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(रेलवे बोर्ड)

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MINISTRY OF RAILWAYS
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INDIAN RAILWAYS
MANUAL OF AC TRACTION

MAINTENANCE AND OPERATION

VOLUME II (PART I)

FIXED INSTALLATIONS

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INDEX

CHAPTER-1
POWER SUPPLY FOR TRACTION

20100 Supply System

1. The single phase 50 Hz power for the electric traction is obtained from 220/132/110/66 kV Extra High Voltage 3-phase grid system through step down single-phase transformers. For this purpose duplicate feeders comprising of only 2 phases are run from the nearest grid substation of the Supply Authority to the traction substation. The brief description of the system is given in Chapter 2 of Volume I. The 25 kV single phase conventional system as adopted on Indian Railways has been described in that chapter. A schematic diagram of the traction sub station and feeding post indicating the general feeding arrangement is indicated at Fig. 1.01.

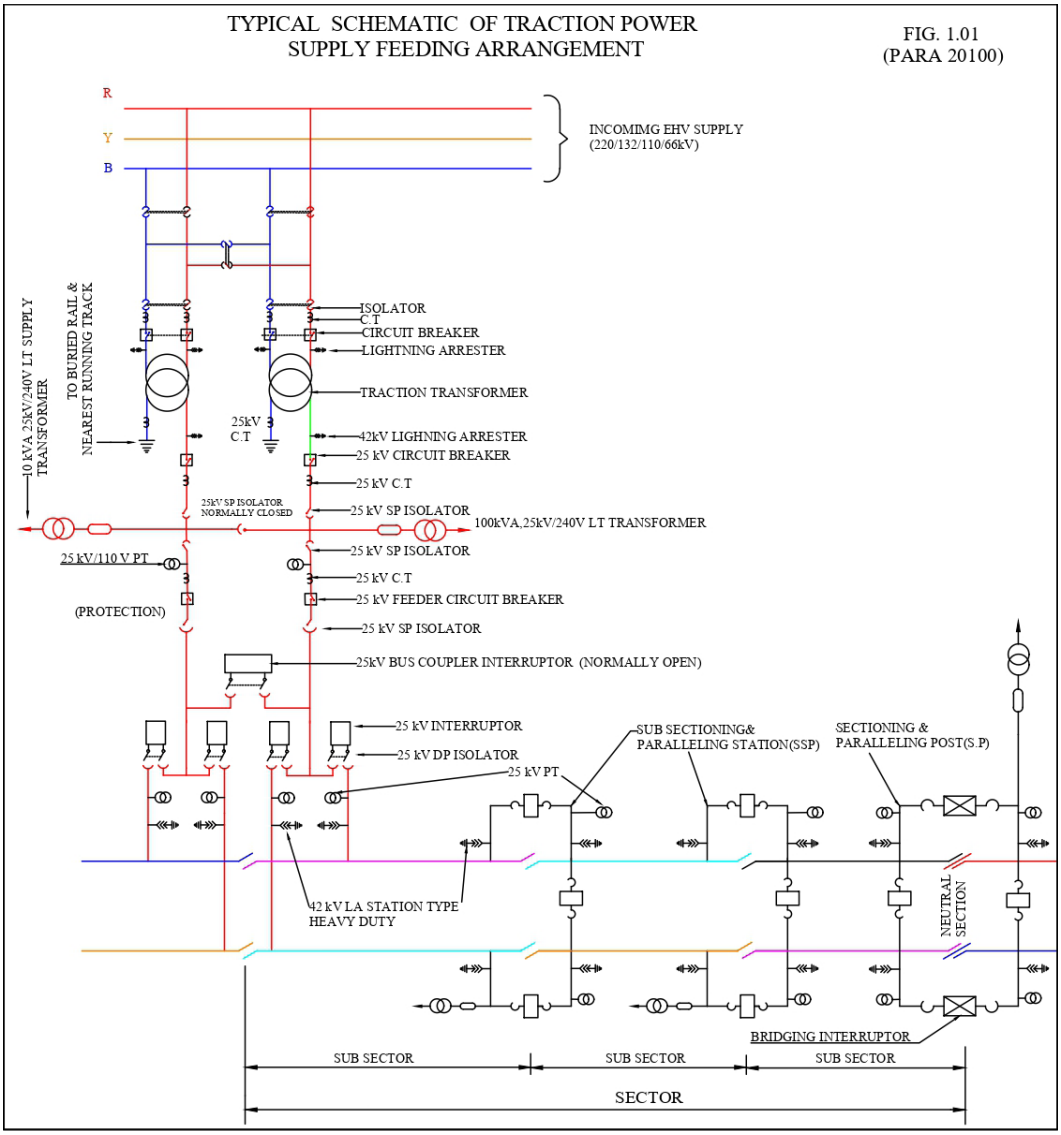
Salient technical features of the 2x25 kV Auto Transformer (AT) feed system are indicated in Chapter XI.

20101 Liaison with Power Supply Authorities.

For ensuring continuity and reliability of power supply for traction it is important that effective liaison is maintained between the officials of Railway and Supply Authorities. Broadly action on the following lines be taken:

1. A system of periodic meetings at different levels at mutually agreed intervals needs to be evolved.
2. Reliability of supply involves also the maintenance of traction voltage between 25 kV and 27.5 kV at the feeding posts and frequency between 48.5 Hz and 51.5 Hz. The serious repercussions on Railway traffic if the above limits are not adhered to should be constantly impressed upon the Supply Authorities.
3. The traction load should be treated as essential load and should not be disconnected or reduced to meet supply system exigencies. This principle has been accepted by most Supply Authorities and where this has not been done, constant efforts should be made at the high level periodic meetings to get this principle accepted.
4. Since the cumulative effect of frequent power supply interruptions, even though of short duration at a time, can be very serious to Railway working, a periodical review of all such interruptions should be made at the Divisional level and the cause of each interruption ascertained as far as possible. The results of the review should be furnished to PCEE to keep him fully informed of the power supply position. This subject should also form an important item for discussion at the periodic meetings with the Supply Authorities.
5. Power supply for electric traction should be governed by a specific Agreement entered into by the Railway with the concerned Supply Authority before the supply is actually taken. Where this has not been done already, urgent action should be taken to have it finalized without delay.
6. When grid supply to any traction sub-station fails and consequently emergency working has to be resorted to by extending the feed from adjacent sub-stations, the maximum demand at these sub-stations may go up. Most Supply Authorities have agreed to ignore such temporary increase in maximum demand for billing purposes. Where this has not yet been agreed to, efforts should be continued to persuade the Supply Authorities to accept this principle.

7. The present methodology of measuring maximum demand at each individual sub-stations for the purpose of billing has been reviewed by the Central Electricity Authority. It has been agreed that Railways should be charged for traction power on the basis of simultaneous maximum demand recorded in contiguous sub-stations of the SEB serviced by the same grid transformers. Modalities to implement the decision would have to be mutually settled between SEBs and Railways, with cost of the equipment borne by Railways.



20102 Tariff for Traction

1. In Electric Traction the energy cost forms a substantial portion of the total operating and maintenance cost. The tariffs charged by various state Electricity Boards, Open access or Power Utilities vary from a simple flat rate for the energy to a very complex tariff structure covering a variety of parameters. The implications of the various parameters should be studied carefully to keep the energy cost to the minimum possible level.
2. Contract demand for each sub-station should be stipulated in relation to the expected actual Maximum Demand in such a manner that in fructuous payments by way of minimum guarantee on the one hand and penal charges for exceeding the contract demand on the other, are avoided. Notice period for altering Contract Demand should also be kept as low as possible in the agreement, preferably 4 to 6 weeks.

3. In the tariff charged for electric traction, following are some of the parameters that should be given careful consideration with a view to keeping down the energy bill to the minimum.

   a. Maximum demand charge Rs/kVA/month: Normally one feeder is "ON" for feeding the traction load. If two sets of trivector meters are provided, the higher of the two should be the MD to be charged. Caution may be exercised to ensure that addition of both is not taken as MD in billing.

   b. Energy charge Paise/kwh

   c. Fuel Adjustment Charge (FAC) accounting for the variations in cost of fuel and calorific value compared to stipulated basis figures. This charge should be realistic and should be periodically verified with the Supply Authorities.

   d. Penalty for low power factor: The penal charge is prescribed as an extra amount leviable in Rs/kVA of Maximum Demand if power factor falls below a specified value. SEBs usually insist on consumer providing PF correcting equipment and do not permit power factor lower than a prescribed value.

   e. Billing Demand is usually a certain percentage of contract demand or the actual MD whichever is higher.

   f. Excess over Contract Demand and corresponding units of energy are usually charged at higher tariff (excluding FAC). Even if the excess MD is for a short period of just 15 min., proportionate units for the entire month are charged at penal rate. One of the SEBs does computation of excess energy as under:

      Excess Energy = TU (1-CD/MD)
      Where TU = Total Energy
      MD = Maximum Demand
      CD = Contract Demand

      The Contract demand therefore, has to be carefully determined and reviewed periodically and if necessary modified to avoid penal charges.

   g. Minimum Guarantee

      Usually, the agreement with SEB stipulates a percentage of 15 to 20% on the capital cost invested by the SEB for giving the connection, as minimum guarantee. This is generally met by the pattern of energy consumption in traction. However, minimum guarantee in some cases is specified in terms of guaranteed average load factor (say 30%). This ties up the Contract Demand with the units consumed.

      If a few heavy trains operate in a section raising the Maximum Demand high, the average load factor may not reach 30% unless adequate frequency of passenger trains also forms part of the traffic pattern. Here, if contract demand is too high, 30% load factor is difficult to achieve while if contract demand is too low, exceeding it and attracting penal changes becomes a possibility. Careful balance between the two conflicting requirements has, therefore, to be struck.

   h. Harmonic Voltage Distortion

      The consumer is required to carry out Harmonic Analysis under full load conditions. It is stipulated that the individual harmonic voltage distortion (Vn) at the point of supply shall not exceed 1% and 3% respectively.

      V - RMS value of fundamental voltage.

Vn – RMS value of harmonic voltage of order "n" , expressed as percentage of RMS value of the fundamental and shall be calculated using the following expression:

$$Vt = \frac{\sqrt{[(V_2)^2+(V_3)^2+(V_4)^2+---+(V_{13})^2]}}{V} \times 100$$

4. The tariff charged for traction should be reviewed periodically with the SEB. It should be ensured that the rates do not exceed those charged in EHV tariff of the SEB applicable to other consumers.

20103 Monthly Meter Readings

1. In earlier Railway Electrification installations, only one set of meters owned by the Supply Authorities has been installed to meter the traction load. In later installations, a second set of meters is being provided on the sub-station switchboard at Railways cost. Where only one set of meters belonging to the supply authority is installed yearly testing of the meter should be carried out. If its accuracy is in doubt at any point of time, the Railway is entitled to ask for testing and certification of the meter. Where a second set of meters has been provided at Railways cost, the figures for billing purposes should ordinarily be based on the average readings of the two sets of meters, unless specifically provided for otherwise in the Agreement. The exact procedure covering these aspects should be embodied in the Agreement with the Supply Authorities.
2. The monthly meter readings should be taken on an agreed date each month jointly by representatives of the Supply Authority and the Railway. The meter card as well as the printomaxigraph chart reading showing the maximum demand for the month should be initialed by representatives of both parties. Only readings jointly recorded as above should be accepted for billing purposes.
3. When visiting the grid sub-stations for taking meter readings, the supervisory official concerned will also obtain additional information such as daily maximum demand for traction, power factor, load factor, variation of voltage, changes in the system of interconnection, which have a bearing on power supply for traction. Suggestions for suitable changes in the Supply Authority's network may be made at appropriate level and if necessary concrete proposals initiated for making power supply 100% reliable.

20104 Scrutiny of Bills

1. The Supply Authorities bills should be carefully scrutinized in the Divisional Office with reference to the Agreement and the tariff. A time schedule should be laid down jointly with the Accounts Department for scrutiny and passing of the bill so as to take advantage of the rebate admissible, if any, for prompt payment. Panel charges levied, if any, should be carefully scrutinized and appropriate remedial measures taken to prevent recurrence. If the minimum charge payable is in excess of the amount warranted by the actual energy consumption, this fact should be promptly brought to the notice of PCEE as well as the operating Department to take special steps to arrange for movement of additional traffic, to the extent possible, in the affected section, including diversion from other routes.
2. Detailed instructions should be issued locally, jointly with the Accounts Department, listing the items to be checked prior to passing the bills from the Supply Authorities. An illustrative list is given below:
   a. Arithmetical accuracy
   b. Meter readings shown on the bill tally with those received earlier from the subordinates.
   c. The tariff applied is in terms of the agreement.
   d. The method of computation of the maximum demand for billing purpose is in accordance with the agreement and that temporary increase in maximum demand on account of emergency feeding has not been taken into account where this principle has been accepted.

e. The time allowed for payment is in accordance with the agreement.
f. There is no duplication in billing.
g. The payee as provided for in the agreement is clearly indicated. The full particulars of the payee should be advised to the Accounts branch to enable that Branch to issue cheques accordingly.
h. Each new bill should be analyzed and compared with earlier bill and the reasons for any significant departures investigated.

In case of any dispute/discrepancy, the payment be made "under protest"

20105 Power Factor Improvement

1. Provision of power factor improvement capacitors at 25 kV bus of traction substations should be planned giving priority to substations (i) which feed large marshalling yards and (ii) where penalty for low power factor and / or exceeding maximum demand has been stipulated in the tariff.
2. The average monthly power factor is calculated as ratio of kWh and kVAh over a month. Care should be taken to make sure that it does not go 'leading' while P.F. correcting equipment is used and is kept near unity. Switched capacitor be used where load variations are wide.
3. The Guidelines issued by RDSO in respect of selection of the kVAr rating should be kept in view at the time of planning.

20106 Shut-Downs of Traction Supply to be Pre-planned

1. At all grid sub-stations and traction sub-stations owned by the railways, duplicate EHV feeders are available. Most of the sub-stations also have two sets of traction power transformers and associated switchgear. Maintenance of equipment and transmission lines should not, therefore, necessitate total shut-down of EHV and 25 KV supply at a sub-station. It should be arranged with the Supply Authorities that on the rare occasions when such shut-down becomes inescapable, notice should be given well in advance to Sr. DEE/DEE(TRD) stating the reasons for the shut-down and the anticipated duration. Such shut-downs should be arranged by Sr. DEE/DEE (TRD) in consultation with the Operating Department which may have to re-schedule trains and take other measures as necessary.
2. A double circuit set of transmission lines from the Grid sub-station are run to give supply to traction sub-station. Therefore, maintenance of the transmission line does not necessitates total shut-down of the systems. However, all such shut-downs should be planned well in advance giving the reasons for the shut-down and anticipated duration.

20107 Operating instructions for Grid Sub-stations

Detailed operating instructions mutually agreed to between the Supply Authorities and the Railway should be made out for each grid sub-station as well as traction sub-station owned by the Railway and should be issued to TPC as well as operators at grid stations. These instructions should contain the following details.

1. Procedure for carrying out switching operations at the sub-station.
2. Procedure for interchange of message of pre-planned or emergency shut downs.
3. Procedure to be followed in case of failure of supply and information to be conveyed by grid sub-station operator regarding duration of failure and anticipated time of restoration to enable emergency working to be introduced.
4. Records to be maintained by grid sub-station operator and TPC regarding emergency feed arrangements.
5. List of office and residential telephone numbers of important grid and railway officials to be contacted in an emergency.

6. Mutual assistance to be rendered for transmission of important messages in the event of telephone failures at the grid sub-stations or RCC.

20108 Statistical Data Regarding Energy Consumption

In the divisional office, a register should be maintained to record month wise the following particulars in regard to energy consumption at each supply point:-

1. Energy consumption (kWh)
2. Maximum demand (kVA)
3. Average power factor (kWh/kVAh)
4. Monthly average load factor (percent)
5. Payment for energy
6. Payment for maximum demand
7. Payment towards meter rent
8. Payment of fuel surcharges, if any
9. Payment for P.F. surcharge/penal charge
10. Payment of covering the minimum guarantee load, if any
11. Other payments, if any
12. Total amount of bill under all heads
13. Average total cost per kWh.

A consolidated statement giving the above details for all supply points should be furnished by Sr. DEE/ TRD to PCEE each month by a stipulated date. PCEE will in turn furnish a monthly statement in the prescribed Performa to the Railway Board and Research Design and Standards Organization (RDSO).

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CHAPTER-2
SUB-STATIONS AND SWITCHING STATIONS

20200 Introduction

1. This chapter is divided into 4 sections as under –

Section I Organization: A broad set up of the organisation and duties of SSE (Power Supply Installations) are covered.

Section II Operation of Sub-Stations: The important points relating to operation of transformers and protective devices are covered.

Section III Guiding Notes on Maintenance: The important points to be borne in mind in the maintenance of power supply equipments are covered.

Section IV A recommended schedule of maintenance for power supply equipments is given.

2. The following documents have been incorporated as Appendices to this Volume.

2.1 "Code of Practice for Earthing of Power Supply Installations for 25 KV, ac, 50 Hz Single Phase Traction System issued by RDSO (Appendix III)

2.2 Guidelines for Relay setting at Traction Sub-stations and Switching Posts issued by RDSO (Appendix V)

2.3 Guidelines for Provision of Maintenance Depots, Tools and Plants and Transport Facilities (Appendix VI)

2.4 List of Specifications and for Equipments and Materials for Railway Electric Traction issued by RDSO (Appendix IX)

I ORGANISATION

20201 Organizational Set up

The Divisional set up of senior subordinates working under Sr. DEE/TRD has been arranged on two types of patterns.

a) Territorial basis

b) Functional basis

In the territorial set up one Sr. Subordinate is responsible for all the activities of maintenance and operation over a predetermined section of electrified territory or a sub-division. The functional set up envisages separate Sr. Subordinate to be incharge of each activity viz. sub-station, OHE, workshop, PSI etc. in a division or sub-division. Duties, however, have been specified here in relation to particular function. For territorial set up, the SSE incharge will perform his duties keeping all functions in view, the next in command viz. SSE being the functional incharge of the specific activity.

Remote Control system or protective relay testing being a specialized activity, SSE (RC) and SSE/Test Room usually have a functional jurisdiction over the entire division, with Head Quarters at the Remote Control Centre and Divisional Repair Shop respectively. The SSEs in territorial charge, should keep a constant liaison between themselves since these aspects will have an element of dual control.

