PREFACE

The book of "Over Head Equipment" was brought out by Institution of Railway Electrical Engineers (IREE) long back. Since, lot of changes have taken place in the field of Railway Electrical Engineering, it has become necessary to incorporate the changes in this Volume. Few additions and modifications regarding "Over Head Equipments" are also included in this book.

For bringing out this book Shri M. K. Jain, Section Engineer and Shri M. A. Suryawanshi, Rail Bhasha Supdtt. have made substantial efforts, under the guidance of Shri R. B. Bhargav, Professor (TRD).

I am delighted to note that lot of efforts have been made in bringing out this book of "Over Head Equipments" in the present form. I am sure that this book will serve the needs of Electrical Engineers working in the field of Traction Distribution.

Nasik Road
30TH Aug. 2010

A. K. RAWAL
DIRECTOR
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TRACTION DISTRIBUTION

1.0 INTRODUCTION:

1.01 In 1955, French National Railways (SNCF) demonstrated that 25 KV single phase, 50 cycles (Industrial Frequency) A.C. system is superior to other types of Electric Traction. Initially, in 1957 Indian Railways adopted this system for their Electrification scheme in collaboration with SNFC. After acquiring the know how the Indian Railways are now carrying out the Electrification works independently.

PLAN WISE PROGRESS OF ELECTRIFICATION ON I.R.

<table>
<thead>
<tr>
<th>Plan</th>
<th>Period</th>
<th>Electrified</th>
<th>Cumulative</th>
<th>Plan</th>
<th>Period</th>
<th>Electrified</th>
<th>Cumulative</th>
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<td>388</td>
<td>6th</td>
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<td>1522</td>
<td>6440</td>
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<td>1945-47</td>
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<td>141</td>
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<td>Inter Plan</td>
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<td>1951-56</td>
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<td>1678</td>
<td>2423</td>
<td>8th</td>
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<td>2708</td>
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<td>3237</td>
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<td>1961-66</td>
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<td>1810</td>
<td>17811</td>
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<td>Annual Plan</td>
<td></td>
<td>533</td>
<td>4723</td>
<td>Upto</td>
<td></td>
<td>1299</td>
<td>19942</td>
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<tr>
<td>1966-69</td>
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<td>9th</td>
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<td>1969-74</td>
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<tr>
<td>Inter Plan</td>
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<td></td>
<td></td>
<td>31.3.2009</td>
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<td></td>
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<tr>
<td>1978-80</td>
<td></td>
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</tbody>
</table>

First Electric Train   BINA to KATNI (C.RLY.) 16.1.1995
On 2 x 25 KV AC Traction

1.2.1 Electrification Progress Year wise is shown in Fig.1.

INDIAN RAILWAYS TOTAL TRACK = 63327 RKM
ELECTRIFIED upto 31.3.2009 = 18942 RKM
% ELECTRIFIED = 29.85%
1.3 **COST OF ELECTRIFICATION**

The approximate average cost of electrification is as under:

<table>
<thead>
<tr>
<th>PER RKM</th>
<th>DOUBLE LINE</th>
<th>SINGLE LINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>For 25 KV AC TRACTION</td>
<td>1 crore</td>
<td>75 Lakh</td>
</tr>
<tr>
<td>For 2X25 KV AC TRACTION</td>
<td>94 LAKH</td>
<td>(1995)</td>
</tr>
</tbody>
</table>

1.4 **DETAILS OF ELECTRIFICATION**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total RKM energized on 1500 V DC</td>
<td>BG 258</td>
</tr>
<tr>
<td>Total RKM energized on 25 KV AC</td>
<td>BG 18942</td>
</tr>
<tr>
<td>Total RKM energized on 2X25 KV AC</td>
<td>BG 627</td>
</tr>
<tr>
<td>Electrification work in progress (Dec 09)</td>
<td>1000 RKM</td>
</tr>
<tr>
<td>Target for Rly. Electrification during year 2009-10</td>
<td>1000 RKM</td>
</tr>
<tr>
<td>Passenger Train KM Hauled by Electric Traction</td>
<td>49%</td>
</tr>
<tr>
<td>BG Freight GTKM Hauled by Electric Traction</td>
<td>63%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2005-06</th>
<th>2006-07</th>
<th>2007-08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Traction Charges (Mil. Rs.)</td>
<td>38974</td>
<td>44276</td>
<td>46124</td>
</tr>
<tr>
<td>Total Energy Consumed (Mil. KWH)</td>
<td>9085</td>
<td>10226</td>
<td>10469</td>
</tr>
<tr>
<td>Average Cost/ KWH (PAISA)</td>
<td>4.29</td>
<td>4.32</td>
<td>4.41</td>
</tr>
</tbody>
</table>

1.5 **OVER HEAD EQUIPMENT (OHE)**

1.5.1 A simple polygonal type of overhead equipment is comprising of a single 65 sq. mm. size Catenary wire of Cadmium Copper and a hard drawn grooved copper Contact wire of 107 sq. mm. size suspended from the Catenary by 5 mm dia copper dropper wire spaced 9 meters apart. The OHE is supported by swiveling type Cantilever bracket assembly. A tension of 1000 kgs is given in each conductors i.e., Catenary and Contact wire. This tension is kept constant, automatically compensating the variations in conductor length due to change in temperature through the regulating equipment erected at the termination of conductors, also known as Automatic Tensioning Device.

1.5.2 The Catenary wire comprises of 19 strands of cadmium copper, each strand of 2.10 mm dia, with overall dia of 10.5 mm having about 80% conductivity and 65 sq. mm cross-sectional area. The contact wire is a solid hard drawn electrolytic copper of 12.24 mm dia and 107 sq. mm cross-sectional area. Total current carrying capacity of both wires is 600 Amps. The condemning size of contact wire is 8.25 mm.

1.5.3 The OHE span varies between 72 Meters and 27 Meters with a step of 4.5 M. The maximum span of 72 M is adopted on section having wind pressure of 112.5 kgs/ M2 and 75 kgs/M2 only. The span is reduced on curvature depending upon the degree of curvature.

1.5.4 As a standard practice, an independent mast is used to support the OHE for each track to obtain mechanical independence Steel masts are of Four types i.e., BFB (Broad

---

Over Head Equipments
Flanged Beam), RSJ (Rolled Steel Joist) and fabricated rectangular sectional mast of K and B type.

1.5.5 Portals are also used to serve multiple track section where space between two tracks to locate an independent mast is not adequate. There are three types of Portals in use i.e., N, O & R type. P,G and double BFB type uprights are used where track separation is less. All Masts & Portals are galvanized before installation.

1.5.6 Traction Mast / Portals are embedded in the concrete foundation. There are different type of foundations which are used according to soil pressure and location. The five standard types of foundations mostly used are:

(a) Side Bearing  
(b) Side gravity  
(c) New Pure gravity  
(d) Wet Black cotton soil  
(e) Dry Black Cotton soil

1.5.7 A presag of 100 mm is provided on the contact wire for the maximum span of 72 meters and proportionately reduced for lesser spans. Regulated OHE with 100 mm presag is considered suitable for 160 Kmph speed operation.

1.5.8 The contact wire is staggered at support so that as the pantograph glides along the contact wire, the contact wire sweeps to and fro across the bearing surface of the pantograph pan upto a distance of 200 mm on either side of the centre line of pan on tangent track and 300 mm on curved tracks towards the outer side. This ensures uniform wear of the steel strips of the pantograph.

1.5.9 The electrical clearance between live part, and earthed part i.e. fixed structures or moving load shall be maintained normally as large as possible. The minimum clearance under worst condition of temperature, wind etc are given below:

(a) Minimum Vertical distance for

<table>
<thead>
<tr>
<th>Duration</th>
<th>Clearance</th>
</tr>
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<tbody>
<tr>
<td>Long duration</td>
<td>250 mm</td>
</tr>
<tr>
<td>Short duration</td>
<td>200 mm</td>
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</tbody>
</table>

(b) Minimum horizontal distance for

<table>
<thead>
<tr>
<th>Duration</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long duration</td>
<td>250 mm</td>
</tr>
<tr>
<td>Short duration</td>
<td>200 mm</td>
</tr>
</tbody>
</table>

1.5.10 The OHE conductors are terminated at intervals of 1.5 kilometers and suitably anchored. The change over is made by overlapping the conductors, normally on 3 spans. The conductors height at support is so adjusted that the conductors are physically clear from any obstruction under all conditions as well as the pantograph glides over from one conductor to another smoothly without any spark. There are two types of overlap:

(a) Uninsulated Overlap
In this type of overlap the distance between two conductors is kept 200 mm and the conductors are permanently connected by jumpers to have electrical continuity.
(b) Insulated Overlap
In this case, the two OHE conductors are kept apart at a distance of 500 mm. The electrical continuity at the insulated overlap is bridged by Interrupters or Isolating Switches except at Neutral Section (SP).

1.5.11 In regulated OHE, to ensure uniform distribution of the mechanical tension in the OHE conductors, an anticreep point is installed at the midpoint of the tension length of OHE conductor.

1.5.12 Section Insulators are provided to insulate the OHE of one track and another track, such as at turn outs & cross over, and to separate secondary tracks and sidings from the main line or other sidings.

1.5.13 When the pantograph of a locomotive passes from one track to another along a cross over, current collection changes from one OHE to another. The runners do have the overlap so that there may not be any sparking during change over.

1.5.14 Solid core Porcelain Insulators are used to support the OHE as Bracket and Stay arm Insulators. For termination 9 ton insulators are used.

1.6 CONTACT WIRE HEIGHT

| i)   | Over Line Structure to permit C class ODC | - | 4.92 M |
| ii)  | Electric Loco Shed and Inspection Pits   | - | 5.80 M |
| iii) | Level Crossing                           | - | 5.50 M |
| iv)  | Unregulated OHE Temperature 4°C to 65°C  | - | 5.75 M |
|      | Temperature 15°C to 65°C                 | - | 5.65 M |
| v)   | Regulated OHE with 50 mm Sag             | - | 5.55 M |
| vi)  | Regulated OHE with 100 mm Sag            | - | 5.60 M |
| vii) | Height of the Rail Gauge at level crossing| - | 4.67 M |

1.7 TRACTION SUB STATION (TSS):
Every TSS has 2 nos. traction transformer out of which one is working at a time and the second transformer is stand by. The capacity of each traction transformer is sufficient to feed its own feed zone and half of the adjoining feed zone.

1.7.1 Feeding Post (FP):
To feed 25 KV traction power to OHE.

1.7.2 The section of OHE normally fed by a traction transformer.

1.7.3 Feed Length :
The distance for which a traction transformer will feed power in emergent conditions i.e., the distance between two adjoining FPs.
1.7.4 Over Head equipment (OHE)

A system of conductors / equipments carrying traction power from traction sub station to electric locomotive.

1.7.5 Neutral Section (NS)

To separate OHE of two adjoining feed posts. A short neutral section (PTFE) type is provided opposite the Traction Sub Station to avoid the need of lowering the pantograph during extended feed conditions.

1.7.6 Sectioning Post (SP)

1. To facilitate the extension of traction power from one feed zone to half of the adjoining feed zone during emergency.

2. Parallel the UP and DN OHE in double the sections.

1.7.7 Sub-sectioning and paralleling post (SSP):

1. To sectionalize OHE.

2. To parallel the UP and DN OHE in double line sections.

1.7.8 Sector:

The section of the OHE between the FP & SP is called the sector.

1.7.9 Sub-Sector :

The section of the OHE between the FP & SSP, SSP & SP is called sub-sector. This is the shortest section of the OHE which can be isolated through Remote Control by the Traction Power Controller.

1.7.10 Elementary Section (ES):
This is the shortest section of the OHE which can be isolated manually for carrying out OHE maintenance work.
2.0 PURPOSE OF RAILWAY ELECTRIFICATION

Electric power contact lines are provided as overhead conductors over running Railway Lines to provide energy to electrically driven Railway locomotives or to train sets. As compared to diesel locomotives, whose power is limited by the permissible axle load and the moving dimensions for accommodation of the diesel engine, the contact lines permit almost unlimited power at the disposal of the electrically driven vehicle. Higher power permits heavier trains to achieve higher speeds. Electric Multiple Units provide fast commuter services with quick reversal at with main line trains, the Electric Multiple Units offer least interference to the latter due to the EMU’s high acceleration rates.

The major advantages of electric traction are, economy in operation and maintenance, saving in consumption of scarce diesel oil and increased through put of traffic. The capital cost for provision of fixed installation required for electric traction is found adequately remunerative for routes having high levels of traffic.

2.1 RAILWAY ELECTRIFICATION WORKS

2.1.1 Main works

These consist of:

1. Provision of most economic reliable electric contact system to continuously supply power to the moving electric rolling stock.
2. Power Supply Arrangements.
3. Provision of switches to regulate the flow of power along with the electric protective gear.
4. Monitoring and remote control of power supply.
5. Immunization of signalling and the trackside telecommunication circuits against electromagnetic and electrostatic induction effects of 25 KV, 50 HZ, single phase traction power supply.
6. Modernization of signalling and telecommunication.
7. Provision of maintenance and operation facilities for electric traction.

2.1.2 Discipline wise Division of Works

Different Engineering disciplines take up their portion of the work which form components of Electrification works. These are given below:

a) Electrical

iii) Remote Control of the Power Supply Equipment.

iv) Electric Locomotive maintenance facilities.

v) Ancillary Works of modification to the existing power supply arrangements on the route to immunize the system against induced voltages due to the traction current and provision of power supply at new points.

vi) Liaison with Electricity Authorities to modify their power line crossings to suit 25 KV ac traction.

vii) Consequential electrical works for electrification and air-conditioning of service buildings and staff quarters.

b) Signal and Telecommunications:
   i) Provision of colour light signals and immunization of the signalling installation against induction effects of 25 kV ac traction power supply system.
   ii) Provision of underground cables for the Railway’s telecommunication lines and provision of additional traction control circuits.
   iii) Liaising with the Department of Telecommunications for modification of their circuits to immunize them against induced voltages due to traction current.

c) Civil Engineering:
   i) Yard remodeling, slewing of tracks, sidings and oil track works.
   ii) Construction of loco sheds, service buildings and staff quarters.
   iii) Modification to overline structures such as overbridges, flyovers, through girder bridges, as well as to tunnels, platform shelters and water columns to suit 25 kV ac clearances.

2.1.3 Choice of system of Power Supply:

Before designing the Power Supply arrangements and the type of overhead equipment of a section, a choice is required to be made whether conventional 25 kV system is to be adopted or 2 X 25 KV Auto Transformer system is to be adopted. This choice depends upon a number of factors viz. the sections to be provided with booster transformers and return conductor as demanded by the Department of Telecommunications, the demand of power for the volume and type of the traffic and suitable location available for traction substations.

2.1.4 Coordination of Works

Railway Electrification, being a multi-disciplinary project work, needs close coordination amongst electrical, signalling & telecommunications and civil engineering disciplines. It further needs coordination with outside agencies such as Power Supply Authorities, the Department of Telecommunications, the Revenue officials as well as with the Open Line organization or whose section the work is to be taken up. Accordingly the organization for Railway electrification coordinates works
of all the disciplines and the agencies from inception to completion including support services to the open line in early stages of electric traction over the section.

2.2 SELECTION OF ROUTE FOR ELECTRIFICATION

2.2.1 Main Consideration

Railway Electrification, being in the nature of major improvement to the infrastructure of a section, is taken up basically on routes having high density of traffic. Short spurs of, or those lines which interconnect the electrified lines, which improve the mobility of the rolling stock are also taken up for electrification.

2.2.2 Financial Evaluation

As Railway Electrification entails capital expenditure, the sanction to the project is subject to Cost Benefit Analysis (CBA) through Discounted Cash Flow (DCF) technique. Two scenarios are considered, one under diesel traction, and the other under electric traction, for the given volume of traffic forecast on the section over a long enough period of time such as 30 years after the energization of the section for electric traction. The cash outflows under the two scenarios are discounted at the approved rate of 12% over the life of the project (taken as 35 years, about 5 years for construction and 30 years thereafter of operation). If the total of the stream of the annual discounted cash flows for electric traction is found to be lower than that for diesel traction, the project is considered as remunerative and desirable for approval. Sometimes an Economical analysis is also called for such as when funding by an International Aid Agency viz. the World Bank or Asian Development Bank is proposed. Although the Economic analysis is also carried out on the same DCF technique, the inputs and the outputs reflect the Social Costs and benefits, and the discount factors chosen may also be different, being dependent upon funds available for investment for future benefit against those required for immediate consumption and as decided by say, the Planning Commission. The investment in electric traction is found remunerative on account of:

i. Lower fuel-costs
ii. Less number of locomotives
iii. Lower operating costs
iv. Lower locomotive maintenance costs.

as compared to diesel traction of the given traffic. The traffic level in Gross Million tonne per route kilometer per annum at which the minimum acceptable rate of return is obtained is called the “Break Even Level” of traffic density.
2.2.3 Past policy on Electrification

a) Early Years

At the end of the 19th century electricity was in widespread use for running trams in North America and Europe, being found more economic than their haulage by horses. By 1930s on the Railway systems electric traction was in different parts of the world over short high density main line or suburban sections. The system of supply was usually 1500 V dc although some sections at 600 V dc or 750 V dc with third rail system were also adopted. The Copper Catenary was heavy and complex Rectifier substations were required to be located at close intervals. The cost of electrification was high. In India, also, by 1930 the suburban sections of Bombay and Madras were electrified at 1500 V dc. There were only two main line sections on electric traction, being Bombay to Pune and from Kalyan to Igatpuri, the electrification being beneficial in drastically increasing the throughout of traffic over these two sections, both having 1 in 37 gradient over the Western Ghats. The traction required reversing stations to negotiate, such steep inclines. There being no Extra High voltage grid system in the country or adequate generating capacity, the entire power for these electrified sections were generated and transmitted by the then Great Indian Peninsular Railway to its traction substation.

b) Post World War – II Scenario

After India’s Independence electrification of Howrah-Burdwan section on 3000 V dc was taken up and was completed in 1958. In the meanwhile in 1955 the French National Railway (SNCF) who had perfected the system of Electrification on 25 kV ac, demonstrated its advantages at the International conference of the International Union of Railways (UIC) at Lille in France. The major advantages of 25 kV ac 50 Hz single phase was a light Overhead Equipment, simple transformer substations located far apart feeding power to rectifier locomotives having tap changer control giving greatly improved adhesion characteristics. But the adjacent signalling and telecommunications circuits needed immunization from the electro-magnetically induced voltages due to traction currents. This called for modification to these circuits and to their terminal equipment, but in the process gave an opportunity to improve and upgrade these equipment. This system was more reliable and on the whole cheaper to construct and to maintain. The ac locomotives could haul heavier loads and gave better acceleration than dc locomotives. However, such a system was dependent upon power supply from Extra High Voltage (132KV) grid system having adequate short circuit capacity required for supplying the extent of single phase traction loads. Weighing the advantages of this system and the fact that 132 kV grid system was also in the process of being set up in the country, Indian Railways in the year 1957 decided to adopt 25 kV ac 50 Hz single phase system for all future Railway Electrification schemes, as well as to convert the system of 3000 V dc traction recently established in Howrah Burdwan section of Eastern Railway and the one existing at 1500 V dc on the suburban metre gauge section of Madras on Southern Railway, to this system for uniformity. For the initial stages the technical collaboration of SNCF was taken. Choice of 25 kV ac single phase system at industrial frequency (50Hz) gave a large drive towards main line electrification of the coal and iron ore routes serving the steel plants located on the Eastern and South Eastern Railways was carried out. To cater for the suburban commuter traffic of Sealdah Division of Eastern Railways was carried out. To cater for the suburban commuter traffic of Sealdah Division of Eastern Railways so far on stream traction, these routes on the
Division were Electrified. Electrification of Igatpuri-Bhusawal section of Central Railway and Tambaram-Vilupuram (metre gauge) section of Southern Railway, was also taken up.

c) Corporate Plan of Indian Railways

Indian Railways, in their first Corporate plan for the period 1974-89, identified the Broad Gauge trunk routes interconnecting the four major metropolitan cities viz. Calcutta, Madras, Bombay and Delhi which should ultimately be electrified, having high potential for growth of traffic, along with other high density coal and ore carrying routes.

d) Accelerated electrification

The Arab-Isreal wars of the 1970s highlighted the strategic nature of Petroleum and their scarcity value. Further the sharp increase in the cost of oil in the period from 1973 to 1980 and increasing outflow of India’s foreign exchange for importing petroleum and its products spurred the Government of India in 1980, to take a policy decision to accelerate the pace of Railway Electrification. The target was to achieve an electrification programme of energizing 1000 route kilometer per year. Though this was not achieved, a rate of hitherto 150 to 200 km of energization was increased to a rate of 500 to 600 km per year from 1985 onwards. Electrification of complete route rather than section has been, thereafter, planned. By 1992 Electrification of Delhi-Calcutta, Calcutta-Bombay, Delhi-Bombay, and Delhi-Madras was completed. The Overhead Equipment and the Power Supply on some of the electrified routes are being strengthened to cater to goods train loads of 9000 tonne. By march 2009 a total of 18942 km are electrified.

2.2.4 Present Policy on Electrification

The successive Corporate Plans of Indian Railways generally identify the routes most suitable for electrification. Following considerations dictate the priority or electrification of a route.

a) high traffic density
b) extension of an electrified route on short spur or interconnection of two electrified routes to improve rolling stock mobility, and
c) passenger commuter sections.

Availability of requisite power supply at reasonable rates is a basic condition combined with availability of adequate short circuit power of tap for the single phase traction power needs. The zonal Railways and the Railway Board maintain section wise traffic density figures as a part of their statistics. With this as the base and the anticipations of future traffic the highest traffic density routes which are not electrified are short listed. After making a list of such routes and short listing them in order of their operating benefits, priorities for electrification are finalized by the Ministry of Railways in consultation with the Planning Commission.
2.3 SURVEY FOR ELECTRIFICATION

2.3.1 General

After having narrowed down the choice of routes which may be considered for electrification, it is essential to further examine the chosen route in detail for its suitability for electrification in following aspects:

a) The feasibility of electrification viz. availability of power supply, suitability of the terrain and of the overline structure (or their amenability to modifications) to suit the electrical clearances, and of terminal yards to be able to provide lines for change of traction.

b) A realistic assessment of the cost of the project.

c) The financial viability of the investment.

To ascertain the above details a route is surveyed for Railway Electrification. The survey may either be a ‘Reconnaissance Survey’ or a detailed Foot by Foot, ‘Cost-cum-Feasibility Survey’ as the circumstances call for.

2.3.2 Reconnaissance Survey

This is a rapid survey examining the salient and vital points, leaving the details to be worked out in the extensive Foot by Foot Survey. The survey covers the following items.

a) Assessment of existing traffic forecast of projected traffic, both for goods and passenger, including special requirements such as plans for running Superfast passenger trains or / and of heavy haul goods trains.

b) Availability of Electric Power.

c) Details of the section covering the terrain, the terminal yards, the signal and telecommunication installation and the volume of work involved in modification to overline structures and the over bridges to suit ac traction. This is normally done by a joint inspection by the officers of the concerned disciplines biz, electrical, civil engineering, and signal and telecommunications using motor trolley or an OHE inspection car.

d) An idea of the lengths of the route to be equipped with booster transformers and return conductor, involving a preliminary discussion with Department of Telecommunications.

e) The information collected by this rapid survey yields a fairly accurate idea of the volume of electrification work content. For obtaining an estimate within 10 to 20% of its cost. Unit costs derived from a recently completed project on cost per unit of work, or per route of track km. As most applicable, are applied to the quantities of the component works estimated, and the project cost is worked out. Based on the latest cost of inputs, of fuel electric energy, specific fuel or energy consumption and other
operating and maintenance norms derived from statistical data, a rate of return is worked out.

The feasibility for electrification, its cost and its remunerativeness so worked out gives adequate information based on which the project can be sanctioned. However, if the competent authority desires to examine the project more closely, then a detailed cost-cum-feasibility survey has to be taken up. This survey has to be included in the programme for surveys and sanctioned in the annual works.

Programme by the Railway Board and a separate organization set up to conduct it. Such a situation may arise for example, when the cost of inputs have altered radically and the traffic density forecast on the route is not very much above the ‘break even’ level.

2.3.3 Cost-cum-Feasibility Survey

A multi disciplinary Survey Team is formed expressly for carrying out the detailed survey. This survey organization finalises the wiring plan, conducts foot by foot survey of the route and prepares the survey plans followed by the prepegging and pegging plan. The team examines the clearances on the route to suit 25 KV ac 50 Hz single phase system and suggests modifications wherever required. By liaising with power supply authorities and the Department of Telecommunications, it also examines in detail the availability of power and the quantum of protection required by involved and the cost implications to be worked out. Based on these the financial viability of the work is examined. Finally all these details are incorporated in the Project Report and the Abstract Estimate which is placed before the competent authority for sanction of the Railway Electrification project. On sanction of the project the drawings prepared and the estimates made are used for calling of tenders and finalisation of schedule of quantities. Accurate foot by foot survey, and carefully finalised designs prepared by a survey organization is the cornerstone of a successful Electrification Project.

2.4 FOOT BY FOOT SURVEY

2.4.1 General

In order to prepare the designs of Overhead Equipment Layout forming the basis of the Project construction work a detailed foot survey of the route proposed for Electrification is taken up. This survey forms the basis of Survey Sheets. These sheets are prepared to scale, the longitudinal scale being 1:1000 in open route and 1:500 within station limits and in yards. The sub-scale chosen for cross-sections is 1:200. On these sheets the OHE structures and anchor, foundations are marked according to the Principles for OHE Layout Plans and Sectioning Diagrams for 25 KV ac Traction. Document No. ETI/OHE/53, issued by RDSO. These plans, called prepegging plans are then verified at site and modified to site conditions and finalised. The final plan thus issued is called the Pegging Plan, and forms the basis for estimation of quantities, the cost estimates and for schedule of quantities to tenders for OHE construction Contracts. Bonding and Earthing plans and plans for modifications of power distribution lines at stations and yards are also prepared based on these survey plans. Preparation of accurate detailed survey plan, therefore, cannot be overemphasized.
2.4.2 Field Book

A Surveyor’s field book is required to be maintained in which all the details obtained during the survey should be entered. These details are transferred to field sketches. Such sketches are then sent to the Drawing Office to enable preparation of Survey plans. The entries in the field book should be dated and progress in accordance with increasing chainage. Details entered should include important features along the track and their offset from the centre line of the nearest track. The chainage of location where embankment changes to level ground, or level ground to cutting or vice versa should be recorded as these are essential in ascertaining the soil bearing pressure, required for design of foundations for OHE structures. Continuous features, such as, Track centres, width of cess, offsets to continuous running drains, fences or pipes, cables; either on surface or buried underground, should be recorded at 50 m intervals on open route and at 25 m intervals in yards and within station limits. Cross section of the route at intervals of 250 m should be measured and recorded.

2.4.3 Important Features to be noted

These are:

a) Track centres between all tracks.

b) Track structure i.e. type of sleeper, depth of ballast, width of cess, embankment, level of cutting. The programme of track works such as re-sleepering with prestressed concrete sleepers, deep screening of ballast or rail renewal works, which affect the track levels and / or alignment, should also be ascertained and noted.

c) Details of cross section every 250 m

d) Type and condition of soil every 250 m and at geologic discontinuities.

e) Buried water mains, and cables and their runs alongside and across tracks.

f) Signal cabins and location boxes, signal wires, point rods, cranks and signal cables.

g) Signals: Main Routing, Shunt; their type and track for which meant.

h) Buildings, huts, platforms, other structures such as columns for overbridges, abutments of road overbridges.

i) Platform shelters, their profile across tracks, height and distance of columns, and edges of shelters from adjacent track.

j) Turnouts, crossovers, and diamond crossings, their deviation numbers viz. 1 in 8.5, 1 in 12 or 1 in 16 chainage of the fouling boards / marks, track centres at toes of turnouts and at the fouling boards / marks.

k) Water columns, ash pits and steam blowdown pits.

l) Fueling points for Diesel locomotives.
m) Metallic circuits (electric, low or high tension, signal, or telecommunications) running parallel to tracks and their distance from adjacent track centres.

n) Fencing: Metallic or otherwise, running along tracks, chainages of their beginning and end, and their distance to adjacent track at regular intervals; their type of construction.

o) Overhead wire crossings of tracks Telecommunications (Railway or belonging to Department of Telecommunications); signalling and power including their ownership, their voltage and clearances from each track crossed, if the voltage of the power line is 33 KV or above the angle of crossing and also the location of two adjacent supports on either side of the tracks.

p) Overline structures such as Road overbridges. Flyovers, foot overbridges and signal gantries: their vertical clearances from each track spanned, and horizontal distances of their support columns or abutments form the adjacent tracks, if the overline structure has smoke baffle plates, the clearance to the lowest member of the structure should be recorded. A sketch of the cross-section across the tracks giving the leading dimensions is required to be prepared.

q) Curves: Whether right hand or left hand as seen in the direction of increasing chainage; the degree of curvature, and the chainage of tangent points both at the beginning of transition and of main curves. Versines in mm are taken every 50 m with nylon cord for the entire curve. The super-elevation as found at site should be recorded. Actual versines measured at site may be different depending upon the disturbance the track has suffered since its last realignment.

r) Level crossings, their chainages, and location of gate lodges, whether manned or unmanned and location of gate signals, if an. Special note should be made of level crossings on important roads or those giving access to main roads (this is useful during construction and subsequently for maintenance).

s) Locations of gradient posts and signal location marker posts.

t) Culverts and bridges: Chainage of their abutments, piers, trolley and man refuges, whether culverts or long bridges. If so whether deck type or through girder type. For through girder types the head room of entry portals. Sketch showing plan and elevation of the piers and the entry portals are also required. Location of alignment of water mains, cables and open wires running on the bridge structures should also be noted.

u) Tunnels; their chainages and profile, whether lined or unlined, location of trolley and man refuses, areas with extensive water seepage, arrangements of water drainages, and location of drains.

v) Identification and extent of Exposed Locations: Areas where full wind effects are likely to be encountered by OHE structures and termed ‘Exposed locations’ should be noted down. These are generally encountered on approach embankments to long bridges and on them, high bare grounds and in valleys subject to funnel effect of wind.
w) Identification of polluted locations: Areas, adjacent to factories and power stations having high ambient pollution particles should be identified and recorded.

2.4.4 Field Survey:

To ensure accuracy only steel tape or fibre glass / plastic coated tape should be used for measurements. Yellow paint or crayon marks should be marked on the web of the rail along which measurements have been made every 25 m. on curves the chainage should be taken along the outer rail of the middle track when there are odd number of tracks. If there are even number of tracks the chainage should be taken along the inner rail of the first track outside the centre line of the group of tracks. At the point of start ‘zero’ chainage is taken. While proceeding along the tracks the features detailed in paragraphs 2.4.2 and 2.4.3 are recorded indicating their chainages and offset distances. When the next kilometer post is reached, the closing chainage distance to the km post is recorded. Chainage distance with respect to the new km post is commenced afresh. Thus chainages are taken from one km post to the next.

2.4.5 Overline Structure

The headroom available under an overline structure is an important parameter, the design of OHE under it being governed by this parameter. It is necessary to mark the track level on the adjacent support column with yellow paint and use this reference mark to measure the headroom. This reference point is essential to be made permanent, since alteration to the level by permanent way gang subsequent to survey may radically affect the solutions to provide adequate electrical clearance which are found after a detailed study subsequent to field survey. Accordingly, all locations under overline structures where change in the track level by more than 50 mm may cause reduction in clearance of OHE from such structure or of the height of contact wire above the rail, need a special investigation by the field survey team.

2.4.6 Soil Characteristics

The survey of soil characteristics ever 250 m should also include its type and a bearing pressure capacity. Samples of the soil should be collected and sent to a soil mechanics test laboratory to obtain the type of soil and its bearing pressure. This information is required to be recorded on the survey sheet.

2.4.7 Curve Realignment

While measuring versines on curves if it is found that the figures are not uniform as should be found for a circular curve of that degree it may be necessary to have it examined by the open line permanent way engineers and get the curves realigned prior to finalisation of designs of OHE. Similarly, the super-elevations may also be adjusted to the designed values. This will ensure that the OHE designs have been appropriately made for the designed track layout minimizing subsequent adjustments during operation of the services.
2.4.8 Proposal to alter the track geometry

During the survey it is essential to obtain from the open line details of work on the track which may alter the track geometry and which may be taken up earlier than the anticipated programme of electrification such as

a) Provision of prestressed concrete steepers, resulting in raising of track level.

b) Realignment of curves for higher speeds, resulting in longer transition curves and higher super-elevation.

c) Easing of gradients.

d) Remodelling of yards, and doubling works.

e) Replacement of lower speed turn-outs to higher speed turn-outs.

2.4.9 Programme of Improvement to track structure

As OHE is erected to suit the track, alteration to the erected OHE to follow the changed track geometry subsequently becomes difficult and expensive. It is therefore, necessary for the open line to complete the works for improvement to track structure prior to taking up the OHE work. The Survey Plans should, wherever possible, indicate the existing track layout as well as the altered location with respect to the existing track after improvement. Details of such improvements should be invariably obtained through joint inspection with open line officials during foot by foot survey.

2.4.10 Field Sketches

The data recorded in the field books by the surveyor should be promptly transferred to field sketches as the survey proceeds so as to ensure full details are recorded and another visit to the site for items left out is obviated. In the basic form the field sketch sheet may contain pre-lined vertical and horizontal lines.

The vertical lines may each denote distances of 50 m on open route and 25 m in yards and station limits. The horizontal lines may represent centre line of tracks. Major yards having more than five to six lines may need special sketches to be made as required to suit the geographical conditions. Each sheet may contain details for 250 m of track and have at least one cross-section of the route. All details should be neatly recorded, as this forms the basic document for preparation of the survey sheet. All distances should be in metre and the versines in milli-metre.

