be borne by theowner of the crossing.

7.0 Method of Crossing – overhead line or underground cable:

7.1 For tracks already electrified or to be electrified in the foreseeable future:

All low, medium and high voltage upto and including 11 kV crossing(s) shall normally be by means of underground cable(s). While for voltages higher that 11 kV, crossings may be by overhead lines or underground cables, the use of underground cable to the extent possible would be advantageous, particularly for 22 kV and 33 kV system.

8.0 Protection of Communication Lines:

8.1 The crossing shall in no way interfere with or endanger any Railway communication lines. Approval given by the Railway for placing of any crossing shall not be construed as affecting in any way the requirements of the Indian Post and Telegraph department In regard to the protection of their communication lines.

8.2 The crossing shall also comply with the stipulations in the "Code of Practice for the protection of Telecommunication lines at crossings with overhead power lines other than Electric Traction Circuits" issued by Central Electricity Authority. Telecommunication Directorate, Power and Telecommunication Coordination Committee (PTCC Unit), Government of India, B-67/19 Safdarjung Enclave, New Delhi-29 and the latest amendments if any, thereto.

9.0 Maintenance of Crossing:

9.1 No work whatsoever on any crossing shall be undertaken by the Owner without obtaining the consent in writing from the Railway. All such works shall be carried out under the direct supervision of the Railway.

9.2 The crossing shall always be maintained in a state of good repair so as to reduce hazards to life and property. It shall be jointly inspected by the Owner& Railway officials at interval not exceeding 12 months in order to determine its fitness for service. Defects, if any, noticed or as pointed out by the Railway shall be rectified by the owner expeditiously. The decision of the Railway in regard to defects noticed and rectification(s), if any, to be done by the owner shall be final and binding on the owner. For regular maintenance required for safe, reliable upkeep of the crossing from Railway point of view to ensure uninterrupted Rail operation due to any fault/breakdown of overhead line crossings, a fixed specified One hour block per year shall be granted (without levy of charges) by Railway to the State Utility/ Transmission line owner. (Ref.RB JPO issued vide letter No. 2010/ Elect(G)/148/6, Dt. 30.01.17)

9.3 The crossing span as well as two adjacent spans on either side of the overhead line crossing shall be kept free by the owner from any trees and branches which, if they fall on these spans, would foul with the overhead line. The growth of bushes and wild vegetables shall not be permitted on either side of the overhead line for the same reason.

9.4 Where galvanized steel structures support the crossing span, they shall be maintained free of rust, corrosion, etc.

9.5 If at the instance of the Railway, the crossing is to be shifted or modified or dismantled, the work shall be carried out by the owner at the cost of the Railway. However, in those cases where the need for such works on account of Railway's anticipated developments/requirements was foreseen in time and the owner had agreed in writing prior to the construction of the crossing to meet the cost of such works. Such works shall be carried out on a priority basis by the owner within a fixed schedule, as mutually agreed upon between the owner and the railway and to the satisfaction of the electrical Inspector. The Railways shall have the right to claim compensation for any loss and/or inconvenience caused if there is avoidable delay in completing the works.

10.0 Defects and Failures:

10.1 1. All defects/failures like snapping of conductors in the crossing span, breaking of insulator string in the overhead line crossing or any defect that is likely to affect the safe movement of the railway traffic or the safety of the railway property or personnel shall be reported forthwith by the owner to the Station Master on duty at the railway station on both sides of the crossing as well as to the Principal Chief Electrical Engineer, the Divisional Railway Manager (Electrical), the Electrical Inspector and the Director (Transmission), Central Electricity Board, S 907, Seva Bhavan, R.K. Puram, New Delhi – 66. A detailed report of the failure or defect, shall also be sent to the Principal Chief Electrical Engineer, the Divisional Railway Manager, the Divisional Railway Manager (Electrical), the Electrical Inspector and the Director (Transmission), Central Electricity Board, New Delhi as soon as possible – preferably within 48 hours of the first report.

2. In the even of an accident to Railway's tracks/rolling stock in the vicinity of an overhead line crossing, the owner shall, if required by any official acting on behalf of the Railway, expeditiously switch off the overhead line and effectively connect the conductors to earth as long as is necessary to enable Railway's cranes if any, to work safely in the area.

II. OVERHEAD LINE CROSSINGS

11.0 Angle of crossing

11.1 An overhead line crossing shall normally be at right angles to the railway track, in special cases a deviation of upto 30 degree may be permitted. Deviations larger than 30 degree shall have to be specifically authorised by the Electrical Inspector of the Railway.

12.0 Structures

12.1 Steel poles/masts fabricated steel structures or reinforced or pre-stressed concrete poles either of the self-supporting type or guyed type conforming in all respects to the Indian electricity Rules 1956 (as amended upto November 1984) and complying with the latest editions of codes of practice, IS 800-1962 for "Code of Practice for use of structural steel in general building construction, IS 875-2015 for "Code of Practice for structural safety of buildings; loading standards" and IS 456-1978 for "Code of Practice for plain and reinforced concrete" shall be used on either side of the track to support the crossing span. These structures shall be of the terminal type. For arriving at the crippling load, the wind loads as detailed in the latest edition of IS 802 (Part I) 1977 for "Loads and permissible stresses " shall be adopted. The steel structures shall normally be galvanized in accordance with IS 2629-1966 for "recommended practice for hot-dip galvanizing of iron and steel".

12.2 The minimum distance of the structures (supporting the crossing span) from the center of the nearest railway track shall be equal to the height of the structure in meters above normal ground level plus 6 meters. In special circumstances, the Electrical Inspector may permit a lesser distance being adopted subject to any conditions he deems fit to impose.

12.3 The crossing span shall be restricted to 300 m or to 80% of the normal span for which the structures are designed, whichever is less.

13.0 Wind Pressure

13.1 The maximum wind pressure for design of the structure shall be as prescribed in IS 802 (part-I) 1977 for load and permissible stresses.

14.0 Temperature

14.1 The maximum and minimum temperatures for design of the conductors and other wires shall be as prescribed in the latest edition of IS 802 (Part I, Clause-4) with necessary correction for conductor maximum temperature.

15.0 Provision for Ice/Snow Loading:

15.1 Where provision has to be made for ice and/or snow loading, it shall be determined in the light of local conditions with the approval of the Railway.

16. Factor of Safety

16.1 The factor of safety of all structures, conductors, guards, guys and ground wires used in the crossing shall be as stipulated in the Indian Electricity Rules, 1956 (as amended in November 1984) and the relevant codes of practice.

17.0 Clearance between the overhead line and railway track:

17.1 An overhead line crossing over railway track already electrified shall be located at the middle of overhead equipment span supported by two adjacent traction masts/structures. The distance between any of the crossing conditions and the nearest traction mast or structure under the most adverse, conditions shall not be less than 6 m.

17.2 No overhead line crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area.
(As per ACS -27 ACTM)

17.3 Vertical Clearance:

1. Vertical clearance for OHE (Other than high rise OHE) :

Table 17.3 (a)

SN	Overhead crossing voltage	Minimum clearance from Rail Level		Minimum clearance to be maintained between lowest transmission line crossing conductor and railway structure as per clause 61 CEA	Minimum clearance to be maintained between highest traction conductor and lowest transmission line crossing conductor as per clause 69 CEA
		Existing power line crossing for existing Non-electrified line	New power line crossing (for electrified or non-electrified routes) or existing power line crossing planned for alteration or modification (for electrified or non-electrified routes)	At structure	At Mid span
(1)	(2)	(3)	(4)	(5)	(6)
1	Upto & including 11 kV	By underground cable			
2	Above 11 kV & upto 33 kV	10860	14660	3700	2440
3	Above 33 kV & upto 66 kV	11160	14960	4000	2440
4	Above 66 kV & upto 132 kV	11760	15560	4600	3050
5	Above 132 kV & upto 220 kV	12660	16460	5500	4580
6	Above 220 kV & upto 400 kV	14460	18260	7300	5490
7	Above 400 kV & upto 500 kV	15360	19160	8200	7940
8	Above 500 kV & upto 800KV	18060	21860	10900	7940

2. Vertical clearance for high rise OHE :

Table 17.3 (b)

SN	Overhead crossing voltage	Minimum clearance from Rail Level		Minimum clearance to be maintained between lowest transmission line crossing conductor and railway structure as per clause 61 CEA	Minimum clearance to be maintained between highest traction conductor and lowest transmission line crossing conductor as per clause 69 CEA
		Existing power line crossing for existing Non-electrified line	New power line crossing (for electrified or non-electrified routes) or existing power line crossing planned for alteration or modification (for electrified or non-electrified routes)	At structure	At Mid span
(1)	(2)	(3)	(4)	(5)	(6)
1	Upto & including 11 kV	Normally clearances mentioned in 4 are applicable for double stack container routes; however EIG may relax as per clause 20.4	By underground cable		
2	Above 11 kV & upto 33 kV		16660	3700	2440
3	Above 33 kV & upto 66 kV		16960	4000	2440
4	Above 66 kV & upto 132 kV		17560	4600	3050
5	Above 132 kV & upto 220 kV		18460	5500	4580
6	Above 220 kV & upto 400 kV		20260	7300	5490
7	Above 400 kV & upto 500 kV		21160	8200	7940
8	Above 500 kV & upto 800KV		23860	10900	7940

Note (Applicable for 17.3 (a) & (b):

1. All height/ clearance are in mm under condition of maximum sag.
2. For existing power line crossing
   a. In case of new line (with or without electrification) column 4 shall be applicable.
   b. Dimensions at column 5 are applicable if the nearest OHE structure/fixed structure is within 6000 mm from overhead crossing conductor. In other cases, dimensions at column 6 are applicable.

3. If the crossing is provided with guarding, aminimum clearance of 2000 mm shall be maintained between bottom of the guard wire and highest traction conductor.
4. Height of double stack container to be taken as 7100 mm.

Note: The working of a Railway crane under an overhead line crossing shall normally be avoided. If it becomes absolutely essential for a crane to work under such a crossing, the minimum clearance required to be maintained between the highest working point of the jib and the lower crossing conductor shall be as under:-

Normal System Voltage (kV)	Min. safe clearance (In Metre)
33	1.50
66	2.00
110	2.25
132	2.50
220	3.50
400	6.00
500	7.25
800	11.50

The crane driver/supervisor shall be guided in this regard by the senior most official of the electrical engineering department at site.

18.0 Minimum clearances between crossing conductors and any railway structure

18.1 The minimum vertical and horizontal clearances to be maintained between any of the crossing conductors and any railway building and/or structure, other than traction masts and structures and overhead equipment, under the most adverse conditions shall be as specified in Rule 80 of the Indian Electricity Rules, 1956 (as amended upto Nov. 84)

19.0 Minimum vertical clearance between power line crossings.

19.1 The minimum vertical clearances to be maintained between any of the power line crossings at the same or at different voltages shall be as specified in Rule 87 of the Indian Electricity, 1956 (as amended upto November 1984)

19.2 Separate guarding shall be provided above the lower power line in all cases except when the voltage of the higher line is 33 kV and above. Where such guarding is provided, the clearance from the guard wires to the lower power line shall be not less than 2 m and to the upper power line not less than 1.5 m.

20.0 Clearance between power line & communication line

20.1 The minimum clearance to be maintained between a power line and a communication line shall be as prescribed in the “Code of Practice for the Protection of telecommunication lines at crossings with overhead power lines other than Electrical Traction Circuits” (latest edition) issued by Central electricity Authority, Telecommunication Directorate, Power and Tele-communication Coordination Committee (PTCC Unit).Govt. of India

21.0 Relaxation by the electrical inspector

21.1 Power line crossing in station areas and yards to be avoided. Under un-avoidable circumstances, relaxation by EIG will be necessary.

21.2 For electrification works of existing lines &existing electrified lines, existing power line crossings can continue, if dimensions are as per column (5) & (6)of para 17.3 above. EIG of the concerned Railway to ensure fullfillment of vertical clearances at coloumn 5 & 6 of para 17.3 with additional safegaurds if necessary. Whereever feasible special design of traction overhead equipment, return conductor, 25 kV feeder line be developed keeping in view the need for economy.

21.3 All new power line crossings, whether in electrified and non electrified territories, must satisfy the dimensions as mentioned at column 4, 5 & 6 of para 17.3.

21.4 In case of non-electrified line in double stack container route all efforts should be made for maintenance of dimensions as per column 4, However EIG may issue relaxation with suitable safeguards on a case to case basis, after ensuring vertical clearances as per dimensions in column 5, considering height of double stack container as 7100 mm from rail level.

22.0 Insulators

22.1 A double set of strain insulator strings shall be used in crossing span in conjunction with a yoke plate where necessary as illustrated in Fig A 4.01 attached to these Regulations. Each string of such strain insulators shall have one insulator more than the number used in a normal span of the overhead line. The factor of safety of each string of insulators under the worst conditions shall not be less than 2. The arrangements of power line crossing shall generally be as shown in Fig A-4.01, A 4.02 & A 4.03 attached to the Regulations.

23.0 Guarding

23.1 All overhead power line crossings upto and including 33 kV shall be provided with guarding under the power line. Guarding need not necessarily be provided for overhead power line crossings of voltages above 33 kV if the transmission/distribution line is protected by circuit breakers of modern design with total trippings times of 0.20 seconds for voltages below 220 kV and 0.10 seconds for 220 kV and above, from the time of occurrence of the fault to its clearance. Wherever guarding is adopted for the crossing span, cradle guards shall also be provided.

23.2 The minimum height above the rail level to the lowest level of any cradle guard or guard wires under conditions of maximum sag shall not be less than the values specified in clause 18. In special cases, however, the Electrical Inspector of the Railway may permit lower heights under the provisions of clause 20 of the Regulations.

23.3 The minimum height between any guard wire and a live crossing conductor under the most adverse conditions shall not be less than 1.5 m.

24.0 Anti-climbing Devices and Warning Notices.

24.1 Where the voltage exceeds 650 V, the supporting structures, (of the overhead line crossings) on railway land shall be provided with anti-climbing devices. Besides, suitable caution/warning notices shall be erected on all such structures, in the languages as may be prescribed for the purpose. The anti climbing devices and the caution/warning notices shall be approved by the Railway.

25.0 Protection from Moving Road Vehicles.

25.1 Supporting structures, (of the overhead line crossing) including guys, adjacent to roadways shall be so located that the danger of their being struck by moving road vehicles is avoided or reduced to the minimum. Wherever required, guard rails, suitably painted to make them conspicuous, shall be provided for the purpose.

26.0 Communication Lines

26.1 The owner of a communication line shall provide adequate safety devices so that no damage is caused in the event of snapping of conductors of a power line crossing. In addition to the safety devices, the owner shall also provide necessary surge absorbers in the system to guard against the effects of surges caused during switching operations or system faults.

26.2 Overhead communication lines may be permitted to be supported on the structures used for the crossing span of a power line crossing, provided the owner of both lines is the same. The factors of safety for conductors and insulators, the clearances above rail level and the method of supporting such crossings shall be not less than those specified for power line crossing.

27.0 Earthing

27.1

1. Each structure on either side of the crossing span supporting the transmission/distribution line conductors shall be earthed effectively by two separate and distinct earths and connections. At least one separate earth electrode shall be provided for each earth connection.
2. All guard and stay wires, shall be properly clamped to the structures connected to earth so as to maintain proper electrical continuity to earth.
3. Where struts are provided, they shall also be effectively connected to earth separately as well as to the main structure earths.
4. Where the earth resistance of the independent tower/structure is higher than 10 ohms, the owner shall take necessary steps to improve the earth resistance either by providing multiple earth electrodes or by suitably treating the soil surrounding the earth electrode or by resorting to counterpoise earthing. The method of earthing the transmission/distribution line structures etc. for the crossing span shall be approved by the Railway.
5. The earth shall be inspected and tested annually on a hot dry day and results thereof furnished to the Railway for verification and record. If the earth resistance is found to be high, i.e. above 10 ohms, steps shall be taken to reduce it and an advice given to the Railway.
6. The cross section of the earth conductor/connections for the earthing system shall be adequate for the application. They shall not be damaged or overhead or melt while carrying the short circuit current.

28.0 Fire Hazards

28.1 Structures supporting the crossing span shall be so placed, guarded and maintained as to be least exposed to bush, grass, rubbish and building fires as is possible.

III. CABLE CROSSINGS

29.0 Cable Crossing

29.1 As far as possible cable crossings shall make use of any existing culverts, sub-ways etc. where track(s) is/are already equipped for electric traction on 25 kV Hz. Single phase ac system, the crossing shall be provided at locations at least 5 metres away from any traction sub-station or switching station or mast or structure erected or proposed to be erected by the Railway for the purpose of supply and distribution of power to the traction over head equipment. The exact locations of such traction sub-station or switching station or mast or structure in any particular area shall be obtained by the owner from the Railway.

30.0 Type of Cables

30.1 The owner shall specify and obtain prior approval of the Railway for the type of cable he intends to use for the crossing. It shall preferably be armoured. Where cables are suspended from supports and not laid in a protective pipe, they shall be of the anmoured and sheathed type.

31.0 Cathodic Protection

31.1 Cathodic protection of the cables shall not be adopted without the specific prior approval of the Railway.

32.0 Method of Laying

32.1 Where the cable is laid under railway track(s) it shall be laid through cast iron pipes or spun concrete pipes of suitable diameter and strength. In order to avoid disturbance to the railway track/formation in case it become necessary to lay additional cable(s) in future, it would be advantageous to provide protective pipes of adequate (larger) diameter initially to cater for additional cables. The specifications for the pipes to be used shall be submitted to the Railway for approval. The pipe shall be laid at not less than one metre below the formation level. It shall be possible to withdraw the cable(s) for repair for replacement without disturbing the railway track or formation. Long lengths of pipe shall be laid with gradient to facilitate drainage of water if any. The pipe shall be laid upto the Railway boundary at both ends or upto as prescribed by the Railway. The laying of the cable in the Railway premises shall be in accordance with the latest edition of IS 1255-1967 “Code of Practice for installation and Maintenance of Power Cables”.

33.0 Works Carried out under or near Railway Track.

33.1 Where the cable is to be laid under a railway track(s) the use of case iron or spun concrete pipe for protection of the cable is obligatory and such pipe shall be laid in accordance with the contents of clause-7.

33.2 The armoring and sheathing of the underground cable laid across or near any electrified railway track shall be earthed by independent earths at the two sealing ends of the cable. No further earthing of the armouring and sheathing of the cable shall be done within 500 m of the electrified track. The scheme and method of earthing shall specifically be approved by the Railway.

34.0 Structures on which cable ends are supported and terminated.

34.1 Where the ends of a cable of an underground crossing are terminated on structures for connection to an overhead line, such structures shall comply with the Regulations in so far as they are applicable to overhead line crossing in respect of structures.

35.0 Marking of Crossings

35.1 Each cable crossing shall be indicated by at least two cast iron cable markers, one at each end of the crossing, within the railway boundaries. The cable marker shall be fixed at both ends of the underground crossings. They shall be of a design approved by the Railway. The following information shall be clearly marked on the markers.

ELECTRICAL CABLE	Volts
NUMBER	Cables
DANGER	In English, Hindi and the vernacular of the district
DEPTH OF CABLE	Below track level.
DEPTH OF CABLE	Below ground level between the toe of bank and railway fencing.

Annexure A 4.01

DATA DESIGNS, CALCULATIONS AND DRAWINGSTO BE FURNISHEDBY OWNER

The following data, designs calculations and drawings together with the application for the proposed power line crossing incorporating the particulars as detailed below – all in duplicate shall be furnished by the owner to the Divisional Railway Manager (Electrical) for approval by the Electrical Inspector of the Railway.

I. Overhead line crossings.

a. Data and Designs

1. Location of the proposed crossing, the names of railway stations on either side of the crossing, the distance of the crossing from the nearest railway station, the painted numbers of Telegraph poles and or traction mast or structures between which the crossing is proposed to be located and the exact location in relation to such poles or masts or structures.

Note: The alignment of the crossing should, as far as possible be at the mid-point of the span between adjacent traction masts or structures in the case of electrified tracks. (See Cl. 17.1 of the Regulations)

2. Particulars of the overhead line, including voltage, frequency, number of phases, size of conductors etc. and whether the neutral is earthed or not and if earthed, the type of earthing.
3. Wind Pressure adopted.
4. Temperature data adopted
5. Particulars of ice/snow loading, if any, adopted
6. Factors of safety adopted in the designs, for conductors, structures, guard wires/cross wires if provided, earth-wire, stay wire, insulator-strings, etc.
7. Design calculations of structures and foundations for the crossing span, communication lines or guarding, if any.

Note: If the structures and foundations are of standard type used for the transmission/distribution line concerned, the detailed design calculations shall be furnished.

8. Calculations leading to the minimum values under worst conditions of the following.
   a. Vertical clearance between the lowest crossing conductor, communication lines and/or guarding and the different railway tracks in the crossing span.
   b. Vertical clearance between the lowest crossing conductor, Communication lines and/or guarding and railway's conductors of the traction system or other conductors if any.
   c. Horizontal clearance to railway mast/structure/building, if any.
   d. Lateral clearance to the nearest Railway mast/structure/building, if any.

Note: Full particulars of the number, size, material and characteristics of various wires and conductors shall be furnished.

9. Particulars of insulators, bridling of the conductors.
10. Details of guarding, size of guard and cross wires and their characteristics. A detailed drawing showing the guarding arrangement, if provided, shall be given.
11. Size and characteristics of guy wire, if provided, and the number of supports.
12. Details of earthing indicating the earth electrode, size of earthing connection, method of connection to the support and the method of article soil treatment if proposed. Details of counterpoise earthing, if contemplated, shall be furnished.

13. Details of protection against moving road vehicles.
14. Particulars of anti-climbing devices, if provided, and warning and caution notices.
15. Detailed scheme of protection for the transmission/distribution line including particulars of relays, operating times etc. and particulars of circuit breakers, if any.

b. Drawings

1 Layout and site plan of the proposed crossing indicating railways boundaries.
2. Longitudinal elevation of the crossing. The drawing shall indicate full particulars of one span on either side of the crossing span with various clearances with respect to the Railway track(s). the drawing shall show the cross section of the railway formation and tracks.
3. Drawing for warning and caution notices.

Note: 1. All drawings shall be in standard sizes as prescribed in the latest edition of IS 696-1972 "Code of Practice for General Engineering Drawing."

2. All drawings are to be endorsed with a certificate as given below.

I hereby certify that the details of the equipment provided are designed with the object of minimizing danger in the event of breakage/fault and in accordance with recognized modern Engineering Practice", and signed by the owner.

II. Underground cables

a. Data and designs

1. Location of the proposed cable crossing, the names of the railway stations on either side of the crossing, the distance from the nearest railway station, the painted numbers of telegraph poles or traction masts or structures between which the crossing is proposed to be located and the exact location in relation to such poles or masts or structures.
2. Supply system particulars, particulars of cables, their number, size and number of cores, voltage, type of insulation, armouring etc.
3. Full particulars of the protective pipe for the crossing.
4. Method of earthing of the cable armouring and sheathing, if any
5. Method of making the cable crossing for identification.
6. Design calculation for masts/structures for supporting and terminating cable(s), and drawings to show that the masts/structures would not foul the railway track(s) in the event of their failure in so far as movement or railway vehicles is concerned.

b. Drawings

1. Layout and site plan including route, location of structures, if any, for supporting and terminating the cable and railways boundaries.

Note: Earths in the vicinity (upto 100m all round) of the crossing shall be distinctly indicated.

2. Drawings showing cable/crossing marker.

Note: 1. All drawings shall be in standard size as prescribed in the latest edition of IS 696-1972 "Code of practice for General Engineering Drawings".

2. All drawings are to be endorsed with a certificate as given below:

"I hereby certify that the details of the equipment provided are designed with the object of minimizing danger in the event of breakage/fault and in accordance with recognized modern Engineering Practice".

III. Overhead line crossings and underground cables

Along with a reproducible print, eight copies of the drawings showing the completed power line crossing shall be furnished to the Railway along with the "Certificate of Compliance (as at Annexure A 4.03 to the Regulations).

HIGH TENSION CROSSING WITH TERMINAL STRAIN INSULATORS

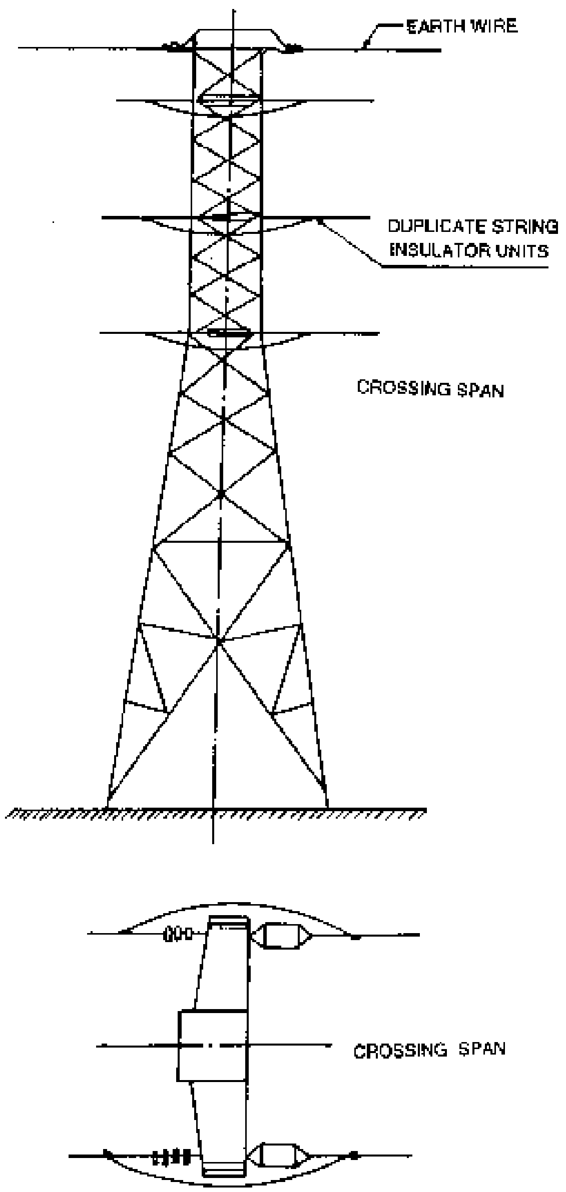


FIG. A 4.01

INDIAN RAILWAYS – AC TRACTION MANUAL - VOLUME II PART II 1981

HIGH TENSION CROSSING WITH SUSPENSION INSULATORS

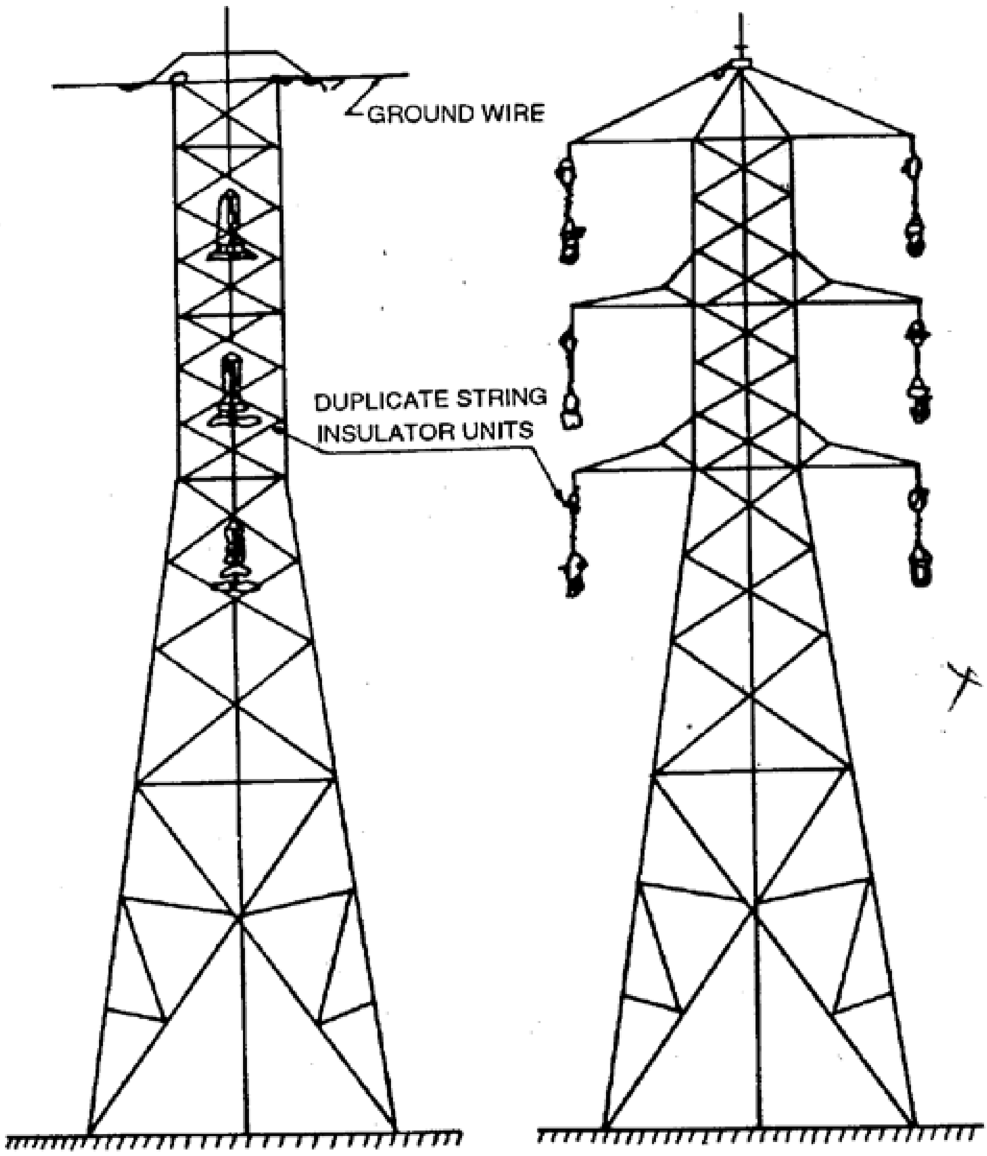


FIG. A 4.02

OVERHEAD LINE CROSSING WITH PIN INSULATOR

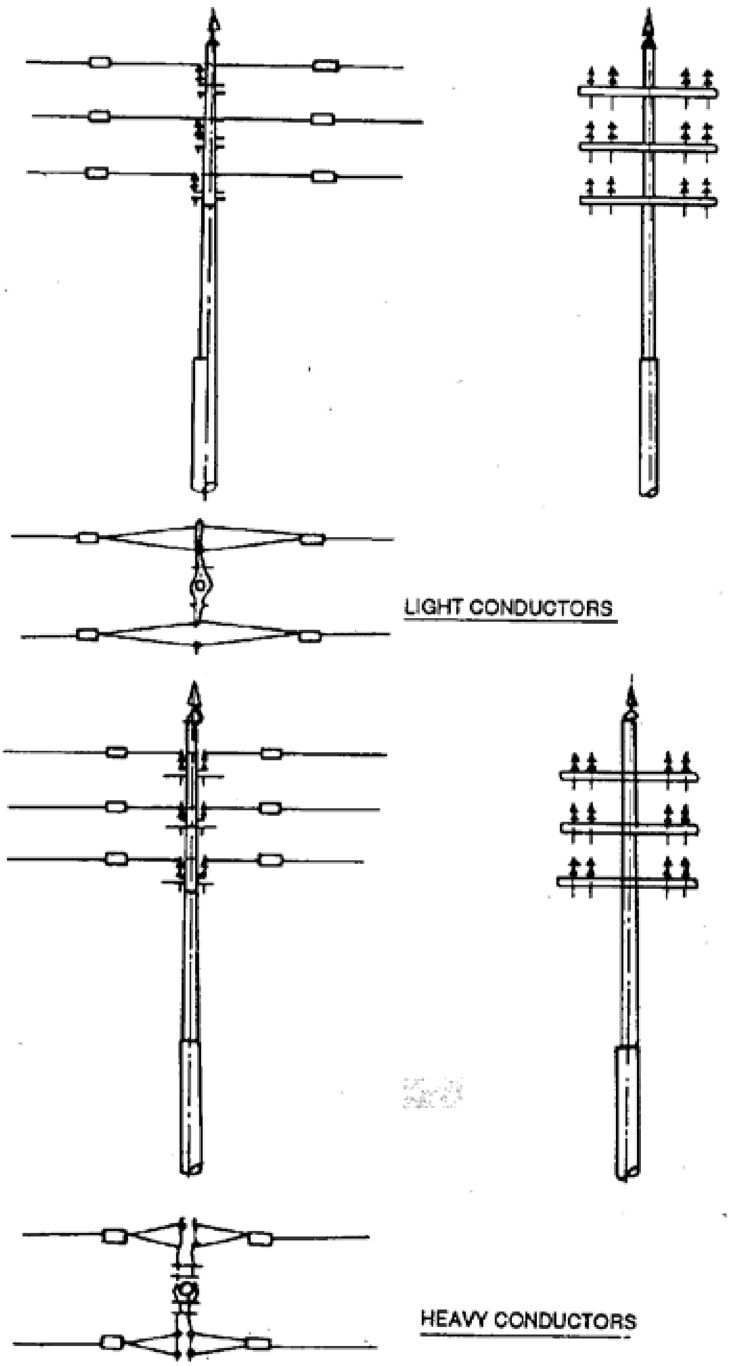


FIG. A 4.03

Annexure A. 4.02

AGREEMENT FOR ERECTING AND MAINTAINING AN OVERHEAD POWER LINE CROSSING OVER AND ACROSS RAILWAY TRACKS.

An agreement made this................. day of .... Two thousand and .... Between the President of India acting through the Principal Chief Electrical Engineer/ Divisional Railway Manager/Divisional Railway Manager (Electrical) of the ....Railway administration (hereafter called the Railway") of the one part and .... (hereinafter referred to as "the owner" of the other part. Whereas the owner wishes to erect an electric Overhead line and carry out the works connected herewith for transmission of distribution of electrical energy over and across the railway tracks and/or land at Kilometrage .... in the section.................at................Railway station, of the Railway, the said overhead line where it crosses the railway tracks and/or land works connected therewith hereinafter referred to as the "Crossing". Now IT IS HEREBY AGREED AS folllows:

1. **General:** the Railway will permit the owner as from the.....................day of ....20……, to lay the crossings as per Drg. No. ....approved by the Railway hereunto attached as Annexures, and in compliance with Regulations for Power line crossing of Railway tracks hereunto attached as Annexures hereinafter referred to as the Regulations, for the purposes hereinbefore mentioned subject to the terms and conditions hereinafter contained.

2. **Permission to erect and maintain the crossing:** The Railway will, subject to the provisions of clause 3 hereinafter contained, permit the owner to erect and maintain in accordance with the Regulations the crossing over and across the Railway tracks and/or land at the place(s) shown on the said drawing and to execute all repairs in connection therewith when necessary from time to time and all such works shall be executed at the cost of the owner at such times as may be permitted and to the satisfaction of the Railway in all respects.

   Provided that if shifting of or modifications to or dismantling of the crossing is required for the proper functioning of the Railway and is to be carried out by the owner as desired by the Railway, the costs of such works shall be borne by the Railway except in those cases where the need for such works on account of railway's anticipated development/requirements was foreseen in time and the owner had agreed in writing prior to the construction of the crossing to meet the cost of such works.

3. **Railway to carry out protection works:** In the event of it being necessary in the opinion of the Railway to support or protect the railway tracks and/or land or works during the erection of the crossing or the execution of any repairs hereto or any removal thereof the work of supporting of or protection the railway tracks or land and resorting the tracks and/or land to its original condition or such part of the said work as the Railway shall deem fit will be carried out by the Railway at the cost of the owner in all respects. The amount of such costs will be determined by the Railway in its absolute discretion and will be paid by the owner to the Rly. On demand. The owner will, if so required, deposit with the Railway prior to the carrying out of the said work such sum of money as may be estimated by the Railway to be the cost of the work required to be done and the amount of the said deposit will be set off against the said cost to be determined as aforesaid and the balance paid as aforesaid.

4. **Cost of Supervision of works**

   All works in connection with the matters referred to in clauses 2,3 and 6 will be subject to such supervision by the Railway as may be considered necessary by the Railway and the owner will pay to the Railway on demand all costs of such supervision including the cost for the staff required to look after the safety of the railway tracks and/or land while all or any of such works are/work is in progress. The costs of such supervision and other costs as aforesaid shall be determined by the Railway in its absolute discretion.

5. Access

Neither the owner nor his employees will at any time enter upon the railway land for any purpose whatsoever in connection with the crossing as aforesaid without the consent in writing of the Railway.

6. Modification, shifting or removal of crossing.

If for convenience of operation, unsatisfactory maintenance or for any reason whatsoever the Railway desires special maintenance, repairs, modifications, shifting or removal of the crossing the owner will, subject to the provisions of clause 3 hereof carry out such works or such portion thereof from the date of notice issued by the Railway and to the satisfaction of the Railway within a reasonable period determined by the Railway in its absolute discretion as the Railway shall not under provision of clause 3 hereof proposed to carry out the work. If the owner so desires he may re-erect the same at this own expense but to the satisfaction of the Railway in all respects on such other land or track of the Railway, as it may in its absolute discretion consider suitable and available for the purpose. In the event of the crossing being so re-erected the land on which the same is re-erected will be used and occupied upon the terms of the Agreement mutatis mutandis, as if the same has originally been subject to the Agreement.

7. Termination of Agreement by the Railway.

The railway may be any time (and from time to time) be at liberty in its absolute discretion to suspend temporarily and/or terminate this Agreement and all or any of the privileges hereby granted upon the expiration of three months' notice in writing of its intension to do so being left at or sent to the registered office of the owner/and not withstanding that the owner may have executed any work of a permanent or temporary character and incurred expenses in the execution thereof. The owner shall not be entitled to any damages or compensation by the reason of such termination or suspension.

8. Same as otherwise provided in this contract, all notices to be given on behalf of the President of India and all other actions to be taken on his behalf may be given or taken on his behalf by the Principal Chief Electrical Engineer/Divisional Railway Manager/Divisional Railway Manager (Electrical) of the Railway.

9. Termination of Agreement by the owner:

The owner may on giving to the Railway one month's notice in writing terminate this Agreement and such notice shall be sufficiently served if sent by registered post to the Principal Chief Electrical Engineer/Divisional Railway Manger/Divisional Railway Manger (Electrical) of the Railway or left at his office.

10. Termination of Agreement for default:

In the event of the Railway giving notice under Clause 7 hereof for special maintenance, repairs, modifications, shifting or removal of the crossing and the owner failing within the time stipulated to carry out the said works except such position thereof as the Railway may propose to carry out under the provisions of clause 3 hereof or in the event of the owner committing any other breach of this Agreement or any part thereof, the Railway shall be entitled in its absolute discretion (notwithstanding the provisions of clause 8 hereof) to terminate this Agreement all and any of the privileges hereby granted upon the expiration of six months' notice in writing of its intentions to do so being given in the manner provided in clause 7.

11. Removal of crossing:

Prior to the termination of this Agreement and subject to the provisions of clause 3 hereof the owner will at his own cost remove the crossing from the property of the Railway and restore the land to its original condition to the satisfaction of the Railway in all respects. In the event of the owner failing to remove the said crossing and restore the land to its original condition in the manner hereinbefore provided the Railway will be entitled at its option immediately after the termination of the Agreement to carry out the work of removal of the crossing and restoration of the land without being responsible for any loss or damage whatsoever to the said crossing or any part thereof. In such an event the owner will pay to the Railway on demand all costs incurred by the Railway in connection with such work including supervision charges, the amount which will be determined by the Railway in its absolute discretion. The said crossing and the materials used in connection therewith and belonging to the owner will be and remain the property of the owner but the Railway will be entitled to retain the same but without any liability therefore until the amount of such costs as aforesaid have been paid by the owner to the Railway.

12. Indemnity

The said crossing will be used at the sole risk and responsibility of the owner. If at any time owing directly or indirectly to such use or to the existence of the said crossing or to the carrying out of the work of erection and/or repair and/or removal of the said crossing and restoring the land to its original condition or to be exercise by the owner of any privileges hereby granted or to any other cause arising out of the operation of the Agreement any damage will be caused to the Railway or to the permanent way and works, Rolling Stock or any other property of the Railway or if in consequence of any of the matters aforesaid or of any default in fulfilling any of the conditions of the Agreement or of any negligence on the part of the owner or any person connected with him, any claim or damage or loss be substantiated by any person or perons against the Railway the Owner will upon demand pay forthwith and make good the same and shall also make good to the Railway all costs and expenses which it may incur in regard to any such claim or damage or loss as aforesaid. In the event of there being any dispute as to what specific loss and/or damage has been caused by reason of any decision hereon shall be final and binding.

13. Railway Accident

The Railway shall not be responsible for any damage to the crossing and other property of the owner due to any accident in the working of the Railway due to any cause whatsoever

14. Sub-letting

The owner will not sub-let, transfer or assign this Agreement or any of the privileges hereby granted without the previous consent in writing of the Railway.

15. Limitation of rights

Nothing herein contained will be construed as conferring upon the owner or his permitted assignee any rights over the property of the Railway.

16. Cost of Agreement

All costs and expenses incidental to the preparation and completion of these presents including Stamp duty will be borne and paid by the owner.

In witness whereof the parties have hereunto set and subscribed their respective hands and seals the day, month and years respectively mentioned against their respective signatures.

(Seal of the Owner) (Signature)

Signed at....................................... by Shri...............................
For and on behalf of the Owner in the presence of :

1. Name

   Address

2. Name

   Address

(Signature of witness)

Signed at ....by Shri .... Signature

For and on behalf of the owner in the presence of

1. Name

   Address (Signature of witness)

2. Name

   Address (Signature of witness)

Note: 1. In the case of Railway Companies or Port Commissioners Railways, the term Principal Chief Electrical Engineer wherever occurring in this Agreement may be replaced by the designation of the Officer on whom the duties of the Principal Chief Electrical Engineer devolve.

2. The agreement should be signed on behalf of the President of India by an officer duly authorized under Article 299 (1) of the Constitution of India.

Annexure A 4.03

AGREEMENT FOR ERECTING AND MAINTAINING AN UNDERGROUND POWER LINE CROSSING ACROSS AND UNDER RAILWAY TRACKS.

An agreement made this ....day of .... two thouand and .... between the President of India, acting through the Principal Chief Electrical Engineer/ the Divisional Railway Manager/Divisional Railway Manager (Electrical) of the .... Railway Administration (hereafter called "the Railway") of the one part and ....(hereinafter referred to as "the owner " of the other part. Whereas the owner wishes to lay an underground cable and carry out works connected herewith for transmission or distribution of electrical energy across and under the railway tracks and/or land at kilometrage.......................In the section .... at ....Railway station, of the Railway the said cable and works connected herewith hereinafter referred to as the "crossing" NOW IT IS HEREBY AGREED as follows

1. **General:** The Railway will permit the owner as from the ....day of 20…………, to lay the crossings as per Drg. No. approved by the Railway, hereunto attached as Annexures and in compliance with Regulations for power line crossings of Railway Tracks, hereunto attached as Annexure hereinafter referred to as the Regulations, for the purpose hereinbefore mentioned, subject to the terms and conditions hereinafter contained.

2. **Permission to lay and maintain the crossing:** The Railway, will, subject to the provisions of clause 3 hereinafter contained permit the owner to lay, keep and maintain in accordance with the Regulations the crossing under the Railway tracks and/or land at the place(s) shown on the said drawing and to execute all repairs in connection herewith when necessary from time to time and all such works shall be executed at the cost of the owner at such time as may be permitted and to the satisfaction of the Railway in all respects.

   Provided that if shifting of or modifications to or dismantling of the crossing is required for the proper functioning of the Railway and is to be carried out by the owner as desired by the Railway, the costs of such works shall be borne by the Railway except in these cases where the need for such works on account of Railway's anticipated development/requirements was foreseen in time and the owner had agreed in writing prior to the construction of the crossing to meet the costs of such works.

3. **Railway to carry out protection works:** In the event of it being necessary in the opinion of the Railway to support or protect the railway tracks and/or land or works during the laying of the crossing or the execution of any removal thereof the work of supporting or protecting the railway tracks or land and/or laying or removing the encasing protective pipe to carry the crossing cable and restoring the tracks and/or land to its original condition or such part of the said work as the Railway shall deem fit will be carried out by the Railway at the cost of the owner in all respects. The amount of such costs will be determined by the Railway in its absolute discretion and will be paid by the owner to the Railway on demand. The owner will, if so required, deposit with the Railway prior to the carrying out of the said work such sum of money as may be estimated by the Railway to be the cost of the work required to be done and the amount of the said deposit will be set off against the said cost to be determined as aforesaid and the balance paid as aforesaid.

4. **Method of laying:** The cable shall be laid as indicated in the said drawing and shall be carried through an encasing pipe in such manner that the cable can be laid, withdrawn without interfering with or endangering the railway tracks and/or land. The costs of providing and laying such encasing pipe for the crossing shall be borne by the owner as aforesaid.

5. **Cost of supervision of works:** All works in connection with the matters referred to in clauses, 2,3,4,7 & 11 will be subject to such supervision by the Railway as may be considered necessary by the Railway and the owner will pay to the Railway on demand all costs of such supervision

including the cost for the staff, required to look after the safety of the railway tracks and/or land while all or any of such works are/works is in progress. The costs of such supervision and other costs as aforesaid shall be determined by the Railway in its absolute discretion.

6. **Access:** Neither the owner nor his employees will at any time enter upon the railway land for any purpose whatsoever in connection with the crossing as aforesaid without the consent in writing of the Railway.
7. **Modification, shifting or removal of crossing:** If for convenience of operation, unsatisfactory maintenance or for any reason whatsoever the Railway desires special maintenance, repairs, modification, shifting or removal of the crossing the owner will, subject to the provisions of clause 3 hereof carry out such works or such portion thereof from the date of notice issued by the Railway and to the satisfaction of the Railway within a reasonable period determined by the Railway in its absolute discretion as the Railway shall not under provision of clause 3 hereof proposed to carry out the work. If the owner so desired he may relay the same at his own expense but to the satisfaction of the Railway in all respects on such other land or track of the railway as it may in its absolute discretion consider suitable and available for the purpose. In the event of the crossing being so re-erected the land on which the same is re-erected will be used and occupied upon the terms of the Agreement mutatis mutandis, as if the same has originally been subject to this Agreement.
8. **Termination of Agreement:** The Railway may at any time (and from time to time) be at liberty in its absolute discretion to suspend temporarily and/or terminate this agreement and all or any of the privileges hereby granted upon the expiration of three month's notice in writing of its intention to do so being left at or sent to the registered office of the owner and notwithstanding that the owner may have executed any work of a permanent or temporary character and incurred expenses in the execution thereof. The owner shall not be entitled to any damages or compensation by the reason of such termination or suspension.
9. Same as otherwise provided in this contract, all notices to be given on behalf of the President of India and all other action to be taken on his behalf may be given or taken on his behalf by the Principal Chief Electrical Engineer/Divisional Railway Manager/Divisional Railway Manager (Electrical) of the Railway of left at his office.
10. **Termination of Agreement by the Owner:** The owner may on giving to the Railway one month's notice in writing terminate this agreement and such notice shall be sufficiently served if sent by the registered post to the Principal Chief Electrical Engineer/Divisional Railway Manager/Divisional Railway Manager (Electrical) of the Railway or left at his office.
11. **Termination of Agreement for default:** In the event of the Railway giving notice under clause 7 hereof for special maintenance, repairs, modification, shifting or removal of the crossing and the owner falling within the time stipulated to carry out the said works except such portion thereof as the Railway may propose to carry out under the provisions of clause 3 hereof or in the event of the owner committing any other breach of this Agreement or any part thereof, the Railway shall be entitled in its absolute discretion (notwithstanding the provisions of clause 8 hereof) to terminate this Agreement and all and any of the privileges hereby granted upon the expiration of six month's notice in writing of its intentions so to do being given in the manner provided by clause 7.
12. **Removal of crossing:** Prior to the termination of this Agreement and subject to the provisions of clause 3 hereof the owner shall at his own cost remove the crossing from the property of the Railway and shall restore the land to its original condition to the satisfaction of the Railway in all respects. In the event of the owner failing to remove the said crossing and restore the land to its original condition in manner hereinbefore provided the Railway will be entitled at its option immediately after the termination of this Agreement to carry out such work of removal of the crossing and restoration of the land without being responsible for any loss or damage whatsoever to

the said crossing or any part thereof. In such an event the owner will pay to the Railway on demand all costs incurred by the Railway in connection with such work determined by the Railway in its absolute discretion. The said crossing and the materials used in connection therewith and belonging to the owner will be and remain the property of the owner but the Railway will be entitled to retain the same but without any liability therefor until the amount of such costs as aforesaid have been paid by the owner to the Railway.

13. **Indemnity:** The said crossing will be used at the sole risk and responsibility of the owner. If at any time owing directly or indirectly to such use or to the existence of the said crossing or to the carrying out of the work of erection and/or repair and/or removal of the said crossing and restoring the land to its original condition or to the exercise by the owner of any privileges hereby granted or to any other cause arising out of the operation of the Agreement any damage will be caused to the Railway or to the permanent way and works, Rolling stock or any other property of the Railway or if in consequence of any of the matters aforesaid or of any default in fulfilling any of the conditions of the Agreement or of any negligence on the part of the owner or any person connected with him, any claim or damage or loss be substantiated by any person or persons against the Railway, the owner will upon demand pay forthwith and make good the same and shall also make good to the Railway all costs and expenses which it may incur in regard to any such claim or damage or loss as aforesaid. In the event of there being any dispute as to what specific loss and/or damage has been caused by reason of any of the matters aforesaid such dispute will be preferred to the Principal Chief Electrical Engineer of the Railway, whose decision thereon shall be final and binding.
14. **Railway Accidents:** The Railway shall not be responsible for any damage to the crossing and other property of the owner due to an accident in the working of the Railway due to any cause whatsoever.
15. **Sub-letting:** The owner will not sub-let ,transfer or assign this Agreement or any of the privileges hereby granted without the previous consent in writing of the Railway.
16. **Limitation of rights:** Nothing herein contained will be construed as conferring upon the owner or his permitted assignee any rights over the property of the Railway.
17. **Costs of Agreement:** All the costs and expenses incidental to the preparation and completion of these presents including stamp duty will be borne and paid by the owner.

In witness whereof the parties have hereunto set and subscribed their respective hand and seals the day, month and year respectively mentioned against their respective signatures.

(Seal of the Owner) (Signature)

Signed at............................by Shri.............................for and on behalf of the owner in the presence of:

1. Name
   Address Signature of witness

2. Name
   Address Signature of witness

Signed at .... by Shri..................................for and on behalf of the President of India in the Presence of :

1. Name
   Address

Signature of witness

2. Name
   Address

Signature of witness

Note: 1. In the case of Railway Companies of Port Commissioner's Railway, the term Principal Chief Electrical Engineer wherever occurring in this Agreement may replaced by designation of the officer on whom the duties of the Principal Chief Electrical Engineer devolve.

2. The agreement should be signed by and on behalf of the President of India by an officer duly authorised under Article 299(1) of the Constitution of India.

ANNEXURE A.4.04

CERITIFCATE OF COMPLIANCE

It is hereby certified that the electrical overhead line/underground cable crossing No.........................at Km........on the section ....Of the Division of the ....Railway has been constructed in compliance with Indian Electricity Act, 1910 and Indian Railway Act., 1890, and the rules made thereunder and as amended from time to time and the Regulations for Power line crossings of Railway tracks, 1987. The crossing has also been constructed in accordance with the drawings approved by the ....Railway and the Electrical Inspector of the ....Railway, the reference of which are given below:

SN. Drawing No. Title of Location of Reference Approving

Drg. Crossing under which authority

$ Drawing is

Approved.

1.

2.

3.

2*. It is also hereby certified that the overhead line crossing specially released as per clause 21.4 of the Regulations for Power Line Crossing of Railway Tracks. 1987' would be modified by the owner, on an approved design whenever Railway will require to modify such crossings due to introduction of electric traction on the section of the Railway.

Along with a reproducible print eight copies of the drawings showing the completed power line crossing is/are enclosed.

Signature

(Seal of the owner) Name of the owner

Date

Place

* Strike off, if not applicable

$ The location of the overhead line crossing or underground cable will be identified by indicating the kilometerage with the painted number of the traction masts/structures and/or telegraph posts, as available, between which the overhead line or underground cable crossing is located.

*****

GUIDELINES FOR RELAY SETTINGS AT TRACTION SUBSTATIONS AND SECTIONING POSTS

1.0 DISTANCE PROTECTION ELEMENT SETTING

1.1 The correct method of entering relay settings be adopted as per the maintenance user manuals provided by the respective relay manufacturer.

1.2 The following procedure may be followed to calculate the forward reactance setting for single, double or triple line.

a. In order to ensure protection under all OHE configurations possible, calculate the single line impedance of the OHE from the feeding post/TSS to the adjoining feeding post/TSS. In other words, consider the maximum OHE impedance under possible configuration considering long yards, sidings and feeding lines.

   A factor of 1.25 is to be multiplied to the total impedance to take account of the errors due to CT, PT and the relays say this is ZL.

   Where ZL = 1.25x calculated impedance of single line OHE

b. Calculate the forward reactance by using following formula for setting on the relay. Say this is XF

   XF = ZLX(CT ratio/PT ratio) X sin of OHE impedance angle

c. The forward reactance setting may be calculated by following the procedure given at

   (a) and (b) above for the two sides of the feeding post/TSS separately. However the distance protection relays of the both feeder should be set to higher of the two calculated values. This is to ensure that when one feeder breaker is taken out for maintenance, the relay shall be able to see the faults on either side of feeding post/TSS.

1.3 Forward resistance (RF) setting:

This is computed based on peak load impedance (ZPL) likely to occur in the system and to accommodate arc resistance and tolerances of CT, PT and relay.

$$ZPL = \frac{25000 \times \text{CT Ratio}}{1.5 \times \text{rated secondary current of traction transformer} \times \text{PT Ratio}}$$

In order to accommodate arc resistance & tolerances of CT, PT and the relay,

Z= 70% of ZPL

From the adjacent figure

X=AB tan 70° and also X=Z Sin 36.9°

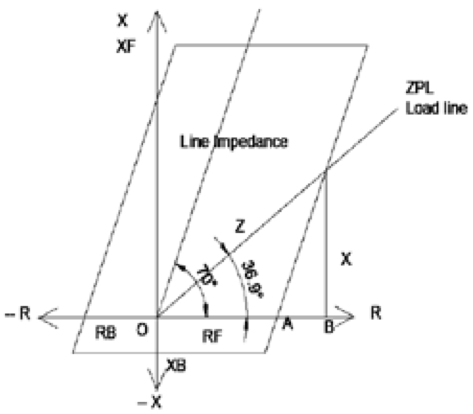
Hence, AB tan 70° = Z Sin 36.9°

Thus, AB = 0.2185 Z

Also OB = Z Cos 36.9° = 0.7997 Z

As RF = OB-AB = 0.7997 Z - 0.2185 Z

Hence, RF = 0.5812 Z



1.4 Backward reactance setting (XB)

It is selected to give a reverse reach in case pf grid supply failure or in case of failure of supply at TSS feed from the adjacent TSS.

Backward reactance setting be calculated by the following method

XB= 25% of forward reactance setting subject to minimum 6.0 Ohms.

1.5 Backward resistance (RB) setting: It is selected to be of same value as RF.

The setting of distance element shall be selected by following the above procedure for other side of the TSS also and the larger of the two settings selected.

2.0 Instantaneous over current protection element

This element provides primary protection to the OHE for near end faults in the vicinity of the feeding post. Assuming that a factor of 1.15 will account for the CT, PT& relay errors, the relay will allow loads of about 200% i.e. 174% of the rated load current.

3.0 Wrong phase coupling element setting.

Wrong phase coupling relay continuously monitor the phase angle and impedance of the faults. If phase angle lies in IInd quadrant of R-X plane between 900 to 1500, impedance between 11 to 39 Ω and regenerative current more than 3 amp, relay initiate a trip command. The earlier version of supplied feeder protection module type AZ1114 of M/s ALIND make; there was no need of settings in WPC elements, because manufacturer fixed each parameter. However now the phase angle is internally fixed and does not require settings. Lower limit of impedance setting may be set at 11 Ω if the exact setting value is not available on the relay then next lower value as available on the relay may be set. The upper limit may be set at 39 Ω; if this value is not available on the relay then next available higher setting may be selected.

Some manufacturer also provides separate settings of regenerative current, if the same is available; this setting is to be kept at 3 amps.

4.0 PT Fuse failure setting

The following values be set for PT fuse failure element

Vp< or = 10V

Ip= 1.5 Amp.

However if manufacturer internally sets these values then no setting is required.

5.0 Auto reclosure relay

The following values may be set on the relay.

Dead time (Dt)	=	0.5	Sec
Reclaim time (Rt)	=	30	Sec
Number of shot	=	1	

If enabled setting of high fault current for which auto reclosure is bypassed = 5000 Amps.

6.0 Trip fail delay (TF)

This is the feature for providing backup protection in case even after initiation of trip command by feeder protection module, feeder CB fails to operate within set time TF the feeder relay module shall send trip command to transformer LV CB to clear the fault. In order to use this feature wiring for tripping both LV CB's as per the terminal details of respective relay manufacturer manual should be available.

The setting of trip fail delay may be calculated by following method.

T_F= DPR operating time + MTR operating time + CB operating time + Terance.

1. 40ms+15ms+50ms+100ms
2. 195 ms

Note: If the above value is not available on the relay then closest available value may be set on the relay.

7.0 CT ratio setting

The CT ratio is settable in M/s ALIND make module; it may be set according to CT used in the field.

8.0 Sectioning posts Under-voltage protection

In case of extended feed, the bridging interrupter at the SP is in closed condition. SCADA system open this interrupter when the OHE voltage falls below a satisfactory operating value.

The under-voltage relay may be set to operate between 19 and 20 kV depending on local conditions.

Sample calculation for transformer protection relay setting

The following assumptions are made for sample calculation:

1. **Traction power transformer**
   a. Traction transformer rating = 21.6 MVA
   b. % impedance = 12.5
   c. No load primary voltage, VPO = 132 kV
   d. No load secondary voltage, VSO = 27 kV
   e. Rated secondary current, ISec

   $$I_{Sec} = \frac{21.6 \text{ MVA}}{27 \text{ KV}} = 800 \text{ Amp}$$

   f. Rated primary current, IP

   $$I_P = I_S \times V_{SO} / V_{PO} = 800 \times 27 / 132 = 163.6 \text{ Amp}$$

2. **CT ratio**
   a. 27 kV side ……… 750 / 5
   b. 132 kV side …...…. 200 / 5

   Bushing CT ratio
   a. 27 kV side ………1600 / 5
   b. 132 kV side …………330 / 5

3. **Fault MVA**
   10000 MVA at 132kV base voltage.

1.0 Low (25kV) voltage side

1.1 Restricted earth fault relay

Current setting in amp, Iref

$$= \frac{800 \times 10}{100 \times 750/5} = 0.53 \text{ Amp}$$

Setting in % = 0.53 / 5) * 100

=10.6% i.e 10%

1.2 IDMT over current relay

1.2.1 Current setting

$$= \frac{800 \times 180}{100 \times 750/5} = 9.6 \text{ Amp}$$

Setting in % = (9.6 / 5) * 100

=192%

1.2.2 TMS setting

Source impedance, Zsource at 132kv base

$$= \frac{(132)^2}{10000} = 1.74\ \Omega$$

Loop impedance = 2 x 1.74 = 3.48 Ω

Source impedance as seen from the 25 kV bus

$$= 3.48 \times \frac{(27)^2}{(132)^2} = 0.146\ \Omega$$

Impedance of traction transformer at 27 kV base, Z transformer

$$= \frac{(27)^2 \times 12.5}{21.6 \times 100} = 4.21\ \Omega$$

Total impedance, Z = 0.146 + 4.21 = 4.36 Ω

Fault current for 27 kV bus fault, If

$$= \frac{27000}{4.36} = 6192 \text{ amp}$$

Fault current reflected to secondary side of CT

= 6192 x 5/750 = 41.28 amp

To achieved the operating time 300 ms for bus fault, the TMS setting should be

$$\frac{300}{1000} = \frac{\text{TMS} \times 0.14}{[41.28/9.6]0.02 - 1}$$

$$\frac{300}{1000} = \frac{\text{TMS} \times 0.14}{1.03 - 1}$$

TMS = 0.0642 i.e. the available setting on the relay 0.07

1.3 Current and time setting of definite time over current relay

1.3.1 Stage 1 OCR

Current setting in amp, IOCR1

$$= \frac{800 \times 120}{100 \times 750/5} = 6.4 \text{ Amp}$$

Setting in % = (6.4 / 5) * 100

= 128 %

1.3.2 Stage 2 OCR

Current setting in amp, I_{OCR2}

$$= \frac{800 \times 140}{100 \times 750/5} = 7.47 \text{ Amp}$$

Setting in % = (7.47 / 5) * 100

= 149 %

1.3.3 Stage 3 OCR

Current setting in amp, I_{OCR3}

$$= \frac{800 \times 170}{100 \times 750/5} = 9.07 \text{ Amp}$$

Setting in % = (9.07 / 5) * 100

= 181 %

1.3.4 Post over load

Current setting in amp,

$$= \frac{800 \times 100}{100 \times 750/5} = 5.33 \text{ Amp}$$

Setting in % = (5.33 / 5) * 100

= 107 %

2.0 High voltage side

2.1 Restricted earth fault relay

Current setting in amp

$$= \frac{163.6 \times 10}{100 \times 200/5} = 0.41 \text{ Amp}$$

setting in % = 0.41 / 5) * 100

= 8%

2.2 IDMT over current relay

2.2.1 Current setting

$$= \frac{163.6 \times 190}{100 \times 200/5} = 7.75 \text{ Amp}$$

Setting in % = (7.75 / 5) * 100
= 155%

2.2.2 TMS setting

Fault current for 27 kv bus fault, If

$$= \frac{27000}{4.36} = 6192 \text{ amp}$$

Fault current seen at HV side

$$= 6192 \times \frac{27}{132} = 1266 \text{ amp}$$

Fault current reflected to secondary side of CT

= 1266 x5/200 = 31.66 amp

To achieved the operating time 600 ms for bus fault, the TMS setting should be

$$\frac{600}{1000} = \frac{\text{TMS} \times 0.14}{[31.66/7.75]^{0.02} - 1}$$

$$\frac{600}{1000} = \frac{\text{TMS} \times 0.14}{1.029 - 1}$$

TMS = 0.12

2.3 Current and time setting of definite time over current relay

2.3.1 Stage 1 OCR

Current setting in amp, I_{OCR1}

$$= \frac{163.6 \times 130}{100 \times 200/5} = 5.32 \text{ Amp}$$

Setting in % = (5.32 / 5) * 100
= 106%

2.3.3 Stage 2 OCR

Current setting in amp, IOCR2

$$= \frac{163.6 \times 150}{100 \times 200/5} = 6.13 \text{ Amp}$$

Setting in % = (6.13 / 5) * 100
= 123%

2.3.3 Stage 3 OCR

Current setting in amp, IOCR3

$$= \frac{163.6 \times 180}{100 \times 200/5} = 7.36 \text{ Amp}$$

Setting in % = (7.36 / 5) * 100
= 147 %

2.3.3 Post over load

Current setting in amp,

$$= \frac{163.6 \times 110}{100 \times 200/5} = 4.5 \text{ Amp}$$

Setting in % = (4.5 / 5) * 100
= 90 %

Sample calculation protection of feeder/OHE

The following assumptions are taken for sample calculation.

1. OHE impedance.

   The following values of OHE impedance for 107mm2 contact and 65 mm2 catenary wire may be used for the purpose of calculating relay settings.

   i- Single-track OHE without return conductor: 0.41 700 Ω/Km

   ii- Single-track OHE with return conductor: 0.70 700 Ω/Km
   Add booster transformer impedance at the rate of 0.15Ω per Booster transformer, where these are provided.

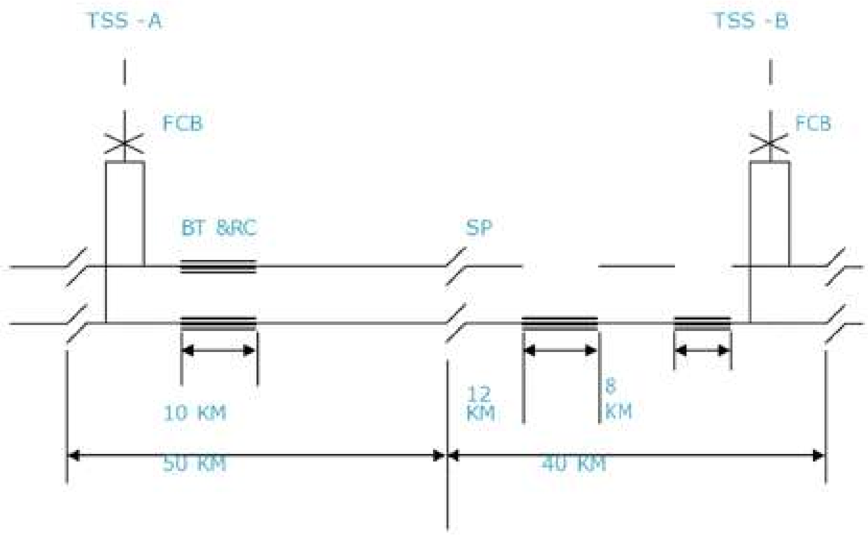
2. Traction power transformer.

No load voltage:

Primary side	=	132kV
Secondary side	=	27kV
Secondary voltage at rated output	=	25kV
Rated output	=	21.6MVA
Rated secondary current	=	$\frac{21.6 \text{ MVA}}{27\text{KV}}$ = 800Amp
CT ratio 25kV side	=	750/5 Amp
PT ratio 25kV side	=	25kV/110V

1.0 Parallelogram characteristic distance protection element

The following OHE section details assumed here for calculation given below.



Calculate single line impedance from TSS A to TSS B

Single line with BT&RC	=	30Km
Single line without BT&RC	=	60Km
Total Line impedance	=	30*0.70+600*0.41
	=	21 + 24.6
	=	45.6 Ω
ZL =1.25 X 45.6	=	57Ω

$$\text{XF Setting} = \frac{57x750/5}{25000x110v} \text{ X Sin 70}$$

$$= \frac{57x150}{227.27} \text{ X } 0.939$$

$$= 35.35\Omega$$

$$\text{XB setting} = \frac{35.35 \text{ x } 25}{100} = 8.83$$

RF setting:

$$\text{ZPL} = \frac{25000x750/5}{1.5x800x25000/110}$$

= 13.75

Z = 70% of ZPL

= 13.75 x 0.7

= 9.63Ω

RF = 0.5812 Z

= 0.5812 x 9.63

= 5.60Ω

RB setting:

RB = 5.60Ω

2.0 Over current setting

Rated secondary current = $\frac{21.6MVA}{27kV}$ = 800Amp

Value of setting on the relay = $\frac{800 \times 2}{750/5}$

= 10.66Amp

= $\frac{10.66}{5} \times 100$

= 213%

Note : according to availability of setting on the relay whether in amperes or percentage may set accordingly.

3.0 Biased differential protection

3.1 Calculation of ICT multiplication factor

LV Bushing CT multiplication factor

$= \frac{5x1600/5}{800} = 2$

HV Bushing CT multiplication factor

$= \frac{5 \times 330/5}{163.6}$

= 2.02

3.2 Bias setting calculation

Calculate the transformer HV current at lowest tap position i.e. -15%

$= \frac{21.6 * 1000}{112.2} = 192.5$ Amp

Current read by relay = $\frac{192.5 * 2.02}{330/5} = 5.89$

Spill Over Current in amp = 5.89 – 5

Percentage differential current = $\frac{0.89x100}{(5.89+5)/2} = 16.34\%$

To allow the relay and CT errors, the % differential current further increased by a factor of 1.25.

% biased setting = 1.25 x 16.34

= 20.43% i.e. 20%

4.0 Setting guide line of Vectorial Delta – I relay (type AVDI 11-C and AIDI/IC of M/s ALIND and M/s ASHIDA make respectively)

1. **Delta-I current setting**

   Current setting of Delta-I relay is based on the assumption on number of locos entering or number of locos switched on simultaneously in the section causing sudden rise of load current to avoid the false tripping due to sudden rise of load current. The Delta-I current setting should be more than the sudden rise of load current.

   Assuming 2 numbers loco entering or switched on simultaneously in the section and load current of one loco is 150 Amp.