20202 Duties of SSE, Power Supply Installation

He is the senior supervisor working under the control of DEE/ADEE/TRD and directly responsible for the safe and efficient operation and maintenance of traction power supply installations including sub-stations (when owned by the railway), switching stations, booster transformer and auxiliary transformers in his jurisdiction. He shall be thoroughly conversant with all technical details of the equipment under his charge including their rating, trend of power demand as also correct methods of their operation and maintenance, in particular, he shall

1. supervise the maintenance of installations under his charge in accordance with the prescribed schedules to keep them fully serviceable at all times and in a state of good repair;
2. maintain proper co-ordination with the Traction Power Controller, SSE(OHE), Supply Authorities and render assistance when required to ensure reliability of power supply;
3. keep his organization in constant readiness to deal promptly with any breakdowns and failures of equipment;
4. ensure that the programme of testing and maintenance of protective relays is adhered to and ensure that other safety equipment including bonding and earthing are functioning effectively;
5. instruct, train and supervise staff under his control and ensure that they do operate and maintain the equipment properly and in particular do actually observe all rules and regulations and safety precautions laid down;
6. depute staff for refresher courses as prescribed, particularly for such staff as are found deficient in their working;
7. Ensure that special instruments and tools provided for maintenance operation and testing of all installations are properly cared for;
8. keep a close watch on availability of spare parts and other stores required for maintenance and operation of the installations and initiate timely action to recoup stocks;
9. ensure proper accountal and periodical verification of stores and tools in his charge;
10. Depute staff when required to man sub-stations and switching stations in the event of failure of remote control equipment;
11. Inspect all installations under his charge at least once a month, with particular attention to safety aspects;
12. Submit prescribed periodical returns after careful scrutiny to ADEE/TRD and Sr. DEE/DEE(TRD);
13. Keep his superior officers fully informed of all important development and seek their guidance when required;
14. Carry out such other duties as may be allotted by superior officers from time to time.
15. Carry out inspections as indicated at Annexure 2.01.

II OPERATION OF SUB-STATIONS

20203 Introduction

Since the electric traction system depends upon continuous availability of power supply, sub-stations and switching stations have to be kept in proper working condition at all the time. To ensure this, the transmission lines, the 25 KV feeder lines and traction transformers with associated switch gear and control and relay panels are duplicated so that if one unit fails, the standby unit can be brought into service to continue power supply. All switching operations are also centralized and controlled by remote operation by a single authority, namely Traction Power Controller.

20204 Inspection Book and Log Book at Sub-Stations

An "inspection Book" shall be maintained at every sub-station in which observations made by supervisory officials visiting the sub-station for periodical inspections shall be recorded. In addition a log book should also be maintained to keep a record of the traction transformer oil temperature, ambient temperature as well as currents and voltages as indicated on the control panel at a fixed time every morning. If there is any thing abnormal unusual, SSE/PSI will investigate the cause thoroughly and take necessary remedial action.

20205 Overload Capacity of Traction Transformers

Traction transformers usually have the following overload capacity:

1. Overload rating : (a) 50% overload for 15 min. and (b) 100% overload for a period of 5 min. ,after the transformer has attained steady temperature on continuous operation at full load.
2. Over an ambient temperature of 45 degree C the maximum permissible temperature rise shall be as under:

   a. Winding = 50 degree C (by resistance method)

   b. Oil = 40 degree C (by thermometer)

   C. Current carrying parts = 35 degree C (by thermometer)
3. The hot-spot temperature after 50 % overload for 15 min, or 100% overload for 5 min. shall not exceed 115degree C for an ambient temperature of 50degree C.
4. Interval of time permissible between two successive overloads (after continuous working at maximum ambient temperature of 50 degree C is 3 hours for both 50% overload for 15 min. and 100% overload for 5 min.

20206 Tap Setting on Traction Transformers

Low Capacity Traction Power Transformer (13.5/18.9MVA & 21.6/30.24 MVA) are provided with the off load tap changers in steps of 5% and High Capacity Traction Power Transformer (30/42MVA and 40/56MVA) are provided with the on load tap changers with per tap voltage as mentioned in the concerned transformer specification. To decide the correct tap setting a recording voltmeter should be connected at the traction sub-station to the secondary side of a potential transformer to ascertain the pattern of voltage variation throughout the 24 hours for at least 3 typical days. Based on the readings from the recording, the tap position should be fixed so that the daily OHE voltage peaks at the traction sub-station lie just below 27.5 KV but does not touch 27.5 KV. This will ensure that the OHE voltage is well above the minimum of 19 KV at the farthest point on the system even when heavily loaded. Once a year a 24 hours record of voltages available on the two sides of every neutral section should be taken to make sure that the voltage does not fall below 19 KV at any time.

Since any change in the inter-connections of the grid system would have repercussions on the voltage at the traction sub-station, the SSE/PSI should keep in touch with the supply authorities in regard to system changes so that he may arrange to take another set of 24 hour voltage readings if any change has taken place and to change the tap setting if required.

20207 Tests on Transformer Oil

In order to improve the performance and to prolong the life of the transformers, EHV grade oil is used. The following two specifications the first one for new oil and the second for oil in service, are adopted.

1. IS- 335 Specifications for New Insulating Oils.

2. IS- 1866 Code of practice for maintenance and supervision of insulating oil in service.

A summary of tests for various characteristics, the requirements to be complied with and methods of tests as contained in the two specifications is at Annexure 2.03 (A&B). The tests are wide ranging and should be done once a year. However, some of the tests like Breakdown voltage (BDV) test, acidity tests, crackle test for moisture, may be carried out in PSI depots or sub-stations once in six months when samples are drawn for condition monitoring as per para 20216 Procedures for these test are indicated in IS 1866.

20208 Purification of Transformer Oil

The object of oil purification is to remove all contaminants such as water, carbon deposits, dirt, sludge, dissolved moisture and gases. The most important quality to be preserved is the di-electric strength, which is affected by the presence of moisture.

The insulating materials used in the winding are hydroscopic by nature and therefore moisture is absorbed through defective breathers, gaskets and addition of untreated make up oil. It is essential to remove these impurities by purifying the oil when the di-electric strength goes below the permissible limits.

20209 Oil Purification Plant

For purifying the transformer oil, machines conforming to RDSO's Specification No. ETI/PSI/103 may be used. These are normally operated from 240 V single phase supply taken from the 100 kVA Station transformer provided at the sub-station. Supervisory officials in charge of maintenance of transformers should make themselves familiar with the supplier's instructions in regard to the operation and maintenance of the oil purifying equipment.

20210 Insulation Resistance During Drying Out

Readings of temperature and insulation resistance should be recorded every two hours, from commencement until the full operation is completed. If the readings are plotted on a graph, the appearance will be as shown in Fig. 2.01.

It will be observed that there are four distinct stages:

1. Initially the insulation resistance drops down to a low value because of rise in temperature of the oil upto about 75 degree C.
2. Insulation resistance will continue to remain at a low level despite temperature being maintained at a high level until most of the moisture from the windings and oil has been driven out.
3. The insulation resistance will thereafter rise gradually and level off, indicating that all moisture has been driven out and the drying out operation has been completed. At this point oil circulation should be discontinued.
4. As the oil cools off, the insulation resistance will rise much above the leveling off point at the end of stage (C). This is because the insulation resistance value doubles for a fall in temperature of about 10 degree C to 15 degree C.

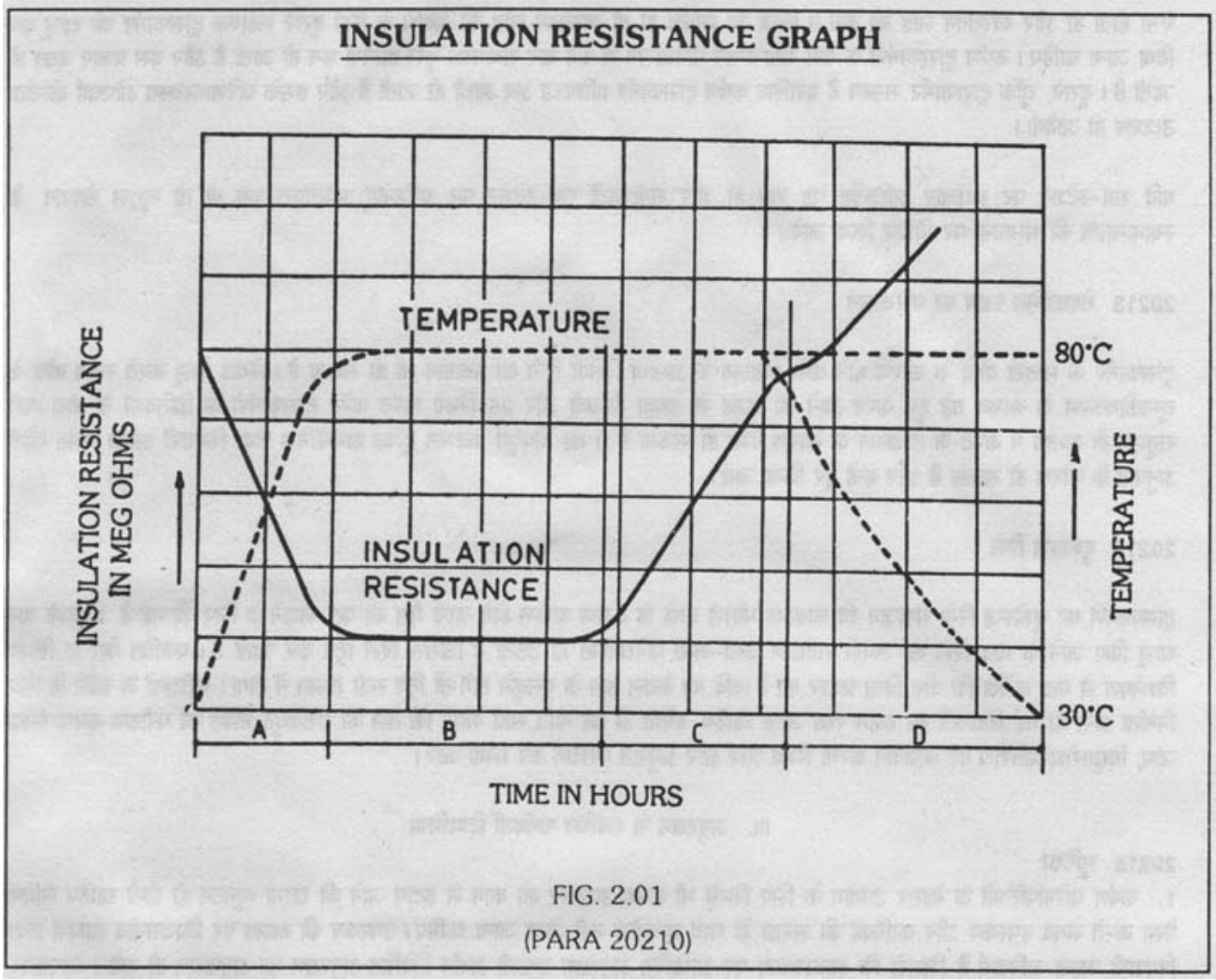

FIG. 2.01
(PARA 20210)

20211 Protective Devices

A number of protective devices are provided to ensure safe operation of traction transformers and other equipment (under normal and extended feed condition with appropriate adjustment of settings). Alarm and trip circuit operations are tele-signalled and indicated at the RCC. The TPC shall in every such case advise SSE, so that he could arrange for the inspection of the sub-station to investigate the cause and take necessary corrective action and submit a detailed report to Sr. DEE/DEE(TrD).

20212 Operation of Temperature Alarm or Trip

Alarm and trip contacts are provided to operate should the temperature of transformer windings or transformer oil exceed pre-set limits. If alarm or the trip contacts have operated, both of which are indicated at the RCC, SSE should personally inspect the installation. If the dial settings are correct, the reason for excessive temperature rise should be investigated. Normally instantaneous overloads of over 150% of full load are taken care of by protection relays, while sustained overload below 150% are cleared by thermal protection. It is advisable to connect a recording ammeter and get a 24 hour chart showing the current loading of the transformer in services. The shape of the load curve would give valuable clues as to corrective action to be taken.

If the alarm and trip circuits operate frequently during peak periods, attempt should be made with Operating Department to space out the trains more uniformly throughout the day so as to reduce the peak load. If, on the other hand, it is a suburban section and the peak load cannot obviously be brought

down, the second standby transformer may have to be pressed into service for the duration of the peak load. Such parallel operation of traction transformers may sometimes also incidentally result in reduction of the total losses thereby effecting economy. Secondly, it will also result in higher OHE voltage, since traction transformer impedance is now halved as the transformers are identical.

If a sub-station is persistently overloaded and an adjacent sub-station is appreciably underloaded, the possibility of shifting the neutral section may be considered.

20213 Operation of Differential Protection

Apart from operation on account of internal faults in the transformer, the differential relay could also operate either because of current in-rush on account of magnetization of the core at the time of switching on or because of spill current caused by lack of perfect balance between secondaries of EHV and 25 KV current transformers. The causes for such mal-operation may be defective harmonic restraint filters or wrong CT ratios and should be eliminated.

20214 Buchholz Relay

The Buchholz relay assembly is provided on transformers to detect evolution of gas caused due to internal faults. After first commissioning, the upper assembly of the relay may sometimes be found to operate causing the relay to trip. Analysis of the composition of gas collected will indicate the nature of fault. If it is mere air bubbles the transformer is sound. For details of tests manufacturers write up may be referred to. It is always a wise policy to get the di-electric strength of the oil tests, measure the insulation resistance and carry out ratio test.

III Guiding Notes On Maintenance

20215 Introduction

1. For better utilization of traction assets, outage of any traction equipment from service should be minimum without compromising on safety of the equipment and personnel. Monitoring of condition of the equipment by reliable means is essential for following system of need based maintenance i.e. directed maintenance. However, till such time reliable condition monitoring techniques are introduced, the present system of preventive maintenance has to continue.
2. Recommendations of Original Equipment Manufacturer (OEM) and guidelines issued by RDSO, time to time, shall be kept in view while defining the scope and periodicity of the schedules.
3. The tightening torque for fasteners of various sizes is given in Annexure 2.08.

20216 Transformers

1. Condition Monitoring

In oil filled equipment like transformers, normal deterioration or ageing of insulation is caused by thermo-chemical reaction with participation of heat, moisture and oxygen. This results in formation of soluble and insoluble products which accumulate and deteriorate the properties of oil and cellulosic insulation. Whereas the oil can be reconditioned to restore functional properties, no such treatment is possible for the cellulosic insulation, which suffers from reduction of mechanical and di-electric strength. The condition of the insulation, therefore, needs to be checked by suitable methods.

The thermal and electrical stresses caused during short circuits, overloads and over voltages in the system result is gas formation in appreciable amount and deterioration of di-electric properties and lowering of flash point of oil from 145 degree C to somewhere between 50 degree to 80 degree C in

extreme cases.

In the case of incipient faults, the gases being soluble, are absorbed in oil. The Buchholz relay cannot respond during early stages of trouble and by the time these devices operate the damage is done. Dissolved gas analysis (DGA) provides an important means in the art of condition monitoring of power transformers and other oil filled equipment. Of the various methods of gas analysis Gas Chromatography (GS) is one of the most sensitive, efficient and rapid method, eminently suited for detection of incipient faults and for monitoring of growing faults which are not always revealed by established routine tests etc. In order to timely detect the deterioration of insulation, oil sample shall be drawn annually and subjected to gas chromatography.

Guidelines for condition monitoring of traction transformers by Dissolved Gas Analysis technique are appended at Annexure 2.04.

2. Overhaul of Transformers

a. Overhauling of Traction Power Transformer can be undertaken either at site (Traction Sub-Station) or in Traction repair shop subject to fulfillment of conditions as stipulated in SMI no. TI/MI/0039 Rev.02 (or latest). In addition to this, if transformer overhauling is required at OEM /Approved manufacturer premises, same to be decided by Sr. DEE/TRD.Before commencing the work ensure that spare gaskets of proper quality are available. Drain out the oil, disconnect all leads, remove manhole covers where required. The EHV and 25 KV bushings are then carefully removed out and stored well protected in a safe place. Then remove the core by means of the lifting hooks and place on shop floor over a trestle in a large receptacle into which oil can drain out.

b. If the transformer has been opened up because of any internal fault, make a careful note of colour of transformer oil, arc-marks, carbon deposits, charring of insulation, condition of the windings, unusual odor and other abnormalities which would all help in ascertaining the cause of the failure. If a coil has been burnt out, the whole transformer will have to be completely dismantled and then the damaged coil replaced with a new coil. In the case of the traction transformer, the replacement of the damaged coil is best done in the manufacture's works where necessary facilities and staff with the requisite skill are available.

c. Arrange for the interior of the transformer tank to be thoroughly cleaned of all accumulated debris, sludge, etc. and wash with fresh oil. Remove the drain plug, lightly polish the valve seat and renew the oil-tight gasket round the spindle so that when assembled the plug is fully oil tight; the same remarks apply to the oil sampling valve, if provided. Opportunity should also be taken to plug or weld up any small blow holes through which oil seepage was observed earlier. Finally paint the exterior of the tank if necessary after thoroughly cleaning it up of all paint work, rust and traces of oil and dirt.

d. If the coil assembly is lifted up after 5,10 or more years of service, considerable amount of sludge formation would have occurred on all parts of the transformer i.e. at the bottom of the tanks, metal work of the transformers, windings and inter-spaces between windings. All these should be scrapped off carefully with a wooden or fiber wedge without causing any damage to the windings. Traces of the sludge left over in inaccessible places are best removed by directing a thin jet of transformer oil under pressure using small oil purifier. At the same time the old surface contamination should be brushed and washed down, until the clear surface of the winding is exposed.

e. Care should be taken to protect the windings against ingress of moisture particularly during inclement weather. Care should also be taken by wiping off body sweat with a towel. The

windings should also be kept warm by surrounding the open windings by a number of infra-red lamps or by other means.

f. Fully push home the wedges between the coils and take up the slackness of end-plates by tightening up the bolts and locking them. These are provided on traction transformers to hold the windings tightly together to withstand the high mechanical forces generated at the time of short circuits. Shrinkage and settlement usually take place within the first six months of the commissioning of a transformer. The coils are also liable to suffer displacement due to short circuit forces. If the coils are not held tightly in position, it will lead to repeated movement of the coils as well as layers and turns which will in turn cause abrasion and wear of insulation and ultimately failure. It is, therefore, sometimes recommended that the first available opportunity should be taken to have the wedges fully home and tighten up the pressure screws where they are provided.

g. Finally put back the core assembly inside the tank, assembly the bushing check tightness of all internal connections, fit the top, provide new gaskets, fill pure oil and dry out as detailed in para 20208 to 20210. Experience has shown that tools like spanners and foreign objects like washers, pieces of cloth, etc. are sometimes inadvertently left behind in the transformers, which present hazard of short circuits. It is, therefore, important that al tools, etc. used in the overhaul work should be listed out at the beginning and accounted for at the end of the work.