2.4.11 Survey Sheets

The preparation of survey sheets in the drawing office proceeds serially as the field sketches are received there. These should be prepared in sheets of standard metric sizes with top sheet having the standard proforma, legend, and letter sizes. These are contained in RDSO’s Specification No. ETI/OHE/25. The drawings should be on tracing and in ink to permit reproduction.
2.5 PREPARATION OF PREPEGGING AND PEGGING PLANS

2.5.1 GENERAL

Prepegging plans are prepared on the survey sheets in accordance with the ‘Principles for OHE Layout Plans and Sectioning Diagrams for 25 KV ac Traction’ issued by RDSO. The aim is to provide the most economical support arrangement for the Catenary system, being technically sound for the maximum traction current expected. The maximum speed envisaged, and the maximum number of pantographs expected in a span. The prepegging plan is superimposed in soft pencil on a print of the survey sheet. After a number of trials, the best plan providing for least number of structures, called the ‘Prepegging Plan’, is got ready for check at site for its feasibility. This plan is sent to site for marking out the location of structures and anchors on the adjacent rail. A joint inspection of the site is then conducted, by Electrical (OHE designs). Civil, and Signal & Telecommunications engineers. During the inspection the plan is verified, and if required, modified to suit the field conditions. At this time the Civil and the Signal and Telecommunications engineers also make out their plans for track slewing, shifting of drains, pipes, or signal point rods, cranks etc to make way for the foundations for the OHE structures and their anchors. The site verified plan is then finalized as ‘Pegging Plan’ and is available for use for tendering for the contract for field work and for estimation of quantities. On award of the contract for field work, the pegging plan is once verified by the contactor jointly with project electrical (OHE) engineer prior to taking up the field work. The plan actually followed for field work, incorporating further details of type of structures used, the style of the cantilevers used, the stagger of the OHE conductors, the run of wires, portal spans as well as the setting distances of the structure legs becomes the ‘OHE layout plan’. This plan is the record to be kept for proper maintenance of the equipment after commissioning. The prepegging and the pegging plans are finalised in series in increasing chainages without leaving an gap in between. There may be exceptions over sections where yard remodeling, doubling or an other work involving insertion of turnouts and crossovers are contemplated but not taken up or not marked at site. The field party of the survey organization takes up site marking and assists in the verification of the plan.

2.5.2 Particular Specification

Prior to commencement of work on prepegging plan, the site conditions and the specific design of the equipment to be adopted needs to be finalised. Based on these parameters known as particular specifications the various details of the designs are adopted.

2.5.2.1 Meteorological conditions

a) The maximum, the minimum and the mean ambient temperatures:

The mean temperature adopted over the entire Indian subcontinent is 35 Degree C. A range of 15 Degree C to 65 Degree C as the minimum and the maximum is adopted for India except the northern plains having colder winters for which the range adopted is 4 Degree C to 65 Degree C. For unregulated OHE a contact wire height at supports of 5.65 m is adopted for the former range of temperatures and of 5.75 m for the latter range of temperatures.
contact wire height of regulated OHE is uniformly kept at 5.60 m at supports. The extreme temperature variations dictate the limit of the length of the OHE conductors from the anticreep central mast to the balance weight anchor mast, the movement of the balance weights on the masts due to thermal expansion and contraction of conductors being limited as also to limit the swing of the bracket assemblies nearer the balance weights. For both the temperature ranges a maximum distance of 750 m from anticreep to the balance weight anchor mast is prescribed, inside long tunnels the temperature ranges are much lower and, therefore, advantage may be taken of this fact for specially designing the passage of OHE through them by minimizing the number of anticreeps and balance weight anchors.

b) Wind Speed Zone

It is to be ascertained from IS 875 as to in which zone area the section to be electrified falls. This dictates the maximum permissible span to be adopted and the relevant employment schedule to be adopted for the design of structures and foundations.

c) Identification of ‘Exposed Locations’

As ascertained during foot by foot survey (refer paragraph 2.4.3 (V) the exposed locations which are likely to have maximum severity of wind velocity, which are identified on the survey sheets, should have maximum spans reduced by 4.5 m below the maximum permissible for the section as determined for item (b) above.

2.5.2.2 Design Parameters

The design parameters and the type of equipment to be adopted is required to be specified in regard to the following:

a) Choice of Portals or Individual masts at stations and on multitrack (more than two tracks) sections: Whether portals spanning all the wired tracks are to be provided or individual masts should be provided, if the track centres permit. Whether headspans are to be used for yard lines, and if so, where?

b) Sections of open route and yard lines where regulated / unregulated OHE is to be used.

c) Choice of the type of OHE for :
   
   i) Main lines – Whether conventional copper conductors or an other material is to be taken into consideration.
   
   ii) Sidings and yards – whether conventional OHE with catenary and contact wires is to be used or tramway type of equipment is to be used. For tramway type, whether the equipment is to be regulated or not.

d) Booster transformers and return conductors: The decision jointly arrived at with the Department of Telecommunications, of the sections over which these are to be provided.

e) Decision to use 2 x 25 kV AT system. A decision jointly arrived at with the open line Railway whether this system is to be adopted: if the Department of Telecommunications require Booster transformers and return conductor over the concerned section, their consent
to the use of this system in lieu of the provision of booster transformers and return conductors is also necessary.

f) Finalisation of track slewing plans for yard or secondary lines to locate OHE structures in the identified lanes.

2.5.2.3 Movement of Over dimensional consignments (ODC)

The minimum height of the contact wire under heavy overline structures is normally kept such that class ‘C’ over dimensional consignments of Height 4.92 m can be moved at unrestricted speed with electric locomotives. At heavy overline structures such as through girder bridges, road over bridges or tunnels having low clearances, and where modifications may not be feasible or the cost excessive a decision may have to be taken in regard to their passage such as :

a) Whether adequate clearance may be provided to move with electric locomotive at restricted speed.

b) Whether the ODC can be diverted through another line not spanned by the overline structure.

c) Whether the ODC can be diverted through another line not overline structure can be nominated to move the ODC with electric locomotive.

d) Whether ODC can be moved with ‘power off’ on OHE by a non electric engine, ensuring only adequate physical clearance.

e) Or, whether the ODC should not be permitted under the overline structure, nominating an alternative route through which ODCs should be diverted.

A suitable solution may need a careful examination of the extent of modifications, the cost; feasibility and the time frame for carrying out the modifications.

2.5.3 Principles of Prepegging Plans

It is essential to be conversant with ‘Principles for Layout Plans and Sectioning Diagrams for 25 kV ac Traction’, Document No. ETI/OHE/53 issued by RDSO before attempting preparation of a prepegging plan. Some important principles, however, are brought out in the following paragraphs for read reference.

2.5.3.1 Span Lengths

Span lengths are chosen in multiples of 4.5 m. The shortest span adopted is 22.5 m and the longest, depending upon the particular specification of the wind speed zone and the type of equipment, being a maximum of 72 m. The difference between two consecutive spans should not exceed 18 m to ensure compatible flexibility over the adjacent spans. Non standard span lengths are permitted only if special conditions do not permit choice of standard span sizes, such as while locating on bridge structure. The maximum span lengths as permitted by the location should be aimed at. On tangent track this is the maximum permissible depending upon the particular
specification of the section. On curves, turnouts and crossovers, the span lengths are lower, being governed by the maximum permissible stagger of the contact wire at the structure and in the middle of the span; this limitation being guided by the design consideration of pantograph contact surface its sway and blow-off of OHE conductors in wind. As a general rule the maximum stagger at a structure should not exceed 300 mm on curves and 200 mm on tangent track. Mid span staggers should also not exceed the figures prescribed by RDSO.

2.5.3.2 The Setting Distance (Implantation) of Structures

The setting distance to be provided are:

a) For individual masts carrying one OHE:

i) On tangent track

<table>
<thead>
<tr>
<th>Standard</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.80 m</td>
<td>2.36 m</td>
</tr>
</tbody>
</table>

(*Note: In special circumstances, with prior approval of the Chief Electrical Engineer of the Railway)

ii) On curves

<table>
<thead>
<tr>
<th>Degree of curve</th>
<th>Radius of curve in m</th>
<th>Setting distance in m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside Curve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero to 1/2°</td>
<td>Above to 3500</td>
<td>3.20</td>
</tr>
<tr>
<td>1/2° to 3/4°</td>
<td>3500 to 2350</td>
<td>3.35</td>
</tr>
<tr>
<td>3/4° to 1/2°</td>
<td>2350 to 1150</td>
<td>3.55</td>
</tr>
<tr>
<td>1 1/2° to 6°</td>
<td>1150 to 300</td>
<td>3.60</td>
</tr>
</tbody>
</table>

| Outside Curve   |                      |                       |
| Zero to 2       | >1 = to 875          | 2.80                  |
| Above 2         | less than 875        | 2.95                  |

b) For a Portal upright or a headspan leg or a mast carrying more than one OHE the setting distance adopted should not be lesser than 3.00 m

c) Lower setting distances permissible on curves: If the stipulated standard setting distances mentioned in subparagraphs (a) and (b) above cannot be obtained, lower setting distances up to a minimum may be adopted as found out from following reckoning: To the minimum setting distance as permitted in the schedule of fixed structure as provided in the ‘Schedule of Dimensions, 1676 mm Gauge’, a slewing allowance of 150 mm should be added; to this a curve allowance for the degree of curve should be added. The curve allowance for different degrees of curves and for different speed potentials are given in the ‘Schedule of Dimensions, 1676 mm Gauge’ and in tables I, II, and III of RDSO’s Document No. ETI/OHE/53: Principles for Layout plans and Sectioning Diagrams for 25 kV ac Traction.
2.5.3.3 Location of obligatory structure

There are certain features along the track, within a few metre of which an OHE structure should be provided. These are, for example, at turnouts and crossovers or adjacent to overline structures. These OHE structures are called ‘Obligatory structures’. While commencing a prepegging plan it is most convenient to commence from an obligatory structure at a turnout or a crossover. An OHE structure should be located within 2 m of the theoretical centre of a turnout. If this is found not feasible, as an exception the structure may be located farther away. The maximum distance from a centre of a turnout that a structure can be located is indicated in Table 2.5.2. In all cases, the contact wire stagger at structures and at mid spans should be verified during site verification of the prepegging plan. During the verification the location of the section insulator, if required to be provided in the span should also be fixed. The span under an overline structure should not exceed 54 m to limit the amount of push up of Catenary by the upward thrust of the pantograph; also the structures supporting the OHE should be more or less equidistant from the centre line of the overline structure to ensure maximum clearance between the overline structure and the OHE conductors. Passage of OHE under heavy overline structures having restricted clearance has to be designed specially through a “profile study”. Such a study fixes the location of OHE structures, the span lengths to be adopted under and adjacent to the overline structure along with the contact wire gradient and the encumbrances at the supports.

Table 2.5.2

<table>
<thead>
<tr>
<th>No. of Turnout</th>
<th>Distance from centre of turn-out to maximum distance permissible from centre of turnout to the OHE structure, towards Toe (m) track separation = 150 mm</th>
<th>Nose (m) track separation = 700 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in 8 1/2</td>
<td>11.15 14.30</td>
<td>5.72 4.20</td>
</tr>
<tr>
<td>1 in 12</td>
<td>15.15 20.15</td>
<td>7.00 6.10</td>
</tr>
<tr>
<td>1 in 16</td>
<td>20.10 26.85</td>
<td>9.60 7.50</td>
</tr>
<tr>
<td>1 in 20</td>
<td>23.75 33.50</td>
<td>10.70 10.50</td>
</tr>
</tbody>
</table>
FIG. 2.5.1(a)

STRUCTURE LOCATION TOWARDS NOSE AT MAXIMUM PERMISSIBLE TRACK SEPARATION OF 700 mm

FIG. 2.5.1(b)

STRUCTURE LOCATION TOWARDS TOE AT MINIMUM PERMISSIBLE TRACK SEPARATION OF 150 mm

NOTE: ALL DIMENSIONS ARE IN mm
This is based on the fact that on a turn out, although the contact wire for the main track is, appropriately placed for the pantograph of a locomotive running at speed, it is the contact wire for the turn out that should always be within appropriate stagger (=300 mm at support and the appropriate mid-span stagger for the turn out span). The curvature on the turn out requires staggers of 300 mm in all cases towards the main track. Further, there should be a minimum horizontal separation, between the two contact wires, of 50 mm and a maximum of 200 mm at support to ensure non-interference between two OHEs and smooth change over of contact wire for the pantograph of the locomotive negotiating the turn out.

This is possible if the obligatory structure at a turn out is located at any point between the track separation of 150 mm and 700 mm, irrespective of the number of the turn out, as would be clear from the Figure 2.5.1.

2.5.3.4 Location of OHE structures in advance of a Signal:

OHE structure should not be located nearer than 10 m behind and 30 m in advance of a signal. For proper visibility of a signal, a larger setting distance is given to a few OHE structures in advance of a signal. For Semaphore signals a larger setting distance is required for 5 OHE structures, with the one immediately in advance having a minimum setting distance of 3.05 m, followed by the next one at 2.9 m and the next three consecutive structures having a minimum setting distance of 2.75 m. For colour light signals, the minimum setting distances are regulated upto 600 m in advance of the stop signals and upto 300 m in advance of a signal with route indicators. On curved track, depending upon the topography and curvature, the structures should be so located as to ensure the best continued visibility of signals. In such cases the setting distances and the lanes for location of OHE structures should be fixed by a joint field inspection of Electrical (OHE designs) engineer with the Signal Engineer.

2.5.3.5 The location of overlaps

The insulated overlaps are located at the appropriate sites selected for the subsectioning and paralleling posts (Neutral sections are required to be provided at the sectioning and at feeding posts), the locations for the manually operated isolating switches, and for the booster transformers stations, all of these having been finalized in the sectioning diagram earlier. Having located the insulated overlaps the uninsulated overlaps are inserted ensuring longest tension lengths, the effort being to have minimum number of overlaps in the section. There is a limit of 750 m between the anticreep central mast to the corresponding balance weight anchor mast at the overlap for regulated OHE. This limits the tension lengths to 1500 m maximum. For unregulated OHE no anticreeps are required and the maximum tension length of conductors is increased to 2000 m. In case the insulated overlap is on a curve having a radius of 5000 m or sharper (0.35 degrees) a 4 span overlap becomes necessary with a central overlap OHE structure having two brackets at different elementary sections. To ensure satisfactory clearance between the brackets the distance from anticreep to the centre of the 4 span insulated overlap is limited to 600 m. In view of the problem of maintaining appropriate clearances at the overlap central mast and need to take power block on two elementary sections for maintenance of such overlaps, location of insulated overlaps on curves should be avoided as far as possible. The tension lengths
at conventional overlap type of neutral section and at short neutral section are limited to 600 m or less. The overlaps should be also so adjusted that their location at a station does not result in use of three bracket structures. If, adjustment of the uninsulated overlaps between the predetermined location of insulated overlaps results in having a tension length 750 m or lower (600 m if adjacent to 4 span insulated overlap or adjacent to a 41 m neutral section), a half tension length of OHE, having one end as fixed termination may be adopted, omitting the anticreep.

2.5.3.6 Location of Section Insulator

The total weight of the section insulator including the weight of the two insulators on the OHE and the copper runners is 55 kg. to accommodate the two insulators for both the conductors and to permit the locomotive pantograph to glide over the two runners of the section insulators there is a requirement of a minimum dropper length of 450 mm, and a maximum permissible stagger of 100 mm at the location of the section insulator. Since the maximum encumbrances at the OHE structure is limited to 1.4 m, this imposes a limit to the sag and therefore, the distance of the section insulator from the nearest OHE support. This limit is given in Table 2.5.3 below. In view of the limit of 100 mm of stagger, this should be achieved by adjusting the staggers at the adjacent OHE structures during site verification of the prepegging plan.

<table>
<thead>
<tr>
<th>Span</th>
<th>72.0</th>
<th>67.5</th>
<th>63.0</th>
<th>58.5</th>
<th>54.0</th>
<th>49.5</th>
<th>45.0</th>
<th>&lt; 45.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>7.7</td>
<td>8.1</td>
<td>9.4</td>
<td>12.3</td>
<td>13.5</td>
<td>15.0</td>
<td>18.2</td>
<td>No limit</td>
</tr>
</tbody>
</table>

At a turnout the section insulator assembly should be located beyond the Nose of Crossing with runners facing away from the centre of turn out. It is a good design practice to locate the OHE mast towards the Nose so as to make the span over the turnout short permitting wider latitude in location of the section insulator and having adequate latitude in selection of suitable staggers at the structures in order to achieve the stagger of contact wire below 100 mm under the section insulator.

2.5.3.7 OHE at a turnout

On main running lines the OHE of the turnout should have overlap type of equipments. On secondary lines this may be crossed type to reduce the cost. The turnout OHE taking off from the main line should be regulated and have both, the contact wire and the Catenary. The OHE for a secondary line taking off from a loop line may be either unregulated or tramway type. Three bucket assemblies at a turnout
structure should be avoided as adjustments to the OHE are difficult. As mentioned in paragraph 2.5.2.3 above, in this effort overlap multicantilever OHE supports should be suitably located away from turnout structures.

2.5.3.8 OHE at Special locations:

a) Adjacent to overline structures:

Prior to preparation of OHE prepegging plan in vicinity of a heavy overline structure the clearance study should be completed. In case of restricted clearances the profile drawing should be prepared in advance for incorporation in the OHE prepegging plan.

b) On long bridges

The spans on long bridges are dictated by the location of the piers on which the OHE structures are located, therefore, these are usually non standard. On through girder bridges the OHE may have to be supported on specific members of the trusses, as such the design of OHE on such a bridge may be finalized subsequently, without delaying the finalization of the prepegging over the rest of the route. However, the feasibility of location of the OHE support must be established in advance during the survey.

c) In tunnels:

The design of OHE in tunnels require careful study. The spans are required to be kept short as it becomes difficult to obtain adequate headroom for large encumbrances. Unless the tunnel is long, anticreeps and overlaps should not be located inside the tunnel. For long tunnels one method to avoid the anticreep is to erect unregulated OHE, the seasonal temperature variations inside the tunnel being limited, provided there are permanent speed restrictions inside the tunnel imposed due to civil engineering considerations; the effort being to avoid imposition of speed restriction on account of OHE only. In sum a detailed examination of the local conditions is required before finalizing the design of OHE inside a tunnel.

2.5.4 Provision for Remodelling

Yard remodelling works may be in progress or proposed on the route. Doubling works may also be in progress. If the electrification works is expected to be taken up either after remodelling or has to take in account such remodelling, so as to conveniently modify the OHE when such remodelling is taken up, the design for OHE should take into account such works in the prepegging plan. Accordingly the proposed locations of toes of turnouts and alignment of the new track should be jointly examined by the civil engineer in charge of the track construction works and the OHE design electrical engineer, so as to obtain the most economic plan involving least amount of traffic block for carrying out the remodelling work both for the track and for the OHE when the plan is finalized. The toes of the turnouts and the alignment of the proposed tracks are marked out on the ground with permanent bench marks. These are incorporated in the survey sheet. The special arrangements to be provided for in the prepegging and subsequently in the pegging plans including in the phase plans, if any, should be noted in the finalized plans.
2.5.5 Preparation of prepegging plans

The drawings should be of standard size and follow the standard orientation of the top sheet and the direction of progress. For this purpose provision contained in RDSO’s Specification No. ETI/OHE/25 may be followed. The exercise for preparation of the prepegging plan should commence as an exercise in soft pencil on a print of the survey sheet. It may begin from an obligatory structure of a turnout on the main line and structures marked according to the guidelines. Adjusting the location of structures, to minimize their number, and those of the location of the overlaps, anticreeps and anchors to the most suitable locations may need a number of exercises. At stations where portals are not to be used, main and loop line cantilevers may be located in an umbrella fashion on a common mast, provided they are on the same elementary section. Number of brackets on a mast, the anchors, return conductors, earth wires, and 25 kV feeders should be clearly marked. After the trials, when the plan is considered satisfactory the structure numbers and their chainages are marked out. This plan is now transferred to the inked tracing of the survey sheet, but in SOFT PENCIL, so as to erase and incorporate the changes, if required, after site verification of the plan. To confirm the feasibility of the plan during site verification the prepegging plan should include the following details:

a) Anchors – Balance weight, fixed termination, and anticreep for OHE, 25 kV feeders, return conductors and earth wire.

b) Anticreep central masts – indicating thereon the number of spans and distance in metre to the balance weight anchors.

c) Multiple cantilevers – 0 for overlaps, turnouts and out of run wires.

d) Overlaps – insulated, uninsulated or neutral section, the insulated overlaps being at the location selected for the supply control post, manually operated isolating switch or for booster transformer.

e) Conductors – OHE return conductors 25 kV feeders and earth wires. The length of the OHE span is to be recorded in the middle of the span.

f) Section insulators – for sectioning or for neutral sections: the distance to the nearest mast should be recorded.

g) Signals – existing as well as those to be installed.

h) Auxiliary transformer (25/0.230 kV) stations – for stations, signal cabins, intermediate block signal huts and level crossings. At least two prints of the prepegging plan, thus made ready are furnished to the survey civil and S&T engineers who are required to attend the site inspection for verification of the plan.

2.5.6 Marking at site

On receipt of the print of the prepegging plan at site, the field subordinate marks the locations of the structures and anchors in yellow paint on the web of the rail adjacent to the shown location of the OHE structure or anchor 7.5 m away from the OHE structure alongside, structure numbers and their chainages are also marked. During marking out the locations on web of the rail, simultaneously, obstructions, if any to the location of structures or anchors, found at site should be recorded on the print. Further at the location of structure the following measurements are taken and recorded on the print for:
a) track centres,
b) width of the cess, if in a cutting distance to the drain and its width and to the edge of the slope,
c) turnouts: distance of the structure location from the toe of the switch and track separation at the location,
d) drains, point roading underground, pipeline or cables running along the route distance from the adjacent track to be checked if located in the same lane in which the structure locations are proposed,
e) versines in mm of span for the tracks on curves and of turnouts and crossovers,
f) signals: distance to the nearest OHE structure location,
g) powerline, signal or telecommunication crossings: distance along the track from the nearest structure location,
h) obstruction, if any, for location of structures as shown in the prepegging plan.

Marking out the prepegging plan at site gives one more opportunity to the survey team to verify ground conditions and incorporate changes, if any, since the original survey. After marking out the locations of structures on rails and incorporating other details as required, one copy of ‘as marked’ plan is returned to the OHE design office. One copy is retained by the field subordinate as his copy.

2.5.7 Joint field inspection

In the OHE design office the ‘as marked’ plan is carefully examined and the plan is modified, taking into consideration the ground conditions viz. obstructions or excessive versines on curves or at turnouts or inadequate track centres for location of a structure. This revised prepegging plan is now ready for Joint Field Inspection. Copies of this plan is distributed to the civil and signal and telecom engineers of the Survey organization. A programme of joint inspection of the site is now made by the Electrical (OHE designs) engineer with the concerned civil and S&T engineers. The Officials must be of adequate level so as to take decisions on the spot during the inspection in regard to modifications, if any, required to be done to the civil engineering or S&T installations at site. The S&T official should have with him the finalized plan for the proposed colour light signals. Modifications, such as, diversions of drains, pipelines, trolley or man refuges, or slowing of tracks to obtain adequate track centres, or shifting of point roading alignments or of cranks for locating OHE structures are recorded for their compliance. All overhead crossings of Signal and telecommunications circuits including those belonging to the DOT are specifically taken note of, so as to either divert them or cable them well before commencement of OHE construction work. Any power line crossing should confirm to the Regulations for Power Line Crossings of Railway Track. If it does not, the owner of the crossing will have to be advised to modify the crossing to confirm to the Regulations contains

Over Head Equipments
some of the important provisions of the Regulations for Power Line Crossings of Railway Tracks for ready reference. Based on the decisions taken during the joint inspection the OHE layout is finalized. This plan is now termed the ‘Pegging Plan’.

2.5.8 The Pegging Plan

The location of OHE structures and of anchors, being final, are now inked over in the tracing of the original Survey Sheet. Vital details at the location of structures, such as the track centres and measured cess widths; spans of portals; versines of spans on curves, at turns outs and at crossovers are recorded on the plan. This pegging plan forms the basis for estimation of quantities of work and of materials, based on which the tender schedules are finalized.

2.5.9 The OHE Layout Plan

This pegging plan is further completed in stages as the construction work proceeds. Finally when the construction work is over, the final plan, called the OHE layout plan contains the details of run of conductors, showing both ‘in run’ and ‘out of run’ contact wires, setting distance of each structure and its type, the type of portal and span of its boom, the stagger of the contact wire and any other special features which may be required to be given such as reference to a profile drawing for passage of OHE below an overline structure. There is usually a time gap between preparation of pegging plan which indicates the milestone of conclusion of the survey, and the OHE layout plan, prepared during construction by the contractor, who commences the work after further verifying the pegging plan. On completion of the work the contractor finishes the OHE layout plan as “As completed” plan for handing over to the maintenance organization.

2.5.10 Modifications to Railways electrical overhead distribution lines

The overhead distribution lines running on platforms or in yards need to be checked for the quantum of electromagnetic and electrostatic induction from the 25 kV ac 50 Hz single phase traction currents. During the survey, drawings should be also made of the power distribution lines indicating their separation distance from the centre line of the track to be electrified and the arrangement of feed, whether in the middle or at the end to ascertain the extent of parallelism, on receipt of the survey sheets in the electrical design office the voltage rise due to electromagnetic induction and the discharge current due to electrostatic induction in the distribution lines are checked in accordance with the formula obtained form SNCF. If the induction effects are found to be beyond permissible limits, the distribution lines would need to be modified to bring down the effect to be within safe limits, the distribution lines would need to be modified to bring down the effect to be within safe limits and plans are accordingly made.

2.5.11 Bonding and Earthing plans

All metal work adjacent to electrified lines have electro-magnetically induced voltages, which increase in proportion to their length, such as metallic or platform shelters running parallel to tracks. Other metal work open to public such as the foot overbridges and platform columns may also pick up hazardous voltages either
induced or by accidental contact with the live OHE. Rails of the track carry heavy traction currents in vicinity of feeding posts or at other locations where some rails are taken up for track circuits, these locations may pose hazard to the permanent way gang. Accordingly plans for suitable earthing and bonding of the metal work adjacent to track, breaking the long fencing in smaller electrical section, and providing safe passage of traction currents through rails by providing longitudinal and transverse bonds for running rails of electrified tracks are made. All OHE structures are bonded to the non track circuited rail through structure bonds, or if such a rail is not available to an earth wire run on the OHE structures, the earth wire being broken up electrically in parts and each part individually earthed. Accordingly bonding and earthing plans are made for the entire route to be electrified in accordance with the Code for bonding and Earthing. Document No. ETI/OHE/71 issued by RDSO. This plan, however, needs to be made only at the stage of construction activity.

2.5.12 Progress Chart

To monitor the progress of survey, preparation and finalization of the plans, conduct soil tests and do the clearance studies under overline structures a progress chart is essential.
3.0 Introduction

These principles for preparation, checking and finalization of overhead equipment layout 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, 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 the contact wire at the requisite height and to keep it within the working range of the pantograph under all circumstances.

3.1 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:

3.1.1 Bond

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

i) Bond, continuity : A rail bond used for maintaining continuity of the rail circuit at crossings and junctions.

ii) Bond, Cross – A rail bond used for connecting together two rails of a track or rails of adjacent tracks.

iii) Bond, Impedance : A special rail bond used to bridge an insulated rail joint in ac track circuited sections in areas equipped for electric traction.

iv) Bond Rail – An electrical connection across a joint between two adjacent lengths of rail as part of the track return.

v) Bond, Structure – An electrical connection between the steel work of track structures, bridge or station bulking, to which the traction overhead equipment is attached and the track return.

3.1.2 Cantilever (Assembly)

It is an insulated swiveling 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.

i) 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 form mast by stay arm insulator.

ii) 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 form this member by Catenary suspension bracket and Catenary suspension clamp.
iii) Register Arm – It comprises of dia 28.4 x 33.7 mm tube to register the contact wire in the desired position with the help of steady arm.

iv) Steady arm assembly: It is 32 x 31 mm BFB section made of aluminium alloy to register the contact wire to the required stagger and to take the push up of contact wire. It is always in tension.

3.1.3 Crossings

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

i) Power line crossing – An electrical overhead transmission or distribution line or underground cable placed across railway tracks whether electrified or not for transmission of electrical energy.

ii) Crossing OHE – Crossing of two conductors of OHE crossing without physical contact.

3.1.4 Dropper

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

3.1.5 Electrical Clearance

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

3.1.6 Encumbrance

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

3.1.7 Feeder

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

3.1.8 Height of contact wire

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

3.1.9 Interrupter

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

a) Bridging Interrupter: 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.
b) **Sectioning Interruptor:** An interruptor which connects adjacent sub-sectors together to maintain continuity of supply. This normally remains in closed position.

c) **Paralleling Interruptor:** An interruptor which connects overhead equipments of two different tracks. This normally remains in closed position to reduce the voltage drop.

### 3.1.10 Jumper

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

### 3.1.11 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 and TTCs are also called masts.

**Note:** Pre-stressed concrete spun poles for traction overhead equipment are under development.

### 3.1.12 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.

### 3.1.13 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.

### 3.1.14 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, interruptor or booster-transformer.

### 3.1.15 Over-line structure

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.

### 3.1.16 Pantograph

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

A conductor which carries return current from the tracks to the sub-station in the booster transformer system.

3.1.18 Regulating Equipment

A device for maintaining the tension of OHE conductors constant under all ambient temperature conditions.
Note: Such OHE is called regulated OHE.

3.1.19 Setting Distance (implantation)

The horizontal distance from the nearest face of traction mast to the centre line of the track.
3.1.20 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 the face of cross arm channel in case of multiple cantilever assembly. (Ref. Fig. 3.01)

3.1.21 Span

The distance between the centre line 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.

3.1.22 Stagger

Stagger of the contact wire is the horizontal distance of the contact wire from the vertical plane through the centre of track.

3.1.23 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.

3.1.24 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.

a) Feeding Post (FP) – It is a supply post where the incoming 25 kV feeder lines from substation are terminated and connected to the overhead equipment through interruptors.

b) Sectioning and Paralleling Post (SP) - It is the supply control post situated mid-way between two feeding posts at the neutral section and provided with bridging and paralleling interruptors.

c) Sub-sectioning and Paralleling Post (SSP) – It is a supply control post where sectioning and paralleling interruptors are provided.

d) Sub-sectioning Post (SSP) – (for single line section) : It is a supply control post where a sectioning interruptor is provided.

3.1.25 Sector

A section of Overhead equipment of a track which can be energized by closing a feeder circuit breaker at the substation.

a) Sub-sector – The smallest section of overhead equipment which can be isolated remotely by opening of interruptors.

b) Elementary Section – The smallest section of overhead equipment which can be isolated from the rest of the system by manual operations.
3.1.26 Tension Length

Length of conductor which is stretched between the two anchor points

3.1.27 Versine

The versine is the maximum offset of the rail on which spans have been measured (para 3.5.1) of the curved track form the chord connecting two points, each opposite adjacent masts.

3.2 Electrical Clearance

3.2.1 Clearance

The clearance between 25 kV live parts and earthed parts of fixed structures or moving loads shall be as large as possible. The electrical clearances to be maintained under the worst conditions of temperature, wind, etc are given below:

a) Maximum vertical distance between any live part of overhead equipment or pantographs and parts of any fixed structures (earthed or otherwise) or moving loads:
   
   i) Long duration 320 mm
   ii) Short duration 270 mm

b) Minimum lateral distance between any live part of overhead equipment or pantographs and parts of any fixed structures (earthed or otherwise) or moving loads:

   i) Long duration 320 mm
   ii) Short duration 220 mm

Note:  
I) These clearances may be reduced to 250 mm (long duration) and 200 mm (short duration) with the personal approval of the Chief Electrical Engineer in very difficult locations (Rly Board’s letter No. 76/RE/240/1 dated 27.3.80).

II) A clearance study should be made for every over-line structure / tunnel and, if required, should be referred to RDSO for advice.

3.3 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. 3.22.2/3)

3.4 Wind Pressure

3.4.1 Wind Load

Wind pressures for design of all masts and determination of spans are based on IS-875-1964 – “Code of Practice for Structural Safety of Buildings – Loading Standards”. Vide an amendment issued in 1971 to this specification, wind pressures for structures of height less
than 30 m were reduced by 25%. Accordingly, the standard wind pressures adopted are as follows for all new works for different zones as indicated in the specification.

I) Green zone (light) 75 kg/m²  
II) Yellow zone (medium) 112.50 kg/m²  
III) Red zone (heavy) 150 kg/m²  

3.4.2 Loading calculation

For working out the wind loading the total projected area for the rolled sections, 150% of the projected area for fabricated structures, and 2/3rd 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.

a) at 35°C temperature and full wind pressure  
b) at 4°C temperature and 20% of the governing wind pressure.

3.5 Spans

3.5.1 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.

3.5.2 Standard span

Standard spans shall be determined in accordance with

i) Drg. No. ETI/OHE/G/00202 for conventional OHE  
ii) Drg. No. ETI/OHE/G/04201 for regulated tramway OHE, and  
iii) Drg. No. ETI/OHE/SK/375 for composite OHE (Aluminium – alloy Catenary and copper contact wire).

3.5.3 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, sway of pantograph and deflection of the mast under wind condition. Standard spans shall be used to maximum extent possible.

3.5.4 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 cart (ETI/OHE/G/00202), taking into account the stagger at the common support and the stagger at the extreme supports (See para. 3.8)
3.5.5 Restrictions

The following restrictions are applicable

I) On main tracks, the lengths of two consecutive spans shall not normally differ by more than 18 m.

II) The lengths 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.

III) Spans in the vicinity of over line structures with restricted head room shall be determined with reference to the electrical clearances available (see para 3.3)

IV) The lengths of spans loaded with section insulators may require to be restricted (See para 3.11)

V) 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.