   Total load current = 2 x 150=300Amp

$$\text{Load Current transferring to relay side} = \frac{\text{Load current}}{\text{CT Ratio}}$$

$$= \frac{300}{750/5} = 2\text{Amp}$$

(Assuming CT ratio 750/5 Amp)

Hence Delta –I current setting = 2 Amp

Note : If relay gives more spurious tripping then next higher value may be selected.

2. **X-BLINDER SETTING**

   This is the setting of reactance of OHE in ohms below which delta I relay shall pick up if other conditions like delta I, time delay are met.

a. First calculate the OHE impedance from feeding TSS to adjacent feeding TSS considering the lowest OHE configuration (Single line OHE)

b. Multiply a factor 1.25 to accommodate CT, PT & relay error.

   Say ZL. ZL = 1.25 X Calculated impedance of the single line OHE

c. Calculate the reactance (X) blinder setting on the relay side by following formula.

$$X = ZL \times \text{Sin (Impedance angle)} \times \frac{\text{CT ratio}}{\text{PT ratio}}$$

Example :

Let the distance between adjacent TSS	=	70 Km
Single line OHE impedance	=	0.43 700 Ω/Km
Total impedance	=	70 x 0.43 700
	=	30.1 700 Ω
Effective impedance ZL	=	1.25 X 30.1 700
	=	37.63 700

$$\text{Reactance blinder setting X} = 37.63 \times \text{Sin } 700 \times \frac{750/5}{25000/110}$$

(Assuming CT ratio 750/5 & PT ratio 25000/110)

= 23.34 Ω

3. Second & Third harmonic blocking feature setting

Generally manufacturer set these parameters internally during relay manufacture. However some relay manufacturers made provision to set these parameters externally through knob or keypad. If external setting available, it is to be set at 15%.

4. Additional time delay setting

Additional time delay setting is to be calculated by following method.

Additional time delay = DPR operating time + MTR operating time +CB operating time + tolerance

Assuming	DPR time	=	50 ms
	MTR time	=	15 ms
	CB time	=	50 ms
	Tolerance	=	30 ms
Hence time delay setting		=	50+15+50+30 = 145 ms

If exact value is not available on the relay then a setting close to higher side of 165 ms, is to be selected.

5. DS (De- sensitivity for 3rd harmonic) and DT (Delta time)setting:

These parameters are settable only in M/s ASHIDA make relay. The following value is recommended by manufacturer. DS=100%

The relay monitors the current samples continuously, this delta time setting defines time duration between the two samples.

DT = 60 ms.

Setting guide line for 25 kV shunt capacitor bank protection relay

1.0 IDMT Over current relay

1.1 Current setting

Calculate the capacitive reactance at rated voltage

XC = kV2 * 1000 / KVAr Ω

Calculate the effective reactance of complete capacitor & reactor unit

XC1 = XC – 0.13 XC Ω

Calculate the KVAR capacity ofbank at 25KV

KVAr rating at 25kv system voltage

KVAr = (25)2 * 1000 / XC1

Calculate the rated current of capacitor bank at system voltage 25 KV

Capacitor bank current in Amp, Icap = $\dfrac{\text{KVAR}}{\text{Rated System voltage in KV}}$

To accommodate the CT and relay errors, the 10% higher value of above calculated current is recommended for setting of relay.

$$\text{Current setting of IDMT relay in amp (Irelay)} = \frac{1.10 \text{ x Icap}}{\text{CT ratio}} \text{ Amp}$$

1.2 TMS setting

Calculate the fault current after reactor and select the suitable TMS to achieve the operating time of 500 ms.

$$\text{Fault current} = \frac{27000}{\text{Source Z + transformer Z + Reactance of reactor}} \text{ Amp}$$

$$\text{Plug setting multiplier} = \frac{\text{Reflected fault current to relay side}}{\text{set current of IDMT relay (Irelay)}}$$

From IDMT curve (3 sec at 10 time of setting), choose the suitable TMS for getting the relay operating time of 250 ms at above calculated plug setting multiplier or calculate TMS by formula given below:

t = TMS x a
{I/Iset} − 1

Where a & b are current a =0.14, b=0.02

t= operating time in second

TMS= Time multiplier Setting

I= Measured current by relay I set = set current

2.0 Over voltage relay

2.1 Over voltage setting

The over voltage relay shall be set at 10% higher than the rated nominal no load voltage of traction transformer.

Setting in Volt (Vo/v) = <u>1.1 x Rated nominal no load voltage of traction transformer</u> V

PTratio

$$\text{Setting in \%} = \frac{\text{Setting in volt (Vo/v)}}{\text{Rated PT secondary voltage}} \text{ x100}$$

2.2 Time multiplier setting (TMS)

Calculate the plug setting multiplier by formula given below:

$$\text{Plug setting multiplier} = \frac{\text{setting in volt(Vo/v)}}{\text{Rated PT secondary voltage}}$$

Form IDMT curve 7sec at 1.5 times, select the suitable TMS for above calculated plug setting multiplier to obtain the operating time of approximately 1 second.

3.0 Under voltage relay

3.1 Under voltage setting

The under voltage relay shall be provided to cut off the shunt capacitor bank from power supply when 25 kV supply fails or low voltage occurs. The bank should not be put back in to system again before it is totally discharged. To fulfill this requirement a timer is also provided in the closing circuit, it is generally inbuilt with numerical relay, timer setting shall be set at 10 minutes. As the lowest permissible voltage in IR traction is 17.5kV, hence the under voltage relay shall be recommended to be set at 17.5kV.

$$\text{Setting in volt (Vu/v)} = \frac{17500}{\text{PT Ratio}}\ \text{V}$$

$$\text{Setting in \%} = \frac{\text{Setting in Volt(Vu/v)}}{\text{Rated PT secondary voltage}} \times 100$$

3.2 Time multiplier setting (TMS) setting

Calculate the plug setting multiplier by formula given below:

$$\text{Plug setting multiplier} = \frac{\text{Setting in Volt}}{\text{Rated PT Secondary voltage}}$$

From IDMT curve 5sec at 0 Voltage; select the suitable TMS for above calculated plug setting multiplier to obtain the operating time of approximately 1 second.

4.0 Current unbalance relay

4.1 Current setting

This protection element is provided for internal faults in the capacitor units. At present as per RDSO specification No. ETI/PSI/67(11/96) A & C slip No. 7, each capacitor unit of 220 kVAR is rated for 8 kV, and its construction comprises of number of elements in parallel & individually protected by internal fuses. In case of failure of the element and therefore blowing of the internal fuse the voltage across the remaining healthy elements of affected and other units increases. The neutral unbalance current protection should be set so that it trips if the ratio of the voltage across healthy elements in parallel to the failed elements in one unit and rated voltage of healthy element is above 1.7. The manufacturer of the HT capacitor bank should provide the calculation for the above based on the internal design of the capacitor unit. Generally the unbalance current generated after failure of 7-10 elements may cause the voltage appearing on the remaining healthy elements to 150-175% of the rated voltage which may damage the healthy capacitor element. A sample results of unbalance current and voltage rise produced due to failure of number of internal elements is placed at Annexure-I for reference.

Set current in amp, IUB = Recommended unbalance current

NCT Ratio

$$\text{Setting in \%} = \frac{\text{IUB}}{\text{Rated CT Secoiindary}} \times 100$$

4.2 Time setting

The time setting shall be kept at 200 – 400 ms

Sample calculation for capacitor bank protection relay setting Assumption

The following assumptions are made for sample calculation:

a. Shunt capacitor bank rating = 5500 VAr at 40 kV
b. NCT ratio = 2/1
c. PT ratio = 27500/110
d. Fault MVA = 10000 MVA at 132 KV base voltage.
e. CT ratio = 100/5

1.0 IDMT Over current relay

1.1 Current setting

Calculate the capacitive reactance at rated voltage

X c = 402x1000/5500 = 5500

= 290.91 Ω

Calculate the effective reactance of complete capacitor & reactor unit

XC1 = 290.91 – 0.13 * 290.91

= 253.09 Ω

Calculate the KVAr capacity of bank at 25 kV

KVAr = $(25)^2$ * 1000 / 253.09

= 2469.47 KVAr

Rzated current of capacitor bank at system voltage 25 kV

$$\text{Capacitor bank current in amp, Icap} = \frac{2469.47}{25} = 98.77 \text{ amp}$$

To accommodate the CT and relay errors, the 10% higher value of above calculated current is recommended for setting of relay.

Current setting of IDMT relay in amp(Irelay) = $\frac{110x98.77}{100/5}$ = 5.43

= 5.43 Amp

$$\text{Setting in \%} = \frac{5.43}{5} \times 100$$

= 108.65 i.e. 109 %

1.2 TMS setting

$$\text{Fault Current} = \frac{27000}{4.36+37.82}$$

= 640 Amp

(Source and traction transformer impedance 4.36 ohm as calculated above for traction transformer setting)

$$\text{Plug setting multiplier} = \frac{640x5/100}{5.43}$$

= 5.89

To achieve the operating time 500 ms for fault after shunt reactor, the TMS =

$$\frac{250}{1000} = \frac{\text{TMS x } 0.14}{[33/5.43]^{0.02} - 1}$$

$$\frac{250}{1000} = \frac{\text{TMS x } 0.14}{1.0367 - 1}$$

TMS = 0.0656 i.e. 0.07

2.0 Over voltage relay

2.1 Over voltage setting

$$\text{Setting in volt (Vo/v)} = \frac{1.1x27500}{27500x110}$$

= 121 Volt

$$\text{Setting in \%} = \frac{121 \times 100}{110}$$

= 110%

2.2 Time setting

$$\text{Plug setting multiplier} = \frac{121}{110}$$

$$= 1.1$$

Form IDMT curve 7sec at 1.5 times, at 1.2 times of setting the operating time is 17 sec atTMS 1. To achieve the operating time 1 sec.

$$\text{TMS setting} = \frac{1}{17} = 0.058 \text{ i.e } 0.06$$

3.0 Under voltage relay

3.1 Under voltage setting

$$\text{Setting in Volt (Vu/v)} = \frac{17500}{27500/110} = 70 \text{ Volt}$$

$$\text{Setting in \%} = \frac{70\text{x } 100}{110} = 63.64\% \text{ i.e } 64\%$$

3.2 TMS setting

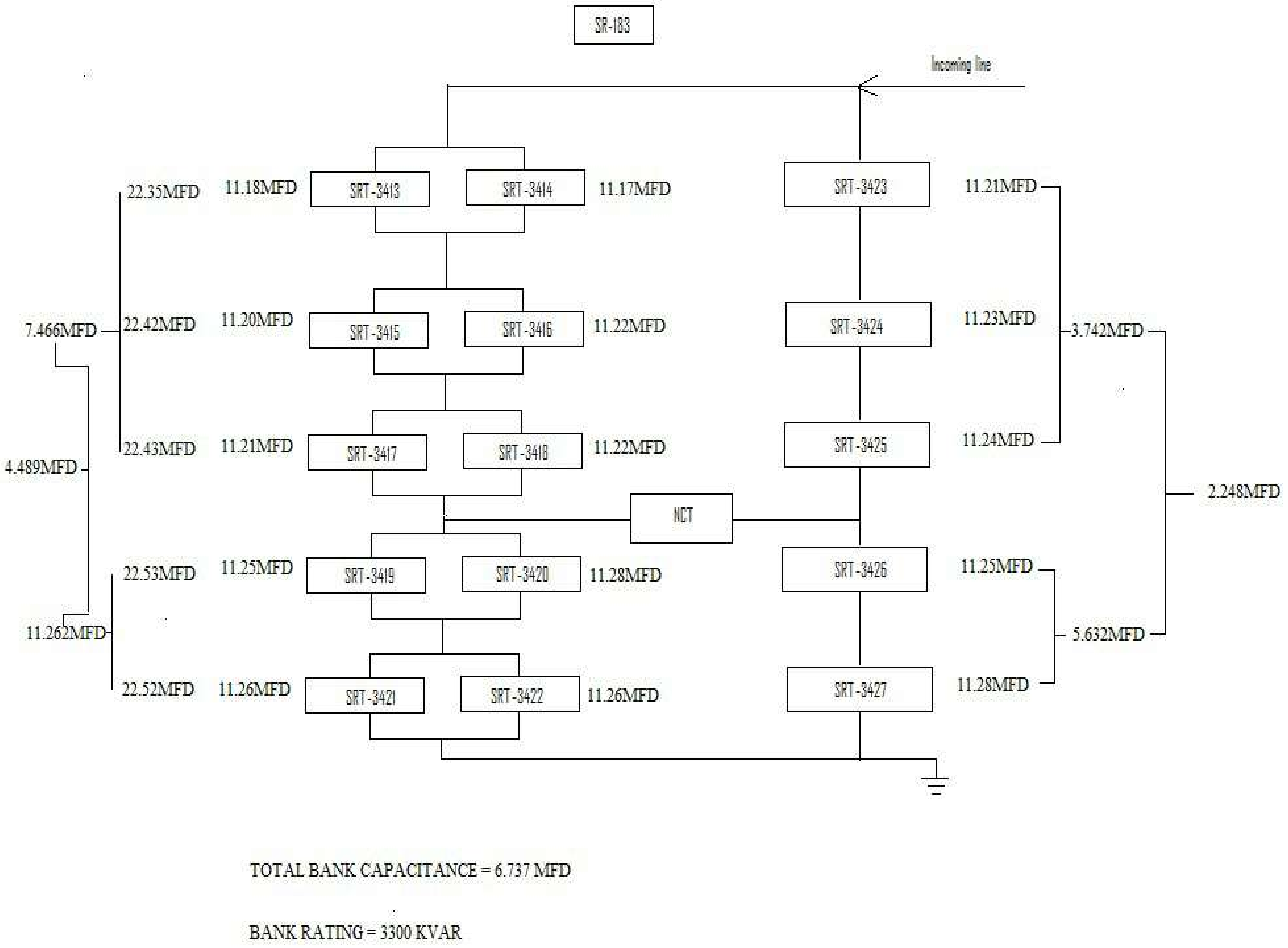
Calculate the plug setting multiplier by formula given below:

$$\text{Plug setting multiplier} = \frac{70}{110} = 0.64$$

Form IDMT curve 5sec at 0 Voltage; at 0.64 times of setting the operating time is nearly 9 sec at TMS 1. To achieve the operating time 1 sec.

$$\text{TMS setting} = \frac{1}{9} = 0.11$$

4.0 Current unbalance relay



4.1 Current setting

A sample result of unbalance current & voltage rises on healthy element and units of a capacitor bank vendor are given below:

X	In(A)	Vu/Vuo	Vel/Velo	Iu(A)
0	0.000	1.00	1.00	27.50
1	0.065	1.00	1.06	27.14
2	0.137	1.01	1.12	26.73
3	0.219	1.01	1.19	26.27
4	0.312	1.02	1.28	25.74
5	0.419	1.03	1.37	25.14
6	0.543	1.04	1.48	24.44
7	0.689	1.05	1.61	23.62
8 trip	0.863	1.06	1.76	22.64
9	1.073	1.07	1.95	21.46
110	1.333	1.09	2.18	19.99
11	1.662	1.11	2.47	18.14
12	2.094	1.14	2.86	15.70
13	2.638	1.18	3.38	12.38
14	3.536	1.24	4.13	7.58

X – Number of failed elements. In(A) – Neutral current in Amps.

Vel – Voltage across healthy element in parallel to failed element.

Velo – Rated voltage of healthy element.

Vu – Voltage across healthy unit in series with failing unit.

Veo – Rated voltage of healthy unit.

Iu(A) – Unit current in amps.

As per the above sample result, it is seen that with the failure of 8 elements resulting voltage appeared across healthy elements parallel to failed elements is 1.76 times of rated voltage, the unbalance current above number of elements failure is 0.863 amps. This is the sample results only; it may vary from manufacturer to manufacturer, therefore approach to capacitor bank manufacturer for actual permitted unbalance current

Set current in amp, IUB = $\frac{0.863}{2/1}$ = 0.4315

Setting in % = $\frac{0.4315 \times 100}{1}$ = 43.15 % i.e. 43 %

4.2 Time setting

The time setting shall be kept at 200-400 ms.

*****

APPENDIX-6
GUIDELINES FOR PROVISION OF MAINTENANCE DEPOTS, TOOL AND PLANTS AND TRANSPORT FACILITIES

1.0 OHE Maintenance Depots

1.1 In the overall interest of minimum capital and recurring costs with electric traction, the number of OHE maintenance depots need be optimized. The general conditions that govern the location and the spacing of the OHE maintenance depots are as under:-

1. The total equipped track kilometres to be maintained by each depot;
2. Beat of the depot on either side;
3. Traffic density obtained on the section and the time factor in reaching the farthest point;
4. The proximity of major yards with considerable equipped track kilometres;
5. Availability of educational, medical and other infrastructure facilities in the vicinity.

1.2 The total staff required for OHE maintenance for a given section is arrived at, based on the prevalent yardsticks for maintenance and the schedules of maintenance laid down for various equipments. The total staff is distributed amongst the maintenance requirements of OHE under their respective jurisdictions. The staff requirement for the maintenance as per the yardstick is in no way linked with the number of OHE Depots in a particular sections.

1.3 The total equipped track kilometres normally assigned for maintenance to a single OHE depot should be at least 150 track kilometres which amounts to 250 to 300 EETKMs (Electrical Equated Track km) to ensure that the installations to be maintained by a single depot do not become unwieldy. On a normal double line section this would work out to a spacing of 60 RKMs between successive OHE maintenance depots. In the case of depots in the vicinity of terminal/major yards (having large wired Tkm.), the spacing would correspondingly get reduced. In view of the concentration of work load in major yards, it will be necessary to locate maintenance depots in or around the vicinity of the major yards.

1.4 The beat of the depot on either side should not normally exceed four block sections (occasionally five) so as to ensure quick transportation of staff to the breakdown spot even if it happens at the farthest end of the jurisdiction of the depot.

1.5 The location of the depot should be such that reasonable educational and medical facilities are available at the place as otherwise the staff would be generally reluctant to stay at such a place.

1.6 The standard lay-outs of OHE depots have undergone several changes over a period of time, with varied concepts like major depots, minor depots etc. emerging to meet specific requirements. The essential difference between major and minor depot is the provision of a tower wagon with its shed and associated track connections and OHE Depot Workshop in a major depot.

1.7 The standard OHE maintenance depot need only be provided with a drilling machine, bench grinder etc. the standard layout of OHE depot with workshop is shown at Fig. A6.01, the schematic layout of Divisional Repair shop to be provided as an adjunct to one of the OHE depots is shown at Fig. A6.02.

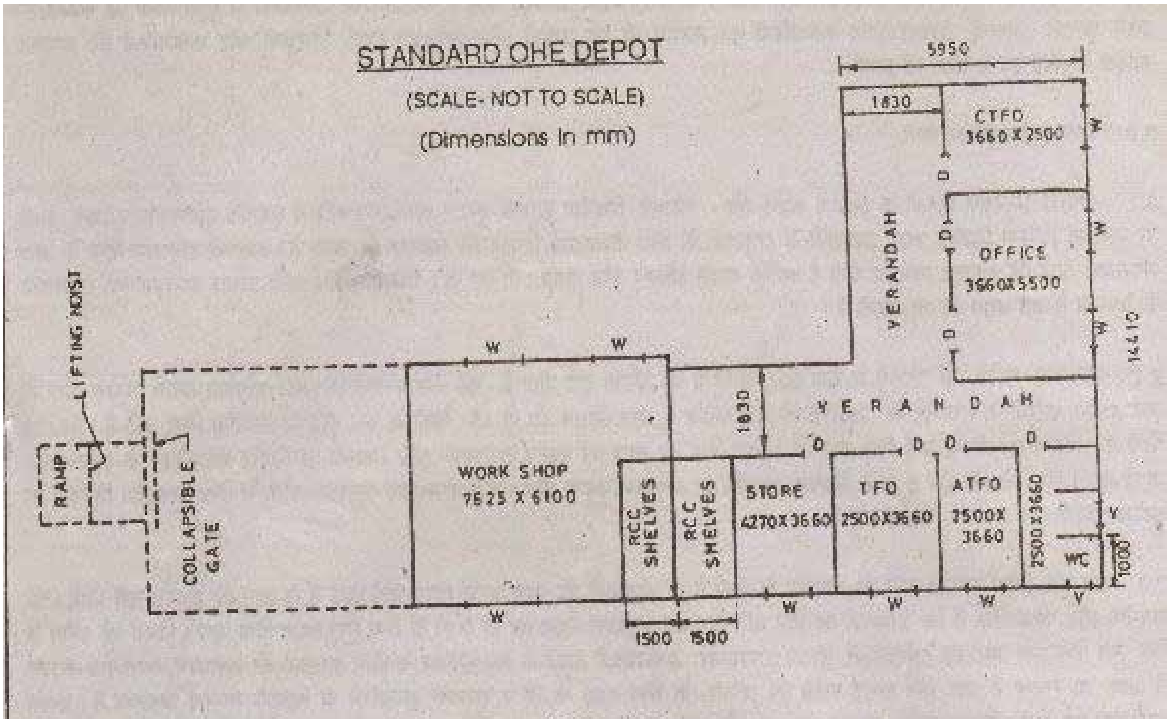


FIG. 6.01

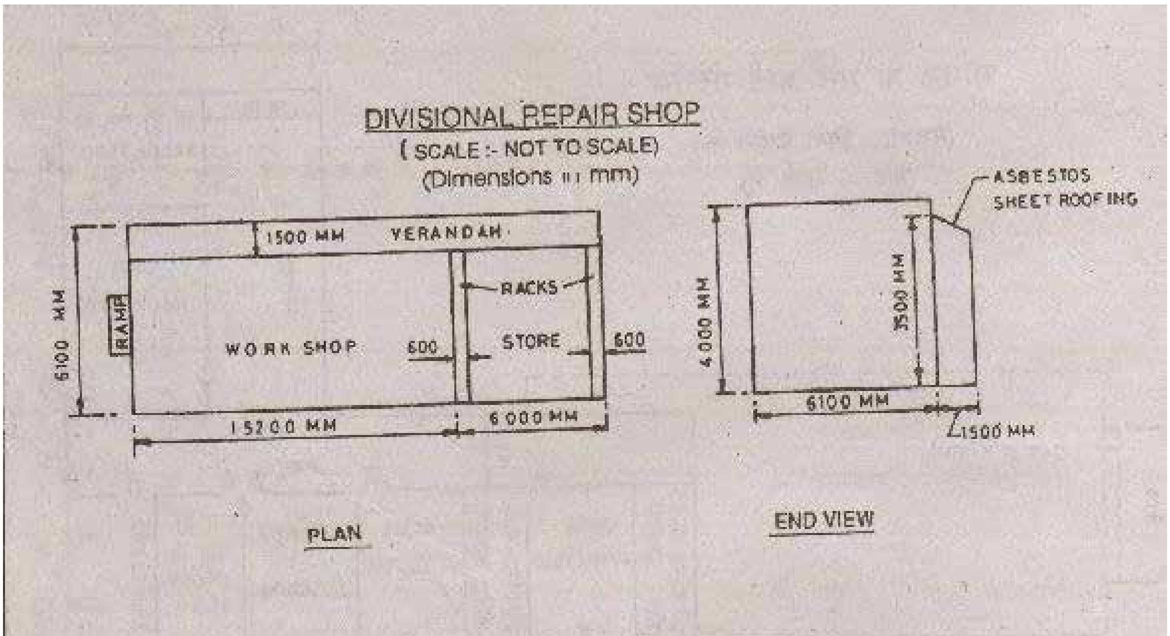


FIG. 6.02

1.8 Secondary activities/facilities in OHE maintenance depots, such as smithy, carpentry, welding etc. can be provided at a central plan either at the Divisional Headquarters or at one of the maintenance depots, depending upon convenience of location. Such a facility will have standard workshop equipments, such as lathe, hacksaw cutting machine, welding set, vertical drilling machine etc. Along with the above, a store can be provided where large quantities of OHE materials which are required for major breakdowns for the entire section can be stored, relieving the other maintenance depots from the responsibility of storing large quantities of materials which are required only occasionally. This would also increase the utilization of staff such as welders, black smiths, carpenters, and incidentally is likely to result in overall savings of the staff in the ancillary categories and equipments.

2.0 PSI Maintenance Depots

2.1 Besides the OHE maintenance depots, PSI maintenance depots are provided for maintaining the various power supply equipments installed at traction substations, switching stations, auxiliary transformer stations etc. It is advantageous to locate the PSI maintenance depot alongwith the OHE maintenance depot so as to achieve some economy in requirements of T & P, transport and other infrastructural facilities.

2.2 Normally the average spacing between traction substations is 60/70 km. On trunk routes with high traffic densities, where operation of 4500 t trains is to be catered for, sub-stations are provided at reduced spacing of 40 to 45 km. With PSI depots spaced at 60/70 km., each depot will be called upon to maintain one or two traction sub-station and 5 to 6 switching stations, besides booster transformer and auxiliary transformer installations on the sections. A sketch showing the suggested layout for a PSI maintenance depot is shown at Fig A6.03.

2.3 If a Zonal Repair Shop is provided, necessity of transporting the equipments to the PSI depot may not arise. It is desirable and feasible to give all attention that is required for day-to-day maintenance of the equipments at site. For any major attention such as oil circulation of the breakers/auxiliary transformers, booster transformers, interrupters, etc. the equipment can be transported to the nearest traction sub-station, where power supply is available from the 100 kVA auxiliary transformer for working of the oil filtration plant. This results in minimum transportation of these equipments. Major repairs, which cannot be done at the sub-station, should be done only at the Zonal Repair Shop.

2.4 By combining the OHE and PSI depots, the OHE transport facility can be conveniently utilized for PSI work as well. A common depot will be cheaper with a common compound wall and security arrangements. Better coordination and supervision can be obtained between OHE and PSI maintenance staff if both the depots are located together. It is likely to result in faster attention to breakdowns. In addition, it would be desirable to have this combined OHE/PSI maintenance depot at a station where traction sub-station is also located, wherever it is feasible.

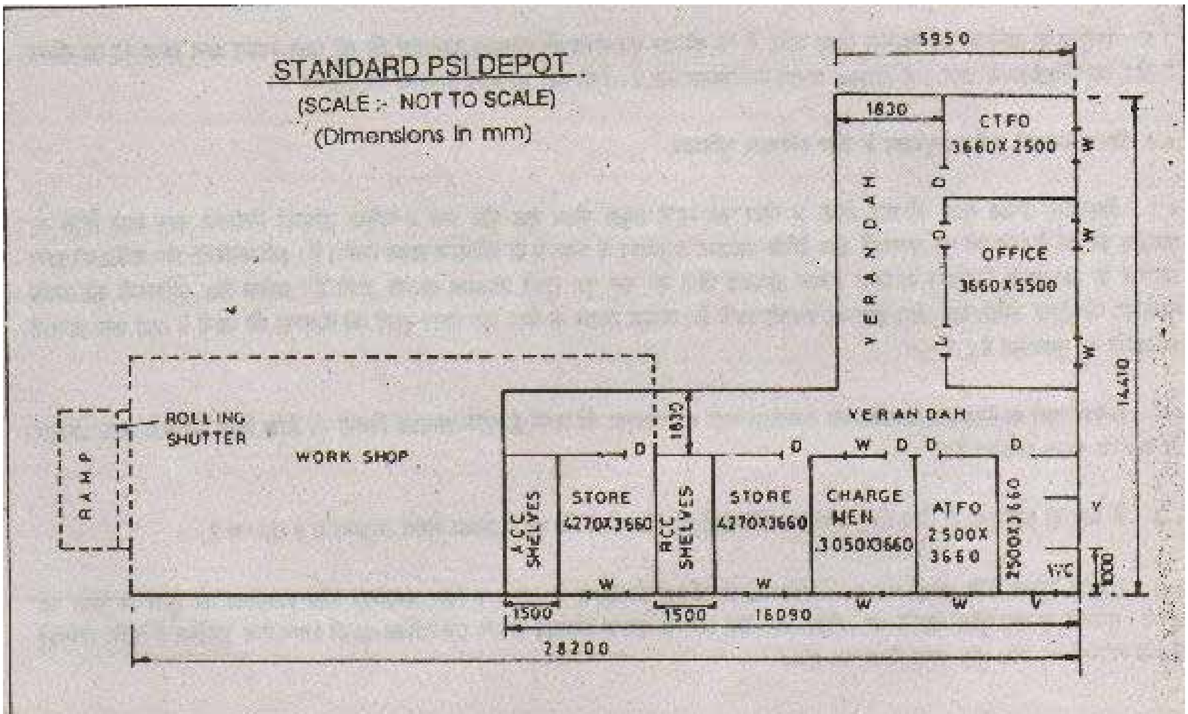


FIG. 6 03

3.0 Scale of T&P for OHE Depots

3.1 The list of T & P items to be procured by R.E. for OHE maintenance given at Annexure A6.01. This annexure also lists the items to be procured by R.E. for equipping each of the tower wagons as well as the break-down train.

3.2 The T&P recommended to be procured by R.E. for PSI maintenance is given at Annexure A6.02.

3.3 In addition, the T&P recommended to be procured by R.E. for Divisional Repair Shop for OHE is given at Annexure A6.03. Likewise, the T & P to be procured by R.E. for Divisional Repair Shop for PSI is given at Annexure A6.04.

3.4 The office furniture to be supplied by R.E. for field offices and depots is shown at Annexure A6.05.

3.5 Besides the above, it is felt that general user items of T & P can be procured by the Open Line and need not be provided by R.E. A list of such items is given at Annexure A6.06.

4.0 Transport Facilities for Maintenance Including Breakdown Attention

4.1 At present each major OHE Depot is provided with one heavy duty motor truck and one 4-wheeler/8-wheeler OHE Inspection Car. These transport vehicles are adequate for attending to breakdowns and for normal day-to-day maintenance.

4.2 One wiring-cum-breakdown train is to be provided for each Division to meet any major OHE breakdowns which require wiring of OHE.

4.3 Transport facilities recommended for TRD maintenance are summarized at Annexure A6.07.

4.4 On sections with higher traffic density, eight wheeler high speed tower wagons would enable quicker transportation of men and materials to the site. With increased emphasis on quick restoration after accident, quicker attention to OHE breakdowns is called for to provide early restoration of OHE power supply.

Annexure A6.01

T&P Items to be Procured by R.E. for OHE Maintenance Organization

Sl. No.	Description	Major Depot	Tower Car	Break Down Train
1.	Tirfor 3.2 Tonne/ 1.6 Tonne	4	4	-
2.	Tirfon 5 Tonne /3 Tonne	2	1	-
3.	Tirfor 2/3 Tonne	4	4	
4.	Pull-lift 3 Tonne	2	1	2
5.	Pull-lift 1.5 Tonne	2	1	2
6.	Pull-lift ¾ Tonne	2	-	2
7.	Dropper making Jig and Wire straightener for 5 mm dropper wire.	1	-	-
8.	Dropper making Jig and Wire straightener for 7 mm dropper wire.	1	-	-
9.	Come-along clamps for catenary suitable for 19/2.108 mm conductor	4	4	4
10.	Come along clamps for contact wire 107 mm2.	4	4	4
11.	Come along clamps for Aluminum “SPIDER” Conductor (20 mm2)	4	4	4
12.	Come along clamps for earth wire (19/205 mm) Galvanized steel.	4	2	2
13.	Universal come along clamp	6	6	
14.	Rail Jumpers with Clamps at both ends	30	-	6
15.	Rail Jumpers extension with clamp at one end	30	-	6
16.	Earthling discharge rod complete	10	4	6
17.	Aluminum straight ladder (8 m) with hook on top	4	1	2
18.	Aluminum straight ladder extensible (11m)	4	2	1
19.	Drilling Machine (25 mm) Motor Driven (Radial or Pillar)	1	-	-
20.	Bench Grinder (Double end) Pedestal Motor Driven (203 mm) disc	1	-	-
21.	Portable Welding-cum-cutting Set (Gas Range Cutting 1-100 mm. Welding 0.5 to 30 mm (Complete with Oxygen and Acetylene Cylinder, Trolley, Helmet etc.).	-	-	1
22.	Portable Electric Drill 21.0 mm 1 ph, 230 V (For Drilling rails for bonding)	1	-	-
23.	Honda Welding Generating Set (100/200A) with all accessories	1	-	-
24.	Portable Diesel Generating Set 3 kVA, 240V, 1 ph	1	1	1
25.	Flood Light fitting with 500 Watt Lamps	3	4	4
26.	Portable inflatable emergency lighting system	1	1	-
27.	Tool Box	8	4	-
28.	Set of “D” spanners10-11 to 34-35	10	4	
29.	Set of “Ring” spanners10-11 to 34-35	10	4	
30.	First Aid Box	2	1	1
31.	Stretcher	1	-	1
32.	Fire Buckets 10 Ltrs.	4	-	6
33.	Safety helmets	10	10	-
34.	Safety belts harness	30	30	-

Sl. No.	Description	Major Depot	Tower Car	Break Down Train
35.	Safety shoes	25	10 -	-
36.	Portable fire extinguisher (Cap. 10 Ltyr) Dry chemical powder	2	2	2
37.	Portable fire extinguisher (Cap. 9 Ltr.) (Foam Type)	2	2	2
38.	Contact wire cutter 36”	1	1	1
39.	Dropper wire cutter 12”	1	1	1
40.	‘D’ Shackles set of one each (1”, ¾”, 5/8”, ½”)	6	4	6
41.	Single sleeve pulley block 3.1/2” x ½ Grove Steel)	4	4	4
42.	Single sleeve pulley block 31/2” x ½” Groove fiber for drawal of contact catenary wire.	6	4	10
43.	Single sleeve pulley block 6” x 1” groove steel	4	2	2
44.	Contact wire twist-cum-bender 6”	2	2	2
45.	Steel sling with eye each end 19 mm dia 1 m. long 2 m long 3 m long	6	4	6
46.	Steel sling with eye each end 19 mm dia 4 m long 2 1 1	2	1	1
47.	Steel sling with eye each end 19 mm dia 10 m long 2 1 1	2	1	1
48.	Polyester webbing slings 1m long	8	8	
49.	Polyester webbing slings 2m long	6	6	
50.	Polyester webbing slings 3m long	6	6	
51.	Polyester webbing slings 4m long	4	4	
52.	Polyester webbing slings 10m long	3	3	
53.	Contact wire splicing jig	1	-	1
54.	Micro meter	1	-	-
55.	Metric tape 30 m, 15 m each	2	1	1
56.		4	-	-
57.	Engineering Ratchet	2	-	-
58.	Siren covering distance 1 km range	1	-	-
59.	Tilly lamps	-	4	-
60.	Portable Metal cutting machine	1	1	
61.	Portable rotary Hammer	1	1	
62.	Fibre ladder 11m, 8m	2		2
63.	Inflatable light source	1		2
64.	ATD bearing remover/fitment tool	2		
65.	Contact wire kink remover	2		2
66.	Contact wire twister cum bender	2		2
67.	Rail hole drilling machine for fixing bonds	2		1
68.	Bender cum twister for MS Flat bonds	2		2

Sl. No.	Description	Major Depot	Tower Car	Break Down Train
69.	Hydraulic Crimping Tools	1		1
70.	Motorized Earth Auger			1
71.	Insulator replacement jig	1	1	1
72.	Cantilever replacement tool	1	1	1
73.	Laser based distance measurer	1		1
74.	Portable power drilling machine	1		
75.	Portable welding machine	1		
76.	Industrial type suitable jacket for technicians for carrying different tools	All staff		
77.	Hydraulic Spanner set	2		1
78.	Digital Spirit Level	1	1	
79.	Demolition hammer for reclaiming mast			1
80.	Computer with B/W printer	2		
81.	Computer with Colour printer	1		
82.	Laptop with latest Configuration	1		
83.	33kV Hand Gloves	5 Pair	5 Pair	1 Pair
84.	Rechargeable heavy Duty LED Torch	2	1	1
85.	Laser Type Contactless Thermometer	1	1	1

TESTING AND MEASURING EQUIPMENTS				
1.	Digital Megger 2500 V	1	2	-
2.	Dynamometer (3500 kg x 20 kg) m300 mm dia	1	-	-
3.	Earth megger / tester	1	-	-
4.	High Resolution Binoculars	1	1	-
5.	Digital Vernier Callipers	1	1	-
6.	Walkie Talkie sets (5 W out put VHF set)	2 Pair	4 Pair	2 Pair
7.	Emergency Telephone	6	1	-
8.	Multimeter	1	-	-
9.	Thermal Imaging Camera for checking OHE/PSI connectors.	2		
10.	Conductivity meter for measuring pollution level	1	-	-
11.	Insulator Tensile testing Machine as per RDSO specification.	1		
12.	Power driven tree cutting machine	1	1	
13.	Telescopic tree pruner	1	1	
14.	Oliver G Plus for current collection test	1	1	
15.	25 kV insulated telescopic rods for clearing foreign materials (kites, strings, crow nest etc.) from OHE	1	1	
16.	Earth resistance tester clamp type (suitable for 8x75mm flat)	1		
17.	Cable fault detector	1		
18.	Digital camera	1		
19.	Digital 5 kV, 2.5 kV, 500 V Megger	2 Each		

Annexure A6.02

T&P for PSI Depots to be Supplied by R.E. Organization

Sr. No.	Description	Quantity
1.	Tirfor 3 ton cap.	4 Nos.
2.	Tirfor 5 ton cap.	2 No.
3.	Barrel Pump	1 No.
4.	'D' Shackles 5/8", 1", ¾"	3 Sets.
5.	Steel rope slings 1m, 3m each.	2 Nos.
6.	-do- -do- 10m	1 No.
7.	Chain Pulley block 3.0 ton cap.	1 No.
8.	Pulley Single Sheave 3.0 ton cap.	2No.
9.	First Aid Box	1 No.
10.	Stretcher	1 No.
11.	Fire Buckets	4 No.
12.	Portable Electric blower	1 No.
13	Portable electric grinder	1No.
14.	Portable electric drilling machine 13mm	1 No.
15.	Crimping tool upto 6mm2 size	2 Nos.
16.	Aluminum step ladder 8' height	2 Nos
17.	Aluminum step ladder with hook on top 8'	2 Nos.
18.	Aluminum step ladder16'	1 No.
19.	Mobile Aluminum step ladder 36'	1 No.
20.	Magic pole ladder 8'	2Nos.
21.	Earthing Pole Assembly/Discharge Rod	6 Nos.
22	Drop out fuse pull rod	2 Nos.
23.	Portable diesel engine operated welding set 230 V	1 No.
24.	½" square drive socket set containing 19 sockets with 6 attachments	3 Sets
25.	Acidity testing kit	1 No.
26	Mains operated insulation tester 5 kV	1 No.
27.	Pocket size clip on tong tester (0-5A/25A) (0-150V/300/600V)	1 No.
28.	AC Voltmeter 0-150 V	1 No.
29.	AC Voltmeter 0-500 V	1 No.
30.	Digital time interval meter 15-1000 seconds	1 No.
31.	Insulation tester 2.5 kV	2 Nos.
32.	Earth Tester	1 No.
33.	Megger 500 V	1 No.
34.	Oil testing Kit	1 No.
35.	125 Ltr. Cap. Oil filtration plant	1 No.
36.	Insulation tester 250 V	1 No.
37.	Multimeter	2 Nos.
38.	Auto transformer 2 A Capacity	1 No.
39.	Load cell tester	1 No.
40.	Emergency Telephones	4 Nos.
41.	Cycle Pump	1 No.
42.	Thermal Imaging Camera for checking PSI connectors.	1
43.	Digital relay testing kit.	1

Sr. No.	Description	Quantity
44.	DGA testing Machine	1
45.	Stainless Steel Oil Sampling Bottle with stop cock at both ends for DGA testing of Transformer	4
46.	Digital Multimeter with accessories for voltage measurement	2
47.	Clamp meter for current measurement.	2
48.	Earth resistance tester clamp type (suitable for 8x75mm flat)	2
49.	Contact resistance meter	1
50.	5kV Portable insulation tester (Electronic)	1
51.	Portable tan delta tester	2
52.	Digital timer	1
53.	Cable fault detector	1
54.	Digital camera	1
55.	Fiber ladder 11m, 8m	2
56.	Portable High voltage tester up to 95kV	1
57.	Laser based distance measurer	1
58.	Portable power drilling machine	1
59.	Crimping tool for TSS Cable	2
60.	Digital LCR Meter	2
61.	Battery operated time interval meter	1
62.	CT excitation, ratio and polarity tester	1
63.	Safety Helmet	5
64.	Industrial type suitable jacket for technicians for carrying different tools	All staff
65.	Primary Current Injection Test set, 230V, AC, Single Phase, Capacity 0-2000A	1
66.	Hydraulic Spanner set	1
67.	Oil BDV Tester up to 100kV	1
68.	Hot air gun for heating Silica Gel (portable)	1
69.	Blower for cleaning switch gears and control panel (portable)	1
70.	Capacitance Meter	1
71.	Leakage Current Detector	1
72.	Multipurpose portable power drill machine	1
73.	Computer with B/W printer	1
74.	33kV Hand Gloves	5 Pair
75.	Rechargeable heavy Duty LED Torch	1
76.	Laser Type Contactless Thermometer	5
77.	Secondary Injection kit (0-100 amp)	1
78.	Polyester sling 1m,2m,3m,4m, and 10 m long set	4 nos each
79.	Safety Belt Harness	5
80.	Safety Shoes	5
81.	Tool Box	5
82.	Pull lift 1.5 tonne	1
83.	Oil Centrifuging plant single phase 125 litre/h	1
84.	Digital 5 kV, 2.5 kV, 500 V Megger	2 Each

Annexure A6.03

T&P to be Procured by R.E. for Divisional Repair Shop (OHE)

Sr. No.	Description	Quantity
1.	First Aid Box	1 No.
2.	Fire buckets 10 Ltr Cap.	8 Nos.
3.	Portable fire extinguishers cap. 10 Ltrs (DCP type)	2 Nos.
4.	Portable fire extinguishers cap. 10 Ltrs (Foam type)	2 Nos.
5.	Portable Honda Generating set 0.75 kVA, 240V, 1 ph.	1 No.
6.	Stretcher	1 No.
7.	Black smith hammer 12 Kg	2 Nos.
8.	Black smith hammer 10 Kg	2 Nos.
9.	Micrometer (mm)	1 No.
10.	Metallic tape 30 m, 15 m each	2 Nos.
11.	Bench vice (6”)	2 Nos.
12.	Portable Electric Grinder	1 No.

Annexure A6.04

T&P to be Procured by R.E. for Divisional Repair Shop (PSI)

Sr. No.	Description	Quantity
1.	Primary injection testing kit (0-2000 A)	1
2.	Secondary injection testing kit (0-100 A)	1
3.	Digital/Numerical relay testing kit	1
4.	2500 Ltr cap mobile oil filtration plant	1
5.	250 Ltr cap oil filtration plant	1
6.	Distilled water plant Cap. 50 Ltr.	1
7.	5 kV Megger	1
8.	2.5 kV Megger	1
9.	500 V Megger	2
10.	Hydraulic Jack 50 Ton. Cap.	6
11.	Auto Transformer 2 Amps. Capacity	1
12.	Spray painting machine	1
13.	Multi meter	2
14.	Portable clip tong tester 0-5-25A, 0-150-300-600V	2
15.	Oil testing kit	1
16.	Acidity testing kit	1
20.	A/c Voltmeter 0-150 Volts	1
21.	A/c Voltmeter 0-500 Volts	1
22.	Centrifuging plant single phase 125 Litre capacity	1

Annexure A6.05

Furniture to be Supplied by R.E. for OHE and PSI

Sl. No.	Description	AEE	OHE	PSI	RC
1.	Chairs with hands	1	4	3	3
2.	Chair without hands	3	6	4	4
3.	Supervisors Tables	-	3	2	2
4.	Ministerial staff tables	3	1	1	1
5.	Steel Almirah	3	3	2	3
6.	File racks	2	2	2	2
7.	Stools	4	6	4	3
8.	18 Pigeon holes lockers	-	4	3	2
9.	Steel trays	4	8	6	6
10.	Telephone tables	2	2	1	1
11.	Waste paper boxes	4	4	3	3
12.	Officers tables	1	-	-	-
13.	Drawing Cabinets	1	-	-	-
14.	Steel book case	1	1	1	1

Annexure A6.06

T&P Items to be Procured by Maintenance Organisation for OHE/PSI

Sl. No.	Description of Item	Major Depot	Tower Car. D	Break own train	PSI
1.	Bond Press	3	-	1	-
2.	Dekinker	3	1	2	-
3.	Swivel Clip Openers	2	2	2	-
4.	Portable hand drill 12.5 mm	1	-	-	-
5.	Portable hand drill 8 mm	2	-	-	2
6.	Portable hand tap 8 mm	2	-	-	2
7.	DE Spanners sizes (6/7 to 27/30 mm) complete set	4	1	1	2
8.	DE Spanner 30 – 32	10	2	2	2
9.	DE Spanner 24 – 26	10	2	2	2
10.	DE Spanner 21 – 23	6	2	-	2
11.	DE Spanner 18 – 19	-	-	-	4
12.	DE Spanner 16 – 17	6	2	2	-
13.	DE Spanner 14 – 15	6	2	2	-
14.	DE Spanner – 12 – 13	-	-	-	6
15.	Ring Spanners set (6/7 to 27/30 mm)	2	1	1	2
16.	Ring Spanners 30 – 32	10	2	2	2
17.	Ring Spanners 24 – 26	10	2	2	2
18.	Ring Spanners 20 – 22	6	-	-	2
19.	Ring Spanners 18 – 19	-	-	-	2
20.	Ring Spanners 16 – 17	6	2	2	-
21.	Ring Spanners 14 – 15	6	2	2	-
22.	Ring Spanners 12 – 13	-	-	-	6

Sl. No.	Description of Item	Major Depot	Tower Car. D	Break own train	PSI
23.	Screw Driver 18”	4	1	1	-
24.	Screw Driver 16”	4	1	1	1
25.	Screw Driver 12”	4	1	1	-
26.	Screw Driver 8”	2	-	-	2
27.	Screw Driver 6”	2	-	-	4
28.	Insulated cutting Piler (8”, 12”)	4	2	2	4
29.	Insulated Nose Piler (8”)	2	-	-	2
30.	Adjustable Pillars Wrench 10”	2	1	1	1
31.	Adjustable Spanner 12”	2	1	-	1
32.	Adjustable Spanner 8”	2	1	-	1
33.	Adjustable Spanner 6”	-	-	-	1
34.	Set of Screw Driver	2	1	-	2
35.	Pipe Wrench 12”	1	-	-	1
36.	Pipe Wrench 8”	-	-	-	1
37.	Hacksaw frame Adj. 12”	2	1	1	2
38.	Plump bob	4	1	1	2
39.	Spirit level 12”	1	1	-	-
40.	Spirit level 6”	2	1	-	1
41.	Allen Key Sizes (2 to 10 mm)	-	-	-	2
42.	Detonators Boxes	1	1	1	-
43.	Banner Flags	2	2	2	-
44.	Hand Signal Flag (Red & Green)	6	2	2	-
45.	Hand Signal lamps	2	2	2	-
46.	Blow Lamp ½ Ltr. Cap.	2	-	-	2
47.	Wall Clocks	1	-	-	-
48.	Grease Gun	2	-	-	1
49.	G.I. Pots	2	-	-	2
50.	Oil Sampling bottles	-	-	-	6
51.	Hydrometers	-	-	-	4
52.	Thermometers	2	-	-	4
53.	Crow Bars	4	-	2	2
54.	Pick Axe	4	-	2	1

Annexure A6.07

Transport Facilities for TRD Maintenance

Sl.	Unit	Type / No. of Vehicles			
		Jeep With Trail-Ler/MUV	Tower Car.	Heavy Duty Motor Truck	Wiring Cum Break Down Train
1.	a. Each station where an OHE Officer is based	1	-	-	
	b. Each field officer at his Headquarters				
	i. OHE	1	-	-	-
	ii. PSI	1	-	-	-
2.	OHE Depot	1	1*	1*	-
3.	Zonal Repair Shop	-	-	1	-
4.	Divisional Headquarters/ Divisional Repair Shop	1	-	-	1

(*) Will also be used by associated PSI Depot.

*****

APPENDIX-7
GENERAL GUIDELINES FOR ANTI-THEFT CHARGING OF OHE

1.0 General

1.1 In the theft prone area the energisation of OHE at 2.2 kV as an anti-theft measure may be done to avoid theft of contact/catenary wire. As energisation at 2.2 kV is purely for the purpose of arresting the theft of catenary and contact wire and not for train operation, it is not likely to produce any inductive interference affecting signalling and telecom. installations due to practically no current flowing in the circuit. Therefore, even though certain works like erection of isolators and section insulators, installation of SWS, BTs,. ATs adjustment of OHE, SED checks, tower wagons checks, provision of CLS, Telecom, cabling etc. are not completed in all respects, OHE can be charged at 2.2 kV.

1.2 Period of anti-theft energization will generally be restricted at night hours i.e. from 7 PM to 7 AM. It may, however, be changed with the approval of PCEE of the zonal railway.

2.0 Works to be completed prior to 2.2 kV Energisation

2.1 The following works are essentially required to be completed prior to 2.2 kV anti-theft energisation of OHE.

2.1.1 Stringing of catenary and contact wire complete with droppering, clipping, and insulation and provision of automatic tensioning device.

2.1.2 Provision of structure bonds in open route and structure and rail bonding in station areas in accordance with the Bonding and earthing code. In station areas where Bonding and Earthing work has not been completed, the return conductor (RC), if provided, may be used as earth wire and connected solidly to the OHE structures/supports by means of suitable jumpers. At both the ends of the station, RC shall be connected to rails.

2.1.3 All necessary LT modification works

2.1.4 Necessary modification to all HT crossings to meet at least the requirements for 2.2 kV as per the standards laid down in Appendix IV.

2.1.5 Provision of wire mesh screen on the working platform of existing semaphore signals in case the requisite electrical working clearance of 2 m is not available. No portion of the signal post or its fittings shall be less than 700 mm from the live conductor.

2.1.6 Replacement of existing dc track relays by ac immunized relays.

2.1.7 Conversion of all track crossings of communication lines into cables and removal of overhead wires thereof.

2.1.8 Provision of height gauges and 25 kV caution boards at all level crossings.

2.1.9 Provision of protective screens with 25000 V caution boards on over line structures like ROBs, FOBs Fly Overs etc.

2.1.10 Provision of Public Warning board for 25000 V and shock treatment charts and First-Aid Boxes at all relevant places like stations, cabin buildings, repeater stations, cable huts etc.

2.1.11 Supply of insulated tools to maintenance staff.

2.1.12 Modification to carriage watering arrangements and water columns to suit anti-theft energisation.

2.2 All the relevant rules and precautions in accordance with the Indian Electricity Rules should be complied while carrying out the works.

3.0 2.2 kV Power Supply Arrangements

3.1 2.2 kV energisation will be done through local supply available at one of the stations through a step-up transformer provided with fuse of suitable capacity with an audible and visual Indication arrangements. A Schematic Diagram indicating the power supply arrangement and the controls and scheme of connection for supply of power at 2.2 kV shall be prepared and submitted to EIG for his approval.

3.2 The 2.2 kV supply arrangement will be manned round the clock by RE. The organisation to be available for manning the feeding installation and duties of the staff and ASMs in case of both normal operation and breakdown/abnormal operation shall be detailed out and issued in the form of a circular.

3.3 As stated in para 1.2 above even though the OHE will be normally kept energised during night, the OHE in the energise section shall be regarded as live at all the times and consequently dangerous to human life. No person except those deputed to work on or near the overhead electrical equipment and who are in possession of a 'permit to work': issued by an authorised representative of RE, shall approach within 2 m from the OHE.

3.4 A joint procedure order indicating the detailed procedure to be followed for taking power block and issue to "permit to work" for issuing notices to drivers, for attending to breakdowns shall be make out and issued to all concerned. This order will be signed jointly by the concerned officers of both RE and Division. A model circular is given in the Annexure A 7.01.

4.0 Procedure to be Adopted for Energisation

4.1 Publication and display of Notices.

4.1.1 At least a month in advance of energisation of any section or sections the following public notifications should be got published in all the prominent dailies in English, Hindi and Local Language and issued to all concerned as normally done for 25 kV energisation, (Reference may also be made to para 21008)

1. General Notification to the users of Railway lines regarding section/sections to be energised.
2. Notification to the users of level crossings.

4.1.2 Display of general caution notices for public and staff at prominent places at each station, stenciling on the diesel/steam locos warning message to not to climb on the top of locos, caution notices at all steam and diesel loco sheds at which locos working in the energised section are maintained.

4.1.3 The steam/diesel loco drivers/firemen shall be warned not to climb on the roof of the tender and the engine on the section proposed to be energised.

4.2 On completion of the work as mentioned in Para 2 above the following certificates from the concerned officers will be obtained.

1. Certificate regarding removal of L.T. & H.T. infringements by Dy. CEE(G) of the project.
2. Certificate regarding S&T works

3. Department of Telecommunications (DOT) clearance certificate for 2.2 kV anti-theft energisation.
4. Certificate by Dy. CEE(OHE) or DEE(OHE) regarding completion of OHE works.
5. Certificate by OHE Contractors
6. Certificate by Dy. CE/DEN/RE regarding provision of level crossing gauges and provision of protective screens on ROBs and FOBs

4.3 Besides the certificates regarding completion of works to suit 2.2 kV energisation as mentioned in para 4.2 above, the following safety certificates shall also be obtained.

1. Joint certificate by CEE (P), CSTE (P) and CE (P) regarding safety to traffic as per draft at annexure A 7.02.
2. Certificate of concerned officers of Division of particular Railway about knowledge of their staff regarding safety.

4.4 EIG Sanction

An application to EIG seeking his approval to the proposal of energisation of OHE at 2.2 kV as anti-theft measure may be made in advance. While applying for sanction, the uptodate status of works to be completed prior to 2.2 kV energisation should be given and the list of certificates for its completion as well as other safety certificates proposed to be forwarded at the time of seeking EIG's' formal sanction may also be indicated, EIG's' sanction shall be obtained prior to energization.

4.5 Checks and Tests prior to Commissioning:

4.5.1 PCEE and Electrical Inspector to the Government for the Railway may nominate at his discretion one of his officers preferably Sr. DEE (TRD) for joint check and tests of the section proposed to be energised. For such joint check Dy. CEE(OHE)/RE will associate from RE side. Alternately he may authorize Dy. CEE(OHE)/RE to conduct checks and tests before energisation. The following checks and test shall normally be carried out.

4.6 Checks

4.6.1 That clearance between live and earthed structures is in accordance with the provision of Schedule of Dimensions.

4.6.2 That earthing and bonding of the OHE have been carried out as per Bonding and Earthing code with exception for station area as specified in para 2.1.2 above.

4.6.3 That height of contact wire at level crossings is proper and that height gauges have been provided

4.6.4 That protective screens have been provided in FOB, ROBs and signalling structure

4.6.5 That the earthing and isolation of overhead equipment adjacent to the section to be energised has been carried out properly.

4.6.6 Ac immunised track relays have been provided

4.6.7 Overhead P&T as well as Rly. Crossings have been cabled and wire removed.

4.7 Tests:

4.7.1 Megger tests for continuity and insulation of the OHE

4.7.2 With the above checks and test and after it is certified either jointly by Sr. DEE/TRD and Dy. CEE(OHE)/RE or by Dy. CEE(OHE)/RE that the section can be energised at 2.2 kV for test purpose, the following fault tests shall be conducted on the section energised at 2.2 kV.

1. By creating earth fault at the farthest end of energised OHE through discharge rod

2. By creating earth fault at the farthest end of energised OHE touching only ballast.
3. By creating earth fault at the farthest end of energised OHE touching only rail.

   In all these cases of earth fault, lit should be ensured that fuse provided at the supply point is blown.

4.8 Immediately on the successful completion of the checks and tests of the OHE, OHE can be energised provided that:

1. All the certificates as mentioned in paras 4.2 and 4.3 above are obtained
2. DOTs clearance and EIG's sanction are obtained.

4.9 Immediately after energisation, a notification to that effect may be issued as normally done for 25 kV energisation.

Annexure A 7.01

JOINT OPERATING AND RAILWAY ELECTRIFICATION CIRCULAR NO……….ANTI-THEFT ENERGISATION IN SECTION…………

The OHE wires, in section are to be kept energised on high voltage continuously, In order to guard the erected overhead equipment against theft. The energising work is being started immediately on (Group) and (Group) sections. Audible and visual indication arrangements will be made in the office of the Assistant Station Master on duty at and stations. These will be the controlling Masters for anti-theft energisation. Normally a green light will be ON. The alarm will sound a buzzer as well as light a red lamp, whenever a defect, appears on the OHE due to its coming in contact with earth or earthed structure. Immediately when such an occurrence takes place it is necessary to ensure that (a) the equipment damaged does not obstruct the traffic (b) also the line is patrolled, causes of earthing and the defects rectified as quickly as possible. The OHE in the energised section, shall be regarded as being alive at all times and consequently dangerous to human life. No person, except those deputed to work on or near the overhead electrical equipment and who are in possession of a "permit to work" issued by an authorised representative of RE, shall approach to with in 2 metres from the OHE.

1.0 Duty of ASM at controlling stations

1.1 He shall maintain the attendance of operator/lineman. The shift duty of this staff will be fixed by the respective supervisor of RE, who will maintain their muster sheets.

1.2 In the case of abnormality observed through the indicator of Red light provided for the purpose, the ASM on duty will direct the operator to take necessary action as required.

1.3 In the case abnormality indicated by an alarm or red light in any of the indication boards, the ASM shall immediately direct the operator/lineman and inform him of the indication, arrange for calling the respective Supervisor of RE. After the supervisor of RE has declared OHE to be defective, the ASM will advise the Section Controller to issue caution order through the ASMs of the previous train stopping stations where necessary, to drivers of all trains both in Up and Down directions to be on a sharp lookout for the infringement of the track from OHE and to be prepared to stop short of any infringement.

1.4 In addition to this on advice of the Supervisor of RE, the ASM of the station at the other end of the faulty section to send the lineman/operator of RE with staff of the contractor to attend the abnormality/breakdown. The ASM should also inform the Section Controller and the RE Controller about the abnormality/breakdown to convey the message to the supervisor concerned so that the breakdown gang can be moved on the line immediately.

1.5 If any message is received from section controller, or Driver about the location of the fault, he will immediately inform the supervisor of RE and the RE controller.

1.6 When asked by the Supervisor of RE, the ASM make arrangements to stop a train or light engine at the station for the transportation of staff.

2.0 Duty of RE Controller

2.1 He will assist the Section Controller, in case of any breakdown/abnormality, informing all concerned.

2.2 He will immediately inform DOM/RE and DEE(OHE)/RE concerned, on the autophone and also on P&T phone, if necessary and also the EFO/OHE concerned and the representative of the RE contractor immediately on receipt of breakdown message.

2.3 He will assist the breakdown gang in reaching the site by arranging light engine or train where road facility is not available, in co-ordination with the Section Controller.

2.4 On receipt of the information about wire cutting, he will immediately inform the ASI/RPF concerned as well as local/Railway Police and control/autophone and P&T phone also.

2.5 He will in constant touch with the Section Controller and ASM concerned until the infringement of the OHE is cleared and normal conditions are restored.

2.6 He will pass on the requisition for 'permit to work' when received to the supervisor of RE at the station.

3.0 Duties of Drivers and Guards

3.1 On receipt of caution orders from the ASM that the OHE in the section is faulty, he shall proceed cautiously and shall lookout for any hanging OHE wire on Up and Down track.

3.2 In case OHE is found to be hanging and the same does not infringe the standard moving dimensions, the Driver should pass the hanging wire under caution without further damage to the hanging wire, and on reaching the next station he should inform about the location of hanging wires to the ASM.

3.3 In case the hanging OHE wires are infringing the standard moving dimensions, the driver shall stop short of infringements and shall report the location and nature of infringement to the nearest ASM.

3.4 The driver or any other person shall not come in contact with any of the wires laying either on ground or hanging loose and shall prevent others from doing so.

3.5 In case of passenger trains where the Guard is in possession of a portable telephone, the same may be used for giving the information regarding the hanging of wires to the Section Controller, On the energised sections, riding on the top of engine/tender by the crew is strictly prohibited.

4.0 Duties of the Section Controller

4.1 On receipt of the advice from ASM that there is a defect in the overhead equipment, he shall arrange to give caution orders to all Drivers in the faulty section to be on sharp lookout for any obstruction or wires hanging around, and report the same to the ASM of the station adjacent to the Block Section.

4.2 He should immediately advise the RE controller also for passing on the information to all concerned.

4.3 He should arrange for light engine/or train when asked for the movement of the breakdown gangs of RE

4.4 If any Driver/Guard/ASM informs him about the locations of hanging OHE wires or breakdown of OHE, will advise the same to the RE controller.

4.5 On receipt of the advice from any of the ASMs or RE controller that the infringement has been cleared, he will arrange for the cancellation of the caution order issued para 4.1 above.

5.0 Normal Operations

5.1 'Permit to work' for carrying out further construction work on the OHE and for works of other departments viz. Engineering, signalling etc. within two metres of OHE, the energised OHE will have to be switched off. All these works can be carried out only when the "permit to work" has been given by the authorised representative of RE.

5.2 Cancellation of 'Permit to work' and recharging of OHE: After the work has been finished by the party requiring ' permit to work' the party will give back in writing to the authorised representative of RE at site, who originally handed over the ' permit to work' to them, that the work in the vicinity of the OHE has been completed and there is no objection for the overhead equipment to be energised. The authorised RE representative will then remove the discharge rods and return the 'permit to work' to the Supervisors of RE from whom he has taken in writing by exchange of private numbers. The Supervisors of RE will ensure that all 'permit to work' given by him, has been suitably returned to him. After he has ensured this, he shall remove discharge rods from OHE, and shall then energise the transformer, thus energising the overhead equipment on 2.2 kV ac.

6.0 Abnormal Operations

As already stated the OHE will normally be energised on 2.2 kV ac and treated as live by every body and hence the 'permit to work' has to be obtained from authorised supervisor of RE for any work within two metres of OHE. In case of any accident/abnormality, or in case of miscreants' activity, if the OHE gets earthed and the L.T. fuse of transformer blows off, the same will be indicated in the room of ASM by the sounding of buzzer and also by lighting a red lamp. In such case the ASM should immediately call for the authorised representative of RE posted with him. He should also send a message to the supervisor of RE who will take charge of the situation. He will declare the section faulty after further checking if required. He should then, advise the ASM on duty in writing to send necessary information to the section controller for issuing caution orders to the Drivers of all up and down trains of the defective zone. The supervisor has to then isolate the faulty section and send the patrolling party online. The patrolling party incharge will take ' permit to work' from the supervisor. The supervisor will not energise the OHE unless and until all the patrolling parties in section return the 'permit to work', by exchanging private numbers or in writing.

7.0 Authorisation of staff

No body other than the person authorised will carry out Switching operations on OHE and other installation, issue, receive and cancel ' permit to work'. Such persons will be authorised only after duly being tested by DEE/AEE (RE) and shall not be below the rank of skilled artisan.

8.0 Special Instructions

8.1 Every Railway employee is required to make himself familiar with the methods of first aid to be rendered in case of Electric shock.

8.2 Proximity of a live conductor has to be avoided; since the risk of direct contact would occur while working very close to a live conductor.

8.3 It is important to note that induced voltage may appear at any instant in metallic masses in the vicinity of traction conductors.

8.4 Since there can be presence of return current in rails, use of Rails as a footpath, a seat or for other purpose is stictly prohibited.

8.5 No persons should go on top of a wagons, Bogie, engine or any other structure, without properly ensuring that OHE power supply is completely cut-off and the overhead equipment is earthed.

Annexure A 7.02

RAILWAY ELECTRIFICATION

GENERAL SAFETY CERTIFICATE OF WORKS

It is hereby certified that all the electrification works to be executed by the Railway Electrification .... for 2.2 kV single phase anti theft energisation of section from .... (km.) to ……….. (Km) over.........

Railway have been carried out properly and that the section can be energised without endangering safety of the travelling public or employees of the railway.

CSTE(P)/RE CPD/RE CEE/P/RE

*****

MODEL CIRCULARS

1. Joint Procedural orders are issued by Zonal railway laying down guidelines for officers and staff of different disciplines to clearly demarcate role and responsibilities among these disciplines. Likewise circulars are issued to the all concerned to inform (i) new rules and procedures (ii) changes in procedures due to some alteration in the system; and at times to reiterate extant rules and procedures.
2. Extract from some of the JPO's/Circulars issued by Zonal Railways are appended for illustration and reference.

1.0 Closing and Securing of Flap Doors of Wagons

Instructions exist that flap doors of the wagons, loaded or empty, should be properly closed and secured before being taken out from goods sheds, siding in yards and on trains. Many cases have, however, been reported when the wagons with open flap and other doors or with doors improperly secured have created situations fraught with danger. Several accidents have taken place in the electrified territories where the OHE masts were struck by the open doors of the wagons causing serious dislocation of traffic. Determined steps should be taken to completely arrest such accidents.

Prompt and proper closing and securing of wagons doors and bottom hinged as well top hinged dalas must be ensured while undertaking the following operations:-

1. At loading and unloading points
   a. After loading and or unloading of wagons in goods shed lines and other railway sidings, the goods clerk incharge of getting the loading and unloading operations will be responsible for ensuring that all the doors of the dalas are properly closed and secured on completion of work. Services of the train examiner where available will be availed in case of a stiff door or dala.
   b. The shunting Jamadar or the traffic official deputed to draw out wagons from goods shed lines and other sidings will ensure that the doors and dalas are closed and secured before they start drawing out.
   c. Similarly, the incharges of the various departmental siding such as loco sheds, diesel sheds, electric sheds, stores sidings, engineering sidings etc. will be responsible for closing and securing of doors and dalas after loading and unloading of materials, fuels, stores etc.

2. In shunting operations in yards

Before starting the shunting operations in the yards, the shunting Jamadar will ensure that the doors and dalas of all the wagons being pulled are properly closed and secured. He should call for the assistance of a TXR in case of a stiff door or dala. He should observe this while sorting wagons, while attaching wagons on trains, while detaching wagons from trains and in all other miscellaneous shunting movements.

3. On train

The guard incharge of the train will ensure that doors and dalas of all the wagons put on his train are properly closed and secured before he starts his train. He will point out any lapse in this regard to the

Station Master/Yard Supervisors on duty well in time so that the same is rectified without any detention to the train. He will observe this while taking charge of an originating train as well as through train taken over from the adjoining railway, adjoining divisions and the adjoining section of the Division.

4. Examination of trains

During the course of examination of a train, the TXR will ensure that all doors and dalas of the wagons on the train are closed and the stiff doors and dalas are rectified and closed by his own staff. The issue of fit certificate for the train should be subject to proper closure of the wagon doors and dalas.

5. Security staff involvement

The security arrangements by the RPF staff should be tightened so that no door or dala of any wagon in the yard and sidings is opened by the trespassers. Any laxity in observance of the above instructions should be seriously viewed and deterrent action taken against staff at fault. For this purpose, checks should be organized by officers and supervisors, particularly the safety officers and inspectors. Ambush checks should also be undertaken by Sr. DSO/DSO.

2.0 Movement of Insulated Consignments on Open Wagons

Escorting consignments loaded on open wagons in electrified areas needs caution against electric shock to escorting personnel. Approach to any point within two metres of the live parts of traction equipments is strictly forbidden.

Cases of accident caused by electric shocks to the personnel escorting insulated consignments loaded on open wagons, insulated from the body of the wagons by rubber tyres or wooden logs, etc. are on record. To prevent such accidents the following procedure must be followed.

In cases where the consignment is kept on insulated supports, like military or civil trucks on rubber tyres, over an open wagon shocks due to induced voltage might be caused. Induction causes voltage of a high order on all metallic consignments while being underneath the traction wires. If the exposed metallic surfaces of the consignment are in good electrical contact with the body of the wagon, their potential will be same as at the body of the wagon. Presence of Insulation between the body of the consignment and the wagon will result in dangerously high potential difference being set up between the consignment and the wagon which may cause shock to a person on the wagon escorting the consignment. For the movement of such consignments through electrified sections, therefore, the following precautions are essential.

1. A temporary metallic connection should be made between the body of the consignment and the wagon. For the purpose, standard steel wire or size 7/16 SWG (Cross sectional areas 14.5 mm 2) or any other available size higher in cross sections may be used to fasten the metallic portion(s) of the consignment to the wagon at 4 independent points, without tempering the consignment. Steel chains of equivalent cross sections can also be used in lieu. The train examiners of train originating stations will effect and ensure such fastenings prior to issuing fit memos for movement of the consignment.
2. No train shall leave a train originating point without the above having been provided.
3. However, prior to entry of such consignments in the electrified sections, the Guard in charge shall check up the provision of such arrangements and ensure onward movement only after confirming the following:
    a. The wire fastenings are effected by the TXR staff if available.
    b. If item (a) above is not possible, the escorting personnel should be detained from the wagon carrying such consignments till such time the fastenings are provided for by the TXR – staff or by the nearest traction (OHE) staff as indicated in the working time table.

c. On entry into the electrified section the bonding used will be got checked by the TRD staff.