When overhauled transformers are to commissioned the same procedure as detailed in Chapter IX for new transformers should be followed.

Each railway should plan, taking into consideration the resources available with them to carry out the POH and repairs of the transformer and decide the agency to execute the work.

3. Investigation into causes of Failures of Transformers.

In most cases the causes of the fault can be surmised by careful observation of the condition of the windings, e.g. displacement of the turns or coils, coil insulation (brittle or healthy), evidence of overheating, carbon deposit or flash marks on the core, supports, the inner surface of the tank or cover. The following notes may be of help in identifying the cause.

a. Failure due to lightning discharge or over voltages. This is characterized by breakdown of the end turns close to the line terminal. There may be a break in the turns or end lead, and also flash marks on the end coil and earthed parts close to it, but the rest of the coils will be found to be healthy.

b. Sustained overloads – The windings in one or all phases would show signs of overheating and charring; the insulation would be very brittle and would have lost all its elasticity.

c. Inter-turn short, inter-layer short, or inter-coils short - The same signs as for indicated for sustained over load would be noticed, but only on affected coils, the rest of the coils being intact. This is likely if the differential relay or the Buchholz relay has operated.

d. Dead short circuit – This can be identified by the unmistakable, lateral or axial displacement of the coils. The coils may be loose on the core, some turns on the outermost layer may have burst outwards and broken as if under tension. If, in addition to these signs, the windings are also completely charred, it is conclusive evidence that the short circuit has continued for an appreciable period, not having been cleared quickly by the protective relays.

e. If the upper chamber of the Buchholz relay alone has tripped, check the insulation of core bolts, by applying a voltage of 230 V to 1000 V between the core and each bolt. If it fails, renew the insulating bush. Observe also all the joints, and tap-changer contacts, for over heating and arcing.

f. If the oil shows a low BDV, it does not necessarily mean that it has caused the breakdown. At high voltage ratings, excessive moisture content in the oil may result an internal flashover between the live parts and earth, which will leave corresponding tell-tale marks.

20217 Circuit Breakers and Interrupters.

The following types of circuit breakers and interrupters are now in use.

Circuit Breakers:

1. 220/132/110/66 KV Double pole
   - SF6 type
2. 25 KV single pole
   - Vacuum type
3. Interrupters
   - 25 kV Double pole
   - Vacuum type
4. Single and Double Pole Interrupters: (RDSO SPEC No. TI/SPC/PSI/HV CB /0121(MAY 2021) & (RDSO SPEC No. TI/SPC/PSI/LV CB /0120(DEC 2013)
   - Vacuum type

Oil type circuit breakers/interrupters require considerable attention for maintaining satisfactory condition of the oil. In case of minimum oil type equipments frequent replacement of oil is necessary on account of service conditions. To overcome these limitations, SF-6 type and vacuum type circuit breakers and interrupters are now standardized.

Manufacturer's detailed instructions may be referred to for installation, commissioning, operation and maintenance for all types of breakers/interrupters. RDSO's additional instructions on maintenance and modifications to the circuit breakers/interrupters should also be followed. Some tips for the maintenance of circuit breakers and interrupters, in general, are given in the succeeding paragraphs.

20218 Guidelines for Maintenance of Circuit Breakers and Interrupters.

1. Deleted (RDSO SPEC No. TI/SPC/PSI/HV CB /0121(MAY 2021) & (RDSO SPEC No. TI/SPC/PSI/LV CB /0120(DEC 2013)
2. SF 6 Circuit Breakers:

   a. Gas System

   The SF-6 gas in a pure state is inert, exhibits exceptional thermal stability and has excellent arc quenching properties as well as exceptional high insulating properties. Physical properties of SF-6 gas are indicated in the Annexure 2.05. There is very little decomposition of the gas after long periods of arcing. Such decomposition has virtually no effect upon dielectric strength and interrupting capability. The solid arc product formed by arcing is metallic fluoride which appears in the form of a fine gray powder which has high dielectric strength under dry conditions as existing in the breaker. A good quality absorbent is used in the apparatus to remove decomposed gaseous by-product. During the maintenance, record gas pressure and temperature. Supply the gas if pressure is less than the prescribed value. Check setting of gas pressure switches.

b. Interrupting Unit

Clean the surface of the porcelain and other parts. Contacts should be inspected and replaced if necessary.

Renew the absorbent taking care that exposure of the absorbent to the atmosphere is minimal. The breaker should be evacuated as soon as possible.

c. Operating Mechanism

Check stroke from closed position to completely opened position and over stroke from completely opened position to stopped position. Check prescribed clearances. Relubricate moving parts. Check that pressure gauge is working correctly. Check pneumatic system for tightness.

The housing should be checked for water penetration and rust. Ensure that fasteners are not loosened. Check connections of control circuit wires for tightness.

3. Vacuum Circuit Breakers

Maintenance is to be conducted as per the maintenance instruction no. TI/MI/0054 or latest. (RDSO Letter No. TI/PSI/CVINT/POLICY/Dt.13.09.2017)

20219 Lead Acid Batteries

A battery is considered to be very vital equipment in the power supply installations and therefore, its proper maintenance is imperative.

On electrified sections batteries and battery chargers are installed at the following locations:-

1. Traction Sub-Stations –

110 V 200 Ah. Lead acid cells for control, protection and indication circuits.

2. Switching Stations –

110 V or 72 V, 40 Ah. Lead acid batteries for operation of circuit breakers and interruptors and motor operated isolators.

3. Remote Control Equipment

Batteries of suitable voltage and capacity at remote control centre, traction sub-station and switching stations.

To reduce number of batteries at TSS/SS the remote control equipment is now being connected to the battery of TSS/SS.

In all cases, mains operated battery chargers are provided with facilities for either trickle charge or boost charging. The rating of the battery charger should related to the capacity of the battery.

20220 Guidelines for Maintenance of Batteries.

1. As the entire system of protection at a sub-station depends upon a sound battery, it should always be in proper condition. It should under no circumstances be disconnected when the sub-station is in operation.

   Batteries should be maintained keeping in view instructions of the manufacturer by a trained staff. The points to be observed during the inspections are summarized below –

   a. General condition of the battery room and cells

   b. Specific gravity of electrolyte in the cells

c. Charging current

d. Cell voltage

e. Condition of the plates and extent of deposits

f. Inter-cell connectors and main battery terminals

A detailed history of every battery should be separately maintained in which all relevant information is periodically entered. Fortnightly specific gravity readings should be taken and recorded in appropriate forms.

Smoking or the use of open flames or tools which may generate sparks is strictly forbidden in the battery room. The battery room should be well ventilated and dust free and should have acid proofing done on the walls and flooring. It should be kept isolated from other electrical equipment. Appropriate fuse protection for short circuit in the wiring between the battery and distribution switch board should be provided.

2. Specific Gravity

The specific gravity of the electrolyte should be maintained at about 1.210 at 27 degree C and when it drops to 1.150 the cell may be considered discharged. These values vary with the type of battery, temperature, age and working conditions.

Specific gravity is related to electrolyte temperature. For the purpose of test requirements, the fully charged specific gravity shall be 1.20 + 0.005 corrected to 27 degree C. Temperature correction hydrometer readings of specific gravity shall be made as follows (Ref. IS 1652)

a. For each 1 degree C above 27 degree C add 0.0007 to the observed reading and

b. For 1 degree C below 27 degree C deduct 0.0007 from the observed reading.

When the battery is first commissioned the specific gravity of all the cells would be almost equal. Subsequently during periodical inspections, variations in specific gravity may be observed due to unequal rate of evaporation. This should be corrected by adding distilled water. In no circumstances should concentrated or diluted sulphuric acid be added to any cell except when acid is known to have spilled out. Distilled water alone should be used for topping up the level.

Hydrometer readings taken when a cell is gassing freely gives the specific gravity of a mixture of gas bubbles and electrolyte and not the true specific gravity of the electrolyte. The readings should therefore be taken after allowing all bubbles to subside. Hydrometer of reputed make should only be used. Hydrometers of 300 mm length are necessary to give required accuracy. Two hydrometer should always be maintained in a station and they should be periodically checked to see that they read alike.

3. Pilot Cells

One of the cells in each row of the battery set should be selected and kept as the pilot cell. Readings should be taken on these cells with sufficient frequency to indicate its state of discharge and charge and serve as a guide to the condition of the other cells. The pilot cell when once selected should not be changed unless the cell has to undergo special treatment or repairs in which case a note should be made immediately on record sheets. The height of the electrolyte in the pilot cell should invariably be kept at a fixed point (say 12mm) above the top of plats by adding distilled water every fortnight, if necessary.

4. Trickle Charging

Lead acid batteries are very sensitive to overcharging as well as cover discharging. If over charged, the positive plates will shed their active material quickly. If kept in discharged condition for long, the plates will suffer ‘sulphation’ evidenced by appearance of whitish deposits on the plates. Prolonged

charging at a very low rate after emptying the electrolyte and filling the cell with distilled water is sometimes useful if the sulphation is very light. However, there should be no occasion at all for any battery set used in stationery traction installations to be sulphated, as they are continuously on trickle charge. A long life for the battery is achievable if the battery is kept floating on a battery charger so that the terminal voltage of each cell is maintained close to 2.15 V.

This can be achieved if the battery is kept on a very low rate of charge, say, 1 milli-ampere per Ah capacity of the battery. The exact rate of charge should be fixed having regard to the normal and intermittent rates of discharge over a period of 24 hours, so that the battery is always kept in fully charged condition and never overcharged or over-discharged.

When a battery is being properly float-charged very small gas bubbles (about the size of a pin head) rise slowly from the plate to the surface of the electrolyte in batteries, that are being overcharged the bubbles are much larger and reach the surface at a higher rate.

5. Cell Voltage

The voltage of cell at the end of charger is not a fixed value but will vary depending on the age of the battery. The temperature, specific gravity of the electrolyte and charging rate. The voltage of new cells at the end of a full charge will be about 2.5 to 2.75 V when it is receiving charge at the 10 hour rate. This gradually decreases as the age of the battery increases until it comes down to 2.4 V with normal temperature and charging rate.

No cell should ever be discharged below the point where the cell voltage reaches 1.85 V as measured when the cell is discharging at the normal 10 hour rate.

It should be noted that the voltage of a cell gives an approximate indication of its state of charge (or discharge) only when it is being discharged, say at the 10 hour rate, and not when the cell is an open circuit.

Sulphated plates, lug corrosion, partial short circuit due to cracked separators and other defects of a lead-acid cell cause a noticeable drop in the terminal voltage with current flowing in the cell. This drop varies with the amount of current flowing and in order to get voltages that can be compared from month to month, the voltages should be taken with the same current flowing in the cell. The cell testing voltmeters in use should be periodically checked and recalibrated, if necessary. When not in use they should be kept in a safe place.

6. Condition of Plates and Deposits

The active material in the positive plates in healthy cells in use for more than 12 months (when fully charged) should be chocolate in color and negative plates light or bluish grey according to age. The chief indications of weak cells are badly coloured plates, irregularity in gassing or entire failure to gas and a fall in voltage and specific gravity below that of other cells.

In new batteries, flakes of brown scale will be seen getting detached from edge of positive plates. This formation of scale is normal. Until all this scale is dispersed, the plate cannot be considered as stabilized. Sometimes pieces of this scale may lodge across adjacent negative plates and cause a partial short circuit. Such flaked pieces should be gently dislodged with a thin piece of wool and allowed to fall to the bottom of the cell. This scaling occurs only on the edges of the plates. The removal of the scales should be done very carefully so that the plates are not damaged.

Examine carefully the physical condition of the plates such as cracks, distortions, accumulation of whitish deposits, etc.

The color of the deposits gives a good indication of the state of health of the cells. Whitish deposit indicates undercharging leading to discharged condition. In healthy cells, the deposit is brown in

colour but excessive shedding of active material for the positive plates indicates overcharging of the battery. If this is noticed, reduce the rate of charge immediately. If all the cells in a battery show whitish deposits immediate action should be taken to give a boost charge at an appropriate rate and then to increase the trickle charging rate sufficiently to keep the battery in a healthy condition all the time. Weak cells should be immediately examined for any possible short circuit or metallic contact between positive and negative plates. The short circuit should be removed and the cell should then be given special additional charging by cutting it out and putting it back again when a healthy condition is regained, after it is attended to.

7. Inter-Cell Connectors

The inter-cell connectors of the battery should be examined to ensure that they are clean and tight, making perfect contact with cell lugs and that no corrosion is taking place. Light viseline should be applied to prevent corrosion.

Inspection of copper inter-row connectors should also be made for any signs of copper sulphate corrosion which should be cleaned up. Acid-proof paint or enamel should be applied to all exposed copper work in the battery room and any flaking of paint work given prompt attention.

20221 Protective Relays

1. Each electrified division shall have specialist staff attached to the Central Repair Shop trained in the maintenance overhauling, testing adjustment and calibration of protective relays as well as indicating, integrating and recording instruments. Such specialist staff shall hold competency certificate No. TR-7 as explained in Chapter XII.
2. The Central Repair Shop should be fully equipped with necessary apparatus, instruments, tools and equipment for overhauling, testing and calibration of relays.
3. Each Supervisor responsible for maintenance and testing of protective relays should maintain a register in which full details regarding each relay should be entered. The details to be recorded are the type and serial number, PT & CT ratios, range of settings available, characteristic curves (where applicable), location where installed, schematic diagram of connections, normal settings and details of calculations for fixing the normal setting. Details of tests as well as repairs carried out should be entered in this register from time to time. These particulars should also be maintained in the office of Sr. DEE/TRD.
4. No alterations in the settings of protective relays should be carried out without the written authorization of Sr. DEE/TRD, who will submit proposals including detailed calculations for changes required, if any, for prior approval of PCEE. Guidelines for setting of relays are given in the Appendix V.
5. The procedure for commissioning of protective relays has been given in Chapter IX.
6. The normal maintenance attention required for relays in service is generally as under:

    a. It is essential to ensure that the cover gaskets are in good condition and the fixing screw quite tight, so that the instrument is dust-tight.

    b. Manual operation to confirm that the relays do operate the trip circuits in the manner prescribed. These tests should be carried out by atleast at the level of ADEE once in a year for all relays. Simultaneously visual checks on relay connections, condition of the trip battery, trip and alarm circuits, and also the dust-tightness of protective covers should be made. The relay cover should then be sealed. A record should be maintained showing the date and time this is done.

    On each occasion when the seal is broken subsequently the reasons should be recorded in the log book.

c. Distance protection relay may be tested for calibration once in a year with primary injection set.

d. Secondary injection test - These should be done annually preferably before onset of busy season, making use of portable testing equipment and at the settings approved by the competent authority. Apart from testing the operation at the normal setting tests should also be carried out at other settings to make sure that the relay has the required characteristic.

e. Overhaul bench tests and calibration: These are necessary once in ten years of when a relay is not found functioning correctly. This work should invariably be carried out only in the Central Repair Shop by highly skilled technicians fully conversant with all details of construction and adjustment.

The bench tests and final calibration should be carried out after overhaul of the moving parts if any and measurement of coil resistance and other datain case of electro mechanical relays. Transport of the relays to and from the Central Repair Shop also requires utmost care including locking of the moving parts and careful packing and handling. When laboratory tests are fully satisfactory, the relays should be sealed and date of overhaul painted on the outer cover of the relay.

However, if numerical relays are provided, periodic calibrations should be done with the help of suitable Relay Test Kit. It shall also be ensured the healthiness of the cable/wiring and tightness of the connection of wires terminal with the TBs after testing.

Note : Existing relays are numerical relays and has no moving part if numerical relays are used then measurement of coli resistance and other data in relay shall not be required.

20222 Guidelines for Maintenance of Switching Stations

The maintenance required for equipment in switching stations is more or less similar to that for traction sub-station equipment, except that traction transformers, circuit breakers and current transformers are not present and area is much smaller. However, the only additional but important item which requires attention is condition of the return feeder connection to all the rails (at the feeding posts). These return feeder connections are liable to be damaged by Permanent Way gangs in their normal work of packing and maintaining the permanent way. Supervisory officials, therefore, should stress the importance of these from the electrical point of view to the SSE(P. Way) so that they in turn may warn their maintenance gangs not to damage the connections. In addition, the supervisory officials shall, during their periodical inspection, make it a point to inspect the return feeder rail connections and ensure that they are in excellent condition.

IV MAINTENANCE SCHEDULES

20223 Schedules of Inspection

1. In order to achieve high reliability and ZERO DEFECT, and to ensure effective checks on the maintenance work minimum schedules of inspections to be carried out each month by the TRD officers and Sr. Subordinates in charge of operation and maintenance of PSI equipments, are indicated at Annexure 2.01.

The schedule of inspections as indicated is the minimum quota to each official per month and should be independent of other tasks. They will not be of routine nature but shall be carried out in depth to identify:

a. Deficiencies and short comings.

b. Lack of skill amongst staff.

c. Inadequacies in maintenance facilities.

d. Constraints experienced.

e. Conditions of environment, which lead to poor quality of work if any.

2. The inspecting officials should adjust their inspections in such a manner as to cover all of the installations in their jurisdiction within the stipulated periods and stagger the inspections among themselves to avoid over inspections of the some installations repeatedly in a very short time and neglect of other installations. A check list in brief for various inspections is given in the Annexure 2.02.
3. The items of attention listed hereunder at any particular periodicity are over and above those mentioned in the previous schedule. This should be kept in view while carrying out maintenance work.
4. The periodicity of the items of attention listed in the following paragraphs may be modified to suit local requirements with the approval of PCEE.
5. 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 view the local conditions also and followed with the approval of PCEE.
6. Schedules for maintenance of SF-6 type circuit breakers as recommended by one of the manufacturers are indicated in the Annexure 2.06. Schedules for maintenance of vacuum circuit breaker as recommended by one of the manufacturers are indicated in the Annexure 2.07.