VI) With crossed type equipment with actual crossings of OHEs at facing turnouts, the anchor spans shall be restricted to 54 m.

VII) Where earth wire is provided, the maximum span over level crossings should be 58.5 m.

3.6 Masts, Portals, Head Spans and Foundations

3.6.1 Types of masts

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

3.6.1.1 Nine types of masts are used. These are designated as 150 x 150 BFB, 200 x 150 RSJ, K-100, K-125, K-150, K-175, K-200, K-225 and K-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.

Note: Sometimes 200 x 200 (8” x 8”) BFB have been imported. These are used in lieu of 200 x 150 RSJ as specified in mast employment schedules.

3.6.1.2 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:

a) Conventional OHE (65 mm 2Cd-Cu Catenary and 107 mm2 copper contact wire):

   Light wind pressure : Drg. No. ETI/C/0702,
   (75Kg/m2) Sheet 1 to 5.

   Medium wind pressure : Drg. No. ETI OHE/G/00153.
   (112.5 kgf/m2) and 00154 Sheet 1 to 4
Heavy wind pressure: Drg. No. ETI/C/0706, ETI/C/0727, 0728 and 0729.
(150Kg/m²) Sheet 1 to 4,
b) Composite OHE (comprising of aluminium alloy Catenary and 107 mm² copper contact with 1000 tension in each conductor).
Light wind pressure: Drg. No. ETI/C/0701,
(75Kg/m²) Sheet 1 to 4 & ETI/C/0722, 0723 & 0724..
Medium wind pressure: Drg. No. ETI/c/0717,
(112.5 kgf/m²) Sheet 1 to 4 & ETI/C/0713, 0719 & 0720.

The mast employment schedules are prepared only for standard setting distance as given in Drg. No. ETI/IHE / G/00111 Sh. 1. For 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 location and safety of the mast checked in accordance with Drg. No. ETI/OHE/G/00141 Sheet 3. The permissible bending moments of the masts are given in Drg. No. ETI/SK/C/122.

3.6.1.2.1 On long (more than 150 m) bridges and within 100 m from their abutments on either side and on the ban where the height of the Catenary above surrounding mean retarding surface is more than 30 m 25% reduction in wind pressure (para 4.1) should not be taken into consideration. These masts should be designed for full wind pressure i.e.,

Heavy (red) wind pressure zone 200 kg/m²
Medium (yellow) wind pressure zone 150 kg/m²
Light (green) wind pressure zone 100 kg/m²

The maximum span should be restricted to 54 m for heavy wind pressure zone and 63 m for medium wind pressure zone. In case of curves on the banks of such bridges, the span should be 4.5 m less than the max. span permitted by relevant span and stagger chart, but should not exceed 54 m for heavy (red) wind pressure zone and 63 m medium (yellow) pressure zone.

3.6.2 Two Track Cantilever
In the yards and sidings when the mast cannot be erected near the track to be equipped, it may be erected span one or two tracks using a two-track cantilever. (Drg. No. ETI/C/009, Sheet 1). This is generally used for supporting OHE near turnouts and X-overs. These arrangements 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.

3.6.3 Portals
On multiple track sections, where adequate track centres are not available and tracks cannot be slewed, port 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.

3.6.3.1 Three types of portals have been standardized. ‘N’ type portal is used for clear spans of 10 m – 20 m tracks maximum). ‘O’ type portal is for clear spans of 20 m – 30 m.
(for 6 tracks maximum) and ‘R’ type portal with spans of 30 m – 40 m (for 8 tracks maximum).

3.6.3.2 Where the upright of standard portals cannot be erected due to limited track centres. ‘P’ type portal not to 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 1) may also be used in exceptional cases when ‘N’ type portals cannot be used.

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

3.6.4 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 arrangement at not used normally.

3.6.5 Foundations

3.6.5.1 Volume Charts

The foundation bending moment codes (FBM) for each location are obtained from the mast employment schedule or by actual calculations (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 do 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. ETI/C/0058) on the basis of FBM code, type and bearing capacity of soil/shoulder width and the extent of projection above ground level.

3.6.5.2 Type of foundations

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

<table>
<thead>
<tr>
<th></th>
<th>(A)</th>
<th>Side bearing (Type B)</th>
<th>Drg. No. ETI/C/058 Sh.1</th>
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<tbody>
<tr>
<td></td>
<td>(B)</td>
<td>Side gravity (Type: BG)</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>(C)</td>
<td>Pure gravity (Type: G)</td>
<td>-do-</td>
</tr>
</tbody>
</table>
(D) Pure gravity for black cotton soil (Type: WBC)

ii) New pure gravity (Type: NG) -do- Sh.2A

iii) NBC type foundation for dry black cotton soil (16500 & 11000 kgf/m²) 3.0 m depth.

iv) New pure gravity for different soil and site conditions (500 mm exposed) (Type: NG or SPL) -do- Sh.4

v) New pure gravity for black cotton soil (for 8000 kgf/m² soil pressure, 2.5 depth) (Type: NBC) -do- Sh.5

vi) Foundations in soft rock (bearing capacity 45000 kg/m²) Drg. No. ETI/C/0059

vii) Foundations in hard rock (bearing capacity 90000 kg/m²) Drg. No. ETI/C/0050
(2) For portals

i) In ordinary soil Drg. No. ETI/C/0058/68
ii) In dry black cotton soil Drg. No. ETI/C/0063

1. In the case of OHE foundations in deep rock cutting the foundations should be below the drain.
2. For all future constructions of pure gravity foundations drawing No. ETI/C/0058 Sheet – 2A only shall be followed.

3.6.5.3 Selection of foundations

Side bearing foundations are used for masts where the soil bearing capacity is 11,000 or 21,500 kg/m² and 300 mm wide shoulder is available on the banks. 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, A3.02)

3.6.5.4 New pure gravity foundations may be used for masts where soil bearing capacity is 5500, 8000 and 11000 kg/m² 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.

3.6.5.5 Side gravity foundations may be used for masts where soil bearing capacity is 8000 and 11000 kg/m² or adequate shoulder width is not available. No portion of the foundation should be exposed.

3.6.5.6 Pure gravity foundations (Type-G) are used for independent masts where soil surrounding the foundations is loose and can not exert passive pressure on the foundations. G-type foundations have been designed for soil bearing capacity of 5500, 8000 and 11000 kg/m². Pure gravity foundations (Type P) are used for portals and are designed for soil bearing capacity of 8250 and 11000 kg/m².

3.6.5.7 Foundations in black cotton soil

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.

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.

3. The safe bearing capacity should be determined in accordance with IS-6403.

4. When in doubt regarding classification of BC soil as to dry or wet, it is preferably to make NBC type foundation.
3.6.5.8 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 desired 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. A3.03.

3.6.5.9 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 for un-regulated OHE. A 135 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. ETI/C/0058 Sheet – 1 corresponding to a depth of 500 mm of embankment having slope of 1:2 may be exposed.

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

### 3.7.0 Contact Wire Height

#### 3.7.1 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:

<table>
<thead>
<tr>
<th>Type of OHE</th>
<th>Normal height of contact wire at the support point</th>
</tr>
</thead>
<tbody>
<tr>
<td>j) Regulated</td>
<td></td>
</tr>
<tr>
<td>a) Normal with 10 cm pre-sag</td>
<td>5.60 m</td>
</tr>
<tr>
<td>b) Old electrification</td>
<td>5.55 m</td>
</tr>
</tbody>
</table>

Note : 5 cm pre-sagged OHE was provided upto 1968. For new works 10 cm pre-sagged OHE shall normally be provided. However, OHE with 5 cm pre-sag may be provided in long tunnels and through girder bridges to achieve the minimum electrical clearance.

<table>
<thead>
<tr>
<th>Type of OHE</th>
<th>Normal height of contact wire at the support point</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Unregulated</td>
<td></td>
</tr>
<tr>
<td>a) Unregulated OHE designed for areas with a temp range of 4°C to 65°C</td>
<td>5.75 m</td>
</tr>
<tr>
<td>b) Unregulated OHE designed for areas with a temp. range of 15°C to 65°C</td>
<td>5.65 m</td>
</tr>
</tbody>
</table>
3.7.2 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 metre gauge to permit movement of “C” class ODCs without physical lifting of wires. In case “C” class ODC movement is not required, the height could be reduced to 4.80 m (BG). Height may be further reduced to 4.65 m if rolling stock higher than 4.265 m are not allowed on such lines. (Ref. Fig. A. 3.04)

3.7.2.1 At electric locomotive sheds and loco inspection pits; the minimum height shall be 5.80 m for the broad gauge and 5.50 m for the metre gauge.

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

3.7.3 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 where 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.
3.7.4 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.

3.7.5 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 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 overline structure unless additional head room has been provided.

3.8.0 Stagger

3.8.1 Tangent track

On tangent track, the contact wire is normally given a stagger of 200 mm at each support alternately on the 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.

3.8.2 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.

3.8.3 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.


3.8.4 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.
3.8.5 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 stagger different from those indicated in these drawings are adopted the following points should be observed.

i) The stagger of the in-running contact wire does not exceed 200 mm on tangent track and 300 mm on curve track at any support, at which only one contact wire is in-running.

ii) 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.

iii) The two contact wires run parallel to each other between the intermediate supports at a distance of 20 mm from each other.

3.8.6 Insulated overlap

At insulated overlaps stagger should confirm to Drg. No. ETI/OHE/02131 sheet 1. On non-uniform curve 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.

3.8.7 Neutral Sections

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

3.8.7.1 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))

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

3.9.0 Encumbrances

3.9.1 Normal

The encumbrance shall normally be 1:40 m
3.9.2 Reduced encumbrance

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

<table>
<thead>
<tr>
<th>Span under overline structure (m)</th>
<th>Recommended encumbrances for span under over-line structure (m)</th>
<th>Largest permissible adjacent spans. (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>63.0</td>
<td>0.9</td>
<td>67.5</td>
</tr>
<tr>
<td>58.5</td>
<td>0.9</td>
<td>67.5</td>
</tr>
<tr>
<td>54.0</td>
<td>0.75</td>
<td>67.5</td>
</tr>
<tr>
<td>49.5</td>
<td>0.6</td>
<td>63.0</td>
</tr>
<tr>
<td>45.0</td>
<td>0.6</td>
<td>63.0</td>
</tr>
<tr>
<td>40.5</td>
<td>0.5</td>
<td>58.5</td>
</tr>
<tr>
<td>36.0</td>
<td>0.40</td>
<td>54.0</td>
</tr>
<tr>
<td>31.5</td>
<td>0.40</td>
<td>49.5</td>
</tr>
<tr>
<td>27.0</td>
<td>0.30</td>
<td>45.0</td>
</tr>
</tbody>
</table>

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 3.8.9.

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.

3.9.3 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 if the dropper is without loop or of rigid type of less than 150 mm, the overhead equipment is deemed suitable upto 90 km/hr speed.

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

3.10.0 Droppers

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

3.10.2 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.
3.10.3 Special dropper arrangement

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

3.10.3.1 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.

3.10.4 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.

3.11.0 Section Insulators

3.11.1 Location

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

i) 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.

ii) The section insulator is to be located beyond the point where the centre distance between the two tracks is equal to or more than 1.65m. If the section insulator is erected with the free ends of the runners away from the centre of the turnout this distance may be reduced to 1.45 m.

iii) The stagger of the contact wire at the location of the section insulator should normally be zero, but in no case should exceed ± 100 mm.

iv) On loops, the section insulator shall, as far as possible, be located close to the first support of the overhead equipment for the loop.

v) The preferred location of section insulator on main running track is 2 to 10 m from the support in the direction of traffic through its provision on the main line should be avoided.

vi) In double line section, the runners should be in the trailing direction.

3.11.2 Permissible Speeds

3.11.2.1 On double line sections, with runners trailing, the section insulator assembly using porcelain sectioning insulators are fit for speeds upto 120 km/h provided it is installed within the first one-tenth and one-third of the span.
3.11.2.2 In case the runners of the section insulator are facing or it is not installed within 1/3rd of the span the speed should be restricted to 80 km/h (Ref. Fig. 3.05)

![Diagram showing speed restrictions](image)

3.12.0 Arrangement of Jumpers

3.12.1 In span jumpers

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

3.12.2 Turnout jumpers

The arrangement of connections at turnouts and at diamond crossings is indicated in Drg. No. ETI/OHE/G/05103 and 05106 respectively.

3.12.3 G jumpers

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

3.12.4 Potential equalizing jumpers

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

3.12.5 Anti-theft jumpers

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

3.13.1 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.

3.13.2 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 m.

3.13.3 Bridges and tunnels

Where the catenary is anchored on the face of an overline structure, the anchor shall be the anticreep 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.

3.13.4 Masts with three brackets

In the case of masts with three brackets supporting regulated equipment, anticreeps or fixed terminations of the overhead equipments 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.

3.13.5 Unregulated equipment

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

3.13.5.1 Unregulated OHE shall not take off from main running lines.

3.13.6 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.

3.13.7 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. ETI/OHE/G/02111.

3.13.7.1 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.

3.14.0 Anchor Height

3.14.1 Crossing of anchoring spans

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

3.14.2 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.

3.14.3 Anchoring near signals

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

3.14.4 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 weights).

3.14.5 Anchor near buffers

In order to equip the full length of a buffer end siding, the scheme of anchoring as indicated in Fig. A.3.06 may be adopted.
3.14.6 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.

3.14.7 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 limited travel zone of counter weight assembly. However, single span anchoring should be avoided as far as possible.

3.14.8 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 mechanically to the anchor mast without providing the insulator in the anchor assembly.

3.14.9 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, neighbourhood of chemical / fertilizer / cement plants, near loco sheds, ash, pits, water columns, etc long creepage path (1050 mm) Insulator should be used on the anchoring arrangement.

3.15.0 Location of Overlap

3.15.1 Platform lines

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

3.15.2 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)

3.15.3 Cross-over

In the case of emergency cross-over insulated overlaps in the direction of the trailing end should permit the longest train to be accommodated between the lock bar of the
crossover switch and the first intermediate mast of the overlap with a minimum margin of 50 m. 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 3.20)

3.15.4 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 2 m for smooth change over by the pantograph.

3.15.5 The arrangement of overlaps should be as per standard drawings (see para)

3.15.6 Feeders to overlaps

Feeding overlaps should be sufficiently away (see para 3.42) 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.

3.16.0 Neutral Section

3.16.1 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.

3.16.2 Short Neutral Section of Section Insulator Assembly type

In heavy 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/hr (Para 3.11.2)

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

3.16.2.1 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.

3.16.3 Short Neutral section of PTFE type

If adoption of short neutral section on main line is unavoidable, short neutral section of ceramic beaded resin bonded glass fibre rod insulators be provided. This is lighter and is considered fit for speeds upto 130 km/h.

Note: Ceramic beaded rod insulator type neutral section equipments have not yet been developed indigenously and are still under trial. Standard drawings will be issued after the indigenous product proves successful.

3.16.4 Neutral section shall be located away from stop signals, level crossing and shall be on tangent track and on level to the possible extent.
3.16.4.1 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.

3.16.4.2 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.

3.16.5 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 guidelines are difficult or entail heavy investment, the 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. A3.07)

3.16.6 Location of ‘OPEN DJ’ and ‘CLOSE DJ’ boards.

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

3.16.6.1 Separate ‘CLOSE DJ’ boards are required for EMUs and loco hauled trains.

3.17.0 Points and Crossings

3.17.1 General arrangement

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

3.17.1.1 The general arrangement of regulated overhead equipment at turnouts and cross-overs is shown in Drg. No. ETI/OHE/G/02141 and 02151. For high speed running, the overlap type should be provided.

3.17.1.2 The general arrangement of regulated overhead equipment at turnouts and cross-overs is shown in Drg. No. ETI/OHE/G/03151 and 03152, Sheet 1&2.
3.17.1.3 The leading dimensions of standard turnouts and crossings are given in Drg. No. RE/33/G/01104, sheet 1 and 01105, Sheet 1 for the broad gauge and in Drg. No. RE/33/G/01104, sheet 2 and 01105, sheet 2 for the metre gauge.

3.17.2 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 turnout, before it is anchored. A crossover is equipped in the same manner as two ordinary turnouts.

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

3.17.2.1 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).

3.17.3 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.

3.17.3.1 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.

3.18.0 Arrangement of Masts

3.18.1 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.

3.18.2 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.

3.18.3 Restrictions

3.18.3.1 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 9m, though a minimum stagger of 4.5 m is permissible in exceptional cases (Ref. Fig. A3.08(i))

3.18.3.2 If one of the masts mentioned in an anchor mast, and the anchor falls between the two masts, they should be staggered by 13.5 m minimum (Ref. Fig. A3.08(i))

3.18.3.3 If both the masts mentioned are anchor masts and both anchors fall between the masts, they should be staggered by 18 m (Ref. Fig. A3.08(i))

3.18.3.4 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 two overhead equipment and the second mast. (See para. 3.32 Cut in insulators or special anchor arrangements may be adopted in special cases (Ref. Fig. A3.08(iv)

3.18.4 If masts are located on both sides of a track, they shall be staggered by 4.5 m (Ref. Fig. A3.08(iv))

3.18.5 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.
3.18.6 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.

3.18.7 Masts with counterweights should be avoided on platforms

3.18.8 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.
3.18.9 Masts shall not be located in front of station entrances.

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

3.18.11 No masts 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 30m. (Ref. Fig. A3.10)

3.18.12 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 10m.

3.18.13 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.

3.18.14 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.

3.18.15 Support for OHE in tunnels
In the lined tunnels, slubs 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 slubs on one side.

3.18.16 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 and covered with a concrete slab.

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

3.19.0 Cantilever Arrangement

3.19.1 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.

3.19.2 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, Sheets 1 and 3.

3.19.2.1 Platform location
The arrangement of cantilever on platform shall be as per Drg. No. ETI/OHE/G/02104, Sheet 2.
3.19.3 Allowance for adjustment
The bracket assembly shall be such as to permit easy adjustment of the whole equipment after erection to catenary for displacement of track during maintenance to the extent of 100 mm on either side of the track centre.

3.19.3.1 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 fitting is at least 150 mm to facilitate future adjustment.

3.19.3.2 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.

3.19.3.3 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 3.19.3.1 and 3.19.3.2 above, new cantilever may have to be provided taking care that at no stage the contact wire is beyond the specified stagger.

3.19.4 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).

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 mast, if the OHE of the two tracks are of the same elementary section. This is called ‘Umbrella’ construction.

3.19.6 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.

3.19.7 Bridge & Tunnels
Bracket assembly of special design may be adopted on bridges and tunnels after making clearance study.
3.19.8 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 Drg. No. ETI/OHE/P/3050 and RE/33/P/3100 shall be used.

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

3.20.0 Setting of Masts
3.20.1 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 m 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 for the broad gauge and 2.50 m for the metre gauge.

3.20.2 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 Board gauge and Table-II for Meter gauge. Normally, the standard setting distance on board gauge main lines on curves should not be less than the values given below:

<table>
<thead>
<tr>
<th>a) On outside curves</th>
<th>Standard settings (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Radius curvature</td>
<td>2.80</td>
</tr>
<tr>
<td>greater than or equal to 875 m.</td>
<td></td>
</tr>
<tr>
<td>ii) Radius of curvature less than 875 m.</td>
<td>2.95</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) On inside curves</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Radius of curvature greater than or equal to 3500 m.</td>
</tr>
<tr>
<td>ii) Radius of curvature greater than or equal to 2350 m. but less than 3500 m.</td>
</tr>
<tr>
<td>iii) Radius of curvature greater than or equal to 1150 m. but less than 21350 m.</td>
</tr>
</tbody>
</table>
iv) Radius of curvature greater than equal to 300 m. but less than 1150 m.

**TABLE – I**

**Curve allowance for maximum speed**

**Upto 105 km/h – Broad Gauge.**

<table>
<thead>
<tr>
<th>Degree of curvature</th>
<th>Radius of curvature (meter)</th>
<th>Max. permissible speed (km/h)</th>
<th>Super elevation (mm)</th>
<th>Extra clearance between adjacent track (mm)</th>
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<tbody>
<tr>
<td></td>
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<td>Inside curve</td>
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<tr>
<td>1</td>
<td>1747</td>
<td>105</td>
<td>50</td>
<td>130</td>
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<td>1 ½</td>
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<td>420</td>
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<tr>
<td>6</td>
<td>292</td>
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<td>550</td>
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<td>10</td>
<td>175</td>
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<td>120</td>
<td>500</td>
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Note : See Drg. No. ETI/OHE/G/00111 Sheet 1, also for this reference.
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<thead>
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<th>Degree of curvature</th>
<th>Radius of curvature (meter)</th>
<th>Max. permissible speed (km/h)</th>
<th>Super elevation (mm)</th>
<th>Extra clearance between adjacent track (mm)</th>
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<td>Inside curve</td>
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Note: See Drg. No. ETI/OHE/G/00111 Sheet: 2 also for reference.
**TABLE – III**

Curve allowance for Meter Gauge

<table>
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<th>Degree of curvature</th>
<th>Radius of curvature (meter)</th>
<th>Max. permissible speed (km/h)</th>
<th>Super elevation (mm)</th>
<th>Extra clearance between adjacent track (mm)</th>
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<td></td>
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<td>Inside curve</td>
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<tr>
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<td>71 (40)</td>
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<td>1747</td>
<td>190 (160)</td>
<td>185 (100)</td>
<td>575 (295)</td>
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<td>640 (60)</td>
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</tr>
<tr>
<td>6°</td>
<td>292</td>
<td>80</td>
<td>185</td>
<td>655 (80)</td>
</tr>
</tbody>
</table>

Note: i) Figures in bracket indicates super elevation and curve allowance for 60 km/h speed.

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

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

**3.20.2.1** 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.

**3.20.3** Masts with counter weights

In the case of masts with counter weights, 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.

**3.20.4** 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.

**3.20.5** 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.
3.20.5.1 Colour light signals located all tracks
a) Colour light signals without route indicators.
   i) Where no approach signal is provided.
      The minimum setting of mast before signal should be 3.25, 3.10, 3.05, 2.90 and 2.75 m for distance up to 80 m, beyond and up to 110 m, beyond and up to 190 m, beyond and up to 270 m beyond and up to 400 m respectively.
   ii) Where approach signal is provided and for signals other than distant signals.
      The minimum setting of mast before signal should be 3.25, 3.10, 3.05, 2.90 and 2.75 m for distance up to 85 m, beyond and up to 70 m, beyond and up to 115 m, beyond and up to 160 m beyond and up to 240 m respectively.

b) Colour light signal with route indicators:
   i) With horizontal route indicator:
      The minimum setting of mast before signal should be 3.72, 3.50, 3.25, 3.05, 2.90 and 2.75 m for distance up to 60 m, beyond and up to 125 m, beyond and up to 170 m, beyond and up to 215 m beyond and up to 250 m, beyond and up to 310 m, respectively.
   ii) With other than horizontal route indicator:
      The minimum setting of mast before signal should be 3.50, 3.25, 3.05, 2.90 and 2.75 m for distance up to 70 m, beyond and up to 130 m, beyond and up to 170 m, beyond and up to 215 m, beyond and up to 280 m, respectively.

Note: 1. See Drg. No. ETI/OHE/G/00112 also. The setting may be reduced in special cases, confirming to figs 6 to 9 of ibid.

2) Setting distance may be reduced for starter signals of loop lines and yard lines.

3.20.5.2 Colour light signals located between tracks:
 a) 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 signal 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 spectra 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.

   b) Signals with route indicators:

      The principles mentioned under para 20.5.2(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 rail 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.
3.20.5.3 For semaphore signals located outside the track:
The minimum settings of masts before the signal should be 3.05, 2.90 and 2.75 m for the first
second and next three masts respectively.

Note: For details, see Drg. No. ETI/OHE/G/00112.

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

3.20.7 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)

3.20.8 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.

TABLE – IV

<table>
<thead>
<tr>
<th>Standard Clear Spans for ‘N’ type portals</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Spans in metres)</td>
</tr>
<tr>
<td>Nominal range : 10.0 m to 20.0 m</td>
</tr>
</tbody>
</table>

<table>
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TABLE – V

Standard Clear Spans for ‘O’ and ‘G’ type portals
(Spans in metres)
Nominal range : 20.0 m to 30.0 m

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3.21 Over line structure

3.21.1 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.

3.21.2 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.

3.21.3 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.

i) The catenary may be suspended from the two faces of the over line structures.

ii) Suspension from over-line structure.

The catenary may be suspended from the over-line structure at an intermediated point.
iii) 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.

iv) 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 as possible and generally should not exceed 54.0 m.

3.21.4 Polluted one

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

i) In tunnels (see 3.19.9)

ii) 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.

3.22.0 25kV Feeders

3.22.1 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.

3.22.2 Clearances from overhead 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 metres under any conditions.

3.22.3 Clearance from the 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 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.
3.23.0 Cross-Spans at Switching Stations

3.23.1 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.

3.23.2 Setting distance

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

3.23.3 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.

3.24.0 Tramway type overhead equipment

3.24.1 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:

3.24.1.1 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.

3.24.1.2 Span

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

3.24.1.3 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.

3.24.1.4 The arrangement of tramway equipment at anti-creep and points and crossings are shown in Drg. No. ETI/OHE/G/04205 and 04208 respectively.
3.24.2 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:

3.24.2.1 The maximum span is restricted to 30 m. 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.

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

3.25.0 Booster Transformers

3.25.1 100 kVA Booster Transformers 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.

3.25.2 The Booster transformers are located at an approximately spacing of 2.66 km between each other.

3.25.3 The location of the booster transformer should be decided considering the following aspects.
   a) At feeding posts and sectioning and paralleling posts the booster transformers should be located equidistant on either side so that the mid-point falls in front of these switching stations.
   b) In exceptional circumstances where the booster transformers are not placed equidistant 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.
   c) The booster transformer should not be located:
      - In the vicinity of the stop signals to avoid bridging of insulated overlap by locomotives pantograph.
      - Within the station limits except for very big stations.

3.26.0 Return Conductors

3.26.1 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. ETI/OHE/G/05307.
The clearance between the return conductor and the overhead equipment should not
be less than 400 mm under the worst conditions.

3.26.2 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.

3.26.3 Return conductors at over-bridges

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

3.26.4 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.

3.26.5 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.

3.26.6 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 transformer and the connections of the return conductor to the
booster transformer should be carried out in accordance with Drg. No. ETI/OHE/G/05413.

3.26.7 (i) 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.
(ii) 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.
(iii) 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 posts and sectioning post on either side of the
insulated overlap / neutral section. In these cases, mid-point should not be connected
to rail.
3.27.0 LT Supply Transformer

3.27.1 Low tension power supply

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

3.27.2 Capacity

LT supply transformers are of 10 kVA capacity. More than one transformer are provide at large station, yard etc.

3.27.3 Protection

LT supply transformers are protected only by a 25 kV, Amp, dropout fuse on the primary side and 63A fuse (wire able dc type with 20 SWG tinned copper wire) on the secondary side.

3.27.4 Mounting arrangement

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

3.27.5 Substation LT Supply

At substation, in order to provide power to single phase transformer oil centrifuging / filtration plant, 100 kV, 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.

3.28.0 Mast and Rail Bonds

3.28.1 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 3.29.1). In the case of portals, only one 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.

3.28.2 Rail Bonds

The Rail bonds to connect the running rails longitudinally across rail joint shall be in accordance with Drg. No. ETI/OHE/P/ 7030.
3.28.3 The cross bonds connecting two rails of track or rails of adjacent track shall in accordance with Drg. No. ETI/OHE/G/05251.

3.29.0 Earth Wires

3.29.1 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 serial 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.

3.29.2 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.

3.29.3 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.

3.29.4 Anchoring

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

3.30.0 Sections Arrangement

3.30.1 Necessity of sectioning

OHE is divided into electrically isolated sections by provision of interruptors or isolators at overlaps and with section insulators at turnouts. 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 requirements.
3.30.2 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 have 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.

3.30.3 Sectioning arrangements for different types of stations:
Since most of the electrified routes are on the double line section, only double line stations have been considered. Since most of the electrified routes are on the double line section, only double line stations have been considered.

3.30.3.1 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 120 m away from the starting signal. This arrangement enables the trains to be received at the station Fig.A.3.11 shows the layout.

3.30.3.2 The first loop line adjacent to the main is normally provided in the same elementary section as that 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. A3.12.
3.30.3.3 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 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 cross-over before backing. It is advisable to deep 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.

3.30.3.4 Stations provided with emergency cross-over and loop lines.
At stations having loop lines the isolation arrangement as shown in Fig. A1.14 and A1.15 should be adopted. Where space is available, the insulated over-lap and the isolator should be provided between the points, A&B as shown in Fig. A3.14. Otherwise, the insulated overlap should be provided before the point and a section insulator provided in the loop line as shown in Fig. A3.15.
3.30.3.5 Section 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. A3.16 would meet these requirements.

Note: Where space is available the insulated overlap and isolator should preferably provided between (A) & (B).
For layouts having a group of (common) loops on one side, sectioning arrangement shown in Fig. A3.17 should be followed.

Where an SSP is located the sectioning arrangement as shown in Fig. A3.18 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 44kV. Passage of electric locos in such condition would result in bridging of 2 phases which may damage the section insulator assembly.

3.30.3.6 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. A3.19.

![Diagram](image)

3.30.3.7 Sectioning for the loco sheds and major yards:
3.30.3.7.1 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 interruptor located in the SSP with provision to supply from either UP or DOWN line. In case the circuit breaker or interruptor 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 Drg. No. ETI/PSI/704.

3.30.3.7.2 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 interruptor in
such a way that interruption to any elementary section should cause minimum upset to the yard working.

3.31.0 Numbering of OHE masts

3.31.1 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 kilometerage 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.

3.31.2 Single line section

In single line section where these is no chance of future doubling, numbering is done progressively in the direction of increase of kilometerage, i.e., 70/1, 70/2, etc. In case where doubling is anticipated in future the system of numbering will be according to para 3.31.3

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 kilometerage.

3.31.3.1 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 one line and so on.

3.31.3.2 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 kilometerage (see Fig. A3.20)
3.31.4 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.

3.31.5 Numbering of masts
Single cantilever and double cantilever mast supporting OHEs of track 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. 10). This system of numberings is applied from one end of a yard in the kilometrage 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 kilometrage.

3.31.5.2 (a) In case of 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 in 3000 series. In case of 3-leg portals, the farthest leg from the main track shall be given a number in 4000 series.

3.31.5.2 (b) In case 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.

3.31.5.2 (c) 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’.

3.31.5.2 (d) The uprights of portals in UP yard shall have odd numbers i.e., 2001-3001, 2003-3003 etc and the uprights in DOWN yard shall have even numbers i.e., 2002-3002, 2004-3004 etc.

3.31.6 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).
3.31.7 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. 70/14P.

3.31.8 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.

3.31.9 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.

3.32.0 Numbering of Equipment

3.32.1 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/230kV Auxiliary Transformers.
BT: Booster transformers.
BM: Interruptor for main lines.
BS: Interruptor for yard lines.
BX: Bux coupler interruptor.
BC: Bus coupler isolator.
CB: Circuit breakers.
CT: Current Transformers.
DP: Double pole Isolators.
LA: Lighting arrester.
PT: Potential Transformer
SF: Single pole Isolator at Switching Station
SP: Single pole Isolator at substation.
SM: Isolator for main lines.
SS: Isolator for secondary lines loops and yards.
TR: Power transformers

3.32.2 Numbering circuit breakers

Each power transformer, current transformer, potential transformer is given a serial number in a Railway starting from 01 except 25kV circuit breakers which shall be according to para 32.2.2
3.32.2.1 High voltage (132/110/66 kV) 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.

3.32.2.2 25kV 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.

3.32.2.3 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.

3.32.2.4 Interruptors

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

3.32.2.5 Yard Interruptors. The yard line interruptors are numbered serial wise on a railway i.e., BS01, 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.

Fig No A3.21 is given on next page.
3.32.6 Other equipment

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

3.32.7 Numbering of elementary section

Elementary section for main line are given a number beginning with the number of interruptor which feeds it (See Fig. A3.21)

3.32.7.1 The first two/three digits of the number for an elementary section indicate the governing interruptor and last two digits indicate the progressive serial numbers. This 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.

3.32.7.2 Yard elementary sections

The elementary section 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 ‘X118’.

3.32.7.3 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.

3.32.7.4 Type of number plates

The number plates shall be in accordance with drawing No. RE/33/P/7501.

SCHEMATIC ARANGEMENT OF REGULATED & UNREGULATED OHE
Figure shown on the next page.
**STANDARD/LARGE BRACKET ASSEMBLY**

**STANDARD BRACKET TUBE (Ø 30/38mm)**

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<th>ASSEMBLED LENGTH 'L' IN METRES</th>
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**LARGE BRACKET TUBE (Ø 40/49mm)**

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**CATENARY DROPPER ASSEMBLY**

- CATENARY (65)
- Catenary Dropper Clip
- Catenary Dropper Link
- DROPPER (65)
- Contact Wire Dropper Clip
- Contact Wire (107)
MAINTENANCE SCHEDULES FOR OHE

4.0 Schedule of Inspections

1. In order to achieve high reliability and ZERO DEFECT OHE, and to ensure effective checks on the maintenance work a minimum schedule of inspections to be carried out each month by the officers and Senior Subordinates in charge of operation and maintenance of OHE and associated system.
2. The schedule of inspections is the minimum quota for each official and should be independent of other tasks. They will not be of routine nature but shall be carried out in depth to identify:
   i. Deficiencies and shortcomings
   ii. Lack of skill amongst staff
   iii. Inadequacies in maintenance facilities
   iv. Constraints experienced
   v. Conditions of environment leading to poor quality of work
3. The inspecting officials should programme their inspections in such a manner as to cover the widest areas in their jurisdiction over the year and so stagger the inspections as to avoid over inspections of the same section repeatedly, in a very short time while neglecting other areas. A check list in brief for various inspections is indicated in para 4.13

4.1 General

The OHE is subject to dynamic oscillations due to the constant contact and movement of the fast moving pantograph coupled with wind pressure. It is necessary to maintain the OHE in perfect condition through proper checks on its geometry and all parameters adopted in the design.