3.0 Joint Procedure Order for TPCs, Section Controllers, Drivers and Guards of Electric Traction in the event of Hot Axle or other Abnormality in trains, in OHE, in Track etc. necessitating Switching Off of OHE Supply.

In the event of Hot axle or other abnormalities in trains, OHE or in track, joint procedure for switching off and switching on of OHE in indicated below:

1. In case any hot axle or any abnormality is seen in a running train in block sections or at stations, power supply to OHE of the affected section shall be switched off immediately by TPC on duty by opening of the feeder C.B. on advice from Section Controller, Station Master or others as the case may be under clear exchange of private numbers.

   If the block section is falling in the zone of two feeding posts, then feeder CBs of both feeding posts may be switched off and the section isolated must be reduced to sub-sector after finding out the details of train by TPC.

   Regarding switching off of OHE power. TPC shall inform the concerned SCNL in writing and Section Controller shall take immediate necessary action.

2. Station Master and Section Controller should thereafter in consultation with TPC should take detailed information regarding damages, infringements or any other abnormalities of track. Rolling Stock or OHE. Section Controller should ensure that no train is allowed to enter dead section on either one direction to avoid snapping of OHE.

3. Look-out caution to driver of the first train of opposite direction which is likely to enter the affected section will be issued by Section Controller. After issuing of caution order to the first train which is likely to come in the effected section and after ensuring the safe position, TPC will be asked by Section Controller under clear exchange of private number to charge the particular healthy section which was switched off as a precautionary measure.

4.0 Joint Procedural Order for TRD, RSO staff and ASMs in Case of any Abnormality on OHE

1. In case of breakdown of OHE, when it is necessary for a train to proceed cautiously the TFO(OHE) responsible for such notification shall arrange for issue of caution order, An authorised person shall be present at the site and shall be responsible for showing signals.
2. A caution order detailing the kilometers between which such precaution is necessary, the reason for taking such precaution and the speed at which a train shall travel, shall be handed to the driver at the stopping station/other station in such a manner, as prescribed under special instructions.
3. Showing of Signals

Whenever due to lines being under repair or due to any other obstruction it is necessary to indicate to the Driver that he has to stop or proceed at a restricted speed, the following signals shall be shown and where prescribed and detonators used, it on a double line the direction from which trains approach, and if on single line in each direction.

a. When the train is required to stop and the restriction is likely to last only for a day or less –

   A banner flag shall be exhibited at distance of 600 m on the B.G. and the 3 detonators shall be placed, 10 m apart, at a distance of 1200 m on B.G. from the place of obstruction. In addition, stop hand signal shall be shown at a distance of 30 m from the place of obstruction, at the banner flag and at distance of 45 metres from 3-detonators. The Railway Servant at the place of obstruction shall give proceed hand signal to indicate to the Driver when he may resume normal speed after the train has been hand signalled past the place of obstruction.

b. When the train is required to stop and the restriction is likely to last for more than a day

A stop indicator shall be exhibited at a distance of 30 m from the place of obstruction and a caution indicator at 1200 metres on the B.G. from the place of obstruction. In addition Termination Indicators shall be provided at the place where a driver may resume normal speed.

c. When the train is not required to stop and the restriction is likely to last only for a day or less

Proceed with Caution hand signal shall be exhibited again at a distance of 30 m and at a distance of at least 800 m shall be suitably increased by special instructions, where required. The Railway Servant at the place of obstruction shall give proceed hand signal to indicate to the Driver when he may resume normal speed after the train has been hand signalled past the place of obstruction.

d. When the train is not required to stop and the restriction is likely to last for more than a day

A speed indicator shall be exhibited at a distance of 30 metres from the place of obstruction and again a Caution indicator at a distance of at least 800 metres shall be suitably increased by special instruction, where required. In addition, Termination indicators shall be provided at the place where a Driver may resume normal speed.

5.0 Safety Measures to be observed in Case of Unusual Occurrences on Electrified Sections.

1. Duties and responsiblities of Traction Power controller, Section conroller and Station Master in case of No tension / Fault tripping in Over Head Equipment:

a. **Fault Isolation:**

i. In an electrified section in the event of Overhead equipment failure, Traction power controller shall immediately identify and localise the faulty section and isolate the same. In case of double and multiple line sections, he shall also isolate healthy section on adjacent track on the same route length as faulty section. The Traction power Controller shall then advise the section controller in writing or on phone under exchange of private number, of the section found faulty and healthy section temporarily isolated.

ii. On the receipt of the advise from Traction Power Controller, the section controller shall take action as under:

Section Controller shall, under exchange of private number, advise station masters of stations of either side of isolated sections to treat the faulty sectionas if the same is under emergency power block and take action accordingly.

On double line section- Healthy section temporarily isolated

b. The Section Controller shall check whether any train has entered in the faulty section. If not he shall advise the concerned SM to issue caution order to the driver of the first train on unaffected section to 'keep a sharp look out on the adjacent line/lines to see if there are any OHE abnormalities' On reaching the next station, Driver, should report whether or not the section over which they have passed is safe for train movement. Then Section Controller will advise the Traction Power Controller in writing to re-energize the healthy section that was temporarily isolated.

c. If however, a train has entered in faulty section, the Section Controller shall immediately inform SMs of all stations who are concerned with working of train in the faulty section and also in the section in which healthy Over Head Equipment is temporarily isolated, under exchange of private number, that they shall not allow any train to enter the affected block sections unless both driver and guard of the first train in unaffected section have been issued caution order to this effect.

i. "Proceed with speed not exceeding 60 km/h during day when visibility ahead is clear and not exceeding 30 km/h during night subject to observance of other speed restrictions."

ii. "Keep a sharp look out and be prepared to stop short of any obstruction, which may be due to any infringement from the adjacent line/lines and also keep a sharp lookout on the adjacent line/lines to see if there are any Over Head Equipment abnormalities.On reaching the next station report whether or not the section over which they have passed is safe for train movement"

iii. Only after taking this action the Section Controller shall advise the Traction Power Controller in writing that necessary precaution have been taken to ensure safety of the train. The Traction Power Controller shall then restore the feed to the healthy section, which was temporarily isolated.

iv. Action to remove speed restrictions shall be taken by the Section Controller in consultation with Station Master on receipt of report from the driver and the guard that the section is free of obstruction. Section Controller shall also advise the Traction Power Controller of the report of driver/guard of the train indicating whether or not there are any infringements or abnormalities in Over Head Equipment. Till such time it is decided to remove speed restriction, subsequent train shall be allowed to enter into the section only with permission from the Section Controller and shall continue to be issued caution order prescribing clearly the speed restriction and other precautions, as pointed out in c (i) above.

2. Duties and responsibilities of Traction Power Controller and Section Controller in the event of any abnormality in train on Electric Traction necessitating 'Switching off of Over Head Equipment Supply:-

a. As soon as Traction Power Controller comes to know about unsafe condition of a train working on Electrified Traction, he shall immediately switch 'Off' the Over Head Equipment supply of both the lines of relevant Sub-Sector. Traction Power Controller shall then advise in writing, the Section Controller of sections in which Over Head Equipment has been switched 'Off'.

b. On receipt of advice from Traction Power Controller, the Section Controller shall, under exchange of private number, advise Station Masters of all stations, who are concerned with working of trains in the affected section to treat the Dead section as if the same is under emergency power block and to ensure that no train is allowed to enter into the section.

Healthy section temporarily isolated:

c. Station Masters will not allow any train to enter even Healthy line of the affected section unless both driver and guard of the first train of unaffected section have been issued caution order to proceed with the restricted speed not exceeding 60 km/h during day when view ahead is clear and 30krn/h during night subject to observance of other speed restrictions and keep a sharp look out and be prepared to stop short of any obstruction, which may be due to any infringement or Over Head Equipment abnormalities from the adjacent line/lines. Also advise driver to report immediately on reaching the next station whether or not the section over which they have passed is safe for the train movement

d. If Driver of unaffected section contacts him on phone, the Over Head Equipment of unaffected portion should be resumed and he will be asked to proceed with the restricted speed not exceeding 60 km/h during day when view ahead is clear and 30 km/h during night subject to observance of other speed restrictions and shall keep a sharp look out and be prepared to stop short of any obstruction, which may be due to any infringement from the adjacent line/lines. On reaching the next station Driver will report whether or not the section over which they have passed, is safe for train movement.

e. After ascertaining that there is no infringement to adjacent track, the caution order as indicated shall be withdrawn immediately.

Section - having affected train:

f. After getting information from the crew of the affected train about the nature of abnormality, decision regarding recharging of the Over Head Equipment shall be taken by the Section Controller in consultation with Chief Controller /Dy. Chief Controller (Shift duty) and controller of concerned department.

g. If the driver of the affected train contacts Traction Power Controller/Control and no defect is detected in the train, on resumption of Over Head Equipment he will be asked by control to clear the block section with the restricted speed not exceeding 60 km/h during day when view ahead is clear and 30 km/h during night subject to observance of other speed restrictions and shall keep a sharp look out for any abnormality in the train. On arrival at the station the staff of concerned department should check the train. If no abnormality detected the train should resume at normal speed.

3. Duties and Responsibilities of the Driver and the Guard in case of Over Head Equipment tripping/ No tension in Over Head Equipment-

   a. In cases of transient Dipping of Over Head Equipment the Driver shall resume normal traction and keep a sharp look out including on the adjacent line/lines to see if there are any abnormalities/ obstructions and will inform to the guard through walkie-talkie or whistle code about Tripping in Over Head Equipment. The Guard of the train will look out for any abnormality on his train. The Assistant Driver should look back and observe his train for any abnormality.

   b. If no tension in Over Head Equipment continues, the Driver shall immediately switch 'On' the loco flasher and control the speed (not exceeding 60 km/h at night) so as to be able to stop short of any obstruction and stop his train close to first emergency socket and will communicate with the Traction Power Controller/control to know the reason for no tension in Over Head Equipment. The Crew should act according to advice of control.

   c. If it is not possible to communicate with the Traction Power Controller/control immediately, the driver shall depute the Assistant Driver to get down and check the train with the Guard in order to look for any abnormality for any defect in his train including Locomotive. After the train has been checked, the Driver/Guard shall inform Section Controller of the abnormality, and assistance required, if any, or otherwise, through eemergency phone of other line, Walkie -Talkie, Level Crossings gate or through train of other direction or by any other means of communication and act in accordance with advice of control. In case no abnormality is noticed in his train, driver should switch 'Off' the loco flasher.

   d. If in the mean time Power supply to Over Head Equipment gets restored, the Driver shall resume normal traction no sooner he comes to know of such resumption of supply.

6.0 Joint Procedural Order for TPC, SCNL, ASMs, Drivers & Guards in Case an Animal is Run Over in Electrified Route.

When cattle or animals are run over, vultures generally assemble on the body nearby the track and sometimes entangle with OHE and/or pantograph causing damage leading to major breakdowns.

Whenever such cases of run over of animals take place or are observed.

a. Drivers and Guards will make effort to advice the same to the SM/ASMs at the next stoppage for relaying the same to SCNL/TPC or TLCs.
b. Other railway staff will immediately advice the same to ASMs, SCNLs, TLCs and Engineering Control.

   On receipt of such information the ASM concerned shall take necessary action to remove the body to a safe distance to avoid risk of damage to pantographs of passing trains and OHE.

7.0 Joint Procedural Orders for TPCs and ASMs in case of Electric Shocks with 25 kV OHE supply.

1. TPC shall arrange to cut-off 25 kV OHE supply of concerned sub-sector and also sub-sector of adjacent line to reduce the effect of induction and shall advise all concerned.
2. TPC shall inform nearest electrical department official and simultaneously arrange an authorised person to come to spot and move tower wagon/road vehicle from nearest depot if no authorised person is available near site.
3. TPC shall also inform section controller for regulating the traffic so as to avoid possibility of accidental charging of the section due to Loco entering the section so made dead.
4. TPC shall inform SM/ASM of nearest Railway Station for medical assistance.
5. TPC/SM/ASM shall inform nearest Railway Doctor for Medical assistance with available means of communication.
6. TPC/SM/ASM shall inform GRP/RPF staff to reach site of accident provided RPF/GRP post is located at the stations.
7. TPC shall advise for movement of medical van if situation warrants.
8. On arrival of authorised person on spot, he shall be advised to cordon off the area so that no one else may get injured.
9. TPC shall advise authorised person to remove the victim with the help of some insulating rod.
10. TPC shall also advise authorized person to administer artificial respiration and other help as needed.
11. TPC shall arrange quick shifting of victim from site to nearest hospital by
    a. Stopping first available train
    b. Sending Tower wagon or road Venice from nearest OHE depot.
    c. Sending ambulance/stretcher
12. TPC shall advise controlling officer about the accident and take guidance.
13. On arrival of authorised person on spot, TPC must find out the detailed cause of electrical accident and preserve the documents/materials related to it.
14. TPC shall restore 25 kV OHE supply after confirmation from the site by authorised person or SS/ASM on duty that the victim has been dis-associated from the 25 kV OHE. Authorised person, after dis-association should give it in writing to the nearest SM.
15. TPC shall collect details about the victim i.e. hospital where admitted, percentage of burns injury, his day to day condition and apprise of the position to controlling officer.
16. In case of damage to electrical equipment on this account TPC shall make arrangements to get equipment attended at the earliest to enable restoration of supply.
17. SM/ASM shall also inform TPC of electrical accident or possibility of accident by exchange of private number for making the OHE dead provided SM/ASM is first to get such information.

18. If it is possible to keep the traffic moving by other line, TPC will advise to Section Controller in writing to introduce single line working.

8.0 Joint Procedure Order Regarding OHE Voltage

To take timely action for the problem of low/high OHE voltage, following procedure should be strictly followed:

1. The half hourly voltage readings recorded by TPCs should be scrutinized by CTPC concerned daily, in case where voltage of feeding point has gone below 23 kV steps should be taken to improve the voltage. The taps of traction transformers should be changed so as to improve the feeding voltage. If the problem still persists the Supply Authorities should be contacted. The concerned Sr. DEEs/ DEEs should be informed who will establish contact with officials of the Supply Authority and get the voltage improved.

   Normally the tap setting of Traction Transformer at Traction sub-station will be fixed so that daily OHE voltage peaks do not exceed 27.5 kV. This will ensure that the voltage is well above the minimum of 19 kV at the farthest point of the feeding zone.

2. The cases of low/high voltages observed by the drivers during the run should be reported to the concerned TLC before signing off indicating time, voltage observed and location/section where abnormal voltage observed. The abnormal voltage in this case will be above 27.5 kV and below 19 kV
3. TLC would also immediately check the reports of other drivers in the same section and advise the consolidated position regarding abnormal OHE voltage to traction power controller. The TPC/ CTPC would then take immediate measures as indicated above at para (2).

9.0 Working Instructions for Permanent Way, Traction and S&T staff for Changing the Rails, Carrying out Track Circuiting and Automatic Signalling Works.

1. Before any alteration to alignment or level of electrified track is commenced, due notice of 48 hrs. in advance shall be given to those responsible for the OHE so that OHE may be adjusted to conform to the new condition (at PQRS site, work will be done under the Joint Supervision of Permanent way inspector, Electric Chargeman/TRD, and S&T staff continuously).
2. A permit to work must be obtained, if work is to be carried out or any worker is required to come within 2 metres of the 25 kV live overhead equipment.
3. When unloading the rails along the track, care shall be taken by PWI/PWM or mate to ensure that the rails do not touch each other to form a continuous metallic mass of length greater than 300 m.
4. In case of track renewals, temporary connections shall be provided with the other rail of the track at both ends by TRD staff. In case of renewal of both the rails of track simultaneously, temporary connection shall be provided within rails of adjacent track at both ends by TRD staff.
5. Before fish plates are loosened or removed, temporary electrical connection between the two rails shall invariably be made.
6. In case of defective or broken rails bond, a temporary connection shall be made.
7. In case of “rail fracture” the two ends of the fractured rail shall be first temporarily connected by a temporary metallic jumper of approved design. In all cases of discontinuity of rail. The two parts of the rails shall not be touched with bare hands of un-insulated tools. Gloves of approved quality shall be used.
8. Permanent way staff shall keep clear of the tracks and avoid contact with the rails either when approaching or reaching the work spot when an electrically hauled train in within 250 m.

9. In track circuited area, insulated joints shall not be bridged with bare hands or any metallic articles.
10. Use of steel measuring tapes or long metallic wires is prohibited in electrified sections.
11. Before replacing the rails/glued joints in track circuited area the permanent way inspector will ensure that traction distribution staff and S&T staff are available at site for removing and replacing the "traction bonds" and jumper/bonding connections where required.

    In each cases, PWI will cancel the block to resume the normal traffic only after ensuring that the traction bonds cable jumpers, bond wire etc. have been reconnected by TRD staff and S&T staff. TRD and S&T staff should be made available at 48 Hr. notice given by PWI for changing rails in case of planned works and on the same day in case of rail fracture.
12. The Traction Foreman shall see that all insulating sleeves on traction bonds passing under positive rail of track circuits are intact and take prompt action to replace the missing/damaged one.

10.0 Joint Procedural Order for Ensuring Safety During Track Renewals.

Since the working of relaying unit involves removal of existing rails along with all the different types of traction bonds, it is absolutely essential that temporary jumpers for passage of return current are provided till such time the permanent bonds are fixed to the new rails.

Following procedure shall be followed by the site In-charges of both the Engineering and TRD branches associated with Relaying work.

1. Before energizing the OHE after completion of work at the end of each day, temporary jumpers/ temporary structure bonds shall be provided on the auxiliary rails and the new rail by the TRD supervisors as per instructions contained in ACTM. This shall be jointly witnessed by the PWI in a register provided for this purpose. TRD supervisor shall keep the register in this custody.
2. PWI at site should ensure that temporary rail bonds are connected through auxiliary rail before opening/dismantling of rails joints for replacing the panel.
3. It would be the responsibility of the PWI in-charge to ensure the safety of the staff once the TRD supervision has attended to the above work to ensure that temporary bonds/ jumpers are not damaged by Engineering staff during the course of working.
4. The length of section of track provided with the temporary jumpers shall also be indicated in the above register at the end of each working day.
5. NO bonds/temporary jumpers shall be opened by the Engineering Branch without first informing the TRD Supervisors.
6. Formation of auxiliary track shall also be done in the presence of TRD Supervisor, who shall provide necessary temporary earthing connection to ensuring safety of staff.
7. At the time of dismantling/replacing track from the site, PWI concerned will provide continuity jumpers as per instructions given in ACTM in addition to other instructions for the precautions to be observed by permanent way staff.
8. The temporary jumpers shall be replaced by permanent bonds in the quickest possible time.
9. The implantation of OHE masts shall be maintained by the Engineering Branch as recorded in the SED.
10. All the staff should be clearly instructed not to interfere with the track after the work has stopped for the day and the entries in the register made.
11. All other bonds would be done by the TRD Supervision as per instructions contained in ACTM.

11.0 Joint Engineering and Electrical Department Circular

Consequent upon Electrification of various sections of track on Railway/Division, a number of additional assets have been created. It is therefore necessary to define the responsibilities in respect of maintenance of such assets and precautions to be taken in maintaining existing assets.

1. General
   a. Electrification System :

      The system of electrification on the Railway is ac, Single Phase, 25 kV, 50 Hz. The sections under electrification are from ....to................................

   b. Rules :

      Subsidiary rules for 25 kV ac traction issued by CEE and COM and Permanent Way Safety Rules issued by Principal Chief Engineer as supplement to Part " J " Chapter II of Indian Railway Permanent Manual shall be in possession of every PWI, APWI, IOW. They shall be conversant with all rules and shall also be responsible for ensuring that all staff under them know the rules and follows them strictly.

   c. Safety First Waning to Staff ;

      All electrical equipment shall be regarded as alive at all times and consequently dangerous to human life, save and except in cases where the electrical equipment has been specially made dead in accordance with the provisions of these rules. All Railway servants other than those deputed to work on or near electrical equipment shall keep away therefrom.

   d. Admission to and permit-to-work in the supply control posts :

      No person other than authorised traction maintenance staff, their assistants, when accompanying them and persons provided with special permits issued by Sr. DEE/TRD and others as mentioned in SR shall be admitted to supply control posts.

   e. Work on electrical equipment in supply control posts and other electrical equipments:

      No work shall be undertaken on any part of electrical equipment or adjacent to it until the person has received a permit-to-work card. The PWI or IOW will get this from authorised persons as per provisions of SR.

   f. Engineering staff on track patrol shall look for any missing locks on the isolator switches mounted on traction mast along the track and report the same to ATFO or the TPC without delay.

2. Maintenance
   a. Buildings :

      A number of buildings have been constructed for locating various equipment for maintenance and operation of traction equipment. These include Remote Control Centres, supply control posts (at various points along the track), maintenance depots, OHE inspection Car Sheds etc.

      The Engineering Department shall maintain all these buildings in a fit condition. Special care should be exercised to ensure that Remote Control Cubicles along the track and Remote Control Centres are maintained leak proof and vermin proof as these contain costly sophisticated equipment, whose correct operation is vital for safety of staff and equipment on the Railway. The Engineers shall therefore execute all such works that may be required for ensuring the above as expeditiously as possible.

      Painting and white washing of the interior of the building housing various equipments will be done by Engineering Staff under the supervisor of Electrical Staff. All repair to fencing at supply control posts around high voltage equipments including painting will also be done by Engg. Staff under the Supervision of Elec. Staff.

b. Tunnel roofs are also to be maintained water proof by the Engineering Department to avoid flashovers and breakdowns to OHE.

c. All OHE supporting masts and their foundations will be maintained by the Electrical Department. Ballast, sand and cement will be supplied by the Engineering Department on demand. Foundations at special locations like bridges will however be maintained and replaced by the Engineering Department as per the requirements of the Electrical Department. The earth work around the foundations block will be maintained by the Engineering Department.

d. Track Bonds :

All bonds between track rails and between rail and traction masts will be maintained by the Electrical Department. During track patrol the engineering staff shall look for any damaged bonds between rail & structure, or those between rail to rail and report such damages as they notice to the TFO concerned without delay.

e. Level Crossing Gauges, Screens etc. on bridges :

The maintenance of level crossing including caution boards thereon will be done by the Engineering Department. Special care shall be taken to prevent the approach road levels going down below the mark given in level crossing gauges, to prevent passage of unsafe road traffic under the OHE. The **maximum height** of the top member of L.C. gauge above the road shall be 4.78m and contact wire shall **be at a height of minimum 5.5m above the rail level at level crossings.** Similarly screens provided on foot over, road over bridges etc. shall be maintained by the Engineering staff. (ACS:32 dt 09.10.2020)

f. Slewing of tracks and alteration to super elevation and heights of rails :

It shall be ensured that the level of rails under foot over bridges, road over bridges, and other overline structures does not exceed the level marked under such structures. Whenever any work on track, which is likely to affect rail bonds, is undertaken by permanent way staff, adequate notice shall be given to the Traction foreman (OHE) to enable him to arrange for bonding staff for removal and replacement of bonds.

Bonding staff when working with a permanent way inspector, sub-inspector or Assistance Inspector shall work under the instructions of Permanent Way Inspector, Sub-Inspector or Assistance Inspector who shall then be responsible for the safety of the track and of the staff.

g. Work involving traffic or power blocks and permits work on traction electrical or overhead equipment :

All departments in the electrified area who require traffic blocks, power blocks, or permits-to-work in the danger zone of the traction equipment or who require over head line bond/or bonding staff to be present at site for scheduled maintenance works, shall deliver at the office of the Sr. Divisional/Divisional Electrical Engineer (Traction Distribution) not later than 10.00 hr. on every Monday morning, statements in the prescribed form showing (i) the nature of the work and the date on which it is to be performed, (ii) by whom the work is to be carried out, (iii) location of the work and the section of the lines to be blocked (iv) the trains between which the block is required and (v) whether the track will be available for steam or diesel traffic.

The requirement of all departments will be co-ordinated in the office of the Sr. Divisional/ Divisional Electrical Engineer (Traction Distribution) and a consolidated statement forwarded to the Sr. Divisional/Divisional Operating Manager concerned at 12.00 hrs. on every Wednesday for inclusion in the weekly programme of traffic and power blocks.

Works of an urgent character shall be attended to by obtaining emergency blocks and permits-to-work from the TPC.

A weekly programme of work involving traffic blocks, power blocks and permits-to-work shall be prepared in the office of the Sr. Divisional/Divisional Operating Manager and dispatched to all concerned by Friday evening, for the week commencing on the following Monday.

h. Work on station roof, signal gantries etc. – Precaution to be taken by staff.

Measuring taps of all kinds, tools and metal articles (such as paint pots, oil case, metal bars) shall not be used where they can be lifted or be dropped or be carried by the wind on to overhead equipment when such overhead equipment is alive.

i. Working on service building and structures in the vicinity of the equipment :

Railway staff when required to carry out work on service, buildings and structures in proximity to overhead equipment, shall exercise special care to ensure that tools, measuring taps, materials etc. are not placed in a position where there are likely to fall, or may contact with electric equipment.

Wherever such work has to be carried out under conditions which involve risk to the workmen or other persons, arrangements shall be made for authorised overhead equipment staff to be present, who shall take such precautions as may be necessary for the safety of the persons concerned.

j. Working near cables :

When excavations are being made adjacent to tracks and cable routes in an electrified area adequate precaution shall be taken for the safety of staff and to avoid damage to underground cables and rail bonds. Markers are placed wherever possible, along the cable alignment and plans are available indicating generally the position of burried cables. Excavation must not be undertaken in the vicinity of cable routes until the exact position of the cables has been ascertained and a representative of the department concerned is present. This is applicable to cables of Posts and Telegraphs Departments also.

If circumstances make it imperative that work be undertaken without sufficient notice. Asstt. Signal and Telecommunication Engineer concerned must be informed by telegram for arranging staff to be present.

k. Working of Cranes :

No steam or hand-crane shall be worked adjacent to traction overhead equipment unless such overhead equipment is made dead and earthed and authorised OHE staff are present. All movements of the crane jib shall be carefully controlled so as not to foul the traction overhead equipment. Wherever possible the direct blast from the crane funnel to the over-head equipment and particularly to section insulators shall be avoided.

Except in emergency, 24 hours notice of intention to work a crane adjacent to overhead equipment shall be given to the Sr.Divisional/Divisional Electrical Engineer (Traction Distribution) in order to make arrangements for overhead equipment staff to stand by. When possible the working of cranes shall be included in the weekly programme. In an emergency, the Traction Power Controller shall be advised and he shall make arrangements for overhead equipment staff to stand by.

l. Sanded catch sidings :

On sanded catch sidings, the rails shall be kept clear of bond for a length of about 25 metres beyond live overhead equipment of the track.

m. Transport of heavy materials :

In the case of accidents and breakdowns involving OHE, PWIs/APWIs in charge shall arrange at short notice for labour required for carrying heavy materials, erection of structures etc.

n. Caution Boards :

The caution boards at stations warning passengers and staff not to come in contact with the traction installations should also be maintained by the Engineering Department.

o. No blasting is to be done in the vicinity of the electrified lines without the specific sanction of the Sr. Divisional/Divisional Electrical Engineer (TRD)

p. Numbering of traction masts :

The kilometer number painted on the traction masts as well as the signs showing the direction of the nearest emergency Telephone sockets will also be maintained by the Engineer Department staff. The painting of masts themselves, as and when required, will be carried out by the Electrical Department.

12.0 Railway Board Policy Circular No.1113/Elect./TRD 06-2012

Circulated vide letter no No.2008/Elect(G)/161/8 Pt.Dated 05.09.2012

Sub: Trimming/cutting of trees in the electrified section.

Relevance Provision of advance correction (AC) slip No. 79 dated 10.10.2002 of Indian Railways Permanent Way Manual 1986-Edition regarding cutting of trees by Engineering department and tree trimming by TrD department is reproduced.

2.0 Pursuant to above, relevant provisions of above AC slip are reproduced below for compliance:

(c) No part of the tree shall be nearer than 4 mtrs. from the nearest live conductor. Any tree or branches likely to fall on the live conductors should be cut or trimmed periodically to maintain the safety clearances. The responsibility for wholesale cutting of the trees, i.e. cutting of tree trunks, will rest with the Engineering Department. In the electrified territories, however, the cutting of the trees shall be done by the Engineering Department in the presence of authorized TrD staff to ensure safety and satisfactory completion of the work. The day-to-day trimming of the tree branches, wherever required, to maintain the 4 m safety clearances from OHE shall be done by the authorized TrD staff and Supervisors.

Similarly, provisions in para 10422 (2) of AC Traction Manual Vol.I and its AC slip No.4 dated 22.09.1998 read in conjunction with the above AC slip No.79 dated 10.10.2002 also stipulate about the methodology and procedure for tree cutting/trimming affecting OHE.

Zonal Railways are accordingly advised to chalk out a detailed plan in the form of JPO (in electrical territory) complying above directives of CVC and as per the codal provisions mentioned in Para 2 & 3 above for streamlining the procedure for cutting/trimming of trees to harmonize inter-departmental co-ordinations so as to minimize the incidences of traffic disruption due to falling of trees/branches on track/OHE. The JPO may also include the provision of periodic joint checking and identification of trees for its cutting/trimming by Engineering and TRD organization at the Divisional level along with the action plan and target for tree cutting/trimming by the respective department. This should also be monitored at Headquarter level regularly. A copy of JPO thus issued be sent to Board's office for reference and record.

*****

1.0 RDSO SPECIFICATIONS

OVERHEAD EQUIPMENT

Sl. No.	SPECIFICATIONNO.	LAST REV.	DESCRIPTION	DATEOFISSUE
1	ETI/OHE/3(2/94)	1	Technical specification for Annealed stranded copper conductors for jumper wire for ElectricTraction.	Apr.95
2	RE/30/OHE/5 (11/60)	-	Specification for Copper busbar.	Nov.60
3	ETI/OHE/11(5/89)	-	Specification for Steel tubes.	May.89
4	ETI/OHE/13(4/84)	3	Specification for Hot dip zinc galvanization of steel masts (Rolled& Fabricated),tubes and fittings used on 25kV ac OHE.	Apr.90
5	TI/SPC/OHE/WR/ 1060(06/06)	2	Specification for Stainless Steel Wire Ropes.	May07
6	TI/SPC/OHE/INS/ 0070(04/07) with A & C Slip No.-01 & 02 (10/16)	2	Specification for Solid Core Porcelain Insulators for 25kV AC 50Hz Single phase over head Traction lines.	Oct 16
7	ETI/OHE/16(1/94)	2	Specificationfor25kVa.c.SinglePoleand DoublePoleIsolatorsforRailwayElectrification.	Mar.04
8	TI/SPC/OHE/FASTENERS/0120	5	Specification for Steel fasteners and Stainless Steel Fasteners for 25 kV AC Traction steel Overhead Equipment	March.13
9	ETI/OHE/21(9/74)	-	Aluminum alloy section and tubes for 25kV Traction Over head Equipment.	Sep.74
10	RE/OHE/22(9/61)	-	Specification for Dynamo meters	Sep.61
11	TI/SPC/OHE/LWTSI/0060(Rev.1) with A &C Slip no.1	1	Specification for Light weight Section insulator assembly.	Jul. 16
12	ETI/OHE/33(8/85)	-	Specification for Enameled steel plates	Aug.85

13	ETI/OHE/33A(12/97)	8	Specification for "Retro-reflective Structure Number Plates."	Nov. 12
14	TI/SPC/OHE/MCS/01 50 with A & C Slip No.- 01 (08/15)	-	Performance specification for modular cantilever system for 25 kV ac traction.	Sep. 16
15	ETI/OHE/36(12/73)		Specification for Galvanized Steel Wire Rope.	May'98
16	ETI/OHE/37(12/73)	-	Specification for Hard drawn Copper catenary.	Dec.73
17	ETI/OHE/48(7/84)	3	Technical specification for Winch type regulating equipment for 25kV a.c. traction.	Dec.04
18	TI/SPC/OHE/ATD/ 0060 Rev.1 with A & C Slip No.- 01	3	Specification for Three PulleyType Regulating Equipment (3:1Ratio)	Sep. 16
19	ETI/SPC/OHE/FITTINGS/0130(10/13)	1	Technical specification for Fittings for 25kV ac OHE	Oct.13
20	ETI/OHE/50(6/97) with A & C slip No. 1 to 5	5	Technical Specification for cadmium copper conductors for over head Railway traction	Sept, 16
21	TI/SPC/OHE/HDCS CF/0030(06/03)	-	Technical Specification for 37/2.25mm.Hard Drawn Stranded copper conductor	Jun.03
22	ETI/OHE/51(9/87)	1	Specification for Discharge/ earthing pole assembly for 25kV ac traction.	Oct.92
23	ETI/OHE/52(10/84)	-	Specification for Inter locks for a.c.traction switch gears	Oct.84
24	ETI/OHE/53(6/88)	5	Principles for OHE Layout Plans and Sectioning Diagrams for 25 kV a.c. traction.	Nov.06
25	ETI/OHE/54(2/85)	2	Specification for 19/2.79 mm all aluminum alloy, stranded catenary wire.	Oct.92
26	ETI/OHE/55(4/90)	-	Specification for Bimetallic (aluminium–copper) strip.	Apr.90
27	TI/SPC/OHE/4 WDHTW/0070(08/07)	0	Technical specification for 4wheeler over head equipment inspection car 1676mm.Gauge.	Jun.07
28	ETI/OHE/58/1(1/95)	-	Specification for hand operated lifting and swiveling platform.	Jan.95
29	TI/SPC//OHE/8WDHTW0070(06/07)	1	Technical specification for 8-wheeler Diesel Hydraulic OHE inspection car 1676mm gauge.	Jun. 07
30	TISPC/OHE/SNS/0 000 (Rev.1)with A & C slips 1.	1	Specification for Short Neutral Section Assembly (Phase Break)	Jan.16
31	ETI/OHE/65(8/87) with A & C slip No. 1 to 5	5	Specification for continuous cast copper wire rods	July, 18

32	ETI/OHE/71(11/90)	2	Code of bonding and earthing for 25kv a.c.50Hz single phase traction system.	Mar.93
33	ETI/OHE/72(11/91)	-	Specification for 4 axle car for winding and/or unwinding of contact wire and catenary wire.	Nov.91
34	ETI/OHE/76(6/97) with A & C slip No. 1,3,4,5,6, 7,8& 9. (Slip No. 2 is in abeyance)	8	Technical Specification for hard drawn grooved contact wire for electric traction (drawn out of continuous cast copper (coc) wire rods).	Nov. 2016
35	TI/SPC/OHE/TOOLP L/0990(11/99)	-	Gear less hand operated pulling and lifting machines (TIRFOR)	Nov. 99
36	TI/SPC/OHE/TOOLP L/1990(11/99)	-	Ratchet lever Hoist (Pull-lifts)	Nov.99
37	TI/SPC/OHE/INSCAT /0000with A & C slip No.1&2	2	Specification for Insulated Cadmium Copper Catenary 19/2.10 mm diameter for provision under over line structures in the 25kVa.c.Electric traction.	Sept, 16
38	TI/SPC/OHE/TIPS/0 010(03/01)	-	Technical specification for infra red imaging system for hand held application	Mar.01
39	TI/SPC/OHE/TIPS/10 31	-	Technical specification for infra red imaging system for stationary Installation	Dec.13
40	TI/SPC/OHE/TIPS/2 030(08/03)	-	SpecificationforLocomountedcurrentcol lectioncheckingandanalysissystem	Aug.03
41	TI/SPC/OHE/GALST B/0040 with A & C slip No. 1 & 2	1	Technical specification for galvanized steel stranded wire for traction bonds for 25kV.ac.Electric traction system	Aug.06
42	TI/SPC/OHE/ INSCOM /1071, Rev-01 (12/16)	1	Technical specification for Silicone Composite Insulators for 25 KVA.C.50 Hz Single Phase Over head Traction Equipment	Dec, 2016

43	TI/SPC/OHE/CWRIG /0990(09/99)	-	Technical specification of Test Ring for wear of contact wire.	Sep.99
44	TI/SPC/OHE/FRPN P/0060	-	Specification for Retro-Reflective structure number plate on FRP base.	Jun.06
45	TI/SPC/OHE/CW/WE AR/0080(02/80)	-	Technical specification for On-Board Equipment for On-line scanning for thickness of contact wire used in 25kVac traction.	Feb.08
46	TI/SPC/OHE/GATD/0 080(9/08)	-	Technical specification for Gas Auto tensioning device.	Sep.08
47	TI/SPC/OHE/INSTES T/0090(02/09), Rev '0' with A & C Slip No-01 (10/16)	1	Specification for Testing load testing Machine for 25kV Porcelain & Composite Insulators before installation.	Oct 16
48	TI/SPC/OHE/POST/0 100(01/10) with A & C Slip No-01 (10/16)	1	Specification for Solid core Porcelain cylindrical Post Insulators for system with nominal Voltage of 66kV, 110 kV, 132kV & 220 kV.	Oct. 16
49	TI/SPC/OHE/OLIVIR0 051(01/2015)	1	Technical specification for over head line inspection with video recording system for current collection test.	Jan.15
50	TI/SPC/OHE/AUGER/ 0090(02/09)	-	Technical specification for Self-propelled Auger vehicle for digging of foundations of over-head lines	Feb.09
51	TI/SPC/OHE/RRV/0 090(05/09)	-	Technical specification for Self-propelled road Rail vehicle for maintenance of over-headlines	May09
52	TI/SPC/OHE/MEMV/0 090(03/09)	-	Technical specification for Self Propelled Mast Erection Machine Vehicle for running on (1676mm) Routes of Indian railways.	Mar.09
53	TI/SPC/OHE/GSSW /0090(10/2009) with A&C Slip no.1&2	-	Technical specification for galvanized steel stranded wire for traction mast	Sep. 2016
54	TI/SPC/OHE/SPMUV/ 0090 (01/2017)	0	Technical specification for Self Propelled Multipurpose Utility Vehicle for hauling stringing vehicle and other electrification vehicle.	Jan 2017
55	TI/SPC/OHE/MRI/014 0(03/16)	-	Technical specification for Measuring and Recording Instrumentation for Retro fitment on 8-Wheeler Tower	March'16
56	TI/SPC/OHE/SPOLT0 140	-	Technical specification for Self Propelled Overhead Equipment Laying Train.	June'16

57	TI/SPC/OHE/NETRA/0 140	-	Technical specification for Self Propelled OHE Recording cum test Car (NETRA)	March'16
58	TI/SPC/OHE/WIRING /0091	1	Technical specification for self-propelled wiring train for paying of contact & catenary wire of over headlines on BG (1676mm) Routes of IRS.	Feb.13
59	TI/SPC/OHE/SPRINGA TD/0110(03/12)	-	Technical specification for Spring Auto Tensioning Device.	Jan'16
60	TI/SPC/OHE/5PATD/01 30		Technical specification for 5 pulley Auto Tensioning Device for 25kV a.c. traction.	Oct'15
61.	TI/SPC/OHE/3PHTATD /0150		Technical specification for 3pulley Auto Tensioning Device with 2400 kgf Tension for 25kV a.c. traction.	Sep 16
62.	TI/SPC/OHE/8WDETC/ 0092 with A& C Slip No. 1	1	Technical Specification for 8-Wheeler Diesel Electric Inspection & maintenance OHE Car under slung type for operation on Broad gauge (1676mm)	Oct, 16
63.	ETI/OHE/27 (8/84) with A & C slips 1 & 2.	-	Specification for Section Insulator Assembly without Sectioning Insulator	Aug,84

2.0 POWER SUPPLY INSTALLATION

SI.No.	SPECIFICATIONNO.	LAST REV.	DESCRIPTION	DATEOFISSUE
1.	ETI/PSI/1(6/81)	-	Battery charger for 110volt battery,40Ah.	Jun. 81
2.	ETI/PSI/14(01/86)	1	25kV Drop out fuse switch.	Apr. 87
3.	ETI/PSI/15(08/2003)	-	25kV/240V Auxiliary transformer, 5KVA,10kVA.,25kVA.&50kVA.	Aug.03
4.	ETI/PSI/15A(7/82)	1	25kV/240VAuxiliary transformers, 100kVA.	Sep.89
5.	ETI/PSI/24(6/81)	-	Battery charger for 110 V. battery 200 Ah.	Jun.81
6.	ETI/PSI/29 (12/79)	1	Low Tension Distribution Panels of Railway a. c. Traction Substations	Feb.93
7.	ETI/PSI/31(5/76)	-	Standards for drawings for power supply installation.	May.76

8.	ETI/PSI/36(5/75)	-	Current transformer 132kV(type–II)	May.75
9.	TI/SPC/PSI/CLS/0 020(12/02) with A&C slip no. 1,2,3&4	4	Control & distribution panel for colour light signaling supply in 25kVac.traction systems.	July.10
10.	ETI/PSI/44(12/73)	-	Standards for electrical distribution system in stations & yards where 25kVa.c.traction is to be introduced.	Dec.73
11.	TI/SPC/PSI/PROTCT/ 6071 with A&C slip no.1	1	Control and Relay panel for 25kV acts including specification for numerical type protection relays for traction transformer, 25kV shunt capacitor bank and transmission line for 25kVAC TSS on Indian Railways.	Oct. 16
12.	ETI/PSI/FC & SR/0100(01/10)	1	Shunt capacitor equipment for Railway traction sub-stations	Oct. 16
13.	ETI/PSI/70 (11/84)	-	Hollow porcelain insulators & Bushing.	Nov.84
14.	ETI/PSI/MOGTLA/010 1(02/15)	-	Metal oxide gap less type lightening arrester for use on Railway traction substations and switching stations.	Feb.,15
15.	ETI/PSI/72(9/85)	-	Electric power connectors for AC. Traction power system.	Sep.85
16.	ETI/PSI/75(10/97)	-	25 kV, 50 Hz single phase series Compensation Equipment.	Oct.97
17.	ETI/PSI/90(6/95)	9	25kV ac 50Hz single phase oil filled current transformers with ratio of(i) 1000-500/5A, (for general purposes, (ii)1500-750/5(for heavy duty).	June 18
18.	ETI/PSI/98(8/92)	3	100KVA and 150KVA.25kVsingle phase 50Hz.oil filled booster transformer.	Jun.94
19.	ETI/PSI/99(4/89)	-	Tri-Vector Meter and Maximum Demand Indicator for Railway a.c.Traction.	Apr 89
20.	TI/SPC/PSI/ISOLTR /1060(08/06)With A & C Slip No.2	2	Specification for 25kV. AC Single pole and Double pole Motorized Isolators for Railway Electric traction.	Oct. 16
21.	TI/SPC/PSI/DRPC/00 50(08/05)	1	Dynamic reactive power compensation equipment for Railway traction sub-stations (for development of prototype only).	Oct. 16

22.	ETI/PSI/105(7/93)	-	Gas Chromatograph for use in analysis of dissolved gases of transformer oil.	Jul.93
23.	ETI/PSI/106(10/87)	-	Capacitance bridge and dissipation factor bridge for the measurement of solid insulation of insulating oil.	Oct.87
24.	ETI/PSI/117(7/88)	9	Current transformer (i) 220kV,200-100/5(ii) 132kV,400-200/5(iii)110kV,400-200/5(iv)66kV,800-400/5	Jul. 08
25.	ETI/PSI/118(10/93)	11	Power transformer 21.6MVA, single phase 50Hz, 220/132/110/66/27kV for traction substation.	Oct. 16
26.	ETI/PSI/120(2/91)	1	Code of practice for earthing of power supply installation for 25kV.AC, 50Hz single phase traction system.	Oct.93
27.	ETI/PSI/122(3/89)	1	Specification for 245/145/123/ 72.5kV double pole and triple pole isolators.	Apr.90
28.	ETI/PSI/123(9/93)	2	21.6MVA,220/132/110/66kV/2x 27 kV,single phase,50HzTraction power transformer for'AT' feeding system.	Oct. 16
29.	ETI/PSI/124(7/95)	1	54MVA, 220/2x27kVScott-connected power transformer for2x27kV 'AT' feeding system.	Oct. 16
30.	ETI/PSI/125(7/97)	1	8or 5 MVA, 2x27kV 50Hz, autotrans former for 2x27kV 'AT' feeding system.	Oct. 16
31.	ETI/PSI/126(8/89)	3	25kVshunt capacitor equipment for 2x25kV'AT' feeding system.	Oct. 16
32.	ETI/PSI/127(8/89)	3	Series capacitor equipment for 2x25kV 'AT' feeding system.	Oct. 16
33.	ETI/PSI/128(8/89)	3	Resonance suppressing C-R device for 2x25KV 'at' feeding system.	Sep.90

34.	TI/SPC/PSI/PROTCT/7100(07/2012) with A&C Slip no.1	1	Control & Relay panel including Numerical type protection relays for Scott- connected / single phase traction transformer, OHE protection & shunt capacitor bank protection for 2 X 25 kV traction sub-station.	Oct. 16
35.	ETI/PSI/133(8/89)	2	25 kV ac double pole isolators for 2x25kV 'AT' feeding system.	Oct.91
36.	ETI/PSI/135(8/89)	1	AT Boost up current ratio type fault locator for OHE for 2x25 kV , AT feeding system.	Jan.90
37.	ETI/PSI/137(8/89)	7	Metal oxide gap less type lightning arresters for use of 220/132/110/66kV side of railway ac traction substation.	Jul.07
38.	TI/SPC/PSI/LCMLA/0030Rev.1(07/10)	1	Technical specification for leakage current monitor for lightning arrester	Jul.10
39.	TI/SPC/PSI/PROTCT/5070(Rev.1) with A&C Slip no.1	1	Technical specification for Microprocessor based Numerical Integrated feeder Protection Module Comprising DPR, INST. OCR, PTFF& Auto Re-closure Relay for 25kV.AC single phase 50Hz traction Sub-Station.	Oct. 16
40.	ETI/PSI/145(3/92)	1	Specification for 11kV current transformer with ratio 500/5 for 2x25kV 'AT' feeding system.	Sep.92
41.	ETI/PSI/147(3/92)	1	Specification for 25kV current transformer with CT ratio 100-50/5 for shunt capacitor banks in 2x25kV 'AT' feeding system.	Nov.92
42.	ETI/PSI/148(4/92)	-	Specification for SF-6 Gas leakage detector.	Apr.92
43.	ETI/PSI/163(4/97)	4	21.6MVA,100/27kVOR22/27kV Single phase, 50Hz ,ONAN traction power transformer.	Oct. 16
44.	TI/SPC/PSI/PROTCT/1982(12/03)with A&C Slip no.1&2	2	Specification for Delta-I type High Resistive fault selective relay for 25kV ac Single phase 50 Hz traction systems.	Oct. 16

45.	TI/SPC/PSI/PROTCT/ 2983(09/01)with A&C Slip no.1	1	Specification for Panto Flashover Protection relay for 25kVa.c.Single phase 50 Hz traction system.	Oct. 16
46.	TI/SPC/PSI/PROTCT /4050(11/05) with A&C Slip no.1	1	Control & Relay Panel for protection system of Mumbai Sub-urban area for 50Hz AC Traction power supply system including parallel operation on 25kV Side.	Oct. 16
47.	TI/SPC/PSI/PTS/0 990(09/99)	5	Specificationfor220kVOr132kV.or110 kVor66kVOr25kV.Potentialtransforme r	April.09
48.	TI/SPC/PSI/LVCBIN/0 120 Rev.0(Dec'2013)with A&C slip no.1	1	25 kV Single pole, Double Pole, Pole mounted, out door Vacuum circuit breaker (VCB) and vacuum Interrupter (BM) for Indian Railway.	Oct. 16
49.	TI/SPC/PSI/HVCBIN/ 0120 Rev.0(June'2014) with A & C slip No.2	2	220kV/132kV/110kV/66kV.Double/Tri ple pole outdoor SF6 circuit breaker for Indian Railways.	Oct. 16
50.	TI/SPC/PSI/30TRN/0 030(06/03)	-	30MVA, 22/27kV Single Phase Traction Power Transformer.	Jun03
51.	TI/SPC/PSI/30TRN/1 050(12/05) With A & C Slip No. 2	2	30/42MVA,220/27kV or 132/27kV or 110/27kV or 100/27kV Single phase traction Power transformer with on load top changer (for use in Mumbai Sub-Urban Area)	Jan. 18
52.	TI/SPC/PSI/30TRN/2 070(10/07)	1	30MVA, 220/27kV, 110/27kV & 66/27kV Single phase traction Power transformer ONAN/ONAF with on load top changer (for use in TSSs other than Mumbai area).	Oct. 16
53.	TI/SPC/PSI/OFC/0 050(10/05)	-	25 Core Armoured Optic Fibre Cable for use in Indian Railway straction installation systems	Oct.05
54.	TI/SPC/PSI/PQAR/00 80(09/08)	-	Technical specification for power quality analyzer and Recorder with Remote display.	Sep.08
55.	TI/SPC/RCC/SCADA /0130(Rev.2) With A&C slip No.1	1	Technical specification for Supervisory Control and Data Acquisition System for 25kV single phase 50Hz ac Traction Power supply.	Oct. 16
56.	TI/SPC/PSI/CABLE/0 090(02/09)	-	Manufacture and supply of 132Kv XLPE underground cable and accessories.	Feb.09

57.	TI/SPC/PSI/AUTOTR/0 090(02/09)	-	Technical specification for 50/75/150 MVA ONAN/ONAF/OFAR 220/ 132 kV, 3-Phase Oil Immersed Type Auto Transformer.	Jul'11

3.0CIVILSPECIFICATION

S. No.	SPECIFICATION NO.	LASTR EV.	DESCRIPTION	DATE OF ISSUE
1	ETI/C/2/(8/94)	-	Technical specification for spunpre-stressed cement concrete (PSC) OHE traction mast.	Aug.94
2	ETI/C/3(5/83)	-	Indian Railway standard specification for spraying zinc coating on the OHE mast.	May.83
3	ETI/C/4(8/90)	-	Draft Indian Railway Standard specification for cold roll formed mast for Railway electrification.	Aug.90
4	ETI/C/5(5/88)	1	Specification for Flo-Coat Tube	May01
5	TI/SPC/CIV/POR/00 80(08/2008)	-	Corrosion Resistant Paint System for outdoor structures of Traction Distribution and Traction Rolling Stock.	Aug08

1.0 Amendment History:

S. No.	Amendment Date	Version	Reasons for Amendment
1.0	12.09.2018	1.0	First issue under new documentation system for ISO 9001:2015.

1. GENERAL ARRANGEMENT FOR CONVENTIONAL OHE

1	ETI/OHE/G/00111 Sh.1	C	Extra allowance for setting of structures on curves (broad gauge)	20.10.05
2	RE/33/G/00111 Sh.2	-	Extra allowance for setting of structures on curves (metre gauge)	17.05.62
3	ETI/OHE/G/00112	D	Standard setting of structures in the vicinity of signals (broad gauge)	20.10.05
4	ETI/OHE/G/00131	-	Typical design of side bearing foundation	21.08.71
5	ETI/OHE/G/00144 Sh.3	C	Standard drilling schedule of OHE mast 9.5 m long (RSJ and BFB)	24.12.97
6	ETI/OHE/G/00158 Sh-1	-	Employment schedule of bracket tubes regulated conventional OHE (Cd Cu catenary and Cu contact wire 1000 kgf. tension each for wind pressure 75kgf /.m2	28.06.84
7	ETI/OHE/G/00158 Sh-2	-	Employment schedule of bracket tubes regulated conventional OHE (Cd Cu catenary and Cu contact wire 1000 kgf tension each) for wind pressure 112.5kgf /sq.m.	28.06.84
8	ETI/OHE/G/00158 Sh- 3	-	Employment schedule of bracket tubes regulated conventional OHE (Cd Cu catenary and cu contact wire 1000 kgf tension each) for wind pressure 150 kgf / sq.m.	28.06.84
9	ETI/OHE/G/00159 Sh-1	-	Employment schedule of bracket tubes unregulated conventional OHE (Cd Cu catenary and Cu contact wire 1000 kgf tension each for wind pressure 75kgf /sq.m.	28.06.84
10	ETI/OHE/G/00159 Sh-2	-	Employment schedule of bracket tubes unregulated conventional OHE (Cd Cu catenary and Cu contact wire 1000 kgf tension each) for wind pressure 112.5kgf /sq.m.	28.06.84
11	ETI/OHE/G/00159 Sh- 3	-	Employment schedule of bracket tubes unregulated conventional OHE (Cd Cu catenary and Cu contact wire 1000 kgf tension each) for wind pressure 150 kgf /sq.m.	28.06.84
12	ETI/OHE/G/00161	-	General distribution of droppers.	28.04.72
13	ETI/OHE/G/00166	A	Dropper schedule for unregulated OHE with equal encumbrance (1.40/1.40).	02.08.74
14	ETI/OHE/G/00167	A	Dropper schedule for unregulated OHE with unequal encumbrance (1.40/0.90).	02.08.74
15	ETI/OHE/G/00168	A	Dropper schedule for unregulated OHE with unequal encumbrance (1.40/0.75).	02.08.74
16	ETI/OHE/G/00169	A	Dropper schedule for uninsulated overlap span.	01.12.94
17	ETI/OHE/G/00170	A	Dropper schedule for insulated overlap span.	02.08.74

18	ETI/OHE/G/00173	B	Dropper schedule for compensated OHE with equal encumbrance (1.40/1.40) for speed upto 160km/h.	02.08.74
19	ETI/OHE/G/00173-I	-	Dropper schedule for regulated OHE in worn out condition of 107 sqmm contact wire (9.75mm thickness)	09.10.95
20	ETI/OHE/G/00174	B	Dropper schedule for compensated OHE with unequal encumbrance (1.40/0.90) for speed upto 160km/h	03.04.80
21	ETI/OHE/G/00175	A	Dropper schedule for compensated OHE with unequal encumbrance (1.40/0.75) for speed upto 160km/h	02.08.74
22	ETI/OHE/G/00176	D	Dropper schedule for compensated OHE with unequal encumbrance (1.75/1.40) for speed upto 160km/h	02.08.74
23	ETI/OHE/G/00177	A	Dropper schedule for conventional regulated OHE with zero presage (1400/1400)	05.09.94
24	RE/33/G/00181	A	Outline of pantograph (BG & MG)	05.03.62
25	RE/33/G/00182	C	Arrangement of pantograph multiple headed train BG	04.08.66
26	RE/33/G/00183 Sh. 1	B	General clearance diagram on BG tracks (tangent and flat curves)	09.08.67
27	RE/33/G/00183 Sh. 2	-	General clearance diagram on MG tracks (tangent and flat curves)	06.06.62
28	RE/33/G/00184 Sh. 1	A	General clearance diagram on BG tracks (sharp curves)	10.04.62
29	RE/33/G/00184 Sh. 2	-	General clearance diagram on MG tracks (sharp curves)	06.06.62
30	RE/33/G/00185 Sh. 1	A	Restricted clearance diagram on tangent tracks BG	16.04.64
31	RE/33/G/00185 Sh. 2	-	Restricted clearance diagram on MG tracks (tangent and flat curves)	06.06.62
32	ETI/OHE/G/00186 Sh. 1	-	Restricted clearance diagram on curved track on BG	14.01.83
33	RE/33/G/00186 Sh. 2	-	Restricted clearance diagram on MG tracks (sharp curves)	06.06.82
34	ETI/OHE/G/00187	A	Chart showing the blow off, push up and oscillations of the standard a.c. OHE	25.08.76
35	RE/33/G/00193	-	Adjustment chart of regulating equipment winch type & pulley block type	27.01.67
36	ETI/OHE/G/00195	A	Adjustment chart of regulating equipment three pulley type 3:1 ratio	28.06.94
37	RE/33/G/00197	A	Cantilever adjustment chart at mean temperature 35 ^{0}C	31.01.61
38	ETI/OHE/G/00202	-	Span and stagger chart (conventional OHE Cd copper catenary and Cu contact wire) for wind	27.03.85

			pressure 75,112.5 & 150 kgf/sq. m		
39	ETI/OHE/G/00222 Sh. 1	-	Sag and tension chart for loaded catenary	11.09. 72	FOLDER 4
40	RE/33/G/01101 Sh. 1	A	General formation of single track in embankments and cuttings BG	07.09. 62	FOLDER 5
41	RE/33/G/01101 Sh. 2	-	General formation of single track in embankments and cuttings MG	06.04. 62	FOLDER 5
42	RE/33/G/01102 Sh. 1	A	General formation of double track in embankments and cuttings BG	07.04. 62	FOLDER 5
43	RE/33/G/01102 Sh. 2	-	General formation of double track in embankments and cuttings MG	06.04. 62	FOLDER 5
44	RE/33/G/01103 Sh. 1	A	General formation of multiple tracks BG	07.04. 60	FOLDER 5
45	RE/33/G/01103 Sh. 2	-	General formation of multiple tracks MG	06.04. 62	FOLDER 5
46	RE/33/G/01104 Sh. 1	-	Leading dimensions of turnouts BG	20.04. 62	FOLDER 5
47	RE/33/G/01104 Sh. 2	-	Leading dimensions of turnouts MG	17.05. 62	FOLDER 5
48	RE/33/G/01105 Sh. 1	A	Leading dimensions of crossing BG	20.04. 62	FOLDER 5
49	RE/33/G/01105 Sh. 2	-	Leading dimensions of diamond crossing MG	17.05. 62	FOLDER 5
50	RE/33/G/01112 Sh. 2	-	Normal profile of maximum moving dimensions MG	23.05. 62	FOLDER 5
51	RE/33/G/01401	E	Standard anchor arrangement	06.08. 82	FOLDER 5
52	ETI/OHE/G/01402	B	Anchor arrangement with dwarf mast	25.09. 72	FOLDER 5
53	ETI/OHE/G/01403 Sh-1	D	Schedule of anchor block for BG. Tracks	13.08. 99	FOLDER 5
54	ETI/OHE/G/01403 Sh-2	C	Double guy rod arrangement with anchor block BG track	13.08. 99	FOLDER 5
55	ETI/OHE/G/01403 Sh-3	B	Schedule of anchor blocks for BG tracks (black cotton soil)	29.0 5. 79	FOLDER 5
56	ETI/OHE/G/01502	-	Trapezoidal counter weight arrangement on OHE structures	04.02. 72	FOLDER 6
57	ETI/OHE/G/01503 Sh-1	B	Cement concrete counter weight arrangements on OHE structures for winch type regulating equipment	30.04. 91	FOLDER 6
58	ETI/OHE/G/01503 Sh-2	A	Cement concrete counter weight arrangement on N, O & R type portal upright	30.04. 91	FOLDER 6
59	ETI/OHE/G/01505	-	Standard guide tube arrangement on a mast and structures	19.11. 87	FOLDER 6
60	ETI/OHE/G/01601	-	Arrangement of 3kV and 25kV pedestal insulator supports on OHE masts and portals	03.02. 72	FOLDER 6

61	ETI/OHE/G/01701	A	Standard arrangements for mounting of number plate on OHE structures	23.03.85
62	ETI/OHE/G/01702	-	Standard arrangement for mounting of number plate (Retro-reflective type) on OHE structures	23.02.98
63	ETI/OHE/G/02101	A	Schematic arrangement of regulated OHE	04.07.94
64	ETI/OHE/G/02102	-	Typical arrangement of OHE on cantilever mast for double track section	22.06.81
65	ETI/OHE/G/02102 Sh-3	-	Typical arrangement for fixing of bracket assembly on 9.5 m mast and structure to suit raising of track in future	05.01.77
66	ETI/OHE/G/02103	-	General arrangement of OHE with stitch wire on catenary	06.05.72
67	ETI/OHE/G/02104 Sh-1	A	Mast on platforms BG	20.01.73
68	RE/33/G/02104 Sh-2	A	Mast on platforms MG	25.06.62
69	ETI/OHE/G/02106 Sh-1	A	Details of bracket arrangement on tangent and curved tracks	25.08.72
70	ETI/OHE/G/02106 Sh-3	C	Details of bracket arrangement for OHE high speed	04.07.94
71	RE/33/G/02107	D	Single bracket assembly on structures and dropped arms.	25.07.84
72	ETI/OHE/G/02108	A	Box type cantilever arrangement	09.01.97
73	ETI/OHE/G/02111	A	Arrangement of anticreep	04.07.94
74	ETI/OHE/G/02113	-	Standard cantilever arrangement for boom anchor anticreep location	27.01.69
75	ETI/OHE/G/02121 Sh-1	F	Schematic arrangement of uninsulated overlap (Type I) (3 and 4 span overlaps)	20.05.74
76	ETI/OHE/G/02121 Sh-4	A	Schematic arrangement of uninsulated overlap (3 & 4 span overlaps)	04.07.94
77	ETI/OHE/G/02131 Sh-1	-	Schematic arrangement of Insulated Overlap	25.09.87
78	ETI/OHE/G/02131 Sh-3	A	Schematic arrangement of insulated overlap	04.07.94
79	ETI/OHE/G/02141	C	General arrangement of regulated OHE at turn outs (overlap and crossed type)	25.09.87
80	ETI/OHE/G/02151	-	General arrangement of regulated OHE at cross over (Overlap and crossed type)	13.02.98
81	ETI/OHE/G/02161 Sh-1	C	Arrangement of neutral section	14.06.85
82	ETI/OHE/G/02161 Sh-2	-	Arrangement of short neutral section	15.11.84

83	ETI/OHE/G/02162	-	Arrangement of neutral section assembly (PTFE type) at switching station	01.12.88
84	ETI/OHE/G/03101	-	Schematic arrangement of unregulated OHE	22.06.81
85	ETI/OHE/G/03121	E	Standard termination of OHE (regulated and unregulated)	11.03.03
86	ETI/OHE/G/03151	-	General arrangement of unregulated OHE at turnout (crossed and overlap type)	16.10.82
87	ETI/OHE/G/03152 Sh-1	-	General arrangement of unregulated OHE at cross over and diamond crossings (crossed and overlap type)	16.10.82
88	ETI/OHE/G/03152 Sh-2	-	General arrangement of unregulated OHE at diamond crossings	16.10.82
89	ETI/OHE/G/03201	-	General arrangement of head span	03.02.72
90	ETI/OHE/G/03301	A	General arrangement of pull off	06.08.74
91	ETI/OHE/G/04201	-	Span and stagger chart for tramway type OHE (regulated)	18.06.81
92	ETI/OHE/G/04202 Sh-1	C	Drilling schedule of OHE mast 8.5m long RSJ and BFB for tramway type OHE (regulated)	22.01.98
93	ETI/OHE/G/04202 Sh-2	C	Drilling schedule of OHE mast 9.0m long RSJ and BFB for tramway type OHE (regulated)	22.01.98
94	ETI/OHE/G/04203	C	Schematic arrangement of tramway type OHE (regulated)	04.07.94
95	ETI/OHE/G/04204	B	Arrangement of bracket assembly for tramway type OHE (regulated)	21.06.85
96	ETI/OHE/G/04205	B	Arrangement of anticreep for tramway type OHE (regulated)	04.07.94
97	ETI/OHE/G/04206	B	Arrangement of anticreep for tramway type OHE (regulated) (alternative arrangement)	04.07.94
98	ETI/OHE/G/04207 Sh-1	B	Arrangement of section insulator for tramway type OHE (regulated)	21.06.85
99	ETI/OHE/G/04207 Sh-2	B	Small parts steel for supporting section insulator assembly. (for regulated tramway type OHE)	26.08.96
100	ETI/OHE/G/04208	-	General arrangement of turnout for tramway type OHE (regulated)	18.06.81
101	ETI/OHE/G/04209	-	Adjustment chart for tramway type OHE (regulated)	25.09.81
102	ETI/OHE/G/04212	B	Standard termination of tramway type OHE (regulated with pulley type regulating equipment) (3:1 ratio)	22.04.94
103	ETI/OHE/G/04213	-	General arrangement of connections at switching stations and BT locations for tramway type OHE.	22.04.94
104	ETI/OHE/G/05101	-	In span jumper connection between catenary	15.01.

			and contact wire.	72
105	ETI/OHE/G/05102	C	Continuity jumper connection at un-insulated overlap.	10.07.01
106	ETI/OHE/G/05103	B	Connection at turnouts.	25.07.84
107	ETI/OHE/G/05104	-	Potential equalizer connection at insulated overlap and neutral section.	15.01.72
108	ETI/OHE/G/05106	A	Connection at diamond crossing.	12.01.83
109	ETI/OHE/G/05107	A	Antitheft jumper.	28.10.94
110	ETI/OHE/G/05121 Sh-1	C	General arrangement of connection to OHE by copper cross feeder (150)	30.09.93
111	ETI/OHE/G/05122 Sh-1	C	General arrangement of connection at switching station on double track section by copper cross feeder (150)	30.09.93
112	ETI/OHE/G/05123 Sh-1	C	General arrangement of connection at switching station on multiple track section by copper cross feeder (150)	30.09.93
113	ETI/OHE/G/05143	B	Suspension of 25 kV feeders (spider) on OHE masts.	14.06.85
114	RE/33/G/05145-1	A	Termination of feeder, return conductor and return feeder (copper and aluminium)	04.04.03
115	RE/33/G/05152	C	Arrangement of suspension of double spider 25 kV feeder and return feeder between sub-station and feeding station	13.05.86
116	RE/33/G/05181	C	Assembly of section insulator	24.05.94
117	ETI/OHE/G/05201	A	General arrangement of earth wire on OHE mast.	31.03.79
118	ETI/OHE/G/05201-1	-	General arrangement of earth wire on OHE mast.	04.07.94
119	ETI/OHE/G/05251	A	Arrangement of transverse bonds.	14.01.83
120	ETI/OHE/G/05306	F	Connection of RC to track.	14.09.94
121	ETI/OHE/G/05307	B	Suspension arrangement of aluminium return conductor (spider) on traction structures.	30.10.92
122	ETI/OHE/G/05311	D	Suspension of RC (spider) from boom of structures.	02.11.92
123	ETI/OHE/G/05312	A	Suspension of RC (spider) from boom of structures with clevis type disc insulator.	02.11.92
124	ETI/OHE/G/05413	B	Connection between OHE and aluminium RC at booster station.	14.06.85
125	ETI/OHE/G/05513	A	Mounting of 25 kV Isolators on	07.02.