20224 General

1. No work of any kind shall be commenced on or in the vicinity of live equipment unless power supply to the particular part has been switched off and all other prescribed safety measures taken.
2. To guard against the possibility of unauthorised interference and pilferage from unattended sub-stations and switching station, all electrical department staff shall be vigilant and watch for any such activity when they are in the vicinity. Surprise checks coupled with periodical inspections will also act as deterrents.
3. The TPC shall once a day check up communication to each of the grid sub-stations and obtain the maximum demand and energy consumption for the previous 24 hours and enter the figures in a register. Whenever inspecting staff visit the sub-station or switching stations, they shall contact the TPC on the telephone.

FORTNIGHTLY MAINTENANCE

20225 General Inspection by a PSI Supervisor

1. Go round the whole area of the sub-station ; inspect for general cleanliness, proper drainage, road and rail access. The surface of the roadway and pathways in the sub-station should be firm and sufficiently elevated to prevent water logging. Remove any undergrowth of vegetation around the outer periphery; cut any tree branches likely to come in the vicinity of live lines.
2. If lubricating or transformer oil is stored, inspect for security and fire risk and see that no combustible material is in the vicinity.
3. Examine all "Caution", "Danger", "Shock Treatment" and other boards, whether they are clean and well secured. Inspect fire extinguishers, fire buckets and First Aid Boxes, if they are intact and serviceable.
4. Inspect structure and plant foundations for any sinking or cracking. Go round the structural work for checking tightness of various bolts and nuts.

5. Inspect all indication lamps on control panels for correct working.
6. Carry out inspections as indicated at Annexure 2.01.

20226 Battery

1. Check all cells generally in accordance with para 20220.
2. Take specific gravity and cell voltage of pilot cell and record in register. If any significant change is noticed specific gravity and voltage for all cells should be taken to identify any weak cells. Then top up with distilled water exactly to the correct level for every cell.
3. Check operation of battery charger and note charging rate in register.

MONTHLY MAINTENANCE

20227 Bonding And Earthing

Visually inspect all earth connections and see that they are in order and that every equipment has duplicate earths. Tighten connecting bolts and nuts as necessary. Where the sub-station and feeding post are close by ensure that sub-station structures are properly bonded with the feeding post and the track by two independent connections.

20228 Oil Level in Transformers, CTS ,PTs etc.

Check oil level in sight gauge glass and examine all joints, valves, plugs etc for oil leakage in each equipment; rectify leaky parts if found and restore the oil level.

20229 Insulators

Clean all insulators with dry cloth and look for any flashover marks, cracks, chippings. Insulators which are badly chipped should be replaced. Minor chippings can be rendered impervious to moisture by a light coating of Araldite or similar epoxy resin.

20230 Traction Transformers

1. Clean externally the tank, conservator, radiator, bushings, oil level indicator, gauges, etc with dry cloth.
2. Make a note in the Register of the maximum temperature of transformer oil on dial indicator; reset indicator.
3. Check explosion vent diaphragm for any damage and presence of oil
4. Check silica-gel breather. Traction Transformer (confirming to old specifications) have silica gel whose colour changes from blue to pink as it absorb moisture. Traction Transformer (confirming to latest specifications) have silica gel whose colour changes from orange to dark green as it absorb moisture. If changing color due to moisture, replace it with dry gel and recondition the old silica gel. If the (silica-gel is too wet, check di-electric strength of transformer oil. (RDSO SPEC No. ETI/SI/118(10/93) A&C Slip No. 10 August 2012
5. Check for gas collection, if any, in Buchholz relay.
6. Check for oil leakage on transformer body, conservator tank, oil drain valve and foundations. If leaking, take corrective action by tightening the bolts; replace gaskets, if necessary.
7. Check if heater in the marshalling box is functioning properly, and if all terminal connections are in order.

20231 Operating Mechanism of Circuit Breakers and Interruptors.

1. Open the cover of control box. Examine the interior and remove the accumulated dust, if any part of the interior is badly rusted indicating entry of moisture, find out the cause, plug the holes and repaint the rusted parts. Check in particular if the weather-proof gaskets are in good condition; if not, replace them to make the control box water-tight and dust-tight. Examine if the leading in pipe connections are properly bushed, sealed and water-tight. Check if all pins and checknuts are in place. Check also tie-rod nuts for tightness.
2. Operate the mechanism at least twice manually. Have it operated on remote control from RCC; keeping the control door open, observe whether the mechanism functions smoothly without any rubbing or obstruction, and also if the shock absorber functions properly when circuit breaker is tripped.
3. Examine the commutator of the motor and clean with muslin cloth. Examine carbon brushes and replace if necessary.
4. Check breather and breather holes for clogging.
5. Check gear-oil level in the mechanism and replenish it, if required.
6. Check if heater is functioning properly.
7. Check interlocks of the equipment and associated isolators.
8. Check local position indicator and remote semaphore indicator for operation. Observe for the correct operation of recording counter.

   After complete checking, close the cover and test the breaker for operation under remote, local and manual control. In addition to this, for 25kV Vacuum Circuit Breaker and Interrupter, Maintenance is to be conducted as per the maintenance instruction no. TI/MI/0054 or latest.

   (RDSO Policy Letter No. TI/PSI/CV INT/POLICY/17 Dt. 13.09.2017)

20232 Isolators

1. Manually operate isolator several times and observe if it operates smoothly and correctly. Check interlocks and integral lock, lubricate moving parts as necessary with appropriate lubricant.
2. If isolator is motor-operated, check commutator of motor and clean with dry mull cloth, and check carbon brushes for proper bedding and wear. Check if motor is working smoothly, clean limit-switch and auxiliary switch contacts and check tightness of wiring connections. Examine contactor box and signal box; clean thoroughly and lubricate all gears, shafts, bearings contact etc.

20233 Busbars, Clamps and Connectors

Immediately after switching off the power supply and earthing the lines, feel by hand all connectors and clamps on busbars and equipment terminals which carry heavy currents to see if they are too hot. If any connection is too hot, it indicates poor contact. Open up the connector; carefully clean the contact surfaces, touch up the high spots on the contact surfaces so that the mating surfaces bed well together; apply a very light coat of Vaseline, refit and tighten up. Wherever applicable, replace bimetallic strip.

20234 Control and Relay Panels.

1. Make a note of flag indications, if any, then reset.
2. Check if all indicating and recording instruments are working normally and the pointers are not sticky.
3. Note and record in the Register the ranges of voltage and current variations during a 15 minute period at the time of the day when inspection was carried out. Abnormal voltage or current should be noted for corrective action.
4. Clean the panels externally.

QUARTERLY MAINTENANCE

20235 Batteries and Battery Chargers

1. Take specific gravity and cell voltage of every individual cell and enter in the register.
2. If the battery is not in a fully charged condition, boost charger should be given as required and trickle charging rate increased to the extent required. This should only be done by a supervisory official after investigating the causes for excessive discharge.
3. Make a general examination of battery charger. Check earth connection to the body.

20236 PTs and CTs

These should be maintained generally on lines similar to that of traction transformers except for items which do not obviously apply. In addition, for PT check the fuse holders on the LV side to see if they are in order.

20237 Booster Transformers- deleted

20238 Auxiliary Transformers

1. Measure insulation resistance of transformer winding and record values alongwith temperature.
2. Test a sample of oil for BDV
3. Check that the 25 KV fuse-holder out freely on raising the spring latch. Check rod gap setting. Measure earth resistance of neutral conductor.
   Annual maintenance and periodical overhaul are to be carried out, generally as indicated for the traction transformers.

HALF YEARLY MAINTENANCE

20239 General

SSE/PSI should visit the grid sub-station and ascertain whether any significant change in the EHV grid network has occurred during the past six months or are expected shortly.

20240 Traction Transformers

1. Test oil sample from tank bottom for crackle test, acidity and BDV. If BDV is below the prescribed value, oil should be dried out.
2. Check whether the rod gap settings on bushings of transformers are in order, as per Maker's drawing.
3. Measure and record insulation resistance of all windings to earth and other windings with a 2500 V megger, alongwith temperature of windings and ambient temperature.
4. Check all alarm and trip devices for proper functioning.

20241 Isolators

1. Observe for any signs of overheating and check the wipe of contact blades. Clean blade tips and fixed-contact fingers and lightly vaseline the contact making surfaces.
2. Clean all articulated joints, sliding and bearing surfaces thoroughly.
3. Check all split pins, lock nuts and check nuts for proper condition.
4. Check for correct setting and alignment of arcing horns.
5. Operate the isolator slowly, check for simultaneous operation of the blades on the poles and correct alignment of blade tips in the fixed contact jaws of the poles. Adjust if required to ensure that the blades are fully horn between the contacts when handle is in closed position.

6. Check locking arrangements.

20242 Control and Relay Panels.

1. Check tightness of all connections, remove cobwebs and wipe off accumulated dust with dry cloth.
2. Check if tap and time settings of the relays are in order.However, in case of Numerical Relays this may not be applicable.
3. Examine fuses for signs of overheating or aging, springiness and cleanliness of contact making parts. Clean up and lightly apply vaseline to ensure proper contact.

YEARLY MAINTENANCE

20243 General.

1. Inspect the fence all-round the sub-station and bonding between metal fencing panels and to earth. Put a drop of oil in the hinges of all doors. Repaint any of the structural parts as necessary.
2. Open all the trench cover and clean them completely. Clean all culverts and remove cobwebs; check possibility of lizards or other insects gaining entry into enclosed control equipment, and make them insect-proof.
3. Arrange for painting of walls and metal-works as necessary.
4. Check all explosion vent diaphragms for any damage.
5. Check rod gap setting.

20244 Lightning Arrestors

Annual maintenance of the Lightening arrestors is to be conducted as per the maintenance instruction no. TI/MI/0041 rev.01 (or latest).

20245 Bonding and Earthing

1. Check physically the soundness of bonding and earthing connection to every electrical equipment, structural steel, lightning arrestor etc. and inter-panel connections.
2. Record earth resistance to body of electrical equipment as well as to all parts of the fencing and structural steel work.
3. Check if the terminations of the overhead shield wire covering the whole sub-station are in good physical condition and properly bonded electrically to the structures.
4. Check and record resistance of each group of earth electrodes, after disconnecting it from common earth system. Improve, if necessary.
5. Check condition of connections to the buried rails.

20246 Traction Transformers.

1. Send samples to approved laboratory for all tests listed at Annex. 2.03B (IS 1866) including dissolved gas analysis.
2. Check oil level in bushing
3. Inspect bushing gaskets for leaks and tighten bolts.
4. Move the tap-setting switch up and down the full range a few times so that by self-wiping action good contact is assured. Set the tap finally at the correct position making sure that tap-indication corresponds to position of main contacts.
5. Paint transformer tank on such parts as required.

20247 Isolators

1. Smoothen burrs, if any on the blade tips and fixed contact fingers with fine emery paper and smear Vaseline.

2. Measure clearance of blade in open position and record and adjust crank mechanism, if found necessary.
3. Check the adjustable stop set-screws for proper condition and correct positioning.
4. If the isolator is motor-operated, measure and record insulation resistance of motor windings and contactor coils using a 500 V megger.

20248 Bus Bars and Connectors

Measure with a 'Ductor' or other low resistance measuring instrument the contact resistances of all connections which are carrying heavy current.

20249 Control and Relay Panels

1. Carry out maintenance on relays as detailed in para 20221.
2. Check and clean up control switches and push-button contacts for burnt or corroded marks; polish the surfaces. Check also if the contact springs have the correct springiness.

20250 Batteries and Battery Chargers

If the battery is not in a healthy condition or if there is excessive accumulation of sediment, the whole battery should be replaced with a new set.

Battery Charger

Open out the covers of the battery charger and blow out all dust. Check tightness of all connections, bolts, Nuts and screws. Measure and record the insulation resistance of the transformer windings of the battery charger with 500 V megger.

20251 PTs and CTs

1. Test oil samples if possible.
2. Check rod gap setting, if provided
3. Measure insulator resistance.
4. Check conditions of fuses of PTs and terminal connections for CTs.

20252 Deleted (RDSO SPEC No. TI/SPC/PSI/HV CB /0121(MAY 2021) & (RDSO SPEC No. TI/SPC/PSI/LV CB /0120(DEC 2013)

20253 Pre-Monsoon Check

Before onset of monsoon season, it should be ensured that for every equipment no scheduled maintenance work is overdue. In the scheduled inspection just preceding the monsoon, special attention should be paid to the vulnerable points likely to permit ingress of moisture resulting in reduction in dielectric strength of the equipments and rusting of parts.

20254 Overhaul Schedule for Equipment

1. Overhauling of Traction Power Transformer can be undertaken subject to fulfillment of conditions as stipulated in SMI no. TI/MI/0039 Rev.02 (or latest).
2. Operating mechanism of Circuit Breaker and Interrupters: Maintenance of Circuit Breakers and Interrupters is to be conducted once in six years as per the maintenance instruction no. TI/MI/0054 or latest.

Annexure 2.01
(Para 20202, 20223)

SCHEDULE OF MONTHLY INSPECTIONS

SN.	Nature of Inspection	Sr. DEE	DEE	ADEE	SSE*	JE*
1.	Traction sub-station	1	1	2	4	4
2.	Switching stations	1	2	3	4	4
3.	PSI Depots	1	2	4	-	-
4.	Grid Sub-station	2 in a Yr.	1	2	1	1
5.	Office Insp.	1	1	-	-	-

Notes:

1. These inspections are the minimum quantum per month
2. * In respect of Supervisory staff, the inspections pertain to their respective jurisdiction
3. Check lists of items to be broadly covered are indicated at Annexure 2.02. The maintenance schedules prescribed should also be kept in view.
4. Quota of inspections by HQ officers may be laid down by PCEE.

Annexure 2.02
(Para 20223)

CHECK LIST FOR INSPECTIONS

1.0 PSI depots including Subordinate Offices

a. OHE/PSI Depots

Check

i. Staff grievance register
ii. Quarter Register.
iii. Attendance register
iv. Cleanliness of depot
v. Upkeep of stores.
vi. Stock position in Stores
vii. Compliance of audit & account inspection notes.
viii. Test & Trial report
ix. Availability of latest drawings and specifications.
x. Planning and Progress of Section works.

b. Subordinate Office:

Check

i. Attendance register.
ii. Compliance of audit & account inspection notes.
iii. Compliance of officer's inspection notes.
iv. Test & Trial report
v. Availability of Drgs. And specifications.
vi. Progress & Planning of section works.

2.0 Inspection of Grid Sub-station.

1. Be on look out for any modifications made/being made in the power supply arrangement.
2. Check up if there is any equipment under breakdown which is likely to increase risk of interruption in power supply to traction.
3. Note down meter readings and scrutinize and record important data regarding power supply parameters including daily MD, variation in voltage, frequency and power factor.

3.0 Inspection of Traction Sub-Station.

a. Switch Yard:

Check

i. For vegetation growth and spreading of pebbles.
ii. Painting of fencing and equipments.
iii. Condition of cable trenches & trench covers.
iv. Condition of approach road.

b. Power Transformer:

Check

i. OTI and WTI temperature – present and maximum readings.
ii. Oil level in conservation tank

iii. Tap changer position of standby & service transformer.
iv. For abnormal humming.
v. Colour of silica gel.
vi. For leakage of oil on transformer body, conservator tank, oil drain valve and radiator.

c. Circuit Breaker and Interrupters

Check

i. Control box gaskets for water and dust tightness.
ii. Operation by local & remote control.
iii. Operating mechanism for smooth operation
iv. Closing time of interruptor.
v. Number of trippings since last replacement of oil in case of circuit breaker and counter reading of interruptor.

d. PT, CT, AT.

Check

i. Leakage of oil

e. Isolator

Check

i. Locking arrangements.
ii. For correct alignment of blade tip in the fixed contact jaws.
iii. For correct matching & alignment of arcing horns,

f. Control Panel

Check

i. Fuses for the correct size, overheating or aging signs.
ii. For loose connections at terminal boards.
iii. Functioning of Alarms and visual indication on control panel.
iv. Functioning of auxiliary relays.

g. Battery charger & Batteries.

Check

i. Acid level
ii. Presence of sedimentation
iii. Specific gravity & voltage of pilot cell
iv. Presence of sulphation and tightness of inter cell connectors.
v. Size of fuses of battery charger.
vi. Voltmeter and ammeter readings.

h. Energy meter

Check

i. Recorded maximum demand.
ii. Condition of the seal.

i. Earthing

Check

i. Soundness of earth connection to each electrical equipment and structure.

ii. Last recorded earth resistance readings.
iii. Buried rail connection.

j. Remote Control Equipment

Check
i. General function of relays and selectors.
ii. Wiring for loose connection if any.
iii. For presence of dust & condition of cubicle gaskets.

k. General

Check
i. Availability of fire buckets, Respiration chart, First Aid Box, Tools & Plants.
ii. Working of TPC Phones and emergency sockets.
iii. Inspection register and remarks made therein
iv. History sheets of various equipments.

4.0 Switching Stations

a. Switch yard.

Check
i. For vegetation and spreading of Pebbles.
ii. Painting of fencing and equipments
iii. Condition of cables trenches & trench cabins.

b Interruptors

Check
i. Control box gaskets for water and dust tightness.
ii. Operation by local & remote control.
iii. Operating mechanism for smooth operation.
iv. Interlocking of interruptors and under voltage relay operation at SP.

c. PT & AT

Check
i. Leakage of oil

d. Isolator

Check
i. Locking arrangements
ii. For correct alignment of blade tips, in the fixed contact jaws & alignment of arcing horns.

e. Battery charger & Batteries.

Check
i. Acid level.
ii. Presence of sedimentation.
iii. Specific gravity & voltage of pilot cells.
iv. Presence of sulphation & tightness of inter-cell connectors.
v. Size of fuses of battery charger.
vi. Voltmeter & ammeter readings.

f. Earthing

Check

i. Soundness of earth connection to each electrical equipment & structures.
ii. Last recorded earth resistance readings.

g General

Check

i. Availability of fire buckets, respiration chart, First Aid Box, Tools & Plants.
ii. Inspection register and remarks made therein
iii. History sheets of various equipments.