The following schedules of maintenance for the OHE are required to be followed to ensure good current collection as well as safety of installations and personnel:-

i. Foot patrolling
ii. Trolley inspection
iii. Current collection tests
iv. Special Checks
v. Annual Maintenance and OHE Inspection Car Check
vi. Periodical Overhaul
vii. Re-tensioning of unregulated OHE

2. The importance of OHE arises from the fact that it is extensive, with a very large number of insulators, fittings and other parts; failure of any one of which may result in dislocation of train services for appreciable periods until the defect / breakdown is rectified. The adjustment work is particularly important at cross-overs and at overlaps spans since any departures from the standards laid down could cause entanglement of the pantograph with the OHE, with serious repercussions. The need for a thorough detailed inspection of every part of the installation, mast by mast need not therefore be over-stressed.

3. The periodicity of schedules laid down below apply to the majority of installation. The periodicity may, however, be modified by CEE, where local condition so warrants.
4. As regards new equipments, if schedules have not been drawn up, tentative schedules may be evolved based on the Original Equipment Manufacturer’s guidelines and RDSO’s recommendations, keeping in the view the local conditions also and followed with the approval of CEE.

4.2 Foot-Patrolling of OHE

The object of foot-patrolling is to make visual inspection of every part of the OHE (including feeder line) so that any defects and abnormalities noticed are recorded and reported to the maintenance gangs for attention.

2. An experienced OHE Linesman (accompanied by a Khalasi if demand necessary by local conditions) should be deputed to patrol the section on foot by day, so as to cover every part of the section including yards once a fortnight and suburban sections once a week. If this patrolling is done thoroughly, many of the defects will be noticed at the incipient stage, before they develop into major defects. ATPO or Chargeman should foot-patrol the section once in six months.

3. The Linesman on foot-patrol should be equipped with signal flags, an emergency telephone instrument and essential tools required for attending to defects on the spot e.g. spanners for tightening bond connections.

4. The Linesman on patrol duty should particularly look for the following:
   a. Chipped or damaged insulators;
   b. Displaced fittings and droppers;
   c. Excessive sagging and hogging of contact wire;
   d. Whether equalizing plate is tilted;
   e. Free movement of auto-tensioning device and position of counterweight with reference to upper and lower limits of movement marked on the mast;
   f. Presence of protective screens, caution and warning boards and anticlimbing devices;
   g. Structural soundness of height gauges at level crossings;
   h. Bird-nests and pieces of stray wire likely to cause short circuits and branches of tress likely to infringe the OHE;
   i. Defective bonds and earth connections;
   j. Defects in return-conductor connecting booster transformers and its connection to rails. Oil leakage if any from BT & AT;
   k. Any obstructions including tree branches in the way of free movement of pantograph and trains;
   l. Signs of heavy sparking when trains pass;
   m. Isolators blades being fully in and for signs of sparking or overheating of isolators as also condition of locks;
   n. General condition of switching stations en-route;
   o. Tilting of masts especially on high banks and masts with sand-core foundations;
   p. Number plates.
   q. Any other abnormal / unusual situation.

5. Major defects noticed by the Linesman which endanger safety shall be reported forthwith to TPC through the nearest telephone. Full details should e given to enable the
TPC to decide on the course of action to be taken and if required to regulate train movements in the affected section.

6. The Linesman should himself attend to and rectify such of the minor defects (e.g., loose bond connections) which can be rectified by him on the spot without special assistance. To facilitate this, he shall carry with him a few essential tools. Other minor defects should be noted by him in his diary and entered by him in a Register maintained for the purpose in the depot / sub-depot. The roster of patrolling Linesmen should be so arranged that they will be able to return to the depot / sub-depot for submission of report as above before going off duty for the day. Where this is not convenient, the Linesman must report the defects on telephone to the depot / sub-depot followed by a written report in the Register on the next day. The supervisor in-charge of the depot / sub-depot will carefully scrutinize the Register and take prompt action to rectify defects reported, making suitable entries in the Register.

7. Testing of Emergency Telephone Sockets: During patrol duty, the Linesman will speak to TPC from every emergency telephone socket in route. Such calls from patrolling Linesmen should be recorded in a Register by the TPC indicating the date, time and serial number / location of the socket tested. Defective sockets should be reported promptly to the S&T Department for rectification.

4.3 Trolley Inspection of OHE

Inspection of OHE by push trolley is essential except in sections where use of trolley is prohibited. The object of such inspection is to enable supervisors and officers in-charge of OHE maintenance to observe closely the OHE under their charge and should be carried out during day time. The depot-in-charge (TPO or ATPO) should inspect his entire section once a month. CTPO / AEE(TrD) should inspect their respective sections once in 3/6 months respectively by push-trolley or motor-trolley as convenient. Sr. DEE/DEE(TrD) also should cover his entire section at least once a year by push-trolley or motor trolley.

2. Apart from trolley inspection as above, officers and senior subordinates shall travel be the cabs of locomotives and EMU trains as often as possible but at least once a month to observe the general condition of OHE and to get a first-hand knowledge of operating conditions.

4.4 Current Collection Tests

It is necessary to carry out periodic tests to detect points at which contact between the contact wire and pantograph is unsatisfactory resulting in sparking. Such current collection tests are performed at night.

A mirror can be fixed in front of the look-out glass of the rear cab of a locomotive and adjusted so as to get a reflection of the rear pantograph which is normally in service. A person traveling in the cab can then observe through the mirror any sparking which may take place. The location where the sparking is observed and the severity of the sparking should be immediately noted down and the OHE at the location got checked up as soon as possible to find out and eliminate the cause of sparking.

The current collection tests as above should be carried out by the depot-in-charge (TPO or ATPO) once in 3 months over his entire section. The CTPO/AEE (TrD) should accompany
the depot in-charge during such tests alternately so as to cover their sections once in 38/6 months respectively. DEE (TrD) should accompany the depot in-charge so as to cover his jurisdiction once a year.

4.5 Special Checks

While the majority of items require attention only during Annual Maintenance and Periodical Overhaul, items listed below will require more frequent attention as indicated against each-

1. Insulators: Generally insulators need cleaning once a year along with the annual maintenance schedule. At locations subject to smoke pollution on account of steam locos or pollution due to industrial dust, the frequency of cleaning will have to be fixed based on the extent of such pollution. Where pollution is heavy, cleaning may have to be done more frequently. With the application of silicone grease, the interval for cleaning at such locations can be extended significantly.

2. Section insulators: Section insulators on the main lines such as at neutral sections and passenger yards should be attended to as under once in three months -
   a. Clean insulators and replace badly chipped or even slightly cracked insulators.
   b. Check runners for flash marks.
   c. Check level of the assembly and adjust as required.
   d. Check for excessive contact wire wear near anchor clamps.
   e. Tighten properly the PG clamps of droppers and stiffeners.
   f. Check the pantograph passes underneath the section insulator smoothly.

3. Isolating switches at Yards / Loading sidings. The continuity and soundness of earth connections should be checked once a month.

4. Bi-metallic clamps: These should be checked for tightness and signs of overheating once in 3 months.

5. Earth connections: Apart from general inspection of bond and earthing connections during foot-patrolling, all such connections should be specially checked for continuity and soundness of connections once in six months. Particulars of all earthing connections (other than structure bonds) should be entered in a Register station-wise for each section and the dates of six-monthly inspection entered therein.

6. Feeders: Foot-patrolling of 25kV feeders should be carried out every month. During this check, the Linesman shall also check that safety guards provided under the feeders properly earthed, if the clearances are adequate and caution notice boards are in position.

7. OHE supported on steel girder bridges should be examined as frequently as possible depending upon traffic conditions.

8. Bird nests – Vigil should be exercised especially during the nesting season and the nests removed as soon as possible.
9. **Pre-monsoon checks**: Some of the items to be attended are:

i. Checking condition of insulators specially that of section – insulators at major yards having mixed type of traction;

ii. Over-line structures for any water leakage on the OHE and PVC insulators at major yards having mixed type of traction.

iii. Trimming of trees branches;

iv. Condition of embankments with respect to stability of masts;

v. Rod gaps.

### 4.6 Annual Maintenance and Checks by OHE Inspection Car

1. This schedule must be carried out by Inspection Car. During the schedule, fittings are not generally dismantled, but all fittings which are found defective must be replaced. In addition clearances, heights, staggers etc should be checked and corrected.

2. The details of work to be carried out during this schedule are as under:-

   (a) Mast, portals and cantilever supports:

   (i) Check rail level and setting distance against markings on the masts and entries in the Register. Variation above 30 mm in setting distance and 20 mm in rail level should be notified to the PWI for correction. Variations even within the above limits, should not be permitted if the Schedule of Dimensions are infringed.

   (ii) Check all steel parts and remove rust, if any, from painted steel work. Rusted portions, after cleaning, must be given two coats of zinc chromate primer followed by aluminium paint.

   (iii) Check all anchors for tightness of bolts, nuts and check nuts and pins. Lubricate all turn-buckles / adjusters and pulleys.

   (iv) Examine the base of each structure to ensure that muffs permit drainage of water. Clean the muffs removing any muck or dirt. Cracked or damaged muffs must be recast.

   (v) Check all bonds thoroughly. Defective bonds must be rectified and missing bonds provided.

   (vi) Check and tighten all G.I bolts and nuts.

   (vii) Check all galvanized pipes and fittings. Where galvanization is found to be chipped off, the fitting of pipe should be replaced. Minor chippings may be repaired using ‘cold galvanizing paint’.

   (viii) Examine register arm and all hooks and fittings for cracks. Check for cracks on steady arm tube also.

   (ix) Clean all insulators and carefully check for cracks and broken sheds. If more than 2 sheds are broken or there is any crack on the core the insulator should be replaced.

   (x) Check and adjust heights and staggers on the basis of setting distance and rail level marked. Close co-ordination with Permanent Way, Inspectors is required for keeping the permanent way at the correct location.

   (xi) Check presence and condition of caution notice boards, number plates, coasting boards, etc. Paint the boards as required. Ensure that they are all well secured.

   (xii) Ensure that the drain holes in the tubes are free and not clogged.
(b) Contact and Catenary Wires:

(i) Check carefully condition of contact and catenary wires, particularly for links and twists in contact wire and broken strands of catenary wire. Any stranded conductor (catenary wire etc) should be spliced if more than 20 percent of the strands are broken.

(ii) Check condition of PG clamps and jumpers after opening the clamps and tighten properly.

(c) Droppers

(i) Check droppers and tighten bolts wherever required.

(ii) Make droppers vertical.

(d) Turnouts

(i) With OHE inspection Car running on main line check up if pantograph glides smoothly under the loco line OHE.

(ii) With OHE inspection Car running on main line check up if pantograph glides smoothly under the man line OHE.

(iii) Check stagger of both the OHEs at turn outs. (It shall not normally exceed 300 mm)

(iv) Check that the main line OHE of overlap type turn out is about 50mm below that of the turnout OHE.

(v) Check up cross contact bar, if any, for displacement and distortion.

(vi) Check up rail level and setting of the obligatory mast.

(vii) Check up for hard spots near rigid droppers, if any.

(e) Section Insulators Assemblies:

(i) Clean insulators and replace chipped or cracked insulators.

(ii) Check runners for flash-marks, hit marks and proper adjustment.

(iii) Check for excessive contact wire wear near anchor clamps.

(iv) Check the level of the assembly and adjust if necessary.

(v) Tighten PG clamps of droppers and stiffeners.

(f) Isolators:

(i) Check number plates for cleanliness and security.

(ii) Check correctness of operation, alignment of contacts and arcing horns.

(iii) Check earth continuity where applicable.

(iv) Lubricate moving parts and locks.

(v) Check interlocks where provided.

(vi) Check that the distance between male and female contacts in open position is 330 mm to 500 mm depending upon the type of isolator.

(g) Short Neutral Section Assemblies

Carry out all checks as indicated in para 4.13.5

(h) Overlaps

(i) Check height and stagger of OHE in the overlap section.
(ii) Check whether the normal minimum clearance of 500 mm is available between the two OHEs in an insulated overlap and 200 mm in an uninsulated overlap.

(iii) Check whether the lifting of out-of-run OHE is correct.

(iv) Check that parallel running of contact wires in the overlap for a minimum 2m in the panto sweep region.

(j) Contact Sire thickness:

Measure and record thickness of contact wire.

(k) Neutral Sections:

Carry out all checks as for an insulated overlap in case of overlap type neutral sections and as for section insulators in the case of section insulators in the case of section insulator type neutral section.

(l) Overline structures / Tunnels

(i) Check and record horizontal and vertical clearances and adjust OHE as required.

(ii) Check for any flash-marks on the under side of the bridge structures.

(iii) Check that the prescribed height of contact wire is available.

(iv) Check that the gradient of contact wire on either side does not exceed 3mm/m.

(v) Check that smoke screens are properly secured and have adequate clearance from OHE, if not, get these attended to by Engineering Department.

(vi) In tunnels get necessary repairs done by Engineering Department.

(vii) Check rail level mark on sides of tunnels.

(m) Level Crossings

(i) Check height and gradient of contact wire.

(ii) Check condition of road surface and clearance of height gauge (a black band may be marked on the uprights at a distance of 4m from bottom face of the boom to facilitate measurement of clearance).

(n) Regulating Equipment

(i) Check ‘X’ and ‘Y’ dimensions in the case of pulley block type equipment and ‘Z’ and ‘Y’ dimensions in the case of which type equipment against prescribed values for the temperature at the time of checking. Making use of turn-buckles to adjust as required.

(ii) Check that the compensating plate is vertical, if not, adjust as required.

(iii) Lubricate pulleys and other moving parts.

(iv) Check if 20 mm wide bands in black colour are painted on the mast to indicate upper and lower limits of movement of counter weight.

(v) Check condition of stainless steel wire rope for any signs of corrosion and breakage of strands.

(vi) Check condition of grooves on the drum of which type regulating equipment.
(o) Bonds & Earthing connection:

(i) Check all bonds and replace defective or missing bonds. Paint all bonds.
(ii) Inspect earths and record earth resistance. Earths having resistance of over 10 ohm should be attended to.

(p) Masts:

Check vertically of all masts with plumb-bob and take remedial action as required.

(q) Sites affected by accidents:

Such sites should be specially checked and attended to.

(r) Feeder lines:

(i) Check guard wires at road crossings, if any.
(ii) Check earthing of towers.
(iii) Measure and record earthing resistance of towers.
(iv) Clean insulators and replace those which are cracked or chipped.
(v) Check the jumper connections, strain clamps, PG clamps and bi-metallic strip.

(s) PG clamps:

(i) Check and clean oxide from surface.
(ii) Apply corrosion inhibiting compound.
(iii) Tighten to the prescribed torque.

4.7 Integrated Blocks

The annual maintenance schedule can best be organized by adopting the system of Integrated Blocks. In this scheme a 3 to 6 km block (Jumbo Block) is taken by introducing single line working in the off peak traffic hours between any two stations. Simultaneous work is carried out by permanent way, single OHE/PSI staff during day light hours. This saves considerable time for taking and returning blocks which forms a sizeable proportion of a short duration block. Effective use of available man-power can also be made by using extra gangs depending upon the nature of work. Such work may be organized for 2 or 3 days a week in selected sections and instructions issued in advance by appropriate planning.

4.8 Re-tensioning of Unregulated OHE

The re-tensioning of unregulated OHE in accordance with the tension-temperature chart should be done ordinarily at the end of 6 months from the date of erection and again at the end of 12 months. Thereafter the tension should be checked up once in 2 years and re-tensioning done as required.

4.9 Periodical Overhaul

1. The aim of POH is to recondition and restore the installation in the condition it was when it was first commissioned, whereas preventive maintenance has for its objective to take
care of the wear and tear during normal service and forestalling possible failures by regular inspection and prompt attention. The POH should be thorough and cover every of the installation.

The tests to be done at the time of commissioning of new OHE have been detailed in Chapter 8. the work involved during 4 year POH is somewhat greater in scope than the pre-commissioning tests, since after years of service many parts would have suffered wear and tear, of which necessary adjustment will have to be made or repairs dome to make good the wear, or the irreparable items replaced.

The POH of OHE should be planned on a programmed basis so that every part of the installation receives detailed attention, repair and overhaul at an interval of 4 years. For programming POH, the entire section in each Division should be divided into smaller sections. POH gangs may be provided with camps at convenient locations so that heavy materials do not have to be carried from depot or sub-depot every day. Gangs can move to the site of work in convenient trains or by other means of transport.

As far as possible, gangs for the work should be earmarked so that a uniform standard of is achieved. All POH work should be done under the direct supervision not lower I rank that an ATFO/TFO.

To summarize, the object of POH is to make a through inspection of the OHE and to replace such of the worn-out or damaged parts by those which have been reconditioned earlier in the maintenance depots and kept ready. The parts removed are sent to the maintenance depots for dismantling, through examination, re-conditioning if possible and re-assembly for use again as required.

Maintenance charts, prepared in different colours may be made indicating the type of schedule each section has to undergo. The same chart can be used to indicate the progress of work and special works to be done to exercise check over the tasks and targets.

2. In addition to the items detailed under annual maintenance, the following items should be attended to during POH.

(a) Masts, portals and cantilever supports:

(i) At least one complete cantilever assembly per 10 track-km (this may be modified by CEE if considered necessary) should be removed and taken to the workshop for dismantling and detailed examination of various components after thorough cleaning. This test check would reveal the extent to which other cantilever assemblies have to be examined.

(ii) All regulating equipment should be replaced by previously overhauled ones and the removed equipment should be sent to the workshop for overhaul.

(iii) As the bracket is articulated, check the position with reference to the axis of the mast. The position will vary with temperature and distance from anti-creep. The register arm and steady arm should as far as possible be in the same plane as the bracket.

(iv) Check adjustments of cantilever assemblies, their slope and displacements at every structure for compliance with the ‘as erected’ SEDs.
(b) Catenary and Contact Wires:

(i) Dismantle all jumper connections, clean the conductors, (with emery paper in case of copper or bronze conductors and metallic brush in case of aluminium conductors) clips etc. if the pieces show signs of overheating, this may be because either they are not tightened properly or the clips are deformed and contact surface is insufficient. In the latter case, they should be replaced. In case of the contact wire, it is the groove that has to be cleaned with either a fine metallic brush or emery paper. The use of scraper or file is forbidden. Replace frayed or damaged jumpers.

(ii) Remove kinks if noticed.

(c) Insulated and Uninsulated Overlaps:

(i) Check the position of contact wire with respect to tracks to comply with SEDs.
(ii) Ensure that insulators of anchoring wires are crossing the plane of OHE in correct position as per plan.

(d) Overline Structures: Check the height and gradient of the contact wire and tally the same with ‘as erected’ drawings.

(e) Tunnels:

(i) Check the height and gradient of the contact wire and adjust as per SED.
(ii) 100 per cent OHE fittings in tunnels should be replaced with new or previously overhauled fittings and the removed fittings taken to the Workshop for detailed examination.

(f) Turn outs:

Check the height and gradient of the contact wire and adjust as per SED.

(g) Overhead Cross-feeders, Return Conductors and 25 kV Feeders:

(i) Examine wires for frayed strands, overheating, pinching or corrosion, especially at suspension clamps and PG clamps. Tighten junction sleeves.
(ii) While tightening PG clamps ensure that all joints are properly coated with Vaseline.
(iii) Check tension in wires and adjust if necessary.
(iv) Other overhead wires such as bypass feeders and earth-wires should be inspected. The insulator attachments should be dismantled, overhauled and put back in position. The insulators should be cleaned at the same time.

(h) General:

(i) During POH, fittings which do not provide prescribed margin of adjustment and proper fitting should be replaced.
(ii) All fittings on masts should be checked against “as erected” drawings and any variation should be recorded and reported to Sr. DEE for changing the drawings.
(iii) The position of splice should be recorded in the relevant lay out plans.
(i) Work to be done in Workshops:

Aluminium bronze fittings, bolts and nuts should be cleaned and carefully examined if necessary with a magnifying glass. Particular care should be taken to see that the threads are in good condition. Fittings which have developed cracks should invariably be discarded.

(ii) All G.I fittings and pipes should be examined for deterioration of galvanization. Minor chippings may be repaired by using cold galvanizing paint. (Sand or emery paper should never be used for cleaning).

(iii) In case of a major OHE break down, it is advisable to remove the bracket assemblies in about 8 to 10 spans on either side and examine them critically for cracks, twists, bends or other defects which may cause failures later on.

(iv) The regulating equipment should be dismantled and every part should be cleaned. Bearings should be fitted back after lubricating. Rubber washers / rings should be replaced where necessary. Any grazing or rubbing on pulleys should either be repaired if possible or the damaged equipment should be replaced. All lubricating holes should be free for passage of grease. The stainless steel rope should be closely examined for damage to the strands. Particular attention should be given to the end fittings on the stainless steel rope. Only approved type of lubricant should be used for regulating equipment components.

4.10 Rehabilitation of OHE

Depending upon the condition of the fittings, rehabilitation of the OHE may be undertaken after a period of 20 years. CEE may decide the assemblies to be replaced after a special drive for condition monitoring.

4.11 Transmission Lines

1. General

The overhead lines should be inspected periodically to detect any faults and necessary repairs should be done immediately.

2. Patrolling of Overhead Lines from the Ground

Patrolling of all overhead lines should be done before and after the monsoon. The frequency of patrolling of the overhead lines for the rest of the periods will depend on local conditions. The patrollers should write the inspection notes and pass them on to the maintenance gang for carrying out repairs. The patrollers should be equipped with inspection books, drawings, tape and binoculars. The main points to be noted while patrolling are as follows:

a) Structures:- Learning structures, deformed members, buckled structures, missing fasteners and members; accessories removed, protective coatings like galvanizing or paints disappeared, suspension and strain insulator attachments damaged.

b) Foundations – Signs of external damage; settled and washed out soil below normal ground level over foundations within uplift frustum perimeters; titled stubs; cracks or
breaks in chimney top; slippage of stubs from encasing chimney concrete; uneven settlement of footings; disappearance of gravel blanket protection; backfills embankment and its covers (rip-rap of revetment); damage to retaining walls, abutments and breast walls and disappearance of external earth backing retaining walls below designed lines.

c) Insulators and Fittings – Damage to insulators, heavy surface pollution, missing locking devices like nuts, washers and pin, burnt out fittings, deflected strings, damage to protective coatings. The cracked insulators, bird droppings, dense spider webs, kites with threads hanging on the insulators string.

d) Conductors and Jumpers :- Strands cut and opened up; loose jumpers out of shape and causing infringement of clearance of live wire to earthed metal parts, dead birds, fallen branches or fallen trees on conductors.

e) Earthing Equipment:- Damaged, broken or missing earthing strips.

f) Right of Way and Clearance – Shrubs and trees within right-of-way causing obstruction and infringement of clearance of bottom conductor to ground; objects within line clearance excavation. In no circumstances, however, clearance measurements should be taken from live line.

g) Foreign Objects:- Construction works near lines causing infringement in line safety or electrical clearance; birds nests on structures; use of structure for applying permanent support or pull to other objects; huts newly constructed underneath lines, and embankments / fencing.

3. Inspection of Overhead Lines from Tower Tops

Many breakdowns including slipping of conductor due to loose clamps, cracks in insulator porcelain, defects in insulator fittings, conductor, earth wire and accessories and their attachment points on structures can only be dispensed or seen by going on top of every structure. This inspection should be carried out by taking a shutdown of the line at least once in six years. Along with such inspection, repairs should also be carried out. Any replacement as required should also be made.

4. Special and Emergency Inspection

A special inspection of the overhead lines should be carried out after severe wind / hall storms, quakes, snowfalls, forest fires, floods or heavy rains. Such inspection should be done after a sabotage too. The purpose of such inspection is to detect any damage or breakage on line and to effect necessary repairs. When an overhead line is subject to fault often, if should be inspected to ascertain the nature of fault, such as too much sag, tree branches touching the line etc and to find out remedial measures required with a view to avoiding their recurrence.

5. Maintenance Tests and Measurements

Insulation resistance of line should be measured at convenient interval particularly at the time when the line is shutdown for repairs or maintenance. In regard to
measurements of earth resistance of metal structures, it should normally be carried out annually, however, local circumstances and experience may dictate increase or decrease. In this interval but it should not be less than once in two years.

The clearance and shape of the jumpers should be checked at an interval not exceeding 3 years.

6. Line Repairs Tools

The following special tools, apart from tools required for maintenance of civil works of the lines, should be kept, handy and in working order:

a) Conductor jointing tools
b) Bolted come-along clamps
c) Winches
d) Aerial trolleys
e) Aerial rollers
f) Thermometers
g) Dynamometers
h) Level and theodolite
i) Measuring tapes
j) Linesman’s ratchet

4.12 SCHEDULE OF MONTHLY INSPECTIONS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Nature of Inspection</th>
<th>Sr. DEE</th>
<th>DEE</th>
<th>AEE</th>
<th>CTPO</th>
<th>TPO</th>
<th>ATPO</th>
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<tr>
<td>2</td>
<td>OHE Inspection Car</td>
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<td>3</td>
<td>4</td>
<td>4</td>
<td>6</td>
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<td>2</td>
<td>4</td>
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</tr>
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</tr>
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<td>2</td>
<td>4</td>
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<td>1</td>
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</tr>
</tbody>
</table>

Notes:

(i) These inspections are the minimum quantum per month
(ii) In respect of Supervisory Staff, the inspections pertain to their respective jurisdiction.
(iii) Brief check lists of items to be broadly covered are indicated. Detailed maintenance schedules prescribed should also be kept in view.
(iv) Quota of Inspections by HQ officers may be laid down by CEE.
4.13 CHECK LIST FOR INSPECTIONS

4.13.1 OHE Depots & Subordinate Offices

a) OHE Depots
   1. Staff grievance register.
   2. Quarter register.
   3. Attendance register.
   4. Availability of all drawing (latest), SWRs with latest correction slips.
   5. Cleanliness of depot
   6. Upkeep of Stores
   7. Stock position of stores
   8. Upkeep of wiring train, OHE inspection car, ladders, tools etc

b) Subordinate office
   1. Attendance register.
   2. Compliance of audit & account inspection notes.
   3. Compliance of Officer’s inspection notes
   4. Test & Trail report.
   5. Latest drawings & specifications
   6. Planning & progress of section works.

4.13.2 Station

a) SWR
   1. SWRs with latest correction slips.
   2. Display of traction working diagram and its correctness at SM room & cabins
   3. Traction key Board and key register for its proper maintenance.
   4. Knowledge of traction working of SM/ASM on duty.
   5. Validity of the competency certificate of SM/ASM

b) CLS Board in SM room/cabin.
   1. AT standby supply

c) Isolator:
   1. Locking arrangements.
   2. Correct alignment of blade tip in the fixed pole contact jaws.
   3. Correct matching & alignment of arcing horns.

d) General
   1. Fire extinguishers, sand/water buckets, Respiration chart, First Aid Box, Tools and Plants.
   2. Working of TPC phones and emergency telephone sockets.
   3. History sheets of various equipments.
4.13.3 Cab Inspection

a) Condition of OHE
   1. Flashed / damaged insulators
   2. Displaced fittings & droppers.
   4. Number plates, warning board for rusting and tightness.
   5. BT : Oil leakage and deposits of pollutants on insulators.
   6. AT : Oil leakage and deposits of pollutants on insulators.

b) Obstruction to OHE
   1. Birds nests
   2. Tree branches near OHE

c) Cab equipments
   1. Emergency telephone
   2. Focussing of head lights & flasher lights
   3. Voltage on loco voltmeter at FP & SP locations.

d) Driving technique of Driver
   1. Exchange of signals with station staff
   2. DJ opening & closing at neutral section
   3. Observation of caution orders.

e) Night Inspection
   1. Incidence of sparking from the rear cab of locomotive
   2. Other items as above.

4.13.4 Push Trolley Inspection

a) Masts:
   1. Implantation at selective locations.
   2. Deflection of mast, on leading mast.
   3. Areas affected by accident
   4. RC to rail connection for any loose connection.
   5. Connection bonds and earthing connection
   6. Number plate
   7. Muffing

b) OHE fittings:
   1. The isolator blade is fully in and also for signs of sparking or overheating.
   2. Insulators for any chipping / flash marks / damages.
   3. Displaced fittings & droppers.
   5. Birds nests, stray wire pieces and tree branches likely to infringe the OHE.
   6. Free movement and position of counter weight with reference to upper and lower limits marked or the mast.
c) L.C. Gate & over line structures
   1. Protective screens at FOB/ROB
   2. Height gauges at level crossings and height.

d) Booster Transformer & Auxiliary Transformer
   1. Oil level and leakage of oil.
   2. Anticlimbing devices.
   3. Jumper connections
   4. Earthing
   5. Fuses on ATs.
   6. Colour of Silica gel

e) General
   1. Signs of heavy sparking on OHE when train passes.
   2. General condition of switching stations enroute.
   3. Emergency telephone sockets at important locations.

4.13.5 Inspection with OHE Inspection Car

a) Mast, portals and cantilever supports.
   1. Structures and galvanized tubes for rust & chipping off galvanization
   2. Cracks on steady arm & register arm.

b) Contact & Catenary wires
   1. Kinks & twists on contact wire
   2. Broken strands on catenary wire.
   3. PG clamps, jumpers.
   4. Contact wire wear at selected locations.
   5. Height and stagger at selected locations.

c) Section Insulators
   1. Flash or hit marks on and adjustment of runners.
   2. Level of assembly & alignment
   3. Chipped / cracked insulator.

d) Turn-out
   1. Stagger of both the OHEs.
   2. With inspection Car running on loop line, check up if the main line OHE passes smoothly under the pantograph.
   3. With inspection car running on main line, check up if the loop OHE passes smoothly under the pantograph.

e) Overlaps:
   1. Height and stagger of OHE in the overlap section.
   2. Whether normal minimum clearance of 500 mm is available between the two OHEs in an insulated overlap and 200 mm in the case of uninsulated overlap.
   3. Check up whether lifting of out-of run contact wire is correct.
f) Overline structures
1. Horizontal & vertical clearances
2. Flash marks underside of the structures.
3. Gradient of contact wire on either side.
4. Insulation on catenary wire under the structure.

g) Level Crossings
1. Height & gradient of contact wire

h) Regulating Equipment
1. X-Y and Z-Y values with temperature.
2. Free movement of drum.
3. Lubrication of pulley and other moving parts.
4. Stainless Steel wire rope for opening of strands, broken or rusted strands.

4.14 Regulating Equipment

1. There are three types of regulating equipment in use at present viz. the winch type, pulley block type and 3 pulley type. With all the three types of equipment the chief task of maintenance is to ensure that the counter weight is free to move up and down in the guides without any chaffing or obstruction. If the movement of the counterweight is obstructed, the tension of the OHE will not be correctly regulated resulting in poor current collection. The counterweight should not come down so low so as to touch the muffing in summer, nor should it strike the guide fixture at the top during winter.

During yearly maintenance of the pulley block type of equipment dimension ‘X’ (i.e., the distance between in centres of the movable and fixed pulleys) and ‘Y’ (i.e., the distance between the bottom of the counterweight and the top of the muffing) should be checked against prescribed values and adjusted as required according to the tension length of the OHE and prevailing temperature. Small adjustments can be affected by using the adjuster provided. In the event of appreciable stretching of the contact and catenary wires at the terminations to get correct alignment and adjustment.

In the winch type equipment, corresponding to dimension ‘X’ in the pulley block type dimension ‘Z’ i.e., the distance between the centres of the movable pulley and the winch drum is required to be measured.

To facilitate checking, the position of the bottom of the counterweight corresponding to the lowest and highest temperature should be marked on the masts by means of black bands of width 20 mm. The position of the counterweight at ambient temperature of 35°C may be marked by a red band which can be seen during trolley inspection readily. The bottom of counter weight should coincide with the band mark.

2. The usual defects to be looked for in the pulley block type of equipment are:-
   a) Damage to pulley grooves by the stainless steel rope due to misalignment of the equipment and the catenary wire being not vertically above the contact wire at the termination.
   b) Seizing of the needle bearings due to drying up of lubricant and consequent jamming of the pulley
   c) Jamming of guide pulley due to lack of lubrication and consequent grooving of the pulley. This can be checked by pushing up the counter weight and allowing it to descend due to its own weight.
d) Damage to neoprene washers provided between pulleys resulting in ingress of dirt and water into the needle bearings.
e) Bent slidings rods obstructing the movement of the movable pulley.
f) Blocking of grease nipples.

These defects except for replacement of the guide pulley and attention to clocked grease nipples are not capable of being attended to in-situ. The complete equipment should be replaced with a spare one and the removed equipment taken to the workshop for attention.

The main pulley and guide pulley bearings of the pulley block type equipment should be lubricated using approved type of grease which will be able to withstand 60°C without drying.

Another important check required for the pulley block type equipment is to see that the stop nuts provided at the end of the guide rods are intact. These are provided to prevent the movable pulley coming off the guide rods in the event of breakage of the stainless steel rope.

3. The common defects to be looked for in the winch type equipment are:
   a) Over-riding of stainless steel rope and grazing of grooves,
   b) Breakage of strands of stainless steel wire rope,
   c) Seizure of pulley bearing,
   d) Tilting of anti-falling device.

Stainless steel ropes should be examined periodically with a magnifying glass for pitting and other signs of corrosion.

Regulating equipments should be checked periodically for free movement with the help of a spring balance. If pull required for a visible movement of counter-weight exceeds 10 kgs, the regulating equipment should be overhauled.