	Sh-1		OHE structures (general arrangement).	72
126	ETI/OHE/G/05513 Sh-2	A	Details of small parts steel work for supporting 25 kV Isolators on new TTC boom.	07.02. 72
127	ETI/OHE/G/05516	A	Connection from Isolator to OHE.	30.09. 93
128	ETI/OHE/G/05600	A	Characteristics of conductor/bus bar for 25 kV ac traction.	04.02. 77
129	ETI/OHE/G/06000	B	Suspension arrangement of AT feeder on traction mast (for 2x25 kV).	03.01. 92
130	ETI/OHE/G/06001	A	Suspension arrangement of AT feeder on portals (For 2x25 kV).	03.01. 92
131	ETI/OHE/G/06002	-	Suspension arrangement of 25kv feeder at Switching station/Feeding post (for 2x25 kV).	23.10. 89
132	ETI/OHE/G/06003	-	Termination arrangement for AT feeder.	23.10. 89
133	ETI/OHE/G/06004	B	Arrangement of sectioning of AT feeder (for 2x25kV)	17.02. 92
134	ETI/OHE/G/06005 Sh-1	-	General arrangement of connections at an elementary sectioning point on double track section (for 2x25kV)	28.11. 91
135	ETI/OHE/G/06005 Sh-2	-	Mounting details of double pole Isolator on mast (for 2x25kV)	28.11. 91
136	ETI/OHE/G/06006	-	Suspension of AT feeder (spider) from boom of portals (for 2x25kV AT system)	28.09. 93
137	ETI/OHE/G/06008	-	Mounting details of double pole Isolator on portals (for 2x25kV)	13.10. 92
138	ETI/OHE/SK/124	B	Span and stagger chart.	01.12. 94
139	ETI/OHE/SK/148	-	Dropper schedule for insulated overlap span (for higher section of OHE).	22.11. 94
140	ETI/OHE/SK/149	A	Dropper schedule for uninsulated overlap span (for higher section of OHE).	01.12. 94
141	ETI/OHE/SK/467		Arrangement for endurance and proof load test of regulating equipment (winch type)	06-08-84
142	ETI/OHE/SK/473 Sh.1	-	Bracket arrangement on tangent track inside tunnel.	05.09. 85
143	ETI/OHE/SK/473 Sh.2	-	Bracket arrangement on curved track inside tunnel.	05.09. 85
144	ETI/OHE/SK/473 Sh.3	-	Detail of bracket arrangement inside tunnel.	05.09. 85
145	ETI/OHE/SK/481	A	Insulated Tee Junction	26-09-

				96
146	ETI/OHE/SK/482	A	Earthing clamp assembly	26-09-96
147	ETI/OHE/SK/521-1		Dropper schedule for regulated OHE in worn out condition of 107 mm^2 contact wire (10 mm thickness)	25.09.95
148	ETI/OHE/SK/522	-	Dropper schedule for over lap's spans.	05.02.88
149	ETI/OHE/SK/523	-	Dropper schedule for anchor spans.	05.02.88
150	ETI/OHE/SK/524	A	Counter weight assembly (1200/1200)	26.08.96
151	ETI/OHE/SK/544	-	Typical Sectioning diagram at station with Isolators. (Fo2x25 kV).	26.09.89
152	ETI/OHE/SK/551	-	Arrangement of neutral section for conversion with short neutral section.	24.01.90
153	ETI/OHE/SK/552	-	Arrangement of short neutral section at existing feeding post.	24.01.90
154	ETI/OHE/SK/581	-	Sag and tension chart for catenary (65mm^2) and contact wire (107mm^2) for 1200kgf/1200kgf tension.	02.02.94
155	ETI/OHE/SK/582	-	Schematic arrangement of unined overlap.	02.02.94
156	ETI/OHE/SK/583	-	Schematic arrangement of insulated overlap	02.02.94
157	ETI/OHE/SK/584	-	Dropper schedule for regulated OHE (1200 kgf/1200 kgf tension)	02.02.94
158	ETI/OHE/SK/585	-	Dropper schedule for uninsulated overlap spans (1200kgf / 1200kgf tension)	02.02.94
159	ETI/OHE/SK/586	A	Dropper schedule for insulated overlap spans (1200kgf / 1200kgf tension)	26.06.95
160	ETI/OHE/SK/587	A	Counter weight assembly.	26.08.96
161	ETI/OHE/SK/588	-	Counter weight eye rod.	02.02.94
162	ETI/OHE/SK/597	-	Typical pneumatic circuit for raising/lowering of pantograph from cab of OHE recording cum test car.	11.02.94
163	ETI/OHE/SK/603	-	Schematic arrangement of uninsulated overlap (Three spans and four spans).	15.12.94
164	ETI/OHE/SK/604	-	Schematic arrangement of insulated overlap (Three spans and four spans).	15.12.94
165	ETI/OHE/ SK/605	-	Sag and tension chart (higher section of OHE)	01.12.94

166	ETI/OHE/ SK/606	-	Dropper schedule for regulated OHE (for higher section of OHE)	01.12.94
167	ETI/OHE/ SK/607	-	Schematic arrangement of uninsulated over lap (Three spans and four spans) for higher section of OHE	01.12.94
168	ETI/OHE/ SK/608	-	Schematic arrangement of insulated over lap (Three spans and four spans) for higher section of OHE	01.12.94
169	ETI/OHE/ SK/609	-	Schematic arrangement of uninsulated over lap (Three spans and four spans)	01.12.94
170	ETI/OHE/ SK/610	-	Schematic arrangement of insulated over lap (Three spans and four spans)	01.12.94
171	TI/DRG/OHE/GENL/ RDSO/00001/18/0	0	Arrangement at Anticreep for 125/150 OHE	06.04.2018
172	TI/DRG/OHE/DROP/00001/10/3	3	Dropper schedule encumbrance 1.4m/1.4m tension 1000/1000 for 25 kV AC regulated 65/107 sq mm OHE	07.06.2018
173	TI/DRG/OHE/DROP/00002/10/3	3	Dropper schedule encumbrance 1.4m/0.9m tension 1000/1000 for 25 kV AC regulated 65/107 sq mm OHE	07.06.2018

Chapter - I - OVERHEAD EQUIPMENT

2. ATD Series

1.	TI/DRG/OHE/ATD/ RDSO/00001/99/2	-	Regulating equipment (three pulley type) 3:1 ratio (Modified)	29.08.06	FOL 2
2.	TI/DRG/OHE/ATD/ RDSO/00002/99/3	-	Part Details of Regulating equipment (three pulley type) 3:1 ratio (Modified)	15.05.07	FOL 2
3.	TI/DRG/OHE/ATD/ RDSO/00003/99/0	-	Adjustment Chart of Regulating equipment (three pulley type) 3:1 ratio (Modified)	00-09-99	FOL 2
4.	TI/DRG/OHE/ATD/ RDSO/00004/00/0	-	Trapezoidal counter weight assembly 3:1 ratio.	19.06.01	FOL 2
5.	TI/DRG/OHE/ATD/ RDSO/00005/02/1	-	Clevis & Eye (Forged).	11.02.03	FOL 2
6.	TI/DRG/OHE/ATD/ RDSO/00006/04/0	-	Adjustment Chart of Regulating equipment three pulley types (3:1 Ratio) old for composite OHE.	14.10.06	FOL 2
7.	TI/DRG/OHE/ATD/ RDSO/00007/04/0		Adjustment chart of Regulating equipment three pulley type (3:1 Ratio) modified for composite OHE.	14.10.06	FOL 2
8.	TI/DRG/OHE/ATD/ RDSO/00008/05/0	-	Bolt M-18with castle nut.	30.06.05	FOL 2
9.	TI/DRG/OHE/ATD/ RDSO/00009/05/0		Fixing arrangement of mast Anchor fitting for Anti falling device in three pulley (Mod) ATD	27.09.06	FOL 2

Chapter - I - OVERHEAD EQUIPMENT

2. COMPONENTS, FITTINGS, EQUIPMENTS AND SMALL PART STEEL WORKS (SPS

ISO9001:2008	Document No. TI-M-4.2.3-2	version No. 4.0	Date Effective21/11/2017
Document title Master List of Drawings of equipments and materials for Traction Installation			

1	ETI/OHE/P/150	-	High tensile rusties 'U' bolt 10 mm dia.	19.09.74
2	RE/33/P/160	A	High tensile rusties pin bolt 10 mm dia.	01.06.65
3	RE/33/P/250	B	Steel 'U' bolt and nuts dia 14 mm	03.08.74
4	RE/33/P/260	C	Snap head pin dia 20 mm	30.06.95
5	RE/33/P/500	-	Rail jumper assembly	01.09.59
6	RE/33/P/501	B	Rail jumper clamp body grip screw and ferrule nut	14.02.61
7	RE/33/P/504	A	Rail jumper ferrule	14.02.61
8	RE/33/P/509	-	Rail jumper extension	06.05.60
9	RE/33/P/510	A	Earthing rods	11.01.61
10	RE/33/P/511	-	Earthing rods	06.05.60
11	RE/33/P/520	A	Earthing rod hook assembly	24.01.61
12	RE/33/P/521	-	Earthing rod head	24.01.61
13	RE/33/P/522	-	Earthing rod tongue	24.01.61
14	RE/33/P/523	-	Earthing rod hook pin and other small parts	24.01.61
15	RE/33/P/530	-	Insulated Tee junction	22.03.60
16	RE/33/P/550	-	Automatic come-along clamp (for contact wire)	22.01.62
17	RE/33/P/560	-	Automatic come- along clamp	25.06.65
18	ETI/OHE/P/580	-	Contact wire straightener assembly.	11.03.70
19	ETI/OHE/P/581-599	-	Details of contact wire straightener.	11.03.70
20	ETI/OHE/P/1009	A	Terminal connector (19mm) multiple holes (bolted type)	10.03.05
21	ETI/OHE/P/1010	A	Terminal connector (15mm) multiple holes (bolted type)	10.03.05
22	ETI/OHE/P/1030-2	D	Contact wire parallel clamp large	17.07.91
23	ETI/OHE/P/1030-3	A	Parallel Clamp (157-65/ 107/150) for WKRE	23.08.91
24	ETI/OHE/P/1031-2	C	Contact wire parallel clamp part large	24.01.

				01
25	ETI/OHE/P/1040-2	E	Contact wire parallel clamp part small	17.07.91
26	ETI/OHE/P/1040-3	B	Parallel Clamp (90/50)	19.06.01
27	ETI/OHE/P/1041-2	C	Contact wire parallel clamp part small	19.06.01
28	ETI/OHE/P/1050-2	D	Parallel Clamp (150/105-150) for WKRE	23.08.91
29	ETI/OHE/P/1050-3	A	Parallel Clamp (150/160) for WKRE	19.06.01
30	ETI/OHE/P/1051-2	C	Parallel Clamp part (150/105-150)	19.06.01
31	ETI/OHE/P/1070-1	B	Bridle wire Clamp (6mm) with two bolts	09.06.95
32	ETI/OHE/P/1080	A	Contact wire splice (107)	01.06.88
33	ETI/OHE/P/1080-1	B	Contact wire splice (toothed type)	01.06.88
34	ETI/OHE/P/1081-1	C	Contact wire splice part	17.11.87
35	ETI/OHE/P/1081-2	A	Contact wire splice part	19.03.87
36	ETI/OHE/P/1090	-	Catenary splice (65)	29.06.71
37	ETI/OHE/P/1091	-	Catenary splice sleeve	29.06.71
38	ETI/OHE/P/1092	-	Catenary joint socket	29.06.71
39	ETI/OHE/P/1093	-	Catenary joint socket left	29.06.71
40	ETI/OHE/P/1094	A	Catenary joint cone	08.10.84
41	ETI/OHE/P/1102	-	Feeder joint socket	03.10.72
42	ETI/OHE/P/1104	-	Feeder joint cone	02.08.96
43	ETI/OHE/P/1110-2	D	Contact wire ending clamp (107)	01.06.88
44	ETI/OHE/P/1120	B	Catenary ending clamp (65)	01.06.88
45	ETI/OHE/P/1120-1	A	Catenary ending clamp (65) wedge type	07.12.93
46	ETI/OHE/P/1121	-	Catenary ending clamp body	20.08.71
47	ETI/OHE/P/1130	-	Feeder ending clamp (150)	25.09.87

48	ETI/OHE/P/1131	-	Feeder ending clamp body	19.08.71
49	ETI/OHE/P/1140	B	Large span wire ending clamp (130)	01.06.88
50	ETI/OHE/P/1143	B	Large span wire joint cone.	20.10.00
51	RE/33/P/1160	J	Suspension clamp	01.06.88
52	RE/33/P/1161	E	Suspension clamp body	03.09.84
53	RE/33/P/1163	D	Suspension clamp lock plate	13.09.65
54	RE/33/P/1170	K	Double suspension clamp	01.06.88
55	RE/33/P/1171	F	Double suspension clamp body	03.09.84
56	RE/33/P/1172	C	Double suspension lock plate	04.02.78
57	RE/33/P/1174	B	Packing saddle	08.01.87
58	RE/33/P/1180	F	Contact wire dropper clip (107)	18.01.94
59	RE/33/P/1181	G	Contact wire dropper clip part	18.01.94
60	RE/33/P/1182	C	Locking wire	06.11.69
61	ETI/OHE/P/1190	B	Catenary dropper assembly.	01.06.88
62	ETI/OHE/P/1191	-	Catenary dropper link.	08.11.85
63	ETI/OHE/P/1192	C	Catenary dropper clip.	01.06.88
64	ETI/OHE/P/1193	-	Dropper.	08.11.85
65	ETI/OHE/P/1194	A	Bridle wire dropper clip.	01.06.88
66	ETI/OHE/P/1210-2	C	Knuckle assembly.	03.06.88
67	ETI/OHE/P/1216	D	Knuckle tube clamp.	03.06 88
68	RE/33/P/1220	E	Contact wire swivel clip	06.11.69
69	RE/33/P/1221	D	Contact wire swivel clip part	27.04.74
70	RE/33/P/1222	C	Contact wire swivel clip pin	06.11.69
71	ETI/OHE/P/1230	-	Standard contact wire crossing assembly.	01.11.74

72	ETI/OHE/P/1233	-	Contact wire crossing bar.	01.11.74
73	RE/33/P/1250	D	Double contact wire swivel clip	06.11.69
74	RE/33/P/1251	A	Double contact wire swivel clip part	16.07.65
75	ETI/OHE/P/1260-1	A	Strain clamp link assembly	11.03.96
76	ETI/OHE/P/1263	-	Strain clamp link.	09.08.74
77	RE/33/P/1270-1	F	Suspension clevis assembly (18 mm)	03.06.88
78	RE/33/P/1280	C	Double contact wire splice	03.06.88
79	ETI/OHE/P/1310	-	Pull off Clamp assembly.	12.12.72
80	ETI/OHE/P/1320	B	'U Clamp (50/50)	03.06.88
81	ETI/OHE/P/1330	B	'U Clamp (50)	03.06.88
82	ETI/OHE/P/1350	-	Thimble (10mm)	01.01.73
83	ETI/OHE/P/1360	B	Steel wire Ending Clamp (90)	03.06.88
84	ETI/OHE/P/1361	A	Steel wire joint socket.	18.02.74
85	ETI/OHE/P/1362	B	Steel wire joint cone.	09.10.84
86	ETI/OHE/P/1370-1	F	Raised register arm clamp.	08.05.00
87	ETI/OHE/P/1370-2	-	Raised register arm Clamp (150 FB).	01.12.94
88	ETI/OHE/P/1390-1	D	Crossing clamp.	26.09.88
89	ETI/OHE/P/1391-1	B	Crossing clamp piece.	01.05.79
90	ETI/OHE/P/1400	C	Short dropper assembly.	10.01.89
91	ETI/OHE/P/1410	B	Special dropper assembly.	25.05.88
92	ETI/OHE/P/1530-1	C	Parallel clamp (105/240) for dc OHE.	19.06.01
93	ETI/OHE/P/1540	D	Bimetallic parallel clamp (10/20).	10.01.89
94	ETI/OHE/P/1550	E	Parallel clamp (20/20).	10.01.

				89
95	ETI/OHE/P/1560	D	Bimetallic parallel clamp (15/20).	10.01.89
96	ETI/OHE/P/1580 Sh.1	F	Large suspension clamp 20mm.	10.03.92
97	ETI/OHE/P/1580 Sh.2	-	Large suspension clamp 20mm (with armour rod).	02.11.92
98	ETI/OHE/P/1600	C	Strain clamp 20 mm.	07.07.88
99	ETI/OHE/P/1610-1	-	Compression joint.	06.08.82
100	ETI/OHE/P/1611	B	Compression joint (spider).	01.11.74
101	ETI/OHE/P/1640	-	Repair sleeves (compression type).	01.11.74
102	ETI/OHE/P/1790	C	Contact wire ending clamp (150) (for WKRE/dc OHE).	01.12.94
103	RE/33/P/2041	D	Standard bracket tube Dia. 30/38	22.02.84
104	ETI/OHE/P/2060	-	Tube cap.	21.11.85
105	ETI/OHE/P/2064-1	A	Tube cap 30mm.	10.01.89
106	RE/33/P/2081	E	Large bracket tube Dia 40/49 mm	25.02.84
107	RE/33/P/2086	C	Large bracket sleeve	25.02.84
108	ETI/OHE/P/2104-1	A	Tube cap 40mm.	10.01.89
109	ETI/OHE/P/2110	B	Standard catenary suspension bracket.	03.06.88
110	ETI/OHE/P/2110-1	D	Standard catenary suspension bracket.	03.06.88
111	ETI/OHE/P/2111	B	Standard catenary suspension bracket bottom.	22.11.85
112	ETI/OHE/P/2112	A	Standard catenary suspension bracket top	05.09.84
113	ETI/OHE/P/2120	B	Standard catenary direct clamp	03.06.88
114	ETI/OHE/P/2121	A	Standard catenary direct clamp top	04.09.84
115	ETI/OHE/P/2122	A	Standard catenary direct clamp bottom	04.09.84
116	ETI/OHE/P/2123	C	Direct catenary clamp grip.	22.11.85
117	ETI/OHE/P/2124	B	Direct catenary clamp stud	03.06.88

118	ETI/OHE/P/2125	B	Bridle wire sleeve.	01.12.88
119	ETI/OHE/P/2130	B	Large catenary suspension bracket.	03.06.88
120	ETI/OHE/P/2130-1	C	Large catenary suspension bracket.	03.06.88
121	ETI/OHE/P/2131	B	Large catenary suspension bracket top.	22.11.85
122	ETI/OHE/P/2132	B	Large catenary suspension bracket bottom.	22.11.85
123	ETI/OHE/P/2140	C	Catenary direct clamp (large)	03.06.88
124	ETI/OHE/P/2141	B	Large catenary direct clamp top.	05.09.84
125	ETI/OHE/P/2142	B	Large catenary direct clamp bottom	22.11.85
126	ETI/OHE/P/2150-1	E	Standard register arm hook	03.06.88
127	ETI/OHE/P/2151-1	C	Register arm hook top	02.05.79
128	ETI/OHE/P/2152-1	C	Register arm hook bottom	02.05.79
129	ETI/OHE/P/2160-1	E	Large register arm hook	03.06.88
130	ETI/OHE/P/2161-1	C	Large register arm hook top	02.05.79
131	ETI/OHE/P/2162-1	C	Large register arm hook bottom	02.05.79
132	ETI/OHE/P/2270-4	E	38mm register arm dropper assembly	07.07.88
133	ETI/OHE/P/2270-5	E	49mm register arm dropper assembly	07.07.88
134	ETI/OHE/P/2274-1	D	Dropper clip (38mm) for standard bracket tube	07.07.88
135	ETI/OHE/P/2277	D	Dropper clip (49mm) for large bracket tube	07.07.88
136	ETI/OHE/P/2340	C	Steady rod	11.03.96
137	ETI/OHE/P/2341	B	Steady rod piece	11.03.96
138	ETI/OHE/P/2345	-	Steady rod eye piece	03.10.72
139	ETI/OHE/P/2345-1	-	Double Vee suspension top eye piece	18.02.66
140	ETI/OHE/P/2352	A	Bent steady arm swivel	11.03.96
141	ETI/OHE/P/2360	L	25mm drop bracket assembly	19.07.

				88
142	ETI/OHE/P/2380	C	Hook bracket	19.07. 88
143	ETI/OHE/P/2390	B	BFB steady arm assembly.	09.05. 79
144	ETI/OHE/P/2391	G	Steady arm hook (BFB)	19.11. 99
145	TI/DRG/OHE/FTGFE /RDSO/00003/00/0	-	Steady arm hook BFB (Forged)	29.09. 00
146	ETI/OHE/P/2392	C	BFB steady arm swivel.	04.04. 90
147	RE/33/P/2400	E	Tubular stay arm	19.08. 66
148	RE/33/P/2401	C	Stay tube (25 mm)	18.06. 66
149	ETI/OHE/P/2402	A	Tubular stay adjuster.	25.09. 72
150	ETI/OHE/P/2402-1	B	Tubular stay adjuster (large)	04.04. 90
151	ETI/OHE/P/2403-1	C	Tubular stay sleeve.	04.03. 05
152	TI/DRG/OHE/FTGFE / RDSO/00004/03/0	-	Tubular stay sleeve (Forged).	17.11. 03
153	ETI/OHE/P/2404	C	Stud bolt (10mm)	08.02. 77
154	ETI/OHE/P/2410	-	25mm register arm dropper assembly.	04.07. 94
155	ETI/OHE/P/2420-1	A	Register arm assembly for mast on platforms.	14.06. 85
156	RE/33/P/2421	C	Register arm tube 25mm	25.02. 84
157	RE/33/P/2422-1	B	Register arm eye piece 25mm	26.08. 88
158	TI/DRG/OHE/FTGFE /RDSO/00002/00/0	-	Register arm eye piece 25mm(Forged)	27.07. 00
159	ETI/OHE/P/2423-1	A	Tube cap 25mm.	10.01. 89
160	RE/33/P/2431	D	Raised register arm tube 25 mm	25.02. 84
161	RE/33/P/2432	E	Raised register arm adjuster 25 mm	11.03. 96
162	ETI/OHE/P/2440	-	38mm register arm dropper assembly	04.07. 94
163	ETI/OHE/P/2450	-	49mm register arm dropper assembly	04.07. 94

				94
164	ETI/OHE/P/2460	E	25mm register arm dropper assembly.	07.07.88
165	ETI/OHE/P/2461-1	F	Dropper clip (34mm) for register arm tube.	07.07.88
166	ETI/OHE/P/2462-1	A	Register arm dropper	19.09.85
167	ETI/OHE/P/2463	A	Register arm dropper loop.	19.09.85
168	ETI/OHE/P/2464	-	Register arm dropper loop (short)	18.03.71
169	ETI/OHE/P/2465	B	Register arm dropper loop.	19.09.85
170	ETI/OHE/P/2470	E	Raised register arm dropper assembly.	07.07.88
171	ETI/OHE/P/2471-1	E	Dropper clip (25) for raised register arm.	07.07.88
172	ETI/OHE/P/2472-1	B	Raised register arm dropper	19.09.85
173	ETI/OHE/P/2480	-	Raised register arm dropper assembly	04.07.94
174	ETI/OHE/P/2490-2	E	25mm steady arm clamp	07.07.88
175	ETI/OHE/P/2520	B	Normal bent steady arm.	11.03.96
176	ETI/OHE/P/2522	B	Normal bent steady arm eye piece.	06.05.86
177	ETI/OHE/P/2523	B	Normal bent steady arm hook.	14.10.92
178	ETI/OHE/P/2540	B	BFB steady arm assembly.	19.08.70
179	ETI/OHE/P/2540-1	-	BFB steady arm assembly for tramway OHE (regulated).	09.06.81
180	ETI/OHE/P/2541	E	BFB steady arm eye piece.	14.10.92
181	ETI/OHE/P/2542	C	BFB steady arm swivel	04.04.90
182	ETI/OHE/P/2550-1/2	L	Standard antiwind clamp.	11.03.96
183	ETI/OHE/P/2550-3	E	Antiwind clamp for tramway type OHE(regulated)	11.03.96
184	RE/33/P/2700	E	Vee suspension assembly	18.09.84
185	RE/33/P/2701	C	Tramway Vee clamp swivel	18.09.84
186	ETI/OHE/P/2710	-	Unequal Vee suspension assembly	04.12.74

187	RE/33/P/2720	B	Double Vee suspension assembly	04.02.66
188	RE/33/P/2721	C	Double Vee suspension top	18.09.84
189	ETI/OHE/P/2730	A	Section insulator support clamp.	18.09.84
190	ETI/OHE/P/2731	A	Section insulator support clamp part.	18.09.84
191	RE/33/P/2750	A	Double 'Vee' adjuster clamp assembly	09.06.66
192	ETI/OHE/P/3010	C	Double clevis assembly.	19.07.88
193	ETI/OHE/P/3021	C	Mast fitting for hook insulator.	04.03.05
194	TI/DRG/OHE/FTGFE/RDSO/00005/04/0	-	Mast fitting for hook insulator(Forged)	12.08.04
195	TI/DRG/OHE/FTGFE/RDSO/00006/05/0	-	Modified BFB Steady arm assembly with 25 mm Drop bracket (ID-2306).	23.12.05
196	ETI/OHE/P/3050	B	Stay arm/bracket chair.	11.03.96
197	RE/33/P/3070	J	Mast bracket fitting assembly	11.03.96
198	RE/33/P/3070-1	H	Mast bracket fitting assembly (150)	19.07.88
199	RE/33/P/3070-2	D	Mast bracket fitting assembly (200)	19.07.88
200	RE/33/P/3071	F	Mast bracket clevis	02.05.79
201	RE/33/P/3071-1	B	Mast bracket clevis (forged)	17.03.64
202	ETI/OHE/P/3072	A	Mast bracket clevis pin.	19.07.88
203	RE/33/P/3073	D	Mast bracket swivel (150)	02.05.79
204	RE/33/P/3074	E	Mast bracket swivel (200)	02.05.79
205	ETI/OHE/P/3076	C	Standard backing angle.	11.3.96
206	RE/33/P/3100	G	Multiple cantilever extension	11.03.96
207	ETI/OHE/P/3110	C	Register arm extension frame.	11.03.96
208	RE/33/P/3120	H	Multiple cantilever cross arm assembly	11.03.96
209	ETI/OHE/P/3121	A	Multiple cantilever cross arm.	01.04.

				91
210	ETI/OHE/P/3122	A	Multiple cantilevers cross arm clamp (200).	11.03.96
211	ETI/OHE/P/3123	A	Multiple cantilevers cross arm clamp (280).	11.03.96
212	ETI/OHE/P/3124	A	Multiple cantilevers cross arm clamp (300).	11.03.96
213	ETI/OHE/P/3131	A	Adopter for single bracket on structures and dropped arm.	11.03.96
214	ETI/OHE/P/3230	C	Anchor fitting assembly on rolled section.	11.03.96
215	ETI/OHE/P/3231	C	Mast anchor fitting (welded)	11.03.96
216	ETI/OHE/P/3231-2	C	Mast anchor fitting (welded) for cement concrete counter weight.	11.03.96
217	ETI/OHE/P/3232	C	Mast guy rod fitting welded.	11.03.96
218	ETI/OHE/P/3233	B	Mast anchor fitting (200)	11.03.96
219	ETI/OHE/P/3234/5	B	Mast guy rod fitting (200)	11.03.96
220	ETI/OHE/P/3236/7	B	Anchor backing angle and spacer	11.03.96
221	ETI/OHE/P/3240	D	Anchor fitting assembly on 'K' series mast, TTC mast 'P' type portal upright	11.03.96
222	ETI/OHE/P/3241-2	B	Anchor fitting assembly on 'K' series mast, TTC mast 'P' type portal upright (for cement concrete counter weight)	11.03.96
223	ETI/OHE/P/3250	D	Anchor assembly on 'N' & 'O' type portal uprights.	11.03.96
224	ETI/OHE/P/3250-A	-	Anchor assembly on 'N' & 'O' type portal uprights with (ISA 150x115x12)	24.05.95
225	ETI/OHE/P/3260	G	Boom anchor assembly on 'N' & 'O type portals	11.03.96
226	ETI/OHE/P/3270	A	Anchor assembly on BFB portal upright	28.09.88
227	ETI/OHE/P/3280	A	Anchor assembly on G Type portal upright	28.09.88
228	ETI/OHE/P/3290	A	Anchor assembly on R Type portal upright	28.09.88
229	ETI/OHE/P/3300	A	Clamps and plates for mounting of number plate on OHE structures.	18.03.86
230	ETI/OHE/P/3310	-	Anchor fitting assembly on K series, TTC masts & P type portal uprights (with ISA 150x115x12).	24.09.93

231	ETI/OHE/P/3320	-	Anchor fitting assembly on TM series masts (with ISA 150x115x12)	10.11.94
232	ETI/OHE/P/3330	-	Clamp and plates for Mounting of number plates (retro- reflective type) on OHE structures.	10.03.98
233	TI/DRG/OHE/FTGNF / RDSO/00001/02/1	-	Terminal clamp (15 mm) compression type.	04.03.05
234	TI/DRG/OHE/FTGNF / RDSO/00002/02/1	-	Terminal clamp (19 mm) compression type.	04.03.05
235	TI/DRG/OHE/FTGNF / RDSO/00003/03/0	-	Feeder splice (150)	25.03.03
236	TI/DRG/OHE/FTGNF / RDSO/00004/03/0	-	Feeder splice sleeve.	25.03.03
237	TI/DRG/OHE/FTGNF / RDSO/00005/03/0	-	Feeder joint socket left.	25.03.03
238	TI/DRG/OHE/FTGNF / RDSO/00006/03/0	-	18mm Bus terminal clamp (Compression type).	27.11.03
239	TI/DRG/OHE/FTGNF / RDSO/00007/06/0	-	Parallel clamp (Dia 20 mm/18.75mm).	01.02.06
240	ETI/OHE/P/4001	A	Span wire clip (65)	10.03.92
241	ETI/OHE/P/4002	A	Span wire clip (130)	10.03.92
242	RE/33/P/4010-1	H	Cross span suspension clamp	28.09.98
243	RE/33/P/4011-1	E	Cross span suspension clamp clevis	01.05.79
244	RE/33/P/4012-1	D	Cross span suspension clamp part	01.05.79
245	RE/33/P/4013-1	C	Cross span suspension clamp crank	16.08.74
246	RE/33/P/4030	E	Steady wire clamp	28.09.88
247	RE/33/P/4031	C	Steady wire clamp part	19.09.84
248	ETI/OHE/P/4036	-	'U' bolt saddle.	30.01.73
249	RE/33/P/4080	D	Head span mast fitting assembly (200 mm)	13.08.74
250	RE/33/P/4090	C	Head span mast fitting assembly (250 mm)	13.08.74

251	RE/33/P/4100	E	Head span mast fitting assembly (300 mm)	28.09.88
252	ETI/OHE/P/4110	C	Head span mast fitting assembly (450 mm)	28.09.88
253	ETI/OHE/P/5000	B	Guy rod assembly	17.05.96
254	ETI/OHE/P/5001/5001-1	D	Anchor bolt	17.05.96
255	ETI/OHE/P/5001-3	C	Anchor bolt	17.05.96
256	ETI/OHE/P/5002	B	Guy rod stirrup.	4.04.90
257	ETI/OHE/P/5004/5/6-1	G	Guy rod dia 25mm.	17.05.96
258	ETI/OHE/P/5007-1	B	Anchor 'V' bolt.	17.05.96
259	ETI/OHE/P/5008	B	Anchor loop.	17.05.96
260	ETI/OHE/P/5011	A	5 tonne buckle	19.09.85
261	ETI/OHE/P/5012	B	5 tonne eye bolt right.	11.04.89
262	ETI/OHE/P/5013	B	5 tonne eye bolt left.	11.04.89
263	ETI/OHE/P/5020	B	9 tonne adjuster	11.04.89
264	ETI/OHE/P/5020-1	-	9 tonne adjuster (eye and clevis type)	09.04.92
265	ETI/OHE/P/5020-2	-	9 tonne adjuster (double clevis type)	24.08.92
266	ETI/OHE/P/5021	A	9 tonne turn buckle.	19.09.85
267	ETI/OHE/P/5022	B	9 tonne eye bolt left	11.04.89
268	ETI/OHE/P/5023	B	9 tonne eye bolt right.	11.04.89
269	ETI/OHE/P/5024	-	9 tonne clevis bolt – Left.	09.04.92
270	ETI/OHE/P/5025	-	9 tonne clevis bolt – Right	24.08.92
271	ETI/OHE/P/5030	C	Anchor double strap assembly.	11.04.89
272	ETI/OHE/P/5040	B	18mm single clevis assembly	11.04.89
273	TI/DRG/OHE/FTGFE/RDSO/00001/00/0	-	18mm single clevis assembly modified	20.07.00

274	ETI/OHE/P/5060-2	C	Standard guide tube assembly.	17.05.96
275	ETI/OHE/P/5064/65/66	B	Details of guide tube attachment for trapezoidal counter weight.	17.05.96
276	ETI/OHE/P/5064-1/64-2	A	Guide tube bracket angle (welded) for attachment on BFB mast and portal (for trapezoidal counter weight).	17.05.96
277	ETI/OHE/P/5090	C	Counter weight assembly.	24.08.00
278	ETI/OHE/P/5090-1	D	Trapezoidal counter weight assembly.	24.08.00
279	ETI/OHE/P/5090-3	F	Counter weight assembly (light).	24.08.00
280	ETI/OHE/P/5090-4	F	Cement concrete counter weight assembly.	17.05.96
281	ETI/OHE/P/5090-5	B	Counter weight assembly for regulating equipment (3:1)	24.08.00
282	ETI/OHE/P/5090-6	B	Counter weight assembly (for tramway type OHE) (1250 kgf)	24.08.00
283	ETI/OHE/P/5091	B	Cast iron base weight.	24.08.00
284	ETI/OHE/P/5092/93	B	Counter weight piece.	24.08.00
285	ETI/OHE/P/5094/95	F	Counter weight piece eye rod	04.04.90
286	ETI/OHE/P/5128	A	Regulating rope and fitting.	10.04.89
287	ETI/OHE/P/5183	C	Double eye distance rod (dia 20mm)	04.04.90
288	ETI/OHE/P/5190-1	C	Compensating plate assembly.	22.07.96
289	ETI/OHE/P/5190-2	C	Equalizing plate assembly.	22.07.96
290	ETI/OHE/P/5191	B	Compensating plate.	22.07.96
291	ETI/OHE/P/5191-1/2	D	Compensating plate.	01.12.94
292	ETI/OHE/P/5192	B	Equalizing plate.	22.07.96
293	ETI/OHE/P/5192-1/2	C	Equalizing plate (for WKRE)	01.12.94
294	ETI/OHE/P/5193	B	Short equalizing plate.	22.07.96
295	ETI/OHE/P/5194-1	-	Compensating plate assembly	01.12.94
296	ETI/OHE/P/5195-2	A	Equalizing plate assembly	26.08.

				96
297	ETI/OHE/P/5220	F	Guy rod double strap assembly.	04.04.90
298	ETI/OHE/P/5221/2	D	Guy rod double strap	04.04.90
299	ETI/OHE/P/5300	H	Regulating equipment (winch type) 5:1 ratio.	26.06.98
300	ETI/OHE/P/5311	B	Drum	25.08.87
301	ETI/OHE/P/5312/15/ 21/31	D	Part detail of regulating equipment (winch type).	22.07.96
302	ETI/OHE/P/5314/16-1/17-1/23/24/33-36	B	Part detail of regulating equipment (winch type.)	22.07.96
303	ETI/OHE/P/5313/32	A	Axles	05.11.84
304	ETI/OHE/P/5318	A	Drum anchor fitting	05.11.84
305	ETI/OHE/P/5319-1	B	Arm anchor fitting	29.11.84
306	ETI/OHE/P/5322	A	Clevis and eye	29.11.84
307	ETI/OHE/P/5341	A	Stainless steel rope end fitting.	05.11.84
308	ETI/OHE/P/5350-1	C	Limiting device for winch type regulating equipment (modified)	26.06.98
309	ETI/OHE/P/5500-1Sh.1	K	Regulating equipment three pulley type (3:1 ratio)	22.07.96
310	ETI/OHE/P/5500-1Sh.2	C	Details of regulating equipment (3:1 ratio)	22.07.96
311	ETI/OHE/P/6000	C	Standard stay arm insulator for clean areas.	28.07.04
312	ETI/OHE/P/6000-2	C	Stay arm insulator (for polluted zone).	28.07.04
313	ETI/OHE/P/6001	A	Stay arm insulator tube cap.	28.07.04
314	ETI/OHE/P/6002	-	Stay arm insulator hook cap.	17.12.79
315	ETI/OHE/P/6003	-	Stay arm insulator hook.	17.12.79
316	ETI/OHE/P/6020	A	Standard 9 tonne insulator for clean areas.	27.05.86
317	ETI/OHE/P/6020-1	C	9 tonne insulator (for polluted zones).	27.05.86
318	ETI/OHE/P/6021	-	9 tonne insulator cap.	17.12.79

319	ETI/OHE/P/6030	B	Standard bracket insulator for clean areas.	27.05.86
320	ETI/OHE/P/6030-1	C	Bracket insulator (for polluted zone).	27.05.86
321	ETI/OHE/P/6031	-	Bracket insulator tube cap.	17.12.79
322	ETI/OHE/P/6032	-	Bracket insulator standard cap.	17.12.79
323	ETI/OHE/P/6060-1	A	Disc insulator assembly (socket type)	03.05.79
324	ETI/OHE/P/6061-1	A	Disc insulator (255mm) (Ball and socket type).	02.06.79
325	ETI/OHE/P/6061-3	A	Disc insulator (255mm) (clevis type)	09.05.79
326	ETI/OHE/P/6068	B	Ball eye.	11.12.92
327	ETI/OHE/P/6069	A	Socket eye	02.05.79
328	ETI/OHE/P/6070	H	3 kV post insulator assembly.	17.05.96
329	ETI/OHE/P/6070-1	-	11 kV post insulator.	22.07.83
330	ETI/OHE/P/6075/6076	C	3Kv pedestal insulator cap clamp.	17.05.96
331	ETI/OHE/P/6090	D	Post insulator assembly (with clamps)	17.05.96
332	ETI/OHE/P/6090-1	C	Standard post insulator for clean areas.	27.05.86
333	ETI/OHE/P/6094	B	Post insulator jumper clamp.	17.05.96
334	ETI/OHE/P/6094-1	A	Post insulator jumper clamp (30mm) for 220 kV traction substations.	17.05.96
335	ETI/OHE/P/6095	B	Post insulator bus bar clamp.	17.05.96
336	ETI/OHE/P/6095-1	A	Post insulator bus bar clamp (50mm) for 220 kV traction substations.	17.05.96
337	ETI/OHE/P/6100	B	Section insulator assembly.	24.05.94
338	ETI/OHE/P/6110	A	Standard sectioning insulator for clean areas.	27.05.86
339	ETI/OHE/P/6120	B	Contact wire end link assembly.	24.05.94
340	ETI/OHE/P/6121	A	Contact wire end link body.	24.05.94
341	ETI/OHE/P/6122-6125	B	Fasteners for section insulator assembly.	24.05.94
342	ETI/OHE/P/6130	A	Section insulator cross beam assembly.	24.05.

				94
343	ETI/OHE/P/6131	A	Cross beam.	24.05.94
344	ETI/OHE/P/6132/33	A	Fasteners for section insulator assembly.	24.05.94
345	ETI/OHE/P/6140	A	Runner assembly.	24.05.94
346	ETI/OHE/P/6141	A	Runner bracket.	24.05.94
347	ETI/OHE/P/6142	A	Runner left.	24.05.94
348	ETI/OHE/P/6143	A	Runner right.	24.05.94
349	ETI/OHE/P/6150	A	Runner end contact wire ending clamp.	24.05.94
350	ETI/OHE/P/6151	A	Runner end contact wire ending clamp part.	24.05.94
351	ETI/OHE/P/6160	A	Insulator end contact wire ending clamp part.	24.05.94
352	ETI/OHE/P/6161	A	Ending clamp part left (107).	24.05.94
353	ETI/OHE/P/6162	A	Ending clamp part right (107)	24.05.94
354	ETI/OHE/P/6170	C	Parallel clamp double contact wire.	24.05.94
355	ETI/OHE/P/6180-1	A	Section insulator dropper assembly (without double strap).	24.05.94
356	ETI/OHE/P/6180-2	A	Section insulator dropper assembly (with double strap).	24.05.94
357	ETI/OHE/P/6181-1	D	Section insulator double strap assembly.	24.05.94
358	ETI/OHE/P/6260	A	Standard operating rod insulator for clean areas.	27.05.86
359	ETI/OHE/P/6310-1	B	(18mm) bus terminal (multiple bolt)	04.03.05
360	ETI/OHE/P/6311-1	B	Bus terminal piece (multiple holes).	23.01.87
361	ETI/OHE/P/6313	-	Bus terminal cone.	18.05.77
362	ETI/OHE/P/6312/6314	A	Bus terminal cone socket and check nut.	23.01.87
363	ETI/OHE/P/6320	A	18mm bus splice.	19.09.84
364	ETI/OHE/P/6321	B	Bus splices body.	23.01.87
365	RE/33/P/6330	C	18 mm bus tee joint	23.01.87

366	RE/33/P/6331	D	Bus tee body	23.01.87
367	RE/33/P/6350	B	18 mm bus terminating tee	24.08.74
368	RE/33/P/6351	B	Bus terminating tee body	26.03.74
369	RE/33/P/6600	B	Double wire section insulator	27.02.74
370	ETI/OHE/P/7000	E	Structure bonds.	04.10.91
371	ETI/OHE/P/7011	-	Copper rivet dia 20x30.	04.01.71
372	ETI/OHE/P/7020	B	Earthing station.	06.01.76
373	ETI/OHE/P/7021	A	Earth electrode.	17.05.96
374	ETI/OHE/P/7030	F	Longitudinal rail bond.	25.10.89
375	RE/33/P/7040	E	Earth wire mast clamp	17.05.96
376	RE/33/P/7050	D	Earth wire strain clamp	17.04.89
377	RE/33/P/7501	F	Typical structure number plate (100 mm size)	19.04.89
378	RE/33/P/7502	C	Typical structure number plate (75 mm size)	19.04.89
379	ETI/OHE/P/7503	E	Typical structure number plate (retro reflective type) 125 mm sizes.	02.03.06
380	ETI/OHE/P/7504	-	Typical structure number plate (125mm size).	25.01.05
381	RE/33/P/7511	B	Typical isolator number plate	01.06.79
382	ETI/OHE/P/7531	C	Caution plate 25000 volts ac.	25.05.88
383	ETI/OHE/P/7541	A	Warning board (caution live wire)	27.02.84
384	RE/33/P/7551	C	General caution notice at entrance to Railway station (Hindi and English)	10.12.84
385	RE/33/P/7561	B	General caution notice for staff (Hindi and English)	27.02.84
386	ETI/OHE/P/7572	B	Dead section caution board (electric engine stop).	17.04.89
387	ETI/OHE/P/7573	A	Dead section caution board (caution unwired turnouts)	27.02.84
388	ETI/OHE/P/7574	B	Dead section caution board (power block working limit).	10.12.84
389	ETI/OHE/P/7575	A	Dead section caution board (danger).	27.02.

				84
390	ETI/OHE/P/7581	A	Caution for running staff (lowering panto)	27.02.84
391	ETI/OHE/P/7582	A	Caution board for running staff (raising panto)	27.02.84
392	ETI/OHE/P/8060	C	Medium super mast assembly.	20.04.79
393	ETI/OHE/P/8061	C	Medium super mast channel.	22.07.96
394	RE/33/P/8081	B	Pedestal insulator support clamp.	22.07.96
395	RE/33/P/8082	C	Pedestal insulator base support	22.07.96
396	ETI/OHE/P/8083/3-1	B	Post insulator base support on portal booms	22.07.96
397	ETI/OHE/P/8083-2	A	Post insulator base support on TTC booms.	22.07.96
398	ETI/OHE/P/8084/85/86	A	Small parts steel works for mounting of 3kkV 11kV/ 25kV post insulator.	22.07.96
399	ETI/OHE/P/8087	A	Insulator mounting channel for connection of RC to track.	22.07.96
400	ETI/OHE/P/8091	A	Clamping plate and channel for connection of RC to rail.	22.07.96
401	ETI/OHE/P/8094/96	A	Supporting plate and wooden block for connection of RC to rail	22.07.96
402	ETI/OHE/P/9031/45	A	Mounting of 25 kV isolator on OHE structures (steel work details)	26.06.69
403	ETI/OHE/P/9047	A	bracket angle for attachment on fabricated mast K150, K175, K200, K225, TTC and P Type portal (for trapezoidal counter wt.).	22.07.96
404	ETI/OHE/P/9048	A	Guide tube bracket angle for attachment on G type portal (for trapezoidal counter wt.).	22.07.96
405	ETI/OHE/P/9049	A	Guide tube bracket angle for attachment on 6" x 6" BFB mast and BFB portal (for trapezoidal counter wt.).	22.07.96
406	ETI/OHE/P/9050/51	A	Guide tube bracket angle for attachment on fabricated mast K150, K175, K200, K225, TTC, P type and G type portal	22.07.96
407	ETI/OHE/P/9052/3/4/5	A	Guide tube support angle for attachment on fabricated mast K150, K175, K200, K225, TTC and on P and G type portal.	22.07.96
408	ETI/OHE/P/9070/1	B	Guy rod 20 mm	13.05.96

409	RE/33/302	B	Gill sans medium letter and figure 3 inch	13.03.62
410	RE/33/347	B	Warning for neutral section	25.02.84
411	RE/33/348	B	Signals at neutral section for electric engines to switch off power	25.02.84
412	RE/33/349	B	Signals at neutral section for electric engines to switch on power	25.02.84
413	TI/DRG/OHE/NS/RDSO/00001/00/01	A	Signals at neutral section.	17.04.02
414	RE/33/350	B	Arrangement for fixing of danger board for limit of carriage watering under OHE	16.10.59
415	RE/33/355	B	Warning for neutral section	25.02.84
416	RE/33/371	-	Men –working board for equipment	23.11.59
417	RE/33/411	-	Caution board for gang men	27.04.60
418	RE/33/436	C	Caution board for special locations	06.12.89
419	RE/33/493	-	General caution notice for staff (English and Orriya)	29.09.69
420	RE/33/527	A	Gillsons letters and figures	02.06.64
421	ETI/OHE/SK/22	-	Profile of grooved contact wire (107 mm^2).	25.06.72
422	ETI/OHE/SK/97	-	Suspension clamp for wolf conductor (without armour rod).	16.06.72
423	ETI/OHE/SK/99	-	Socket Eye.	16.06.72
424	ETI/OHE/SK/101	-	Bird guard.	09.08.72
425	ETI/OHE/SK/102	-	Number plate.	09.08.72
426	ETI/OHE/SK/103	-	Phase plate.	09.08.72
427	ETI/OHE/SK/104	-	Danger notice plate.	09.08.72
428	ETI/OHE/SK/105	-	Circuit plate.	09.08.72
429	ETI/OHE/SK/106	-	Anti climbing device.	09.08.72
430	ETI/OHE/SK/107	-	Earthing detail.	09.08.72
431	ETI/OHE/SK/534	C	Parallel clamp (large) compression type.	05.07.93
432	ETI/OHE/SK/535	B	Jumper clamp (large) compression type.	30.06.

				93
433	ETI/OHE/SK/570	-	Typical arrangement of OHE with insulated copper catenary under over line structures.	18.09.91
434	ETI/OHE/SK/575	A	Parallel clamp (small) compression type.	05.07.93
435	ETI/OHE/SK/576	B	Jumper clamp (small) compression type.	05.07.00
436	TI/DRG/OHE/GUYROD/RDSO/00001/07/0	-	Schedule Anchor Block for B.G. Tracks.	19.11.07
437	TI/DRG/OHE/GUYROD/RDSO/00002/07/0	-	Double Guy Rod arrangement with Anchor block for B.G. track.	19.11.07
438	TI/DRG/OHE/GUYROD/RDSO/00003/07/0	-	Schedule of Anchor Block for B.G. track block cotton soil.	19.11.07
439	TI/DRG/OHE/GUYROD/RDSO/00004/07/0	-	Guy rod dia 25mm.	19.11.07
440	TI/DRG/OHE/FTGEE/RDSO/00007/1010	-	Standard Register Arm hook (O.D.38 mm)	01-01-10
441	TI/DRG/OHE/FTGFE/RDSO/00008/1010	-	Register Arm hook top	01-01-10
442	TI/DRG/OHE/FTGEE/RDSO/00009/1010	-	Register Arm hook bottom	01-01-10
443	TI/DRG/OHE/FTGEE/RDSO/00010/1010	-	Register Arm hook (O.D.49 mm)	01-01-10
444	TI/DRG/OHE/FTGEE/RDSO/00011/1010	-	Register Arm hook top	01-01-10
445	TI/DRG/OHE/FTGEE/RDSO/00012/1010	-	Register Arm hook bottom	01-01-10
446	TI/DRG/OHE/FTGEE/RDSO/00013/1010	-	Mast Bracket swivel (150)	01-01-10
447	TI/DRG/OHE/FTGEE/RDSO/00014/1010	-	Mast Bracket swivel (200)	01-01-10
448	TI/DRG/OHE/FTGEE/RDSO/00015/1010	-	25 mm steady Arm clamp	01-01-10
449	TI/DRG/OHE/FTGEE/RDSO/00016/1010	-	25 mm drop bracket assembly	01-01-10

Chapter - I – OVERHEAD EQUIPMENT

4. GENERAL ARRANGEMENT AND FITTINGS FOR COMPOSITE OHE (ALUMINIUM ALLOY CATENARY AND COPPER CONTACT WIRE)

1	ETI/OHE/G/02121 SH3	-	Schematic arrangement of uninsulated overlap for composite OHE	19.05.79	FOLDE 63
2	ETI/OHE/G/02121	-	Schematic arrangement of uninsulated	04.07.94	FOLDE

	SH5		overlap for composite OHE (Aluminium alloy catenary and copper contact wire)	
3	ETI/OHE/G/02131 SH2	A	Schematic arrangement of insulated overlap for composite OHE	25.09.87
4	ETI/OHE/G/02131 SH4	-	Schematic arrangement of insulated overlap for composite OHE (Aluminium alloy catenary and copper contact wire)	04.07.94
5	ETI/OHE/G/02141 SH2	-	General arrangement of regulated composite OHE at turnouts (overlap and crossed type)	19.05.79
6	ETI/OHE/G/03121 SH2	B	Standard termination of regulated composite OHE to suit different tension of conductor	29.03.84
7	ETI/OHE/G/03121 SH3	A	Standard termination of regulated composite OHE with equal tension (116 mm^2 AAA catenary and 107 mm^2 HDGC contact wire)	01.08.97
8	ETI/OHE/G/05101 SH2	B	In span jumper connection between A1 alloy catenary and copper contact wire	02.06.86
9	ETI/OHE/G/05102 SH2	B	Continuity jumper connection at uninsulated overlap for composite OHE	02.06.86
10	ETI/OHE/G/05103 SH2	B	Connections at turnouts for composite OHE	02.06.86
11	ETI/OHE/G/05104 SH2	B	Potential ignaling connection at insulated overlap and neutral section for composite OHE	02.06.86
12	ETI/OHE/G/05106 SH2	C	Connections at diamond crossing for composite OHE	02.06.86
13	ETI/OHE/G/05121 SH3	-	General arrangement of connection to composite OHE by copper cross feeder.	22.04.94
14	ETI/OHE/G/5122 SH3	-	General arrangement of connection at switching station on double track section for composite OHE by copper cross feeder.	22.04.94
15	ETI/OHE/G/05123 SH3	-	General arrangement of connection at switching station on multiple track section (for composite OHE) by copper cross feeder.	22.04.94
16	ETI/OHE/G/05181 SH2	B	Assembly of section insulator for composite OHE.	24.05.94
17	ETI/OHE/G/00194	-	Adjustment chart for winch type regulating equipment for composite OHE.	27.10.87
18	ETI/OHE/P/1171-1	A	Double suspension clamp body for	26.03.84

			aluminium alloy catenary.	
19	ETI/OHE/P/1770	C	Raised register arm clamp(MCI)	16.02.88
20	ETI/OHE/SK/123	D	Parallel grooved clamp (14/9)	17.02.88
21	ETI/OHE/SK/130	D	Aluminium alloy catenary dropper clip (for all aluminium OHE)	15.06.89
22	ETI/OHE/SK/134	D	Catenary splice (cone type) Al. alloy catenary.	28.07.86
23	ETI/OHE/SK/176	D	Suspension clamp (MCI) for Al. alloy catenary	26.03.84
24	ETI/OHE/SK/205	B	Double suspension lock plate (MCI)	26.03.84
25	ETI/OHE/SK/231	C	Parallel groove clamp (18/14)	10.04.85
26	ETI/OHE/SK/285	C	Crimp type repair sleeve for AAA stranded catenary wire.	01.09.89
27	ETI/OHE/SK/333	D	Catenary dropper Clip assembly ignaling washer	15-06-89
28	ETI/OHE/SK/375	A	Span and stagger chart for composite OHE. (for 75 & 112.5 kgf wind pressure)	05.05.84
29	ETI/OHE/SK/436	B	Envelope type end fitting assembly for All Aluminium alloy stranded catenary wire (size 19/2.79 mm)	04.05.92
30	ETI/OHE/SK/449	-	Dropper schedule for regulated composite OHE equal encumbrances (1400/1400) for 1000/1000 kgf tension.	07.05.84
31	ETI/OHE/SK/450	-	Dropper schedule for uninsulated overlap spans of composite OHE.	07.05.84
32	ETI/OHE/SK/451	-	Dropper schedule for insulated overlap spans of composite OHE	07.05.84
33	ETI/OHE/SK/468	A	Aluminium catenary suspension clamp assembly (MCI)	10.04.85
34	ETI/OHE/SK/469	A'	Double suspension clamp assembly (MCI) for Al. alloy catenary.	10.04.85
35	ETI/OHE/SK/479	-	Dropper schedule for compensated with unequal Encumbrance (1.4/0.9) for composite OHE	12.02.87
36	ETI/OHE/SK/480	-	Dropper schedule for compensated OHE with unequal encumbrance (1.4/0.75) for composite OHE	12.02.87
37	ETI/OHE/SK/591	-	Parallel groove clamp (19/14)	23-03-94

5. **GENERAL ARRANGEMENT FOR LOADING MECHANISM**

1	TI/DRG/OHE/COLLAP/ RDSO/0001/99/0	-	Special bracket for collapsible OHE.	23.
2	TI/DRG/OHE/COLLAP/ RDSO/0002/99/0	-	General arrangement of fixing the special bracket assembly & suspension of contact wire.	23.
3	TI/DRG/OHE/COLLAP/ RDSO/0003/99/0	-	General arrangement of suspension of contact wire (S) from existing bracket assembly of tram-way OHE.	24.
4	TI/DRG/OHE/SWL/ RDSO/0004/08/0	-	Motorised arrangement for collapsing the OHE.	03.
5	TI/DRG/OHE/COLLAP/ RDSO/0005/99/0	-	General arrangement for collapsing the OHE.	26.
6	TI/DRG/OHE/COLLAP/ RDSO/0006/99/0	-	General arrangement of fixing of conduit pipe on special bracket assembly & connection of wire rope.	26.
7	TI/DRG/OHE/SWL/ RDSO/0007/08/0	-	General arrangement of Isolator connection to collapsible OHE.	03.
8	TI/DRG/OHE/COLLAP/ RDSO/0008/99/0	-	Special stay arm insulator for collapsible OHE.	30.
9	TI/DRG/OHE/COLLAP/ RDSO/0009/99/0	-	Special jumper clamp.	30.
10	TI/DRG/OHE/SWL/ RDSO/00010/08/0	-	General arrangement (lay out plan) for the swiveling OHE.	03.

Chapter - II – POWER SUPPLY INSTALLATION

1. **GENERAL ARRANGEMENT OF SUBSTATION, LAYOUT, SWITCHING STATION, BT, REMOTE CONTROL AND EARTHING ARRANGEMENT**

1	ETI/PSI/003	C	Typical location and schematic connection Diagram for a three interrupter switching station.	18.12 84
2	ETI/PSI/004	F	Typical General Arrangement of a three interrupter switching station	31.05 02
3	ETI/PSI/004-1	A	Simplified typical general arrangement of a three interrupter switching station by eliminating double pole isolator.	16.03 98

4	ETI/PSI/005	F	Typical location plan and general arrangement for sectioning and paralleling station.	31.05.02
5	ETI/PSI/005-1	A	Simplified location plan and general arrangement for sectioning and paralleling station by eliminating DP isolator.	16.03.98
6	ETI/PSI/006	E	Typical location plan and general arrangement for a feeding station	03.08.01
7	ETI/PSI/008	A	Outrigger arrangement	08.02 80
8	ETI/PSI/009	A	Typical location plan and general arrangement of a single interrupter switching station.	27.02 75
9	ETI/PSI/009-1	-	Simplified typical general arrangement of single interrupters switching station.	21.03.94
10	ETI/PSI/0010	E	Typical layout of remote control cubical at a switching station.	16.11.88
11	ETI/PSI/0011	-	Typical location plan and general arrangement of a single interrupter feeding station.	24.08.73
12	ETI/PSI/0012	-	Layout and general arrangement of sectioning and paralleling station at Baranagar (Sealdah Divn E.Rly)	08.08.75
13	ETI/PSI/0016	A	General arrangement and terminal connection of 25kv PT type-1 at switching station	10.07.81
14	ETI/PSI/0018	-	Typical location plan and general arrangement for a feeding station.	19.03.84
15	ETI/PSI/0019	-	Typical general arrangement of a four interrupter switching station.	21.03.84
16	ETI/PSI/011	C	Typical general arrangement at a booster transformer station (without cross feeder), Type – I	07.09.80
17	ETI/PSI/011-I	A	Typical general arrangement at a booster transformer station (without cross feeder).	08.01.98
18	ETI/PSI/012	-	Typical general arrangement at a booster transformer station (without cross feeder) Type-II	24.12.70
19	ETI/PSI/013	B	Typical general arrangement at a booster transformer station (with 4- cross feeder), Type-III	30.05.81
20	ETI/PSI/013-I	A	Typical general arrangement at a booster transformer station (with cross feeder).	08.01.98
21	ETI/PSI/014	C	Typical general arrangement at a booster transformer station (with SP isolator and 4-cross feeder). Type-IV	26.05.81
22	ETI/PSI/015	-	Typical general arrangement at a booster transformer station (with 4 cross feeder), Type-V	21.07.75
23	ETI./PSI/016	A	Typical general arrangement at a booster	19.06.

			transformer station (without cross feeder and 42 kV lightning arrester) – Type -VI	86
24	ETI/PSI/017	-	280 kVA Booster transformer station Type – VII	27.11.87
25	ETI/PSI/018	A	General arrangement of 280 KVA Booster transformer station (Type III) with four cross feeder.	18.03.88
26	ETI/PSI/019	-	Typical general arrangement at a booster transformer station (for tramway type OHE)	12.04.94
27	TI/DRG/PSI/TSSLO/RDSO/00001/01/0	-	Typical layout of 132/27 kV traction substation (Type-I). (Letter dated 16.07.2014)	16.07.01
28	TI/DRG/PSI/TSSLO/RDSO/00002/01/0	-	Typical layout of 132/27 kV traction substation (Type – II).	16.01.02
29	TI/DRG/PSI/TSSLO/RDSO/00003/02/0	-	Typical layout of 132/27 kV traction substation (Type-III).	22.02.02
30	TI/DRG/PSI/TSSLO/RDSO/00004/02/0	-	Typical layout of 132/27 kV traction substation (Type-IV) with outgoing feeders and metering facilities.	17.05.02
31	TI/DRG/PSI/TSSLO/RDSO/00005/02/0	-	Typical layout of 132/27 kV traction substation (Type-V).	13.06.02
32	TI/DRG/PSI/TSSLO/RDSO/00006/02/0	-	Typical layout of 132/27 kV traction substation (Type-VI).	09.07.02
33	TI/DRG/PSI/TSSLO/RDSO/00007/02/0	-	Typical layout of 132/27 kV traction substation (Type – VII).	28.08.02
34	TI/DRG/PSI/TSSLO/RDSO/00008/02/0	-	Typical layout of 132/27 kV traction substation (Type-VIII).	27.11.02
35	TI/DRG/PSI/TSSLO/RDSO/00009/02/0	A	Typical layout of 132/27 kV traction substation with single transformer (Type IX).	16.12.02
36	TI/DRG/PSI/TSSLO/RDSO/00010/02/0	G	Typical layout of 132/25 kV traction substation with 132 kV switching station (Type – X).	30.12.02
37	ETI/PSI/022-I	B	Typical layout of 132/25 kV traction substation (Type-II).	23.03.94
38	TI/DRG/PSI/CPROOM/RDSO/00001/01/0	-	Typical layout of control room at traction substation.	20.05.01
39	ETI/PSI/0212-1	-	Typical return current connection to buried rail at 132/25 kV traction substation	26.10.98
40	ETI/PSI/0213	A	General arrangement for 132 kV Railway switching station at Aligarh.	20.03.74
41	ETI/PSI/0215	B	Schematic layouts for different types of 132/25 kV traction substation.	21.09.83
42	ETI/PSI/0216	B	Arrangement for typical outdoor illumination of 132/25 kV traction substation.	12.08.83
43	ETI/PSI/0217	B	Typical arrangement of connection for 25 kV potential transformer with 36 mm O/D aluminium Bus bar.	22.12.79

44	ETI/PSI/0225	C	Typical general arrangement of earth screen wire termination at traction substation.	July 00
45	ETI/PSI/0226	B	Typical terminal arrangement for strung bus 'SPIDER' (AAC) conductor at traction substation.	18.03.94
46	ETI/PSI/0226-I	A	Typical terminal arrangement for strung bus at traction substation with ZEBRA conductor.	18.03.94
47	ETI/PSI/0227	A	General arrangement and terminal connection for 25 kV PT (Type-II) at traction substation.	10.07.81
48	ETI/PSI/0227-I	-	General arrangement and terminal connection for 25 kV PT type-II (protection type) at 220 kV traction substation.	10.06.87.
49	ETI/PSI/0233	-	Typical layout of 132/25kv traction substation showing 25kv feeder for yard / electric loco shed supply.	21.03.84
50	ETI/PSI/0235	A	Typicallayoutof132/25kvTraction substation(with three transformer) Type-1	09.03.90
51	ETI/PSI/0237	-	Typical layout of 132/25kv Traction substation (with three transformers) Type-111.	30.05.86
52	ETI/PSI/0239	-	Typical layout of 132/25kv Traction substation (with three transformers) Type –v	05.06.86
53	ETI/PSI/0240	-	Typical layout of 220/25 kV traction substation Type-I	10.06.87
54	ETI/PSI/0240-1	-	Typical layout of 22o/27kV traction substation type-1	
55	ETI/PSI/0242	A	Typical return current connection to buried rail at 220/25Kv traction substation.	18.11.87
56	ETI/PSI/0243	A	Typical termination arrangement for strung bus (ZEBRA,ACSR) conductor at 220 kV traction substation	18.03.94
57	ETI/PSI/0244	-	Typical general arrangement of earth screen wire termination at 220Kv traction substation	10.06.87
58	ETI/PSI/032	D	25kv drop out fuse assembly.	28.01.86
59	ETI/PSI/035	B	4 Pole 5 way rotary switches for colour light signaling and emergency load.	13.09.91
60	TI/DRG/PSI/AT/ RDSO/00001/02/1	-	Arrangement of Mounting 25Kv/240V, 50 kV LT Supply transformer.	18.01.05
61	ETI/PSI/037	C	Structural details for LT supply transformer T-150	30.09.86
62	ETI/PSI/038	C	25Kv dropout fuses switch details.	29.08.89
63	ETI/PSI/039	B	Operating pole for 25Kv dropout fuse switch.	28.01.86
64	ETI/PSI/0310	-	LV Box assembly for LT supplies transformer	08.05.

			stations.	81
65	ETI/PSI/0312	B	Mounting Arrangement of 100 KVA, 25 kV/240 V LT supply transformer at traction substation.	22.09.89.
66	ETI/PSI/101	B	Structural assembly for a feeding station.	15.02.85
67	ETI/PSI/102	B	Structural assembly for a sectioning and paralleling station.	15.02.85
68	ETI/PSI/103	B	Structural assembly for a three interrupter switching station.	15.02.85
69	ETI/PSI/104	E	Typical fencing and anticlimbing arrangement at switching station.	18.12.84
70	ETI/PSI/105	-	Structural assembly for feeding station (for five cross feeders)	21.03.84
71	ETI/PSI/106	A	Structural assembly for a four interrupter switching station	21.03.84
72	ETI/PSI/111	A	Structural assembly for standard booster transformer station (without cross feeder – Type-I)	11.04.75
73	ETI/PSI/112	B	Structural assembly for a standard booster transformer station (without cross feeder type-II)	02.06.86
74	ETI/PSI/113	A	Structural assembly for a standard booster transformer station (with four cross feeder type-III)	02.06.86
76	ETI/PSI/115	-	Structural assembly for a standard booster transformer station (without cross feeder and 42 kV lightning arrester type – VI)	12.04.84.
77	ETI/PSI/121	F	Typical fencing layout at traction substation (details of fencing panel door ant climbing device etc.)	05.03.91
78	ETI/PSI/201	B	Typical earthing layout of sub sectioning and paralleling station.	28.12.71
79	ETI/PSI/201-I		Typical earthing layout of 25 kV a.c. sub sectioning and paralleling station.	26-10-98
80	ETI/PSI/202	B	Typical earthing layout at a sectioning and paralleling station.	20.12.71
81	ETI/PSI/202-I		Typical earthing layout of 25 kV a.c. sub sectioning and paralleling station.	26-10-98
82	ETI/PSI/203	B	Typical earthing layout of a feeding station.	25.11.71
83	ETI/PSI/204	C	Earthing details for interrupter, LT supply transformer 25kV lightning arrester, PT type-1, S-100 mast, S-101 mast, fencing upright and main mast.	08.07.80
84	ETI/PSI/211-1	A	Typical earthing layout of a booster transformer station.	26.10.98

85	ETI/PSI/212	B	Typical earthing layout at a booster transformer station (with four cross feeder for type -111,1V and V).	21.01.75
86	ETI/PSI/222	A	Typical arrangement of an earth electrode at traction substation.	11.07.75
87	ETI/PSI/222-1		Typical arrangement of an earth electrode	26-10-98
88	ETI/PSI/224	E	Typical earthing, cable trench and foundation layout of 132/25kV traction substation.	01.03.85
89	ETI/PSI/228	A	Typical earthing arrangement for equipments and structures at traction substation.	30.09.82
89	ETI/PSI/229	-	Typical earthing cable trench & foundation layout of 132/25kV traction substation with shunt capacitor bay .	15.12.84
90	ETI/PSI/301	C	Typical cable run layout of a sub sectioning and paralleling station.	18.12.84
91	ETI/PSI/302	C	Typical cable run layout of a sub sectioning and paralleling station.	18.12.84
92	ETI/PSI/303	B	Typical cable run layout of a feeding station.	30.10.80
93	ETI/PSI/323	E	Typical details of cable run at a two transformer traction substation.	21.03.89
94	ETI/PSI/501	C	Typical drawing for a terminal board.	19.02.75
95	ETI/PSI/512	-	HV Bushing 36kV, 630 A with adjustable arcing horn	13.02.79
96	ETI/PSI/513	-	LV Bushing 3.6 kV, 630A.	13.02.79
97	ETI/PSI/514	-	Name, rating and terminal marking plate.	03.02.79
98	ETI/PSI/516	-	Details of transformer bushing/porcelain housing for BTs, PTs, Ats, CTs and Las.	29.10.84
99	ETI/PSI/521	-	Typical general arrangement of 132kV double pole double break isolator with earthing blade assembly	30.05.79
100	ETI/PSI/5211	A	Cast ell type mechanical integral / interlock for 132kV isolator	09.07.81
101	ETI/PSI/5212	B	Scheme of locking /interlocking arrangement of 132kV isolator at traction substation.	17.03.87
102	ETI/PSI/5213	A	General arrangement of 25Kv outdoor type CT.	04.02.81
103	ETI/PSI/5214	B	Scheme of interlocking arrangement for 25 kV circuit breakers at traction substations.	03.10.86
104	ETI/PSI/5215	-	Scheme of interlocking arrangement for 25 kV circuitbreakeratthreetransformer substation.	02.06.86

105	ETI/PSI/611	A	Existing and proposed arrangement for provision of rail links between RC and rail.	11.12.85
106	ETI/PSI/623	B	Typical control desk.	12.08.80
107	ETI/PSI/624	A	Schematic diagram of 132/25 kV traction substation showing scheme of interlocking of circuit breaker and isolators.	24.02.84
108	ETI/PSI/628	A	Typical layout of zonal repair shop for PSI equipment.	17.06.87
109	ETI/PSI/642	A	Miniature lamp 25V, 1W for use in discrepancy switch on the mimic diagram board in remote control center.	16.05.85
110	ETI/PSI/651	-	Layout of 25 kV/415V emergency power supply equipment.	21.04.82
111	ETI/PSI/704-I	-	Traction power supply arrangement for yard/electric loco shed	17.04.90
112	ETI/PSI/709	A	General scheme of supply for 25 kV ac traction system in Mumbai area after conversion from dc to ac.	10.10.01
113	ETI/PSI/708	-	Typical earthing arrangement of an auxiliary transformer.	31.01.94
114	ETI/PSI/SK/344	-	Castel and bolted type lock with common key for 25 kV ac single pole CB/interrupters.	18.03.94
116	TI/GRG/PSI/MOTISO/00002/06/0	-	Typical assembly of 25kV single and double pole Motorized Isolator.	18.08.06
117	TI/DRG/PSI/INTERLOCK/RDSO/00001/06/0	-	Scheme of interlocking arrangement of 25 kV circuit breaker at traction substation for MRVC.	07.08.06

Chapter - II – POWER SUPPLY INSTALLATION

2. GENERAL ARRANGE MENT OF SUBSTATION LAYOUT , SWITCHING STATION , BT, REMOTE CONTROL AND EARTHING ARRANGEMENT FOR 2 X 25KV 'AT' SYSTEM.