Annexure 2.03 A
(Para 20207)

Oil Parameter IS:335 (Type-II) and RDSO letter no. TI/PSI/INSOIL/POLICY/19/01 dated 26/29.07.2019

Parameter		IS:335:2018 (Type II)
Viscosity at 40 oC,	Max	15 mm2/s,
Viscosity at 0oC,	Max	1800 mm2/s
Pour Point,	Max	0oC
Water Content,	Max	40 mg/kg
Breakdown Voltage, Min.	New Filtered	30kV 70 kV
Density at 20 oC,	Max	0.895 g/ml
DDF at 90 oC,	Max.	0.005
Particle content		No general requirement
Appearance		Clear, free from sediment and suspended matter
Acidity, mg KOH/g	Max	0.01
Interfacial Tension	Min	40 mN/m
Total Sulphur Content		No general requirement
Corrosive Sulphur		Not Corrosive
Potentially Corrosive Sulphur		Not corrosive
DBDS		<5 mg/kg
Inhibiters according to IS 13631/ IEC 60666		Inhibited Oil (0.2 to 0.3)%
Metal Passivator additives		<5 mg/kg
Other additives		Supplier to declare
2-Furfural and related compounds contents		(<0.05 mg/kg) for each individual compound
Oxidation Stability	(mg KOH/g)	
a. Total Acidity	Max	0.2
b. Sludge	Max	0.8% 0.05%
c. DDF at 900C	Max	0.5
Gassing Tendency		No general requirement
ECT		No general requirement
Flash Point	Min	140 oC
PCA	Max	3%
PCB		< 2 mg/kg

Annexure 2.03 B
(Para 20207)

Application and interpretation of tests on Transformer oil in service
(Ref: IS 1866)

SN	Tests	Value as per IS: 1866 Permissible limits	To be re-conditioned	To be replaced
1.	2.	3.	4.	5.
1.	Electric strength (break down voltage) Below 72.5 kV 72.5 and less than 145 kV 145 kV and above	Min 30 kV 40 kV 50 kV	Less than the value specified in Column 3	
2.	Specific resistance (resistivity) Ohm/cm at 27oC	Above 10 x 1012	Between 1 x 1012 to 10 x 1012	Below 1 x 1012
3.	Water content Below 145 kV Above 145 kV	Max 35 ppm 25 ppm	Greater than the value specified in column 3	-
4.	Dielectric dissipation factor, Tan delta at 90oC	0.01 or less	Above 0.01 to 0.1	Above 0.1
5.	Neutralization value mg KOH/g of oil	0.5 or less	Above 0.5	Above 1.0
6.	Interfacial tension N/m at 27 oC	0.02 or more	0.015and above but below 0.02	Below 0.015
7.	Flash point in oC	140 or more	125 and above but below 140	Below 125
8.	Sludge	Non- detectable	Sediment	Perceptible Sludge
9.	Dissolved gas analysis	Refer Annex 2.04		

Annexure 2.04
(Para 20216)

GUIDELINES FOR CONDITION MONITORING OF TRACTION POWER TRANSFORMER BY DISSOLVED GAS ANALYSIS (DGA) TECHNIQUE

(Reference RDSO's circular No. ETI/PSI/M/4 dated 5.2.91)

1.0 Introduction

1.1 Dissolved gas analysis (DGA) is a powerful diagnostic technique for monitoring the internal condition of transformer as it is capable of detecting faults in the incipient stage, before they develop into major faults and results in the outage of the transformer. The conventional Buchholz Relay is universally used in transformers to protect against severe damages. However, its limitation is that enough gas must be generated first to saturate the oil fully and then to come out or there should be a gas surge to operate this relay. Moreover, Buchholz Relay is never meant to be a diagnostic device for preventive maintenance of transformers.

1.2 The DGA technique is very sensitive as it detect gas in parts per million (ppm) of the oil by use of the GAS Chromatograph. It is possible to check whether a transformer under service is being subjected to a normal aging and heating or whether there are incipient defects such as Hot Spots, Arcing, Overheating or Partial discharges. Such incipient faults otherwise remain undetected until they develop into a major failure.

2.0 Formation of Gases in Oil Filled Transformers.

2.1 It is well known that insulating oil in high voltage equipments can break down under the influence of the thermal and electrical stresses to produce hydro-carbon gases, hydrogen and carbon oxides. Gases may be formed in transformers and other high voltage oil filled equipment due to aging and to a greater extent as a result of faults. The accumulation of gases in transformer oil may be sudden due to a severe arcing fault or more gradual as in the case of slow deterioration of insulation. The principle mechanism of gas formation in a transformer tank can be classified as under:

a) Oxidation b) Vapourisation, c) Insulation decomposition d) Oil breakdown e) Electrolytic action

2.2 Oxidation

Carbon dioxide is the gas predominantly liberated during the process of oxidation. The process begins when small quantities of oil combine chemically with the dissolved oxygen in the oil resulting in formation of traces of organic acids. These acids react with the metal of the transformer, forming metal based soaps which dissolve in the oil and act as a catalyst to accelerate the process of oxidation.

2.3 Vapourisation

The vapourisation of oil occurs at about 280 degree C while that for water occurs at about 100 degree C. The false alarm of a Buchholz relay may be attributed to the fact that the condensation of water vapour takes place when the excess moisture in the tank is vapourized by a heat source. False alarm can also occur, when hydro-carbons, the constituents of the insulating oil, vapourize.

2.4 Insulation Decomposition

The solid insulants in power transformers are mainly of cellulose or resinous type, viz. Paper, press board, cotton, resins and varnishes. These substances contain in their molecular structure substantial amounts of oxygen, carbon and hydrogen. In the temperature range of 150 degree C to 400 degree C the insulation breakdown results in liberation of hydrogen, carbon dioxide and carbon monoxide. Above 400 degree C the gases formed are relatively less.

2.5 Oil Break Down

The direct break down of oil by arcing results in cracking of the oil. The aromatic contents breakdown into simple hydro carbon gases and hydrogen. Acetylene and methane are the major constituents. Other hydrocabon gases may also be liberated due to cracking. If the necessary temperature is maintained for their stable formation.

2.6 Electrolytic action

Hydrogen and oxygen are liberated during electrolytic action. Presence of minute and small particles of fibres within the oil leads to electrolytic action. Light hydrocarbon gases may also be present, if solid insulation is involved.

3.0 Types of Fault Conditions

There are three main types of fault viz. Overheating of windings, core and joints, partial discharges, and arcing.

3.1 Overheating

Overheating metallic parts heat up the surrounding regions such as paper insulating tapes and oil. This leads to thermal deterioration of these materials. Thermal degradation of paper produces Carbon Dioxide, Carbon monoxide and water. The ratio of carbon dioxide to carbon monoxide is typically five, but if the ratio falls below three, there is indication of severe overheating of the paper. Oil degradation produces a number of hydro carbon gases such as methane, ethane, ethylene, and acetylene. Methane and ethane are decomposition products that appear above 120 degree C ethylene appears above 150 degree C while acetylene is a high temperature product, appearing at several hundred degrees centigrade. Some hydrogen is also produced along with the hydro carbons gases. The proportion of the various hydrocarbons varies with temperature. This is the basis of the well known Ratio code introduced several years ago by Dorenberg and R.R. Rogers.

3.2 Partial Discharge

The second type of fault condition is partial discharge which occurs due to ionization of oil in highly stressed areas where gas/vapour filled voids are present or the insulation is containing moisture. The main product during particle discharge is hydrogen, though small amounts of methane and other gases would also be present depending upon thermal degradation. The disintegration of oil and cellulose due to particle discharge is characterized by the removal of the outer hydrogen atoms to form hydrogen gas. The remaining molecular framework polymerizes and long chain products such as waxes are formed. Thermal degradation is a more predictable phenomenon which involves the break up of chemical bonds. Cellulose decomposes ultimately to CO, CO2 and water; oil break up into lower molecular hydro-carbons.

3.3 Arcing

The third type of fault condition is arcing. Arcing can occur between leads, between lead and coil and between other highly stressed regions weakened by fault conditions. The high temperature caused by arcing results in the production of acetylene and hydrogen.

3.4 Pattern of generation of gases in transformer is summarized below:

FAULT/PATTERN	KEY GAS
Conductor Overheating	CO/CO2 (carbon oxides)
Oil overheating	C2 H4 (Ethylene)
Particle discharge	H2(Hydrogen)
Arcing	C2H2 (Acetylene)

4.0 Solubility of Gases

4.1 The solubility of gases in oil varies with temperature and pressure. While solubility of H2, N2,CO, O2 in oil increases with temperature and that of CO2, C2H2, C2 H4 and C2 H6 decreases with temperature, solubility of CH4 remains essentially constant.

All the gases become more soluble in oil with increase in pressure. Solubility of gas is one of the factors contributing to the complexities in formulating permissible levels of gases on the basis of service life of a transformer. Table I show solubility of different gases 25 degree C and at 1 atm. The homogeneity or the gases in the oil is dependent on the rate of gas generation, access of the fault area to flowing oil, rate of oil mixing and presence of gas blanket.

5.0 Dissolved Gas Analysis (DGA)

5.1 Dissolved gas analysis (DGA) of the oil of a transformer in operation is a specialized technique to assess the internal condition of the transformer. DGA is performed by Gas Chromatography. The gases extracted from the oil by a suitable apparatus are transferred to the Gas Chromatograph system for analysis.

5.2 The knowledge of solubility of Hydro-carbon and fixed gases at different temperatures, in insulating oils helps in interpretation of gas analysis. The permissible concentration of dissolved gases in the oil of healthy transformer is shown in table II. The combinations of Gas levels for different types of faults are shown in Table III while table IV shows the gas composition by volume under arcing fault with participation of various components of solid dielectrics in a transformer.

5.3 While the absolute concentration of fault gases gives an indication of status of insulation of transformer, whereas the relative concentration of these gases provides a clue to the type of fault. For fault diagnosis the method based on Roger's Analysis is adopted.

5.4 Rodger's method:

This method hold good for hydro carbon gasses by evaluating the gas ratios, the type of fault is detected. Four ratios are used viz. Methane/Hydrogen, Ethane/Methane, Ethylene/Ethane and Acetylene/Ethylene. The value of ratios can be greater or smaller than unity. The ratio and type of fault represented by that ratio are given in Table V.

6.0 Data Collection and Analysis.

6.1 It is recommended that DGA be performed irregularly once a year on every transformer upto 4 years of service and thereafter twice a year upto 10 years and the frequency thereafter may be increased to thrice a year.

Note: Wherever the Buchholz relay operates, the dissolved gas analysis be carried out immediately after operation of the relay to ascertain the cause of fault.

6.2 The results of the DGA for each transformer should be built into a data and based on the trend of the gas levels over a period of time as well as the faults, if any, that the transformer had suffered, an analysis may be done to establish the exact nature of the incipient fault that may be developing in the transformer.

TABLE I

SOLUBILITY OF DIFFERENT GASES IN TRANSFORMER OIL AT 25 DEGREE C 1 atm

Gas	Volume % With reference to volume of oil
Hydrogen	7
Oxygen	16
Nitrogen	8.6
Argon	15
Carbon Monoxide	9
Carbon dioxide	120
Methane	30
Ethane	280
Ethylene	280
Acetylene	400
Propylene	400
Propane	1900
Butane	4000

TABLE II

RANGE OF GAS LEVELS
(All concentrations are in PPM)

Gas	0-4 years	4-10 years	10 years.
Methane	10-30	30-80	30-130
Ethane	10-30	30-50	30-110
Ethylene	10-30	30-50	50-150
Acetylene	10-16	10-30	10-40
Hydrogen	20-150	150-300	200-500
Carbon Monoxide	200-300	300-500	500-700
Carbon Dioxide	3000-4000	4000-5000	4000-10,000

Table III

Gas levels for different fault conditions
(All concentrations are in ppm)

Fault gases	**Hydrogen H2**	**Methane CH4**	**Ethane C2H6**	**Ethylene C2 H4**	**Acetylene C2H2**	**Carbon Dioxide CO2**
Arcing	500-1000	20-130	10-30	10-30	40-100	3000-4000
Partial discharge	500-1000	20-130	10-30	10-30	10-15	3000-4000
Hot spot	20-150	10-30	10-30	150-200	10-15	3000-4000
Gradual Overheating	20-150	10-30	150-200	10-30	10-30	3000-4000

Table- IV

Gas composition by volume (%) with reference to volume of oil due to arcing faults

Insulation	H2	CO	CO2	CH4	C2H6	C2H4	C2H2	O2	H2
Oil only	60	0.1	0.1	3.3	0.05	2.1	2.1	2.4	6.3
Oil/Kraft paper	52	14	0.2	3.8	0.05	8	12	3	6.7
Oil/ Press board laminate	48	27	0.4	5	-	5	6	2	6.2
Oil, Alkyl paint	55	20	0.2	4	-	5	8	2.4	7
Oil/ Polyure thane enamel	60	1	0.1	9	-	11	10	2	6
Oil/ PVA enamel	61	5	0.1	6.0	-	14	5	2.5	6.5
Oil/ Epoxy glass clothes	57	2	0.1	14	-	10	8	2.5	6.5
Oil/ Isophthalate cotton tape	55	11	4	8	-	8	5	-	-

Table V

Roger's method of diagnosis by Hydro-carbon gas ratios

Methane Hydrogen	Ethane Methane	Ethylene Ethane	Acetylene Ethylene	Diagnosis	% of transformers sampled
0	0	0	0	If Methane/ Hydrogen less than 0.1- partial discharge Normal deterioration	2.0 34.2
1	0	0	0	Slight overheating below 150 oC	11.8
1	1	0	0	Slight overheating 150oC -200oC	9.0
0	1	0	0	Slight overheating 200oC -300oC	7.8
0	0	1	0	Normal Conductor overheating	11.1
1	0	1	0	Circulating currents and/or overheated joints	9.0
0	0	0	1	Flashover without power follow through	2.1
0	1	0	1	Tap changer selector breaking current	1.1
0	0	1	1	Arc with power follow through or persistent arcing	9.7

CH_4 - Methane
$C2H_6$ - Ethane
$C2H_4$ - Ethylene
$C2H_2$ - Acetylene
H_2 - Hydrogen

ANNEXURE 2.05

(Para 20218)

PHYSICAL PROPERTIES OF SF 6 GAS

1.	Molecular Weight	146.07
2.	Melting point	-50.7 degree C
3.	Sublimation Temperature	-60.8 degree C
4.	Critical Temperature	45.547 + 0.0003 degree
5.	Critical Pressure	38.55 Kgf/Cm2
6.	Critical Density	0.730 g/Cm2
7.	Dielectric constant at 25 degree C 1 atm	1.002
8.	Thermal conductivity at 30 degree C	3.36 x 10
9.	Density at 20 degree C:	

kgf/cm^2	gm/lit.
At 0	: 6.25
At 1	: 12.3
At 5	: 38.2
At 10	: 75.6
At 15	: 119.0

Annexure 2.06
(Para 20223)

MAINTENANCE OF SF 6 CIRCUIT BREAKERS

1.1 Schedules

The maintenance and check execution standard depends upon the working conditions of the CB. The checks to be carried out, their frequency and scope are broadly as under:

Type of check	Frequency	Scope
Patrol Inspection	Every Week	The patrol inspection is an external check of the Circuit breaker in live condition for irregularities.
Ordinary Inspection	After every 1000 operation	The ordinary inspection is inspection performed by turning off the circuit breaker for a relatively short time for simple inspection and servicing with emphasis on functional checks e.g. visual check of irregularities and cleaning of dust and dirt.
Detailed Inspection	After every 3000operation	The detailed inspection is an inspection performed by turning off the circuit breaker for a relatively long time to dismantle and inspect the mechanism for irregularities for the purpose of continuously maintaining the performance
Incidental Inspection -	-	The incidental inspection is performed when inspection and repair are necessary due to the detection of an irregularity during patrol inspection or during operation.

1.2 General

Attention should be paid to the following points during ordinary and detailed inspection.

a. Switch off control/compressor motor supply. Discharge all the air in the air receiver through the drain valve.

b. The circuit breaker is to be inspected in the open position unless otherwise specified in these instructions. At the open position of the breaker the safety pins for preventing closing and opening must be inserted. On completion of the inspection, the safety pins must be removed.

c. Good quality grease should be used adequately.

d. Circlips and split pins which are removed must be replaced with new ones.

e. Remove"O" rings must be replaced with new ones. While handling and placing "O" rings in their grooves care should be taken to avoid dust falling on them.

1.3 Inspection and Servicing Procedure

Point/Location	**Item or Part/Procedure**	**Patrol Inspection**	**Ordinary Inspection**	**Detailed Inspection**
Appearance for damage	1. Check the porcelain	x	x	x
	2. Check the main terminal for discoloration			x
	3. Check the foundation bolts for looseness	x	x	x
	4. Check the grounding pad for looseness		x	x
	5. Check the position indicator		x	x
	6. Drain water from air reservoir	x	x	x
	7. Record the number of circuit breaker operation	x	x	x
Interruption unit	8. Inspection of contact and renewal if necessary			x

	9. Renewal of absorbent			x
	10. Measurement of resistance of interrupting units			x
Gas system	11. Record of gas pressure and temperature	x	x	x
	12. Check the valve B is open and valve A is closed		x	x
	13. Supply the gas, if the pressure less than prescribed value	x	x	x
	14. Check the setting of gas pressure switch		x	x
Operating Mechanism Housing	Pressure gauge:			
	1. Ensure that needle indicates rated operating pressure	x	x	x
	2. Ensure that needle indicates with in tolerance(1.5% of full scale) when air is released thoroughly from air tank	x	x	
	Air leakage:			
	1. Check pneumatic system such as valves and piping for air leak sound	x	x	x
	Space heater:			
	1. Check for disconnection	x	x	x
	Operating counter:			
	1. Check number of operations	x		
	2. Ensure that counter counts with operation		x	x
	Draining:			
	1. Drain water from air tank	x		
	Water penetration & rust:			
	1. Check penetration of rain water and rust		x	x
	Fastened Joints:			
	1. Ensure that nuts and bolts etc. are not loosened		x	x
	Control circuits:			
	1. Check connections of control circuit wiring for fastening		x	x
1. Tripping Mechanism	Check the dimensions of tripping solenoid magnet:			
	1. Check the clearance “ST” (Solenoid magnet stroke) between armature and Core		x	x
	2. Check the clearance “GT” between plunger and trigger		x	x
	3. Check ST -GT		x	x
	Part replacement and relubrication (Grease):			
	1. Remove pin “B” and control valve assembly			x
2. Tripping Mechanism	3. Roller lever of control valve Assy:			
	1. Close the breaker and fully drain out the the air from air reservoir. Operate control valve by pushing down trip coil plunger with soft mallet. Rotate rollers (c) and (D) to check that they rotate freely. Open the breaker by using Manual jack assembly.		x	x

Closing mechanism	Check the dimensions of closing solenoid magnet:			
	1. Check the clearance "SC" (solenoid magnet stroke) (between armature (27) and core (28))		x	x
	Check the pumping prevention pin to latch distance:			
	1. Check the clearance "P" between anti pumping pin and latch		x	x
Main piston rod	Relubrication (Grease)			
	1. Wipe contaminated grease off piston rod and apply new grease in closed position.			x
Operating mechanism	Operating Mechanism Stroke:			
	1. Check Stroke "S" from closed position to completely opened position		x	x
	2. Check over-stroke "So" from completely opened position to stopped position		x	x
Testing	Manual Operation			
	1. Remove closing and opening lock pins, and charge air upto 15 kg/cm2 . Operate closing solenoid magnet and opening solenoid magnet to check operation.		x	x
	Check of minimum operating pressure:			
	1. Make sure that circuit breaker is opened at air pressure of 11 kg/cm2		x	x
	Air Pressure switch:			
	1. Make sure that air pressure switch is properly set.		x	x

Annexure 2.07
(Para 20223)

MAINTENANCE OF VACUUM CIRCUIT BREAKERS

1.0 General

The maintenance and check execution standard depends upon the working conditions of VCB, such as the environmental condition, current switching frequency and others. Preventive maintenance is to be conducted as per the maintenance instruction no. TI/MI/0054 or latest.The checks to be carried out, their frequency and scope are broadly as under:

Type of check	Frequency	Scope
Patrol check	Daily	Check VCB under daily operating condition.
Ordinary check	Once every 3 years or once every 1000 switching times	Check VCB after disconnection main supply and local Remote switch in LOCAL position.
Detailed check	Every 6 years	"
Provisional check	When a trouble occurs	"

For the minimum number of operation without replacement of vacuum bottle para 1.5 below may be referred.