Whenever a panto/ OHE entanglement takes place the regulating equipments of all the concerned OHEs should be checked thoroughly, particularly if any of them was overhauled more than two years earlier.

Until such time a grease capable of retaining the properties for 4 years becomes available, all regulating equipments should be overhauled every two years. Priority should be given to those which cover the more vulnerable locations.

During overhaul of regulating equipment special attention should be paid to the shape and dimensions of the winch frame arms (right and left) as they have a direct influence on the angle of incidence of the stainless steel wire rope on the winch drum.

Whenever a regulating equipment is dismantled, the condition of the bearing grease should be checked. If it is found to have lost its oil content and exhibits the consistency of hard soap, the source and type of grease used initially should be investigated.

The condition of rubber or felt seals provided to prevent the ingress of water into bearings should be checked and if they have deteriorated, the quality and source should be investigated and remedial steps taken. All seals should invariably be replaced during periodical overhaul unless their condition is found to be good enough to work satisfactorily for another four years.
4. Most of the points mentioned above are also applicable to pulley type regulating equipment which is now standard.

4.15.2 OHE Inspection Car (Tower Wagon)

1. OHE Inspection Car has a key role in the maintenance of OHE and for attending to break-downs. The satisfactory upkeep of the car is, therefore, of utmost importance. ATFO (OHE) should ensure that the car under his control is maintained satisfactorily and is available at all times for attending to OHE and for use in the event of break-downs.

Each car should carry necessary tools for maintenance of OHE and attending to break-downs, such as tackles, straining screws, clamps, ropes, a minimum of two ladders as well as an adequate stock of insulators, lengths of contact and catenary wires and other OHE fittings. An approved list of tools and equipment to be carried in each car should be issued by DEE (TrD). ATFO (OHE) should ensure that tools and equipments as per the approved list are always available in the car.

2. A monthly mechanical inspection of the bogies and running gear of each car shall be done by a nominated TXR of the Mechanical Department, headquartered close to the OHE depot where the car is normally stabled. For each car on a zonal Railway, the TXR responsible for monthly mechanical inspection will be nominated and a joint circular to this effect issued by CME and CEE laying down his duties.

The ATFO (OHE) in charge of the car will advise the TXR concerned the date on which it is required to be inspected and running repairs carried out. Such advise shall be given at least 48 hr in advance. ATFO (OHE) should ensure that this monthly advice is issued regularly and the car is offered for inspection and attended to every month. The TXR will arrange for examination of bogies, running gear, underframe, under-gear fittings and axle boxes only, in accordance with IRCA rules, Part III. He will also arrange for stenciling the date of monthly examination on the sole bar of the car. The POH of the car shall be done at an interval of 3 years in an EMU shop / electric loco shed / Elec. workshop, as decided by CEE. (Ref. Board’s Letter No. 84/Elec/140/4 Vol. 1 dt. 1.3.90).

3. The day-to-day maintenance of the diesel engines and driving gear of the car will be the responsibility of the ATFO (OHE) concerned. The OHE inspection car Drives should carry out the daily maintenance. Specialist staff conversant with the maintenance and overhaul of diesel engines and driving gear should be available on each division for attending to monthly and six monthly maintenance of the diesel engines and driving gear. If it is more convenient and depending upto the work load, two or three Divisions may be grouped together for the purpose of posting such specialist staff.

4. Taking into account the total number of OHE inspection cars and the need for relief of such cars for purpose of POH etc. In each Zonal Railway, one or more pare OHE inspection cars may be provided as necessary.
4.16 Salient Features of OHE Inspection Cars

The salient features of the OHE inspections cars presently in use on Indian Railways are as under:-

1. Mark II 4 wheeler manufactured by Kanchrapara Workshop / E.Rly.
   i. Diesel Engine - 83 HP (Simpson make)
   ii. Axle load - 6.8 tonnes
   iii. Pay load - 3 tonnes
   iv. Speed Potential - 40 km/h.
   v. Transmission - Gear box system
   vi. Brake system - Vacuum

   i. Diesel Engine - 185 HP
   ii. Axle load - 16 tonnes
   iii. Speed Potential - 75 km/h.
   iv. Transmission - Hydraulic / Hydro-mechanical
   v. Brake system - Compressed Air Brakes

3. OHE Inspection Car – 8 wheeler
   i. Diesel Engine - single 530 HP or twin 285 HP
   ii. Transmission - Volth’s Hydraulic
   iii. Axle load - 16 tonnes
   iv. Pay load - 10 tonnes
   v. Speed Potential - 110 km/h on level tangent track
   - 30-40 km/h on 1 in 60t rising gradient while hauling a loaded bogie flat wagon of 60t.
   vi. Brake system - Compressed Air Brakes
   vii. Paying out facility on one drum each of contact and catenary wires.
   viii. Small workshop fitted with drilling machine etc.
   ix. Two staff cabins with toilet.
   x. A small kitchenette, storage space for tools, spares and traction masts etc.
   xi. Adjustable lifting and swiveling platform.
   xii. Observation dome - To watch pantograph and contact wire interaction during motion.

4.17 Rules for Operation of OHE Inspection Car

1. General
   (i) Authorization:

   No OHE inspection car may be operated by any person unless he is specifically authorized to do so after he has been trained and examined for his knowledge of the rules prescribed.

   (ii) Scope

   The following rules shall govern the working of an OHE inspection car fitted with a pantograph for the purpose of inspection of OHE either during commissioning of completed
sections of OHE or during periodical inspections carried out by the OHE Inspection Car maintenance staff. All staff in-charge of operation of OHE Inspection Car shall make themselves fully conversant with and act according to the special instructions given below.

(iii) Movement

The movement of OHE Inspection Cars on tracks will be governed by all the rules governing movement of trains.

(iv) Driving

i) OHE Inspection Car shall be driven only by an authorized person, and no person shall be so authorized unless he has knowledge of the section (Road and Signals) on which the Car is to operate and is conversant with the operation and maintenance of car. He should also be in possession of competency certificate for the purpose.

ii) The OHE Inspection Car shall be driven at a speed not exceeding 10 km/h when checking contact wire level and stagger. This shall be done by running on the first gear. Riding on the clutch for this purpose is prohibited.

iii) If the OHE Inspection Car is driven for other than recording operations, the speed should not exceed the designed speed subject to the speed restrictions imposed in the section.

iv) In every depot, at least two OHE staff shall be trained and issued with competency certificate to drive an OHE Inspection Car in the event of an emergency.

3. Pantograph Operation

i) The pantograph mounted on the roof of the OHE Inspection Car is electrically bonded to the underframe by means of a cable connection. This cable connection should be checked before starting any operation for checking and adjustment of OHE.

ii) The pantograph should normally be kept in the fully lowered position and clamped securely by means of the special clamp provided for the purpose. No string, cord etc shall be used for this purpose.

iii) Before any person goes up to the roof of the OHE Inspection Car for commencing Inspection and adjustment, the section of the OHE concerned shall be made dead and earthed on either sides. Additional earths shall be provided where necessary. After earthing the OHE, an additional earth shall be provided near the OHE Inspection Car on the OHE of the track on which it is standing. An authorized person not lower in rank than a linesman shall then go up on the roof and remove the clamps to release the pantograph.

iv) Under no circumstances should the OHE Inspection Car be worked with the pantograph raised without an earth on either side of it on the section of the OHE in which it is to be worked.

v) In order to ensure that the pantograph does not enter a section where the OHE is live the OHE Inspection Car shall be protected on both the sides with banner flags and other signal flags. The driver shall always stop the OHE Inspection Car ahead of all turn outs, crossovers, insulated overlaps and section insulators first and then proceed only after ensuring that the section ahead is dead and earthed. Banner flags then be removed for the purpose of admitting the OHE Inspection Car into the section ahead.
vi) At the end of the inspection and checking, the pantograph shall be lowered and clamped by an authorized person not lower in rank than a linesman working on the roof after earthing the OHE of the track on which the OHE Inspection Car operating. The earths on the OHE near the OHE Inspection Car shall then be removed after all persons working on the roof have come down.

4. Operation of Lifting and Swiveling Platform

i. The lifting and swiveling platform shall ordinarily lie in the fully lowered position along the length of the OHE Inspection Car.

ii. The swiveling platform shall be raised or lowered only when the OHE Inspection Car is stationary.

iii. The platform shall be moved out of the normal position only when the OHE Inspection Car is stationary.

iv. The OHE Inspection Car shall be moved only after the platform has been put back in the normal position.

v. If the OHE Inspection Car is to be moved with the platform raised, it may be done at a speed not exceeding 5 km/h.
BREAKDOWNS

5.0 Knowledge of Rules

All officers and Supervisors of the Traction Branch should be fully conversant with the “Rules for Reporting Accidents” and other instructions in force for dealing with accidents and breakdowns. The instructions given in the following paragraphs are to be treated as supplementary instructions applicable specially to traction installations; they should not be taken as nullifying or contradicting the instructions contained in other official manuals.

Electrical accidents are dealt with in the Volume I.

5.1 Types of Breakdowns

The types of break-downs pertaining to electric traction can be broadly divided into the following categories:

1. Sub-station and switching stations
2. Remote control equipment and cables
3. OHE feeder lines and transmission lines

5.2 Breakdown Gangs

Accident and breakdowns involving traction installations and electric rolling-stock should normally be attendee to by the maintenance gangs themselves. It is however, essential that adequate number of experienced traction staff should be selected and housed in railway quarters close to traction installations, so that their services can be utilized at short notice for dealing with breakdowns and accidents whenever required.

In electric suburban sections, however, ‘breakdown gangs’ of adequate strength may be located at selected points to deal promptly with OHE failures, particularly during the hours of peak traffic.

5.3 Emergency Stores and Breakdown Equipment

1. For each OHE depot/sub-depot, the actual quantity of OHE stores lime masts, conductors, insulators, fittings etc. which should be earmarked specially for use in breakdowns will be laid down by Sr. DEE(TrD). To start with, all materials required for 3 kilometers of single line may be kept. Based on experience, the minimum and maximum quantities may be revised from time to time. An inventory of such OHE stores should be maintained by the supervisor-in-charge of the depot/sub-depot and stocks recouped periodically so as to ensure that the minimum quantity is always available. During periodic inspections by officers, scrutiny of this inventory should be one of the important items in order that the required stores are always made available.

2. OHE inspections Cars, wiring trains, breakdown lorries and all break-down tools, tackles, straining screws, clamps, ladders etc. shall be maintained in good condition and kept ready for use at all times. Though it will be equipment is in good working order, supervisors and officers at all levels should specially check their condition during their periodical
inspections. A periodic review should also be made regarding the adequacy of such spares and tools.

3. The CTFO (PSI) and CTFO (RC) should also have in their custody spares and tools pertaining to their work as per scale to be laid down by Sr.DEE (TrD) for dealing with breakdowns and accidents.

5.4 Record of Staff Emergency Staff

To enable the TPC to summon staff as required, a register showing the residential addresses of specified staff of the Traction Distribution branch, particularly those residing in railway quarters or close to railway stations, should be maintained station-wise by TPC. The list of office and residential telephone numbers of officers and supervisors should also be kept up-to-date by him for ready reference. In view of the importance of communication facilities in an emergency every telephone should be tested at least once a month.

5.6 SUB-STATION AND SWITCHING STATION BREAK-DOWNS

5.6.1 Traction Transformer Breakdowns

Breakdowns of any one traction transformer or associated circuit breaker at a traction sub-station (whether owned by the Supply Authority or the Railway) should not normally affect the working since 100% stand-by is available for the transformer at nearly all sub-stations.

5.6.2 Central Repair Shop

Failure of traction transformers, requiring the lifting of core and winding are extremely rare. However; repair and overhaul facilities should be provided at a central point on each railway. At each Central Repair Shop, the following facilities are generally required.

1. A crane bay with the railway line leading into it, so that the traction transformer may be brought in directly into it. The crane hook should be high enough to permit unloading of the transformer from the wagons and placing on the floor, and also for lifting the core out of the transformer tank.

2. To underground transformer oil storage tanks, one for old oil and one for new oil.

3. A 2500 litre/hour, electrically driven oil purification plan with pumps and interconnecting pipes and valves to empty old oil from transformers, to fill-in new, purified oil into the transformers, to dry out the oil in the transformers etc., as required.

4. An enclosure with oil testing set to test dielectric strength of oil.

5. A small workshop with a few essential machines to carry out urgent repair work.

6. A test-room and laboratory fully equipped with testing equipment for carrying out repair, calibration and testing of all types of relays and instruments used on the traction system.
5.6.3 Mobile Power Van

A mobile power van should also be provided on each railway which has to maintain traction transformers. On this the following equipment should be provided.

1. An engine-generator set rated to deliver 100 kVA at 415 ac 50 Hz, 3-phase 4 wire along with necessary oil storage tanks.
2. A 2500 litres / hour electrically driven oil purification plant.
3. A small mobile workshop to attend to urgent on-the-spot repair work, comprising a motor driven drilling machine, grinding machine, a power driven hacksaw, a welding machine and oxy-acetylene flame cutting equipment.
4. Portable flood-lights with trailing cables to light up accident sites to facilitate repair work.

The mobile van can be used for purifying transformer oil of traction transformers in situ when required, eliminating the need for bringing the transformers to the Central Repair Shop. At stations where no 3-phase, 415 V supply is available from a nearby source, the engine set is operated to meet the heater load of the oil purification plant and also the drive the motors. The mobile van would also be useful to flood-light an area such as when there is an extensive OHE breakdown.

5.6.4 Breakdown of Circuit Breakers, Interruptors
If a circuit breaker or interruptor requires major repairs, it should be brought to the PSI maintenance depot after replacing it by a spare one.

5.6.5 Rail and Road Access

Every traction sub-station should have all-weather road access in addition to rail access for transporting heavy equipment to and from the installations. For switching stations too, road access should be provided wherever possible. Suitable fittings and tackle should be available to move an interruptor or circuit breaker from the PSI maintenance depot on a motor trolley or OHE inspection Car and unload it by the side of any switching station and take it in. a suitable platform and a firm pathway leading to the gate should be available and maintained well.

5.7 BREAKDOWNS OF REMOTE CONTROL EQUIPMENT

5.7.1 Procedure for Manning Sub-Stations and Switching Stations

1. Whenever Remote Control working is not possible due to any fault on the P&T cable or in the remote control equipment concerned or failure of the battery etc. CTFO (RC) or TPC shall suspend remote control operation of the particular section or switching station concerned until the defect is rectified. During this period it is necessary to arrange for manning the switching stations by posting suitably qualified staff, who are authorized to carry out emergency switching operations manually as instructed by TPC. Such staff will be referred to as ‘Operator’ in the following paragraphs. To meet such emergencies, TPC shall maintain a register of authorized operators, who have been trained, examined and declared by AEE (TrD) as competent.

2. Whenever an operator is placed on duty at a switching post when the remote control equipment is not functioning due to any reason, the following instructions shall be adhered to
a) Before taking over his duty, the Operator shall make himself conversant with the equipment he is required to operate and the rules that are laid down by the Administration for operation of the equipment.

b) He shall carry out orders issued to him by TPC over the telephone, observing the rules laid down for exchange of telephone messages.

c) He shall maintain a log book showing the details of operations carried out by him in the order in which they were done, interruption to power supply, abnormal occurrences, defects in plant requiring attention, and other information if any. The log will be signed by both the relieving and relieved Operators at every change of shift as a token of having taken over and handed over all equipment correctly.

d) The Operator shall be responsible for all the plant and equipment, spare parts, stores and furniture (at the sub-station or switching station) during his shift.

e) Whenever a switching station is manned, the Operators shall work in accordance with the duty rosters exhibited. The regulation of the shifts shall be effected by TPC.

f) The operator on shift duty is forbidden to leave the post station unless he is relieved by an authorized person. No interchange of duties or variation of duty hours is permitted without the prior permission of TPC, and staff who are unable from any cause to take their shift, shall at once notify TPC.

g) Whenever an Operator is posted at a switching station or sub-station he shall always be accompanied by another person e.g. a Khalasi, who can use the telephone intelligently.

5.7.2 Restoration of Remote Control

CTFO (RC) shall arrange for expeditious rectification of the defect and restoration of remote control. It is undesirable to continue any controlled post on local control for prolonged periods.

5.7.3 Breakdown of Tele-Communication Between TPC and Sub-Stations, Switching Stations etc.

If the TPC circuit becomes defective for any reason, several alternative channels of telecommunication are available. Should the P&T cable itself break-down all circuits through it may be inoperative. In such cases, essential messages may e passed through the P&T telephones, railway local telephones network, railway wireless network or microwave network. Urgent messages from TPC to traction sub-stations could also be passed through the Operators of grid sub-stations.

Close co-ordination should be maintained between the officials of the Traction Distribution Branch, S&T branch and DOT authorities to ensure quick restoration of normal communication facilities.

5.8 OHE BREAKDOWNS

5.8.1 Importance of Expeditious Repairs

Every breakdown of OHE, even if minor in nature, should be attended to urgently as it generally interferes with traffic. Since electrified lines carry a high density of traffic, the effect on traffic will be quite severe if restoration is not arranged expeditiously.
5.8.2 Types of OHE Breakdowns

The common types of OHE breakdowns are as under-
1. Uprooting of or damage to OHE masts on account of cyclone, derailments etc.
2. Entanglement of pantographs with the OHE,
3. Snapping of OHE conductors
4. Flash-over or other damage to insulators
5. Faults on account of stray wires etc
6. Theft of OHE conductors.

5.8.3 Look-out for OHE Defects

The engine crew of all trains should keep a sharp look-out and report to the TPC from the nearest station any defects noticed by them in the OHE.

All break-downs or defects in OHE which are likely to affect the train services, noticed by any Railway servant shall be reported immediately to TPC. If TPC cannot be contacted, the nearest Station Master or Cabin Assistant Station Master shall be advised. The SM/CASM to whom such breakdowns or defects are reported shall convey the information immediately to TPC through the control or other available telephone. The person reporting a breakdown to TPC should give as detailed information as possible on the nature of the breakdown, its location, if masts have been uprooted or both lines in a double track section have been affected etc.

The person conveying the information to TPC should not leave the vicinity of the telephone without TPC’s permission, as the latter may want to contact him again to elicit further information.

5.8.4 Action to be taken by TPC

If required, TPC shall direct the nearest available Electrical Department official to proceed to site to obtain full details. Simultaneously the TPC should switch off power supply to the affected lines and inform the Section Controller.

Though initially power may have to be switched off over a whole sub-sector, the faulty elementary section should be identified and isolated as quickly as possible so that power supply to the affected lines and inform the Section Controller.

Further, it should be possible in many cases to block the lines for electric locos and EMUs only, permitting movement of steam and diesel trains. It may also be possible to move electric locos and EMUs at restricted speed or to coast through the affected section with pantographs lowered if the damage is only slight. It is for TPC to decide after careful study of information available from the site and in consultation with traffic officials the extent of restriction to be imposed on traffic.
5.8.5 Protective steps

1. On receipt of information about OHE break-down, the SM/Section Controller shall also take such steps as deemed necessary to regulate traffic on the affected lines and issue caution order where required. Single line working may be introduced, if feasible.

2. It is the duty of every railway servant who notices hanging OHE conductors to take immediate preventive steps to ensure that no person comes into contact with them treating such conductors as live until an authorized person from OHE section arrives at site and makes the OHE dead and earth it.

5.8.6 Breakdown Staff

1. On receipt of the first report about the breakdown, TPC shall direct the nearest OHE maintenance gang to proceed to site immediately with available breakdown vehicles for dispatch of staff without waiting for full details of the breakdown.

2. A quick assessment should be made on the basis of information available and where necessary one or more gangs from both sides of the site may be asked to proceed to the site. If the accident spot cannot be reached by rail-borne vehicles on account of the line being blocked by other trains, road vehicles equipped with emergency stores, tools and staff may be directed to the site. In sub-urban sections with large number of roads running alongside the track, this method may help in tackling the repairs much more quickly.

3. If the OHE Inspection Car or wiring train is required to attend to the break-down, the Section Controller, on request from TPC shall arrange for quick passage of the OHE Inspection Car or wiring train to the site of the accident.

5.8.7 Officers and supervisors to proceed to site

On receipt of information about an OHE break-down the ATFO(OHE), CTFO (OHE), DEE/AEE(TrD) shall proceed by quickest available means to the scene of accident. The Sr. DEE (TrD) should also proceed to the site in the circumstances of the case require his personal supervision and direction. In the event of a major break-down likely to result in interruption of traffic for more than 12 h, CEDE should also proceed to the site for supervising restoration.

5.8.8 Assistance to be Sought

1. It should be remembered that restoration of traffic in the event of accident or breakdown is the responsibility of the Division as a whole. The Electrical Department Officer in-charge of the restoration work should, wherever required, ask for assistance from the Engineering, Traffic or other Officers as necessary. He should also keep the DRM fully posted with arrangements made and the expected time of restoration.

2. When circumstances warrant, the assistance of OHE gangs of another contiguous Division may be sought for by contacting AEE(TrD) or Sr. DEE/DEE(TrD) of the Division concerned. The officers who receive such requests from neighbouring divisions should treat the matter as of utmost importance and render all possible assistance.
5.8.9 Continuous Communication with TPC

The Officer or Supervisor in-charge of supervising repair work should maintain continuous communication with the TPC from the site of breakdown. For this purpose an intelligent person should be posted to man the nearest emergency telephone socket continuously to transmit and receive messages as required. It is very important that the field staff remains on call all the time until normal service is restored, since no provision exists in the emergency telephone circuit for the TPC to ring up the emergency telephone stations at the site.

5.8.10 Detailed Assessment by the First Supervisor / Officer Reaching Site.

The first Supervisor or Officer of the Traction Branch reaching the site of the breakdown should make a quick assessment of the extent of damage and the time required for restoration. He will ascertain from TPC the details of break-down gangs and equipment directed to the site and if the circumstances warrant, ask for additional gangs and breakdown equipment to be sent to the site. On receipt of these details, TPC should arrange for additional gangs and equipments to be sent to the site expeditiously. In the meanwhile, isolation and repair works should be started at site.

Further details on the extent of damage and estimated time as obtained from the Supervisor / Officer at the site from time to time will be passed on from TPC to the Section Controller to enable him to review the arrangement for regulating the traffic initially made.

In the event of major breakdowns affecting main line traffic, Sr. DOM/DOM of the Division should personally take over regulation of traffic arrangements.

5.8.11 Preservation of Evidence

When a pantograph gets entangled with the OHE, it is often very difficult to establish whether the damage originated from a faulty pantograph or a defect on the OHE.

The first Officer or Supervisor of the Electrical Department arriving at site of a breakdown particularly those involving entanglement of pantographs with the OHE, should make a very careful note of all relevant details pertaining to the breakdown and also prepare a sketch indicating the particulars. He will also arrange for preservation of such evidence as may be useful subsequently for investigating the cause of the breakdown.

Items to be checked on the pantograph and OHE are indicated in the fig.

5.8.12 Safety Rules to be observed

While speed is the essence of emergency working, rules prescribed for safe working shall never be infringed. Repair work may commence only after an emergency power block has been obtained and all other precautions necessary for protection of the staff taken. On completion of the repair work, the power block may be cancelled according to the prescribed procedure.
5.8.13 Temporary Repairs for Restoration of Traffic

In the first instance, repairs to the OHE should be kept to the barest minimum necessary for restoration of traffic with least possible delay. Work must proceed simultaneously at many points. After affecting temporary repairs, the Officer or Supervisor in-charge of the work should personally check the whole area and satisfy himself that the installations are in order and safe. He may impose such speed restriction as necessary for movement of electric and other than electric trains till permanent repairs are carried out. Permanent repairs should be arranged and speed restrictions removed and normal operation restored at the earliest opportunity.

5.8.14 Clearance of Line for Steam / Diesel Traction

If the breakdown is extensive and restoration of electric traction is unlikely in a short time even with temporary repairs, the line should be cleared for diesel / steam traction as soon as possible, so that traffic may be kept moving until repairs to the OHE are completed. After steam / diesel traction is introduced full precautions should be taken for protection of staff working at site.

5.8.15 Wiring trains

If the OHE has suffered extensive damage, the OHE wiring train should be requisitioned to speed up the work.

The wiring train generally consists of a stores – cum tool van, a workshop van, a staff and kitchen van, a reel wagon loaded with one drum of catenary wire and one drum of contact wire, wagon loaded with materials for temporary diversions, a BFR loaded with structures, a hand-operated crane to facilitate erection of masts, a power car with two diesel generator sets for supplying power to the workshop van and for lighting, two brake vans, an adequate quantity of OHE material and flood-lights with trailing cables. The vans have platforms with side-railings to facilitate working on the roof.

5.8.16 Interference with OHE During Restoration

In clearing the line traffic, breakdown staff are forbidden to disturb the OHE masts or to cut the OHE conductors except under the specific orders of Sr. DEE (TrD)/DEE(TrD). If it becomes necessary to slew the OHE conductors to facilitate crane working, this should be arranged to be done by the Electrical Department staff. It should be borne in mind that indiscriminate cutting of OHE conductors will necessitate introduction of splices which are not conductive to good current collection. Also introduction of such splices is liable to delay restoration of normal electric services.

5.8.17 Temporary Diversions

Sometimes with derailments and accidents occurring in electrified sections, temporary diversions have to be laid to clear the traffic with other than electric traction. A quick means of wiring such diversions so as to resume electric traction without waiting for the main line to be commissioned is described below.
The constructional details of the arrangement for such diversions on BG may be seen in Fig. 5.1.

The portal type structures are made out of 80 mm diameter GI pipes using two right angled ‘T’ joints. Guys are used in both perpendicular and parallel directions to the track so as to give extra safety against heavy wind load. The contact wire is suspended with the help of special fittings made of MS flats form the catenary wire stretched between the two upright of the structure and insulated by two 9-tonne insulators as shown in the figure.

The 80 mm diameter GI pipes are placed in 150 mm diameter MS pipes welded on to a 10 mm thick 450 mm x 450 mm MS base plate which in turn is bolted by 10 mm diameter through bolts to a 4880 mm long crossing sleeper.
Put under the rails. The weight of the rails keeps the crossing sleeper and thereby the structure in position. The void between the 80 mm diameter and 1509 mm diameter pipes is wedged by wooden wedges and also filled up with sand and covered by bituminous compound so as to prevent rusting of the GI pipe due to the seepage of water through the sand. Since the whole structures is attached to the track as above, the chances of tilting or sinking of the structure with shrinkage or settlement of the temporary un-consolidated embankment are eliminated.

The contact wire is anchored at both ends at a height of 6 m existing masts and ‘fly guys’ are provided from the anchor mast to the base of the next mast so that no separate foundation is necessary for anchoring and also the guy can be removed easily at the time of dismantling.

The advantages of the above type of construction are as under:-
1. It is cheap.
2. The structures weigh less than 150 kg and 4 men can easily erect or dismantle them.
3. Since no foundations are required, time is not lost in excavation for foundation and consequently the structures can be erected quickly.
4. The equipment can be dismantled and erected at new sites quickly.
5. The traffic can move at the speed restriction imposed for the permanent way and no extra speed restriction on account of OHE is necessary.
6. The materials used for the work are easily obtainable. The new fabrications required can easily be manufactured in workshops and stocked at depots for quick use in emergencies.

5.8.18 Funds Required for Dealing with Breakdowns

Funds required for dealing with breakdowns may be obtained from station earnings in accordance with para 714 of the Indian Railways Permanent Way Manual reproduced below:-

1. The Divisional/District Engineer or the Assistant Engineer on his behalf may draw upon the station earnings according to such instructions as prescribed by the Administration under note to para 1405G, for the following purposes:-
   a) Payment to daily labour employed at the site of breach or accident.
   b) Purchase of tools or materials required in connection with accidents which cannot be supplied in time by the Stores Department.
   c) To provide food to engineering labour at the site of breach or accident with the assistance of Station Masters or Inspectors of the Commercial Department.

The supply of food free of charge is permitted in special circumstances at the discretion of the Administration to facilitate expeditious restoration of traffic.

When food is supplied free at the site of an accident to engineering and other labour the expenditure per head per day shall not exceed the prescribed limit.

2. The Accounts Officer should be advised immediately by telegram of each sum taken from station earnings.

In all cases, Engineers obtaining advances from station earnings should, do so under a clear receipt. On the receipt, the object for which the money has been procured should be clearly stated.
A complete account should be submitted at the earliest possible date to the accounts department supported by pay sheets and vouchers.

3. All payments to labour should be witnessed by the Assistant Engineer at site.

5.8.19 Log of Events and Reporting of Break-downs

1. In all major break downs TPC, senior officials and Officers concerned shall maintain a detailed log of events in their diaries noting the time and brief details which may help in fixing the responsibility for any avoidable delay in restoration.
2. The DRM should submit to CEE and COM a detailed report covering every major break-down of OHE or other traction installations giving all essential information including-
   1. nature of break-downs and lines affected with detailed sketch;
   2. chronological account of action taken to effect repairs and restore traffic;
   3. repercussions on traffic and rough estimated cost for repairing the damage;
   4. cause of break-down and staff responsible, if any,
   5. any other special features including an objective analysis of the time taken for repairs and restoration of traffic with a view to see if these could have been done more expeditiously and if so measures proposed to improve the performance in future.

5.8.20 Protection of Staff
In addition to ensuring that work on OHE is commenced only after obtaining a power block as stated in para 20825 above, the supervisor in-charge shall take all measures for protection of staff and for exhibition of hand-signals as per GR and SR, particularly when the line under repair and the adjacent lines are not blocked for other traffic.

5.8.21 Use of cranes
Special care is necessary when steam or hand cranes are used at the site of break-downs. The movements of the cranes shall be carefully controlled by the person in-charge so as not to come within 2 m of live OHE, in addition to the usual precautions necessary to prevent infringement of adjacent tracks which have not been blocked for other traffic.
6.0 OHE Maintenance Depots

6.0.1 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:

i. The total equipped track kilometers to be maintained by each depot.
ii. Beat of the depot on either side
iii. Traffic density obtained on the section and the time factor in reaching the farthest point.
iv. The proximity of major yards with considerable equipped track kilometers;
v. Availability of educational, medical and other infrastructure facilities in the vicinity.

6.0.2 The total staff required for OHE maintenance for a given section is arrived at, based on the prevalent yard sticks 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.

6.0.3 The total equipped track kilometers normally assigned for maintenance to a single OHE depot should be at least 150 track kilometers 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.

6.0.4 The beat of the depot on either side should not normally exceed four block sections (occasionally live) 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.

6.0.5 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.

6.0.6 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 the OHE Depot Workshop in a major depot.

6.0.7 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
6.0.8 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. Alongwith 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, blacksmiths, carpenters, and incidentally is likely to result in overall savings of the staff in the ancillary categories and equipments.
6.1 PSI Maintenance Depots

6.1.1 Besides the OHE maintenance depots, PSI maintenance depots are provided for maintaining the various power supply equipments installed at traction substations, switching stations, booster transformers stations, auxiliary transformer stations etc. It is advantageous to locate the PSI maintenance depot along with the OHE maintenance depot so as to achieve some economy in requirements of T&P, transport and other infrastructural facilities.

6.1.2 Normally the average spacing between traction sub stations is 60/70 km. On trunk routes with high traffic densities, where operation of 4500 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

6.1.3 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, interruptors, etc, the equipment can be transported to the nearest traction sub –station, where power supply is available from the 100kVA 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.

6.1.4 By combining the OHE and PSI depots, the OHE transport facility can be conveniently utilised for PSI work as well. A common depot will be cheaper with a common compound wall and security arrangements. Better co-ordination 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, as PSI maintenance work is more concentrated at a traction sub – station.

6.1.5 Keeping in view the set up outlined above, it should be possible to locate the PSI depots at alternate OHE depots (instead of locating the same at each and every OHE depot). This would enable a minimum complement of PSI staff both supervisory and others at each of the PSI depots.
6.2 Scale of T&P for OHE Depots

6.2.1 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.

6.2.2 The T&P recommended to be procured by R.E for PSI maintenance is given at Annexure A6.02.

6.2.3 In addition, the T&P recommended to be procured by R.E for Division 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.

6.2.4 The office furniture to be supplied b R.E. for field offices and depots is shown at Annexure A6.05.

6.2.5 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.

6.3 Transport Facilities for Maintenance Including Breakdown Attention

6.3.1 At present each major OHE Depot is provided with one heavy duty motor truck and one 4-wheeler OHE Inspection Car. These transport vehicles are adequate fro attending to breakdowns and for normal day-to-day maintenance. For push trolley inspections of OHE by supervisors and officers, each OHE depot is to be provided with one push trolley. One Jeep with trailer is to be provided for each field officer at
his headquarters. One motor trolley is to be provided for each station where an OHE
officer is headquartered.

6.3.2 One wiring-cum breakdown train is to be provided for each Division to meet any
major OHE breakdowns which require wiring of OHE.