1	ETI/PSI/AT/0201	B	Typical layout of 220/2x 25 kV traction substations with scot-connected transformers (for double line section).	18.09.91	FOLDE 21
2	ETI/PSI/AT/0202	-	Typical layout of 132/2x25 traction sub-station with three single phase transformers for single line section (V connection type).	27.10.89	FOLDE 21
3	ETI/PSI/AT/0203	-	Typical layout of 132/2x25 kV traction sub-station with single phase transformer (for single line section)	27.10.89	FOLDE 21

4	ETI/PSI/AT/00101	A	Typical layout for sub-sectioning and paralleling post (SSP) in 2x25 kV 'AT' system (on double track section).	18.09.91
5	ETI/PSI/AT/00102	C	Typical layout for sectioning and paralleling post (SP) in 2x25 kV 'AT' system (on double traction section)	17.02.92
6	ETI/PSI/AT/00103	A	Typical layout for sub-sectioning post in 2x25 kV 'AT' system (on single track section)	18.09.91
7	ETI/PSI/AT/00104	B	Typical layout for sectioning post in 2x25 kV 'AT' system (on single track section).	18.09.91
8	ETI/PSI/AT/00105	-	Typical layout for a Auto transformer post (on double track section)	23.10.90.

Chapter - II – POWER SUPPLY INSTALLATION

3. PROTECTION FOR 2 X 25 kV ' AT' SYSTEM

1.	ETI/PSI/AT/0204 SH-1/4	B	Protection scheme for scot connected transformer (2x 25 kV system).	29.09.93.
2.	ETI/PSI/AT/0204 SH-2/4	B	Differential protection for scot connected transformer (2 x 25 kV system).	29.09.93.
3.	ETI/PSI/AT/0204 SH-3/4	B	Protection scheme for single-phase transformer (2x 25 kV system).	29.09.93.
4.	ETI/PSI/AT/0204 SH-4/4	B	Protection scheme for 2x 25 kV OHE AT TSS.	29.09.93

Chapter - II – POWER SUPPLY INSTALLATION

4.SHUNT CAPACITORS AND PROTECTION FOR 25 Kv ac TRACTION SYSTEM

1	ETI/PSI/024-I	-	Typical schematic diagram of protection for double transformer traction sub-station.	22.04.94.
2	ETI/PSI/0223	E	Typical layout for 25 kV shunt capacitor unit to be installed at 132/25kV traction substation type-I	23.12.97
3	ETI/PSI/0228-I	-	Typical schematic diagram of protection for single transformer traction substation	22.04.94
4	ETI/PSI/0231-I	A	High speed auto-reclosing scheme for feeder circuit breaker at 25 kV traction substation.	18.03.94.
5	ETI/PSI/0232	-	Schematic diagram ofremote	25.07.83.

			controlled flasher arrangement at TSS and OHE masts opposite feeding post.	
6	ETI/PSI/034	A	Schematic power supply diagram for colour light signaling and other loads from 10KVA, 25 kV/240 V LT supply transformer.	04.05.73.
7	ETI/PSI/035-4	-	Out line general arrangement for control & distribution panel for colour light ignaling with automatic change over facility (3 sources) for 25 kV ac traction system.	21.03.07
8	ETI/PSI/325	-	Typical details of cable run at a two transformer traction substation with shunt capacitor.	15.12.84
9	ETI/PSI/326	-	Typical details of cable run at a two transformer traction substation with shunt capacitor.(220 kV)	10.06.87
10	ETI/PSI/642	A	Miniature lamp 25 kV, 1W for use in discrepancy switch on the mimic diagram board in remote control centre.	16.05.85
11	ETI/PSI/644	C	Schematic interconnection diagram for remote control of power gear and supervision of equipment at traction substation.	21.08.89.
12	ETI/PSI/645	C	Schematic interconnection diagram for remote control of power gear and supervision of equipments at controlled station. (SP and SSP).	21.08.89.
13	ETI/PSI/646	A	Miniature lamp 30 V, 40 Ma for use in discrepancy switch of telefonbau make on the mimic diagram board in remote control center.	16.05.81.
14	ETI/PSI/647	-	Control and relay panel for ac traction substation.	20.07.84.
15	ETI/PSI/648	A	Typical layout of remote control center.	30.04.85.
16	ETI/PSI/652	-	Typical layout of remote control center for computer based SCADA system.	06.09.90
17	ETI/PSI/SK/343	-	Typical schematic protection arrangement of shunt capacitor bank at traction substation.	17.02.94.
18	ETI/PSI/702-1	D	General Scheme of supply for 25 kV, 50 Hz, 1 phases traction system.	18.12.97
19	TI/DRG/PSI/RCC/00001/07/0	-	Fixing arrangement of mast Anchor fitting for Antifouling device in three pulleys (MOD) ATD.	

1.	ETI/PSI/P/6480	C	36 mm Aluminium bus terminal.	10.09.86.
2.	ETI/PSI/P/6480-1	A	Expansion type terminal connector suitable for 36 mm aluminum tubular bus bar to suit 25 kV isolator terminal pad.	7.08.86.
3.	ETI/PSI/P/6480-2	-	50 mm Aluminium bus terminal.	04.06.87
4.	ETI/PSI/P/6480-3	A	Expansion type terminal connector suitable for 50 mm aluminum tubular bus bar to suit 25 kV isolator terminal pad.	26.04.88.
5.	ETI/PSI/P/6481	C	36 mm Aluminium bus terminal.	10.09.86.
6.	ETI/PSI/P/6482	C	Clamping piece.	10.09.86
7.	ETI/PSI/P/6482-1	C	Clamping piece for 36 mm flexible bus splice.	14.11.86
8.	ETI/PSI/P/6490	C	36 mm Aluminium bus splice.	10.09.86
9.	ETI/PSI/P/6490-1.	-	50 mm Aluminium bus splice.	04.06.87.
10.	ETI/PSI/P/6491.	B	36 mm Aluminium bus splice body.	07.08.86
11.	ETI/PSI/P/6500.	C	36 mm Aluminium bus Tee connector.	14.12.88
12.	ETI/PSI/P.6500-1.	-	50 mm Aluminium bus tee connector.	04.06.87
13.	ETI/PSI/P/6501	B	36 mm Aluminium bus tee connector body.	10.09.86.
14.	ETI/PSI/P/6510	D	36 mm Aluminium tee terminal.	10.09.86
15.	ETI/PSI/P/6510-1	-	50 mm Aluminium tee terminal.	10.06.87
16.	ETI/PSI/P/6511	C	36 mm Aluminium tee terminal body.	07.08.86
17.	ETI/PSI/P/6520	B	36/15 mm taps connector.	07.08.86.
18.	ETI/PSI/P/6521.	B	36/15 mm taps connector body.	07.08.86.
19.	ETI/PSI/P/6523	B	Clamping piece (small).	10.09.86.
20.	ETI/PSI/P/6530	C	36/20 mm terminal connector.	07.08.86.
21.	ETI/PSI/P/6531	D	36/20 mm terminal connector body.	13.01.

				87
22.	ETI/PSI/P/6540	A	Terminal connector for 25 kV PT with 36 mm Aluminium bus bar.	07.02.79
23.	ETI/PSI/P/6541	B	36 mm Aluminium bus bar connector body.	
24.	ETI/PSI/P/6550	B	36 mm Aluminium flexible bus splice.	13.11.86
25.	ETI/PSI/P/6550-1	-	50 mm Aluminium flexible bus splice.	22.05.87
26.	ETI/PSI/P/6551	C	36 mm Aluminium bus junction connector body.	13.11.86
27.	ETI/PSI/P/6552	C	36 mm Aluminium bus double sliding body.	13.11.86
28.	ETI/PSI/P/6553	C	Flexible joint.	13.11.86
29.	ETI/PSI/P/6560	B	36 mm Aluminium bus splice cum tee connector.	10.09.86
30.	ETI/PSI/P/6561	B	36 mm Aluminium bus splice cum tee connector body.	10.09.86.
31.	ETI/PSI/P/6570	F	Flexible connector for 25 kV circuit breaker, 25 kV interrupter and 25 kV side of 13.5/20 MVA traction transformer.	18.11.86.
32.	ETI/PSI/P/6580	B	36/20 mm taps connector.	07.08.86
33.	ETI/PSI/P/6580-1	-	50/20 mm taps connector.	04.06.87.
34.	ETI/PSI/P/6581	B	36/20 mm taps connector body.	07.08.86
35.	ETI/PSI/P/6590	B	20 mm Aluminium bus bar tee connector	07.08.86
36.	ETI/PSI/P/6591	B	20 mm Aluminium bus bar tee connector body.	07.08.86.
37.	ETI/PSI/P/6592	D	Clamping piece for 20 mm spider connector.	10.09.86.
38.	ETI/PSI/P/6800	F	Bimetallic terminal connector for 30 mm copper terminal stud and 20 mm spider AAC (RIGID TYPE).	10.09.86
39.	ETI/PSI/P/6830	F	Terminal connector suitable 20 mm spider 'AAC' with terminal pad of 132 kV of isolator and 132 kV MOCB.	07.08.86
40.	ETI/PSI/P/6830-1	D	Terminal connector for aluminum conductors (Bolted type).	08.05.90
41.	ETI/PSI/P/6830-2	A	Terminal connector suitable for 20 mm GOAT "ACSR" with terminal of 22 kV vacuum circuit breaker.	07.08.86
42.	ETI/PSI/P/6831	D	Connector body for 20 mm "AAC" spider conductor.	10.09.86.

43.	ETI/PSI/P/6841	D	Connector body for 30 mm copper terminal stud.	12.09.86	
44.	ETI/PSI/P/6842	D	Clamping piece for 30 mm dia terminal stud.	10.09.86	
45.	ETI/PSI/P/6850	D	Flexible bimetallic terminal connector assembly for 25 kV/100 KVA booster transformer.	10.09.86.	
46.	ETI/PSI/P/6850-2	B	Flexible bimetallic terminal connector assembly for 25 kV/280 KVA, 500 A. Booster transformers.	30.09.92	
47.	ETI/PSI/P/6851	C	Tapped terminal clamp (for 25Kv/100 KVA booster transformer).	06.08.86	
48.	ETI/PSI/P/6860	C	Rigid and flexible bimetallic terminal connector for 25 kV current transformers.	12.09.86.	
49.	ETI/PSI/P/6096	B	Sliding clamp for 36 mm O/D Aluminium bus bar.	07.08.86	
50.	ETI/PSI/P/6096-1	-	Sliding clamp for 50 mm O/D Aluminium bus bar.	22.05.87.	
51.	ETI/PSI/P/7520	B	Typical number plate for interrupter and double pole isolator	23-11-71	
52.	ETI/PSI/P/7521	B	Typical number plate for potential transformer type-I	23-11-71	
53.	ETI/PSI/P/7522	B	Typical number plate for booster transformer	23-11-71	
54.	ETI/PSI/P/7523	-	Typical number plate for circuit breaker	04-03-74	
55.	ETI/PSI/P/7524	-	Caution plate 132000 Volts	29-05-74	
56.	ETI/PSI/P/7525	-	Typical number plate for auxiliary transformer	20-01-78	
57.	ETI/PSI/P/7526	-	Typical number plate for power transformer at traction sub station	15-05-80	
58.	ETI/PSI/P/7526-1	-	Typical number plate for auto transformer	08-11-89	
59.	ETI/PSI/P/7527	A	Typical number plate for potential transformer at traction sub station	06-05-81	
60.	ETI/PSI/P/7528	A	Typical number plate for current transformer at traction sub station	06-05-81	
61.	ETI/PSI/P/7529	A	Typical number plate for isolator at traction sub station	06-05-81	
62.	TI/DRG/PSI/3LTSS/RDSO/00001/07/1	A	Typical schematic diagram for TSS, FP, SSP & SP with 30 MVA Transformer for three (3) line.	05.08.08	
63.	TI/DRG/PSI/4LTSS/RDSO/00001/07/1	A	Typical schematic diagram for TSS, FP, SSP & SP with 30 MVA Transformer for four (4) lines.	05.08.08	

1.	ETI/PSI/P/11010	C	Bimetallic terminal connector to suit 'ZEBRA' ACSR conductor and 30 dia copper stud of CT/CB/traction power transformer.	12.09.91
2	ETI/PSI/P/11020	E	Details of expansion bimetallic terminal connectors suitable for 50 dia Aluminum tubular bus bar to 60 dia copper copper stud of 25 kV CT.	04.10.90
3	ETI/PSI/P/11030	C	Bimetallic terminal connector to suit "ZEBRA" (28.58 dia) ACSR conductor and aluminum/copper pad of isolator/CT/BT (for 220 kV system).	03.02.89
4	ETI/PSI/P/11040	C	Tee connector to suit" ZEBRA" (28.58 dia) ACSR conductor on both ways for (220 kV system).	03.02.89
5	ETI/PSI/P/11050	C	Rigid connector on S.I. to suit "ZEBRA" (28.58 Dia) ACSR conductor (for 220 kV system).	17.02.89
6	ETI/PSI/P/11060	E	Details of expansion type terminal connector to suit 50 dia Aluminum tubular bus bar to terminal pad of 25 kV CT/isolator/CB and interrupter.	10.04.90
7	ETI/PSI/P/11070	B	Details of rigid type bimetallic terminal connector suitable for 50 dia aluminum tubular bus bar to suit 30 dia copper stud of 25 kV current transformers.	03.02.89
8	ETI/PSI/P/11080	B	Details of rigid type terminal connector suitable for 50 dia aluminum tubular bus bar to suit 60 dia copper stud of 25 kV current transformers.	03.02.89
9	ETI/PSI/P/11090	C	Rigid type bimetallic connector suitable for 50 dia aluminum tubular bus bar to terminal pad of 25 kV isolator/CT.	03.02.89
10	ETI/PSI/P/11100	E	Details of expansion type bimetallic terminal connector suitable for 50 dia aluminum tubular bus bar to suit 30 dia copper studs of 25 kV CT/BT/Traction power transformer.	04.10.90
11	ETI/PSI/P/11110	C	Rigid through connector to suit 50 dia aluminum tubular bus bar and	04.10.90

			"SPIDER" AAC conductor for 25 kV PT type II.	
12	ETI/PSI/P/11120	C	Detail of rigid terminal connector suitable for 20 dia aluminum conductor to terminal pad of 25 kV PT type-I and type-II.	03.02.89
13	ETI/PSI/P/11130	B	Inter connector suitable for 50 O/D aluminum tube and "SPIDER" AAC conductor (for 25 kV PT type-I).	03.02.89
16	ETI/PSI/P/11160	B	Tee connector to suit 50 O/D aluminum tube to 36 O/D aluminum tube (for 25 kV systems).	03.02.89
17	ETI/PSI/P/11170	C	Tee connector to suit 50 O/D aluminum bus bar and 15 O/D cadmium catenary (for 25 kV systems).	**03.02.89**
18	ETI/PSI/P/11180	B	Rigid bus splices connector to 50 O/D aluminum tube on both ways (for 25 kV systems).	03.02.89
19	ETI/PSI/P/11190	C	Sliding clamp for 50 mm O/D aluminum bus bar (For 25 kV systems).	03.02.89
20	ETI/PSI/P/11200	C	Rigid type connector on S.I. to suit 50 O/D aluminum bus bar (for 25 Kv systems).	17.02.89
21	ETI/PSI/P/11210	D	Expansion bus coupler on S.I. to 50 O/D aluminum tube (for 25 kV systems).	04.10.90
22	ETI/PSI/P/11220	D	Expansion type terminal connector for 25 kV, 60 mm dia. Terminal stud for traction power transformer.	12.09.91
23	ETI/PSI/P/11230	C	Expansion type terminal connector for 25 kV, 30 mm dia. Terminal for traction power transformer.	04.10.90
24	ETI/PSI/P/11240	C	Tee connector to suit 36 mm O/D aluminum bus bar to 50 mm O/D aluminum bus bar.	04.10.90

Chapter - III – CIVIL

1. OHE MAST (STEEL)

1.	ETI/C/0018-2	D	9.5 m standard traction mast (fabricated 'K' series)	14.08.91
2.	ETI/C/0071	E	9.5 m standard traction mast (fabricated with batten plates) 'B' series.	14.08.91

3.	ETI/C/0072 SH1	-	Emergency OHE mast on sleeper General arrangement	23.11.82
4.	ETI/C/0072 SH2	A	Emergency OHE mast on sleeper Detail of top middle and bottom parts	06.03.91
5.	ETI/C/0072 SH3	B	Emergency OHE mast on sleeper (details of base connection)	05.03.91
6.	ETI/C/0073	A	Dimension of bolts, nuts and lock nuts for 25kV ac traction.	08.04.93
7.	ETI/C/0074	A	16 Dia J Bolts for 25 KVA ac traction	02.02.89
8.	ETI/C/0075	-	Washers and split pin for 25 kV ac traction	07.10.87
9.	ETI/C/0078 SH1	-	9.5 m long standard traction masts (fabricated with batten plate) 'TM' series.	29.09.93
10.	ETI/C/0078 SH2	-	9.5 m long standard traction masts (fabricated with batten plate) 'TM' series (weight schedule)	29.09.93
11.	Ti/DRG/CIV/B-MAST / RDSO/00001/08/0	-	10.850 m. long standard traction mast (Fabricated with batten plates) ``B" Series	08.04.08

Chapter - III - CIVIL
2) OHE PORTALS, TTC, DROP ARMS AND SPS

1.	ETI /C/0004 SH 1	A	'N' type portal short upright. NUS1 - 9.945 m long for RL platform	04.03.91
2.	ETI/C/0004 SH2	C	'N' type portal short upright. NUS2 - 9.490 m long for LL platform	04.03.91
3.	ETI/C/0004 SH3	A	'N' type portal short upright. NUS3 - 9.185 m long for HL platform	4.03.91
4.	ETI/C/0004 SH4	A	'N' type portal short upright. NUS4 - 8.880 m long for Goods platform	4.03.91
5.	ETI /C/0006/68	A	Black weight of 'G' type portal	8.12.74
6.	ETI/C/0008 SH1	A	Standard 'N' type portal (rod laced), General arrangement	6.08.88
7.	ETI/C/0008 SH2	B	Standard 'N' type portal (rod laced) ,Details of upright	4.03.91
8.	ETI/C/0008 SH3	C	Standard 'N' type portal (rod laced), Details of end piece of top boom (length 5380 mm)	4.03.91
9.	ETI/C/0008 SH3A	B	Standard 'N' type portal (rod laced) , Details of end piece of top boom (length 5880 mm)	4.03.91
10.	ETI/C/0008 SH4	B	Standard 'N' type portal (rod laced), Details of central piece of top boom (length 1.5,3.0,4.5, 6.0,7.5&9.0m)	4.03.91
11.	ETI/C/0008 SH5	C	Standard 'N' type portal (rod laced) , Details of splicing and cover angles	4.03.91
12.	ETI/C/0008 SH6	A	Standard 'N' type portal (rod laced) , Details of knee bracing	4.03.91
13.	ETI/C/0009/69 SH1	B	Two track cantilever structure General arrangement	1.05.89
14.	ETI/C/0009/69 SH2	C	Two track cantilever structure Details of upright	4.03.91
15.	ETI/C/0009/69 SH3	B	Two track cantilever structure Details of knee plate	4.03.91
16.	ETI/C/0009/69 SH4	C	Two track cantilever structure Details of 5.5 m boom	4.03.91
17.	ETI/C/0009/69 SH5	C	Two track cantilever structure Details of 8.0 m boom	4.03.91
18.	ETI/C/0011/69 SH1	C	Standard 'R' type portal (rod laced).General arrangement	6.08.88
19.	ETI/C/0011/69 SH2	C	Standard 'R' type portal (rod laced).Details of upright	4.03.91
20.	ETI/C/0011/69	D	Standard 'R' type portal (rod	4.03.91

	SH3		laced).Details of end piece of top boom (length 11.6 & 12.1 m)'	
21.	ETI/C/0011/69 SH4	C	Standard 'R' type portal (rod laced).Details of central piece of top boom (length 7.5,9.0,10.5,12.0&13.0 m)	4.03.91
22.	ETI/C/0011/69 SH5	B	Standard 'R' type portal (rod laced).Details of splicing and cover angle.	4.03.91
23.	ETI/C/0011/69 SH6	C	Standard 'R' type portal (rod laced).Details of knee bracing.	4.03.91
24.	ETI/C/0013/69 SH1	E	Standard arrangement of supporting cantilever on the boom of portals and TTC (general arrangement)	2.12.94
25.	ETI/C/0013/69 SH2	D	Standard arrangement of supporting cantilever on the boom of portals and TTC (SPS details for conventional OHE)	2.12.94
26.	ETI/C/0013/69 SH3	-	Standard arrangement of supporting cantilever on the boom of portals and TTC (for tramway type OHE)	2.12.94
27.	ETI/C/0017 SH1	A	General arrangement standard 'O' type portal (rod laced)	5.08.88
28.	ETI/C/0017 SH2	B	etails of upright standard 'O' type portal (rod laced)	4.03.91
29.	ETI/C/0017 SH3	B	Details of end piece of top boom (length 10548 & 11048 mm) standard 'O' type portal (rod laced)	4.03.91
30.	ETI/C/0017 SH4	B	Detail of central piece of top boom (length 1.5, 3.0,4.5, 6.0, 7.5 & 9.0 m) standard 'O' type portal (rod Laced)	4.03.91
31.	ETI/C/0017 SH5	C	Details of splicing and cover angles standard 'O' type Portal (rod laced)	4.03.91
32.	ETI/C/0017 SH6	A	Details of knee bracing standard 'O' type portal (rod laced)	4.03.91
33.	ETI/C/0019/70 SH1	A	Three legged 'N' type portal (rod laced), general arrangement	6.08.88
34.	ETI/C/0019/70 SH2	A	Details of central upright. Three legged 'N' type portal (rod laced).	4.03.91
35.	ETI/C/0026 SH-1	C	Special ' BFB ' portal for 5 tracks. General arrangement..	5.08.88
36.	ETI/C/0026 SH-2	B	Special ' BFB' portal for 5 tracks. Details of upright.	4.08.98
37.	ETI/C/0026 SH-3	A	Special ' BFB' portal for 5 tracks. Details of end piece of top boom (length 8.5 and 9.0 m)	4.03.91
38.	TI/C/0026 SH-4	A	Special ' BFB' portal for 5 tracks. Details of knee bracing.	4.03.91

39.	ETI/C/0027 SH-1	B	Three legged 'BFB' portal, General arrangement	4.08.98
40.	ETI/C/0027 SH-2	B	Three legged 'BFB' portal. Details of central upright.	4.08.98
41.	ETI/C/0048	B	Standard 'P' type portal, general arrangement and details ofupright and end piece	4.03.91
42.	ETI/C/0052	-	Black weight of 'N' type portal	0.06.74
43.	ETI/C/0053	-	Black weight of 'O' type portal	2.07.74
44.	ETI/C/0056	C	Standard 'G' type portal upright and end piece	3.08.91
45.	.ETI/C/0064	-	Standard portals (N,O,R,P,G, & double BFB type)	2.04.80
46.	ETI/C/0076	C	Standard arrangement of supporting cantilevers on the boom of the portals and TTC (To avoid bird nesting).	2.12.94
47.	ETI/C/0077 SH-1	-	Two track cantilever structure (TTC-17) General arrangement	3.06.90
48.	ETI/C/0077 SH-2	A	Two track cantilever structure (TTC-17) ,Details of upright	4.03.91
49.	ETI/C/0077 SH-3	A	Two track cantilever structure (TTC-17), Details of boom	4.03.91
50.	ETI/C/0077 SH-4	A	Two track cantilever structure (TTC-17), Details of knee plate	4.03.91
51.	ETI/C/0077 SH-5	A	Two track cantilever structure (TTC-17), SPS details.	4.03.91
52.	ETI/C/0079 SH-1	-	OUS1 'O' type portal short upright of length 10.035 m (For Rail level passenger platform only).	04.07.94
53.	ETI/C/0079 SH-2	-	OUS2 'O' type portal short upright of length 9.58 m or low level passenger platform only).	4.07.94
54.	ETI/C/0079 SH-3	-	OUS3 'O' type portal short upright of length 9.275 m (For high level passenger platform).	4.07.94
55.	ETI/C/0079 SH-4	-	OUS4 'O' type portal short upright of length 8.97 m (For goods platform).	4.07.94
56.	TI/DRG/CIV/PORTAL/RDSO/00001/05/0 Sh-1	-	General arrangement for special portal or clear span of 440 m to 60 m for 3 Nos. D line for Chitpur Terminal of Eastern Railway.	7.06.05

57.	TI/DRG/CIV/PORTAL /RDSO/00001/05/0 Sh-2	-	Details of special end piece (SE) for pecial portal for Clear span of 40m to 60m for 3 Nos. DD ne for Chitpur Terminal of Eastern Railway Nominal length 12.63m and 13.13).	07.06.2005	FOLDE 7
58.	TI/DRG/CIV/PORT AL/RDSO/00001/05/ 0 Sh-3	-	Details of special Boom (SB) for special ortal for Clear span of 40m to 60m for 3 Nos. DD ne for Chitpur Terminal of Eastern Railway Nominal length 6.0m,7.5m,9.0m,10.5m,12.0m & 3.0m).	7.06.05	FOLDE 7
59.	TI/DRG/CIV/PORT AL/RDSO/00001/05/ 0 Sh-4	-	Details of cover angle for special portal Or Clear span of 40m to 60m for 3 Nos. DD ne for Chitpur Terminal of Eastern Railway.	7.06.05	FOLDE 7
60.	TI/DRG/CIV/ HGAUGE/RDSO/ 00001/05/0	-	Standard plan Height Gauge for level rossing (for clear Span up to 7.3m) Details of structure nd foundation.	8.03.06	FOLDE 7
61.	TI/DRG/CIV/ HGAUGE/RDSO/ 00001/05/0	-	Standard plan Height Gauge for level rossing (for clear Span above 7.3m up to 12.2m) Details of structure and foundation.	8.03.06	FOLDE 7

Chapter - III - CIVIL

3. STRUCTURAL LAYOUT, STRUCTURES AND FOUNDATIONS FOR TRACTION SUB STATION.

1.	ETI/C/0200 SH-1	H	Structural layout 132/25 kV traction substation (Type I to VI).	15.05.01	FOLDE 8
2.	ETI/C/0200 SH-2	D	Structural layout 132/25 kV traction substation (Type VII to X).	15.05.01	FOLDE 8
3.	ETI/C/0201	D	Details of beam B/1.	15.05.01	FOLDE 8
4.	ETI/C/0202	H	Details of tower T1.	15.05.01	FOLDE 8
5.	ETI/C/0203	G	Details of tower T2.	06.03.91	FOLDE 8
6.	ETI/C/0204	E	Extension of tower T1.	06.03.91	FOLDE 8
7.	ETI/C/0205	E	Extension of tower T2.	05.03.91	FOLDE

8.	ETI/C/0206	D	Foundation and stub details for towers T1 & T1 extension.	05.03.91
9.	ETI/C/0207	D	Foundation and stub details for towers T2 & T2 extension.	04.03.91
10.	ETI/C/0208	E	Details of beam B/2 & column C/1 for 132/25 kV station.	05.03.91
11.	ETI/C/0210	F	Typical cable trench and foundation layout of 132/25 kV traction substation (Trench cover improved).	06.03.91
12.	ETI/C/0211	B	Foundation and stub details of towers T1 extension and T2 extension for 132/25 kV type VI substation only.	05.03.91
13.	ETI/C/0213	D	Details of baffle wall at traction substation in zones of wind pressure 112.5 and 75 kgf/m2.	03.09.84
14.	ETI/C/0214	B	Details of RCC Baffle wall at traction substations in zones of wind pressure 150 kgf/m2.	03.09.84
15.	ETI/C/0216	B	Transformer oil drainage arrangement at substation.	11.11.88
16.	ETI/C/0217 SH-1	C	Lifting frame for 13.5 MVA transformer core in traction substation, General arrangement	06.03.91
17.	ETI/C/0217 SH-2	C	Lifting frame for 13.5 MVA transformer core in traction substation, Small part steel works.	06.03.91
18.	ETI/C/0217 SH-3	B	Lifting frame for 13.5 MVA transformer core in traction substation. Small part steel works& Lifting hook details.	05.03.91
19.	ETI/C/0217 SH-4	A	Lifting frame for 13.5 MVA transformer core in traction substation. Details of pavement and drains.	19.11.84
20.	ETI/C/0219	-	Part layout of foundation and cable trench for 25 kV feeder bay for yard/electric loco shed.	01.05.86
21.	ETI/C/0220	-	Part layout of foundation and cable trench for shunt capacitor bay.	29.04.86
22.	ETI/C/0222	-	Line diagram of structural layout of 220/25 kV traction substation.	18.06.87
23.	ETI/C/0222-I	-	Structural layout of 220/27 kV traction substation (Type-I).	26.05.97
24.	ETI/C/0223	A	Typical cable trench layout of 220/25 kV traction substation.	01.07.88
25.	ETI/C/0223-I	-	Layout of typical cable trench 220/27 kV traction substation (type-I).	26.05.97
26.	ETI/C/0224	A	Details of beam B/4 for 132/25 kV	05.03.91

			traction substation.	
27.	ETI/C/0225 SH-1/2	-	Control room for traction substation.	17.08.88
28.	ETI/C/0225 SH-2/2	-	Control room for traction substation RCC Details.	04.08.88
29.	ETI/C/0226	-	Foundation for towers T1 and T1 Extension for 132/25 kV traction substation (For ZEBRA conductor).	01.08.88
30.	ETI/C/0227	-	Foundation for towers T2 and T2 Extension for 132/25 kV traction substation (For ZEBRA conductor).	01.08.88
31.	ETI/C/0228	-	Foundation for towers T1 Extension and T2 Extension for 132/25 kV (type VI substation for ZEBRA conductor).	01.08.88
32.	ETI/C/0300	E	Details of structure for 132 kV potential transformers.	06.03.91
33.	ETI/C/0310	G	Details of structure for 132 kV double poles Isolator.	05.03.91
34.	ETI/C/0320	E	Details of structure for 132 kV support insulator.	05.03.91
35.	ETI/C/0330	F	Details of structure for 132 kV current transformers.	05.03.91
36.	ETI/C/0340	F	Details of structure for 120 kV lightning arrester.	06.03.91
37.	ETI/C/0350	E	Details of structure for 132 kV triple pole Isolator	06.03.91
38.	ETI/C/0360	F	Details Of structure for 25 kV current transformer	06.03.91
39.	ETI/C/0370 SH-1.	J	Details of structure for 42 kV 10 kA lightning arrester and 25 kV support insulator.	05.03.91
40.	ETI/C/0370 SH-2	-	Black weight of structure for 42 kV 10 kA lightning arrester and 25 kV support insulator.	26.09.89
41.	ETI/C/0380	F	Details of structure for 25 kV single poles Isolator.	05.03.91
42.	ETI/C/0390	E	Details of structure for 25 kV potential transformers.	05.03.91
43.	ETI/C/0400	G	Details of structure for 132 kV double and triple poles MOCB.	05.03.91
44.	ETI/C/0410	B	Details of structure for 3000 kVA shunt capacitors.	06.03.91
45.	ETI/C/0420	B	Details of mounting structure for 25 kV single phases MOCB type TRE 36.12.	06.03.91
46.	ETI/C/0430	A	Structural details for mounting of 7.5 kV/132 V double pole RVT.	06.03.91

47.	ETI/C/0440	A	Foundation and details of structure for mounting of 100 kVA, 25 kV/230 V LT supply transformer at traction substation	04.03.91
48.	ETI/SK/C/179	A	Details of structure for 66 kV DP Isolator.	05.12.88
49.	ETI/SK/C/180	C	Details of structure and foundation for 25 kV DP Isolator at traction substation.	04.03.91
50.	ETI/SK/C/183	A	Details of structure strengthening for 132 kV CT ,LA and PT.	06.03.91
51.	ETI/SK/C/188	A	Strengthening of mounting structure for 132 kV CT, LA and PT.	05.03.91

Chapter - III - CIVIL

4. STRUCTURES, FENCING AND SPS FOR SWITCHING STATION AND BOOSTER TRANSFORMER

1	ETI/C/0030	F	Drilling schedule for S1 mast.	14.08.98
2	ETI/C/0031	D	Drilling schedule for S2 mast.	14.08.98
3	ETI/C/0033	D	Details of anchor beam for SP, SSP & FP.	05.03.91
4	ETI/C/0034 SH-1	K	Details of SPS for switching station	04.03.91
5	ETI/C/0034 SH-2	B	Details of bracing for switching and BT mast.	04.03.91
6	ETI/C/0034 SH-3	A	Details of SPS for switching station.	04.03.91
7	ETI/C/0036	E	Drilling schedule for 8"x 6"x 35 lbs RSJ masts 8.0 m long for BT station type S4.	14.08.98
8	ETI/C/0037	C	Details of SPS of outrigger for Switching station and BT stations.	05.03.91
9	ETI/C/0038	E	Details of precast cable trench for SWS station.	04.08.88
10	ETI/C/0040	E	Details of SPS for BT station.	04.03.91
11	ETI/C/0042	E	Drilling schedule for S-5 mast (11.4 m long).	14.08.98
12	ETI/C/0043	B	S-100 fabricated mast for Mounting LT supply transformer and dropout fuse switch at Switching station	04.03.91
13	ETI/C/0044	A	S-101 details of mast for Supporting Isolator inside Switching station.	04.03.91
14	ETI/C/0067	B	Details of remote control cubical	04.03.91

			(foundation, RCC slab, building plan and steel door).	
15	ETI/C/0180	C	Drilling schedule for S-3 mast (11.4 m long).	14.08.98
16	ETI/C/0181	C	Drilling schedule for S-6 mast (12.4 m long).	14.08.98
17	ETI/C/0182	C	Drilling schedule for S-7 mast (12.4 m long).	14.08.98
18	ETI/C/0183	C	Drilling schedule for S-8 mast (12.4 m long).	14.08.98
19	ETI/C/0184	C	Drilling schedule for S-9 mast (9.4 m long).	14.08.98
20	ETI/C/0185	C	Employment schedule for Switching station main mast	09.11. 17
21	ETI/C/0186 SH-1	E	General arrangement and details of Fencing panel and gate for Switching station.	04.03.91
22	ETI/C/0186 SH-2	E	Details of Fencing upright and ant climbing device for switching station	10.06.94
23	ETI/C/0187	A	Mounting arrangement for FLASHER on OHE mast.	05.03.91
24	ETI/C/0188-B	D	General arrangement and SPS details for mounting DP Isolator on K-250/ B-250 mast at switching station.	04.03.91
25	ETI/C/0189 SH-1	A	Structural assembly for 280 kVA booster transformer station (without cross feeder and 42 kV lightning arrester).	17.03.88
26	ETI/C/0189 SH-2	B	Details of beam B-100-A for 280 kVA BT support (Span 3.2 m).	05.03.91
27	ETI/C/0189 SH-3	B	Details of top beam B-102/1-A for 280 kVA BT to support insulator and lightning arrester (span 3.2 m).	05.03.91
28	ETI/C/0190	A	Details of beam B-100-B for 280 kVA BT support (span 4.3 m).	06.03.91
29	ETI/C/0191	-	SPS Details for mounting of A.T. on OHE mast (typical).	30.11.92
30	ETI/C/0192 SH-1	A	Typical structural assembly for simplified switching station (3 interrupters)	01.03.94
31	ETI/C/0192 SH-2	-	Typical structural assembly for simplified switching station (3 interrupters). SPS Details.	23.07.93
32	ETI/C/0192 SH-3	A	Typical structural assembly for simplified switching station (3 interrupters).SPS Details.	01.03.94
33	ETI/C/0193 SH-1	-	Typical structural assembly for simplified switching station (Single interrupter)	07.04.94
34	ETI/C/0193 SH-2		Typical structural assembly for simplified	07.04.94

			switching station (Single interrupter) SPS Details.	
35	ETI/C/0194 SH-1		Typical structural assembly for simplified sectioning and paralleling station.	03.01.95
36	ETI/C/0194 SH-2	-	Typical structural assembly for simplified sectioning and paralleling station.(SPS Details).	03.01.95

Chapter - III - CIVIL

5. OHE SUPER MAST AND SPS

1.	ETI/C/P/8010	G	Short super mast assembly.	24.07.89
2.	ETI/C/P/8011	A	Short super mast channel.	05.03.91
3.	ETI/C/P/8012	A	Batten plate (type- I).	05.03.91
4.	ETI/C/P/8013	B	0.8 m super mast cross arm.	05.03.91
5.	ETI/C/P/8014	A	Suspension support angle.	05.03.91
6.	ETI/C/P/8014-1	B	Suspension support angle (modified arrangement).	05.03.91
7.	ETI/C/P/8014-2	B	Suspension support angle.	18.09.98
8.	ETI/C/P/8015	B	1.5 m super mast cross arm.	05.03.91
9.	ETI/C/P/8016	A	Batten plate (type-II).	05.03.91
10.	ETI/C/P/8020	C	Long super mast assembly.	22.08.88
11.	ETI/C/P/8021	A	Long super mast channel.	05.03.91
12.	ETI/C/P/8022	A	2.8 m super mast cross arm.	05.03.91
13.	ETI/C/P/8030	B	Bracket attachment assembly on portal upright (N, O, R, P, G and BFB Type).	22.08.88
14.	ETI/C/P/8031	A	Portal bracket attachment.	05.03.91
15.	ETI/C/P/8032	B	Front clamping angle.	05.03.91
16.	ETI/C/P/8050	C	Super mast assembly on portals.	22.08.88
17.	ETI/C/P/8051	A	Portal super mast.	05.03.91

18.	ETI/C/P/8052/3	A	Base clamping angle for portals.	05.03.91
19.	ETI/C/P/8054	A	Clamping angle for portals.	05.03.91
20.	ETI/C/P/8071	C	Suspension support angles on portals for return conductor.	05.03.91
21.	ETI/C/P/8072/4/6	B	Cross arm (TTC and portals).	05.03.91
22.	ETI/C/P/8073/5/7 -	C	SPS for RC suspension (TTC and portals).	05.03.91
23.	ETI/C/P/8078	A	SPS for RC suspension (TTC and portals).	04.03.91
24.	ETI/C/P/8100	A	Details of special guide bracket angle for cement concrete counter weight.	04.03.91
25.	ETI/C/P/8101	A	Details of guide tube bracket angle for cement concrete counter weight.	04.03.91
26.	ETI/C/P/8102	A	Details of guide tube support angle for cement concrete counter weight.	04.03.91
27.	ETI/C/P/8103	A	Details of special guide tube support angle for cement concrete counter weight.	04.03.91
28.	ETI/C/P/8104	A	Details of guide tube support angle for cement concrete counter weight.	04.03.91
29.	ETI/C/P/8111	A	Portal super mast (for 2 x 25 kV AT system OHE).	04.03.91
30.	ETI/C/P/8112	A	1.3 m Feeder super mast cross arm (for 2 x 25 kV AT systemOHE).	04.3.91
31.	ETI/C/P/8113	A	Feeder super mast channel (for 2 x 25 kV AT System OHE.	04.03.91
32.	ETI/C/P/8114	A	2.3m portal super mast cross arm feeder (for 2 x 25 kV AT System OHE).	04.03.91
33.	ETI/C/P/8115	A	Batten plate type III (for 2x 25 kV AT System OHE).	06.03.91
34.	ETI/C/P/8116	A	Cleat angle (for 2 X 25 kV AT System OHE	04.03.91
35.	ETI/C/P/8117	A	Suspension support angle (for 2 x25 kV AT system OHE).	04.03.91
36.	ETI/C/P/8118	A	Feeder support clamp (for 2 X25 kV AT System OHE).	04.03.91
37.	ETI/C/P/8119 SH-1	-	SPS details for double pole Isolator on mast (for 2 x 25 kV).	20.12.91
38.	ETI/C/P/8119 SH-2	-	SPS details for double pole Isolator on 'N' & 'O' type portals (for 2 x 25 kV).	13.10.92
39.	ETI/C/P/8120 SH-1	-	General arrangement of short super mast assembly for TM series mast.	- 06.07.94
40.	ETI/C/P/8120 SH-	-	Short super mast assembly for TM series	06.07.94

1.	ETI/OHE/G/00125 SH1	A	Employment schedule for cantilever mast regulated OHE Al caty-65and 107-cu cont wire. WP 112.5kgf/m2 -- OHE only.	20.09. 05
2.	ETI/OHE/G/00125 SH2	A	Employment schedule for cantilever mast regulated OHE Al caty-65and 107-cu cont wire. WP 112.5kgf/m2 -- OHE + EW.	20.09. 05
3.	ETI/OHE/G/00125 SH3	A	Employment schedule for cantilever mast regulated OHE Al caty-65and 107-cu cont wire. WP 112.5kgf/m2 -- OHE + RC.	20.09. 05
4.	ETI/OHE/G/00125 SH4	A	Employment schedule for cantilever mast regulated OHE Al caty-65and 107-cu cont wire. WP 112.5kgf/m2 -- OHE + EW + RC.	20.09. 05
5.	ETI/OHE/G/00153 SH1	F	Employment schedule for cantilever mast regulated OHE caty 65/cu and cont 107/cu, WP 112.5 kgf/m2 -- OHE only.	20.09. 05
6.	ETI/OHE/G/00153 SH2	F	Employment schedule for cantilever mast regulated OHE caty 65/cu and cont 107/cu, WP 112.5 kgf/m2 -- OHE + EW.	20.09. 05
7.	ETI/OHE/G/00153 SH3	F	Employment schedule for cantilever mast regulated OHE caty 65/cu and cont 107/cu, WP 112.5 kgf/m2 -- OHE + RC.	20.09. 05
8.	ETI/OHE/G/00153 SH4	E	Employment schedule for cantilever mast regulated OHE caty 65/cu and cont 107/cu, WP 112.5 kgf/m2 --OHE + EW + RC.	20.09. 05
9.	ETI/OHE/G/00154	D	Employment schedule for cantilever mast unregulated OHE caty 65/cu & cont 107/cu WP 112.5 kgf/m2 at 35 degree C and with 28 kgf/m2 at 4 degree C without (EW & RC).	09.08. 85
10.	ETI/OHE/G/00156	D	Employment schedule for OHE masts unregulated OHE without RC and also without EW (WP = 150 kgf/m2 at 10 degree C.	31.03. 77
11.	ETI/C/0700 SH-1	-	Employment schedule for cantilever masts regulated OHE in Gr.40 A for TARE section only (wind 150 kgf/m2) caty.65/cu, cont.107/cu. OHE only.	06.11. 80
12.	ETI/C/0700 SH-2	-	Employment schedule for cantilever masts regulated OHE in Gr.40 A for TARE section only (wind 150 kgf/m2) caty.65/cu, cont.107/cu. OHE+EW.	06.11. 80
13.	ETI/C/0700 SH-3	-	Employment schedule for cantilever masts regulated OHE in Gr.40 A for TARE section only (wind 150 kgf/m2) caty.65/cu, cont.107/cu. OHE+RC.	06.11. 80

14.	ETI/C/0700 SH-4	-	Employment schedule for cantilever masts regulated OHE in Gr.40 A for TARE section only (wind 150 kgf/m2) caty.65/cu, cont.107/cu. OHE+RC+EW.	06.11.80
15.	ETI/C/0700 SH-5	-	Employment schedule for cantilever masts regulated OHE in Gr.40 A for TARE section only (wind 150 kgf/m2) caty.65/cu, cont.107/cu. UNREGULATED OHE only.	06.11.79
16.	ETI/C/0700 SH-6	B	Employment schedule for cantilever masts regulated OHE in Gr.40 A for TARE section only (wind 150 kgf/m2) caty.65/cu, cont.107/cu. Notes. (General)	20.09.05
17.	ETI/C/0701 SH-1	B	Employment schedule for cantilever mast regulated OHE for TARE section, wind 150 kgf/m2 (Gr. 40A) only, caty.115/Al, cont. 107/cu. OHE only.	20.09.05
18.	ETI/C/0701 SH-2	B	Employment schedule for cantilever mast regulated OHE for TARE section, wind 150 kgf/m2 (Gr. 40A) only, caty.115/Al, cont. 107/cu. OHE +EW.	20.09.05
19.	ETI/C/0701 SH-3	B	Employment schedule for cantilever mast regulated OHE for TARE section, wind 150 kgf/m2 (Gr. 40A) only, caty.115/Al, cont. 107/cu. OHE +RC.	20.09.05
20.	ETI/C/0701 SH-4	B	Employment schedule for cantilever mast regulated OHE for TARE section, wind 150 kgf/m2 (Gr. 40A) only, caty.115/Al, cont. 107/cu. OHE +EW+ RC.	20.09.05
21.	ETI/C/0702 SH-1	B	Employment schedule for cantilever mast regulated OHE caty. 65/cu, cont.107/cu (WP 75 kgf/m2). OHE only.	20.09.05
22.	ETI/C/0702 SH-2	B	Employment schedule for cantilever mast regulated OHE caty. 65/cu, cont.107/cu (WP 75 kgf/m2). OHE +EW.	20.09.05
23.	ETI/C/0702 SH-3	B	Employment schedule for cantilever mast regulated OHE caty. 65/cu, cont.107/cu (WP 75 kgf/m2). EW+ RC.	20.09.05
24.	ETI/C/0702 SH-4	B	Employment schedule for cantilever mast regulated OHE caty. 65/cu, cont.107/cu (WP 75 kgf/m2). OHE + EW+ RC.	20.09.05
25.	ETI/C/0702 SH-5	B	Employment schedule for cantilever mast regulated OHE caty. 65/cu, cont.107/cu (WP 75 kgf/m2). Unregulated OHE.	20.09.05
26.	ETI/C/0703 SH-1	A	Employment schedule for cantilever mast regulated OHE caty.115/Al, cont.107/cu (WP 75 kgf/m2) OHE only.	20.09.05
27.	ETI/C/0703 SH-2	A	Employment schedule for cantilever mast	20.09.

			regulated OHE caty.115/Al, cont.107/cu (WP 75 kgf/m2) OHE + EW.	05
28.	ETI/C/0703 SH-3	A	Employment schedule for cantilever mast regulated OHE caty.115/Al, cont.107/cu (WP 75 kgf/m2) OHE + RC.	20.09. 05
29.	ETI/C/0703 SH-4	A	Employment schedule for cantilever mast regulated OHE caty.115/Al, cont.107/cu (WP 75 kgf/m2) OHE + EW + RC.	20.09. 05
30.	ETI/C/0704	B	Employment schedule for Tramway type regulated OHE (WP 75kgf/m2) without EW and without RC.	20.09. 05
31.	ETI/C/0705	B	Employment schedule for Tramway type regulated OHE (WP 112.5 kgf/m2) without EW and without RC.	20.09. 05
32.	ETI/C/0706	B	Employment schedule for Tramway type regulated OHE (WP 150 kgf/m2) without EW and without RC.	20.09. 05
33.	ETI/C/0707	A	Employment schedule for 8" X 8" X 35 lbs BFB (9.5m long) (WP 150 kgf/m2) for TARE section Gr. 40A only.(Cu OHE)	20.09. 05
34.	ETI/C/0708	B	Employment schedule for 8" X 8" X 35 lbs BFB (9.5 m long) (WP 112.5 kgf/m2) caty 65/cu and cont 107/cu.	20.09. 05
35.	ETI/C/0709	A	Employment schedule for OHE mast overlap central location with 3.0m implantation ,Caty 65/cu and Cont 107/cu. WP 75 Kgf/m2	08.08. 85
36.	ETI/C/0710	A	Employment schedule for OHE mast (9.5m) overlap central location with 3.0m implantation. Caty 65/cu and Cont 107/cu WP 112.5 kgf/m2.	08.08. 85
37.	ETI/C/0711	A	Employment schedule for OHE mast (9.5m) overlap inter location with 3.0m implantation. Caty 65/cu and Cont 107/cu. WP 75 kgf/m2.	08.08. 85
38.	ETI/C/0712	A	Employment schedule for OHE mast (9.5m) overlap inter location with 3.0m implantation. Caty 65/cu and Cont 107/cu. WP 112.5 kgf/m2.	08.08. 85
39.	ETI/C/0713	B	Employment schedule for 9.5m long 200X200X49.9 kg mast Caty 65/cu and Cont 107/cu, WP 75 kgf/m2.	20.09. 05
40.	ETI/C/0714	B	Employment schedule for 9.5m long 200X200X49.9 kg mast Caty 65/cu and Cont 107/cu, WP 112.5 kgf/m2.	20.09. 05
41.	ETI/C/0715	A	Employment schedule for OHE mast (9.5m) overlap anchor location with 3.0m implantation .Caty 65/cu and Cont 107/cu WP 75 kgf/m2.	08.08. 85

42.	ETI/C/0716	A	Employment schedule for OHE mast (9.5m) overlap anchor location with 3.0m implantation. Caty 65/cu and Cont 107/cu.WP 112.5 kgf/m2.	08.08. 85
43.	ETI/C/0717 SH-1	A	Employment schedule for OHE mast (9.5m) wind pressure 112.5 kgf/m2 for composite OHE (1000+1000) kgf tension. OHE only.	21.09. 05
44.	ETI/C/0717 SH-2	A	Employment schedule for OHE mast (9.5m) wind pressure 112.5 kgf/m2 for composite OHE (1000+1000) kgf tension. OHE + EW.	21.09. 05
45.	ETI/C/0717 SH-3	A	Employment schedule for OHE mast (9.5m) wind pressure 112.5 kgf/m2 for composite OHE (1000+1000) kgf tension. OHE + RC.	21.09. 05
46.	ETI/C/0717 SH-4	A	Employment schedule for OHE mast (9.5m) wind pressure 112.5 kgf/m2 for composite OHE (1000+1000) kgf tension. OHE + EW+RC.	21.09. 05
47.	ETI/C/0718	B	Employment schedule for OHE mast (9.5m) wind pressure 112.5kgf/m2 with 3.0m implantation composite OHE (1000+ 1000) kgf tension. Overlap anchor location.	19.10. 05
48.	ETI/C/0719	B	Employment schedule for OHE mast (9.5m) wind pressure 112.5 kgf/m2 with 3.0m implantation composite OHE (1000 + 1000) kgf tension overlap central location.	19.10. 05
49.	ETI/C/0720	B	EmploymentscheduleforOHEmast (9.5m)wind pressure 112.5kgf/m2 with 3.0m implantation composite OHE (1000 + 1000) kgf Tension . Overlaps inter location.	19.10. 05
50.	ETI/C/0721 SH-1	-	Employment schedule for regulated OHE mast (9.5m) wind pressure 75kgf/m2 for composite OHE (1000+1000) kgf tension. OHE only.	26.08. 86
51.	ETI/C/0721 SH-2	-	Employment schedule for regulated OHE mast (9.5m) wind pressure 75kgf/m2 for composite OHE (1000+1000) kgf tension. OHE + EW	26.08. 86
52.	ETI/C/0721 SH-3	-	Employment schedule for regulated OHE mast (9.5m) wind pressure 75kgf/m2 for composite OHE (1000+1000) kgf tension. OHE + RC	26.08. 86
53.	ETI/C/0721 SH-4	-	Employment schedule for regulated OHE mast (9.5m) wind pressure 75kgf/m2 for composite OHE (1000+1000) kgf tension. OHE+EW+RC	26.08. 86
54.	ETI/C/0722	-	Employment schedule for regulated OHE mast (9.5m)wind pressure 75 kgf/m2 for composite OHE with extra setting distance. Overlap anchor location.	01.09. 86

55.	ETI/C/0723	-	Employment schedule for regulated OHE mast (9.5m) wind pressure 75 kgf/m2 for composite OHE with extra setting distance. Overlap central location.	01.09.86
56.	ETI/C/0725	A	Employment schedule for prestressed spun concrete mast (PC 42) 9.5 m long. Conventional OHE, normal location WP 150, 112.5 and 75 kgf/m2.	14.12.89
57.	ETI/C/0724	-	Employment schedule for regulated OHE mast (9.5m) wind pressure 75 kgf/m2 for composite OHE with extra setting distance. Overlap inters location.	01.09.86
58.	ETI/C/0726 SH-1	-	Employment schedule for OHE mast (9.5m) for wind pressure 150kgf/m2 copper OHE. --OHE only	19.07.88
59.	ETI/C/0726 SH-2	-	Employment schedule for OHE mast (9.5m) for wind pressure 150kgf/m2 copper OHE. --OHE + EW	19.07.88
60.	ETI/C/0726 SH-3	-	Employment schedule for OHE mast (9.5m) for wind pressure 150kgf/m2 copper OHE. --OHE + RC	19.07.88
61.	ETI/C/0726 SH-4	-	Employment schedule for OHE mast (9.5m) for wind pressure 150 kgf/m2 copper OHE. -- OHE + EW + RC.	19.07.88
62.	ETI/C/0727	-	Employment schedule for OHE mast (9.5m) for wind pressure 150kgf/m2 copper OHE, with Higher Implantation. Overlap anchor location.	19.07.88
63.	ETI/C/0728	-	Employment schedule for OHE mast (9.5m) for wind pressure 150kgf/m2 copper OHE, with Higher Implantation. Overlap central location.	19.07.88
64.	ETI/C/0729	-	Employment schedule for OHE mast (9.5m) for wind pressure 150kgf/m2 copper OHE, with Higher Implantation. Overlap inter location	19.07.88
65.	ETI/C/0730 SH-1	-	Employment schedule for OHE mast (9.5m) Wind-112.5 kgf/m2 copper OHE, 1200 kg tensions for high speed 160 km/h. --OHE only.	23.12.88
66.	ETI/C/0730 SH-2	-	Employment schedule for OHE mast (9.5m) Wind-112.5 kgf/m2 copper OHE, 1200 kg tensions for high speed 160 km/h. -- OHE + EW.	23.12.88
67.	ETI/C/0730 SH-3	-	Employment schedule for OHE mast (9.5m) Wind-112.5 kgf/m2 copper OHE, 1200 kg tensions for high speed 160 km/h --OHE + RC.	23.12.88
68.	ETI/C/0730 SH-4	-	Employment schedule for OHE mast (9.5m) Wind-112.5 kgf/m2 copper OHE, 1200 kg tensions for high speed 160 km/h. --OHE + EW + RC.	23.12.88
69.	ETI/C/0730-1	-	Employment schedule for OHE mast (9.5 m)	23.12.

			W.P. 112.5 Kgf/m2copper OHE (1200 + 1200) caty.65 mm2, cont.107mm2 (for high speed 160Kmph) overlap anchor location with 3:1 regulating equipment.	93
70.	ETI/C/731	-	Employment schedule for OHE mast (9.5m) Wind-112.5 kgf/m2, copper OHE, with 1200 kg tensions, with Higher Implantation for high speed 160 km/h. overlap inter location.	23.12. 88
71.	ETI/C/732	-	Employment schedule for OHE mast (9.5m) Wind -112.5 kgf/m2, copper OHE, with 1200 kg tensions, with Higher Implantation for high speed 160 km/h. overlap central location.	23.12. 88
72.	ETI/C/733	-	Employment schedule for OHE mast (9.5m) Wind -112.5 kgf/m2, copper OHE, with 1200 kg tensions, with Higher Implantation for high speed 160 km/h. overlap anchor location.	23.12. 88
73.	ETI/C/0733-1	-	Employment schedule for OHE mast (9.5m) W.P.112.5 kgf/m2 Copper OHE (1200 + 1200) caty. 65 mm2 cont.107mm2 (For high speed 160 kmph) overlap anchor location with 3:1 regulating equipment (with higher setting).	23.12. 93
74.	ETI/C/0734 SH-1	-	Employment Schedule for OHE Mast (9.5 m) wind 75 kgf/m² AAAOHE, with 1000 kg tensions. OHE only.	08.09. 89
75.	ETI/C/0734 SH-2	-	Employment Schedule for OHE Mast (9.5 m) wind 75 kgf/m2 AAA OHE, with 1000 kg tensions OHE+EW.	08.09. 89
76.	ETI/C/0734 SH-3	-	Employment Schedule for OHE Mast (9.5 m) wind 75 kgf/m2 AAAOHE, with 1000 kg tensions OHE+RC	08.09. 89
77.	ETI/C/0734 SH-4	-	Employment Schedule for OHE Mast (9.5 m) wind 75 kgf/m2 AAA OHE,with 1000 kg tensions OHE+EW+RC	08.09. 89
78.	ETI/C/0735	-	Employment Schedule for OHE Mast (9.5 m) wind 75 kgf/m2 AAA OHE, with 1000 kg tension. Overlap central location with higher implantation.	08.09. 89
79.	ETI/C/0736	-	Employment Schedule for OHE Mast (9.5 m) wind 75 kgf/m2 AAA OHE, with 1000 kg tension. Overlap inters location with higher implantation.	08.09. 89
80.	ETI/C/0738 SH-1	-	Employment Schedule for OHE Mast (9.5 m) wind 112.5 kgf/m 2 AAA OHE, with 1000 kg tensions OHE only.	08.09. 89
81.	ETI/C/0738 SH-2	-	Employment Schedule for OHE Mast (9.5 m) wind 112.5 kgf/m 2 AAA OHE, with 1000 kg tensions OHE + EW	08.09. 89

82.	ETI/C/0738 SH-3	-	Employment Schedule for OHE Mast (9.5 m) wind 112.5 kgf/m 2 AAA OHE, with 1000 kg tensions. OHE + RC	08.09. 89
83.	ETI/C/0738 SH-4	-	Employment Schedule for OHE Mast (9.5 m) wind 112.5 kgf/m 2 AAA OHE, with 1000 kg tensions. OHE +EW +RC.	08.09. 89
84.	ETI/C/0739	-	Employment Schedule for OHE Mast (9.5 m) wind 112.5 kgf/m 2 AAA OHE, with 1000 kg tensions. Overlap central location with higher implantation.	08.09. 89
85.	ETI/C/0740	-	Employment Schedule for OHE Mast (9.5 m) wind 112.5 kgf/m 2 AAA OHE, with 1000 kg tensions. Overlap inter location with higher implantation	08.09. 89
86.	ETI/C/0741	-	Employment Schedule for OHE Mast (9.5 m) wind 112.5 kgf/m 2 AAA OHE, with 1000 kg tensions. Overlap anchor location with higher implantation	08.09. 89
87.	ETI/C/0742 SH-1	-	Employment schedule for OHE mast (9.5 m) for 2 X 25 kV with copper OHE with (1000+1000) tension, wind pressure 112.5 kgf/m 2. (OHE+AT feeder) and without EW.	23.10. 89
88.	ETI/C/0742 SH-2	-	Employment schedule for OHE mast (9.5 m) for 2 X 25 kV with copper OHE with (1000+1000) tension, wind pressure 112.5 Kgf/m 2. (OHE+AT feeder), without EW and with extra setting.	23.10. 89
89.	ETI/C/0742 SH-3	-	Employment schedule for OHE mast (9.5 m) for 2 X 25 kV with copper OHE with (1000+1000) tension, wind pressure 112.5 Kgf/m 2. (OHE+AT feeder) + EW.	23.10. 89
90.	ETI/C/0742 SH-4	-	Employment schedule for OHE mast (9.5 m) for 2 X 25 kV with copper OHE with (1000+1000) tension, wind pressure 112.5 Kgf/m 2. (OHE+AT feeder) + EW and with extra setting.	23.10. 89
91.	ETI/C/0743 SH-1	-	Employment schedule for OHE Mast (9.5 m) for 2 X 25 kV composite OHE with (1000+1000) tension, wind pressure 112.5 Kgf/m 2. (OHE+AT feeder) and without EW.	07.02. 90
92.	ETI/C/0743 SH-2	-	Employment schedule for OHE Mast (9.5 m) for 2 X 25 kV composite OHE with (1000+1000) tension, wind pressure 112.5 Kgf/m 2. (OHE+AT feeder),without EW and with extra setting.	07.02. 90
93.	ETI/C/0743 SH-3	-	Employment schedule for OHE Mast (9.5 m) for 2 X 25 kV composite OHE with (1000+1000) tension, wind pressure 112.5 Kgf/m 2.	07.02. 90

			(OHE+AT feeder +EW).	
94.	ETI/C/0743 SH-4	-	Employment schedule for OHE Mast (9.5 m) for 2 X 25 kV composite OHE with (1000+1000) tension, wind pressure 112.5 Kgf/m 2. (OHE+AT feeder +EW) and with extra setting.	07.02. 90
95.	ETI/C/0747 SH-1	-	Employment schedule for OHE mast (9.5 m), W.P 112.5 kgf/m2 copper OHE (cat. 65 mm2. cont.150 mm2 F.B.) (1200 + 1200 with 3:1 regulating equipment). OHE only.	22.04. 93
96.	ETI/C/0747 SH-2	-	Employment schedule for OHE mast (9.5 m), W.P 112.5 kgf/m2 copper OHE (cat. 65 mm2. cont.150 mm2 F.B.) (1200 + 1200 with 3:1 regulating equipment). OHE + EW.	22.04. 93
97.	ETI/C/0747 SH-3	-	Employment schedule for OHE mast (9.5 m), W.P 112.5 kgf/m2 copper OHE (cat. 65 mm2. cont.150 mm2 F.B.) (1200 + 1200 with 3:1 regulating equipment). OHE + RC.	22.04. 93
98.	ETI/C/0747 SH-4	-	Employment schedule for OHE mast (9.5 m), W.P 112.5 kgf/m2 copper OHE (cat. 65 mm2. cont.150 mm2 F.B.) (1200 + 1200 with 3:1 regulating equipment). OHE + EW + RC.	22.04. 93
99.	ETI/C/0748	-	Employment schedule for OHE mast (9.5 m) WP 112.5 kgf/m2 copper OHE (caty. 65 mm2, cont.150 mm2 F.B).with (1200 + 1200) (overlap central location with higher setting).	22.04. 93
100	ETI/C/0749	-	Employment schedule for OHE mast (9.5 m) WP 112.5 kgf/m2 copper OHE (caty. 65 mm2, cont.150 mm2 F.B. with 1200 + 1200) with 3:1 ATD (overlap anchor location with higher setting).	22.04. 93
101	ETI/C/0750	-	Employment schedule for OHE mast (9.5 m) WP 112.5 kgf/m2 copper OHE (caty. 65 mm2, cont.150 mm2 F.B. with 1200 + 1200) (overlap inter location with higher setting).	22.04. 93
102	ETI/C/0755 SH-1	-	Employment Schedule for OHE mast (9.5 m) wind – 150 kgf/m² cat- 65cu, cont-150 cu (FB) with (800+1200) kgf tension. OHE only.	24.03. 95
103	ETI/C/0755 SH-2	-	Employment Schedule for OHE mast (9.5 m) wind - 150 kgf/m² cat- 65cu, cont-150 cu (FB) with (800+1200) kgf tension. OHE + EW.	24.03. 95
104	ETI/C/0755 SH-3	-	Employment Schedule for OHE mast (9.5 m) wind – 150 kgf/m² cat- 65cu, cont-150 cu (FB) with (800+1200) kgf tension. OHE + RC.	24.03. 95
105	ETI/C/0755 SH-4	-	Employment Schedule for OHE mast (9.5 m) wind – 150 kgf/m² cat- 65cu, cont-150 cu (FB) with (800+1200) kgf tension. OHE + EW + RC.	24.03. 95
106	ETI/C/0756 SH-1		Employment Schedule for OHE mast (9.5 m) wind - 75 kgf/m² cat- 65cu, cont-150 cu FB	24.03. 95

			with (800+1200) kgf tension. OHE only.	
107	ETI/C/0756 SH-2	-	Employment Schedule for OHE mast (9.5 m) wind - 75 kgf/m^2 cat- 65cu, cont-150 cu FB with (800+1200) kgf tension. OHE + EW.	24.03.95
108	ETI/C/0756 SH-3	-	Employment Schedule for OHE mast (9.5 m) wind - 75 kgf/m ^{2} cat- 65cu, cont-150 cu FB with (800+1200) kgf tension. OHE + RC.	24.03.95
109	ETI/C/0756 SH-4	-	Employment Schedule for OHE mast (9.5 m) wind - 75 kgf/m^2 cat- 65 cu, cont-150 cu FB with (800+1200) kgf tension. OHE + EW + RC.	24.03.95
110	ETI/C/0757 SH-1	-	Employment Schedule for OHE mast (9.5 m) wind - 112.5kgf/m ^{2} cat- 65 cu, cont-150 cu FB with (800+1200) kgf tension. OHE only.	24.03.95
111	ETI/C/0757 SH-2	-	Employment Schedule for OHE mast (9.5 m) wind - 112.5kgf/m ^{2} cat- 65 cu, cont-150 cu FB with (800+1200) kgf tension. OHE + EW.	24.03.95
112	ETI/C/0757 SH-3	-	Employment Schedule for OHE mast (9.5 m) wind - 112.5kgf/m ^{2} cat- 65 cu, cont-150 cu FB with (800+1200) kgf tension. OHE + RC.	24.03.95
113	ETI/C/0757 SH-4	-	Employment Schedule for OHE mast (9.5 m) wind - 112.5kgf/m ^{2} cat- 65 cu, cont-150 cu FB with (800+1200) kgf. Tension. OHE + EW + RC.	24.03.95

Chapter - III - CIVIL

7) OHE FOUNDATION

1.	ETI/C/0005/68	-	Chart for portal foundation.	21.11.68
2.	ETI/C/0007/68	E	Muff for OHE structures.	21.10.02
3.	ETI/C/0012/69	E	Structure muff for sand cored foundation.	06.02.02
4.	ETI/C/0014/70	-	Dwarf mast foundation for loose soil (SBC=5500 kg/m2).	24.01.70
5.	ETI/C/0023/70	A	Typical side bearing foundation on banks.	01.05.85
6.	ETI/C/0032	B	Details of foundation for fencing upright.	21.10.02
7.	ETI/C/0057	C	Pile foundation for OHE structure in loose banks.	21.10.02
8.	ETI/C/0058 SH-1	E	Volume chart and equivalent chart of foundation.	30.08.99
9.	ETI/C/0058 SH-2A	D	Volume chart and equivalent chart of foundation for NEW PURE GRAVITY TYPE.	06.02.02
10.	ETI/C/0058 SH-3A	B	Volume chart and equivalent chart of foundation for DRY BLACK COTTON soil (NBC Type).for 16500 and 11000 kgf/m2, 3.0m depth.	06.02.02
11.	ETI/C/0058 SH-4	B	Volume chart and equivalent chart of	06.02.

			foundation for NEW PURE GRAVITY Type (500 mm exposed).	02	
12.	ETI/C/0058 SH-5	B	Volume chart and equivalent chart of foundation for DRY BLACK COTTON soil only for 8000 kgf/m2 (NBC Type) 2.5 m depth.	06.02.02	
13.	ETI/C/0058 SH-6	B	Volume chart and equivalent chart of foundation (for a direct load of 4000 kg).	06.02.02	
14.	TI/DRG/CIV/FND/RDSO/00001/04/0 SH.-1	1	Volume chart and equivalent chart of foundation (Side bearing, Side gravity & W.B.C.).	04.06.09	
15.	TI/DRG/CIV/FND/RDSO/00001/04/0 SH.-2	1	Volume chart and equivalent chart of foundation (N. G. Type).	04.06.09	
16.	TI/DRG/CIV/FND/RDSO/00001/04/0 SH.-3	1	Volume chart and equivalent chart of foundation for DRY BLACK COTTON SOIL (NBC Type) for 16500 & 11000 Kgf/m2 3.0 m depth.	04.06.09	
17.	TI/DRG/CIV/FND/RDSO/00001/04/0 SH.-4	1	Volume chart and equivalent chart of NEW PURE GRAVITY FOUNDATIONS (500 mm. Exposed)	04.06.09	
18.	TI/DRG/CIV/FND/RDSO/00001/04/0 SH.-5	1	Volume and equivalent chart of foundations for DRY BLACK COTTON SOIL only (8000Kg/m2) NBC Type 2.5m depth.	04.06.09	
19.	TI/DRG/CIV/FND/00001/13/0 (Sheet-1)	-	Volume Chart and Equivalent Chart of Foundation (Side Bearing, Side Gravity & W.B.C.) High rise OHE	14.05.13	
20.	TI/DRG/CIV/FND/00001/13/0 (Sheet-2)	-	Volume Chart and Equivalent Chart of Foundation (N.G. type) High rise OHE	14.05.13	
21	TI/DRG/CIV/FND/00001/13/0 (Sheet-3)		Volume Chart and Equivalent Chart of Foundation for dry Black cotton soil only(NBC type)for 16500 & 11000kgf/m² 3.0m Depth for High Rise OHE	14.05.13	
22.	TI/DRG/CIV/FND/00001/13/0 (Sheet-4)	-	Volume Chart and Equivalent Chart of New Pure Gravity foundation(500m Exposed) for High Rise OHE	14.05.13	
23	TI/DRG/CIV/FND/00001/13/0 (Sheet-5)	-	Volume Chart and Equivalent Chart of foundation for dry black cotton soil only (8000kg/m²) NBC type 2.5 m depth for high Rise OHE	14.05.13	
24	TI/DRG/CIV/B-MAST/00001/13	-	11.40m LONG STANDARD TRACTION MAST (Fabricated with batten plates)B-Series for High Rise OHE	18.03.14	
25.	TI/DRG/CIV/N-PORTAL/00001/13 (Sheet-1)		Standard 'N' type Portal (General arrangement) for High Rise OHE	31.03.14	
26.	TI/DRG/CIV/N-PORTAL/00001/13 (Sheet-2)	-	Standard 'N' type Portal Rod Laced details of upright part "A" for High Rise OHE	31.03.14	
27.	TI/DRG/CIV/O-PORTAL/00001/13 (Sheet-1)		Standard 'O' type Portal (General arrangement) for High Rise OHE	31.03.14	
28.	TI/DRG/CIV/O-PORTAL/00001/13 (Sheet-2)		Standard 'O' type Portal Rod Laced details of upright part "A" for High Rise OHE	31.03.14	