1.1 Patrol Check

Patrol check shall be done visually. If any abnormality is found, stop the operation forthwith and examine.

Item No.	**Check items**	**Checking parts & key points.**	**Explanation**
1.	General parts	Dust and moisture condensation and evidence of ingress of rain water in operating box.	
		Unusual sound, small and decolouration.	
		Condition of open-close indication.	"On in red, closed condition; "off" in green, open condition.
		Working condition of charge indicator	
2.	Temperature	Main circuit terminals and electrode pole assembly	Check if the operating voltage and control voltage are kept at the respective specified values.
3.	Control Voltage	Check carefully if the terminal section is discoloured and also, the air is waving with heat.	

IV.95 Ordinary Check

The standard checking items and servicing intervals (given by years or number of operation) are generally suggested in table below. However, it is recommended that the checking intervals shall be determined according to the actual working conditions including the installed atmosphere and operating frequency of the circuit breakers.

Item No.	Classification	Checking &Servicing	Recommended Checking &Servicing procedure	Remarks Standard checking intervals.
1.	General parts	Cleaning. each part	Remove dust sticking to circuit breakers, especially the insulators	3 years
		Tightened parts	Looseness in bolts and nuts, and also break &drop off of washers, snap rings, snap retainer etc.	3 years
2.	Operating Units	Operating mechanism &link mechanism	Check the movement Check the deformation &rust. Check limit Switches for proper function	3 years
			Condition of links and collars and damage in them	3 years
			Leakage of oil in the speed regenerator.	3 years
		Control circuit	Looseness of the terminations of wires.	3 years
		Counter	Number of operations	3 years
		Open close indicator	Operating condition	3 years
		Charge indicator	Operating condition	3 years
3.	Check of operation	Open-close operation	Close and open several times each in manual and electrical operations. Spring charging operation	3 years
4.	Measurement of insulation	Across main conductive parts and ground and across poles.	More than 500 M. ohms the general standard (by 1000 megger)	3 years

IV.95 Detailed Check

Checking shall be performed as per items listed in ordinary check and as per items listed below:

Item No.	Classification	Checking &Servicing	Recommended Checking &Servicing procedure	Remarks Standard checking intervals.
1.	VI	Vacuum check	Contact manufacture	6 Years 3000 operations
2.	Operating units	Operating mechanism	Lubrication to rotary part, sliding parts and pin engaging part (use low viscosity machine oil or equivalent)	6 years
		Check of adjusting dimensions of each part	Gap between trip hook and roller followers and other adjusting dimensions Refer to clause 5-6	6 years
		Spring	Rust, damage and deformation	6 years
		Coils	Breaking of wires and others.	6 years
3.	Check of Operating Condition	Min. operating voltage	Tripping Voltage: under 70% rated voltage Closing Voltage: under 85% rated voltage	6 years

1.6. 25 Kv Vacuum Interruptor

The minimum numbers of operations of Interrupter without replacement of vacuum bottle is as follows:

1. At a rated breaking current of 4 Ka - 4600 nos.
2. At a breaking current of 2 Ka - 8000 nos.
3. At a breaking current of 1.2 Ka - 10,000 nos.
4. At a breaking current of 0.4 Ka - 10,000 nos.
5. At a breaking current of 600 A - 10,000 nos.

TORQUE FOR VARIOUS SIZES OF BOLTS IN kg.m

Annexure 2.08
(Para 22015 and 20304)

Bolt Size	Nominal Stress	Steel	Stainless Steel
10	58	4.73	5.91
12	84.3	8.25	10.31
14	115	13.14	16.42
16	157	20.61	25.61
18	192	28.18	35.23
20	245	39.96	49.95

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CHAPTER-3
OVERHEAD EQUIPMENT

20300 Introduction

1. This chapter is divided into five Sections as under:-

Section I - Organization: A broad description of the duties of 3 important categories of staff in OHE Section is given. Here also, in territorial distribution of work, the SSE in charge have all activities under his control, and SSEs next in command will be in charge of functional activity.

Section II – Guiding Notes on Maintenance: The important points to be borne in mind in the maintenance of the main items of OHE are enumerated.

Section III – Maintenance Schedules for OHE: A recommended schedule of maintenance for OHE is given.

Section IV – Safety Rules for OHE: The essential safety rules applicable to OHE staff are given.

Section V - Forms and Registers: The records to be maintained in regard to OHE maintenance and recommended performance for these are given.

2. The following relevant documents have been incorporated as Appendices to this Volume.

2.1 "Principles for Layout Plans and Sectioning Diagram for 25 kV ac Traction" issued by RDSO (Appendix I).

2.2 "Code for Bonding and Earthing for 25 KV ac 50 Hz. Single Phase Traction System" issued by RDSO (Appendix II)

2.3 "Regulations for Power Line Crossing of Railway Tracks "issued by Railway Board (Appendix IV)

2.4 "Guidelines for Provision of Maintenance Depots, Tools and Plants and Transport Facilities (Appendix VI)

2.5 Model Circulars" (Appendix VII)

2.6 "List of Specifications and for Equipments and Materials for Railway Electric Traction" issued by RDSO (Appendix IX)

2.7 "Diagrams of General Arrangement and Fittings" a reference booklet issued by RDSO (Appendix X).

I ORGANISATION

20301 Duties of SSE (OHE)

He is the senior supervisor working under the control of Sr. DEE/DEE (TRD) and directly responsible for the proper maintenance of OHE including the 25 KV feeders and return feeders from the traction sub-stations to the feeding posts. He should be fully conversant with the layout and sectioning of OHE in his jurisdiction as also the rules and procedures laid down for efficient maintenance of OHE and safe working on OHE.

In particular he shall:

1. Supervise the maintenance of installations under his charge in accordance with the prescribed schedules, to keep them fully serviceable and in a state of good repair.

2. Plan in advance the requirement of power blocks for OHE maintenance based on the work to be done in consultation with his section supervisors and ensure the completion of the work within the time allotted.
3. Carry out detailed inspections of OHE under his control by foot patrolling to cover the entire section once in a year.
4. Scrutinize daily the reports on foot patrol and other defects on OHE, as well as reports from section supervisors and inspection reports of officers and arrange prompt rectification of defects pointed out and report compliance to Sr. DEE/DEE/ADEE (TRD)
5. Check the work by sectional gangs under him to ensure that quality work is done and that compliance with prescribed schedules is adhered to.
6. Keep the organization for attending to breakdowns in constant readiness to act promptly and expedite restoration whenever there is a breakdown.
7. Instruct and train staff under him in the correct methods of maintenance with special reference to safety precautions.
8. Arrange to send his staff for training courses as required.
9. Ensure that special testing instruments, tools and equipment including the OHE inspection cars and breakdown vehicles, provided for maintenance of OHE are properly cared for and maintained in proper condition.
10. Keep a watch on availability of spare parts and stores required for maintenance of OHE and initiate timely action to recoup stocks.
11. Ensure proper accounting and periodical verification of the stores and tools under his charge.
12. Submit the prescribed periodical returns to DEE/ADEE(TRD) and carry out their instructions issued, if any, on the basis of such returns.
13. Keep his superior officers fully informed of each and every important development and seek their guidance when required.
14. Carry out such other duties as may be allotted to him by his superior officers; and
15. Carry out inspections as indicated at Annex. 3.01.

20302 Duties of Field Supervisors.

The field supervisors in charge of OHE (SSE, JE etc.) will be under the SSE (OHE) and each supervisor will be responsible for the following.

1. Maintenance of the OHE and allied installations in his jurisdiction in accordance with the prescribed schedules.
2. Submission of the requirements of power blocks for OHE maintenance, in co-ordination with permanent way maintenance as far as possible, so as to take maximum advantage of traffic blocks.
3. Detailed inspection of OHE under his charge on foot as(Once in three month) indicated in para 20322 and 20323.
4. Scrutiny of daily foot patrol and other reports of defects and take prompt action to remedy the defects brought out.
5. Close supervision of the maintenance gang under his control to ensure a high standard of work and compliance with prescribed schedules.
6. Keeping the organization under his control in readiness to deal with breakdowns.
7. Guidance to the maintenance staff for the proper execution of work in accordance with standing instructions.

8. Ensuring that tools and equipment under his charge are properly cared for and maintained in proper condition
9. Keeping watch and taking necessary action to recoup stores and spares required for his jurisdiction.
10. Preparation and submission of periodical reports and returns to superior officials as laid down:
11. Keeping SSE (OHE), ADEE(TRD),DEE(TRD) and Sr. DEE(TRD) informed of all important developments and seeking their guidance when required.
12. Carrying out any other duties allotted by superior officials.
13. Carrying out inspection indicated at Annex. 3.01.

20303 Technician (Rly Bd. L.No. 2013/ELECT/148/1Dt.10.05.2019 Foot Patrolling by Technician)

1. All technicians should have requisite educational qualifications to enable their working independently – to take power blocks from TPC, deal with messages in connection with power blocks and also to submit written reports to their supervisor in regard to patrol and inspection work assigned to them. However, until it is possible to have all Technicians with the requisite educational qualifications, it will be necessary to authorize only selected technicians to deal independently with taking of power block and issue of messages. Literate Technician to be authorized to take power blocks independently should be trained and certified.
2. Every Technician should be conversant with the safety rules pertaining to his work and be capable of independently attending to minor repair and adjustment work on OHE. For this purpose he would be required to carry his tool box, telephone etc. with him wherever needed.
3. A Technician should be able to carry out operation at switching stations on local control in an emergency under instructions from the TPC.
4. Technician shall look for the common types of defects on OHE when they are deputed for patrol work and to report on defects noticed during such patrols to the Section Supervisor (Para 20322)
5. Every Technician should develop the ability to carry out temporary repair in the event of breakdowns so as to restore traffic as quickly as possible and to deal with repairs necessary for all types of breakdowns of OHE.

Assistant

a. As per ACTM CS-31 dated 20.01.2020, "A literate Assistant having minimum three years of working experience is authorized to operate isolator.

b. Provide temporary earth on OHE/PSI installations after they are made dead under the instruction of Section/Batch supervisor

c. Assistant shall look for the common types of defects on OHE when they are deputed for foot patrol work and to report on defects noticed during such patrols to the Section Supervisor.

d. Every Assistant should develop the ability to carry out temporary repair in the event of breakdowns under the instruction of section Supervisor so as to restore traffic as quickly as possible.

II GUIDING NOTES ON MAINTENANCE

20304 Introduction

1. For better utilization of traction assets, outage of any traction equipment from service should be minimum without compromising on safety of the equipment and personnel. Monitoring of condition

of the equipment by reliable means is essential for following the system of need based maintenance i.e. directed maintenance. However, till such time reliable condition monitoring techniques are introduced, the present system of preventive maintenance has to continue.

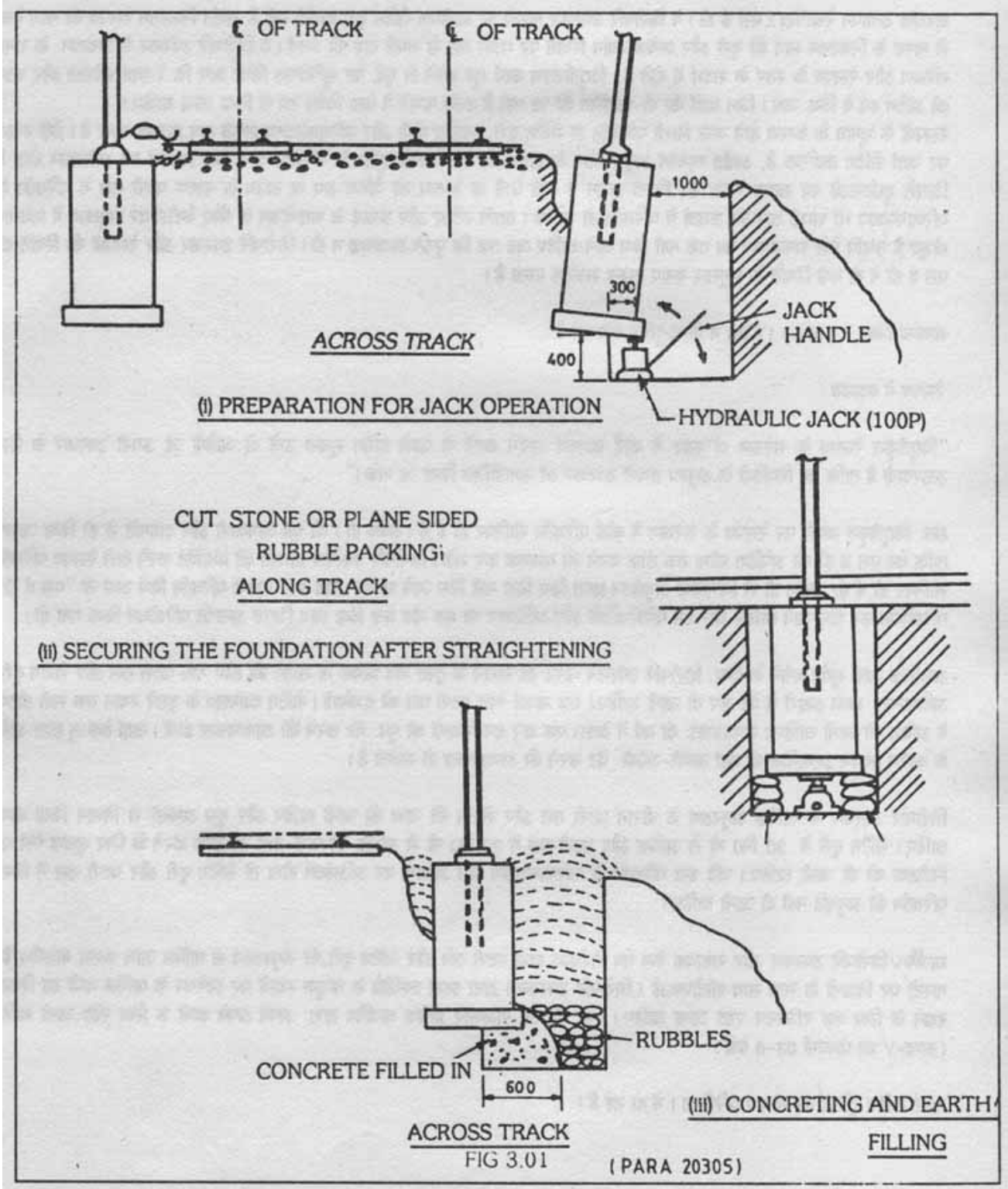
2. Recommendations of Original Equipment Manufacturer (OEM) and Guidelines issued by RDSO, from time to time, shall be kept in view while defining the scope and periodicity of the schedules.
3. The tightening torque for fasteners of various sizes is given in the Annexure 2.08.

20305 Out of Plumb Masts

In spite of the care taken in design and erection, OHE masts do sometimes get out of plumb. This occurs largely on embankments, due to erosion of earthwork on the outer side of the mast on account of poor drainage or excavations in the vicinity or due to sinking of foundations on new embankments. The extent of earthwork initially provided at the back of foundations on embankments is shown in Structure Erection (SEDs). OHE maintenance staff should, during patrolling and inspections, make a particular check of the condition of earthwork has been or is likely to be eroded away, the Engineering Department should be approached to strengthen the embankment, and the matter pursued until it is satisfactorily completed.

Masts which appears to be out of plumb should be checked with a plumb bob. Since the normal height of the contact wire is 5.60 m above rail level, the extent of deflection of the masts at this height can be conveniently found by measuring the deflection at a height of 1.85 m above rail level and multiplying this figure by 3. If the mast is out of plumb, by more than 3 cm upto 5 cm, at contact level it should be kept under watch after making sure that there is enough earthwork all round. To identify such masts requiring watching, a yellow bend of width 5 cm should be painted at a height of 1.85 m from rail level.

Masts which are out of plumb in excess of 5 cm can be set right by releasing the OHE and pulling the mast by a “Tirfor”. To facilitate this, the foundation must first be exposed on the side to which the mast is to be pulled by the Tirfor and the rear under side of the foundation should be packed and rammed with pieces of stone until the foundation is fully supported. If necessary the newly packed part may be strengthened by pouring in cementconcrete. A temporary strut or guy as convenient may be provided for a few days. The work must be so done that when the Tirfor is released the mast remains reasonably vertical, i.e. with the allowance for reverse deflection as required. The earth may be refilled all-round the foundation to a sufficient depth and distance beyond it to stabilize the mast. Finally it is checked up with plumb bob and it is made sure that the setting distance is with reference to the centre line of the track is right.



Any other method considered appropriate as per site conditions may be adopted.

RDSO's report No. ETI/OHE/55 on Tilting of OHE masts, Causes and Remedies may also be referred to.

20306 Rail Level and Setting Distance

Structure Erection (SEDs) show setting distance or implantation of the OHE masts i.e. distance of the nearest part of mast from the centre line of the nearest track as well as the height of the contact wire from rail level at each location. These are with reference to alignment and level of the track at the

time of erection of OHE. Before electrification work is taken up, it should be ensured that the track alignment and level are finalized. This is particularly so in the case of yards under remodeling.