6.3.3 Transport facilities recommended for TRD maintenance are summarized at Annexure
A6.07.

6.3.4 On section 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 breakdown 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

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Major Depot</th>
<th>Tower Car</th>
<th>Breakdown Train</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Trifor 2.5 Tonne / 1.5 Tonne</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Trifor 5 Tonne / 3 Tonne</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Pull-lift 3 Tonne</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Pull-lift 3/4 Tonne</td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Dropper making Jig and Wire straightener for 5mm dropper wire</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Dropper making Jig and Wire straightener for 7mm dropper wire</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>7</td>
<td>Come-along clamps for Catenary suitable for 19/2,108 mm conductor</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>Come-along clamps for contact wire 107mm2.</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>Come-along clamps for Aluminium “SPIDER” conductor (20 mm2)</td>
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<td>4</td>
<td>4</td>
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<tr>
<td>10</td>
<td>Come-along clamps for earth wire (19.2/5 mm) Galvanized steel</td>
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<td>2</td>
<td>2</td>
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<tr>
<td>11</td>
<td>Rail jumpers with Clamps at both ends</td>
<td>30</td>
<td></td>
<td>6</td>
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<tr>
<td>12</td>
<td>Rail jumpers extension with clamp at one end</td>
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<td>6</td>
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<tr>
<td>13</td>
<td>Earthing discharge rod complete</td>
<td>10</td>
<td>4</td>
<td>6</td>
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<tr>
<td>14</td>
<td>Aluminium straight ladder (8m) with hook on top</td>
<td>4</td>
<td>1</td>
<td>2</td>
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<tr>
<td>15</td>
<td>Aluminium straight ladder extensible (11m)</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>Drilling Machine (25 mm) Motor Driver (Radial or Pillar)</td>
<td>1</td>
<td>-</td>
<td>-</td>
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<tr>
<td>17</td>
<td>Bench Grinder (Double end) Pedestal Motor Driven (203mm) disc</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td>Portable Welding-cum-cutting Set (Gas) Range cutting 1-100 mm. Welding 0.5 to 30 mm (complete with Oxygen and Acetylene Cylinders, Trolley, Helmet etc)</td>
<td>-</td>
<td>-</td>
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<tr>
<td>19</td>
<td>Hydraulic Compressor for return conductor splicing</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>20</td>
<td>Portable Electric Drill 21.0 mm 1ph, 230 v (For Drilling rails for bonding)</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>21</td>
<td>Honda Welding Generating Set (100/200 A) with</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Product Description</td>
<td>Quantity</td>
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<td></td>
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<tr>
<td>22</td>
<td>Portable Diesel Generating Set 3 kVA, 240 V, 1 ph</td>
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<td></td>
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<tr>
<td>23</td>
<td>Flood light fitting with 500 Watt Lamps</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>First Aid Box</td>
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</tr>
<tr>
<td>25</td>
<td>Stretcher</td>
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<td>26</td>
<td>Fire Buckets 10 ltr.</td>
<td>4</td>
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<tr>
<td>27</td>
<td>Portable Fire extinguisher (Cap. 10 ltr) Dry Chemical Powder</td>
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<td>28</td>
<td>Portable Fire extinguisher (Cap. 5 ltr) (Foam type)</td>
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<tr>
<td>29</td>
<td>Contact Wire Cutter 36”</td>
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<tr>
<td>30</td>
<td>Dropper Wire cutter 12”</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>‘D’ Shackles set of one each (1”,3/4”, 5/8”, 1/2”)</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Single Sleeve Pulley block 3 1/2” x 1/2 Groove Steel</td>
<td>4</td>
<td></td>
<td></td>
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<tr>
<td>33</td>
<td>Single Sleeve Pulley block 3 1/2” x 1/2 Groove Fiber for drawal of Contact Catenary Wire</td>
<td>6</td>
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<tr>
<td>34</td>
<td>Single Sleeve Pulley block 6”x 1” Groove Steel</td>
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<td>35</td>
<td>Contact Wire twist-cum-bender 6”</td>
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<tr>
<td>36</td>
<td>Steel sling with Eye each and 19 mm dia</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>a. 1 m ling</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. 2 m long</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. 3 m long</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. 4 m long</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. 10 m long</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Slewing Gadget</td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>38</td>
<td>Contact Wire Splicing Jig.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Copper Hammer 2 kg</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Micro Meter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Metric Tape 30m, 15m each</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Bench Vice 6”</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Loaded Trolleys</td>
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<td></td>
<td></td>
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<tr>
<td>44</td>
<td>Engineering Ratchet</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Stren covering distance 1 km range</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Tilly lamps</td>
<td>1</td>
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**TESTING AND MEASURING EQUIPMENTS**

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<tr>
<th></th>
<th>Product Description</th>
<th>Quantity</th>
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<tr>
<td>1</td>
<td>Megger 2500 V</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Dynamometer (3500 kg x 20 kg) 300 mm dia</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Earth Megger / Tester</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Binoculars</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Vemler Callipers</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Walkie Talkie sets (2 W output)</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Emergency Telephone</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>Multimeter</td>
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## Annexure A6.02
### T & P for PSI Depots to be Supplied by R.E. Organization

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<th>Description</th>
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<tr>
<td>1</td>
<td>Trifor 3 Tonne</td>
<td>3 Nos.</td>
</tr>
<tr>
<td>2</td>
<td>Trifor 5 Tonne</td>
<td>1 No.</td>
</tr>
<tr>
<td>3</td>
<td>Barrel Pump</td>
<td>1 No.</td>
</tr>
<tr>
<td>4</td>
<td>‘D’ Shackles 5/8”, 3/4”</td>
<td>3 sets</td>
</tr>
<tr>
<td>5</td>
<td>Steel rope slings 1m, 3m each</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>6</td>
<td>Steel rope slings 10m</td>
<td>1 No.</td>
</tr>
<tr>
<td>7</td>
<td>Chain pulley block 3.0 ton cap.</td>
<td>1 No.</td>
</tr>
<tr>
<td>8</td>
<td>Pulley single sleeve 3.0 ton cap.</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>9</td>
<td>First Aid box</td>
<td>1 No.</td>
</tr>
<tr>
<td>10</td>
<td>Stretcher</td>
<td>1 No.</td>
</tr>
<tr>
<td>11</td>
<td>Fire buckets</td>
<td>4 Nos.</td>
</tr>
<tr>
<td>12</td>
<td>Portable electric blower</td>
<td>1 No.</td>
</tr>
<tr>
<td>13</td>
<td>Portable electric grinder</td>
<td>1 No.</td>
</tr>
<tr>
<td>14</td>
<td>Portable electric drilling machine 13 mm</td>
<td>1 No.</td>
</tr>
<tr>
<td>15</td>
<td>Crimping tool upto 6 mm² size</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>16</td>
<td>Aluminium step ladder 8’ height</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>17</td>
<td>Aluminium ladder with hook on top 8’</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>18</td>
<td>Aluminium step ladder 16’</td>
<td>1 No.</td>
</tr>
<tr>
<td>19</td>
<td>Mobile aluminium ladder 36’</td>
<td>1 No.</td>
</tr>
<tr>
<td>20</td>
<td>Magic Pole ladder 8’</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>21</td>
<td>Earthing Pole Assembly / Discharge Rod</td>
<td>6 Nos.</td>
</tr>
<tr>
<td>22</td>
<td>Drop out fuse pull rod</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>23</td>
<td>Portable diesel engine operated welding set 230V</td>
<td>1 No.</td>
</tr>
<tr>
<td>24</td>
<td>1/2” square drive socket set containing 19 sockets with 6 attachments</td>
<td>3 Nos.</td>
</tr>
<tr>
<td>25</td>
<td>Acidity testing kit</td>
<td>1 No.</td>
</tr>
<tr>
<td>26</td>
<td>Mains operated insulation tester 5 kV</td>
<td>1 No.</td>
</tr>
<tr>
<td>27</td>
<td>Pocket size clip on long tester</td>
<td>1 No.</td>
</tr>
<tr>
<td></td>
<td>0 – 5A / 25A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 – 150V / 300 / 600V</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>A.C. Voltmeter 0-150 V</td>
<td>1 No.</td>
</tr>
<tr>
<td>29</td>
<td>A.C. Voltmeter 0-500 V</td>
<td>1 No.</td>
</tr>
<tr>
<td>30</td>
<td>Digital time interval meter 15-1000 seconds</td>
<td>1 No.</td>
</tr>
<tr>
<td>31</td>
<td>Insulation tester 2.5kV</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>32</td>
<td>Earth Tester</td>
<td>1 No.</td>
</tr>
<tr>
<td>33</td>
<td>Megger 500 V</td>
<td>1 No.</td>
</tr>
<tr>
<td>34</td>
<td>Oil testing kit</td>
<td>1 No.</td>
</tr>
<tr>
<td>35</td>
<td>125 ltr. cap. Oil filtration plant</td>
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</tr>
<tr>
<td>36</td>
<td>Insulation tester 250 V</td>
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</tr>
<tr>
<td>37</td>
<td>Multimeter</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>38</td>
<td>Auto transformer 2A capacity</td>
<td>1 No.</td>
</tr>
<tr>
<td>39</td>
<td>Load cell tester</td>
<td>1 No.</td>
</tr>
<tr>
<td>40</td>
<td>Emergency Telephones</td>
<td>4 Nos.</td>
</tr>
<tr>
<td>41</td>
<td>Cycle Pump</td>
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## Annexure A6.03

**T & P to be Procured by R.E. for Divisional Repair Shop (OHE)**

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<th>Sl. No.</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Centre lathe 600 mm centre distance 125 mm height 3 ph, 440 V or 1 ph 230 Volt</td>
<td>1 No.</td>
</tr>
<tr>
<td>2</td>
<td>Motor driven hacksaw cutting machine (to deal 75 mm channel)</td>
<td>1 No.</td>
</tr>
<tr>
<td>3</td>
<td>Drilling Machine (25 mm) Motor Driver (Radial or Pillar)</td>
<td>1 No.</td>
</tr>
<tr>
<td>4</td>
<td>Bench Grinder (Double end) Pedestal Motor Driven (203mm) disc</td>
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</tr>
<tr>
<td>5</td>
<td>Hand driven blower for smithy</td>
<td>1 No.</td>
</tr>
<tr>
<td>6</td>
<td>Hydraulic Compressor for return conductor splicing</td>
<td>1 No.</td>
</tr>
<tr>
<td>7</td>
<td>3 ph. Welding plant (400 Amps)</td>
<td>1 No.</td>
</tr>
<tr>
<td>8</td>
<td>Portable Welding-cum-cutting Set (Gas) Range cutting 1-100 mm. Welding 0.5 to 30 mm (complete with Oxygen and Acetylene Cylinders, Trolley, Helmet etc)</td>
<td>1 No.</td>
</tr>
<tr>
<td>9</td>
<td>First Aid Box</td>
<td>1 No.</td>
</tr>
<tr>
<td>10</td>
<td>Fire Buckets 10 ltr.</td>
<td>8 Nos.</td>
</tr>
<tr>
<td>11</td>
<td>Portable Fire extinguisher (Cap. 10 ltr) Dry Chemical Powder</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>12</td>
<td>Portable Fire extinguisher (Cap. 5 ltr) (Foam type)</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>13</td>
<td>Portable Honda Generating set 0.75 kVA, 240V,1ph.</td>
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<tr>
<td>14</td>
<td>Stretcher</td>
<td>1 No.</td>
</tr>
<tr>
<td>15</td>
<td>Black smith hammer 12 kg.</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>16</td>
<td>Black smith hammer 10 kg.</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>17</td>
<td>Micro Meter mm</td>
<td>1 No.</td>
</tr>
<tr>
<td>18</td>
<td>Metric Tape 30m, 15m each</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>19</td>
<td>Bench Vice 6”</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>20</td>
<td>Black smith Anvil 2</td>
<td>1 No.</td>
</tr>
<tr>
<td>21</td>
<td>Portable Electric Grinder</td>
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</table>
### Annexure A6.04

**T & P to be Procured by R.E. for Divisional Repair Shop (PSI)**

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<tr>
<td>1</td>
<td>Primary injection testing kit (0.500 A)</td>
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<td>2</td>
<td>Secondary injection testing kit (0.50 A)</td>
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<tr>
<td>3</td>
<td>MHO Relay testing kit</td>
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<tr>
<td>4</td>
<td>2500 Ltr.cap. mobile oil filtration plant</td>
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</tr>
<tr>
<td>5</td>
<td>250 Ltr.cap. mobile oil filtration plant</td>
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</tr>
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<td>6</td>
<td>Distilled water plant Cap.50 Ltr.</td>
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<tr>
<td>7</td>
<td>5 kV Megger</td>
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<tr>
<td>8</td>
<td>2.5 kV Megger</td>
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<td>9</td>
<td>500 V Megger</td>
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<tr>
<td>10</td>
<td>Hydraulic Jack 50 Ton. Cap.</td>
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</tr>
<tr>
<td>11</td>
<td>Auto Transformer 2 Amps. Capacity</td>
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<td>Spray painting machine</td>
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<td>Multi meter</td>
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<td>14</td>
<td>Portable kit tong tester 0-525A. 0-150-300-600V</td>
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<td>15</td>
<td>Oil testing kit</td>
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<tr>
<td>16</td>
<td>Acidity testing kit</td>
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<td>17</td>
<td>R-L-C Bridge to measure resistance, inductance and capacitance</td>
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<td>18</td>
<td>Variable Rheostat-1000 Ohms, 1 Amp</td>
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<tr>
<td>19</td>
<td>250 Volts Megger</td>
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<td>A/c Voltmeter 0-150 Volts</td>
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<tr>
<td>21</td>
<td>A/c Voltmeter 0-500 Volts</td>
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Furniture to be Supplied by R.E. for OHE and PSI

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<th>OHE</th>
<th>PSI</th>
<th>RC</th>
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<td>Chairs and hands</td>
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<td>3</td>
<td>3</td>
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<td>Chairs without hands</td>
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<td>6</td>
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<td>2</td>
<td>2</td>
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<td>4</td>
<td>3</td>
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<td>18 Pigeon holes lockers</td>
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## Annexure A6.06

### T & P Items to be Procured by Maintenance Organization for OHE/PSI

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<th>Tower Car.D</th>
<th>Breakdown Train</th>
<th>PSI</th>
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<td>Bond Press</td>
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</tr>
<tr>
<td>2</td>
<td>Dekinker</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Swivel Clip Openers</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Portable hand drill 12.5 mm</td>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Portable hand drill 8 mm</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Portable hand tap 8 mm</td>
<td>2</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>7</td>
<td>DE Spanners sizes (6/7 to 2 7/30mm) complete set</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>DE Spanner 30-32</td>
<td>10</td>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>DE Spanner 24-26</td>
<td>10</td>
<td>2</td>
<td>2</td>
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<td>DE Spanner 21-23</td>
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<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>DE Spanner 18-19</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
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<td>12</td>
<td>DE Spanner 16-17</td>
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<tr>
<td>13</td>
<td>DE Spanner 14-15</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>DE Spanner 12-13</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>15</td>
<td>Ring Spanners set (6/7 to 27/30 mm)</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>Ring Spanners 30-32</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>17</td>
<td>Ring Spanners 24-26</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td>18</td>
<td>Ring Spanners 20-22</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>2</td>
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<tr>
<td>19</td>
<td>Ring Spanners 18-19</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>Ring Spanners 16-17</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>21</td>
<td>Ring Spanners 14-15</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>22</td>
<td>Ring Spanners 12-13</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>23</td>
<td>Screw Driver 18”</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>Screw Driver 16”</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>Screw Driver 12”</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>26</td>
<td>Screw Driver 8”</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>27</td>
<td>Screw Driver 6”</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>28</td>
<td>Insulated cutting plier (8” ,12” )</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>29</td>
<td>Insulated Nose Plier (8” )</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>30</td>
<td>Adjustable Pillars Wrench 10”</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>31</td>
<td>Adjustable Spanner 12”</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>32</td>
<td>Adjustable Spanner 8”</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>33</td>
<td>Adjustable Spanner 6”</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>34</td>
<td>Set of Screw Driver</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>35</td>
<td>Pipe Wrench 12”</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>36</td>
<td>Pipe Wrench 8”</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>37</td>
<td>Hacksaw frame Adj. 12”</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>38</td>
<td>Plumb bob</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>39</td>
<td>Spirit level 12”</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>40</td>
<td>Spirit level 6”</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>41</td>
<td>Allen Key Sizes (2 to 10mm)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Unit Description</td>
<td>No.</td>
<td>Type/No. of Vehicles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>------------------</td>
<td>-----</td>
<td>----------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Detonators Boxes</td>
<td>1</td>
<td>1 1 1 -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Banners Flags</td>
<td>2</td>
<td>2 2 2 -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>Hand Signal Flags (Red &amp; Green)</td>
<td>6 2 2 -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Hand Signal lamps</td>
<td>2</td>
<td>2 2 -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Blow Lamp ½ Ltr. Cap.</td>
<td>2</td>
<td>- - 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>Wall Clocks</td>
<td>1</td>
<td>- - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>Grease Gun</td>
<td>2</td>
<td>- - 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>G.I. Pots</td>
<td>2</td>
<td>- - 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Oil Sampling bottles</td>
<td>-</td>
<td>- - 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>Hydrometers</td>
<td>-</td>
<td>- - 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>Thermometers</td>
<td>2</td>
<td>- - 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>Crow Bars</td>
<td>4</td>
<td>- 2 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>Pick Axe</td>
<td>4</td>
<td>- 2 1</td>
<td></td>
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</tr>
</tbody>
</table>

**Annexure A6.07**

**Transport Facilities for TRD Maintenance**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Type/No. of Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jeep with Trailer</td>
</tr>
<tr>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(a) Each station</td>
</tr>
<tr>
<td></td>
<td>Where an OHE Officer is based</td>
</tr>
<tr>
<td>2</td>
<td>(b) Each field officer at his Headquarters</td>
</tr>
<tr>
<td></td>
<td>i) OHE</td>
</tr>
<tr>
<td></td>
<td>ii) PSI</td>
</tr>
<tr>
<td>2</td>
<td>OHE Depot</td>
</tr>
<tr>
<td>3</td>
<td>Zonal Repair Shop</td>
</tr>
<tr>
<td>4</td>
<td>Divisional Headquarters/Divisional Repair Shop</td>
</tr>
</tbody>
</table>
TRAINING AND COMPETENCY CERTIFICATES

TRAINING

7.0 Introduction

Electric traction is a specialized field. Efficient operation and maintenance of the traction installations and equipment is only possible if the staff concerned have acquired an intimate knowledge of the details of construction, adjustments and operation of the equipment. A thorough knowledge of the special rules and procedures on the part of the staff is also essential to ensure safety of equipment and personnel. These requirements call for specialized training for all categories of staff before they can be entrusted with the responsibility for maintenance or operation.

7.1 Planning of Training in Advance

Before electric traction is commissioned on any section, adequate strength of well-trained operating, maintenance and running staff should be kept ready for manning the services. Planning the recruitment and training of such staff well in advance is one of the most important tasks of the open line administration. It is also necessary to establish sufficiently in advance suitable training schools with the facilities for imparting the training by qualified instructors.

7.2 Categories to be Trained

Categories of staff for whom special training is required to be organized are generally as under –

1. Degree and Diploma holders recruited directly by Supervisors.
2. Apprentice Mechanics to be absorbed as Supervisors.
3. Trade Apprentices to be absorbed as skilled artisans
4. Artisans and supervisory staff to undergo Refresher Courses.

7.3 Initial Training

1. Categories of staff mentioned below should receive a period of initial training in a training school before they are posted to working posts –
   a. Directly recruited supervisors
   c. Skilled and semi-skilled artisan staff for maintenance of OHE, PSI and RC equipment.
   d. Any other category as approved by CEE.

2. The period of initial training for typical categories is given below, this may be modified by CEE in accordance with local requirements:
   a. Directly recruited supervisors (Degree and Diploma Holders)
      i. OHE  12 months
      ii. PSI  12 months
      iii. Remote Control 12 months
      iv. TPCs/ATPCs 18 months
b. Skilled artisans for maintenance –
   i. Direct recruits 60 weeks
   ii. To be absorbed from Diesel/
       Steam or Electric general
       Services 30 weeks
3. In addition to theoretical training, the trainees should receive thorough practical
   training on the work they will have to perform on completion of training. In all
   cases they should have a period as under-study to senior and experienced staff in
   actual execution of the type of work they have to perform on completion of
   training.
4. For artisan staff the practical training should be so oriented as to enable them to
   understand and be able to carry out independently skilled work of the type
   covered by ‘Inspection books’, ‘Inspection charts’, ‘trouble-shooting charts’ and
   ‘technical charts’. Courses of training for each separate branch viz. OHE, PSI and
   RC should be carefully planned and implemented for each category of staff.

7.4 Promotional Courses
1. No employee should be promoted unless he passes the trade test or other
   prescribed departmental test.
2. Before an employee can be promoted, he should, as a rule, receive training to
   enable him to discharge his responsibilities in the higher post e.g. a semi skilled
   fitter on promotion as a skilled fitter. Such training should precede the
   departmental tests which determine suitability for promotion. The training should
   be generally on the same lines as initial training, but the period may be curtailed
   since the employee would already have a certain amount of background
   knowledge on account of his experience.

Particular attention should be paid to the older men, who although very proficient in the
practical aspects of their work, are unable to pass the prescribed trade tests etc. In regard to
theoretical aspects because of their poor educational background, it often happens in
consequence that they are blocked from being promoted although they are fit in every other
respect. By paying individual attention to such men and teaching them elementary theory,
they could be made sufficiently trained to enable their passing the trade tests. This not only
ends their frustration, but boosts staff morale as a whole.

7.5 Refresher Courses
1. In accordance with extent instructions current on the subject, refresher courses
   should be arranged. This is obligatory for those categories of staff dealing with
   “safety of train operation of having daily contact with the public”. The following
   is an illustrative list of traction distribution staff coming within the scope of these
   instructions:
   - Traction Power Controllers
   - Asstt. Traction Power Controllers
   - Supervisors of OHE
   - OHE Inspection Car Drivers
   - Linesmen authorized to take power blocks and permit to
     work.
2. Refresher courses are also desirable for other categories of maintenance staff. The
   categories of staff for whom refresher courses are to be arranged can be decided
by the General Manager in accordance with para 117(a) of the Indian Railway Establishment Manual.

3. The object of a refresher course is to reinforce and update the knowledge of the staff and bring them up-to-date in regard to the latest rules and procedures and instructions regarding operation and maintenance in the light of experience gained. The duration of the refresher course for each category may be decided by CEE
   a) Supervisors 3 weeks
   b) Artisan Staff 2 weeks

4. For categories of staff liable for inter-divisional transfers, programming of refresher courses should be arranged by the headquarters office. For staff confined to a particular division, the programming should be done at the divisional level.

5. Apart from rules and regulations, the refresher courses for the operating staff should lay emphasis on trouble-shooting procedures for various types of equipments. Actual drilling during the refresher course will be of great benefit. This involves repetition of the same exercise several times so as to make a lasting impression on the staff and should not to be forgotten easily.

6. For Linesmen and Supervisors of the OHE section the main emphasis during the refresher courses should be on standards to be observed in adjustments of OHE, safety rules applicable to OHE work and methods of quick restoration of OHE in the event of break-downs / accidents.

7. During refresher courses, it will be very useful to arrange group discussions amongst the trainees on specific problems encountered during the course of work. Such group discussions will be of great assistance in view of the opportunity for exchange of information based on actual experience in working.

7.6 Facilities for Training

1. Facilities have been provided on an All India basis for the Intensive specialized training of officers and staff of the Electrical Department. The facilities available should be utilised to best advantage.

2. Training schools for OHE staff have also been set up where the specialized techniques of work on 25 kV OHE are taught to skilled artisans as well as supervisors with particular reference to safety rules applicable to OHE work and methods of effecting emergency repairs. For example a cat-walk at a height of about 5 m from ground level is provided, so that a trainee can climb up a post, walk across the cat-walk and get rid of the fear of height, he can be taught the methods of protecting himself by means of ropes and safety belts, the correct method of testing and earthing, the technique of erecting a mast, the correct method of using the various specialized OHE tools and equipment, the method of splicing various OHE conductors etc.

3. In a training school, the essential equipment to be provided for instructional purposes should include the following:-
   a) Special tools and instruments used in electric traction.
   b) Cut-models to show constructional details of equipments
   c) Circuit diagrams, sectioning diagrams etc illuminated and arranged to show the sequence of operations.
   d) Samples of damaged equipment with tablets explaining the nature and causes of failures and preventive checks.
e) Publicity boards with slogans and illustrations emphasizing safe methods of working.
f) Boards illustrating ‘Do’s’ and ‘Don’ts’.
g) Preferably full working models.

7.7 Training in General and Subsidiary Rules

Supervisors, when required should receive initial training as well as refresher courses in General and Subsidiary Rules, normally in the Zonal Transportation Schools, which usually have model rooms to facilitate the proper understanding of the rules and systems of workings. In exceptional cases when such training cannot be arranged conveniently in the Zonal Schools, CEE may authorize the training in GRs & SRs to be included in the syllabus for training in TrD Training Schools. Separate instructors well-versed in the subject should, however, be deputed for imparting the training.

7.8 Responsibility of Officers and Supervisors

Apart from those in-charge of training schools, other officers and supervisors in-charge of operation and maintenance should also take a keen personal interest in the trainees of all grades attached to them. They should deem it as part of their duty to guide the trainees and watch their progress. Training is a continuous process which helps the officers as much as the trainees not only in developing contacts on a personal level, but also in understanding the finer points of operation and maintenance. A record of progress achieved, the period of training given etc should be maintained for every trainee.

7.9 Examination at the End of Training

All trainee should pass the prescribed examination on completion of training. The scope of examination and the level of officers and supervisor responsible for examining will be laid down by CEE. The examination should have a practical bias.

7.10 Specialized Training

1. Selected staff from different categories should be deputed to work with the Contractor’s staff during OHE, PSI and Remote Control construction work, so that they become fully proficient in the various operations including erection, final adjustment, testing and commissioning.
2. Similarly when large contracts are entered into for supply of electric traction equipment incorporating new designs and technology. It is usual practice to include in the contract a clause which permits some staff of the consignee railways to be deputed to the manufacturer’s works during the production stage for practical training on the equipment, so that they may get thoroughly acquainted with the operation and maintenance of the equipment, taking advantage of the training facilities available with the contracting firms.

7.11 Syllabi

Outline syllabi for OHE Linesman is given below as examples. Syllabi on the same lines are prepared for all courses of training.
7.11.1 OHE Linesman (Initial Training) – Duration – 60 weeks

A. Theoretical
(b) Power supply arrangements for ac traction.
(c) Understanding the lay out of OHE at feeding posts, running lines, turn-outs, crossovers, overlaps, neutral sections, yards etc.
(d) Standard values of clearances, setting distances, contact wire height, permissible gradient, stagger etc applicable to 25kV OHE.
(e) Detailed study of various fittings used on OHE viz. insulators, cantilever assembly, clamps, splices, section insulators, anchor fittings, isolating switches, jumpers – constructional details of such fittings and details of assembly and installations.
(f) Study of different types of masts and their foundations.
(g) Detailed study of various tools, tackles and other gadgets used in OHE section.
(h) Various types of bonds and earthing connections installed and maintained by OHE section.
(i) Safety rules for OHE work.
(j) Types of power blocks for OHE work. Detailed procedure for imposition of power blocks and exchange of messages. Precautions to be taken before commencement of work and study of relevant GRs and SRs.
(k) Detailed study of common OHE defects to be looked for during patrolling and inspection.
(l) Prescribed forms for submission of patrol and other reports.

B. Practical
(a) Climbing up different types of masts and walking across a cat-walk at a height of 56 m to get over the fear height.
(b) Practising the use of various tools, tackles and gadgets used in OHE work.
(c) Practising in the repair shop the correct way of assembly and installation of various OHE fittings.
(d) Study of the detailed procedure for imposition of power blocks and precautions to be followed for typical sections by mock drills including speaking over telephones and issue and receipt of messages.
(e) Drills in correct method of earthing the OHE.
(f) Field work with maintenance and construction staff so as to get acquainted with important items of work e.g., erection of mast and cantilever assembly, replacement of insulators, installing splice-fittings, anchoring of wires, replacement of equipment, recording height and stagger etc.
(g) Patrol given section of OHE to spot out and report on defects.

7.12 Authorized Person

An “authorized person” is one who is duly authorized to perform pertaining to his employment the authorization being made by the competent authority empowered for the purpose by the Railway Administration.
7.13 **Competency Certificate**

Each authorized person will be given a “Competency Certificate” defining the works which he is certified as competent to carry out after he has been trained, examined and found fit.

The following categories of traction distribution staff shall be issued with the certificates by the official indicated against each category after written / oral test as shown:-

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Designation of staff</th>
<th>Category of certificate</th>
<th>To be issued by</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Khalasi</td>
<td>TR-1</td>
<td>ATFO or CTFO after oral test.</td>
</tr>
<tr>
<td>2</td>
<td>Lineman</td>
<td>TR-2</td>
<td>AEE(TrD) after oral test.</td>
</tr>
<tr>
<td>3</td>
<td>Supervisor</td>
<td>TR-3</td>
<td>DEE(TrD) after written and oral test.</td>
</tr>
<tr>
<td>4</td>
<td>OHE Inspection Car Driver</td>
<td>TR-4</td>
<td>DEE(TrD) after written and oral test.</td>
</tr>
</tbody>
</table>

**B. PSI SECTION**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Designation of staff</th>
<th>Category of certificate</th>
<th>To be issued by</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Khalasi</td>
<td>TR-1</td>
<td>ATFO or CTFO after oral test.</td>
</tr>
<tr>
<td>6</td>
<td>Skilled staff</td>
<td>TR-2</td>
<td>AEE(TrD) after oral test.</td>
</tr>
<tr>
<td>7</td>
<td>Supervisor</td>
<td>TR-6</td>
<td>DEE(TrD) after written and oral test.</td>
</tr>
<tr>
<td>8</td>
<td>Artisans/Supervisors for Protective Relays and Instruments</td>
<td>TR-7</td>
<td>AEE/DEE(TrD) after written and oral and practical test.</td>
</tr>
<tr>
<td>9</td>
<td>Skilled Staff</td>
<td>TR-8</td>
<td>AEE(TrD).</td>
</tr>
<tr>
<td>10</td>
<td>Supervisor</td>
<td>TR-9</td>
<td>DEE(TrD) after written and oral test.</td>
</tr>
</tbody>
</table>

7.14 **Qualified Person to be in charge of Motor Trolley**

Officers and certain categories of supervisors of the traction branches will be required to use Motor Trolleys in electrified sections. Only those qualified in accordance with GR and SR and certified for the purpose shall be in charge of motor trolleys.

7.15 **Period of Training**

The period of training mentioned in the following paragraphs may be modified as considered necessary by CEE, taking local requirements into account.

7.16 **OHE Inspection Car Driver**

An OHE Inspection Car Driver should undergo courses of training and tests indicted below before the competency certificate is issued to him –

1. General and subsidiary Rules in the Zonal Training School or other approved establishment followed by a written, oral and practical test conducted by the school.
2. An oral and practical test by CTFO(OHE) to see if the employee is fully conversant with the mechanism and operation of the engine and running gear of the Inspection Car, as well as the details of maintenance he is required to carry out.
3. Training for a period of one month to learn the road in the section in which he is required to work the Inspection Car, at the end of such training the employee should sign a declaration that he is fully conversant with the road.
4. A period of practical training for 2 months in the actual driving of the Inspection Car under the supervision of a qualified Car Driver at the end of which a driving test will be taken by DEE(TrD).

5. Prescribed medical examination.

7.17 Knowledge of Rules

Competency Certificate No.TR-1 may be issued to unskilled staff after the safety rules pertaining to their work are explained to them personally by ATFO or CTFO who should satisfy himself that the person concerned has fully understood the instructions, in particular what he is not permitted to do. For other categories of staff, copies of he relevant chapters of the “Manual of AC Traction” and other rules pertaining to their work should be issued to the employee along with the certificate and necessary endorsement to this effect made in the office copy of the respective certificate. That they continue to be aware of the rules prescribed and that they do in practice comply with them shall be checked from time to time by the CTFO and AEE and an entry made of such checks in the Register of Certificates.

7.18 Register of Certificates

A register of Competency Certificates issued shall be maintained in the office of every supervisory official.

7.19 Service Record

An entry should be made in the service sheet of every employee who has been issued with a Competency Certificate.

7.20 Inspections

During Inspections Officers and Supervisors should make it a point to check the competency certificates in the possession of the staff and also test-check their knowledge of the rules pertaining to their work.
GENERAL GUIDELINES FOR ANTI-THEFT CHARGING OF OHE

8.0 General

8.0.1 In the theft prone area the energization of OHE at 2.2kV as an anti-theft measure may be done to avoid theft of contact / catenary wire. As energization at 2.2kV 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 2.2kV.

8.0.2 Period of anti-theft energization will be restricted at night hours only i.e., from 7PM to 7AM

8.1 Works to be completed prior to 2.2kV Energisation

8.1.1 The following works are essentially required to be completed prior to 2.2kV anti-theft energisation of OHE.

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.

3. All necessary LT modification works.
4. Necessary modification to all HT crossing to meet at least the requirements for 2.2 kV as per the standards laid down.
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.
6. Replacement of existing dc track relays by ac immunized relays.
7. Conversion of all tracks crossings of communication lines into cable and removal of overhead wires thereof.
8. Provision of height gauges and 25kV caution boards at all level crossings.
9. Provision of protective screens with 25000 V caution boards on over line structures like ROBs, FOBs, Fly Overs etc.
10. Provision of Public Warning boards for 25000 and shock treatment chart and First-Aid Boxes at all relevant places like stations, cabin buildings, repeater stations, cable huts etc.
11. Supply of insulated fools to maintenance staff.
12. Modification to carriage watering arrangements and water columns to suit anti-theft energization.
8.1.1 All the relevant rules and precautions in accordance with the Indian Electricity Rules should be compiled while carrying out the works.

8.2 22kV Power Supply arrangement

8.2.1 22 kV energization 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 arrangement. A schematic Diagram indicating the power supply arrangement and the controls and scheme of connection for supply of power at 22 kV shall be prepared and submitted to EIG for his approval.

8.2.2 The 22 kV supply arrangement will be manned round the clock by RE. The organization 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.

8.2.3 As stated in Para 1.2 above even though the OHE will be normally kept energized during night, the OHE in the energized 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 authorized representative of Re, shall approach within 2m from the OHE.

8.2.4 A joint procedure order indicating the detailed procedure to be followed for taking power block and issue of ‘permit to work’, for issuing notices to drivers, for attending to breakdowns shall be made out and issued to all concerned. This order will be signed jointly by the concerned officers of both RE and Division.

8.3 Procedure to be Adopted for Energization

8.3.1 Publication and display of Notices

1. Atleast a month in advance of energization 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.
   (i) General Notification to the users of Railway Lines regarding section/sections to be energized.
   (ii) Notification to the users of level crossings.