29.	TI/DRG/CIV/R-PORTAL/00001/13 (Sheet-1)		Standard 'R' type Portal (General arrangement) for High Rise OHE	31.03.14	F 3
30.	TI/DRG/CIV/R-PORTAL/00001/13 (Sheet-2)		Standard 'R' type Portal Rod Laced details of upright part "A" for High Rise OHE	31.03.14	F 3
31.	TI/DRG/CIV/BFB PORTAL/00001/13/0 (Sheet-1)		Special BFB Portal for 5 Tracks (General arrangement) for high Rise OHE	06.05.14	F 3
32.	TI/DRG/CIV/BFB PORTAL/00001/13/0 (Sheet-2)		Special BFB Portal Details of upright par "A" for High Rise OHE	06.05.14	F 3
33.	TI/DRG/CIV/G – PORTAL/00001/13/0		"G" type Portal Special upright and end piece for High Rise OHE	06.05.14	F 3
34.	TI/DRG/CIV/P – PORTAL/00001/13/0		"P" type Portal General arrangement and Details of Upright and End Pieces (High Rise OHE)	17.12.14	F 3
35.	TI/DRG/CIV/TTC/00001/13/0(Sheet-1)		Two Track Cantilever Structure(TTC) General arrangement for High Rise OHE	06.05.14	F 3
36.	TI/DRG/CIV/TTC/00001/13/0(Sheet-2)		Two Track Cantilever Structure (TTC) Details of Upright for High Rise OHE	06.05.14	F 3
37.	TI/DRG/CIV/TTC/00001/13/0(Sheet-3)		Two Track Cantilever Structures (Details of 5.5m Boom)(For High Rise OHE)	01.03.16	F 3
38.	TI/DRG/CIV/H.GAUGE /RDSO/00001/14/0	A	Drawing for Height Gauge at Level Crossing (for Clear Span 7.30 m to 10.0 m) Details of Structure and Foundation (Approved in Principal)	28.10.16	F 3
39.	TI/DRG/CIV/ES/00001 /16/0		Normal Employment Schedule Mast (9.5 m) Wind speed 44 m/s Basic Wind Pressure 136 kgf/m^2 (Without return Conductor and without Earth wire) 800 kgf Tension Cat.- 65 mm^2- Cont.- 107 mm^2	14.12.16	F 3
40.	TI/DRG/CIV/ES/00001 /13/0(Sheet-1)	B	High Rise OHE Employment Schedule Mast (11.4m) (Wind Pressure 155 kgf/m^2) (Basic Wind Speed 47 m/s) (Without Return Conductor and without Earth wire)	17.04.14	F 3
41.	TI/DRG/CIV/ES/00001 /13/0(Sheet-2)	B	High Rise OHE Employment Schedule Mast (11.4m) (Wind Pressure 1136 kgf/m^2) (Basic Wind Speed 44 m/s) (Without Return Conductor and without Earth wire)	17.04.14	F 3
42.	TI/DRG/CIV/ES/00001 /13/0(Sheet-3)	B	High Rise OHE Employment Schedule Mast (11.4m) (Wind Pressure 136 kgf/m^2) (Basic Wind Speed 44 m/s) (Without Return Conductor and without Earth wire)	17.04.14	F 3
43.	TI/DRG/CIV/ES/00001 /13/0(Sheet-4)	B	High Rise OHE Employment Schedule Mast (11.4m) (Wind Pressure 105 kgf/m^2) (Basic Wind Speed 39 m/s) (Without Return Conductor and without Earth wire)	17.04.14	F 3
44.	TI/DRG/CIV/ES/00001 /13/0(Sheet-5)	B	High Rise OHE Employment Schedule Mast (11.4m) (Wind Pressure 73 kgf/m^2) (Basic Wind Speed 33 m/s) (Without Return Conductor and without Earth wire)	17.04.14	F 3
45.	ETI/C/0758 (Sheet-1)	A	Normal OHE Employment Schedule Mast (9.5m) Wind Pressure 178 kgf/m^2) (Basic Wind Speed 50 m/s) (Without Return Conductor and	14.07.14	F 3

			without Earth wire)	
46.	ETI/C/0758 (Sheet-2)	A	Normal OHE Employment Schedule Mast (9.5m) Wind Pressure155 kgf/m^2) (Basic Wind Speed 47 m/s) (Without Return Conductor and without Earth wire)	14.07.14
47.	ETI/C/0758 (Sheet-3)	A	Normal OHE Employment Schedule Mast (9.5m) Wind Pressure136 kgf/m^2) (Basic Wind Speed 44 m/s) (Without Return Conductor and without Earth wire)	14.07.14
48.	ETI/C/0758 (Sheet-4)	A	Normal OHE Employment Schedule Mast (9.5m) Wind Pressure105 kgf/m^2) (Basic Wind Speed 39 m/s) (Without Return Conductor and without Earth wire)	14.07.14
49.	ETI/C/0758 (Sheet-5)	A	Normal OHE Employment Schedule Mast (9.5m) Wind Pressure73 kgf/m^2) (Basic Wind Speed 33 m/s) (Without Return Conductor and without Earth wire)	14.07.14
50.	ETI/C/0759 (Sheet-1)		Normal Employment Schedule Mast (9.5 m) Wind Pressure 178 kgf/m^2 Basic Wind Speed 50m/s (Without return Conductor and Without Earth Wire)(1100+1100 kgf) Tension Cat- 65mm^2 Cont. – 107 mm^2	14.12.06
51.	ETI/C/0759 (Sheet-2)		Normal Employment Schedule Mast (9.5 m) Wind Pressure 155 kgf/m^2 Basic Wind Speed 47m/s (Without return Conductor and Without Earth Wire)(1100+1100 kgf) Tension Cat- 65mm^2 Cont. – 107 mm^2	14.12.06
52.	ETI/C/0759 (Sheet-3)		Normal Employment Schedule Mast (9.5 m) Wind Pressure 136 kgf/ m^2 Basic Wind Speed 44m/s (Without return Conductor and Without Earth Wire)(1100+1100 kgf) Tension Cat- 65mm^2 Cont. – 107 mm^2	14.12.06
53	ETI/C/0759 (Sheet-5)		Normal Employment Schedule Mast (9.5 m) Wind Pressure 73 kgf/m^2 Basic Wind Speed 33m/s (Without return Conductor and Without Earth Wire)(1100+1100 kgf) Tension Cat- 65mm^2 Cont. – 107 mm^2	14.12.06
54.	ETI/C/0759 (Sheet-1)		Normal Employment Schedule Mast (9.5 m) Wind Pressure 178 kgf/m^2 Basic Wind Speed 50m/s (Without return Conductor and Without Earth Wire)(1100+1100 kgf) Tension Cat- 65mm^2 Cont. – 107 mm^2	14.12.06
55.	ETI/C/HR/0076		Standard Arrangement of drop Arm for supporting cantilever on the Boom of Portal and Two Track Cantilever for Normal as well as High Rise OHE	02.12.14
56.	ETI/C/HR/0181		Drilling Schedule for S-6 H Mast(Length- 13.0 m) (For High Rise OHE)	23.01.15
57.	ETI/C/HR/0182		Drilling Schedule for S-7 H Mast(Length- 13.0 m) (For High Rise OHE)	23.01.15
58.	ETI/C/HR/0183		Drilling Schedule for S-8 H Mast(Length- 13.0 m) (For High Rise OHE)	23.01.15
59.	ETI/C/0072 (Sheet-1)	A	Emergency OHE Mast On Sleepers (General Arrangement)	25.06.15

60.	ETI/C/0072 (Sheet-2)	B	Emergency OHE Mast On Sleepers (Details of Bottom, Middle and Top Parts)	25.06.15
61.	ETI/C/0072 (Sheet-3)	C	Emergency OHE Mast On Sleepers (Details of Base Connection)	25.06.15
62.	ETI/C/0059	C	Details of OHE foundation in soft rock (Bearing Capacity 45000 kgf/m2).	21.10.02
63.	ETI/C/0060	D	Details of OHE foundation in Hard rock (Bearing Capacity 90000 kgf/m2).	21.10.02
64.	ETI/C/0061	-	Arrangement of treating black cotton soil at the location of OHE foundation on stable bank.	03.03.76
65.	ETI/C/0062	B	Short bored pile foundation for traction mast (permissible BM and volume).	21.10.02
66.	ETI/C/0063	B	Chart for portal foundation in dry black cotton soil (SBC=16500 kgf/m2).	14.03.78
67.	ETI/C/0080	A	Details of foundation in hard rock for PORTALS.	21.10.02
68.	ETI/C/0209	C	Details of foundation for 132/25 kV traction substation structures.	21.10.02
69.	ETI/SK/C/131	-	Typical design of pure gravity foundation.	21.12.77
70.	ETI/SK/C/142	-	Typical design of side gravity foundation.	24.02.78

Chapter - III - CIVIL

8. MISCELLANEOUS

1.	ETI/C/0002	A	Details of base plate for mast on drains in station yards	16.07.70	FOLD 31
2.	ETI/C/0010	C	Bolted base connection for portals located in drains.	04.03.91	FOLD 31
3.	ETI/C/0045 SH-1	D	132 kV emergency tower (with RSJ) outline diagram	18.03.86	FOLD 31
4.	ETI/C/0045 SH-2	E	132 kV emergency tower (with RSJ) structural drawings	20.08.75	FOLD 31
5.	ETI/C/0068	I	Protective screen at foot over and road over bridge.	14.06.17	FOLD 31
6.	ETI/C/0069	D	Danger plate in level crossing gauge for electrified section	21.08.17	FOLD 31

Chapter - III - CIVIL

9. SPUN PRESTRESSED CEMENT CONCRETE (PSC) OHE MAST

1.	ETI/SK/C/214 SH-1	E	MS Bracket fitting for PSC General arrangement and SPS details	09.02.90
2.	ETI/SK/C/214 SH-2	A	SPS details for earth wire clamp on PSC mast	22.06.94
3.	ETI/SK/C/242	A	RC arrangement in PSC mast	22-09-95
4.	ETI/OHE/SK/537 SH-1	D	Earthing and bonding of PSC mast.	28.12.94
5.	ETI/OHE/SK/537	B	Typical earthing arrangement in spun PSC	28.12.

LATEST RDSO DRAWINGS AND SPECIFICATION

1	28/07/2022	ETI/C/HR/0181	Drilling Schedule for S-6H Mast (Length 13.0m) (For high rise OHE)	Drawings	MOD-A
2	28/07/2022	ETI/C/HR/0182 MOD-A	Drilling Schedule for S-7H Mast (Length 13.0m) (For high rise OHE)	Drawings	MOD-A
3	28/07/2022	ETI/C/HR/0183 MOD-A	Drilling Schedule for S-8H Mast (Length 13.0m) (For high rise OHE)	Drawings	MOD-A
4	28/07/2022	ETI/OHE/G/01402 MOD-C	Anchor Arrangement with Dwarf Mast	Drawings	MOD-C
5	28/07/2022	ETI/OHE/ HR/G/01402 MOD-B	Anchor Arrangement with Dwarf Mast for conventional and high rise OHE (Approved in Principle)	Drawings	MOD-B
6	28/07/2022	TI/DRG/CIV/B-MAST/00001/13/0 MOD-A	11.40 m long Standard traction mast (fabricated with batten plates) â œBâ series for high rise OHE	Drawings	MOD-A
7	28/07/2022	TI/DRG/CIV/BFB-PORTAL/00001/13/0 MOD-A	Special BFB Portal details of upright part â˜Aâ™ for high rise OHE	Drawings	(SHEET-2) MOD-A
8	28/07/2022	TI/DRG/CIV/G-PORTAL/00001/13/0 MOD-A	G-type portal special upright and end piece for high rise OHE	Drawings	MOD-A
9	28/07/2022	TI/DRG/CIV/N-PORTAL/00001/13/0 MOD-A	Standard -N type portal rod laced details of upright Part-A for high rise OHE	Drawings	(SHEET-2) MOD-A
10	28/07/2022	TI/DRG/CIV/O-PORTAL/00001/13/0 MOD-A	Standard-O type portal rod laced details of upright Part-A for high rise OHE	Drawings	(SHEET-2) MOD-A
11	28/07/2022	TI/DRG/CIV/P-PORTAL/00001/13/0 MOD-A	P-type Portal General Arrangement & details of Upright & End -Pieces (High Rise OHE)	Drawings	MOD-A
12	28/07/2022	TI/DRG/CIV/R-PORTAL/00001/13/0 MOD-A	Standard-R type portal rod laced details of upright Part-A for high rise OHE	Drawings	(SHEET-2) MOD-A
13	28/07/2022	TI/DRG/CIV/ TTC/00001/13/0 MOD-A	Two track cantilever structure (TTC) details of upright for High Rise OHE	Drawings	(SHEET-2) MOD-A

14	28/07/2022	TI/DRG/CIV/ TTC/00001/13/0 MOD-A	Two track cantilever structure (Details of 5.5m boom) (for High Rise OHE)	Drawings	(SHEET-3) MOD-A
15	19/07/2022	TI/SPC/PSI/ ISOLTR/0210 (July, 2021)	Technical specification for 25 kV Motorized/ Manual operated and 50kV/66kV/100kV/110 kV/132kV/220kV Manual operated, Single Pole, Double Pole and Triple Pole Isolators for Railway Electric Traction.	Specifica-tions	With A & C Slip No. 1
16	14/07/2022	Specification No. TI/SPC/OHE/ POST/0101	Specification of Solid Core Porcelain Cylindrical Post Insulators for systems with nominal voltage of 66 kV, 110 kV, 132kV & 220kV	Specifica-tions	
17	07/07/2022	ETI/C/0019 (Sheet-2) MOD-B	Three legged â˜Nâ™ type portal Rod laced details of Central upright Part-â˜Fâ™	Drawings	MOD-B
18	07/07/2022	ETI/C/0026 (Sheet-2) MOD-C	Special BFB portal Details of upright Part â˜Aâ™	Drawings	MOD-C
19	07/07/2022	ETI/C/0026 (Sheet-3) MOD-B	Special BFB portal Rod laced Details of end piece of top boom Part-B (Nominal length 8.5 m & 9.0 m)	Drawings	MOD-B
20	07/07/2022	ETI/C/0026 (Sheet-4) MOD-B	Special BFB portal Rod laced Details of Knee Bracing Part E	Drawings	MOD-B
21	07/07/2022	ETI/C/0027 (Sheet-2) MOD-C	Three legged BFB Portal Details of Central upright Part F	Drawings	MOD-C
22	07/07/2022	ETI/C/0048 MOD-D	P-Type Portal General Arrangement & Details of Upright & End Pieces.	Drawings	MOD-D
23	07/07/2022	ETI/C/0077 (Sheet-2) MOD-B	Two Track Cantilever Structures (TTC-17) Details of Upright	Drawings	MOD-B
24	07/07/2022	ETI/C/0077 (Sheet-3) MOD-B	Two Track Cantilever Structures (TTC-17) Details of Boom	Drawings	MOD-B
25	07/07/2022	ETI/C/0077 (Sheet-4) MOD-B	Two Track Cantilever Structures (TTC-17) Details of Knee Plate	Drawings	MOD-B

26	27/06/2022	ETI/C/0030 MOD-G	Drilling schedule for S1 mast	Drawings	MOD-G
27	27/06/2022	ETI/C/0031 MOD-E	Drilling schedule for S2 mast	Drawings	MOD-E
28	27/06/2022	ETI/C/0180 MOD-D	Drilling schedule for S3 mast (Length 11.4 m)	Drawings	MOD-D
29	27/06/2022	ETI/C/0036 MOD-F	Drilling schedule for 8âx6âx35 lbs R.S.J. masts 8.0 m long for booster transformer stations TYPE S-4.	Drawings	MOD-F
30	27/06/2022	ETI/C/0042 MOD-F	Drilling schedule for S-5 mast	Drawings	MOD-F
31	27/06/2022	ETI/C/0181 MOD-D	Drilling schedule for S6 mast (Length-12.4 m)	Drawings	MOD-D
32	27/06/2022	ETI/C/0182 MOD-D	Drilling schedule for S7 mast (Length-12.4 m)	Drawings	MOD-D
33	27/06/2022	ETI/C/0183 MOD-D	Drilling schedule for S8 mast (Length-12.4 m)	Drawings	MOD-D
34	27/06/2022	ETI/C/0184 MOD-D	Drilling schedule for S-9 mast (Length-9.4 m)	Drawings	MOD-D
35	27/06/2022	ETI/C/0043 MOD-C	S-100 Fabricated mast for Mounting L.T. supply transformer and dropout fuse switch as switching station	Drawings	MOD-C
36	27/06/2022	ETI/C/0044 MOD-B	S-101 Details of mast for supporting Isolators inside switching stations	Drawings	MOD-B
37	10/06/2022	ETI/C/0008 (Sheet-2) MOD-C	N-Type Portal Rod Laced Details of Upright PART-A	Drawings	MOD-C
38	10/06/2022	ETI/C/0008 (Sheet-3) MOD-D	N-Type Rod Laced Portal Details of end Piece of top Boom PART-B (Nominal Lengths 5380)	Drawings	MOD-D
39	10/06/2022	ETI/C/0008 (Sheet-3A) MOD-C	N-Type Rod Laced Portal Detail of end Piece of top Boom PART-B (Nominal Lengths 5880)	Drawings	MOD-C
40	10/06/2022	ETI/C/0008 (Sheet-4) MOD-C	N-Type Portal Rod Laced details of Standard Central Pieces of top Boom (Nominal Length 1.5, 3.0, 4.5, 6.0, 7.5, 9.0)	Drawings	MOD-C
41	10/06/2022	ETI/C/0008 (Sheet-5) MOD-D	N-Type Portal details of Splicing & Cover Angles PART-D	Drawings	MOD-D

42	10/06/2022	ETI/C/0008 (Sheet-6) MOD-B	N-Type Portal Rod Laced Details of knee Bracing PART-E	Drawings	MOD-B
43	10/06/2022	ETI/C/0009/69 (Sheet-2) MOD-D	Two Track Cantilever structures (Details of Upright)	Drawings	MOD-D
44	10/06/2022	ETI/C/0009/69 (Sheet-3) MOD-C	Two Track Cantilever structures (Details of Knee Plate)	Drawings	MOD-C
45	10/06/2022	ETI/C/0009/69 (Sheet-4) MOD-D	Two Track Cantilever structures (Details of 5.5m Boom)	Drawings	MOD-D
46	10/06/2022	ETI/C/0009/69 (Sheet-5) MOD-D	Two Track Cantilever structures (Details of 8m Boom)	Drawings	MOD-D
47	02/06/2022	ETI/C/0011/69 (Sheet-2) MOD-D	Standard R-Type Portal Rod Laced Details of Upright PART-A	Drawings	MOD-D
48	02/06/2022	ETI/C/0011/69 (Sheet-3) MOD-E	Standard R-Type Portal Rod Laced Details of end Piece of top Boom PART-B Nominal Lengths 11.6 m & 12.1 m	Drawings	MOD-E
49	02/06/2022	ETI/C/0011/69 (Sheet-4) MOD-D	Standard R-Type Portal Rod Laced details of Central Piece of top boom PART-C Nominal Length 7.5 m, 9.0 m, 10.5 m, 12.0 m, 13.0 m	Drawings	MOD-D
50	02/06/2022	ETI/C/0011/69 (Sheet-5) MOD-C	Standard R-Type Portal Rod Laced details of Splicing & Cover Angle PART-D	Drawings	MOD-C
51	02/06/2022	ETI/C/0011/69 (Sheet-6) MOD-D	Standard R-Type Portal Rod Laced Details of knee Bracing PART-E	Drawings	MOD-D
52	20/05/2022	ETI/C/0017/70 (Sheet-2) MOD-C	âœOâ Type Portal Rod Laced Details of Upright PART-A	Drawings	MOD-C
53	20/05/2022	ETI/C/0017/70 (Sheet-3) MOD-C	âœOâ Type Portal Rod Laced with 1 in 50 Camber (Details of end Piece of top Boom âœPART-Bâ) Nominal Lengths (11048 & 10548).	Drawings	MOD-C

54	20/05/2022	ETI/C/0017/70 (Sheet-4) MOD-C	O-Type Rod Laced Portal details of Central Piece of top boom PART-C (Nominal Length 1.5, 3.0, 4.5, 6.0, 7.5 & 9.0 m).	Drawings	MOD-C
55	20/05/2022	ETI/C/0017/70 (Sheet-5) MOD-D	O-Type Portal details of Splicing & Cover Angle PART-D	Drawings	MOD-D
56	20/05/2022	ETI/C/0017/70 (Sheet-6) MOD-B	O-Type Portal Rod Laced with 1 in 50 Camber Details of knee Bracing PART-E	Drawings	MOD-B
57	27/04/2022	TI/SPC/OHE/ INS/0071	Technical Specification for Solid Core Porcelain Insulators for 25 KV A.C. 50 Hz Single Phase Overhead Traction Lines	Specifica- tions	
58	08/04/2022	ETI/C/0005/68 MOD-A	Chart for portal foundations	Drawings	MOD-A
59	08/04/2022	ETI/C/0063 MOD-C	Chart for portal foundations in dry black cotton soil (Safe bearing capacity 16500 kgf/m2)	Drawings	MOD-C
60	29/03/2022	TI/SPC/OHE/ NETRA/0143	Broad Gauge OHE parameters recording cum test car (NETRA) at 160Kmph for Electric Traction	Specifica- tions	Revision-3 of NETRA Specifica- tion
61	17/03/2022	RDSO-TI0LKO (PSI)/53/2020	Ah capacity of battery bank for SSP/SP equipped with more than 8 numbers of interrupters/CB in 25KV ac traction	Instructions/ SMIs	Ah capacity of battery at SSP/SP equipped with more than 8 numbers of interrupters/ CBs
62	08/03/2022	ETI/OHE/G/01403 SHEET-1 (MOD-G)	SCHEDULE OF ANCHOR BLOCK FOR B.G. TRACKS	Drawings	MOD-G
63	08/03/2022	ETI/OHE/G/00144 (Sheet-3) (MOD-D)	Standard Drilling Schedule of OHE Masts 9.5m long RSJs and BFBs	Drawings	MOD-D
64	08/03/2022	ETI/C/0018-2 MOD-F	9.5m Standard Traction Masts (Fabricated âœKâ series)	Drawings	MOD-F

65	08/03/2022	ETI/C/0071 MOD-F	9.5m Long Standard Traction Mast (fabricated with batten plates) âœBâ series	Drawings	MOD-F
66	08/03/2022	ETI/C/0076 MOD-D	Standard Arrangement of Supporting Cantilevers on the Boom of Portals and TTC (to avoid Bird Nesting)	Drawings	MOD-F
67	08/03/2022	ETI/C/0056 MOD-D	G-Type Portal Special Upright and End Piece	Drawings	MOD-D
68	28/02/2022	TI/SPC/OHE/ TOOLPL/0992	Specification for Gearless Hand Operated Pulling and Lifting Machine	Specifica-tions	Specifi-cation for TOOLPL
69	28/02/2022	TI/STR/007, Rev-02	STR for Gearless Hand Operated Pulling and Lifting Machine and Ratchet Lever Hoist (Pull-Lift)	Specifica-tions	STR for Gearless Hand Operated Pulling and Lifting Machine and Ratchet Lever Hoist (Pull-Lift)
70	07/02/2022	RDSO-TI0LKO (OHE)/25/2020-O/o PED/TI/RDSO	Review of periodicity of POH of Tower Wagon		rdso letter
71	28/01/2022	RDSO-TI0LKO (OHE)/25/2020-O/o PED/TI/RDSO	Review of periodicity of POH of Tower Wagon	Instructions/ SMIs	Review of periodicity of POH of Tower Wagon
72	14/01/2022	TI/DRG/PSI/AT/ RDSO/00009/20/1 Mod C	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Double Line section) with parallel to track.	Drawings	Mod. C
73	27/12/2021	TI/DRG/PSI/AT/ RDSO/00051/21/0 MOD A	TYPICAL SYSTEMATIC DIAGRAM OF PROTECTION FOR 132/ 2*25 kV TRACTION SUB-STATION WITH SCOTT CONNECTED TRANSFORMERS	Drawings	

74	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00054/21/0	Tee Connector to suit BULL 'AAC' conductor and BULL 'AAC' conductor in 2X25 kV system.	Drawings	
75	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00055/21/0	Rigid connector on S.I. to suit BERSISMIS (36mm Dia.) "AAAC" conductor in 2X25 kV system.	Drawings	
76	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00056/21/0	Rigid connector on S.I. to suit BULL (38.25mm Dia.) "AAC" conductor in 2X25 kV system.	Drawings	
77	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00057/21/0	Flexible connector to suit 50MM O/D Al. Tube Bus bar for Double Pole circuit breaker and LV side of Traction transformer in 2X25kV system.	Drawings	
78	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00058/21/0	Rigid through connector to suit BERSIMIS (36mm Dia) âœAAACâ Conductor and SPIDER "AAC" conductor for 25 kV PT type II. (T-Type)	Drawings	
79	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00059/21/0	Rigid through connector to suit BULL (38.25mm Dia) âœAACâ Conductor and SPIDER "AAC" conductor for 25 kV PT type II (T- Type)	Drawings	
80	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00060/21/0	Tee Connector to suit 50 O/D Al. Tube and âœBERSISMISâ 'AAAC' conductor in 2X25 kV system.	Drawings	
81	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00061/21/0	Tee Connector to suit 50 O/D Al. Tube and BULL 'AAC' conductor in 2X25 kV system.	Drawings	
82	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00062/21/0	Typical Termination arrangement for strung bus "BERSISMIS" (AAAC) conductor in 2X25 kV system.	Drawings	

83	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00063/21/0	Typical Termination arrangement for strung bus "BULL" (AAC) conductor in 2X25 kV system.	Drawings	
84	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00064/21/0	Flexible connector to suit BULL (38.25 mm Dia.) "AAC" conductor for Double Pole circuit breaker and LV side of Traction transformer in 2X25kV system.	Drawings	
85	20/12/2021	ETI/PSI/P/11030 Mod. D	Bimetallic terminal Connector to suit ZEBRA (28.58mm Dia.) ACSR conductor & AL/CU Pad of isolator/CT/CB or 50mm O/D Al tube and AL/CU Pad of isolator/ CT/CB.	Drawings	
86	20/12/2021	TI/DRG/PSI/ CONECT/ RDSO/00053/21/0	Tee Connector to suit "BERSIMIS" 'AAAC' and "BERSIMIS' 'AAAC' in 2X25 kV system.	Drawings	
87	16/12/2021	TI/SPC/OHE/ TOOLPL/0991	GEARLESS HAND OPERATED PULLING ANDLIFTING MACHINES	Specifica-tions	REVISED
88	16/12/2021	TI/SPC/OHE/ TOOLPL/1991	Ratchet Lever Hoist (PULL-LIFTS)	Specifica-tions	REVISED
89	25/11/2021	TI/SPC/PSI/ INTRLK/0210	TECHNICAL SPECIFICATION FOR INTERLOCKS FOR AC TRACTION SWITCHGEARS	Specifica-tions	
90	25/11/2021	TI/SPC/PSI/ DRWING/0210	TECHNICAL SPECIFICATION FOR STANDARDS DRAWING FOR POWER SUPPLY INSTALLATION	Specifica-tions	
91	19/11/2021	TI/DRG/PSI/AT/ RDSO/00049/21/0	Typical layout of cable trench, foundation & cable schedule of Switching station 2x25 kV AT System (for four line section).	Drawings	

92	19/11/2021	TI/DRG/PSI/AT/ RDSO/00052/20/0	Typical layout of cable trench, foundation & cable schedule of Sectioning and Paralleling Post (SP) in 2x25 kV AT System on Double line for Scott Connected Transformer TSS.	Drawings	
93	19/11/2021	TI/DRG/PSI/AT/ RDSO/00015/20/01 Mod A	General arrangement of Sub sectioning and Paralleling Post (SSP) in 2X25kV â˜ATâ™ System (on double line section) for Scott Connected Transformer TSS	Drawings	
94	19/11/2021	TI/DRG/PSI/AT/ RDSO/00016/20/01 Mod A	General arrangement of Sectioning and Paralleling Post (SP) in 2X25kV â˜ATâ™ System (on double line section) for Scott Connected Transformer TSS	Drawings	
95	19/11/2021	TI/DRG/PSI/AT/ RDSO/00036/20/01 Mod A	General arrangement of Sub sectioning and Paralleling Post (SSP) in 2X25kV â˜ATâ™ System (on double line section) for V- Connected Transformer TSS	Drawings	
96	19/11/2021	TI/DRG/PSI/AT/ RDSO/00037/20/01 Mod A	General arrangement of Sectioning and Paralleling Post (SP) in 2X25kV â˜ATâ™ System (on double line section) for V- Connected Transformer TSS	Drawings	
97	19/11/2021	TI/DRG/PSI/AT/ RDSO/00017/20/01 Mod A	General arrangement of Sub sectioning and Paralleling Post (SSP) in 2X25kV â˜ATâ™ System (on three line section).	Drawings	
98	19/11/2021	TI/DRG/PSI/AT/ RDSO/00018/20/01 Mod A	General arrangement of Sectioning and Paralleling Post (SP) in 2X25kV â˜ATâ™ System (on three line section).	Drawings	

99	19/11/2021	TI/DRG/PSI/AT/ RDSO/00019/20/01 Mod A	General arrangement of Sub sectioning and Paralleling Post (SSP) in 2X25kV â˜ATâ™ System (on four line section).	Drawings	
100	19/11/2021	TI/DRG/PSI/AT/ RDSO/00020/20/01 Mod A	General arrangement of Sectioning and Paralleling Post (SP) in 2X25kV â˜ATâ™ System (on four line section.	Drawings	
101	19/11/2021	TI/DRG/PSI/AT/ RDSO/00021/20/01 Mod A	General arrangement for Boundary Sectioning and Paralleling Post (SP) in 2X25kV â˜ATâ™ System (on double line section) for Scott connected Transformer TSS.	Drawings	
102	19/11/2021	TI/DRG/PSI/AT/ RDSO/00022/20/01 Mod A	General arrangement for Boundary sectioning & paralleling post (SP) in 2 x 25 kV â˜ATâ™ system (on 3 line section)	Drawings	
103	19/11/2021	TI/DRG/PSI/AT/ RDSO/00023/20/01 Mod A	General arrangement for Boundary sectioning & paralleling post (SP) in 2 x 25 kV â˜ATâ™ system (on 4 line section)	Drawings	
104	19/11/2021	TI/DRG/PSI/AT/ RDSO/00050/21/01 Mod A	General arrangement for Boundary Sectioning & Paralleling post (SP) in 2 x 25 kv "V-connected" 'at' system (on Double line section)	Drawings	
105	17/11/2021	TI/SPC/OHE/ Fittings/0130(10/13) rev.1	Technical Specification for 25kV A.C. OHE fittings	Specifica-tions	
106	15/11/2021	TI/DRG/PSI/AT/ RDSO/00009/20/1 Mod B	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Double Line section) with parallel to track.	Drawings	

107	15/11/2021	TI/DRG/PSI/AT/ RDSO/00010/20/1 Mod B	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Double Line section) with perpendicular to track.	Drawings	
108	15/11/2021	TI/DRG/PSI/AT/ RDSO/00030/20/1 Mod A	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Three Line section) with parallel to track.	Drawings	
109	15/11/2021	TI/DRG/PSI/AT/ RDSO/00031/20/1 Mod A	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Three Line section) with perpendicular to track.	Drawings	
110	15/11/2021	TI/DRG/PSI/AT/ RDSO/00032/20/1 Mod A	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Four Line section) with parallel to track.	Drawings	
111	15/11/2021	TI/DRG/PSI/AT/ RDSO/00033/20/1 Mod A	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Four Line section) with perpendicular to track.	Drawings	
112	15/11/2021	TI/DRG/PSI/AT/ RDSO/00024/20/1 Mod B	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Double Line section) with parallel to track.	Drawings	
113	15/11/2021	TI/DRG/PSI/AT/ RDSO/00025/20/1 Mod B	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Double Line section) with perpendicular to track.	Drawings	

114	15/11/2021	TI/DRG/PSI/AT/ RDSO/00038/20/1 Mod A	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Three Line section) with parallel to track.	Drawings	
115	15/11/2021	TI/DRG/PSI/AT/ RDSO/00039/20/1 Mod A	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Three Line section) with perpendicular to track.	Drawings	
116	15/11/2021	TI/DRG/PSI/AT/ RDSO/00040/20/1 Mod A	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Four Line section) with parallel to track.	Drawings	
117	15/11/2021	TI/DRG/PSI/AT/ RDSO/00041/20/1 Mod A	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Four Line section) with perpendicular to track.	Drawings	
118	02/11/2021	TI/DRG/PSI/ TRCSFD/ RDSO/00048/21/0	Typical layout of cable trench, foundation & cable schedule of 132/2x25 kV traction sub - station with v connected transformers (for four line section) with perpendicular to track	Drawings	
119	02/11/2021	TI/DRG/PSI/AT/ RDSO/00034/20/1 Mod A	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Double Line section) with parallel to track.	Drawings	
120	02/11/2021	TI/DRG/PSI/AT/ RDSO/00035/20/1 Mod A	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Double Line section) with perpendicular to track.	Drawings	

121	02/11/2021	TI/DRG/PSI/AT/ RDSO/00011/20/1 Mod A	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Three Line section) with parallel to track.	Drawings	
122	02/11/2021	TI/DRG/PSI/AT/ RDSO/00012/20/1 Mod A	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Three Line section) with perpendicular to track.	Drawings	
123	02/11/2021	TI/DRG/PSI/AT/ RDSO/00013/20/1 Mod A	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Four Line section) with parallel to track.	Drawings	
124	02/11/2021	TI/DRG/PSI/AT/ RDSO/00014/20/1 Mod A	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Four Line section) with perpendicular to track	Drawings	
125	02/11/2021	TI/DRG/PSI/ TRCSFD/ RDSO/00047/21/0	Typical layout of cable trench, foundation &cable schedule of 132/2x25 kV traction sub - station with Scott connected transformers (for four line section) with parallel to track	Drawings	
126	02/11/2021	TI/DRG/PSI/AT/ RDSO/00042/20/1 Mod A	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Double Line section) with parallel to track.	Drawings	
127	02/11/2021	TI/DRG/PSI/AT/ RDSO/00043/20/1 Mod A	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Double Line section) with perpendicular to track.	Drawings	

128	02/11/2021	TI/DRG/PSI/AT/ RDSO/00026/20/1 Mod A	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Three Line section) with parallel to track.	Drawings	
129	02/11/2021	TI/DRG/PSI/AT/ RDSO/00027/20/1 Mod A	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Three Line section) with perpendicular to track.	Drawings	
130	02/11/2021	TI/DRG/PSI/AT/ RDSO/00028/20/1 Mod A	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Four Line section) with parallel to track.	Drawings	
131	02/11/2021	TI/DRG/PSI/AT/ RDSO/00029/20/1 Mod A	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Four Line section) with perpendicular to track.	Drawings	
132	25/10/2021	TI/SPC/PSI/ LTDPNL/0210	Low tension distribution panels for traction sub-station, sub-sectioning & paralleling post, Sectioning & paralleling post	Specifica-tions	
133	27/09/2021	TI/DRG/PSI/SLD/ RDSO/00045/21/0	General scheme of supply for 2x25 kV, 50 Hz Scott connected traction transformer traction system.	Drawings	
134	27/09/2021	TI/DRG/PSI/SLD/ RDSO/00046/21/0	General scheme of supply for 2x25 kV, 50 Hz V- connected traction transformer traction system.	Drawings	
135	23/09/2021	TI/DRG/PSI/AT/ RDSO/00042/20/01	General arrangement for Boundary sectioning & paralleling post (SP) in 2 x 25 kV âœv-connected" 'at' system (on double line section).	Drawings	

136	23/09/2021	TI/DRG/PSI/AT/ RDSO/00023/20/01	General arrangement for Boundary sectioning & paralleling post (SP) in 2 x 25 kV â˜ATâ™ system (on 4 line section)	Drawings	
137	23/09/2021	TI/DRG/PSI/AT/ RDSO/00022/20/01	General arrangement for Boundary sectioning & paralleling post (SP) in 2 x 25 kV â˜ATâ™ system (on 3 line section)	Drawings	
138	23/09/2021	TI/DRG/PSI/AT/ RDSO/00021/20/01	General arrangement for Boundary Sectioning and Paralleling Post (SP) in 2X25kV â˜ATâ™ System (on double line section).	Drawings	
139	23/09/2021	TI/DRG/PSI/AT/ RDSO/00020/20/01	General arrangement of Sectioning and Paralleling Post (SP) in 2X25kV â˜ATâ™ System (on four line section).	Drawings	
140	23/09/2021	TI/DRG/PSI/AT/ RDSO/00019/20/01	General arrangement of Sub sectioning and Paralleling Post (SSP) in 2X25kV â˜ATâ™ System (on four line section).	Drawings	
141	23/09/2021	TI/DRG/PSI/AT/ RDSO/00037/20/01	General arrangement of Sectioning and Paralleling Post (SP) in 2X25kV â˜ATâ™ System (on double line section) for V- Connected Transformer TSS	Drawings	
142	23/09/2021	TI/DRG/PSI/AT/ RDSO/00036/20/01	General arrangement of Sub sectioning and Paralleling Post (SSP) in 2X25kV â˜ATâ™ System (on double line section) for V- Connected Transformer TSS	Drawings	
143	23/09/2021	TI/DRG/PSI/AT/ RDSO/00016/20/01	General arrangement of Sectioning and Paralleling Post (SP) in 2X25kV â˜ATâ™ System (on double line section) for Scott Connected Transformer TSS	Drawings	

144	23/09/2021	TI/DRG/PSI/AT/ RDSO/00015/20/01	General arrangement of Sub sectioning and Paralleling Post (SSP) in 2X25kV â˜ATâ™ System (on double line section) for Scott Connected Transformer TSS	Drawings	
145	23/09/2021	TI/DRG/PSI/AT/ RDSO/00016/20/01	General arrangement of Sectioning and Paralleling Post (SP) in 2X25kV â˜ATâ™ System (on double line section) for Scott Connected Transformer TSS	Drawings	
146	23/09/2021	TI/DRG/PSI/AT/ RDSO/00017/20/01	General arrangement of Sub sectioning and Paralleling Post (SSP) in 2X25kV â˜ATâ™ System (on three line section).	Drawings	
147	23/09/2021	TI/DRG/PSI/AT/ RDSO/00042/20/01	General arrangement for Boundary sectioning & paralleling post (SP) in 2 x 25 kV âœv-connected" 'at' system (on double line section).	Drawings	
148	13/09/2021	TI-DRG-PSI-AT- RDSO-00044-21-0	TYPICAL SCHEMATIC DIAGRAM OF PROTECTION FOR 220/2*25 kV TRACTION SUB-STATION WITH V-CONNECTED TRANSFORMERS	Drawings	
149	13/09/2021	TI-DRG-PSI-AT- RDSO-00043-21-0	TYPICAL SYSTEMATIC DIAGRAM OF PROTECTION FOR 132/ 2*25 kV TRACTION SUB-STATION WITH SCOTT CONNECTED TRANSFORMERS	Drawings	
150	13/09/2021	RDSO-TI0LKO (PSI)/71/2020	Problem faced with working of M/s Megawin make CB and BM	Instructions/ SMIs	Draining of battery at SSP/SP

151	01/09/2021	TI/DRG/PSI/AT/ RDSO/00041/20/1	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Four Line section) with perpendicular to track.	Drawings	
152	01/09/2021	TI/DRG/PSI/AT/ RDSO/00040/20/1	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Four Line section) with parallel to track.	Drawings	
153	01/09/2021	TI/DRG/PSI/AT/ RDSO/00039/20/1	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Three Line section) with perpendicular to track.	Drawings	
154	01/09/2021	TI/DRG/PSI/AT/ RDSO/00038/20/1	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Three Line section) with parallel to track.	Drawings	
155	01/09/2021	TI/DRG/PSI/AT/ RDSO/00025/20/1	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Double Line section) with perpendicular to track.	Drawings	
156	01/09/2021	TI/DRG/PSI/AT/ RDSO/00024/20/1	Typical layout of 220/2X25kV traction Sub Station with Scott Connected Transformers (For Double Line section) with parallel to track.	Drawings	
157	01/09/2021	TI/DRG/PSI/AT/ RDSO/00033/20/1	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Four Line section) with perpendicular to track.	Drawings	

158	01/09/2021	TI/DRG/PSI/AT/ RDSO/00032/20/1	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Four Line section) with parallel to track.	Drawings	
159	01/09/2021	TI/DRG/PSI/AT/ RDSO/00031/20/1	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Three Line section) with perpendicular to track.	Drawings	
160	01/09/2021	TI/DRG/PSI/AT/ RDSO/00030/20/1	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Three Line section) with parallel to track.	Drawings	
161	01/09/2021	TI/DRG/PSI/AT/ RDSO/00010/20/1	Typical layout of 132/2X25kV traction Sub Station with Scott Connected Transformers (For Double Line section) with perpendicular to track.	Drawings	
162	30/08/2021	TI/SPC/PSI/ HVCB/0121 with A&C Slip No. 1	Specification for 220KV, 132KV, 110KV, 100 KV, 66KV and 50 kV Double Pole, Triple Pole Outdoor SF6 Circuit Breaker for Indian Railway.	Specifica-tions	With A & C slip no. 1
163	25/08/2021	TI/SPC/PSI/ ERTHNG/0210	Technical Specification For Earthing of Power Supply Installations of 25kV & 2X25kV, AC 50Hz, Traction System	Specifica-tions	This specification supersedes the specification no. ETI/ PSI/120 (02/91) with A&C slip no. 01
164	04/08/2021	TI/DRG/PSI/AT/ RDSO/00029/20/1	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Four Line section) with perpendicular to track.	Drawings	

165	04/08/2021	TI/DRG/PSI/AT/ RDSO/00028/20/1	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Four Line section) with parallel to track.	Drawings	
166	04/08/2021	TI/DRG/PSI/AT/ RDSO/00027/20/1	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Three Line section) with perpendicular to track.	Drawings	
167	04/08/2021	TI/DRG/PSI/AT/ RDSO/00026/20/1	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Three Line section) with parallel to track.	Drawings	
168	04/08/2021	TI/DRG/PSI/AT/ RDSO/00043/20/1	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Double Line section) with perpendicular to track.	Drawings	
169	04/08/2021	TI/DRG/PSI/AT/ RDSO/00042/20/1	Typical layout of 220/2X25kV traction Sub Station with V-Connected Transformers (For Double Line section) with parallel to track.	Drawings	
170	04/08/2021	TI/DRG/PSI/AT/ RDSO/00014/20/1	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Four Line section) with perpendicular to track.	Drawings	
171	04/08/2021	TI/DRG/PSI/AT/ RDSO/00013/20/1	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Four Line section) with parallel to track.	Drawings	
172	04/08/2021	TI/DRG/PSI/AT/ RDSO/00012/20/1	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Three Line section) with perpendicular to track.	Drawings	

173	04/08/2021	TI/DRG/PSI/AT/ RDSO/00011/20/1	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Three Line section) with parallel to track.	Drawings	
174	04/08/2021	TI/DRG/PSI/AT/ RDSO/00035/20/1	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Double Line section) with perpendicular to track.	Drawings	
175	04/08/2021	TI/DRG/PSI/AT/ RDSO/00034/20/1	Typical layout of 132/2X25kV traction Sub Station with V-Connected Transformers (For Double Line section) with parallel to track.	Drawings	
176	04/08/2021	TI/SPC/PSI/ AUTOTR/0091	Specification 50/75/150 MVA 220/132kV Three Phase oil immersed type Autotransformer	Specifica-tions	This speci-fication su-persedes the specification no. TI/SPC/ PSI/AUTO-TR/0090
177	29/07/2021	TI/SPC/PSI/200-250/ CHGR/0210	Technical Specification for battery charger for 110 Volt battery, 200/250 Ah at Traction Sub- station for 25kV / 2x25 kV electric traction installation	Specifica-tions	
178	29/07/2021	TI/SPC/PSI/40-150/ CHGR/1210	Technical Specification for Battery charger for 110 Volt battery, 150 Ah (for 2x25 kV) and 40Ah (for 25kV) at SP/ SSP for electric traction installation	Specifica-tions	
179	29/07/2021	TI/SPC/RCC/ SCADA/0133	Technical Specification for Supervisory Control and Data Acquisition System for 25kV and 2x25 kV Single Phase 50Hz ac Traction Power Supply	Specifica-tions	Effective from 29.01.2022

180	29/07/2021	TI/MI/0048 Revision 1	Maintenance Instructions for Provision of Disconnector Assembly to the Lightening Arresters provided over 25 kV side of traction system on Indian Railways	Instructions/ SMIs	for n.a. [lease
181	23/07/2021	TI/SPC/PSI/ PROTCT/7101	Technical specification for Control and Relay Panel Including Numerical type protection relays for Scott-connected/V-Connected Single-Phase Traction Transformers, OHE protection, 55 kV AT Protection & Shunt Capacitor Bank Protection for 2x25 kV Traction Sub-station, Sectioning and Paralleling Post, Sub-Sectioning & Paralleling Post and Auto Transformer Post	Specifica-tions	Specifi-cation of control and relay panel for 2x25KV ac Trac-tion- Effec-tive from 19.01.2022
182	19/07/2021	TI/SPC/PSI/ LVGIS/0210	Technical Specification for 25kV Gas Insulated Switchgear (GIS) for AC Traction System of Indian Railways	Specifica-tions	
183	19/07/2021	TI/SPC/PSI/ HVGIS/0210	Technical Specification for 220kV, 132kV Gas Insulated Switchgear (GIS) for AC Traction System of Indian Railways	Specifica-tions	
184	13/07/2021	TI/STR/019 (Revision - 1)	Schedule of Infrastructure Requirements for Approval of Vendors for supply, manufacture, testing and quality control of Current Transformer	Specifica-tions	
185	29/06/2021	TI/SPC/OHE/ NETRA/0140 (07/2019) Rev2	Technical Specification for Shunt Capacitor & Series Reactor equipment for 2X25kV Feeding System	Specifica-tions	This specifica-tion supersedes the specifica-tion no. ETI/ PSI/126(08/1989) with A&C slip no. 01 to 03

186	29/06/2021	TI/SPC/OHE/ NETRA/0140 (07/2019) Rev2	Technical Specification for Shunt Capacitor & Series Reactor equipment for 2X25kV Feeding System	Specifications	This specification supersedes the specification no. ETI/ PSI/126(08/1989) with A&C slip no. 01 to 03
187	25/06/2021	TI/SPC/PSI/PT/0210	TECHNICAL SPECIFICATION FOR 220kV OR 132kV OR 110kV OR 66kV or 25kV POTENTIAL TRANSFORMER	Specifications	This specification supersedes the specification No. TI/ SPC/PSI/ PTs/0990
188	22/06/2021	TI/SPC/PSI/ TRNPWR/3201	Specification for 13.5/18.9MVA, 21.6/30.24MVA, 30/42MVA & 40/56MVA Single Phase Traction Power Transformer	Specifications	This specification supersedes the specification no. TI/SPC/ PSI/TRNPWR/3200 with A&C slip no. 01, ETI/PSI/118(10/93) with A&C slip no. 01 to 11, TI/SPC/ PSI/30TRN/2070 with A&C slip no. 01, TI/ SPC/PSI/30TRN/1050 with A&C slip no. 01 & 02 and ETI/PSI/163 with A&C slip no. 01 to 04
189	21/06/2021	TI/SPC/PSI/CT/0210	TECHNICAL SPECIFICATION FOR CURRENT TRANSFORMERs WITH CT RATIO OF 220 kV, 400-200/5A & 200-100/5A 132 kV, 800-400/5A & 400-200/5A 110kV, 800-400/5A & 400-200/5A 66kV, 1200-600/5A & 800-400/5A 50kV, 1500-750/5A & 200/5A 25kV, 3000-1500/5A, 1600-800-400/5A, 1500-750/5A, 1000-500/5A, 400-200/5A & 100-50/5A 11kV, 500/5A	Specifications	This specification supersedes the earlier specification No. ETI/ PSI/36(05/75), ETI/ PSI/90(06/95), ETI/ PSI/117(7/88), ETI/ PSI/145(03/92) & ETI/ PSI/147(03/92)
190	07/06/2021	TI/DRG/PSI/ CR2X25/ SPSSPATP/0210	Typical Layout of Control Room Building in 2x25 kv SP/SSP/AT Post.	Drawings	for Switching post in 2X25kV system

191	27/05/2021	TI-DRG-PSI-CR2X25-RDSO-0210	Typical layout of control Room Building in 2X25kV Traction Substation.	Drawings	
192	23/02/2021	ETI/C/3 (5/83) Rev.-1	Technical specification for spraying zinc coating on OHE Masts for railway electrification	Specifica-tions	
193	23/02/2021	TI/SPC/CIV/POR/0080(08/2008) Rev.-1	Corrosion resistance paint system for outdoor structure of traction distribution and traction rolling stock	Specifica-tions	
194	03/02/2021	TI/SPC/PSI/AUTOTR/1200	Specification for 8MVA, 12.3MVA & 16.5MVA - 55/27.5kV Autotransformer of 2X25kV System	Specifica-tions	
195	03/02/2021	TI/SPC/PSI/TRNPWR/5200	Specification of Scott Connected 54MVA & 60/84/100MVA Traction Power Transformer of 2X25kV System	Specifica-tions	
196	03/02/2021	TI/SPC/PSI/TRNPWR/4200	Specification of Single Phase Dual LV 21.6MVA & 38/53/63 MVA Traction Power Transformer of 2X25kV System	Specifica-tions	
197	20/01/2021	TI/SPC/OHE/STRIP(Al-Cu)/0901	Technical Specification for BIMETALLIC (ALUMINIUM-COPPER) STRIP	Specifica-tions	This specification is revision of the Specification No. ETI/OHE/55(4/90)
198	18/01/2021	TI/SPC/OHE/JMP/0941	Technical Specification for Annealed Stranded Copper Conductors for Jumper Wire for Electric Traction	Specifica-tions	This specification is revision of the Specification No. ETI/OHE/3(2/94)
199	08/01/2021	TI/SPC/OHE/CCC/0871	Technical Specification for Continuous Cast Copper Wire Rods	Specifica-tions	This specification is revision of the Specification No. ETI/OHE/65(8/87)
200	04/01/2021	TI/SPC/OHE/CAT(Cu-Cd)/0971	Technical Specification for Cadmium Copper Conductors for Over Head Electric Traction	Specifica-tions	This specification is revision of the Specification No. ETI/OHE/50(6/97)

201	01/01/2021	TI/SPC/OHE/ CW/0971	Technical Specification for Hard Drawn Grooved Copper Contact Wire (Drawn out of Continuous Cast Copper wire rods)	Specifica- tions	This spec- ification is revision of the Specifica- tion No. ETI/ OHE/76(6/97)
202	14/12/2020	TI/SPC/OHE/ HDCSCF/0031	Technical Specification for Hard Drawn Stranded Copper Conductor	Specifica- tions	This specifica- tion is revision of the Specifi- cation No. TI/ SPC/OHE/ HDCSCF/0030
203	24/11/2020	TI/IN/0043 Rev.0	PSI Guidelines for increasing speed potential to 160 kmph on NDLS_- HWH & NDLS- BCT Routes	Instructions/ SMIs	
204	23/10/2020	TI/IN/0042	OHE Guidelines for increasing speed potential to 160 kmph on NDLS_- HWH & NDLS- BCT Routes	Instructions/ SMIs	
205	26/02/2020	TI/SMI/0032 Rev.02	SETTING UP EARTHING STATION AT SWITCHING POSTS (SSP & SP) WITH CONVENTIONAL EARTHING SYSTEM	Instructions/ SMIs	Rev.02
206	20/01/2020	TI/MI/0059	Prevention of bird faults and melting/flashing of catenary wire under suspension clamp	Instructions/ SMIs	
207	08/01/2020	TI/SPC/PSI/ TRNPWR/3200	Technical specification for 13.5/18.9MVA, 21.6/30.24MVA & 30/42MVA Single Phase Traction Power Transformer	Specifica- tions	effec- tive from 01.04.2020
208	18/11/2019	RE/33/P/1160 Rev K	Suspension Clamp	Drawings	Suspension Clamp Including Packing Saddle
209	11/11/2019	TI/SPC/OHE/ MRI/0140 Rev.01	Technical Specification for Measuring and Recording Instrumentation to be Retrofitted on 8-Wheeler Tower Cars	Specifica- tions	W.E.F. 11.11.2019
210	05/11/2019	TI/DRG/PSI/TSSLO/ RDSO/00013/19/00	Layout and General arrangement 132/25kV Traction Sub-Station	Drawings	with reduced area

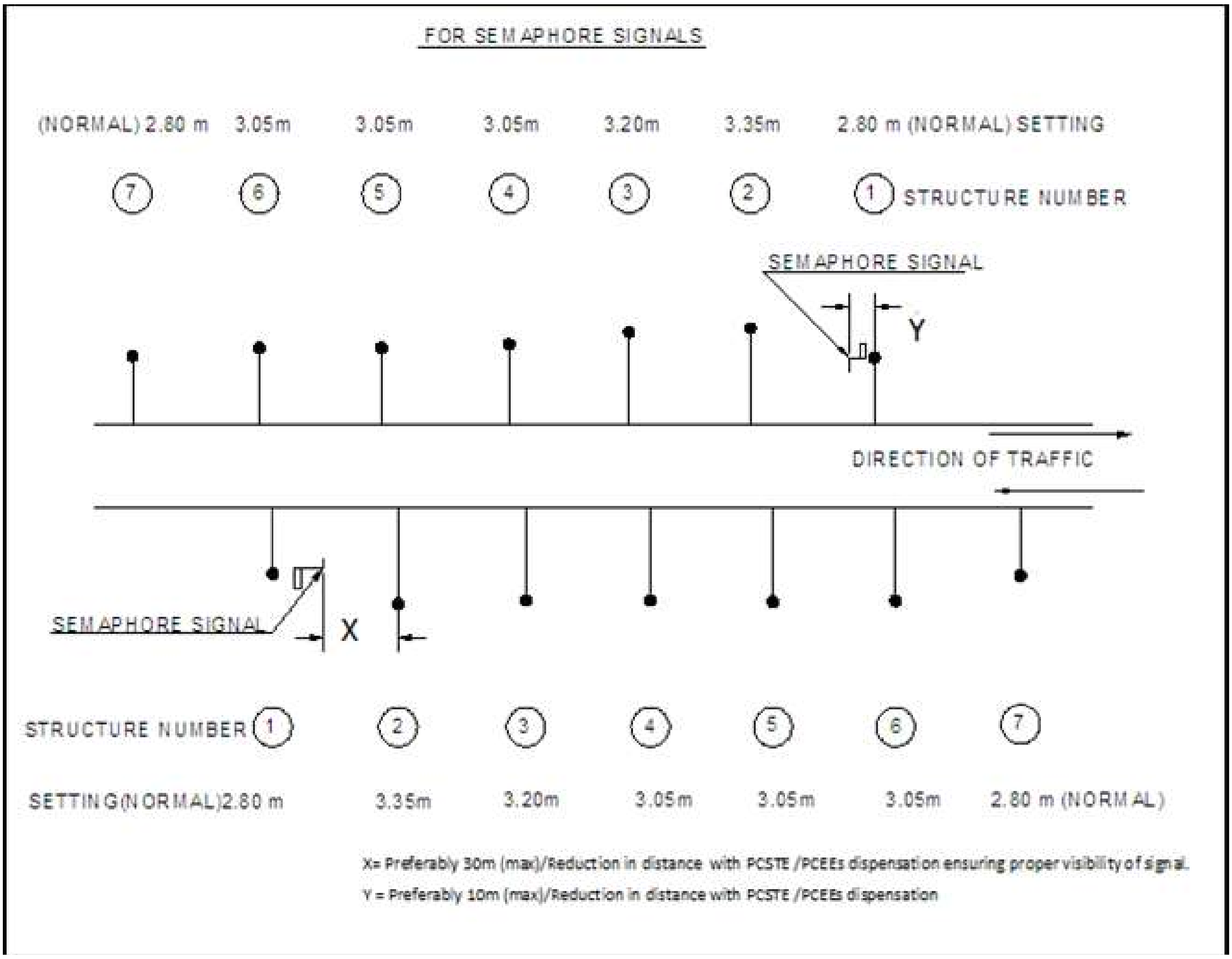
211	02/11/2019	TI/IN/0040 Rev0	Cleaning Instruction for 25 kV Composite Insulator	Instructions/ SMIs	Cleaning Instruction for 25 kV Composite Insulator
212	31/10/2019	TI/SPC/OHE/ SPOLT/0140 Rev.1	Self-propelled Over-Head-Equipment-Laying-Train for Broad Gauge (1676 mm) Routes of Indian Railways	Specifica-tions	
213	08/07/2019	TI/SPC/OHE/ TIPS/1030, REV.1	Specification for infrared imaging system for stationary installation	Specifica-tions	Rev.1
214	25/06/2019	TI/SPC/ OHE/3PHTATD/050	Checklist for maintenance of 25 kV Porcelain & Composite insulators	Instructions/ SMIs	Checklist for Insulators
215	30/05/2019	TI/SPC/PSI/ NCLR/0190	Technical Specification for Numerical Control Logic Relay (NCLR) and Control Panel for Automatic Phase Switching Section (APSS) for 25 kV Single Phase 50 Hz AC Traction Power Supply System of Indian Railway	Specifica-tions	
216	15/05/2019	TI/SPC/RCC/ DCADA/0130 (Rev.02)	Technical Specification for Supervisory Control and Data Acquisition System for 25kV Single Phase 50Hz Traction Power Supply	Specifica-tions	with A&C slip no. 03
217	14/05/2019	TI/SPC/PSI/ LVCBIN/0120 (Dec,2013) Rev. 0	25kV Single Pole, Double Pole, Pole Mounted Outdoor Vacuum circuit Breaker and Vacuum Interrupter for Indian Railway	Specifica-tions	With A&C Slip No. 1 & 2
218	26/04/2019	TI/REPORT/ OHE/2019/00132	Failure Analysis of 25 kV Solid Core Porcelain Insulators used in IR	Reports	Failure Analysis of 25 kV Solid Core Porcelain Insulators used in IR
219	31/12/2018	ETI/OHE/SK/588 REV.B	EYE ROD DRAWING 1.8 METER FOR 800KG COUNTER WEIGHT ASSESMBLY	Drawings	

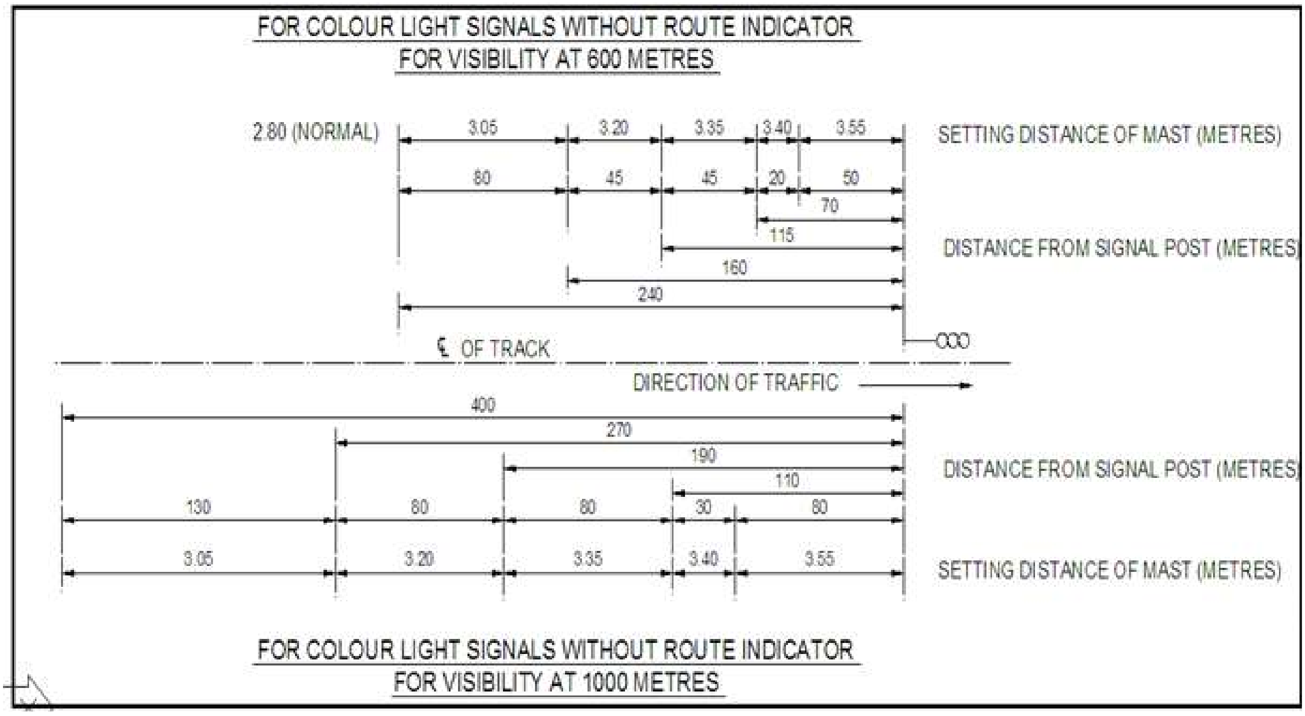
*****

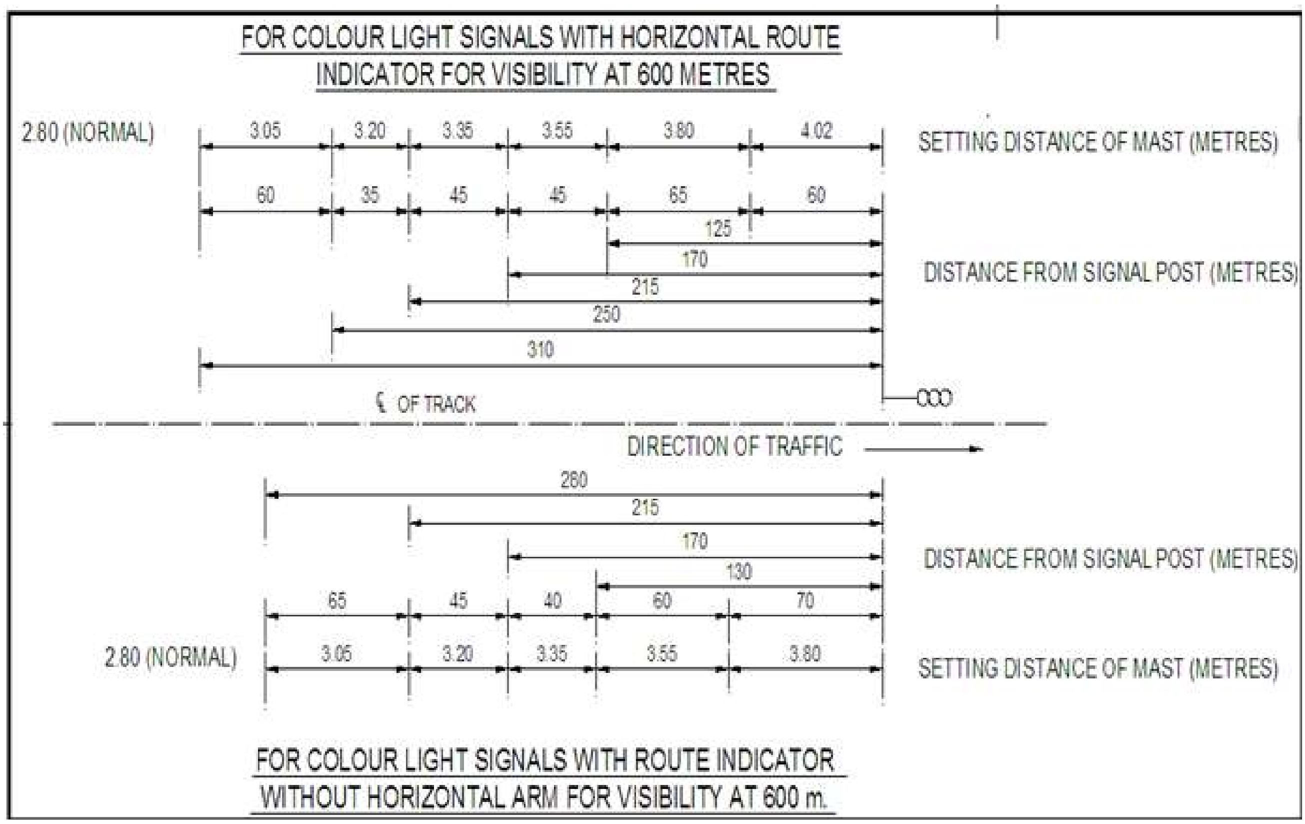
APPENDIX-10
25 kV OHE DIAGRAMS OF GENERAL ARRANGEMENT AND FITTINGS

CONTENTS

41 Catenary dropper assembly.
42 25 mm regulator arm assembly.
43 Tubular stay arm.
44 Steady arm assembly.
45 25 mm raised register arm assembly.
46 Structure bonds.
47 Insulators.
48 Warning boards.




FOR COLOUR LIGHT SIGNALS WITHOUT ROUTE INDICATOR
FOR VISIBILITY AT 600 METRES
2.80 (NORMAL)
3.05
3.20
3.35
3.40
3.55
SETTING DISTANCE OF MAST (METRES)
80
45
45
20
50
70
115
160
240
DISTANCE FROM SIGNAL POST (METRES)
OF TRACK
DIRECTION OF TRAFFIC
400
270
190
110
130
80
80
30
80
DISTANCE FROM SIGNAL POST (METRES)
3.05
3.20
3.35
3.40
3.55
SETTING DISTANCE OF MAST (METRES)
FOR COLOUR LIGHT SIGNALS WITHOUT ROUTE INDICATOR
FOR VISIBILITY AT 1000 METRES


FOR COLOUR LIGHT SIGNALS WITH HORIZONTAL ROUTE
INDICATOR FOR VISIBILITY AT 600 METRES
2.80 (NORMAL)
3.05
3.20
3.35
3.55
3.80
4.02
SETTING DISTANCE OF MAST (METRES)
60
35
45
45
65
60
125
170
215
250
310
DISTANCE FROM SIGNAL POST (METRES)
OF TRACK
DIRECTION OF TRAFFIC
260
215
170
130
65
45
40
60
70
DISTANCE FROM SIGNAL POST (METRES)
2.80 (NORMAL)
3.05
3.20
3.35
3.55
3.80
SETTING DISTANCE OF MAST (METRES)
FOR COLOUR LIGHT SIGNALS WITH ROUTE INDICATOR
WITHOUT HORIZONTAL ARM FOR VISIBILITY AT 600 m.