Any change in alignment due to slewing of tracks will affect the setting distance and consequently the stagger of the contact wire. At locations where the setting is critical i.e. close to the minimum permissible value, slewing of track may result in infringement of the moving dimensions with consequent danger of accidents. Change in rail level due to variation in ballast cushion or packing up or packing down of the track will also result in change in contact wire height. Though provision exists in the cantilever assembly for adjustments of the stagger and height, such adjustment are not to be made unless absolutely necessary. It is best to maintain the position of OHE and tracks as in the SEDs.

General Rule (1976) 17.06 stipulates as under:

Alteration to track

"Before any alteration to alignment or level of electrified track is commenced, due notice shall be given to those responsible for the overhead equipment so that the overhead equipment may be adjusted to conform to the new conditions:"

It follows, therefore, that any alterations of the alignment of the track on electrified sections shall only be made with the prior knowledge and concurrence of the Sr. DEE (TRD) so that he may arrange to correct the SEDs to the extent required. No alterations to the track affecting OHE parameters may be carried out without obtaining specific approval from Sr. DEE (TRD). Whenever any permanent changes are effected, the SEDs should be revised and a note made of the circumstances and the authority under which the revision has been made.

To facilitate periodical checking, rail level and setting distance should be painted at the base of each OHE mast face soon after commissioning, preferably in black letters. A horizontal line would indicate the rail level. The setting should be marked in correct to the second decimal place. Repainting of the these markings will ordinarily be required once in two years. Where pollution due to brake shoe dust etc. is severe, repainting may be required more often.

During yearly maintenance of OHE, rail level and setting distance should be checked and compared with the original figures. Any variation above 30 mm in setting distance and 20 mm in rail level should be advised to the PWI for correction. No change in setting distance and rail level should be allowed if such change results in infringement of moving dimensions. Bench marking of rail level should be done under critical OLS for ensuring no change in track level.

It is essential to have a joint annual check of rail level and setting distance by the JE/OHE and JE/PWAY.

In addition to the marking on the masts, a register should be maintained by SSE (OHE) to record the annual measurements of implantation at critical locations over his jurisdiction. A similar register should be maintained by each JE for his own section (see proforma 03-8 in Section –V)

During various Engineering works at locations with Drop Arms, Special Attention to be given to ensure that variation in Setting Distance of Drop Arms and Rail Level of such tracks are within permissible limits. Stenciling of these parameters of Drop Arms as per SED and bench marking of Rail level of such locations to be done on respective Portal Upright specifically mentioning the Road Number.

Limits for mast setting distances are indicated in Appendix I.

20307 Contact Wire Hard Spots and Wear

Hard spots are points on the OHE where contact wire wear is likely to be higher than at normal locations, due to less flexibility in the OHE. Smoke pollution aggravates wear at hard spots. The usual

spots where the contact wire is likely to show more wear are –

1. Support points at curves;
2. Section insulators;
3. Splices;
4. Turn outs
5. Central mast of 2 span uninsulated overlaps of unregulated OHE;
6. At approaches to tunnels and over line structures;
7. Locations where smoke pollution is pronounced, namely, tunnels with steam traction and at the ends of platforms where steam locos halt for a long time under OHE;
8. Pull offs;

At such hard spots, it is important to keep a watch on wear of contact wire by measuring and keeping a record of contact wire thickness periodically. It is essential to concentrate on these spots during annual measurement of contact wire wear.

20308 Sparking During Current Collection

Sparking occurs when there is loss of contact (or improper contact) between the pantograph and the contact wire. The common causes attributable to the OHE are:

1. Incorrect tension in regulated OHE due to maladjustment or sluggish operation of regulating equipment;
2. Inadequate tension of contact wire in the case of unregulated OHE;
3. Deposit of soot on contact wire due to steam and diesel traction and the resulting roughness of contact face during current collection;
4. Kinks in contact wire.

If OHE on the main line is unregulated the tension in the contact wire should be checked and adjusted if need be once in 2 years. The speed being low in yards and sidings, the adverse effect of incorrect tensioning will be less pronounced and re-tensioning at longer intervals of 3-4 years will be adequate (para 20330)

Deposits of soot on account of steam and diesel traction may cause trouble due to sparking at points where steam engines halt for long periods. Particular note should be made of such locations and cleaning done at shorter intervals. The importance of cleaning of contact wire before introduction of electric traction is dealt with in Chapter IX.

Kinks detected during patrolling and inspection should be straightened or/removed without delay. After re-tensioning it is particularly necessary to inspect the section for kinks.

The periodic current collection tests (para 20324) would reveal points where sparking takes place. Apart from investigating and rectifying the cause of such sparking, it is also important that the roughened surface of the contact wire be attended to, failing which, there will be further deterioration, with successive passage of pantographs resulting in reduced life of contact wire.

20309 Contact Wire Wear

Hard drawn grooved copper contact wire of 107 mm 2 cross sectional area when new is used in the 25 kV electric traction system. With a proper maintenance of the OHE the contact wire is expected to have a life of about 45 years (vide Rly Bd. Letter's no. 2002/ACII/1 Dated 06.06.2022.), with average traffic density and conditions of pollution.

The thickness of new contact wire is 12.24 mm. It will be necessary to replace the contact wire when it has worn to a thickness of 8.25 mm corresponding to a cross sectional area of approximately 74 mm2. At this point 2 mm clearance shall be available between the bottom most point of the dropper clip, parallel groove clamp as well as contact wire splice and the pan of pantograph. Any further reduction in cross sectional area will result in the current density in the contact wire under certain conditions exceeding the permissible limit of 4.7 A/mm2 apart from reduced factor of safety under tension. In siding and lines with a low traffic density, a lower thickness limit of 8 mm may be adopted.

It is important to measure and record the wear of contact wire at the known hard spots (para 20307) and at a few selected locations & mid span where heavy wear may be expected, so as to keep a watch on the rate of wear. Observations have indicated the wear of contact wire between starter and advance starter is high where the train picks speed, specially in suburban sections. In addition to the known hard spots, the wire thickness may be measured at one or two points between each pair of stations where speed is maximum. These measurements should be taken at the time of yearly maintenance and recorded in a register. When the average wire thickness has reached approximately 10 mm, the number of points where measurement is taken may be increased and one location in each tension length may be covered in addition to the known hard spots.

Measurements of contact wire thickness in the vertical direction should be made with a micrometer, preferably one fitted with a ratchet screw adjustment to ensure that the pressure between the jaws when taking measurement does not exceed a particular value. Considerable care is required in using the micrometer.

The measurement will be meaningful only if in successive years the thickness is measured at the same point at each location. It is only then that the values recorded can be directly compared. A 75 mm wide band may be painted on the mast face with black paint. If the location is identified in this manner and a convention followed that measurement should be taken say 20 mm before the swivel clip in the direction of motion. It can be ensured that in successive years, measurement will be taken at identical points. The measurements must be taken personally by a supervisor well acquainted with the use of micrometer. Registers should be maintained in the office of the JE (OHE) for his jurisdiction and SSE(OHE) for the entire division in proforma 03-4 given in Section V.

If any isolated point the contact wire reaches the condemning limit of thickness, a splice should be introduced at the point.

20310 Splice Fittings

The splice in OHE becomes necessary when a small length requires replacement as a result of excessive wear or restoration after breakdown.

The splice fittings commonly in use are –

1. splice for single contact wire to identification No. 1080 or 1080-1
2. splice for double contact wire to identification No. 1280
3. splice for Catenary to identification No. 1090
4. splice for feeder wire to identification No. 1100

The main components are made of aluminum bronze and the studs of contact wire splice are of stainless steel. Samples of splices from each batch of supply are required to be subjected to special tensile tests in addition to the normal tests for quality of material, in view of the need for ensuring reliability of these important fittings.

A contact wire splice should, as far as possible, be located at a distance of not less than 5 m from the

support in the direction of traffic to avoid a hard spot on the OHE. Not more than 15 contact wire splices shall be used in one tension length. The distance between adjacent splices should, as far as possible, be more than 100 m.

In new construction normally no splice shall be provided. Under exceptional circumstances a maximum of two splices may be permitted.

The main points requiring attention during inspection of splice fittings are –

1. Careful examination for cracks or other casting defects or abnormalities.
2. In case of Catenary splice fitting tightness of the right hand and left-hand joint sockets.
3. Check to see if any slipping of the ends of two contact wires has taken place. When viewed through the top window, there should be no gap between the two contact wire ends.
4. Tightness of the stainless steel studs.

Contact wire splices should not ordinarily be re-used. If they are re-used at all, new brass ferrules for contact wire splice to Id No. 1080 should invariably be used to ensure that worn serrations of the ferrules do not result in insufficient grip on the contact wire.

Over-tightening of the stainless steel studs of contact wire splice fittings is harmful. Tightening should only be done to the extent possible with a standard spanner. No extra leverage by means of a pipe etc. should be used.

Registers should be maintained in the Offices of Sr. DEE(TRD), ADEE(TRD), SSE(OHE), JE(OHE) and OHE Section JE showing the location and date of installation of all splice fittings under their jurisdiction. These registers should be brought up-to-date by taking an inventory of splice fittings during yearly maintenance and POH.

20311 Section Insulator Assembly

1. Section Insulators assembly is used to provide electrical isolation between two elementary sections which are otherwise continuous. They are used mainly on cross overs, diamond crossings and turnouts for loops and sidings to isolate section from main line. They may be used on main lines to form neutral sections in heavily graded sections, suburban sections and at inspection pits on secondary lines as well as lines for sheds for maintenance and inspection. Rules regarding the location of section insulators are contained in Appendix I; the speed permissible at these locations is also indicated therein.
2. The section insulator assembly is shown Fig. 3.02. The assembly comprises of a strain insulator with two runners connected to one of contact wires. The bottom of the runners is at the same height as the contact wire on the other side, and so shaped as to allow a smooth passage of the pantograph underneath it. The two runners overlap with the contact wire on the other side for a short length to ensure that there is no interruption in the current drawn by the locomotives as it passes underneath the section insulator. The flexibility of the OHE is reduced where a section insulator assembly is provided.
3. The essential points to be checked during periodical maintenance are as under-

    a. The weight of the section insulator should be fully taken up by the droppers so that the runners are at the same height as the adjacent contact wires both longitudinally and transversely. Fasteners are provided, at both the contact wire ending clamps, at the ends of the contact wire and link assembly and section insulator cross beam assembly, for effecting the adjustment accurately. When correctly adjusted, there should be no sparking when a pantograph negotiates it. The runners if bent or damaged should be either replaced or straightened out. The runners as well as the contact wire should be smoothened by filling off globules of copper which might have

formed due to arcing. The distance between the contact wire and the runner on either side should be not less than 220 mm.

STANDARD SECTION INSULATOR ASSEMBLY

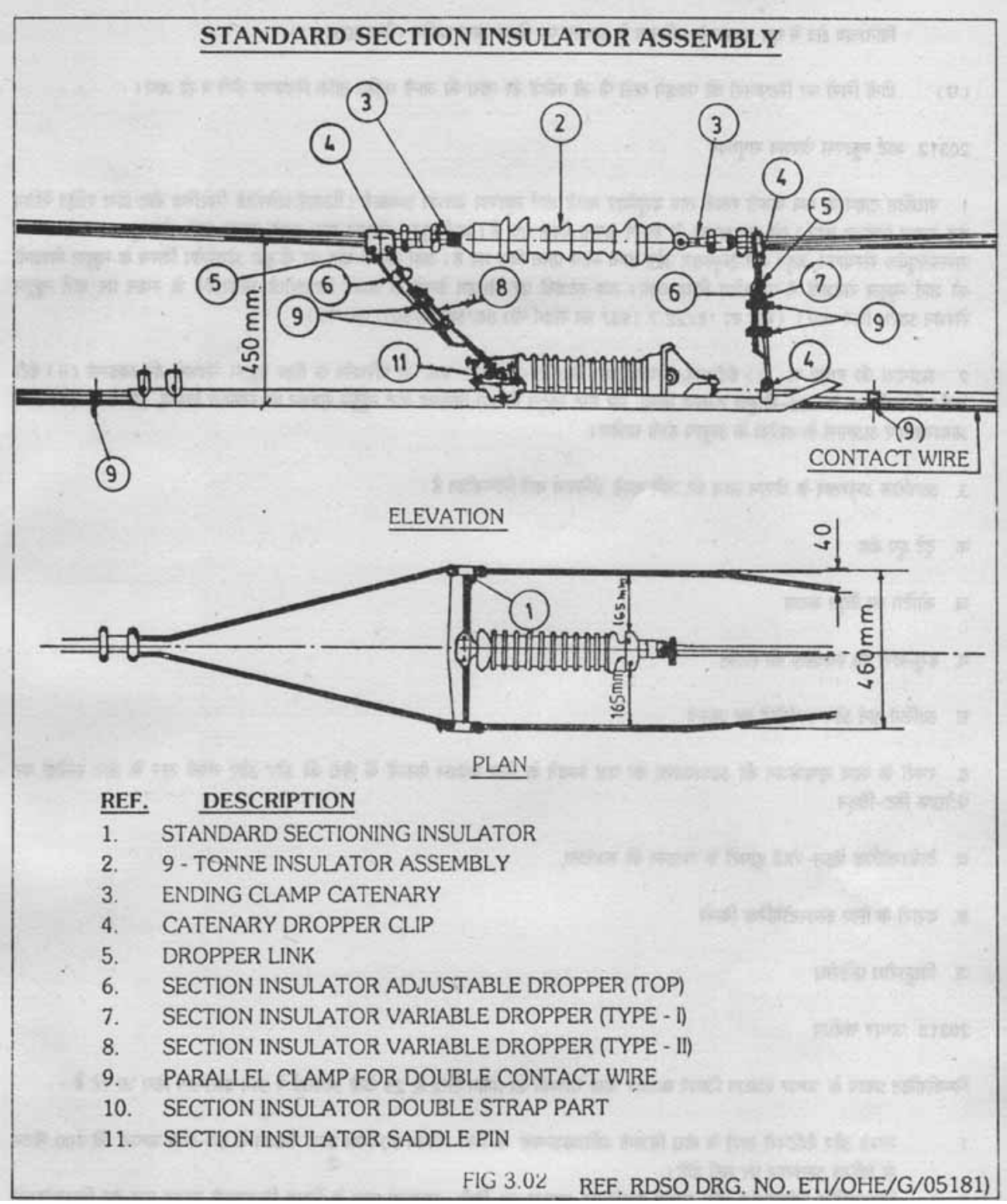
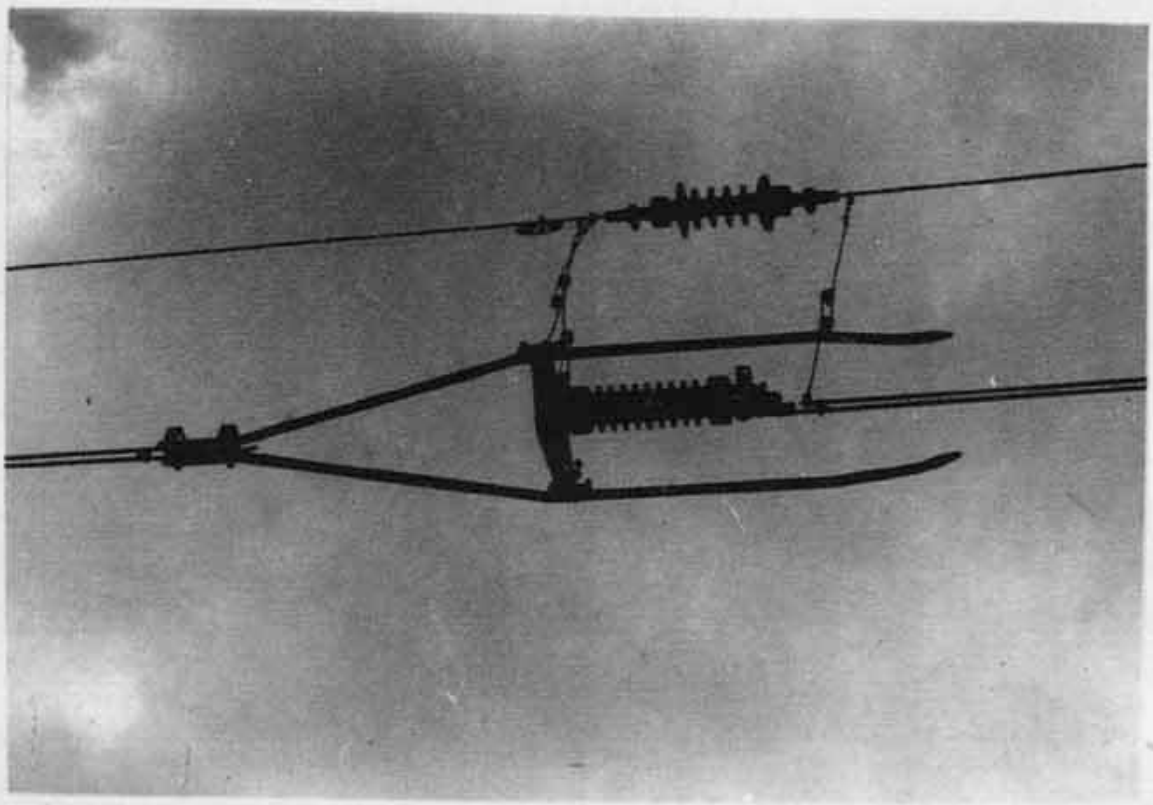


FIG 3.02 REF. RDSO DRG. NO. ETI/OHE/G/05181)

b. The termination of the contact wire anchoring at both ends should be checked and the stainless steel studs of the contact wire ending clamps tightened properly.

c. As the section insulator is located in the centre line of the track it is particularly subject to heavy

smoke pollution. The deposition of smoke on the insulator, if allowed to accumulate, can easily cause enough leakage to render an adjacent section live even after it has been isolated.