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 op of locos, caution notices at all steam and diesel loco sheds at which locos working in the energized section are maintained.

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 energized.
8.3.2 On completion of the work as mentioned in Para above the following certificates from the concerned officers will be obtained.

(i) Certificate regarding removal of L.T and H.T infringements by Dy.CEE(G) of the project.
(ii) Certificate regarding S&T works
(iii) Department of Telecommunications (DOT) clearance certificate for 2.2 kV anti-theft energisation.
(iv) Certificate by Dy.CEE(OHE) or DEE(OHE) regarding completion of OHE works.
(v) Certificate by OHE Contractors.
(vi) Certificate by Dy. CE?DEN/RE regarding provision of level crossing gauges and provision of protective screens on ROBs and FOBs.

8.3.3 Besides the certificates regarding completion of works to suit 2.2 kV energisation as mentioned in Para above, the following safety certificates shall also be obtained:

(i) Joint certificate by CEE(P), CSTE(P) AND CE(P) regarding safety to traffic.
(ii) Certificate of concerned officers of Division of particular Railway about knowledge of their staff regarding safety.

8.4 EIG Sanction
An application to EIG seeking his approval to the proposal of energisation of OHE at 2.2kV as anti theft measure may be made in advance. While applying for sanction, the up to date 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 EIGs formal sanction may also be indicated. EIGs sanction shall be obtained prior to energisation.

8.5 Checks and Tests Prior to Commissioning:

8.5.1 CEE 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 energized. For such joint check by 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 tests shall normally be carried out.

8.6 Checks

1. That clearance between live and earthed structures is in accordance with the provisions of Schedule of Dimensions.
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.
3. That height of contact wire at level crossings is proper and that height gauges have been provided.
4. That protective screens have been provided in FOBs, ROBs and signalling structures.
5. That the earthing and isolation of overhead equipment adjacent to the section to be energized has been carried out properly.
6. ac immunized track relays have been provided.
7. Overhead P&T as well as Rly crossings have been cabled and wire removed.
8.7 Tests

1. Megger tests for continuity and insulation of the OHE.
2. With the above checks and tests 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 energized at 2.2kV for test purpose, the following fault tests shall be conducted on the section energized at 2.2kV.
   a) By creating earth fault at the farthest end of energized OHE through discharge rod.
   b) By creating earth fault at the farthest end of energized OHE touching only ballast.
   c) By creating earth fault at the farthest end of energized OHE touching only rail.
   In all these cases of earth fault, it should be ensured that fuse provided at the supply point is blown.

8.8 Immediately on the successful completion of the checks and tests of the OHE, OHE can be energized provided that:
   a) All the certificates as mentioned in paras 8.3.2/3 above are obtained.
   b) DOT’s clearance and EIG’s sanction are obtained.

8.9 Immediately after energisation, a notification to that effect may be issued as normally done for 25 kV energisation.
**PANTOGRAPH ENTANGLEMENT**

9.0 INTRODUCTION

Electric locomotive gets power from overhead contact wire through pantograph. For smooth operation of locomotive, the movement of pantograph should be even and unobstructed on the contact wire, when any part of pantograph comes in between overhead wires or vice versa, pantograph entanglement takes place.

Pantograph entanglement causes damage to pantograph and overhead equipment resulting in dislocation of Electric Traction traffic.

Pantograph entanglement occurs due to following reasons.

1. OHE defects.
2. Pantograph defects.
3. External detects

9.1 OHE DEFECTS

Damaged OHE components such as insulators, cantilever tubes, jumpers, droppers etc may foul with the movement of the pantograph and result in entanglement. To avoid them:

- Check insulators, droppers and other OHE component periodically for any cracks.
- Ensure provision of C jumpers to avoid dropper failure.
- Ensure provision of double PG clamps on G jumpers and feeder wire locations.

9.1.1 Turnout And Crossovers

It has been observed that about 43% of the total OHE failures are due to improper adjustment at turnout and crossover.

Improper adjustment of stagger and height at turnout or crossover results in pantograph getting entangled with overhead wire while moving on the main line. To avoid this, it should be ensured that he height of turnout/crossover contact wire is kept 5 cm above the main line contact wire at obligatory locations.

Ensure that pantograph is not touching the turnout and crossover contact wire while going on main line.

The height and stagger should be strictly as per RDSO Drgs.

9.1.2 Procedure For Adjustment Of Turn Out And Cross Over.

Before adjustment of Turn-out and Cross-over at any location, ATDs of both main and Loop lines shall be checked for its free movement.

1. Measure the implantation of obligatory Mast from L/L & M/L tracks, track separation and adjust the turn-out as per SED at obligatory point.
2. ‘C’ Jumpers should be provided at 5.6 and 3.0 m distance from obligatory mast for cross-over and turn-out points respectively towards parallel run side.

3. Height of turn out contact wire should be 5 cm more than that of M/L contact wire at Cantilever location of obligatory mast.

4. Adjust A&B droppers as per schedules & their distances from obligatory mast for M/L & turn out OHE both.

5. Hoggging on M/L contact wire be removed by increasing the length of ‘B’ and adjoining droppers upto a distance of 10 m from obligatory mast towards turn out side on M/L OHE contact wire.

6. Adjust the height of Contact wire on L/L one mast before obligatory taking into account the track level diff. of M/L & L/L.

7. At a distance of 10 mts. Towards turn out side, adjust the loop line contact wire height +3cms. (loop line B and adjoining droppers may be adjusted for this purpose) as compared to main line contact wire height.

8. At obligatory mast, contact wire height diff. of M/L & L/L OHE should not be less than 5 cms.

9. Now, while running the tower wagon on M/L, panto should not touch the L/L cross over contact wire.

10. Take the tower wagon to turn out track and M/L contact wire should take in / take off panto pan at about 65 +/- 2 cms. From centre of panto of Tower Wagon.

11. On cross type turn out, height diff. should be +1.5 cms at obligatory, 5 mtrs and 10 mts from mast & panto should not touch turn out contact wire while tower running on M/L for this A&B dropper can be adjusted if required.

9.2 AUTO TENSIONING DEVICE

ATD keeps OHE in correct tension. If ATD drum is not moving freely, the OHE tension will not remain correct. This will cause sag in OHE at higher temperature, any sag in OHE is prone to panto entanglement when pantograph is moving at high speed. Ensuring free movement of ATD and providing 100 mm sleeve on anti falling device rods in short tension length prevents sagging of OHE.

Contact wire consists of joints within the running length. These joints are made during manufacturing. Their failure results in snapping of contact wire. If a locomotive is moving in the same zone where such a snapping takes place panto entanglement will result. Therefore it is necessary to check frequently all the joints, specially those in the polluted area where they are prone to more failures. Provide slice at such joints which may work out to avoid snapping.

We have seen that OHE defects that can cause panto entanglement are

1. Improper adjustment of crossover and turn-out and
2. Malfunctioning of ATD.
3. Damage of OHE components.

Apart from this if locomotive goes in unwired section by mistake it may damage both the panto and 9 tonne insulators. To avoid this, it should be ensure that Loco stop boards are placed at correct locations.
9.3 PANTOGRAPH DEFECTS

The defects of pantograph which cause panto entanglement are:-
1. Spring box failures.
2. Improper static force on OHE.
3. Missing pins and fasteners.
4. Cracks in mechanical parts and
5. Improper leveling of pan.

9.3.1 Spring box failures attributes large share of pantograph defects. To check for any cracks, LPT should be carried out in cylinder, welding portion of the steady link, cylinder support and submounting assembly. Proper lubrication of plunger ensures dampening of vibrations of panto pan and prevents cracks in plunger socket. Plungers should move freely inside the spring box. Ensure that the panto pan strips are replaced when worn upto 2 mm. Sharp edges must be filed.

9.3.2 The static force which pantograph exerts on the contact wire prevents undue oscillations to OHE-pantograph system while the locomotive is in motion. This static force is normally kept at 7 kg. If this force is less, a large oscillation will cause the pantograph to leave its contact with OHE resulting in sparking and local heating which may damage the contact wire.

9.3.3 To ensure static adjustment and counter balancing of pantograph, a weight of 7 kg is put on the panto pan and tension of upspring is adjusted so that the pan remains balanced at a height of 2.25 m. The static adjustment of pantograph is required to be done in the maintenance shed during every IA schedule.

9.3.4 Leveling of panto pan and provision of split sin must be ensured during every inspection and also whenever the pan is changed. The split pins at critical locations of articulation arrangement and full complement of copper shunt helps in reducing pantograph defects. The split pins should be opened out upto 60 degrees, so that they do not work out during running.

9.3.5 The effect of broken and missing components of pantograph such as cracks in plunger, balancing rod and articulation rod lead to damage of panto pan, ultimately resulting in panto entanglement during run. Such broken components can dislodge the panto pan to cause entanglement. Liquid dye penetrant test of these critical components, (preferably during IC maintenance schedule) should be done to detect any such defects. This will reduce failures.

9.3.6 Improper leveling of Pantograph pan lead to tilting of Pantograph pan. Maintaining the level of panto pan should be ensured in the maintenance shed during every inspection and whenever pan is changed.
9.4 CHECKS AFTER PANTO ENTANGLEMENT

Even after ensuring all these precautionary items, panto entanglement may occur. In such causes, it is necessary to quickly check the following items pertaining to the OHE and pantograph. This should be done without causing any delay in the restoration work.

9.4.1 Measurements
Measurement of height and stagger of contact wire of main line and turnout crossover and vertical height of steady arm clamp from register arm.
The measurement so recorded should tally with the measurement in structure erection drawing for those locations. (Show actual on OHE). It should also be checked whether steady arm holding contact wire is freely moving vertically or not.

9.4.2 Locations of Hit Marks
Search for hit marks in steady arm and the registration arm tube, PG clamps, droppers, contact wire, dropper clip, splice and jumpers. Any hit mark observed in these locations should be noted.

9.4.3 Condition of Cracked OHE Fittings
The condition of cracked OHE fittings such as clamps, suspension brackets and clips should be checked to record whether the cracks are fresh or old.

9.4.4 Pantograph Wearing Strips
Pantograph wearing strip should be properly fastened with panto pan. There should be no bent strip or deep grooves. Strip joints must be smooth. The grease plate should be properly fastened.

9.4.5 Mechanical Movement of Panto Pan
The panto pan should horizontal and free to move vertically. The bow plunger should be sliding free when pressed.

9.4.6 Availability of Split Pins
Check availability of split pins at all the locations of pantograph.

9.4.7 Broken Components of Pantograph
The broken parts of the pantograph should be inspected to check whether cracks are fresh or old.

9.5 MEASUREMENT OF PANTOGRAPH

If panto pan is found intact these measurement are possible A=520, B=1800, C=300 and D=380.

9.6 CONCLUSION
Following points must be ensured.

9.6.1 OHE height
That the height of crossover contact wire is kept 5 cm above the main line contact wire. This should be checked every six months.
9.6.2 Free Movement of ATD
At turnout and crossover locations, free movement of ATD should be ensured. 100 mm sleeve should be provided on the anti falling device rod to prevent sag.

9.6.3 Identifying Damaged OHE Components
Check insulator and droppers for breakage. Prevent damage of such OHE component which can come in the path of pantograph movement. Secure G jumpers with double PG clamps and provide C jumper to avoid dropper failures.

9.6.4 Contact Wire Joints
Identify the joints which are giving way by inspection and splice them.

9.6.5 Pantograph Wearing Strips
Proper fastening of pantograph wearing strip, its thickness and fastening of grease plates required to be ensured.

9.6.6 RDPT of Pantograph Components
Red dye penetrant test of critical pantograph components must be performed to detect cracks before they actually fail and cause panto entanglement.

9.6.7 Static Adjustment and Leveling of Panto Pan
To ensure a constant force of 78 kg on OHE leveling of pantograph pan is to be done during each IC schedule.
Even after taking the above precautions, if panto entanglement does take place, then it should be investigated thoroughly to identify the causes. The necessary measurements and checks required to be carried out at the site after entanglement are discussed.

9.7 PANTO ENTANGLEMENTS : ITEMS TO BE CHECKED ON PANTOGRAPH:

1. Check that the pantograph wearing strips are properly fastened with the panto pan and there are no loose fasteners or bent strip or deep grooves on the strips. Pantograph strip joints must be smooth so as not to hinder smooth gliding of the contact wire on the pan.

2. Check that the grease plate is properly fastened.

3. Check the bow plunger for free sliding where pressing. Check that the split pins are intact.

4. Check the horizontality of the pantograph pan and that the vertical movement in force. Check the transverse flexibility of the pan by pulling transversely at the middle cross member with a force of 50 kgf. The displacement of the pan at the middle cross member should be 36+ 5mm. Check that the positioning link is not bent/cracked or dislocated from the fixing pivots. Check that the split pins are intact.

5. Check the pantograph frame for signs of bending or cracks. Check the springs for any cracks.
6. If possible, take the measurement of the pan as per the fig. 9.01

7. Check the broken or cracked fittings of the pantograph and see whether the cracks are old or fresh.

9.8 PROFORMA FOR RECORDING MEASUREMENT / OBSERVATION IN RESPECT OF OHE IN CASE OF PANTO ENTANGLEMENT

1. Location
2. Height of contact wire of main line above RL.
3. Height of contact wire of turn-out / cross-over above RL.
4. Stagger of contact wire of main line.
5. Stagger of contact wire of turn-out/cross-over
6. Length of steady arm holding main line contact wire.
7. Length of steady arm holding turn-out / cross-over contact wire.
8. Position of registration tube and register arm dropper clip.
9. Tracks separation at obligatory point.
10. Position at which horn or pantograph jumped above contact wire.
11. Vertical height of steady arm clamp from register arm.
12. Hitting marks on the steady / registration arm tube, P.G. Clamps droppers, contact wire, dropper clip, splice, jumpers if any.
13. Condition of cracked or broken OHE fittings such as clamps splice and clips etc. Check whether the cracks are fresh or old.
14. Check free vertical movement of steady arm.

Above observations will be made on every mast within at least 500 m in the rear of the location of entanglement.
**SAFETY RULE FOR OHE**

### 10.0 General

1. The following rules are supplementary to the General and Subsidiary Rules and the instructions contained in Volume I.
2. Printed boards containing instructions regarding treatment of persons suffering from electric shock should be exhibited in every OHE maintenance depot, equipment room, switching station, cabin, OHE Inspection Car shed, loco shed, OHE Inspection Car and wiring train and also in offices of SM, ASM, CYM, AYM and HTXR.
3. First Aid Boxes should be kept at every switching station, maintenance depot, in OHE Inspection Car, breakdown vehicle and wiring train.
4. Ropes, come-along clamps, Trifor etc should be tested once in six months at least, in the presence of an ATFO and record of such tests maintained in each depot.

### 10.1 Documents to be kept with OHE Supervisors for Work on OHE.

1. The ATFO(OHE) or other official supervising OHE work shall have with him a complete set of structure erection drawings, lay out plans, sectioning diagram and general supply diagram etc pertaining to the overhead equipment under his charge. He shall also have with him Station Working Rules for the stations between which he is working. He shall, in addition, keep with him all useful information regarding the running of trains over his section.

2. It shall be the responsibility of the TFO/ATFO(OHE) or in his absence the senior-most official in-charge of the work to ensure that all safety rules prescribed are actually observed by the staff when carrying out work on traction installations. It shall be the duty of the supervisor to remind the staff periodically of the various safety rules to be observed at work site.

### 10.2 Permit to Work

Before commencing work on any part of the dead OHE or within 2 m of live OHE, a permit to work shall be obtained from TPC or other authorized person.

### 10.3 Protection of Staff against Traffic Movements and Protection of Trains

1. The supervisory official in-charge of work on OHE shall observe relevant provisions of GR and SR for protection of trains before work on OHE is commenced and for the whole time the work is in progress.
2. Measures laid down for power block shall be observed by all concerned to prevent accidental energisation of the section under power block on account of electric train movements.

### 10.4 Earthing before Commencement of Work

1. All metallic parts within reach (either directly or through tools etc) shall be earthed, after they are made dead.
2. Each working party shall be protected by at least two independent earths, one on each side of a working party.
3. If the distance between the working parties exceeds 100 m intermediate earths shall be provided in such manner as to ensure that the distance between earths does not exceed 100m.

4. Even when earthing is provided by isolator switches with earthing heels, additional temporary earths as about shall also be provided.

10.5 Procedure for Providing Temporary Earths

The following sequence of operations shall be carried out while providing temporary earths on OHE:-

1. Men shall be posted on both sides of the site of work to warn the working party of any approaching train on the same track and adjacent track(s).

2. The permit-to-work shall be obtained prior to commencing work to make sure that power supply has been switched off.

3. For providing temporary earth on the OHE or other equipment after it has been made dead, only discharge / earthing pole assembly specially designed for this purpose alone should be used. The cable shall be flexible and should have adequate cross-section (40 mm2) to be able to withstand short circuit currents.

4. Fix the earthing clamp securely to a mast at least one span away on one side of the work site after making sure that the mast to earth rail bond of this masts is intact. Alternatively, the clamp may be fixed to the bottom flange of one of the traction rails, taking the cable under the rails.
   In single-rail-track-circuited sections, the earthing clamp should be fixed to the traction rail i.e., non-track-circuit rail; on double-rail-track-circuited sections the earthing clamp should be fixed to the mast.
   The mast-end or rail-end clamp of the discharge / earthing pole assembly should be checked for tightness just before connecting the top clamp on to the OHE as the earthing clamp fixed to the rail or mast in advance could have worked loose.

5. Hook securely with a snap action the top clamp of discharge / earthing pole assembly to the OHE conductor close to the mast / structure and tie the earthing pole to the mast / structure. Never hook on the top hook of the earthing cable to the OHE, till the other end has been first connected to earth.

6. The earthing clamps should always be fixed to the traction rail or mast/ structure first and then the top clamp should be hooked to the OHE to be earthed.

7. Repeat operations 4 and 5 for the second temporary earth on the other side of the working party.

8. After temporary earths have been fixed on the OHE on both sides of the work site, staff may proceed with the maintenance work.

9. After work is completed and men, materials and tools have been removed and the OHE is clear, the above earthing rods may be removed in the reverse order i.e., first remove the hook on the OHE and then the clamp fixed to the rail or mast / structure. After warning all staff that supply will be restored and that they should keep away from the equipment, te permit-to-work may be returned and supply restored.
10.6 Precautions in Regard to Discharge / Earthing Pole Assembly

1. The continuity of the cable connection between the top clamp and the earthing clamp should be checked once a fortnight.

Cable should be renewed if more than 20% strands are broken. During use, cable should be continually examined for fraying and breakage of strands.

Discharge / Earthing pole assembly should be inspected by TFO/ATFO once a month.

2. During accidents when slewing the OHE and in similar circumstances, the discharge / earthing pole assembly should be provided at a location where it is not likely to be interfered with during crane working or due to work on the permanent way.

10.7 Work on OHE or any Conductor having a Sectioning Point

When work is to be carried out on OHE or conductors which are not electrically bonded, following additional precautions are required:

i) The two sections of conductors or ends of conductor which may have snapped may be at different potentials. Each end should, therefore, be separately earthed at two points after switching off supply to both parts of the OHE or conductor.

ii) This precaution should also be observed when working on or in the vicinity of a sectioning point and cut-in insulators.

3. Neutral Sections should be treated as live equipment and earthed separately at two points on either side of the work party before commencing work.

4. When work is to be carried out on an isolator, both sides of the isolator should be earthed at two points or more conveniently, isolator jumpered temporarily.

10.8 Protective Helmets

At the work-site, staff are advised to wear helmets to protect their heads against any tools or equipment which may drop down accidentally, as well as to minimize head injury in case of accidental fall from a height.

10.9 Safety Belt

Staff working on structures or a ladder are advised to protect themselves against an inadvertent fall by wearing a safety belt for supporting themselves by a rope sling.

10.10 Rules for use of Ladders

1. It shall be the responsibility of the supervisor to ensure that ladders are stored in a protected enclosure properly maintained and reconditioned as often as required. A ladder should never be in such a position so as to likely to fall on a live part.

2. Ropes used with ladders should be of cotton or jute. Use of metallic ropes is prohibited. A ladder should be held by one person on the ground to prevent slipping, while the top end should be tied to the supporting structure or conductor to keep it in position and prevent in sliding away.

3. Ladders should never be allowed to fall on or rest against the contact wire.

4. If the nature of the work involves risk of the conductor breaking into two parts (due to opening out of sleeves or splices) the ladder shall not be rested against the conductor. Trolley ladders shall be used in such cases.
5. More than one person shall not normally be allowed on a ladder as far as possible.
6. Climbing on a ladder with wet or slippery foot-wear is forbidden.
7. Ladders should not be used for transporting materials.
8. A rope should be used to pass tools or any equipment to the men working on a ladder.
9. No one should stand directly below a work spot under a ladder.

10.11 Other Important Precautions to be taken while Carrying out Works on OHE

1. The useful cross section of a conductor shall not be reduced while making joints.
2. Any contact with conductors which are not specifically earthed is forbidden.
3. The strength of the anchoring rope should not be less than that of the cable to be anchored.
4. Temporary anchoring of conductors should only be done by using stranded flexible steel cable at least of the same tensile, strength as the cable to be anchored. Use of two cables of different strengths joined together is prohibited. Use of cotton, jute or other non-metallic ropes for anchoring is forbidden.
5. Structure bonds and cable connections of the structure to earth shall be maintained in proper condition. No heavy materials should be stacked on the rail bonds; transverse bonds between two rails of the same track as well as rails of different tracks shall also be maintained in proper condition.
6. Where rails to which structures are connected are replaced, the structure shall be connected to the new rail immediately after it has been laid.

10.12 Procedure for Effecting Shut-Down for Work on Auxiliary Transformers

Power supply to auxiliary transformers is effected through fuse-switches on the 25 kV side and the LT side is controlled through fuses or double pole iron clad switch fuses. Isolating fuse switches should be opened out and fuses removed both on the HT and LT sides and the transformer earthed before starting work.

10.13 Work on Overhead lines Running Parallel to Electrified Tracks

No work on any span of any overhead line (LT power line or other line) running parallel to an electrified track where the minimum distance between the nearest conductor of the overhead line and the centre-line of the nearest electrified track is less than 8m, should be done without switching off power from the 25kV traction line(in addition to making dead and earthing the overhead line on which work is to be carried out, in the normal manner ) excepting for the following specific items for work:

1. Replacement of lamps, if below line.
2. Painting of structures/poles upto a distance of 2 m from the live wires of the power line.
3. Reinforcement of foundations where such reinforcement does not involve any prior weakening of the foundation at any time during the work.
4. Replacement of aerials fuses.
10.14 Isolation of Booster Transformers
To isolate a booster transformer for maintenance or other work, the following sequence of operations should be carried out:-

1. Where no isolator is provided a permit-to-work should be obtained for both the elementary sections, the BT should be disconnected from the OHE and the OHE made through by jumpering.
2. When an isolator is provided to disconnect the BT primary winding from 25kV lines, power must be switched off from both the elementary sections to which the BT is connected after which the isolator should be opened to disconnect the BT from the OHE and to make the OHE through.
3. The secondary winding of the BT should be disconnected from the return conductor and the return conductor made through by jumpering.
4. The return conductor should be earthed at the location where the BT has been disconnected; and the mid-point rail links on both sides of the BT should be opened so that booster cells on either side will extend over longer section temporarily.
5. With the OHE and return conductors made through, 25kV power supply may be restored.

It should be noted that during the period when a BT has been disconnected from service, the interference or adjacent communication circuits will be enhanced. In view of this the defective BT should be replaced with a good BT with the least possible delay.

10.15 Isolators
Isolating Switches on the 25kv system shall not be opened or closed when current is passing through them. Normally, isolators should only be opened or closed, after power supply to the section has been switched off by opening the appropriate interruptor.

10.16 Petroleum Sidings
The following arrangements/precautions would be necessary:-
Arrangements
i) An equi potential link between the petroleum sidings installation earth and the track via a switch.
ii) Setting up of neutral zones (insulating joints) in the track to avoid any risk of propagating stray current.
iii) Setting up of neutral zones / sections in the contact wire similar to loco inspection pits.
iv) The tracks must be provided with longitudinal bonds on both the rails as well as transverse bond (30m intervals). All masts and metallic structures in the vicinity of the track / sidings should be provided with structure bonds. Copper rivets should be used for bonding.
v) 10 ohm earths must be connected to the petroleum siding on each side at the insulated joint.
Precautions
i) No oil tanker is permitted to stable under live OHE for inspection purpose.
ii) Fueling to be done by side filling arrangement only.
iii) Pipe lines in the vicinity of the track should be properly earthed.
iv) Minimum 2 m electrical clearance from live OHE of the adjacent track or only other structure nearby must be maintained.
v) During filling/loading and unloading of petroleum products, the isolators at the neutral section of OHE should be kept open to ensure that the OHE is dead and earthed.

10.17 FORMS AND REGISTERS

10.17.1 Records to be maintained

The recommended proforma for Power Block and Permit-to Work messages have been given. Particulars of other essential records to be maintained in regard to OHE maintenance are given below:

1. Daily Report of OHE Maintenance to be submitted by the Supervisor in-charge of field work to ATFO.
   The form in which reports are to be submitted by the ATFO/CTFO to AEE (TrD) and Sr. DEE / DEE (TrD) may be laid down locally by each Division.
2. Register for Foot-Patrol Reports. The reports regarding foot-patrolling should be entered by the Linesman in a Register to be maintained for the purpose by each Section Supervisor.
3. Cantilever Assembly Maintenance Register
4. Register of Contact Wire Thickness Measurements
5. Register of Clearance under over line structures
6. Register of Earth Resistance Measurements
7. Register of Current Collection Tests shall be maintained.
8. Register of Regulating Equipment shall be maintained by each depot / sub-depot for its jurisdiction. This Register should have a page allotted for each Regulating Equipment. Particulars of adjustments carried out, amount of catenary and contact wire cut etc. shall be recorded in this Register, indicating the dates on which these items of work have been done.
9. Register for isolator Switches shall be maintained by each depot / sub-depot indicating dates on which the isolators have been inspected and the details of work carried out
10. Register for Turn outs and Cross overs shall be maintained by each depot / sub-depot. This should indicate the dates on which each turn out / cross over has been checked for adjustment and particulars of work done.
11. Register of Vulnerable Foundations: This should contain details of checks carried out on foundations at vulnerable locations, such as on over bridges, embankments susceptible to erosion etc.
12. Register of Feeder Lines shall be maintained by concerned depots/sub-depots to indicate particulars of patrolling of 25kV feeder lines and maintenance carried out on such feeder lines.
13. Register of Critical Implantations: The annual check of implantation at critical locations shall be recorded in this Register.
14. Register of Level Crossing: This should contain dates on which height of contact wire at Level Crossings as well as that of the height gauges at Level Crossing have been checked.
15. Register of Splices.
16. Register of OHE Break-downs: Each depot/sub-depot should maintain particulars of OHE break-down occurring in its jurisdiction. For each break-down a page should be
allotted. References to detailed reports submitted should also be given to facilitate investigations subsequently.

Register may also be maintained for any other additional items in the proforma prescribed by CEE.

The register should be of A-4 size. As they are required for permanent record they should be cloth-bound. The nomenclature of the register should be shown on the cover in 6 mm block letters.

The Supervisor of the depot/sub-depot will be held responsible for ensuring that these register are maintained up-to-date. Officers and Senior Supervisors during their inspections should scrutinize these registers and initial a few important entries.

10.18 Standard Forms for Power Block Messages

Typical forms for power block messages are attached at the end of this Chapter.

Form ETR.1. This has 3 parts and is used for exchange of message between TPC and Section controller when a power block is to be imposed or withdrawn. When TPC and the Section controller are located in adjacent rooms, the messages will be made out in duplicate and sent to the other party obtaining the acknowledgement of the receiving party on a carbon copy. When they are located far apart, the messages will be exchanged on phone, the receiver recording the message on an identical form and repeating it for confirmation.

Form ETR.2. This has 3 parts and is used for exchange of message between TPC and the authorized persons taking shut downs. These messages will usually be conveyed on telephone, the receiver recording the message on an identical form and repeating it for confirmation.

Form ETR 3. This has 4 parts and is used when an ‘authorized person’ who has taken a power block has to issue a permit-to-work. Messages in this form will invariably be made out in duplicate and sent to the other party obtaining acknowledgement on the carbon copy.

Form ETR 4. This has 3 parts and is used when local blocks are to be arranged. Messages in this form also should invariably be written out and sent to the other party obtaining acknowledgement on the carbon copy.

All messages exchange over telephone should be supported with exchange of Private Numbers.
Form ETR-1
Part A

POWER BLOCK MESSAGE FOR BLOCKING OF LINES FOR ELECTRIC TRACTION PURPOSES

Serial No.  Date.............
           Time Hr........Mts........

From,  To,
Traction Power Controller  Section Controller

at........  .............Section
           .............Place

Block the following line/s to electric trains/all traffic from Hr.........Mts.........on............... And advise me when this has been done.

State below which line/s and between which limits (Sector, Sub-sector, Elementary Section etc.) the block is required.

..............................................................................................................................
..............................................................................................................................
The power block is likely to last for ...........Hr.......Mts.......... 

Private No.........................

Sent by..............................
   (Name)

Received by .........................
   (Name)

Score out whichever is not applicable.
Form ETR-1
Part B

POWER BLOCK MESSAGE FOR BLOCKING OF LINES FOR ELECTRIC TRACTION PURPOSES

Serial No. Date…………..

Time Hr…….Mts…….

From, To,
Section Controller Power Controller

at………. at………………

…………….(Place)

Your No……………………of……………………

The following line/s have been blocked to electric trains/all traffic-
Line/s Duration

……………….From Hr…………………Mts…………

……………….to Hr…………………Mts…………

Block on the following line/s cannot be granted for the reasons stated below-

Particulars of line/s Reasons

…………………………………………………………………………………….

…………………………………………………………………………………….

Private No…………………………

Sent by…………………………….

(Name)

Received by ……………………….

(Name)

Score out whichever is not applicable.
Form ETR-2
Part A

SHUT DOWN NOTICE ON TRACTION OVERHEAD OR OTHER ELECTRICAL EQUIPMENT

Serial No. Date.........
Time Hr.......Mts.......

From, To,
Traction Power Controller

at....... at .................

I hereby declare that the following electrical equipment/s has/have been isolated. The equipment shall be earthed according to standing instructions before commencing any work or prior to issue of Permit-to-work:-

State below exactly which section/s (Sector, Sub-sector, Elementary Section, etc.) of the electrical equipment has/have been isolated-

Lines isolated Limits of isolated

........................................... ...........................................

........................................... ...........................................

........................................... ...........................................

Line/s to be cleared by Time

.........................Date .........................Hr.................Mts...........

.........................Date .........................Hr.................Mts...........

.........................Date .........................Hr.................Mts...........

Private No..........................

Sent by..........................
(Name)

Received by ..........................
(Name)
Form ETR-2
Part B

Railway

Shut Down Notice on Traction Overhead or Other Electrical Equipment

Serial No. Date……………

Time Hr………Mts………

From, To,

To, Traction Power Controller

at……… at ………………..

Your No…………………of…………………

Local earths have been applied as the following points:-

…………………………………………….line earthed at structure Nos……………..

…………………………………………….line earthed at structure Nos……………..

…………………………………………….line earthed at structure Nos……………..

…………………………………………….line earthed at structure Nos……………..

The following ‘Permits-to-work’ have been issued on this authority and I am responsible for the Permits-to-work:-

(1)…………….. (2)…………….. (3)……………..

Permit to work Nos.

Date of Issue

Time of Issue

Dept.Issue to

Person-in-charge of work

Private No…………………

Sent by………………………(Name)

Received by …………………………(Name)
Form ETR-2
Part C
…………..RAILWAY
SHUT DOWN NOTICE ON TRACTION OVERHEAD OR OTHER ELECTRICAL EQUIPMENT

Serial No.          Date…………..
Time Hr…….Mts…….

From,
……………………..
To,
Traction Power Controller

at………          at ……………..

My No…………………………………of………………………………..

I hereby declare that the work on or near electrical equipment/s which has/have been isolated been comp. All men and materials have been withdrawn and the men have been warmed that it is no longer safe to or adjacent to electrical equipments. All Permits-to-work issued by me and have been withdrawn and cancelled. All earths have been removed, and the electrical equipment/s can be made alive.

Private No…………………..

Sent by……………………
(Name)

Received by …………………
(Name)
Form ETR-3
Part A
…………..RAILWAY
PERMIT-TO-WORK ON OR NEAR AC TRACTION ELECTRICAL EQUIPMENT

Serial No. Date

From, To,
……………………….. …………………
at……… at ………………..

I hereby declare that it safe to work on or near electrical equipment/s which is dead, isolated from live conductors and is connected to earth.

State below exactly the electrical equipment on or near to which it is safe to work. (Sector, Sub-sector, Elementary Section, etc.)
…………………………………….
…………………………………….

ALL OTHER PARTS ARE DANGEROUS.

The equipment shall not be alive until this Permit-to-work is returned duly signed by the person in-charge of the work.
The No. of the Permit-to-work, date and time issued has been intimated by me to Traction Power Controller………………………………..at…………..Hr…………..Mts…………… on…………(date).

Signature…………..
(of the authorized person)

Name…………..
Designation………
Date……..Hr……..Mts……..
Form ETR-3
Part B

RAILWAY

PERMIT-TO-WORK ON OR NEAR AC TRACTION ELECTRICAL EQUIPMENT

Serial No. Date

From, To,
……………………….. ………………
at……… at ........................

Received the original foll of this Permit-to-work, I fully understand the portion of the electrical equipment which is dead, isolated and that all other parts are dangerous.

The Permit-to-work will be returned by……….Hr………..Mts…………as required.

Signature…………..
(of the authorized person)

Name…………….
Designation……….
Date……..Hr……..Mts…….