SUITABLE FOR MAX. SPEED OF 200 KM/H

DEGREE OF CURVATURE	RADIUS OF CURVATURE(m)	EXTRA CLEARANCE IN mm. BETWEEN STRUCTURE AND ADJACENT TRACK (OTER THAN PLATFORMS) — INSIDE OF CURVES: UPTO 840 mm ABOVE RAIL LEVEL (mm)	FROM 840 mm TO 4420 mm ABOVE RAIL LEVEL (mm)	AT 5410 mm ABOVE RAIL LEVEL (mm)	OUTSIDE OF CURVE FOR ANY HEIGHT (mm)	EXTRA CLEARANCE BETWEEN ADJACENT TRACKS WHEN THERE IS NO STRUCTURE BETWEEN TRACKS (mm)
1	2	3	4	5	6	7
½°	3492	—	195	245	—	90
¾°	2328	45	400	500	—	160
1°	1746	80	575	710	—	220
1½°	1164	90	585	720	—	230
2°	873	100	590	730	10	250
3°	582	115	605	745	30	285
4°	436.5	130	620	760	45	315
5°	349.2	145	640	775	60	350
6°	291	160	655	790	80	380

NOTE :-

1. WHERE ELECTRIC TRACTION IS LIKELY TO BE INTRODUCED, FOR HEIGHT ABOVE 5410mm AND UPTO THE HEIGHT OF TRACTION CONDUCTORS, THE FIGURES IN COLUMNS 5 IS TO BE INCREASED BY 1mm FOR EVERY 12 AND 8 mm INCREASE IN HEIGHT EXCEEDING 5410 1:1 TABLE
2. WHERE STRUCTURE IS LOCATED BETWEEN TRACKS THE EXTRA CLEARANCE SHOULD BE PROVIDED ACCORDING TO COLUMNS 3, 4, 5 & 6

3 (A) STANDARD SETTING ON TANGENT AND ON OOUT SIDE OF CURVED TRACKS } 2500 mm
(B) STANDARDF SETTING ON INSIDE OF CURVED TRACK FOR

(I)		RADIUS ≥	3500 m	2750 mm
(ii)	3500 m >	RADIUS ≥	2350 m	2900 mm
(iii)	2350 mm >	RADIUS ≥	1150 m	3050 mm
(iv)	1150 m	RADIUS ≥	300 m	3100 mm

G/00111 SH.1

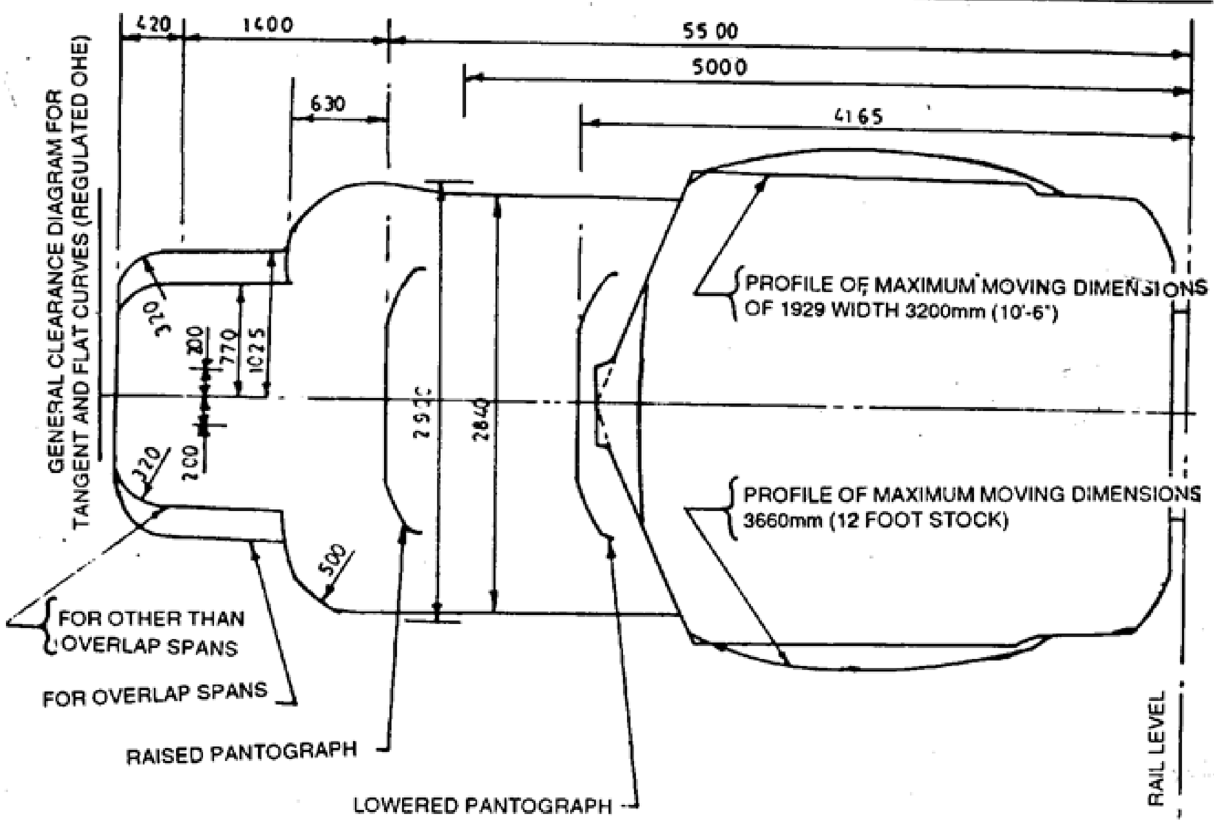
SUITABLE FOR MAX. SPEED OF 106 KM/H

DEGREE OF CURVATURE	RADIUS OF CURVATURE(m)	EXTRA CLEARANCE IN mm. BETWEEN STRUCTURE AND ADJACENT TRACK (OTER THAN PLATFORMS) — INSIDE OF CURVES: UPTO 840 mm ABOVE RAIL LEVEL (mm)	FROM 840 mm TO 4420 mm ABOVE RAIL LEVEL (mm)	AT 5410 mm ABOVE RAIL LEVEL (mm)	OUTSIDE OF CURVE FOR ANY HEIGHT (mm)	EXTRA CLEARANCE BETWEEN ADJACENT TRACKS WHEN THERE IS NO STRUCTURE BETWEEN TRACKS (mm)
1	2	3	4	5	6	7
½°	3492	—	—	—	—	—
¾°	2328	—	—	—	—	—
1°	1746	—	130	170	—	80
1½°	1164	20	220	280	—	120
2°	873	40	310	380	10	170
3°	582	70	390	480	30	220
4°	436.5	90	420	520	40	260
5°	349.2	100	420	510	60	280
6°	291	110	390	470	80	300
7°	250	140	470	560	90	350
8°	219	160	540	640	110	400
9°	194	180	550	650	130	430
0°	175	180	500	590	140	450

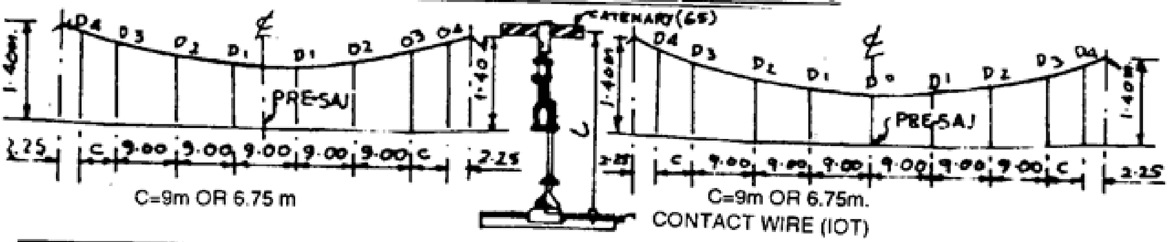
SEE PAGE - 5

EXTRA ALLOWANCE FOR SETTING OF STRUCTURES ON CURVES

G/00111 SH.2



DROPPER SCHEDULE FOR REGULATED OHE WITH EQUAL ENCUMBRANCE 1.40/1.40

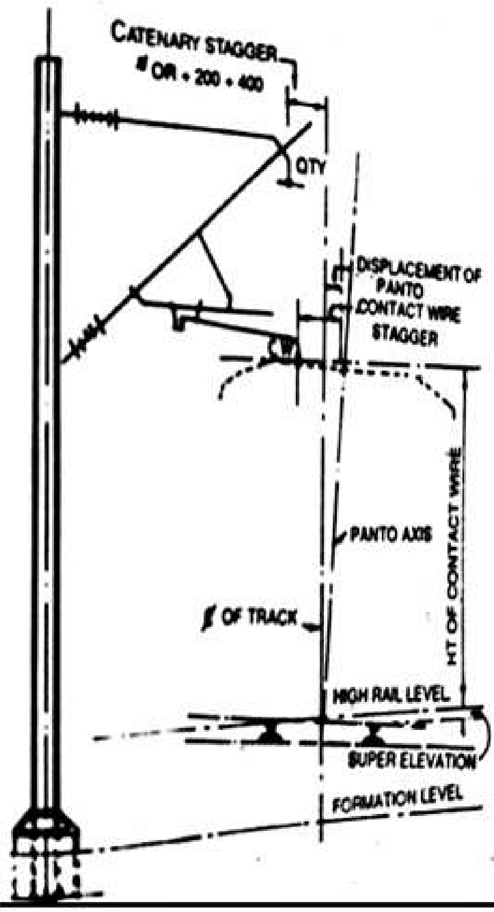


FOR 50 mm PRE SAG. - OHE

SPAN IN METRES	NO. OF DROPPER	DROPPER LENGTHS IN mm(L) D4	D3	D2	D1	D0
72.00	9	1272	985	702	532	475
67.50	8	1280	940	713	600	—
63.00	8	1280	1044	817	704	—
58.50	7	—	1296	1013	843	786
54.00	7	—	1305	1102	932	876
49.50	6	—	1313	1086	972	—
45.00	6	—	1321	1161	1048	—
40.50	5	—	—	1329	1159	1102
36.00	5	—	—	1337	1220	1163
31.50	4	—	—	1345	1232	—
27.00	4	—	—	1353	1279	—
22.50	3	—	—	—	1361	1305

FOR 100 mm PRE SAG. - OHE

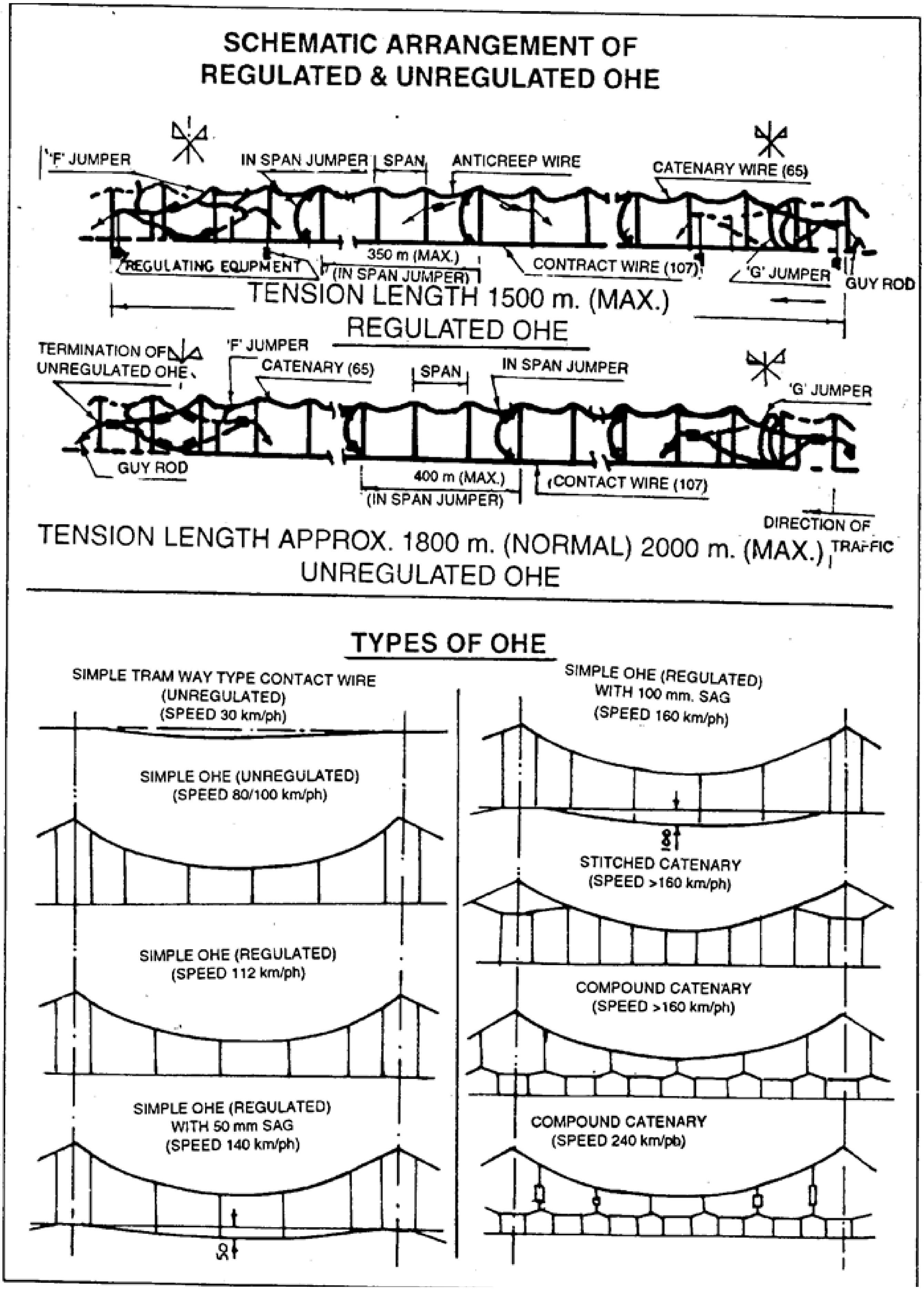
SPAN IN METRES	NO. OF DROPPER	DROPPER LENGTHS IN mm(L) D4	D3	D2	D1	D0
72.00	9	1273	1018	767	617	566
67.50	8	1281	980	778	678	—
63.00	8	1288	1071	870	770	—
58.50	7	—	1298	1046	896	845
54.00	7	—	1305	1126	975	925
49.50	6	—	1313	1112	1011	—
45.00	6	—	1921	1180	1079	—
40.50	5	—	—	1329	1178	1128
36.00	5	—	—	1337	1233	1183
31.50	4	—	—	1345	1245	—
27.00	4	—	—	1353	1287	—
22.50	3	—	—	—	1362	1311
18.00	3	—	—	—	1370	1342

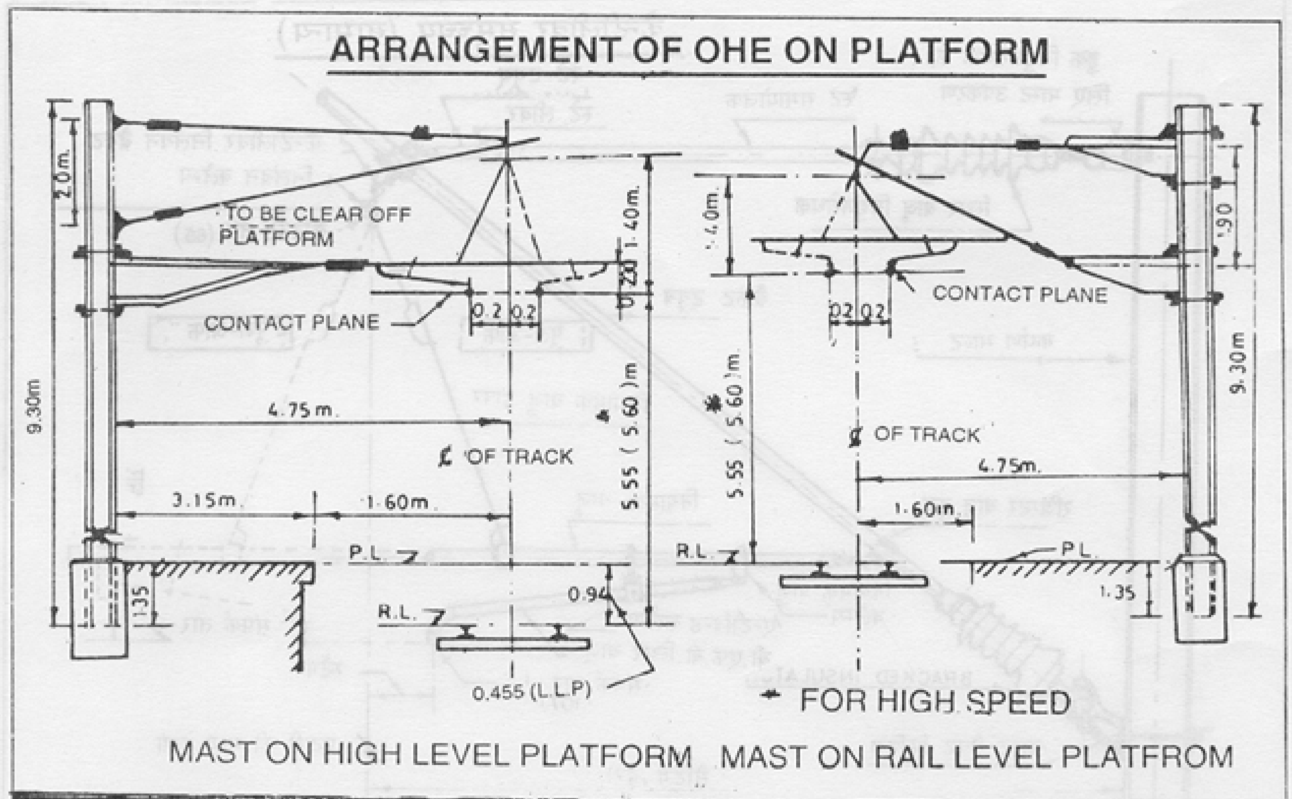


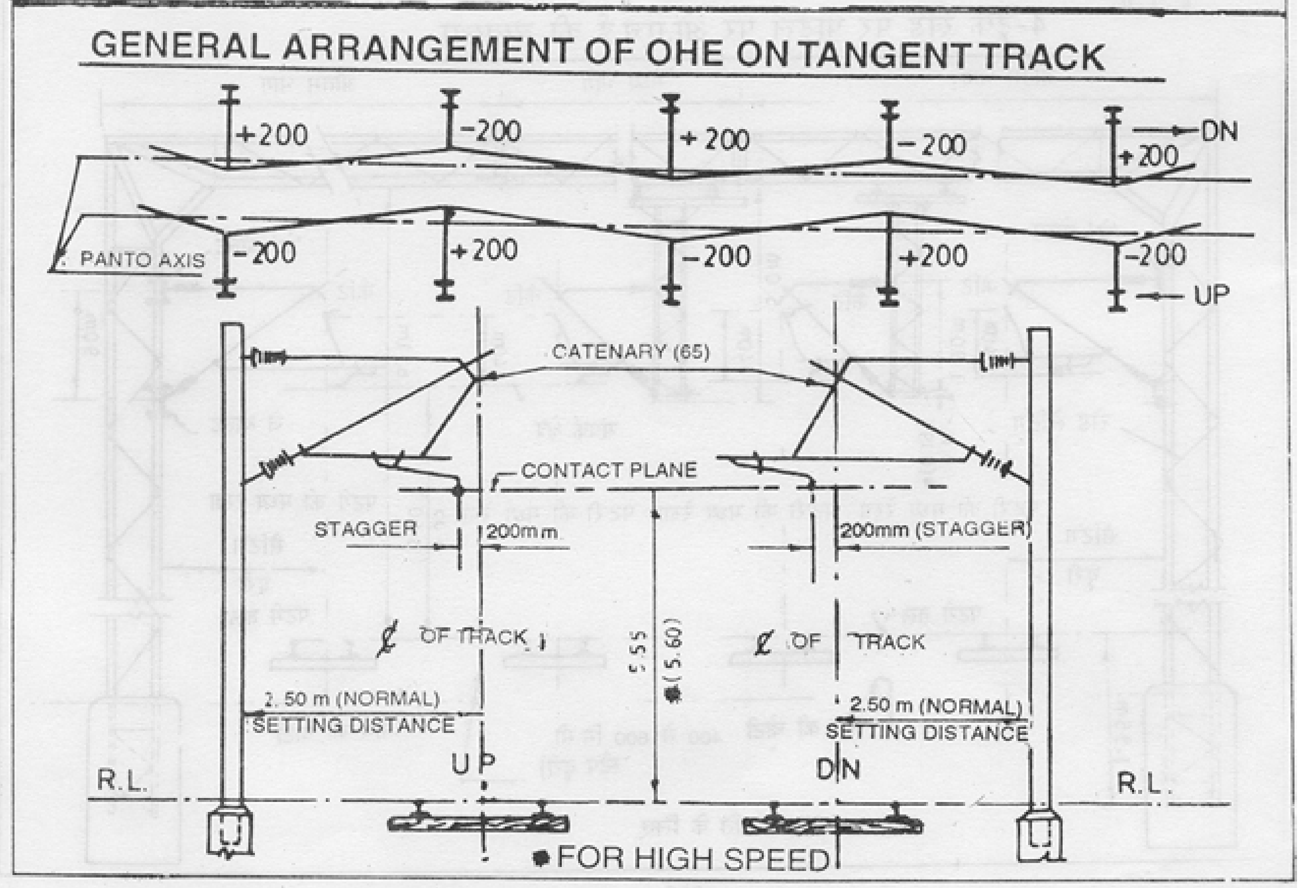
SPAN & STAGGER CHART FOR MIRROR IMAGE
(Sections undergoing doubling & trippling with Electrifications)

Radius of Curve	Maximum OHE Span wind load (kgf/sq. m)					Contact wire stagger at support
	73	105	136	155	178	
m	m	m	m	m	m	mm
∞	72	72	72	67.5	63	± 200
≥5000	67.5	67.5	67.5	63.0	58.5	± 100
≥4000	67.5	67.5	67.5	63.0	58.5	± 150
≥3000	67.5	67.5	67.5	63.0	58.5	± 150/200
≥2500	67.5	67.5	67.5	63.0	58.5	± 200/250
≥2200	67.5	67.5	67.5	63.0	58.5	± 250/300
≥1900	67.5	67.5	67.5	63.0	58.5	±300
≥1600	63.0	63.0	63.0	58.5	58.5	±300
≥1400	58.5	58.5	58.5	54.0	54.0	±300
≥1150	54.0	54.0	54.0	49.5	49.5	±300
≥850	49.5	49.5	49.5	49.5	49.5	±300
≥700	45.0	45.0	45.0	45.0	45.0	±300
≥550	40.5	40.5	40.5	40.5	40.5	±300
≥400	36.0	36.0	36.0	36.0	36.0	±300

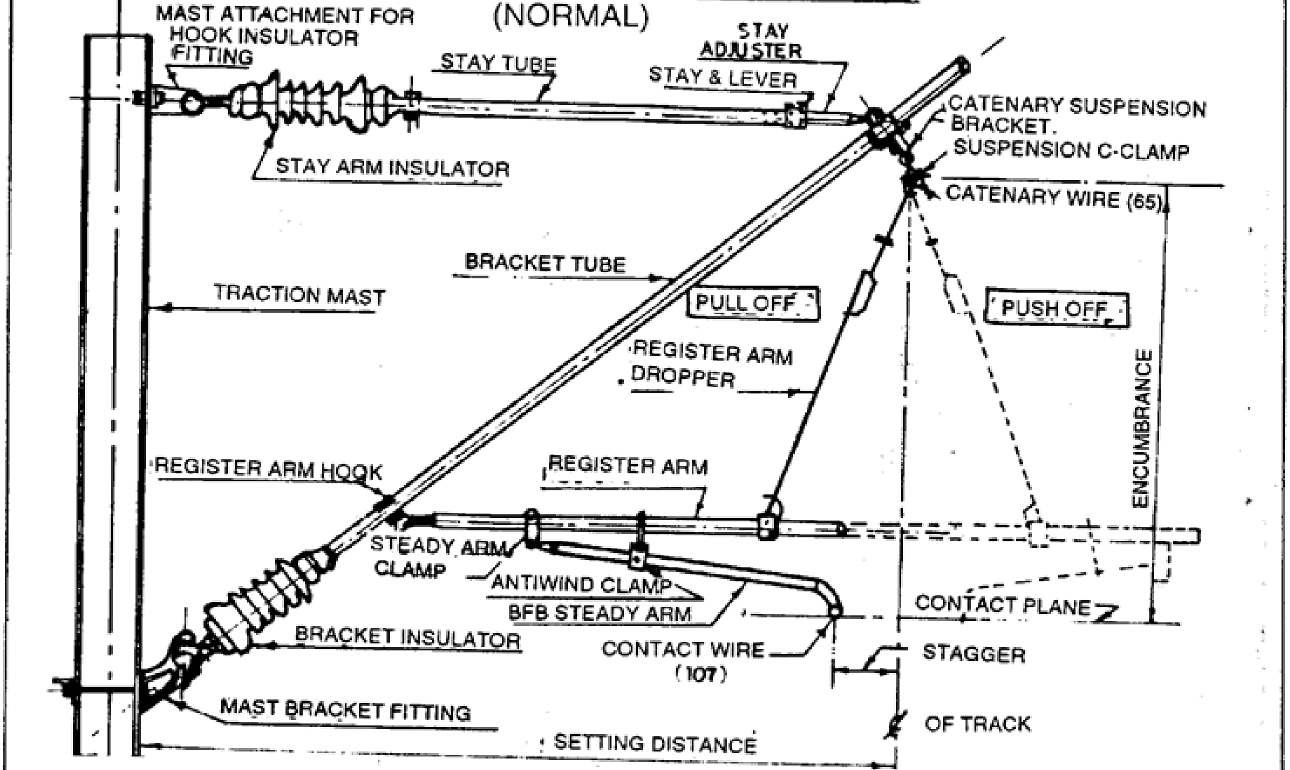
MAX. SPAN CONSIDERED ON NON MOVEMENT OF ELECT. LOCO FOR W.S > 30M/S


SCHEMATIC ARRANGEMENT OF
REGULATED & UNREGULATED OHE
'F' JUMPER
IN SPAN JUMPER
SPAN
ANTICREEP WIRE
CATENARY WIRE (65)
REGULATING EQUIPMENT
350 m (MAX.)
(IN SPAN JUMPER)
CONTRACT WIRE (107)
'G' JUMPER
GUY ROD
TENSION LENGTH 1500 m. (MAX.)
REGULATED OHE
TERMINATION OF UNREGULATED OHE
'F' JUMPER
CATENARY (65)
SPAN
IN SPAN JUMPER
'G' JUMPER
GUY ROD
400 m (MAX.)
(IN SPAN JUMPER)
CONTACT WIRE (107)
DIRECTION OF TRAFFIC
TENSION LENGTH APPROX. 1800 m. (NORMAL) 2000 m. (MAX.)
UNREGULATED OHE
TYPES OF OHE
SIMPLE TRAM WAY TYPE CONTACT WIRE (UNREGULATED) (SPEED 30 km/ph)
SIMPLE OHE (UNREGULATED) (SPEED 80/100 km/ph)
SIMPLE OHE (REGULATED) (SPEED 112 km/ph)
SIMPLE OHE (REGULATED) WITH 50 mm SAG (SPEED 140 km/ph)
SIMPLE OHE (REGULATED) WITH 100 mm. SAG (SPEED 160 km/ph)
STITCHED CATENARY (SPEED >160 km/ph)
COMPOUND CATENARY (SPEED >160 km/ph)
COMPOUND CATENARY (SPEED 240 km/pb)

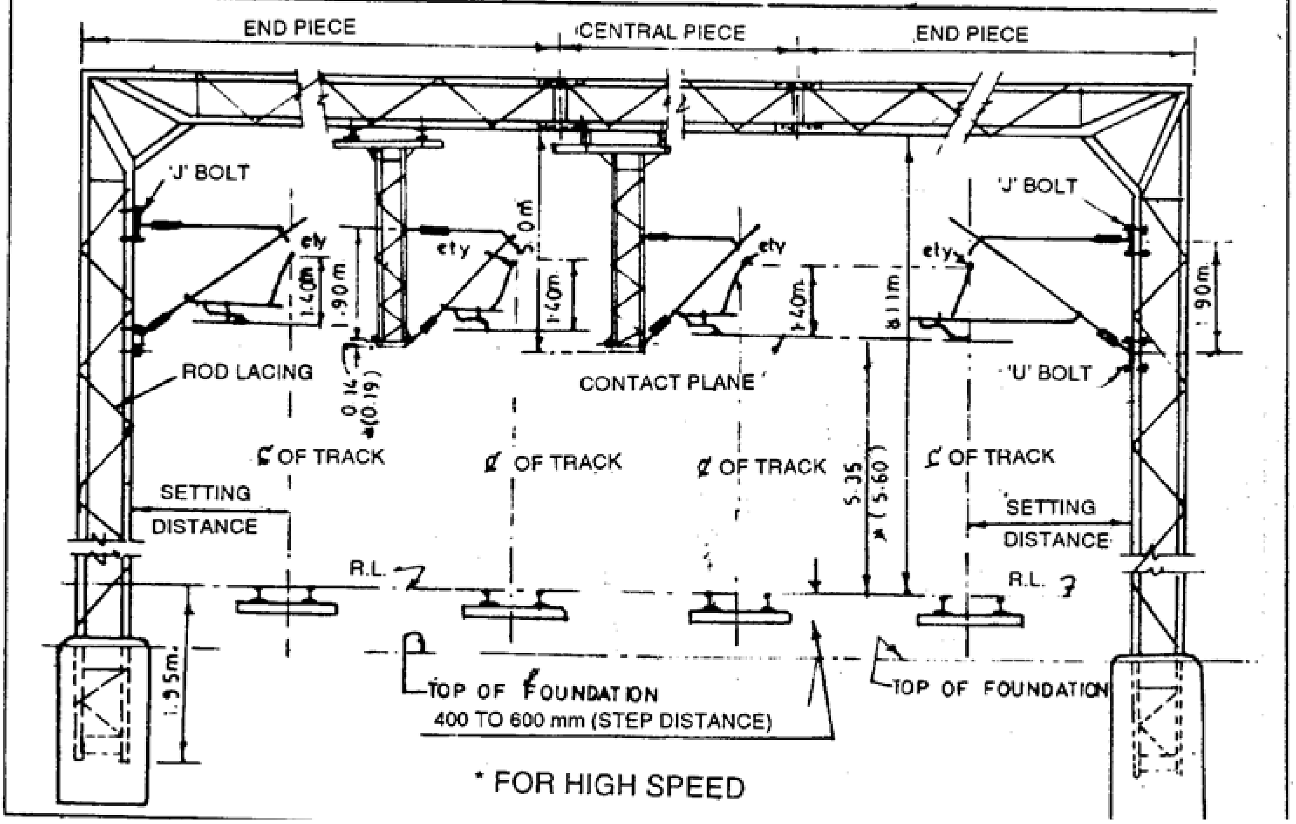

ARRANGEMENT OF OHE ON PLATFORM
2.0m.
TO BE CLEAR OFF PLATFORM
CONTACT PLANE
0.2 0.2
1.40m.
230
9.30m
4.75 m.
OF TRACK
5.55 (5.60)m
3.15m
1.60m
P.L.
135
R.L.
0.94
0.455 (L.L.P)
4.0m.
CONTACT PLANE
0.2 0.2
1.90
9.30m
5.55 (5.60)m
OF TRACK
4.75m.
1.60m.
R.L.
P.L.
1.35
FOR HIGH SPEED
MAST ON HIGH LEVEL PLATFORM
MAST ON RAIL LEVEL PLATFROM


GENERAL ARRANGEMENT OF OHE ON TANGENT TRACK
+200
-200
+200
-200
+200
DN
PANTO AXIS
-200
+200
-200
+200
-200
UP
CATENARY (65)
CONTACT PLANE
STAGGER
200mm
200mm (STAGGER)
OF TRACK
5.55
(5.60)
OF TRACK
2.50 m (NORMAL)
SETTING DISTANCE
2.50 m (NORMAL)
SETTING DISTANCE
UP
DN
R.L.
R.L.
FOR HIGH SPEED

CANTILEVER ASSEMBLY (NORMAL)

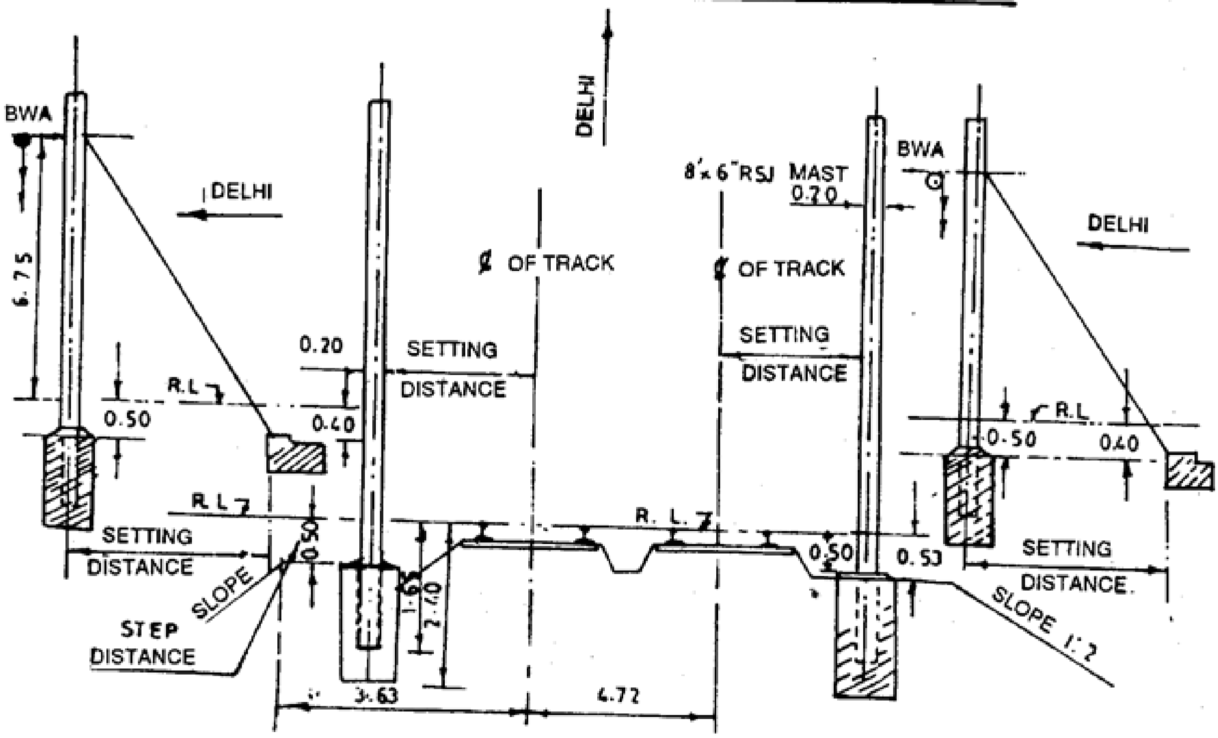


ARRANGEMENT OF OHE ON PORTAL AT 4 TRACK SECTION



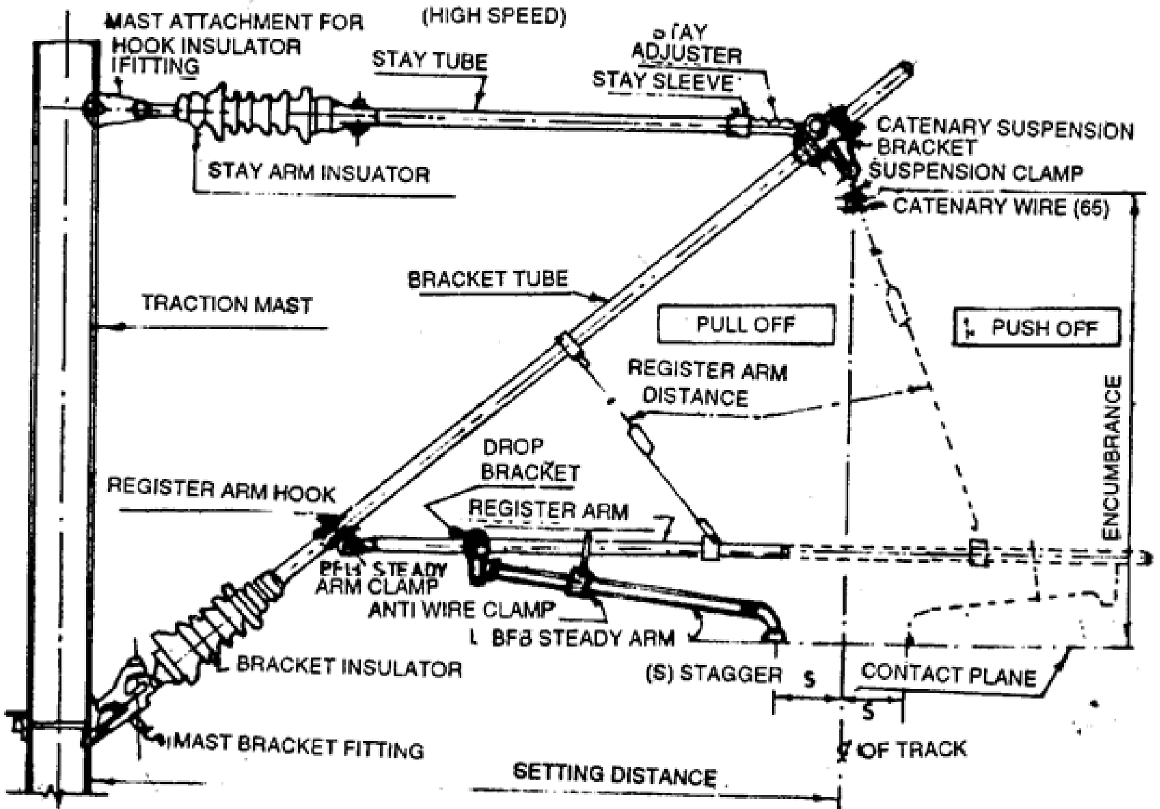
* FOR HIGH SPEED

TYPICAL CROSS SECTION OF TWO TRACK SECTION WITH ANCHOR BLOCK



CANTILEVER ASSEMBLY

(HIGH SPEED)



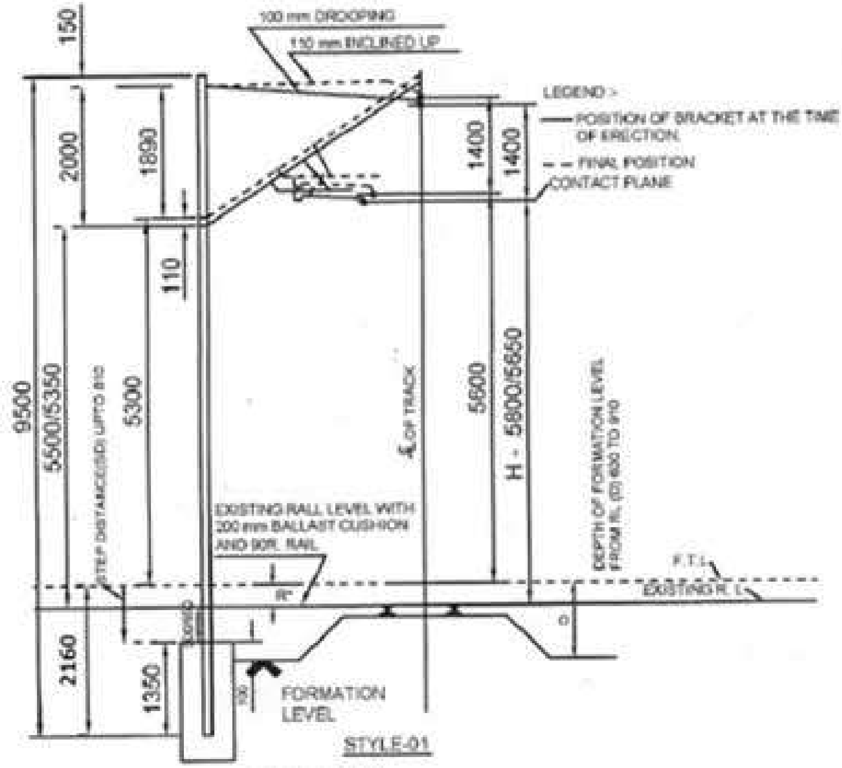
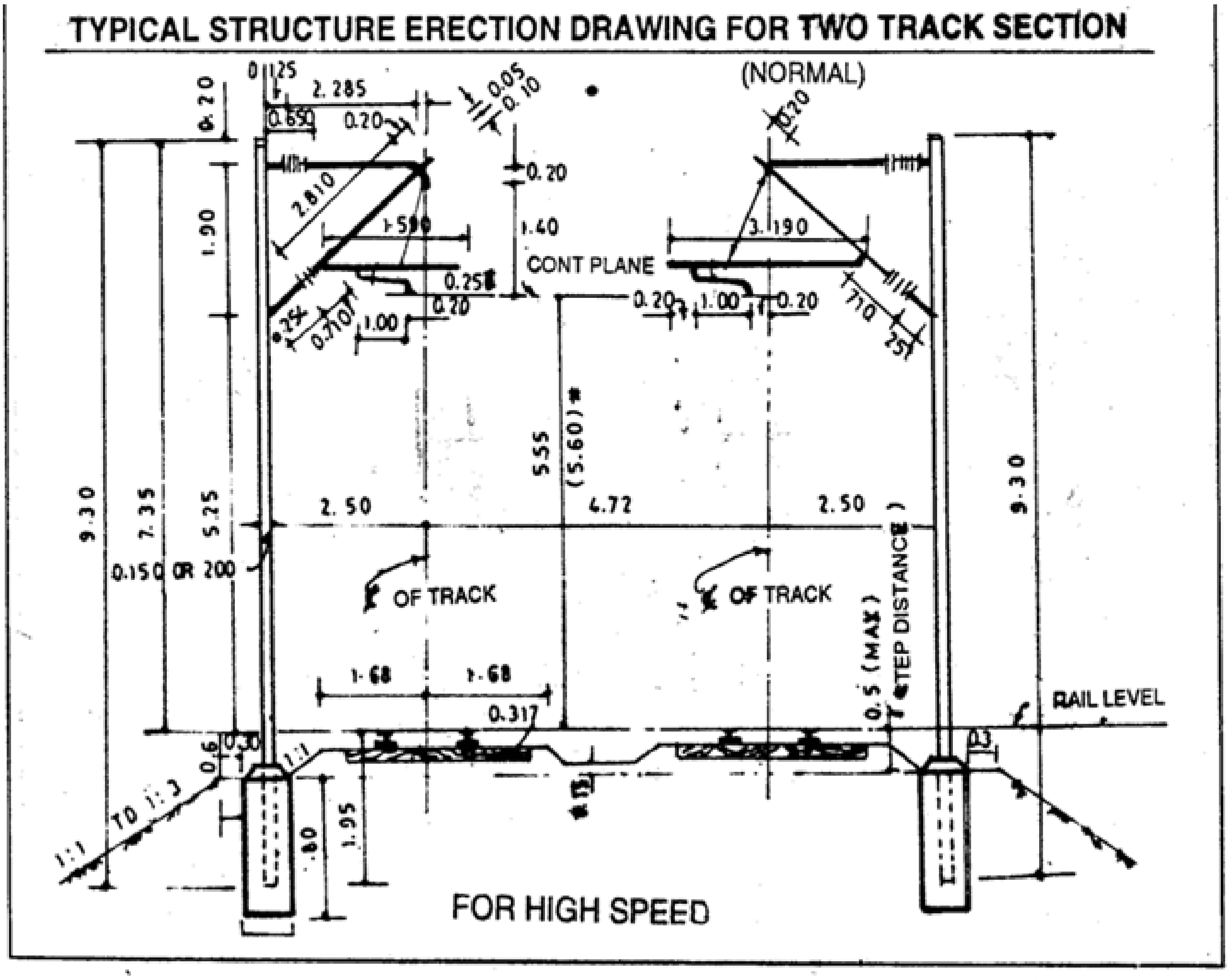
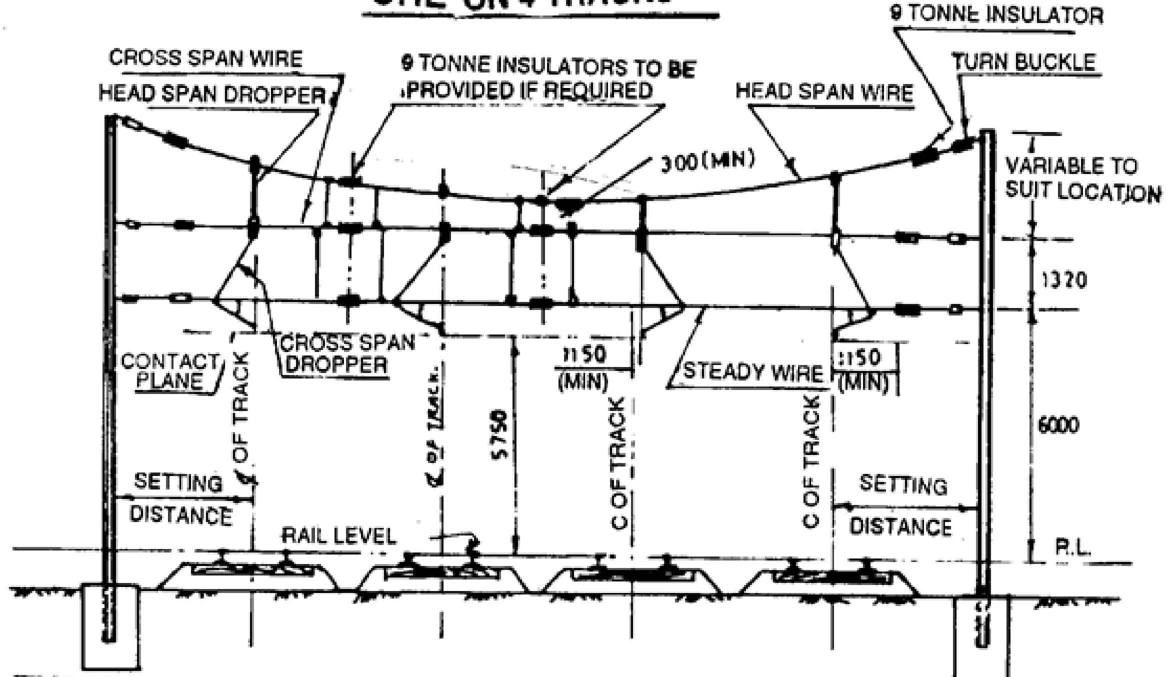


TABLE-II

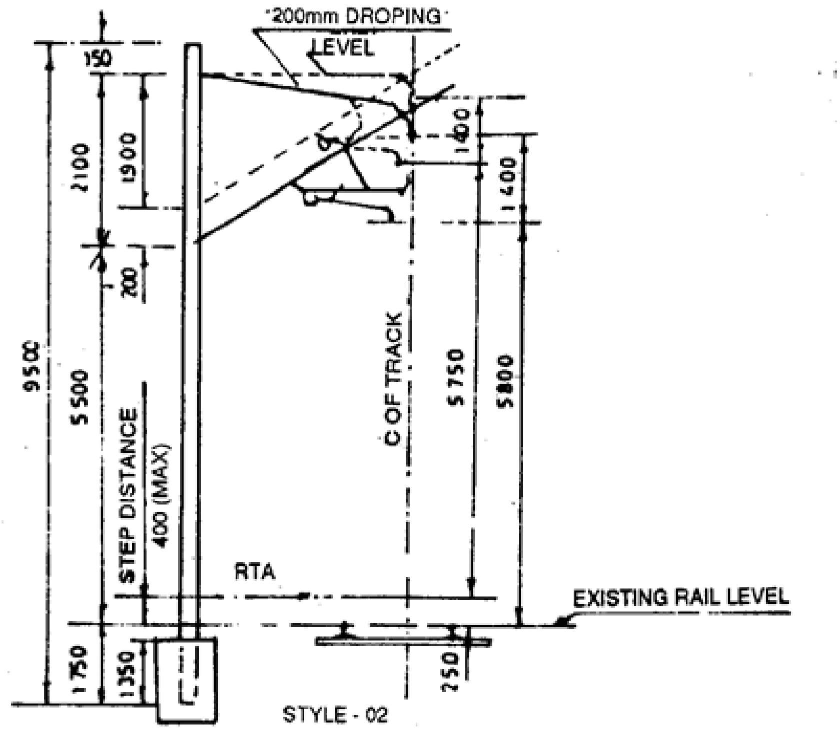
ERECTION SCHEDULE OF BRACKET ASSEMBLY FOR REGULATED OHE								
AT THE TIME OF ERECTION				SUBSEQUENT POSITION				
LENGHT OF MAST BELOW RAIL LEVEL	CONTACT WIRE HEIGHT H	POSITION OF STAY ARM	DISTANCE BETWEEN MAST ATTACHMENT	MAX RAISE IN EX. RAIL LEVEL R'	CW HEIGHT	POSITION OF STAY AEM	DISTANCE BETWEEN MAST ATTACHMENT	ADJUSTMENT REQUIRED
(1)1650 (SD-500) (D-600)	5600	100 mm DROOPING	2000	200	5600	100 mm DROOPING	2000	NOT REQUIRED
				310	5600	110 mm INCLINED UP	1890	RAISE THE MAST BRACKET FITTING BY 110mm
(2.)2000 (SD-650) (D-750)	5650	100 mm DROOPING	2000	50	5600	100 mm DROOPING	2000	NOT REQUIRED
				160	5600	110 mm INCLINED UP	1890	RAISE THE MAST BRACKET FITTING BY 110mm


TYPICAL STRUCTURE ERECTION DRAWING FOR TWO TRACK SECTION
(NORMAL)
CONT PLANE
OF TRACK
OF TRACK
RAIL LEVEL
STEP DISTANCE
0.5 (MAX)
0.150 OR 200
FOR HIGH SPEED

GENERAL ARRANGEMENT OF HEADSPAN FOR OHE ON 4 TRACKS



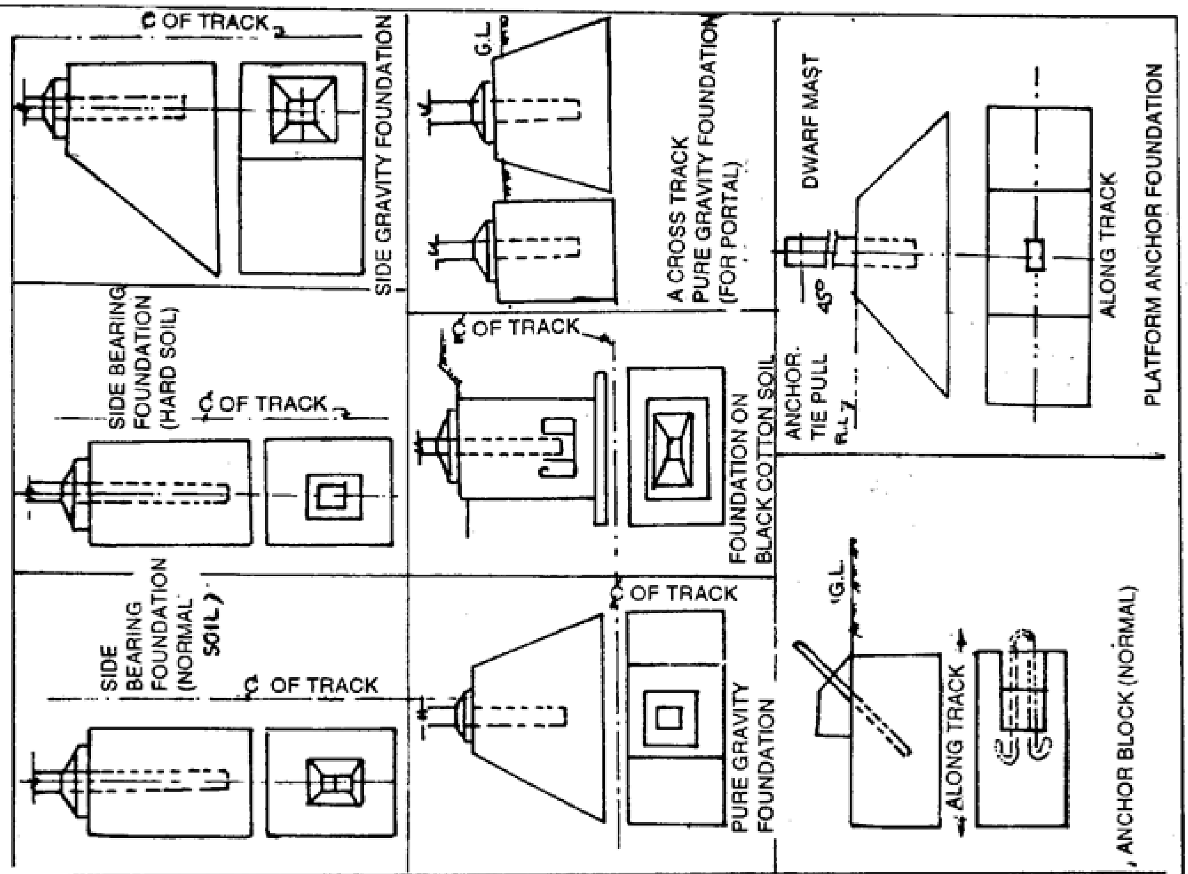
TYPICAL ARRANGEMENT OF STRUCTURE & BRACKET ASSEMBLY TO SUIT RAISING OF TRACK



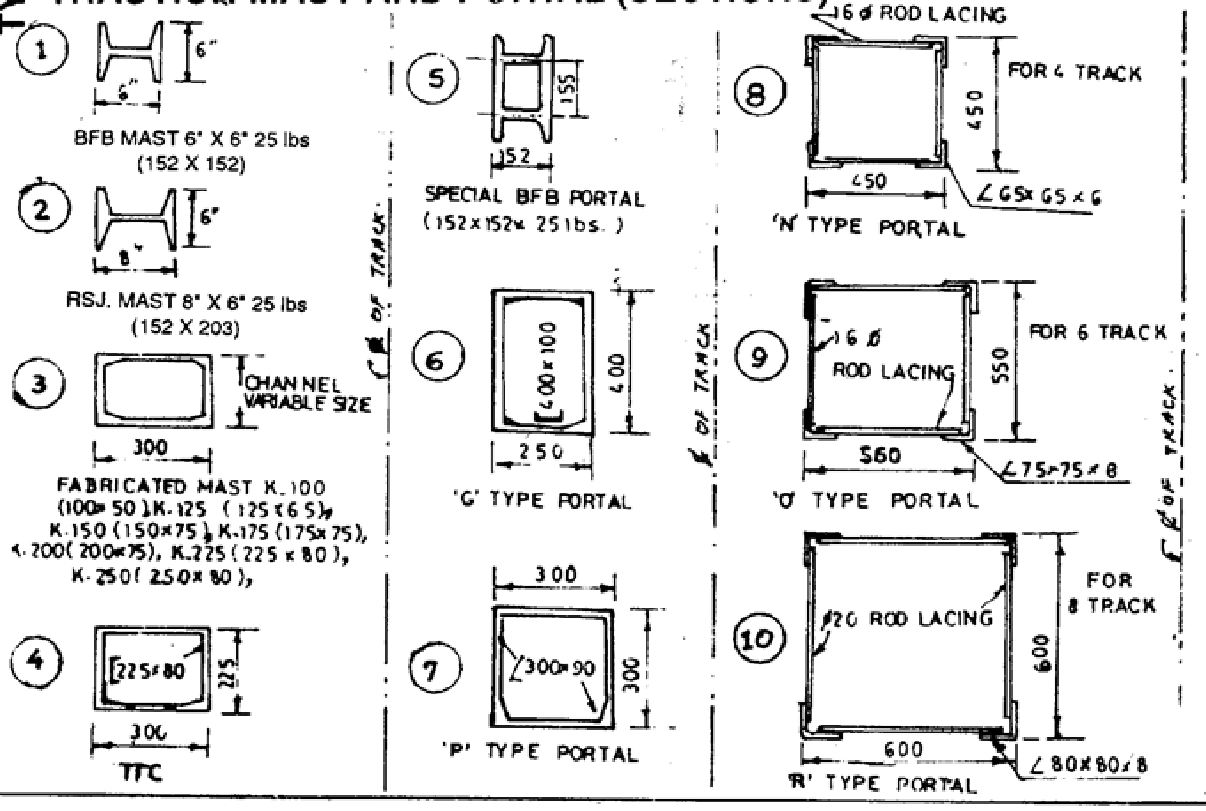
STYLE - 02

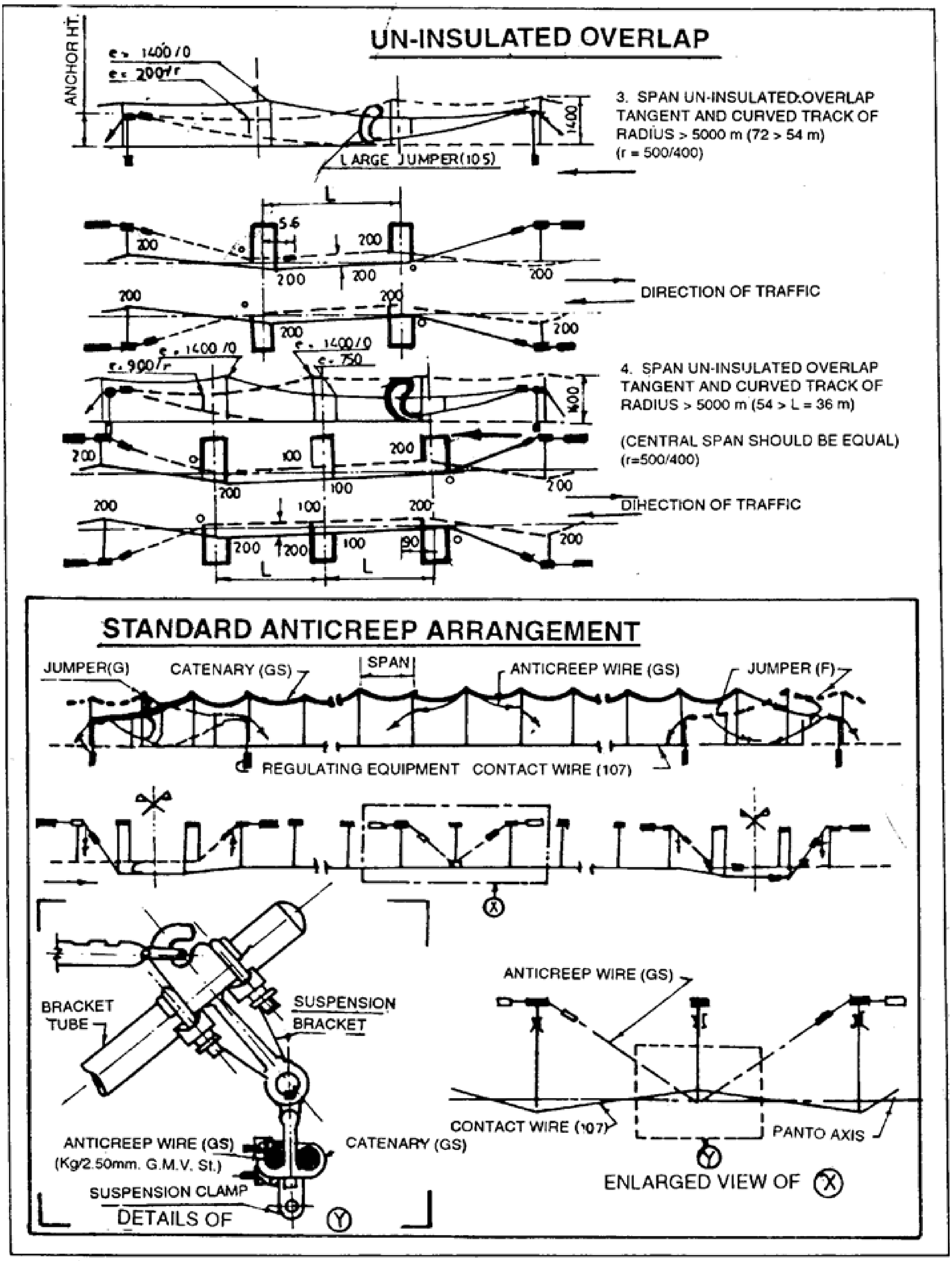
ERECTION SCHEDULE OF BRACKET ASSEMBLY FOR UNREGULATED O.H.E.								
AT THE TIME OF ERECTION				SUBSEQUENT POSITION				
LENGTH OF MAST BELOW R.L.	CONTACT WIRE HEIGHT	POSITION OF STAY ARM	DISTANCE BETWEEN MAST ATTACHMENT	RAISE IN RAIL LEVEL	CONTACT WIRE HEIGHT	POSITION OF STAY ARM	DISTANCE BETWEEN MAST ATTACHMENT	ADJUSTMENT REQUIRED
1750	5800	200mm DROPPING	2100	50	5750	200mm DROPPING	2100	NO ADJUSTMENT NECESSARY
				250	5750	LEVEL	1900	RAISE THE MAST BRACKET FTG BY 110MM

TYPICAL FOUNDATION FOR OHE MAST AND PORTAL

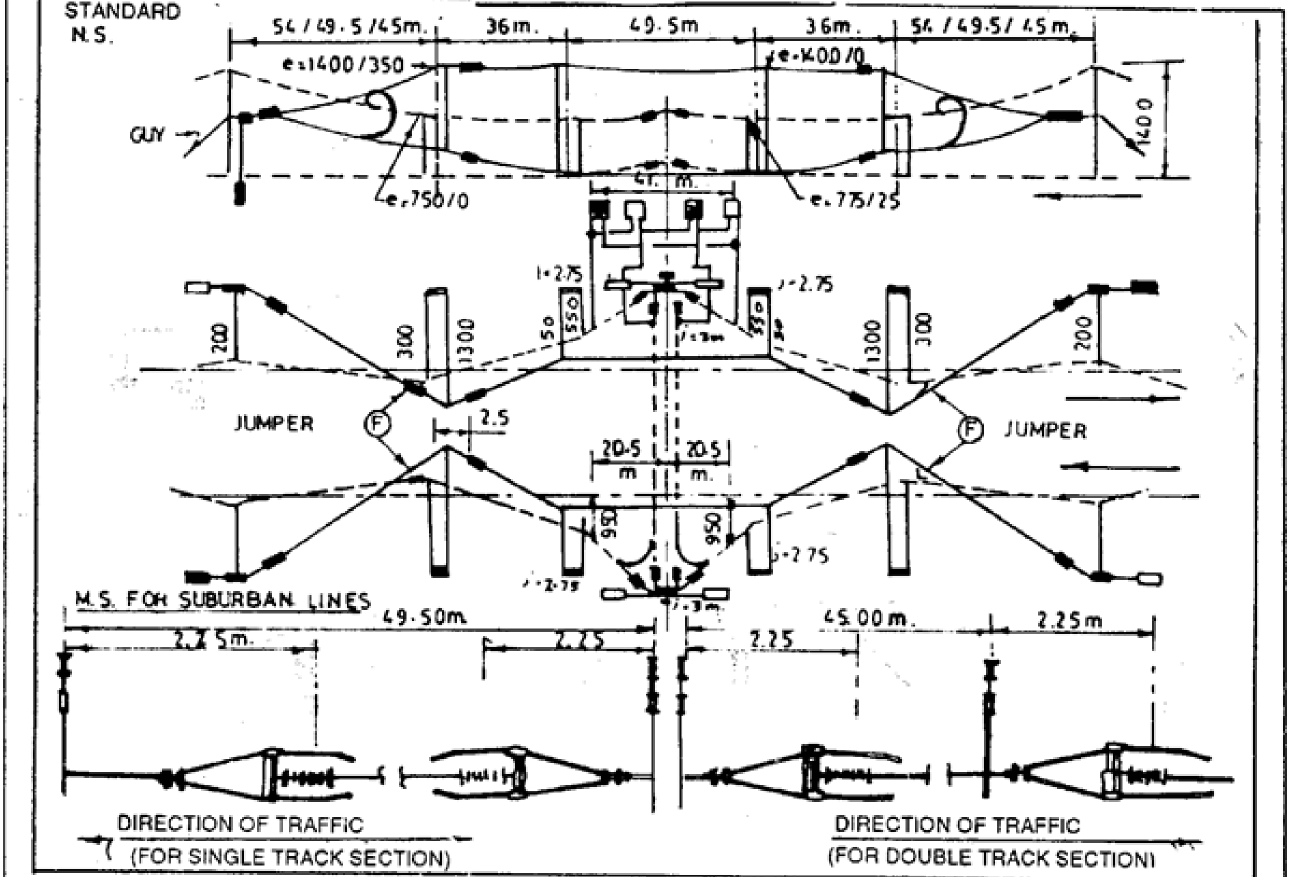


TRACTION MAST AND PORTAL (SECTIONS)

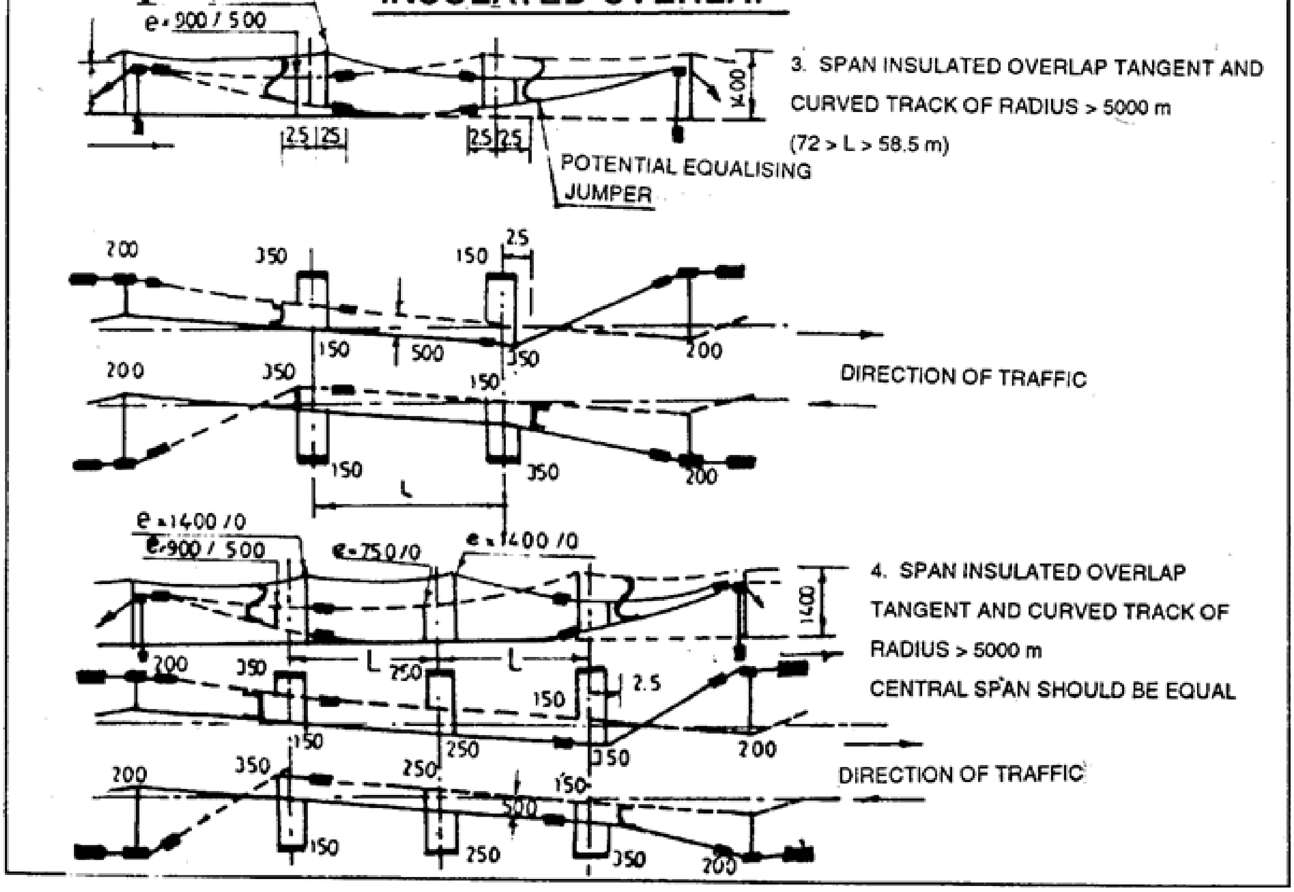



UN-INSULATED OVERLAP
ANCHOR HT.
LARGE JUMPER(105)
3. SPAN UN-INSULATED OVERLAP TANGENT AND CURVED TRACK OF RADIUS > 5000 m (72 > 54 m)
(r = 500/400)
DIRECTION OF TRAFFIC
4. SPAN UN-INSULATED OVERLAP TANGENT AND CURVED TRACK OF RADIUS > 5000 m (54 > L = 36 m)
(CENTRAL SPAN SHOULD BE EQUAL)
(r=500/400)
DIRECTION OF TRAFFIC
STANDARD ANTICREEP ARRANGEMENT
JUMPER(G)
CATENARY (GS)
SPAN
ANTICREEP WIRE (GS)
JUMPER (F)
REGULATING EQUIPMENT
CONTACT WIRE (107)
BRACKET TUBE
SUSPENSION BRACKET
ANTICREEP WIRE (GS)
(Kg/2.50mm. G.M.V. St.)
SUSPENSION CLAMP
CATENARY (GS)
DETAILS OF Y
ANTICREEP WIRE (GS)
CONTACT WIRE (107)
PANTO AXIS
ENLARGED VIEW OF X