Form ETR-3
Part C

RAILWAY

PERMIT-TO-WORK ON OR NEAR AC TRACTION ELECTRICAL EQUIPMENT

Serial No. Date

From, To,
……………………….. ………………
at……… at ........................

I hereby declare that the work for which this Permit-to-work was issued has been completed and all men and materials under my charge have been withdrawn the men have been warned that it is no longer safe to work on or near the electrical equipment covered by this Permit-to-work.

Signature…………..
(of the authorized person)

Name…………….
Designation……….
Date……..Hr……..Mts…….
Form ETR-3
Part D

PERMIT-TO-WORK ON OR NEAR AC TRACTION ELECTRICAL EQUIPMENT

Serial No.                              Date

From,                                       To,

............................................................

at...........                                  at ...............

I hereby declare that the Permit-to-work is cancelled and all local earths have been removed. The cancellation of this Permit-to-work has been intimated to Traction Power Controller...........at...........Hr...........Mts...........

Signature...........
(of the authorized person)

Name.............
Designation...........
Date...........Hr...........Mts...........
Form ETR-4
Part A
RAILWAY
LOCAL BLOCK

Serial No.                  Date.............
Hr.......Mts.......

From,                      To,
Name.......................... Station Master/Yard Master

Designation...........

The Isolator number        at location number
Interruptor number         at switching station

in............................................................Yard........................................

will be kept open and overhead equipment of elementary Section/s

No/s........................................will be made dead and earthed.

The lines in the above elementary Section/s will not be available for electric stock/all traffic

movement.......................hour until further advice.

The block is likely to last for ........................................Hrs.........................Mts.........

Signature.............

Copy to:- (1) Traction Power Controller
(2) Section Controller

Form ETR-4
Part B
RAILWAY
LOCAL BLOCK

Serial No.                  Date.............

ACKNOWLEDGEMENT

Received Message No.................................from....................................

at..........................Hr....................................Mts..........................

Signature of Station Master/Yard Master

Place.................................
Form ETR-4
Part C
…………..RAILWAY
LOCAL BLOCK

Serial No.       Date…………..
                ……..Hr………Mts…………
From,
Name………………          Station Master/Yard Master
Designation……………..                          ……………………………..
No…………………………………of……………………………………..(date)

The Interruptor number
Isolator number opened by me has been closed and the overhead equipment of the
…………………………..elementary Section/s No./s……………………………..have been
made alive and are now available for electric stock/all traffic movements.

Signature………..

Copy to:- (1) Traction Power Controller
         (2) Section Controller
SAFETY PRECAUTIONS ON ELECTRIFIED SECTIONS

11.0 Induction Effect of 25 kV ac 50 Hz Single Phase Traction

1. The attention of all railways staff is drawn to the fact that under 25 kV ac 50 Hz single phase traction, there is heavy induction on all metallic structures and conductors in the tract. The induction is two-fold.

   a) Electro-static which result from the high potential of 25 kV on the OHE system.
   b) Electro-magnetic which is proportional to the currents passing from the sub-station to the OHE to the locomotives/EMUs and back partly through the track and partly through the earth.

2. Those who have been used to work on DC traction are liable to overlook taking adequate precautions required to guard themselves against the dangerous inductive effect of 25kV ac system. Attention is therefore specially drawn to the need for taking adequate precautions.

3. The voltage induced is quite appreciable on overhead conductors running parallel to the tracks depending on the length of parallelism. This explains why most of the overhead telecommunication lines are replaced by underground cables. Special protective measure are required to reduce the adverse effects of induction.

4. In a railway yard voltage of the order of 200 volts may be induced on yard lighting mains situated 8m away from the centre of double-line track, if it runs parallel to the 25 kV lines for a distance of about 270 m it could be several thousand volts when parallelism is much longer. In such a case a dangerous voltage due to induction will exist even after power supply to the line has been switched off. No one shall therefore attempt to work on any overhead line running alongside the electrified tracks without taking special precautions of earthing on both sides of the work. Before a section is electrified, the necessary modification to distribution lines in all stations and yards should be carried out, so as to limit the induced voltage within permissible values, but this by no means obviates the need of earthing the lines on both the sides of the working party. Earthing should be done individually by each working party as close to the work-spot as possible. The distance between the two earths shall not exceed 1 km.

5. Such inductive effects occur on large metallic structures such as fencings, structural steelwork of platforms running parallel to the track. They will therefore have to be earthed suitably to afford safety.

6. Inductive efforts also show themselves on any metallic conductor, such as metallic clothes-lines, power lines and lines belonging to private parties running parallel and close to the electrified tracks. Wide publicity should be given to the effects of induction so that special precautions are taken by the private parties.
11.1 WORKING OF STEAM AND DIESEL LOCOMOTIVES IN ELECTRIFIED SECTIONS

11.1.1 Prevention of Smoke Pollution

Pollution of OHE insulators due to smoke on account of operation of steam locomotives causes appreciable operating and maintenance difficulties. To reduce pollution to the minimum, the following precautions shall be taken:

1. No steam locomotive should be left standing with the chimney under an OHE insulator. Stabling of steam locomotives with chimneys under traction structure is prohibited.

2. Continuous blowing of safety valves, sudden opening of blower and priming through exhaust steam should be avoided as they cause flash over of insulators resulting in severe consequences. Sudden starting of a steam engine shall also be avoided as it may cause slipping of wheels which would result in priming through exhaust steam which in turn may cause flashover.

11.1.2 Standing of Boiler Shell or Tender

Staff are warned of the danger of standing on the boiler shell or tender when stabled under live OHE as it may result in electrocution.

11.1.3 Working the Fire-Spraying, Advancing and Fuel and Handling of Tools

1. Special care must be taken while firing coal or raking fire to ensure that the TOOLS DO NOT GET WITHIN THE DANGER ZONE of the OHE. Spraying of coal with water under electric overhead lines is forbidden.

2. The firing tools must be handled with great care, and special care should be taken to see that THESE TOOLS ARE NEVER LIFTED OR RAISED TOWARDS THE OHE. Tools must always be placed in their respective positions after use.

3. A jet from a hose should never be directed towards the OHE. The jet of water should only be directed horizontally far away from the live OHE and not vertically.

11.1.4 Loading of Fuel

1. The loading of coal or fueling of the locos shall only be carried out in yards outside the Electrified zones.

2. The height of the coal in the tender must not be more than 4.28 m above the rail level on BG and 3.65 m above rail level on MG.

11.1.5 Watering of Steam Locomotives

Whatever may be the height of the contact wire, NO ONE SHOULD CLIMB ON THE TENDER to open the cover of the water tank or to insert the funnel of the water column. Water columns have been suitably modified for operation from ground level. Only the operating rods provided should be used for this purpose.
11.1.6 Crane Working

No crane shall be worked on or near traction overhead equipments unless an authorized representative of the OHE section is present. When so working, care shall be taken to avoid hitting or damaging OHE structures.

11.1.7 Decorative Fittings

No decorative or extension pieces be attached to the chimney of a steam locomotive that would raise its effective height.

11.1.8 Engines Owned by Outside Parties

The safety precautions mentioned above are equally applicable to locomotives owned by Steel Works or other factories in the neighbourhood of electrical sections that are likely to work in electrified sidings for shunting or other purposes. The special safety rules to be observed in electrified sections should be advised by Sr. DEE (TrD) to parties owning such locos and their written assurance obtained that their operating staff have been made familiar with these rules.

11.2 WATERING OF CARRIAGES IN ELECTRIFIED SECTIONS

11.2.1 Watering Arrangements – Basic Precautions

With electrification, ‘side filling’ arrangements for coaches have been introduced as a long term measure, in lieu of overhead filling arrangements which necessitate shut down of power for watering and other precautions. Since all carriages have not yet been provided with side filling arrangement, special arrangements have been made to overhead watering of carriages in some electrified stations. The following precautions must be observed in such interim arrangements.

1. If the carriages are standing on lines having overhead traction wires, nobody shall get on to the roofs of the carriages unless the overhead traction wires above are made dead and earthed.
2. Shall getting on to the roofs of the carriage for watering, after the overhead traction wires above such carriage are made dead, should be warned against carrying long poles or any other articles which may come within the danger zone, that is within 2 m of the live traction wires on the adjoining lines. They should also be warned about the risk of extending the water hoses or any part of their body or directing water jets within the danger zone i.e. within 2 m of live overhead traction wires.

11.2.2 Watering Section

1. For the purpose of isolation and earthing the OHE, wires above the watering arrangements for each platform will form a separate elementary section i.e. different platforms will have different watering sections. This is to ensure that isolation of each platform can be done independently. The limits of each watering section shall be marked by danger limit board(Fig.11.01) hanging from the catenary at either end. These constitute the
limits within which alone watering of the carriages may be done in Fig.11.02 CD is the watering section.
Separate interruption or isolators shall be provided for controlling supply to each watering section. Keys for such interruptors / isolators shall be provided with metal tags on which the numbers of the interruptors / isolators are punched.

2. A neutral section about 12 m long bounded by section insulators is provided at either end of each watering section. The purpose of the neutral section is to afford additional protection to the watering section against approach of any electric locomotive or any other type of “feeding in: from the live sections on either end. In Fig. 11.02 BC and DE are the neutral sections.

11.2.3 Controlling Switches

1. ‘L’ is the locally operated interruptor / isolator at the end of the platform in a separate enclosure. The key for the enclosure is with the ASM on duty.

2. S1 and S2 are manually operated isolators – one at each end of the watering section, the purpose being to switch off power from the respective small neutral sections and to earth the two ends of the watering section. For this purpose the two isolators are provided with earthing heels.

3. Elementary sections AB and EF are normally live.

4. A feeder line for maintaining continuity (shown dotted in Fig. 11.02 is carried on the OHE structure having super masts.)

11.2.4 Sequence of Interlocking and Operation

The following are the interlocking arrangements and the sequence of operations:

1. The enclosure to interruptor / isolator ‘L’ is locked and its key is with the ASM on duty. When required, the ASM issues it to the linesman, only against a receipt on the register kept for the purpose.

2. If an interruptor is provided, on its frame is mounted the opening key which is accessible only after the enclosure to the interruptor is opened. This ensures that no one can open the interruptor, without taking the key of the lock of the enclosure from the ASM. The tripping key is normally back locked in the lock on the interruptor frame. It can be extracted from the lock only after the interruptor is opened to switch off supply to the watering section. Similarly, when an isolator is provided it can be opened only by the linesman on receipt of its key from the ASM on duty. For opening the (main) isolator ‘L’ the additional precautions shall be observed.

3. Each of the isolators S1 and S2 is provided with a double lock. The opening key extract as above from interruptor ‘L’ when inserted in S1 and turned, releases the operating handle of S1. if the isolator S1 is now opened or closed a key K1 (normally back-locked in the double lock on S1) is released, simultaneously locking the operating handle as well as the opening key. This ensures that once that once the key K1 is in the hands of the operator, the interruptor ‘L’ as well as isolator S1 cannot be operated. The key K1 as obtained now is known as the isolator interlocked key.
4. Key K1 is taken to the other end of the platform and inserted into the double lock of S2. This releases the operating handle of S2 and if isolator S2 is now opened another K2 normally back-locked in lock of S2 is released. This key is handed over to the TXR in charge by the authorized person as an assurance that the supply to the watering section is cut-off and made dead and earthed. Key K2 is known as the “permit-to-work” key.

5. The details given above and in subsequent paras are mainly for watering sections controlled by interruptors. The same principles however apply for watering sections controlled by manually operated isolating switches, though the details very somewhat between installations at different stations.
11.2.5 Persons Authorized to Open Interruptors and Isolator Switches

No staff of rank lower than a linesman working under the Traction Foreman (OHE) is authorized to open or close the interruptors of isolators controlling power supply to the overhead traction wires in the watering section.

A list of names of the authorized linesmen duly signed by the Traction Foreman (OHE) shall be exhibited prominently in the office of the ASM and the TXR of the station concerned. Each such linesman should also carry an identity card with photograph or specimen signature.

It will be the duty of the linesman concerned to report to the ASM on duty at least half an hour before the scheduled arrival of a train. No linesman on duty shall leave his place of duty until he has been properly relieved by his reliever and that too after his reliever has been introduced by him to the ASM on duty at the time.

11.2.6 Custody of Keys

1. The keys of the interruptor enclosures and isolators shall be inscribed with the distinguishing marks and locked in glass-fronted key box and kept in the personal custody of the ASM on duty. The keys should never be kept in a bunch, but hung on individual pegs provided for each. The description of each key shall be painted above each peg to avoid confusion.

2. When the watering section of a particular platform is required to be made dead and earthed for watering of carriages, the ASM on duty shall give the key of the lock of the enclosure of the controlling interruptor / isolator of the platform to the linesman on duty and getting his acknowledgement in a “Key Register” to be provided for the purpose at the station. This key shall be handed over immediately on arrival of the passenger train concerned. If hauled by an electric loco, if however, the train, the carriages of which are to be watered, is not hauled by an electric locomotive, the key may be handed over to the linesman even prior to the arrival of the train in question so as to save time, provided the earlier isolation of the watering section does not interfere with the movement of the other train. It is to be understood that the handing over of the key of he interruptor enclosure to the linesman amounts to the requisition for a power block.

3. The ASM shall ensure that no electric locomotive with raised pantograph is allowed to enter a watering section till the watering linesman returns the key back to the ASM and signs in the Key Register.

11.2.7 Watering of Carriages

On receipt of the ‘permit-to-work’ key of the concerned watering section, the TXR-in-charge of watering shall personally check that the key received by him bears the correct number and relates to the concerned watering section on which the carriages to be watered are standing. The TXR-in-charge shall also ensure that the train is standing within the limit of the watering section bounded by the danger limit boards on the overhead traction wires. He will then arrange to fix yellow flags (or yellow lights by night) on either end of the train high enough to be visible from the carriage roof. He will at the same time hand over to each of his men who are to go up on the roof of the carriages, a number badge of the legend and description shown in Fig. 11.03 as the authority to go on the carriage roof for the watering.
Only the staff holding the badges mentioned above are authorized to go to the roof of the carriages and water the same. The badges when not in use, shall be kept in the personal custody of the TXR-in-charge of watering under lock and key. Any loss of the badge shall be notified immediately and the badge canceled.

The TXR shall ensure that his staff deputed for watering are conversant with the following precautions:

1. Watering operation shall be confined to the limits specifically marked by “Danger Limit Boards” hanging from the catenary wire of the OHE above the concerned watering section.
2. The hydrants shall not be opened till the other end of the hose pipe has been inserted in the overhead tank of the carriage.
3. The hose pipes shall not be withdrawn from such overhead tank, till the hydrant has been closed.

Precautions 2 and 3 above are necessary to avoid accidental contact of a water jet with the live overhead traction wires of the adjacent tracks.

Each platform adjoining the watering section shall have a small area marked with the legend “Watering Gang”. Each of the staff deputed for watering shall be instructed to assemble in this area as soon as watering is completed or they are signaled to stop watering and get down from the roof of the carriages.

On completion of the watering, the TXR-in-charge of watering shall collect the authority badges given to his men and ensure that all the badges have been returned and there are no men on the top of the carriages in the watering section. The TXR shall also ensure that no material has been left on the carriage roof and that all the watering hoses have been brought down and the watering hydrants closed.

11.2.8 Restoration of Supply

On receipt of the permit-to-work key the linesmen on duty shall proceed to restore supply as under:-

He shall insert the “permit-to-work key” in the double lock of the isolator switch S2 and turn the same. This will release the isolator switch handle which shall then be operated to close the isolator. After this operation the isolator interlock key shall be extracted from the double lock and taken to isolator S1 and inserted in its double lock and turned. This will release the operating handle of isolator S1 which shall then be closed, thus back-locking the isolator interlock key. The interruptor opening key may then be taken out and inserted in the key hole of the interruptor lock and turned after which operation the interruptor should be closed. The interruptor enclosure shall then be closed and locked and the key returned to the ASM on duty. The returning of the key to the ASM on duty signifies that the power block has been cancelled. The linesman on duty returning the key, shall sign the Key Register entering the time at which the key is returned. The ASM on duty shall also sign the register in acknowledgement of having got the key back.

On receipt of the key the ASM shall arrange to start the train.
11.2.9 Key Register

Each watering station shall have a key register for recording the interchange of keys between the ASM on duty and the linesman. This key register will have the following columns:

1. Date
2. Description of the key
3. Watering Section No.
4. Train No.
5. Time made over
6. Signature of the linesman
7. Time returned
8. Signature of the linesman
9. Brief reasons for delay if any
10. Signature of ASM on duty

Safety depends essentially on the proper exchange of the keys and correct record of the same. All exchange of keys shall take place directly between the persons concerned and not through messengers. The custody of any key shall be the responsibility of the person possessing the same at the time.

11.2.10 Loss of Key

In case of loss or damage to any key controlling the switching arrangements to the watering section, the same should be reported at once to the TPC over phone and by XXR message addressed to the Sr. DEE(TrD), Sr. DOM and Chief Controller of the Division. The Sr. DEE (TrD) shall make immediate arrangements for the provision of a new locking system requiring a different set of keys.

During such period the TXR-in-charge of the watering shall personally be responsible for making dead and earthing the overhead traction wires of the watering section concerned. He shall arrange to lock the operating handles of the interruptor ‘L’ and isolator switches S1 and S2 by his own padlocks, the keys of which shall be in his personal custody till the watering is completed and the brass badges authorizing his staff to go on the top of the carriages for watering are returned to him.

11.3 LOADING AND UNLOADING OF PETROLEUM PRODUCTS

11.3.1 Precautions to be observed

In order to avoid any sparking during loading or unloading of petroleum products at the petroleum siding, electrical continuity must be maintained between the earth systems of petroleum installations, the track and electric overhead traction installations. The loading zone should be insulated from the rest of the railway net-work during loading and unloading operations. The following precautions / arrangements would be necessary.
Arrangements

1. Provision of an equi potential link between the earth system of petroleum siding installations and the track via a switch.
2. Setting up of neutral zones (insulating joints) in the track to avoid any risk of propagating stray current.
3. Setting up neutral zones / sections in he contact and catenary wires similar to loco inspection pits.
4. Provision of longitudinal bonds on both the rails as well as transverse bond (30 m intervals) on the track. All masts and metallic structures in the vicinity of the track / siding should be provided with structure bond.
5. Provision of 10 Ohm earths connected to the petroleum siding on each side at the insulated joint.

Precautions

1. No oil tanker is permitted to stable under the OHE for inspection purpose.
2. Fueling to be done fitting arrangements only.
3. Pipelines in the vicinity of the track should be properly earthed.
4. Minimum 2 m electrical clearance from live OHE of the adjacent track or any other equipment nearby must be maintained.
5. During service operations, the continuity of track and the contact wire should be set up at the same time the link between the track and petroleum facility should be opened.
6. The isolators at the neutral section of OHE should be kept open, OHE made dead and earthed.

11.4 RULES APPLICABLE TO PERMANENT WAY STAFF

11.4.1 General

These instructions have already been included in the supplement to Part ‘J’ of Chapter II of the Indian Railways Permanent Way Manual.

These instructions lay down precautionary measures to be observed by railway personnel working in the vicinity of the tracks equipped with 25 kV ac OHE. These have already been included in the supplement to para ‘J’ of Chapter II of the Indian Railway Permanent way manual which are reproduced below:-

11.4.2 Need for precautions

Precautions are required to be taken on account of the following:

a) Proximity of a live conductor. The risk of direct contact with live OHE is ever present while working in electrified sections such as for painting of steel work of through spans of bridges and platform covered sheds.

b) Build up of potential due to return current in rails. The return current in the rails may cause a potential difference-
   i) between rail and the surrounding mass of earth;
   ii) between the two ends of a fractured rail;
iii) between the two rails at an insulated joint;
iv) between earth and any other metallic mass.

c) Building up of potential due to induction in metallic bodies situated close to OHE. It is important to note that dangerous voltages may be induced in metallic masses such as fencing posts in the vicinity of traction conductors. To avoid possibility of shock due to such voltages the metallic structures are bonded together and earthed.

11.4.3 General Precautions

The precautions laid down below must be followed under all circumstances in sections equipped for 25kV ac single phase, 50 Hz traction in addition to those referred to in Indian Railway Permanent Way Manual.

1) No work shall be done above or within a distance of 2 m from the live OHE without a ‘permit-to-work’.
2) No part of a tree shall be nearer than 4 m from the nearest live conductor. Any tree or branches likely to fall on live conductor should be cut or trimmed periodically to maintain this clearance. Cutting or trimming should be done by engineering staff in the presence of authorized staff of the OHE section.
3) No fallen wire or wires shall be touched unless power is switched off and the wire or wires suitably earthed. In case the wires drop at a level crossing, the Gate-keeper shall immediately make arrangements to stop all road traffic and keep the public away.
4) As far as possible closed wagons shall be used for material trains. In case open or hopper wagons are used, loading and unloading of such wagons in electrified tracks shall be done under the supervision of an Engineering Official not below the rank of a Permanent Way Mistry who shall personally ensure that no tool or any part of the body of the worker comes within the ‘danger zone’ i.e. within 2 m of the OHE.
5) Permanent Way staff should keep clear of the tracks and avoid contact with the rails either when approaching or reaching the work-spot when an electrically hauled train is within 250 m.
6) When unloading rails along side the tracks, it should be ensured that rails do not touch each other to form a continuous metallic mass of length greater than 300 m.

11.4.4 Continuity of Track

During maintenance or renewal of track, continuity of the rails serving electrified tracks shall invariably be maintained. For bridging gaps which may be caused during removal of fish-plates or rails, temporary metallic jumpers of approved design shall be provided as under:-

a) In case of a rail fracture, the two ends of the fractures rail shall be first temporarily connected by a temporary metallic jumper of approved design (Fig. 11.04) In all cases of discontinuity of rails, the two parts of the rail shall not be touched with bare hands. Gloves of approved quality shall be used.
b) In the case of track renewals, temporary connections shall be made as shown in Fig. 11.05
c) In the case of a defective or broken rail bond, a temporary connection shall be made as mentioned in (a) above in
d) Before fish-plates are loosened or removed, a temporary connection shall be made as in (a) above in
11.4.5 Permanent Way Tools

Permanent way tools along with the gloves shall be used in the manner as approved by the Chief Engineer of the Railway.
11.4.6 Track-Circuited Rails

In track-circulated areas where the rail/s has/have insulated joints, such points shall not be bridged with bare hands or any metallic article. Similarly simultaneously contact with an insulated section of rail/s and non-insulated section of rail/s of the same or other tracks shall be avoided.

11.4.7 Care in Handling Pipes etc

Use of rails as a foot path, a seat or for such other purposes is strictly prohibited. Particular care shall be taken when carrying or handling long pipes, poles, ladders, over hanging on the shoulder or otherwise to avoid all possibility of such objects and work pieces coming inadvertently in contact with or within 2 m of live equipment.

11.4.8 Street Measuring Tapes not to be used

In electrified tracks, steel tape or metallic tape or tape with woven metal reinforcement should not be used.

11.4.9 Traction Structure Foundation

1. The top of foundation block of track structures shall be kept clear of all materials and kept dry.
2. While excavating, the foundations not be exposed and there should be no risk of sinking of the foundations.

11.5 RULES FOR S&T INSTALLATIONS

11.5.1 Effect of 25kV ac, 50 Hz, Single Phase Traction on S&T Equipment

1. Any circuit in the vicinity of 25 kV ac OHE is influenced by electrostatic and electromagnetic induction. The electrostatic induction is practically eliminated by transferring S&T circuits into underground cables protected with metal sheath. The electromagnetic induction causes various currents and voltages to develop in conductors parallel to the track. These include the rails, traction return conductor where provided, cable sheath, any other conductors in the vicinity and S&T circuits. The voltages that occur in the conductors appear a potential gradients. The value of induced voltage depends on various factors such as :
   a) Length of parallelism between the cable conductor and electrified track,
   b) Soil conductivity.
   c) Screening efficiency of cable sheath where existing.
   d) Return current through the rails and return conductor where provided.
   e) Mutual inductance between catenary and cable conductors.
   f) Current in the OHE.

Appropriate precautions to overcome the effects of the induced voltages therefore have to be taken by S&T departments.

Other aspects in which S&T equipment is affected are:
1) OHE structure and fittings affect visibility of signals to some extent and may come in the way of a signal;
   ii) Restrictions come in the path of traction return currents on section provided with track circuits.
2) Essential precautions to be taken while working on signalling and telecommunication installations as described. Reference may also be made to Chapter XVII of the Indian Railways Telecommunication Manual.

11.5.2 Precautions in the Event of Breakage of Wires

Should a catenary or contact wire snaps and falls on the running track, it is possible that the fault current may damage signalling equipment. The following precautions shall, therefore, be taken.

1. The Section controller on receipt of an advice of a break in traction overhead lines shall immediately advise, by the quickest possible means, the signal maintenance and operating staff of the section where the catenary/contact wires have broken.
2. If abnormal working of any equipment is noticed, its working shall be immediately suspended and necessary action under the rules shall be taken.
3. On receipt of the intimation from the Section Controller the staff responsible for the maintenance of signalling of the section shall immediately proceed to the site and test all signalling circuits and allied equipment paying particular attention to the outdoor signalling gear to check if any damage has taken place. An authorized representative of the Signal Department shall submit a certificate that everything is working all right and send it to his superiors along with a detailed test report as soon as possible.

11.5.3 Works on Signal Posts and Fittings

1. No staff shall work on any portion of a signal post or its fittings within a distance of 2 m from a 25 kV live OHE or a metal part electrically connected to this OHE unless such portion is protected with a metallic screen in accordance with approved instructions.
2. If for any reasons the protective metallic screen is not provided, the staff shall not undertake any work on those portions of the signal or its fittings falling within 2 m of 25 kV live OHE, unless power to the 25 kV live OHE has been switched off and a “permit to work” has been obtained. To draw the attention of the staff in such cases a red bend 10 cm wide shall be painted all-around the signal post at a height of 3 m above the rail level.
3. The inspectors of the Signal Department and the Station Masters shall explain these instructions to the staff working under them and ensure that they are correctly understood.

11.5.4 Precautions against build up of Potential due to Return Current in Rails.

1. The flow of return current in the rails may cause a potential difference to build up between
   a) two rails at an insulated joint of the track circuit or at an ordinary joint in case the fish plates are broken;
   b) two ends of a fractured rail;
c) an insulated rail and the rail used for the traction return current; and
d) the rail and the surrounding mass of earth

2. Whenever staff have to work on installations which are in direct contact with the rails, they shall:
   a) use tools of the types approved for the purpose by the Chief Signal and Telecommunication Engineer of the Railways; and
   b) observe the provisions of Chapter II of the Indian Railways Permanent Way Manual.

11.5.5 Precautions against Induction Potential in Metallic Bodies

Voltage will be induced in signalling and telecommunication circuits when the length of the parallelism to the track is appreciable, due to normal load currents or short circuit current in the event of a fault on the traction system. Dangerous potentials may also develop in circuits with earth connection if the earth connection gets broken for any reason. Consequently, every time staff have to work on signalling and telecommunication circuits along with 25 kV ac electrified lines, they shall take precautions to protect themselves and the equipment as prescribed by the S& Department.

Some of the important precautions are however given below:

a) Rubber gloves and tools with insulated handles should be used.

b) When the work to be done is of such a nature that rubber gloves cannot be used, splitting of the circuits into sections to reduce the length of parallelism and earthing them to ‘drain out’ the voltage should be adopted. Both the steps should be taken simultaneously. If these protective measures cannot be applied, staff must get insulated from ground by using rubber mats and other approved form of protection.

c) The line wires of the electric block instruments are likely to get heavy induced voltages and every time the staff handles the line wire terminals of the block instruments, they must observe the provisions of paras (a) and (b) above. Line wire terminals should be painted red to remind the maintenance staff of the danger. The maintenance inspectors shall explain the meaning of the painting to the maintenance staff and ensure that it is correctly understood by them.

d) Before cutting the armour or the lead sheath of a cable or the wires in the cable, an electrical connection of low ohmic resistance should be established between the two parts of the armour or the sheathing and the wires that are to be separated by cutting.
11.6 OVER-DIMENSIONED CONSIGNMENTS

11.6.1 Definition of Over-Dimensioned Consignment (ODC)

When a consignment whose length, width and height are such that one or more of these dimensions infringe Standard Moving Dimensions at any point during the run from start to destination, then the consignment is called an over dimensioned consignment (ODC). It is also known as out-of-gauge load.

If any consignment exceeds the following dimensions, it is to be treated as ODC or over dimensional consignment.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>BG</th>
<th>MG</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Length</td>
<td>13716 mm</td>
<td>12192 mm</td>
</tr>
<tr>
<td>b) Height</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) at centres</td>
<td>2743 mm</td>
<td>2540 mm</td>
</tr>
<tr>
<td>ii) at corners</td>
<td>2134 mm</td>
<td>2134 mm</td>
</tr>
<tr>
<td>c) Width</td>
<td>2997 mm</td>
<td>2540 mm</td>
</tr>
<tr>
<td>d) Top width</td>
<td>610 mm</td>
<td>610 mm</td>
</tr>
</tbody>
</table>

11.6.2 Classification of ODCs.

ODC’s are classified as under:

‘A’ class ODC having clearance (i.e., clearance measured under stationary conditions) of 228.6 mm and above from the fixed structures but infringes the standard moving dimensions.

‘B’ class ODC having gross clearance of 152.4 mm

‘C’ class ODC having clearance of less than 152.4 mm but more than 76.2 mm

11.6.3 Precautions for Movement of ODCs in 25 kV as Electrified Sections

The following precautions must be observed for transport of ODCs in the electrified sections:

1. Movement of ODC shall be undertaken only after sanction of competent authority has been obtained.

2. In all cases where ODC is to be moved, staff accompanying the ODC shall remember that the OHE is ‘live’ except when a power block has been obtained from the traction officials. Even when a power block has been obtained, all lines other than those for which the power block has been granted are to be treated as ‘live’ at 25 kV.

3. The following are the prescribed clearances from contact wire for the passage of ODCs through electrified sections and the special restrictions required:
a) Special speed restriction is not required when the gross clearance is more than 390 mm.
b) Speed must be restricted to 15 km/h when the clearance is between 390 mm and 340 mm.
c) Speed must be restricted to 15 km/h and power to OHE must be switched off when
the clearance from the contact wire is less than 340 mm.

4. No consignment with less than 100 mm clearance from the overhead contact wire will be
permitted in a 25 kV electrified section.

5. A representative of the OHE section should accompany all ODCs having clearances
as specified in items 3(b) and 3(c) of item (3) above, to supervise safe movement of the ODC
at locations where clearance form the contact wire is critical.

6. A representative of the OHE section should also accompany ODCs having width
more than 1981 mm for BG and 1910 mm for MG from centre line of track.

7. Section Controller and Traction Power Controller must coordinate while an ODC
moves in electrified section in order to ensure that OHE masts are not damaged at locations
where the clearance is critical.

8. A list of structures where the clearances are restricted in the electrified section and
also the clearance, available under the over-bridges should be with the Section Controller and
TPCs.

9. To facilitate checking of clearance form the Contact wire for over-dimensioned consignments, the Operating and Engineering branches at the Divisional and Headquarter level should have with them up-to-date charts showing location of the minimum height of
contact wire and clearances of OHE structures in the electrified section. The Operating Department may permit movement of ODCs on the basis of clearance checked with the help of the above mentioned charts subject to the speed restrictions. However, when sanction of CRS is required to be obtained for movement of any particular ODC, a specific reference
should be made to CEE and a certificate obtained from him in the following form:

“Certified that the minimum height of contact wire on the section over which the
consignment is to move is not less than ........except at the following locations where
restrictions as indicated below should be observed”:-

<table>
<thead>
<tr>
<th>Section</th>
<th>Location</th>
<th>Height of Contact wire</th>
<th>Power ‘ON’ or ‘OFF’</th>
<th>Speed Restriction in Km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>2.</td>
<td>3.</td>
<td>4.</td>
<td>5.</td>
</tr>
</tbody>
</table>

11.6.4 Power Blocks for Movement of ODC

When an ODC is permitted to be moved in an electrified section with the OHE power off, it
will be the responsibility of the Section Controller to arrange with the TPC for power to be
cut off before admitting the ODC into the section. An authorized representative of the
Traction Distribution Branch will obtain confirmation from TPC by message supported by
private number that power has been switched off and then issue a memo to the Guard or other
traffic official in-charge of the train to the effect that power has been switched off over the specified section. Only on receipt of such memo may the train carrying the ODC be allowed to enter the section.

Note: Since such a memo is not a “permit-to-work”, earthing of the OHE is not necessary.

11.7 OTHER PRECAUTIONS

11.7.1 Movement of Rubber Tyred Vehicles on Railway Wagons

All metallic parts of rubber tyred vehicles which are transported on railway wagons through 25 kV electrified area, shall be earthed to avoid the effect of induction.

11.7.2 Hoarding Boards

Hoarding boards provided in the vicinity of electrified tracks should be located at a safe distance from the track so that in the event of their supporting structures being damaged during agitation or storms it should not fail on the OHE or infringe the track. For this purpose, CCS and CPRO will ensure that while granting approval for erection of hoardings boards. It must be ensured that not only these are located at the safe distance from the track but also their structural arrangements are properly secured.

11.8 COMPETENCY CERTIFICATE

11.8.1 Competency Certificate and Courses for Assistant Station Masters / Guards of EMUs.

All staff who are required to work in electrified territory must have undergone a course in Electric traction so that they are made familiar with the working rules in the electrified sections. ASMs are also sometimes required to operate isolators at the station premises for which necessary training is to be imparted. Similarly, the guards of the EMUs are also required to undergo an operational course for the working of EMUs and are to undergo a refresher course at regular intervals of 6 months at Electrical Training Schools. Operating department will ensure that only those staff who have undergone the course in Electric traction are posted in electrified areas.