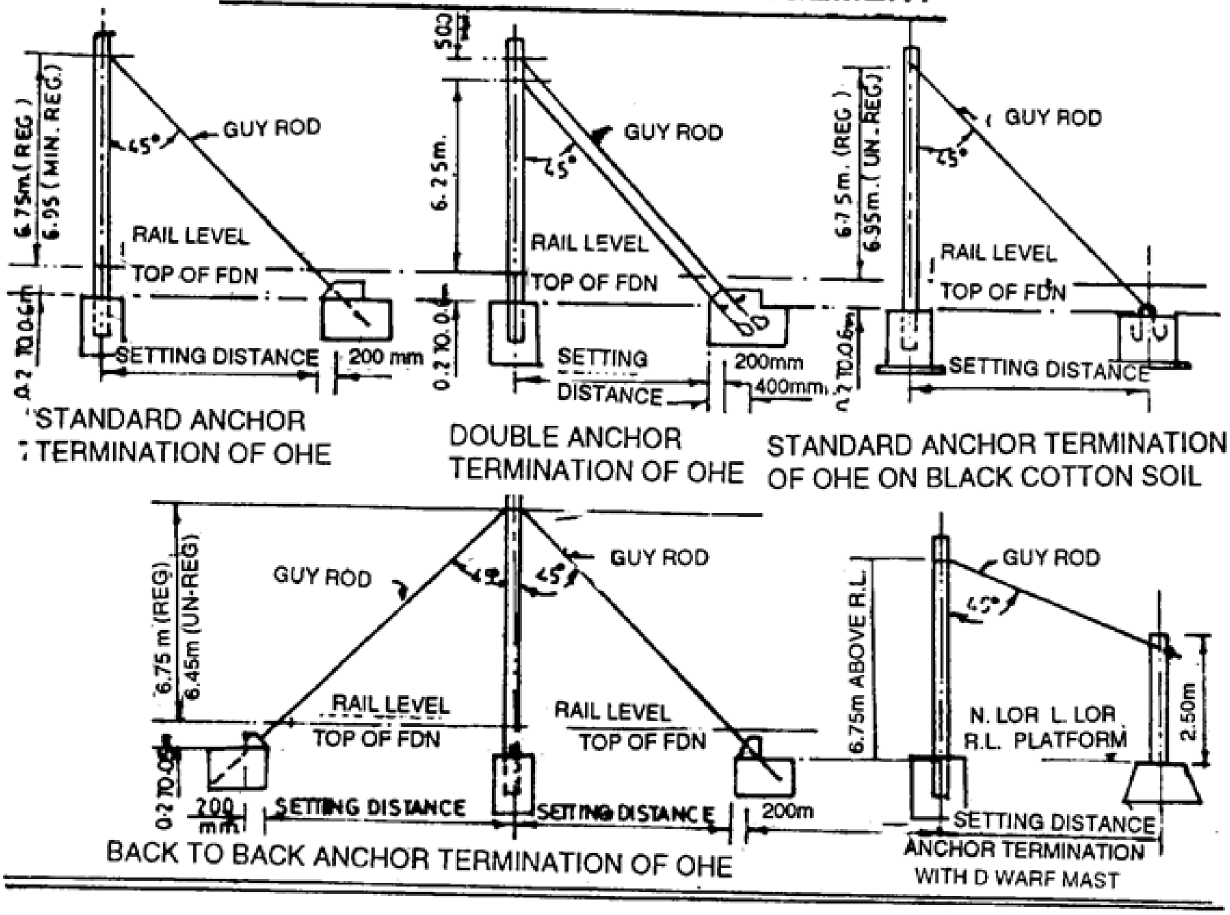
NEUTRAL SECTION

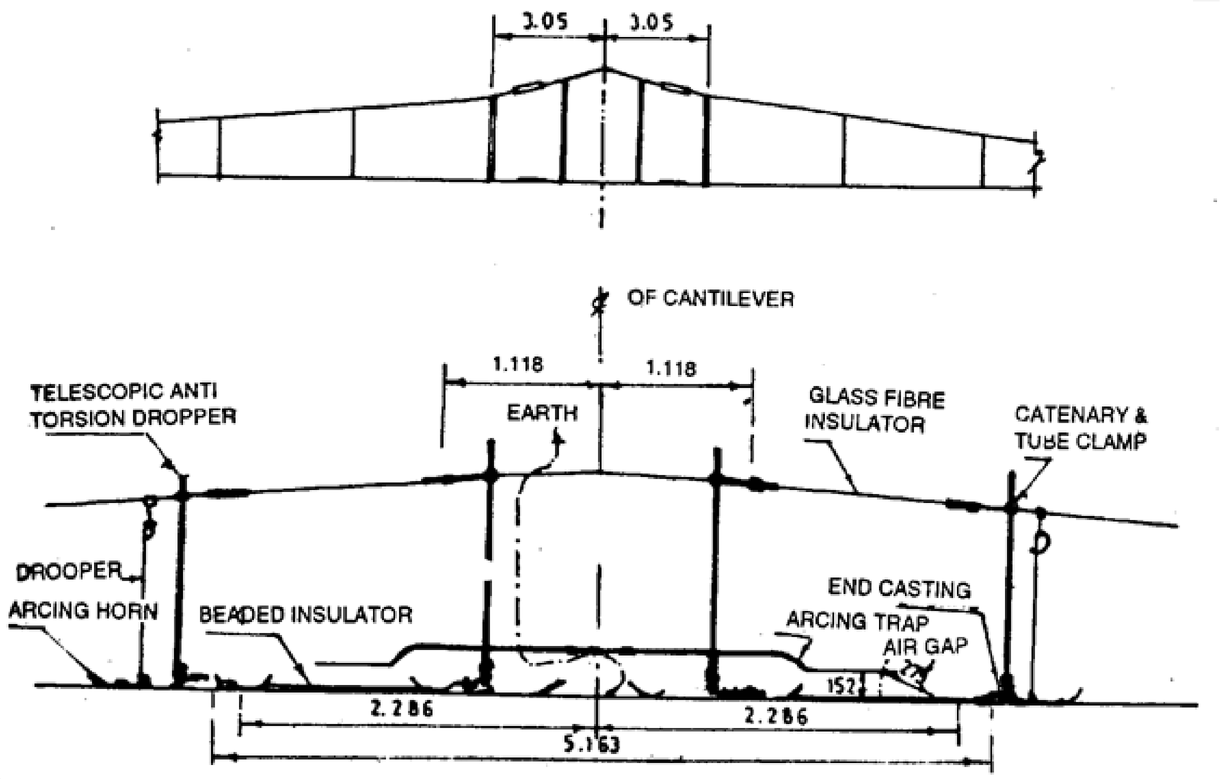


INSULATED OVERLAP



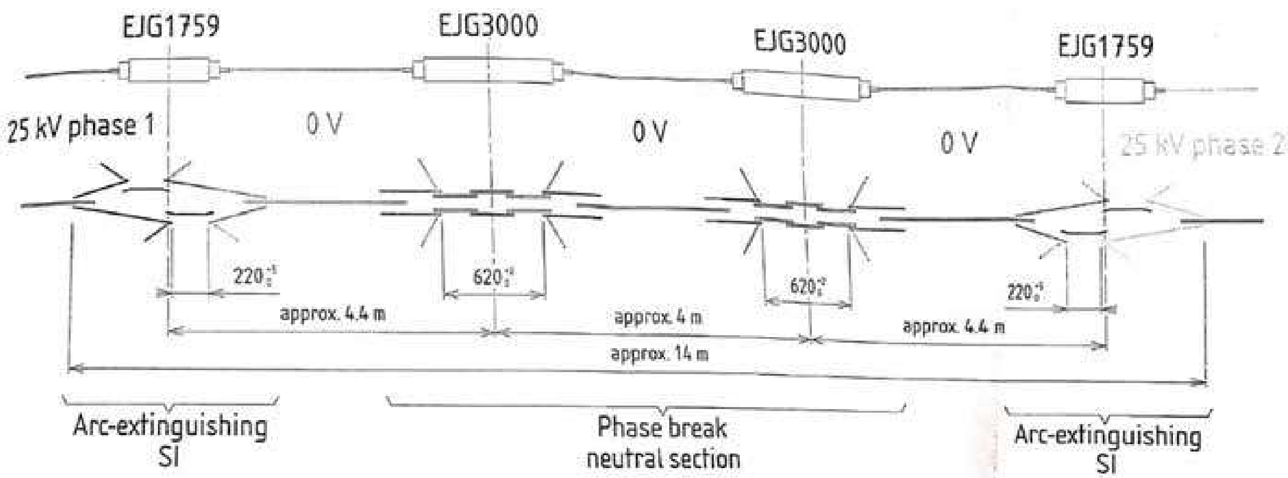
STANDARD ANCHOR ARRANGEMENT





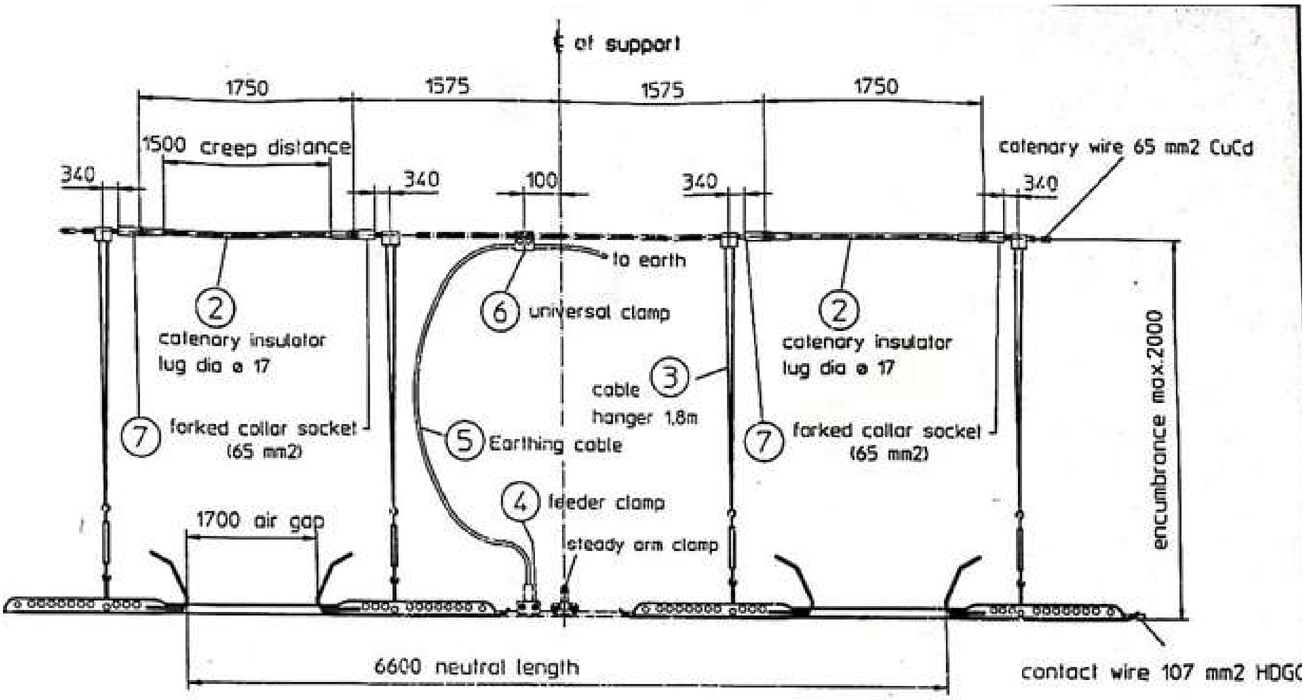
CERAMIC BEADED NEUTRAL SECTION AT CANTILEVER SUPPORT

SHORT NEUTRAL SECTION

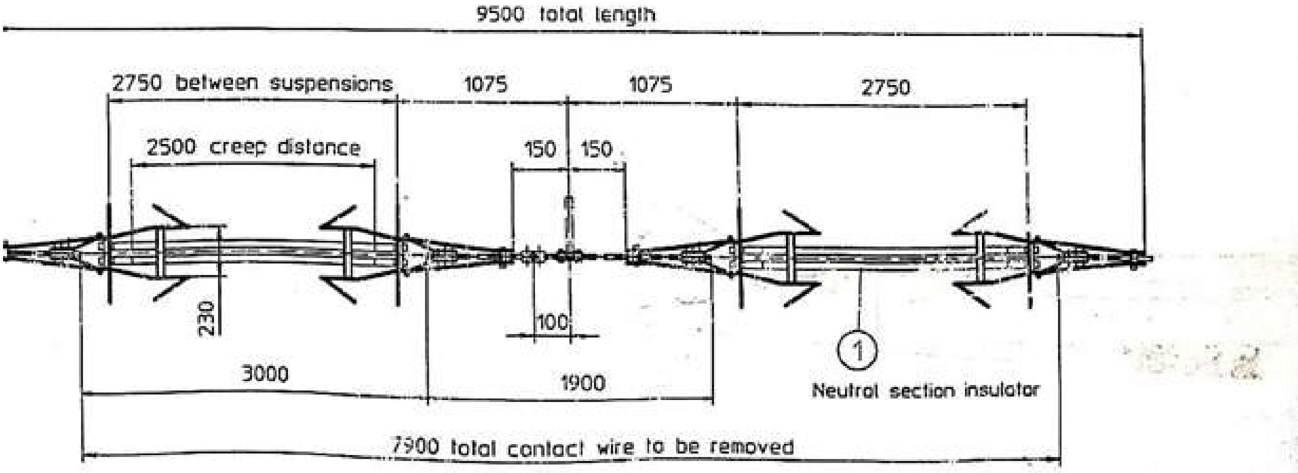


SHORT NEUTRAL SECTION

TYPE -1

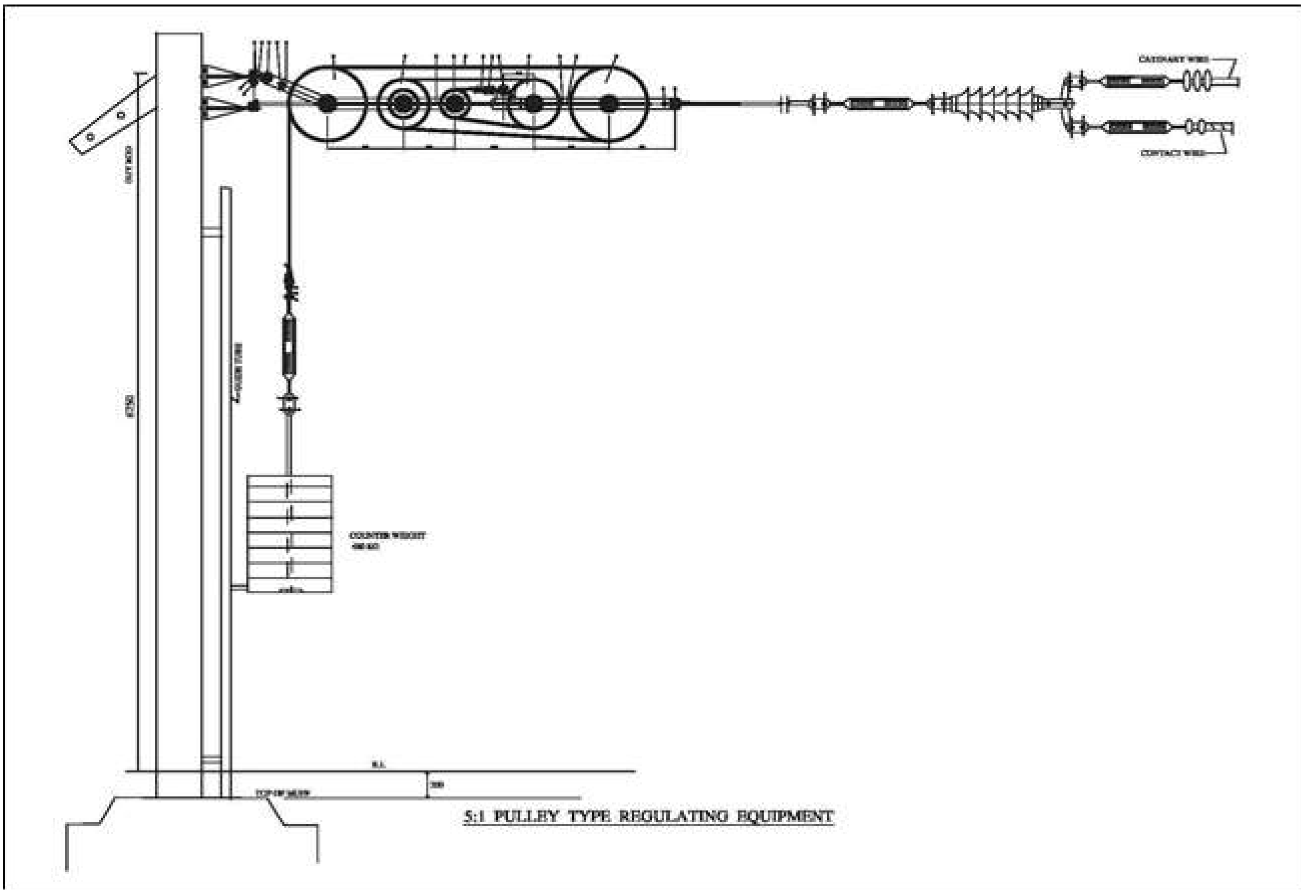


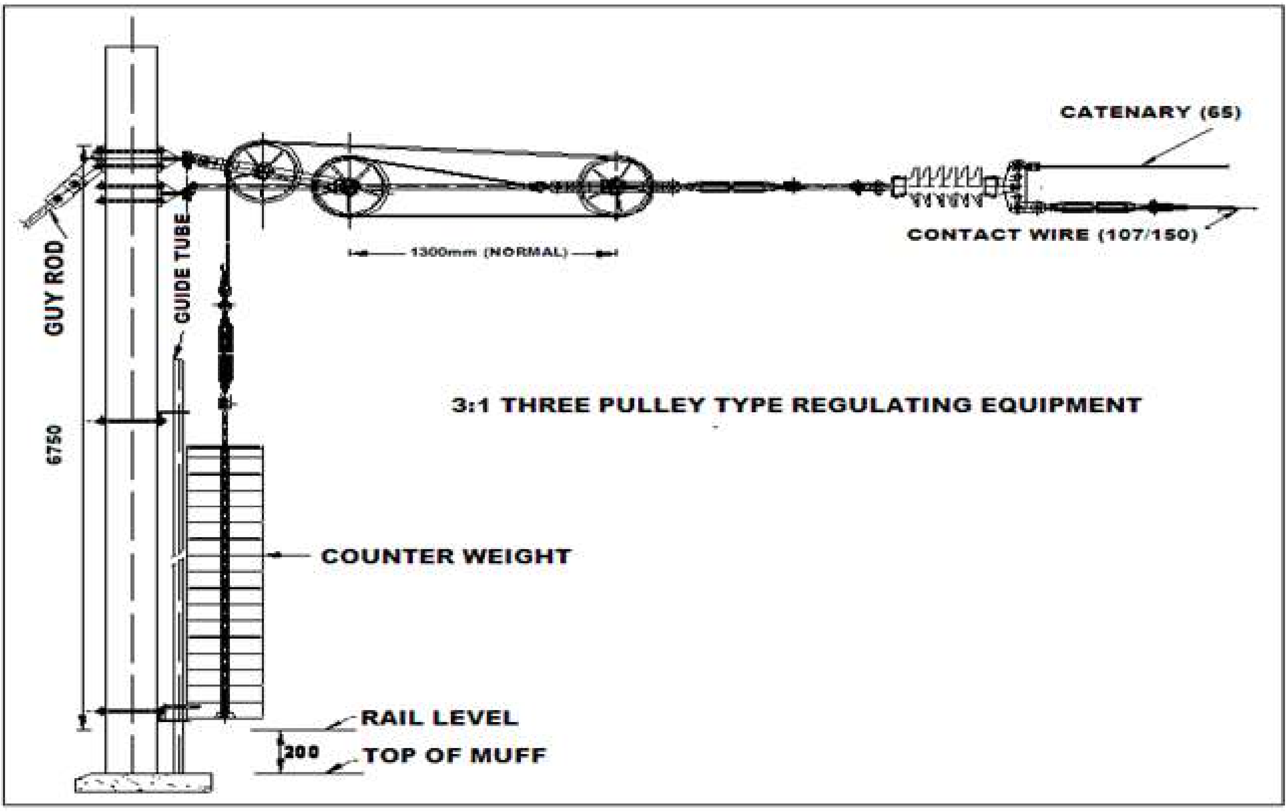
℄ of support
1750
1575
1575
1750
1500 creep distance
340
340
100
340
340
catenary wire 65 mm2 CuCd
to earth
2 catenary insulator lug dia ø 17
6 universal clamp
2 catenary insulator lug dia ø 17
cable hanger 1,8m 3
7 forked collar socket (65 mm2)
5 Earthing cable
7 forked collar socket (65 mm2)
4 feeder clamp
steady arm clamp
1700 air gap
encumbrance max.2000
6600 neutral length
contact wire 107 mm2 HDGC

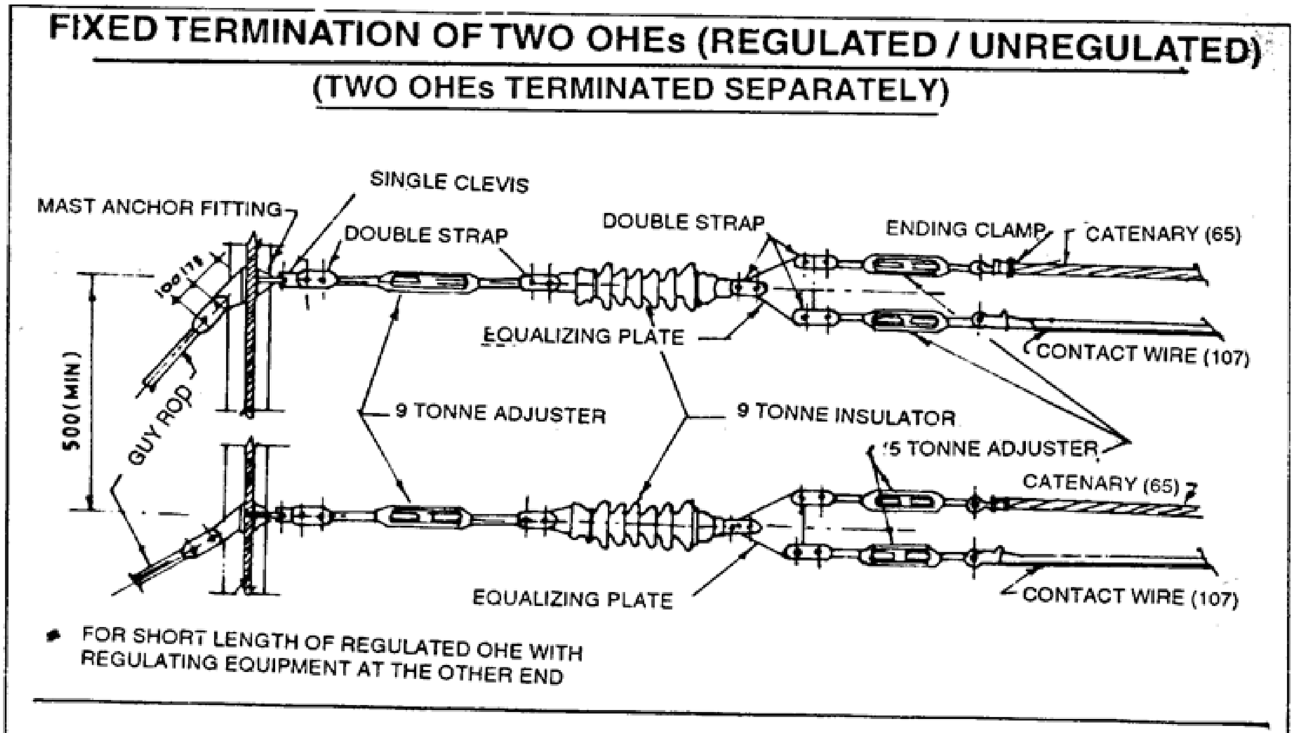


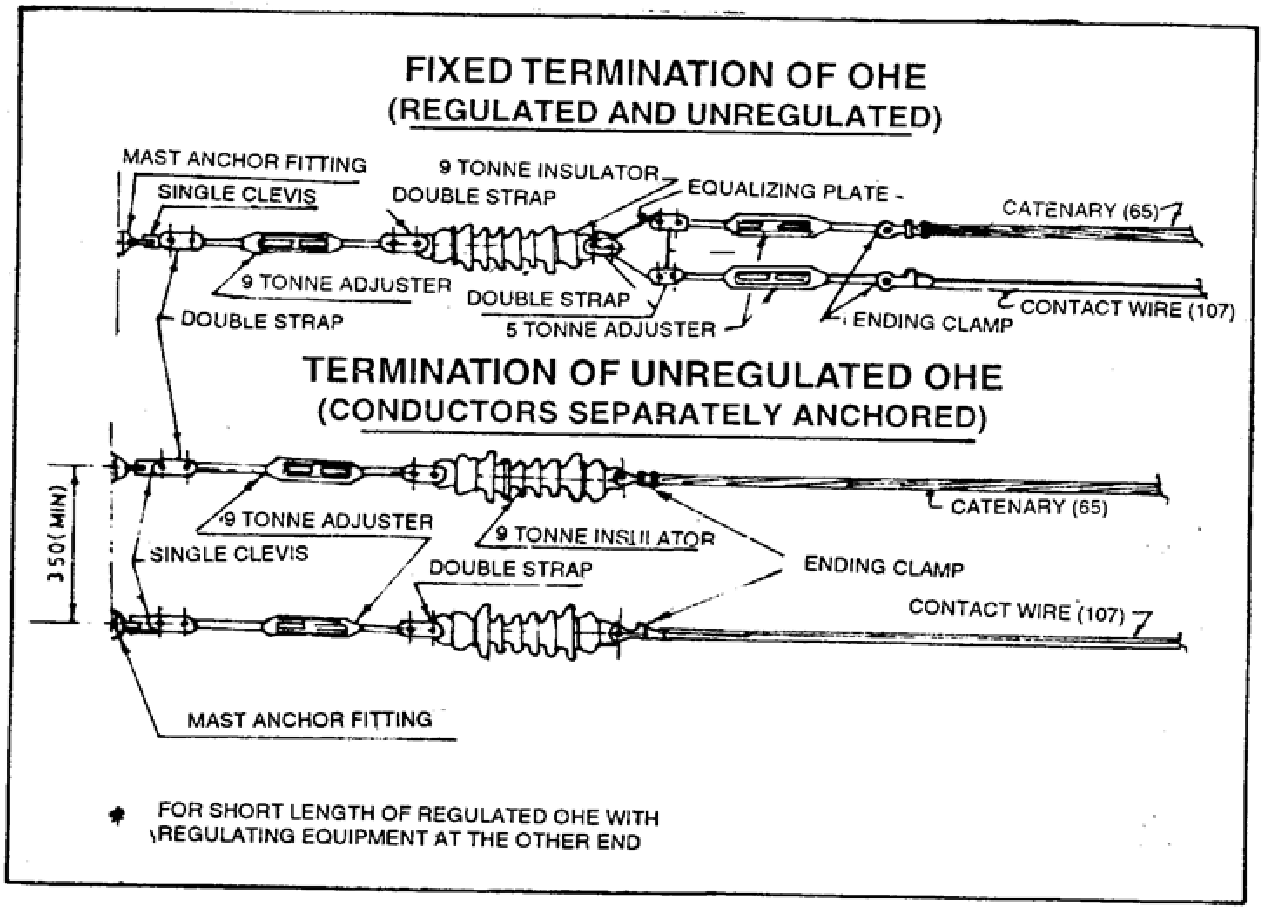
9500 total length
2750 between suspensions
1075
1075
2750
2500 creep distance
150
150
230
100
3000
1900
1 Neutral section insulator
7900 total contact wire to be removed

TYPE-2

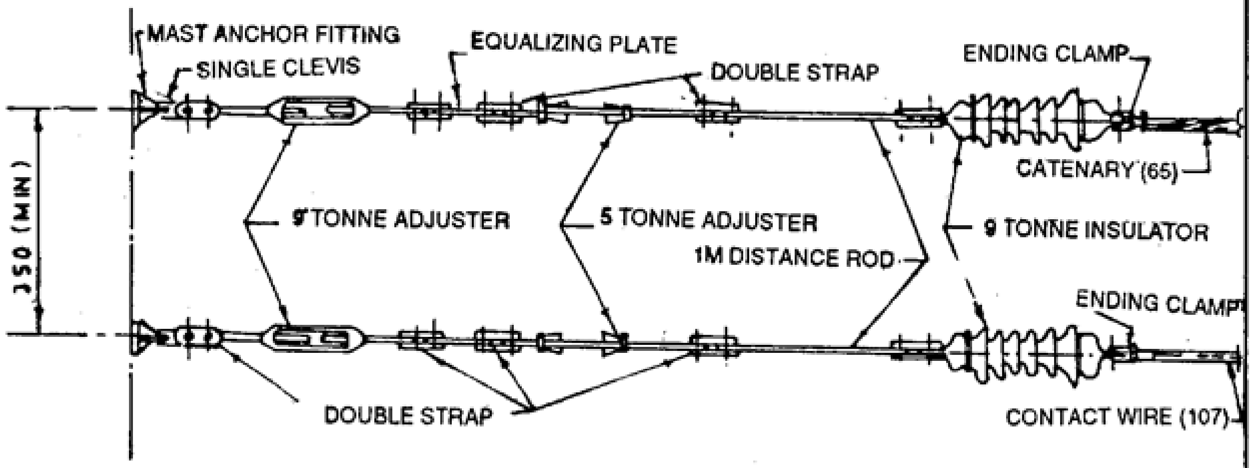

5:1 PULLEY TYPE REGULATING EQUIPMENT


CATENARY (65)
CONTACT WIRE (107/150)
1300mm (NORMAL)
GUY ROD
GUIDE TUBE
6750
3:1 THREE PULLEY TYPE REGULATING EQUIPMENT
COUNTER WEIGHT
RAIL LEVEL
200
TOP OF MUFF


FIXED TERMINATION OF TWO OHEs (REGULATED / UNREGULATED)
(TWO OHEs TERMINATED SEPARATELY)
SINGLE CLEVIS
MAST ANCHOR FITTING
DOUBLE STRAP
DOUBLE STRAP
ENDING CLAMP
CATENARY (65)
EQUALIZING PLATE
CONTACT WIRE (107)
500 (MIN)
GUY ROD
9 TONNE ADJUSTER
9 TONNE INSULATOR
5 TONNE ADJUSTER
CATENARY (65)
EQUALIZING PLATE
CONTACT WIRE (107)
FOR SHORT LENGTH OF REGULATED OHE WITH
REGULATING EQUIPMENT AT THE OTHER END

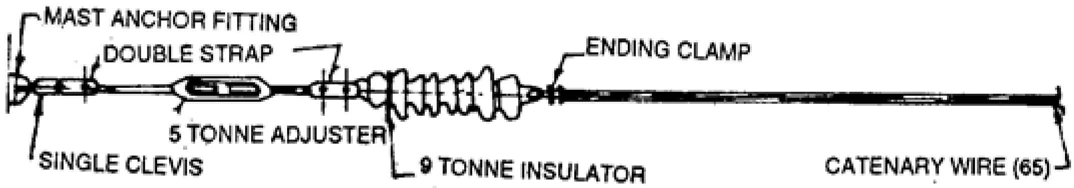

FIXED TERMINATION OF OHE
(REGULATED AND UNREGULATED)
MAST ANCHOR FITTING
SINGLE CLEVIS
9 TONNE INSULATOR
DOUBLE STRAP
EQUALIZING PLATE
CATENARY (65)
9 TONNE ADJUSTER
DOUBLE STRAP
DOUBLE STRAP
5 TONNE ADJUSTER
ENDING CLAMP
CONTACT WIRE (107)
TERMINATION OF UNREGULATED OHE
(CONDUCTORS SEPARATELY ANCHORED)
350 (MIN)
CATENARY (65)
9 TONNE ADJUSTER
SINGLE CLEVIS
9 TONNE INSULATOR
DOUBLE STRAP
ENDING CLAMP
CONTACT WIRE (107)
MAST ANCHOR FITTING
FOR SHORT LENGTH OF REGULATED OHE WITH
REGULATING EQUIPMENT AT THE OTHER END

TERMINATION OF TWO UNREGULATED OHEs (TWO CONTACT WIRES TOGETHER AND TWO CATENARIES TOGETHER)

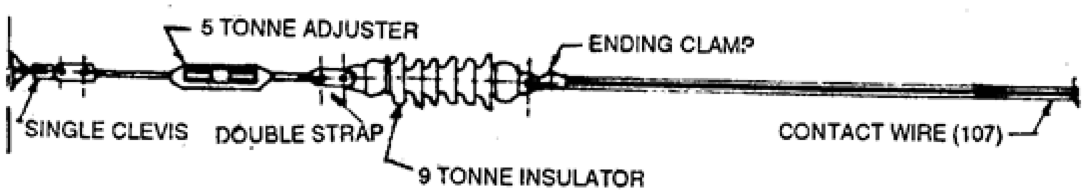


(ELEVATION)

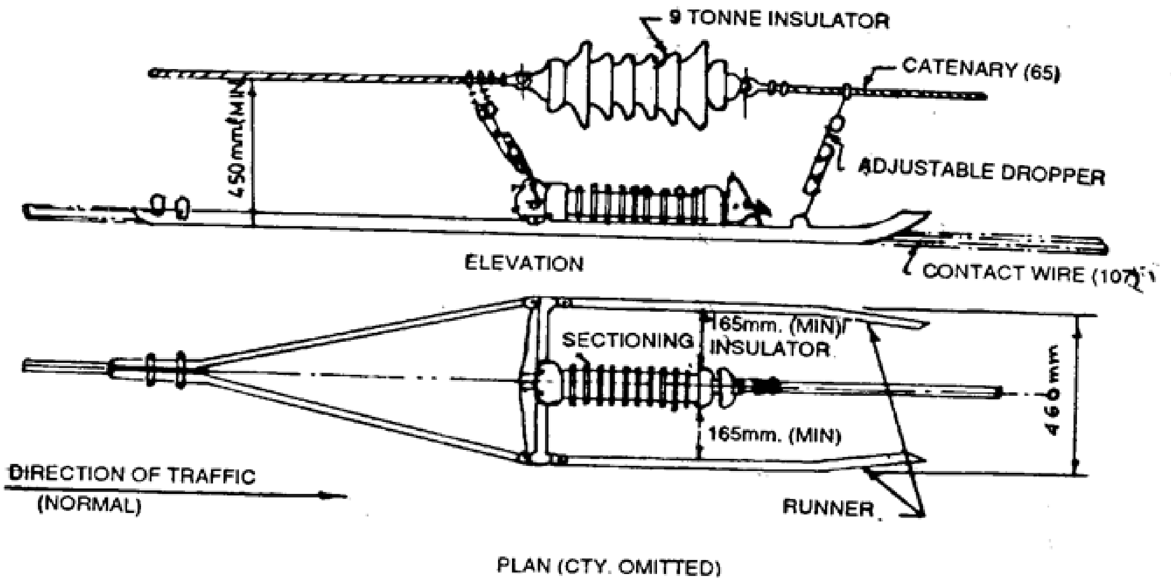
TERMINATION OF SINGLE CATENARY (65)



TERMINATION OF SINGLE CONTACT WIRE (107)

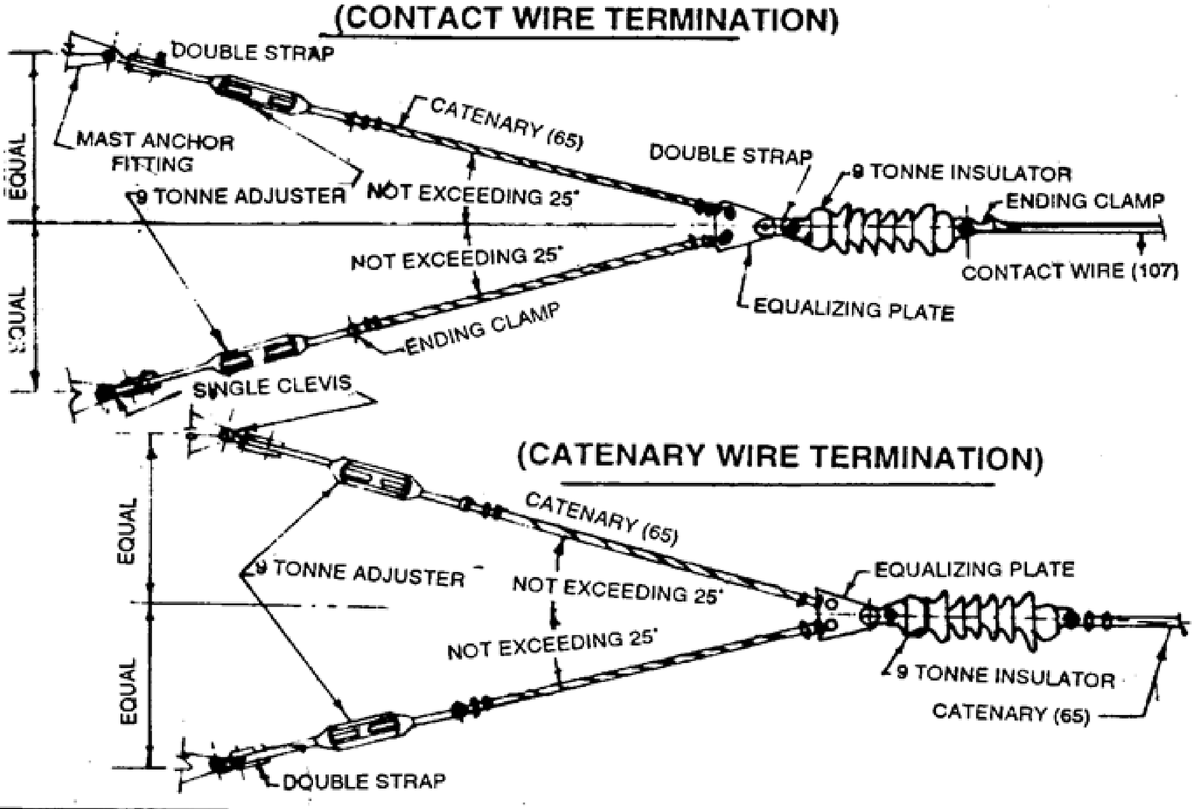


STANDARD SECTION - INSULATOR ASSEMBLY

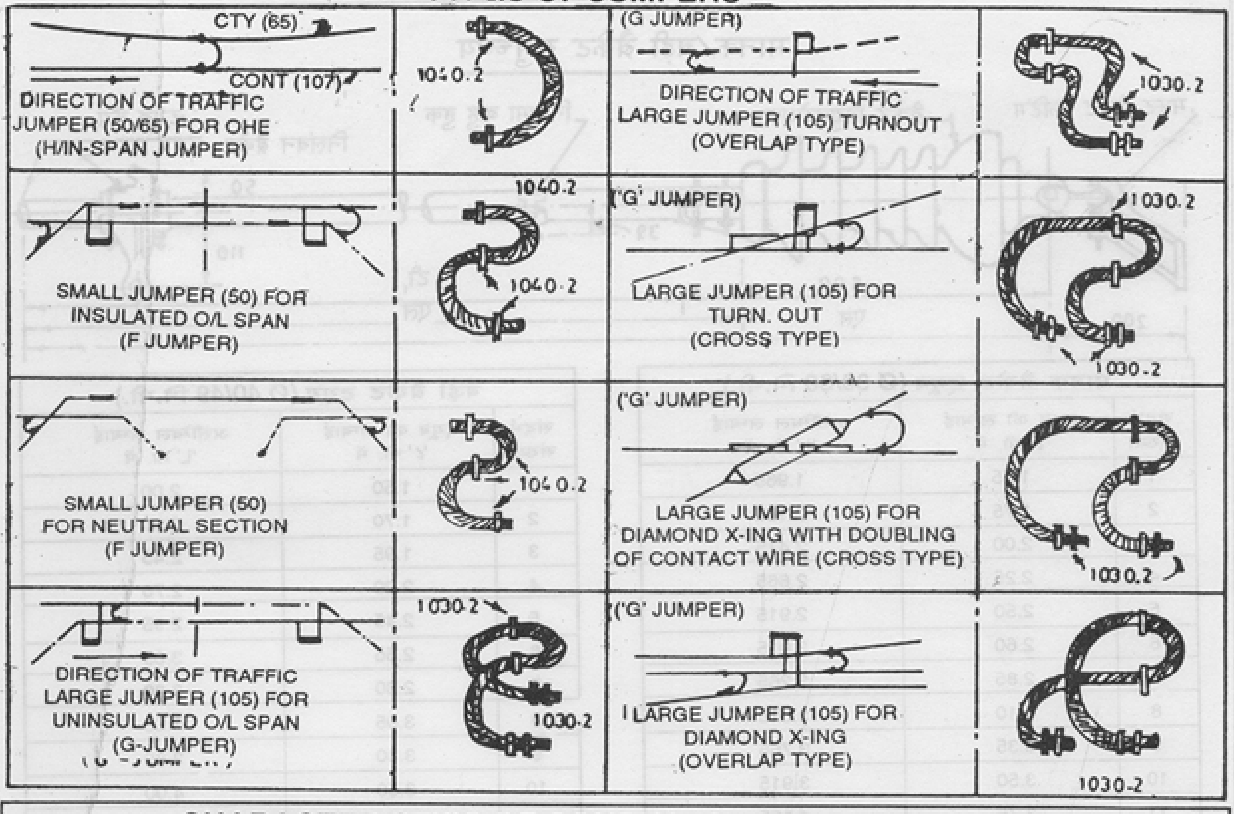


OHE TERMINATION AT BUFFER END SIDING AND TO AVOID OBSTRUCTIONS

(CONTACT WIRE TERMINATION)



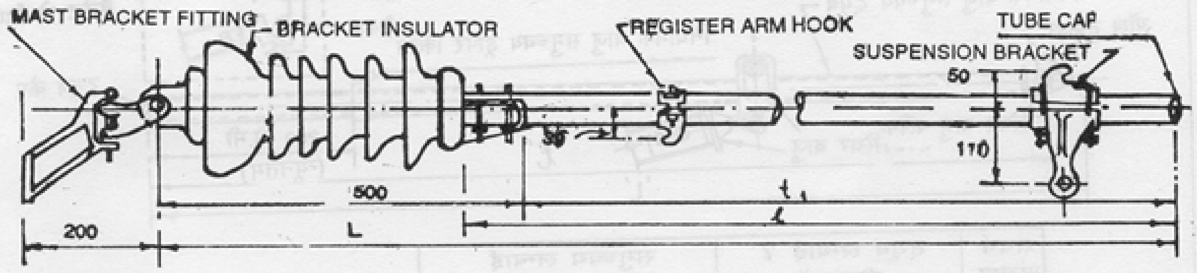
TYPES OF JUMPERS



CHARACTERISTICS OF CONDUCTORS FOR 25 kV ac OHE

TYPE OF CONDUCTOR	MATERIAL	NO. OF STRANDS	DIA OF EACH STRAND mm	OV. ALL Ø OF COND. mm	X-SEC. AREA sq mm	COPPER EQUIVA-LENT (sq mm)	WEIGHT (kg/m)	NORMAL TENSION (kg)	BREAK-ING LOAD (kg)	MAX SAFE WORK-ING	FACTOR OF SAFETY (Approx) LOAD(kg)
CATENARY (65)	CADMIUM COPPER	19	2.1	1050	64.84	53	0.5973	1000	3920	1307	3
CONTACT WIRE (107)		1	12.24	12.24	107	104	0.9612	1000 1250	3905	1708	23
FEEDER/ RETURN CONDUCTOR (130)	HARD DRAWN COPPER	37	2.25	15.75	147.10	144	1.326	1000	6080	2026	3
LARGE SPAN WIRE (130)	CADMIUM COPPER	37	2.10	14.70	125.6	102	1.1692	2000	7650	2550 1915	3
SMALL JUMPER (50)	ANNEALED	19	183	9.14	48.98	48	0.952	—	1130	317	3
LARGE JUMPER (105)	COPPER	133	1.013	15.20	107.3	103	0.982	—	—	—	—
SMALL DROPPER (5mm)	ELECTRO-LYTIC COPPER	1	5	5	1964	19	0.1746	—	825	275	3
LARGE DROPPER (7mm)	HARD DRAWN	1	7	7	3848	38	0.3421	—	1530	510	3
EARTH WIRE (50)	A.C.S.R. RAOCOON	6/1	4.90	12.27	77.83 FOR ML	48	0.318	320	2746	915	3
RETURN CONDUCTOR	ALLUMINI-UM (SPIDER)	19	3.99	19.90	233.50	140	0.652	500	3736	1245	3
EARTH WIRE	GALVANI-SED STEEL	19	2.50	12.5	93.3	—	0.7314	1000	6100	2033	3
AI LARGE	ALUMINIUM	133	1.40	21	205	120	0.5696	—	3380	1125	3

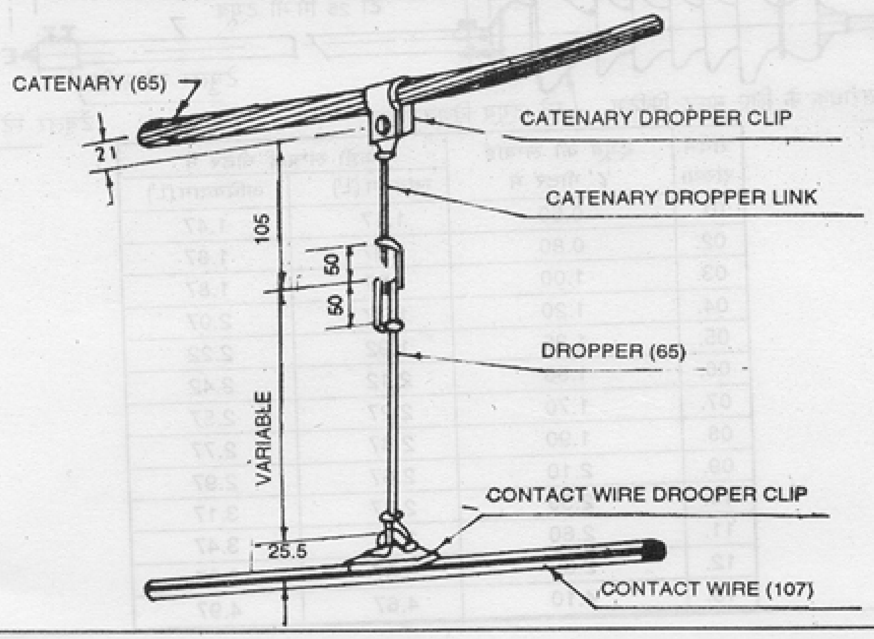
STANDARD/LARGE BRACKET ASSEMBLY



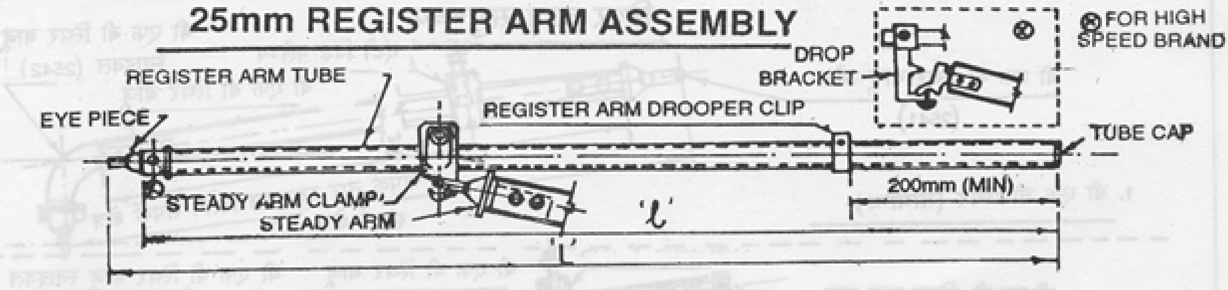
STANDARD BRACKET TUBE (Ø 30/38mm)		
REF NO.	LENGTH OF TUBE 'ℓ' IN METRES	ASSEMBLED LENGTH 'L' IN METRES
1	1.55	1.965
2	1.75	2.165
3	2.00	2.415
4	2.25	2.665
5	2.50	2.915
6	2.60	3.015
7	2.85	3.265
8	3.10	3.515
9	3.35	3.765
10	3.50	3.915
11	3.75	4.165

LARGE BRACKET TUBE (Ø 40/49mm)		
REF NO.	LENGTH OF TUBE 'ℓ' IN METRES	ASSEMBLED LENGTH 'L' IN METRES
1	1.50	2.00
2	1.70	2.20
3	1.95	2.45
4	2.20	2.70
5	2.45	2.95
6	2.55	3.05
7	2.80	3.30
8	3.05	3.55
9	3.30	3.80
10	3.50	4.00
11	4.60	5.10

CATENARY DROPPER ASSEMBLY

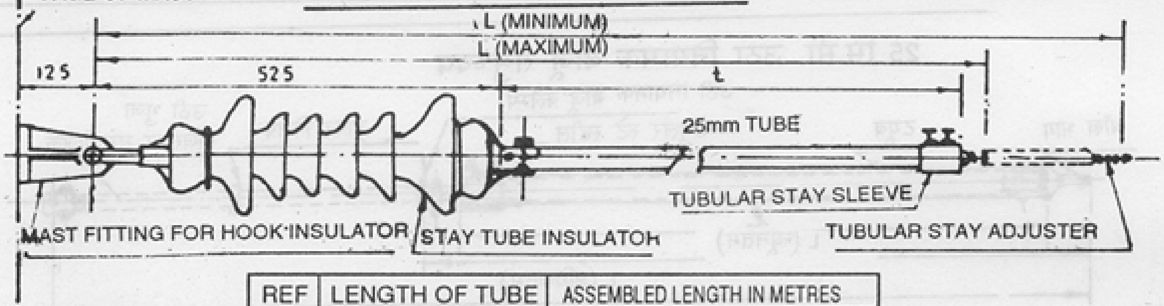


25mm REGISTER ARM ASSEMBLY



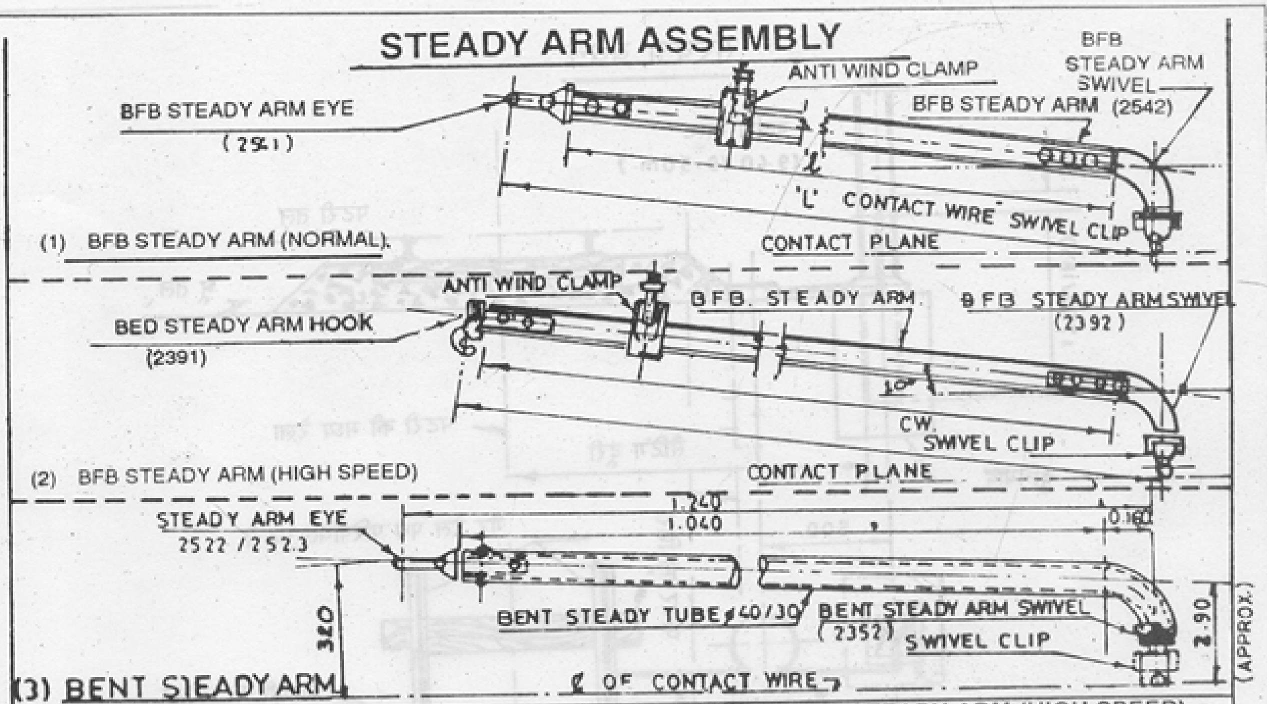
REF NO.	TUBE LENGTH 'ℓ' IN METRES	ASSEMBLY LENGTH 'L' IN METRES
1.	0.85	0.89
2.	1.10	1.14
3.	1.25	1.29
4.	1.50	1.54
5.	1.75	1.79
6.	2.00	2.04
7.	2.30	2.35
8.	2.60	2.64
9.	2.90	2.94
10.	3.05	3.09
11.	3.30	3.34
12.	3.60	3.64
13.	3.80	3.84
14.	4.10	4.14

TUBULAR STAY ARM



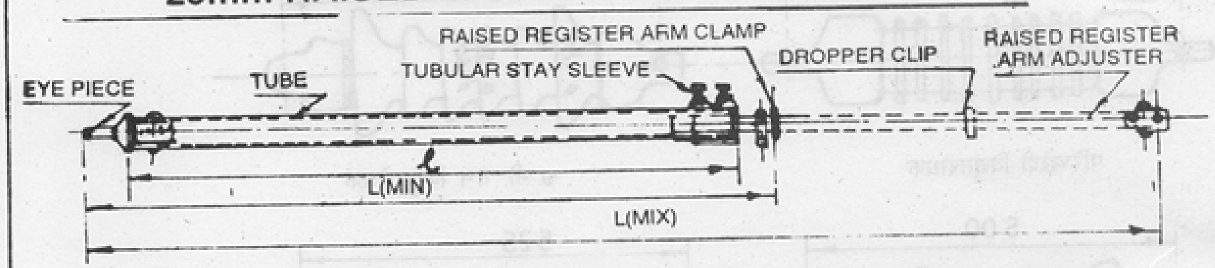
REF NO.	LENGTH OF TUBE 'ℓ' IN METRES	ASSEMBLED LENGTH IN METRES	
		MINIMUM ('L')	MAXIMUM ('L')
01.	0.60	1.17	1.47
02.	0.80	1.37	1.67
03.	1.00	1.57	1.87
04.	1.20	1.77	2.07
05.	1.35	1.92	2.22
06.	1.55	2.12	2.42
07.	1.70	2.27	2.57
08.	1.90	2.47	2.77
09.	2.10	2.67	2.97
10.	2.30	2.87	3.17
11.	2.60	3.17	3.47
12.	2.80	3.37	3.67
13.	4.10	4.67	4.97

STEADY ARM ASSEMBLY

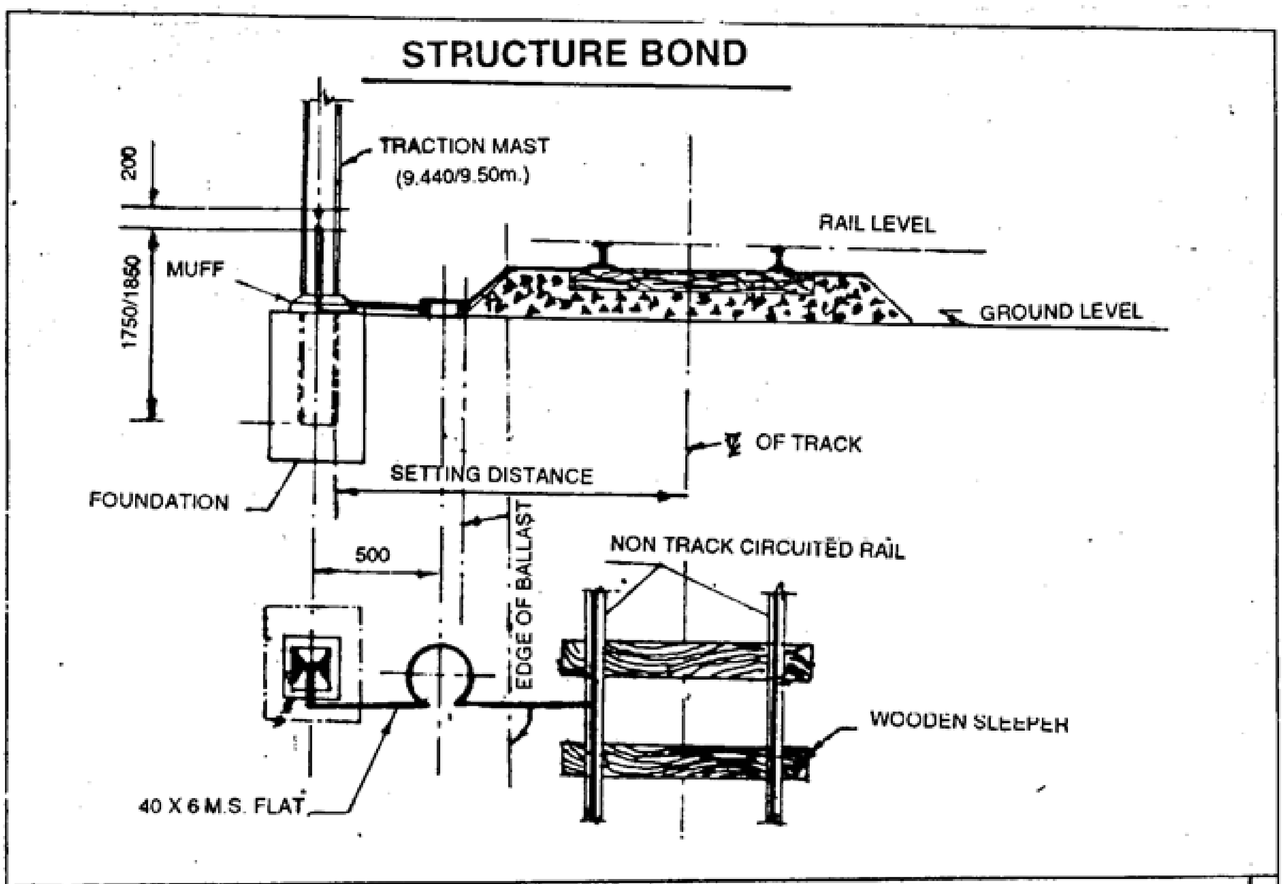


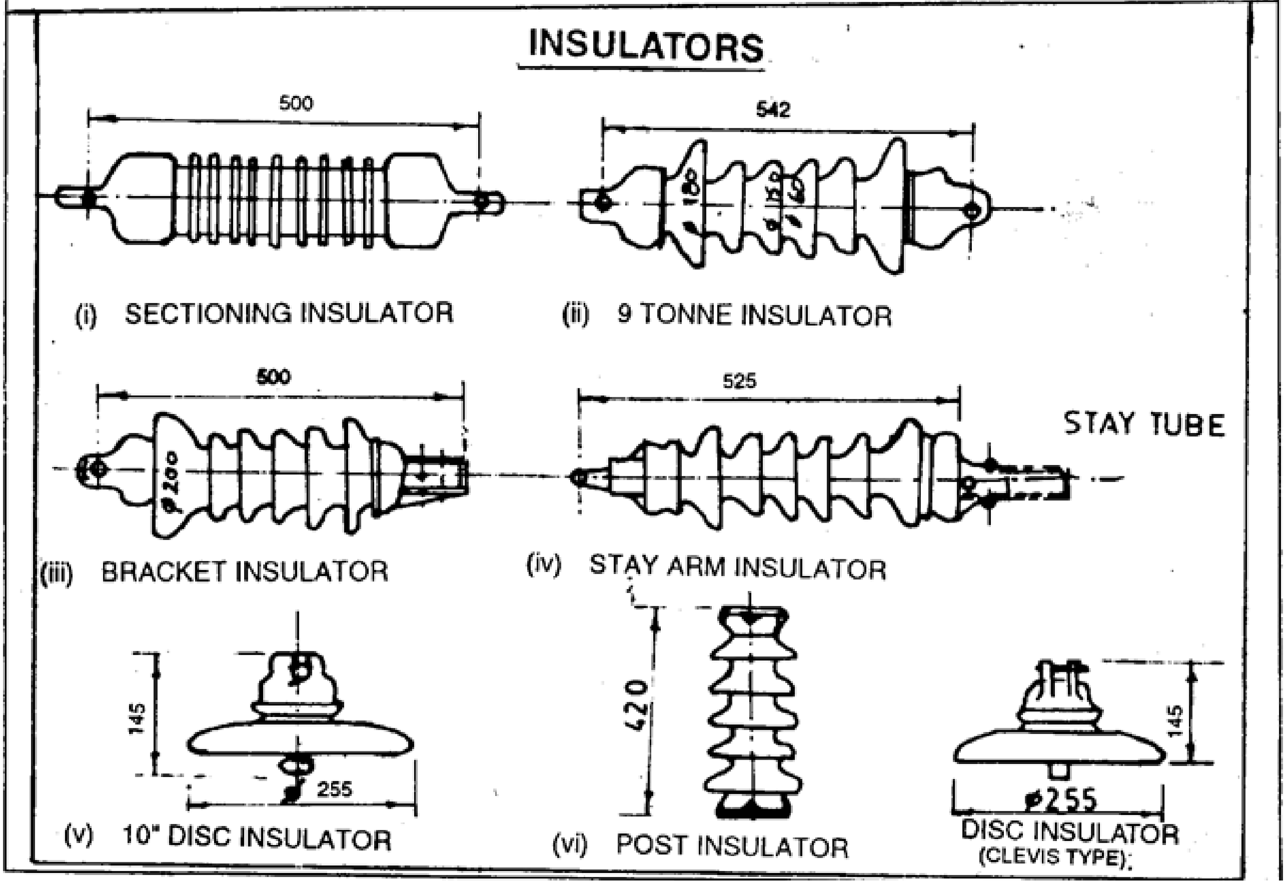
REF. NO.	B.F.B. STEADY ARM (NORMAL) TUBE LENGTH 'ℓ' IN METRES	ASSEMBLED LENGTH 'L' IN METRES	REF. NO.	B.F.B. STEADY ARM (HIGH SPEED) TUBE LENGTH 'ℓ' IN METRES	ASSEMBLED LENGTH 'L' IN METRES
1.	0.72	0.80	1.	0.69	0.75
2.	0.92	1.00	2.	0.89	0.95
3.	1.12	1.20	3.	1.09	1.15
4.	1.32	1.40	4.	1.29	1.35

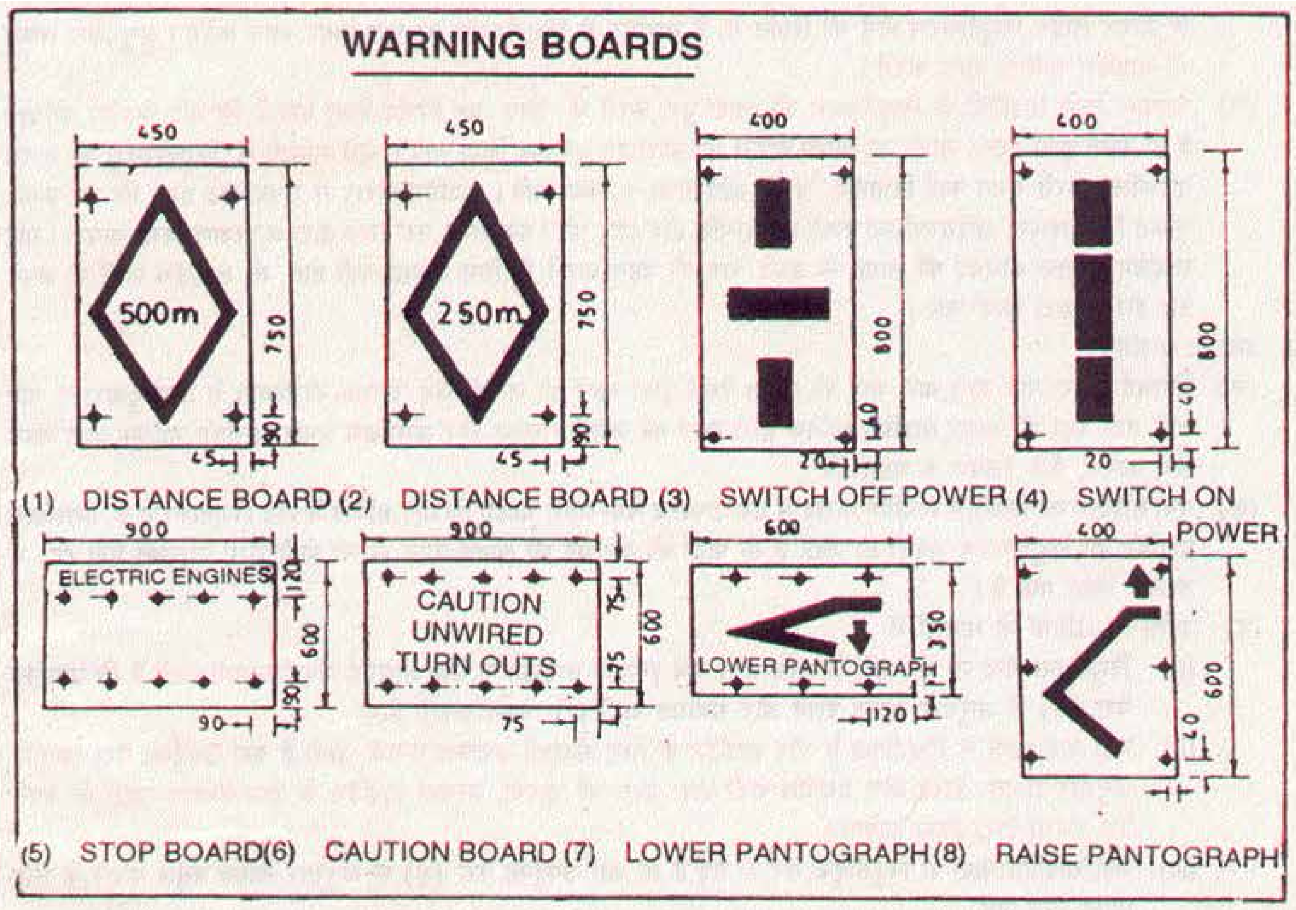
25mm RAISED REGISTER ARM ASSEMBLY



REF. NO.	TUBE LENGTH 'ℓ' IN METRES	RANGE OF ADJUSTMENT LENGTH IN METRES MIN. (L)	MAX. (L)
01.	0.30	0.415	0.715
02.	0.60	0.715	1.015
03.	0.80	0.915	1.215
04.	1.00	1.115	1.415
05.	1.20	1.315	1.615
06.	1.50	1.615	1.915
07.	1.70	1.815	2.115


STRUCTURE BOND
TRACTION MAST
(9.440/9.50m.)
RAIL LEVEL
GROUND LEVEL
200
1750/1850
MUFF
OF TRACK
SETTING DISTANCE
FOUNDATION
500
EDGE OF BALLAST
NON TRACK CIRCUITED RAIL
WOODEN SLEEPER
40 X 6 M.S. FLAT


INSULATORS
500
542
(i) SECTIONING INSULATOR
(ii) 9 TONNE INSULATOR
500
525
STAY TUBE
(iii) BRACKET INSULATOR
(iv) STAY ARM INSULATOR
145
255
420
145
ø255
(v) 10" DISC INSULATOR
(vi) POST INSULATOR
DISC INSULATOR
(CLEVIS TYPE)


WARNING BOARDS
450
500m
750
45
90
(1) DISTANCE BOARD
450
250m
750
45
90
(2) DISTANCE BOARD
400
800
40
20
(3) SWITCH OFF POWER
400
800
40
20
(4) SWITCH ON POWER
900
ELECTRIC ENGINES
120
600
90
(5) STOP BOARD
900
CAUTION
UNWIRED
TURN OUTS
75
600
(6) CAUTION BOARD
600
LOWER PANTOGRAPH
350
120
(7) LOWER PANTOGRAPH
400
600
40
(8) RAISE PANTOGRAPH

*****

APPENDIX-11
ELECTRIFICATION OF PRIVATE AND ASSISTED SIDINGS

This matter will be dealt by “Policy Circular On Private Sidings: Freight Marketing Circular No.11 of 2016 with latest amendment, Circulated vide letter No. Railway Board’s 99/TC(FM)/26/1/Pt.-II dated 22.8.16.

*****