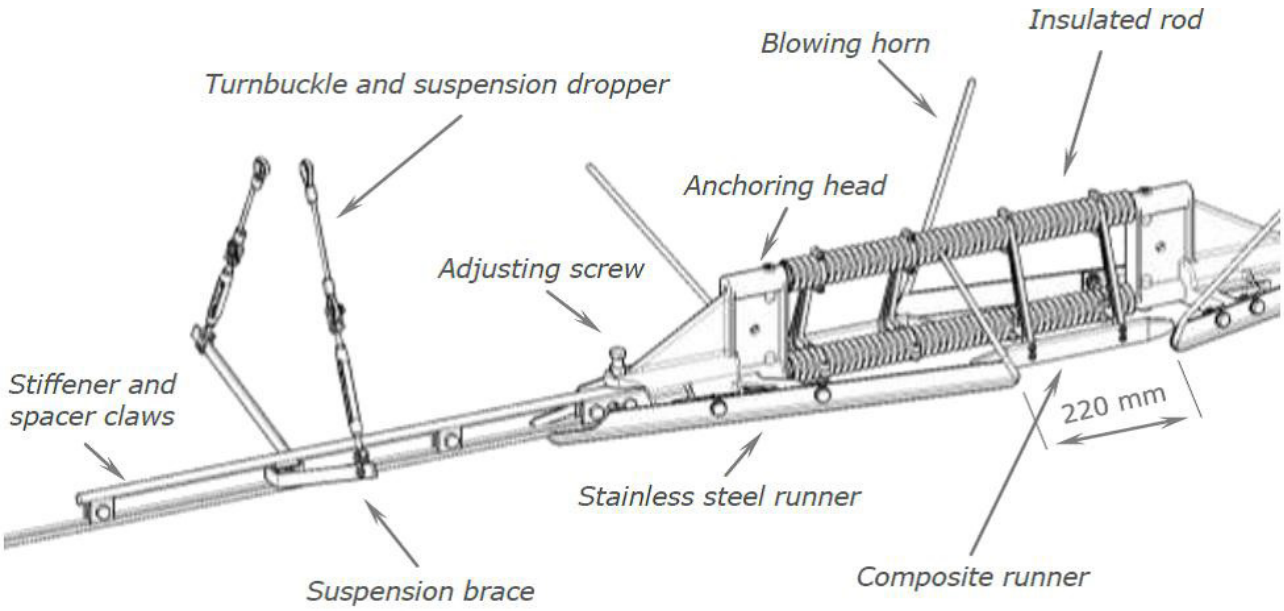
Conventional Section Insulator Assembly (Porcelain Insulator)
परम्परागत खंड विद्युतरोधक समुच्चय (पोर्सलीन विद्युतरोधक)

d. The PG clamps holding the stiffeners at both ends should be checked to ensure that the stiffeners do not work loose.

Light Weight Section Insulator Assembly:

(Rly Bd L.No. 2003/RE/161/1Dt. 03.03.2005)

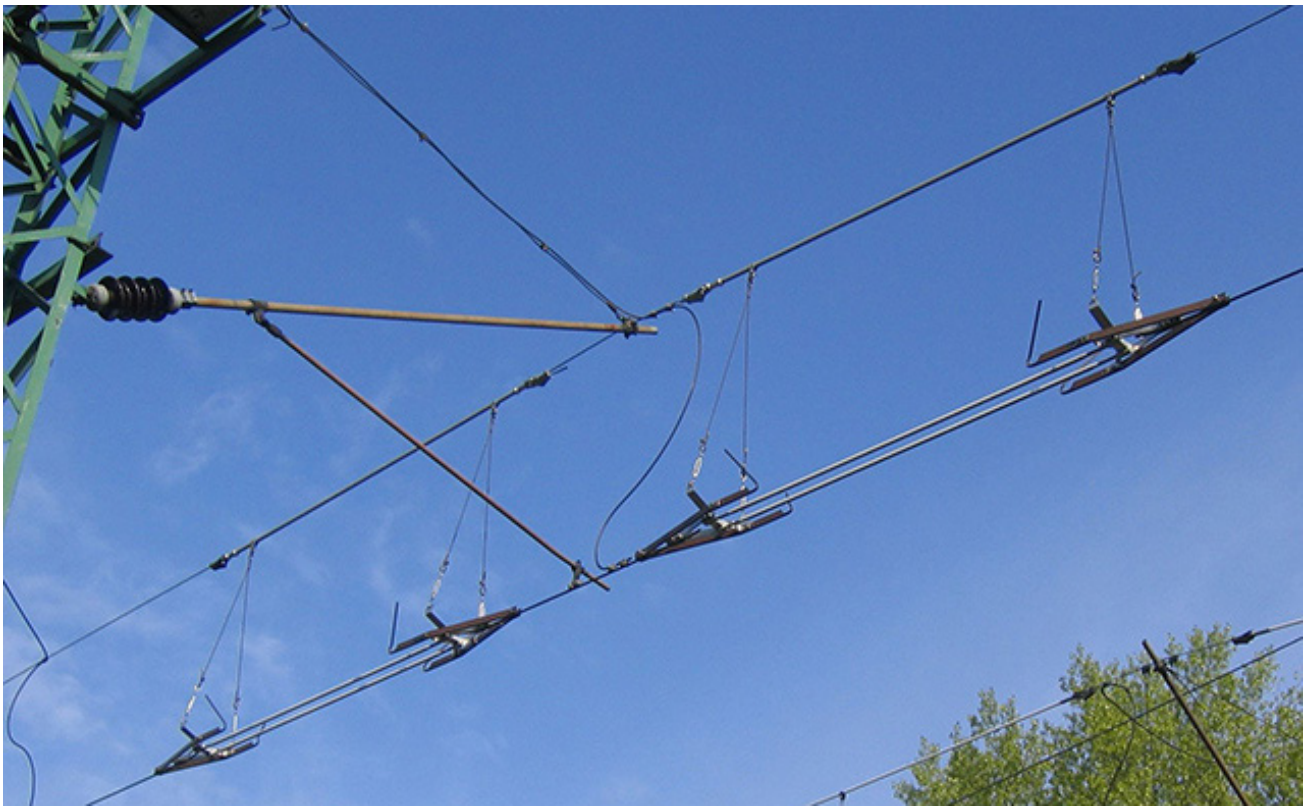
1. Light Weight Section Insulator Assembly (LWSI) may also be used as it is advantageous to conventional type section insulator assembly in terms of lesser weight and fitness for higher speed hence the Light Weight Section Insulator Assembly can be installed in main line fit for high speed train operation.
2. Schematic Diagram of Light Weight Section Insulator Assembly showing constructional details is given below.



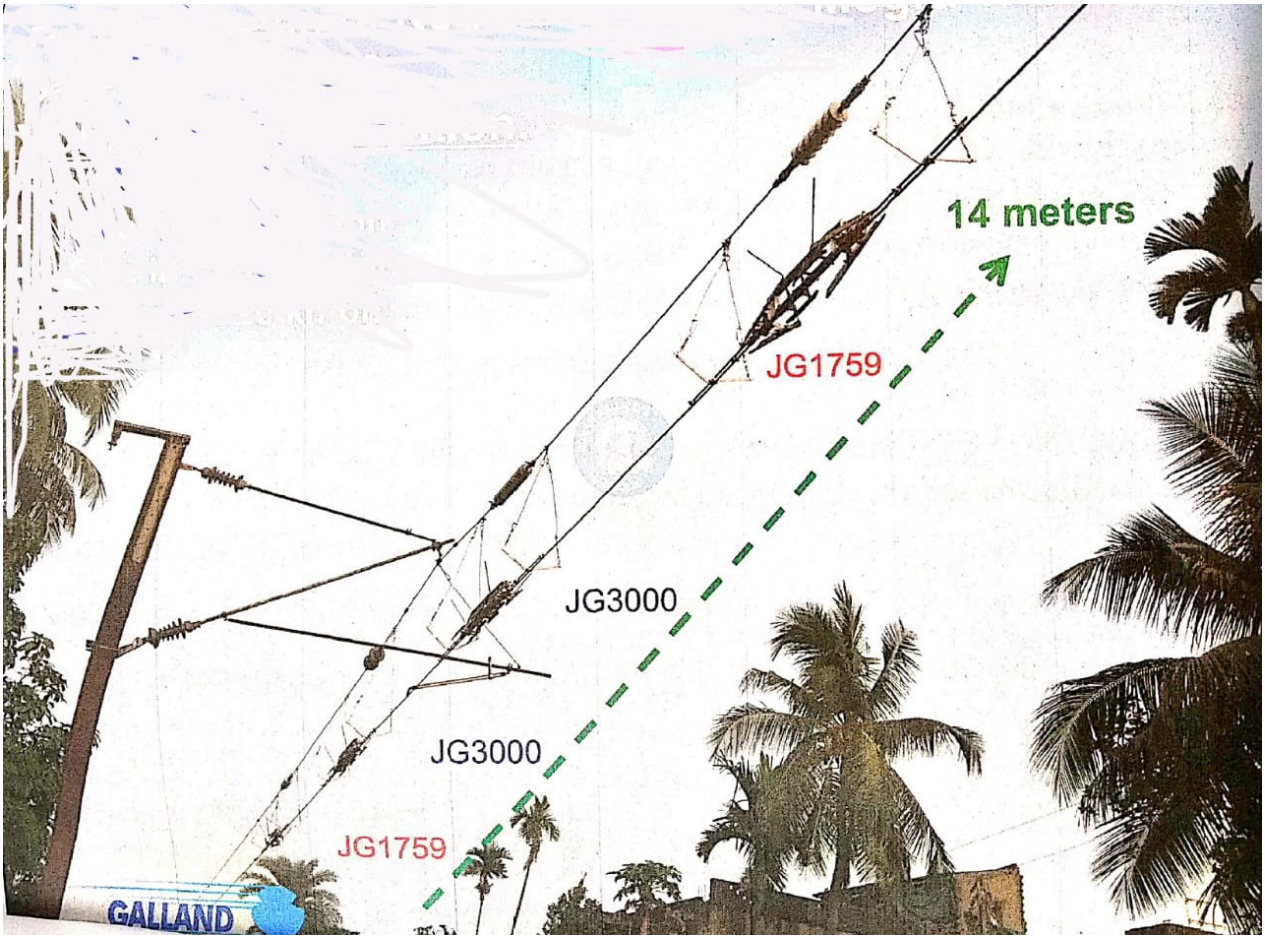
20312 Short Neutral Sections Assembly

1. Short neutral sections assembly incorporating light weight contact wire insulator of composite type (resin bonded glass fibres core protected with PTFE)has now been adopted as standard. Ease of installation even on flat curves and difficult locations, substantially reduced maintenance and other advantages are gained by introducing short neutral section. Conversion of existing overlap type neutral sections to short neutral sections may be done where it is not yet done. Short neutral sections should also be introduced in lieu of insulated overlaps opposite to the feeding posts at sub-stations. (Board's Ref. 86/RE/501/1 (N/S) dt. 16/22.7.1987).
2. The general construction, design and other requirements of short neutral sections shall conform to RDSO's Drg. Nos. (I) ETI/OHE/SK/551-Arrangement of Neutral Sections for Conversion with Short N.S. (ii) ETI/OHE/SK/552-Arrangement of short N.S. at Existing Feeding Post.
3. The essential points to be checked during periodical maintenance are as under:
   a. PTFE in A F make SNS /sheds in Galland make SNS.
   b. Electrical erosion of PTFE coating
   c. State of cleanliness of insulators.
   d. Burning of arcing horns
   e. Pantograph hit marks on the under side of Runners ,PTFE insulator and end fittings of the contact wire insulators to ascertain need for adjustment of SNS.
   f. Wear of Runner and PTFE Insulator rod (in AF make SNS)/Shoe(in Galland make SNS) , if wear is 2 mm or more then 2 mm then the Runner/Insulator Rod should be replaced.
   g. Insulation resistance.
4. Maintenance schedule of SNS. (Rly Bd's. Letter no. 2013/Elect(G)/148/1 dated 10.05.2019) & OEM Maintenance Instruction

Short Neutral Section (SNS)	Annual maintenance should be carried out Yearly along with following: a. Cleaning of SNS insulator: Preferably cleaning of SNS insulator shall be done annually for normal/non- polluting section. For polluted section cleaning shall be done half yearly. In addition, visual check or under power block, cleaning of insulator should be done if locomotive is passing with VCB ON condition. b. Measurement of parameters : Measurements should be divided into power block and without power block as divided by the Railway. c. Adjustment of SNS: Preferably should be done annually along with the measurement. d. All Railways should take appropriate decision based on the local conditions. e. Adjustment of SNS during change of track layout (gradient, curve, implantation, height etc.) should be ensured.



Short Neutral Section Assembly



Short Neutral Section Assembly

20313 Jumper Connections

The following types of jumper connections, using stranded copper conductors and PG clamps, are in common use in 25 KV OHE.

1. In-span jumpers of approximately 50 mm2 cross section for electrical continuity between contact and Catenary wires, at intervals not exceeding 400m.
2. Potential equalizer jumpers of approximately 50 mm2 cross section at insulated over laps and neutral sections to keep the portion of OHE between the cut in insulators and the nearer anchorage at the same potential as the adjacent run of OHE.
3. Continuity jumpers of cross section 160/105 mm2to provide electrical continuity between the two portions of OHE at uninsulated overlaps and between the main line OHE and turn out/cross over OHE at turn outs/cross over respectively.
4. Jumpers of cross section 160 mm2 between feeders and OHE at feeding points for reliability purpose .
5. Jumpers of cross section 50 mm2 provided between out of run OHE and anticreep wire as an anti theft measure.

Jumper connections play a vital part in maintaining continuity of supply. On account of the up and down movements of the contact wires, the jumper connections are bent to some extent every time a pantograph passes through. With repeated bendings the strands of the flexible jumper connections are liable to get broken in course of time on account of fatigue. To guard against this possibility, special

attention should be devoted to the jumpers during periodical maintenance.

The essential requirements for reliability of jumpers are –

1. Sufficient length and adequate looping to provide flexibility so as to prevent failure on account of repeated up and down movements and movements on account of elongation and contraction of OHE due to temperature variations.
2. Adequate cross section to carry the normal currents and possible overloads due to shut downs on adjacent lines, as well as faults.
3. Proper bonding and tin soldering of the ends.
4. Proper seating and tightness of connections at PG clamps.

Failure of continuity jumpers will result in discontinuity of the OHE and consequent serious interruption of traffic. Though failures of potential equalizer jumpers may go unnoticed, such failures can result in electrical accidents. Also, unscheduled attention to such jumpers will necessitate power-block on both the adjacent elementary sections, which may be quite difficult to arrange without repercussion to traffic. Proper attention to jumpers during scheduled maintenance is, therefore, very important. Jumpers, particularly continuity jumpers, with broken strands should be invariably replaced, failing which the reduced cross-section may cause overheating and eventual failure. Broken strands are most likely at the point of entry into PG clamps, possibly due to sharp edges in the clamp. PG clamps should have properly rounded off edges to prevent the cutting of strands. The clamps should be checked for signs of overheating and proper tightness.

It should, however, be remembered that a PG clamp should not be interfered with unless there are signs of overheating or damage.

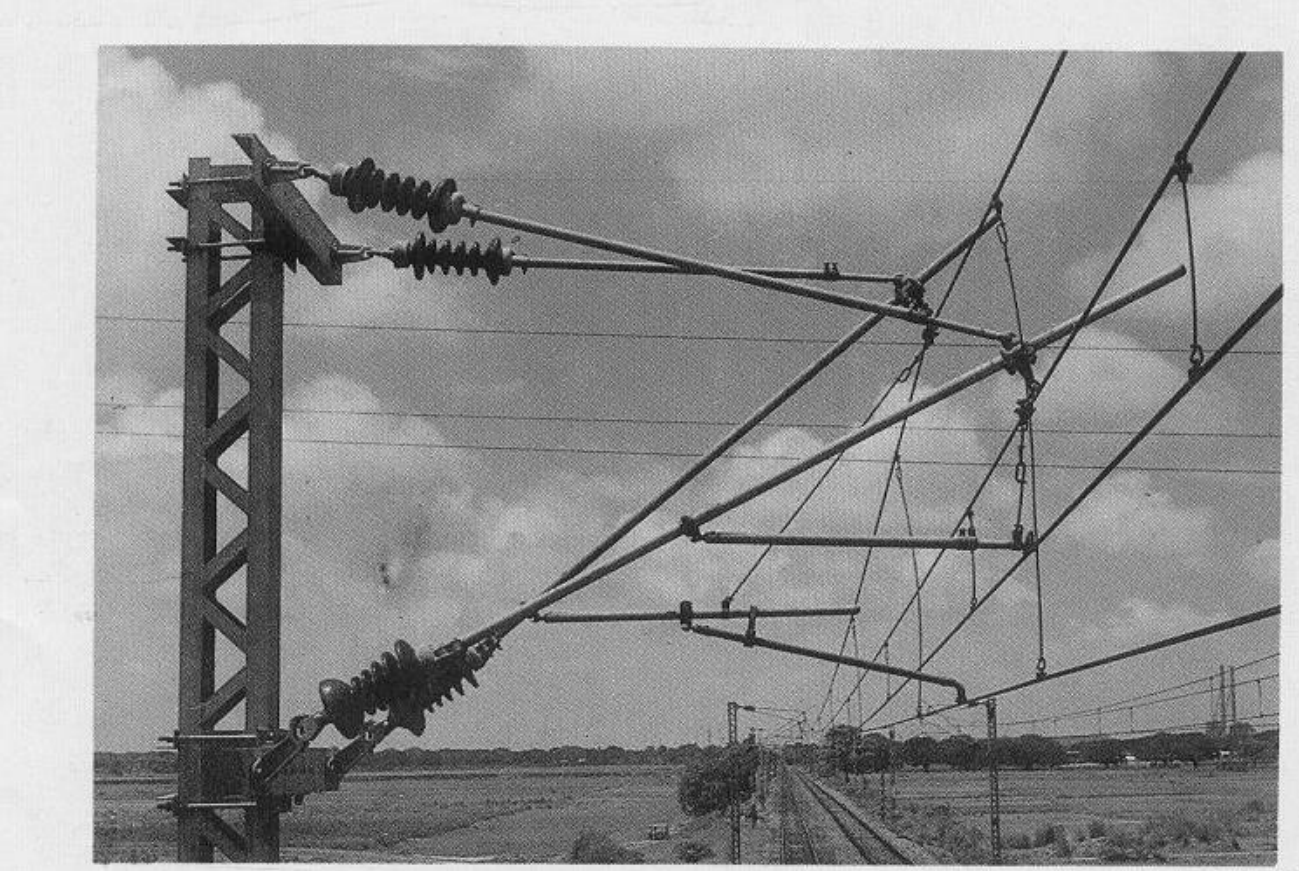
20314 Environmental Effect on OHE

Atmospheric Pollution

The atmospheric pollution has caused a large number of insulators flash over in certain areas such as Howrah and Asansol in Eastern Railway, Ahmedabad, Vadodara, Surat and Valsad sections of Western Railway and Madras-Gudur section of Southern Railway. The flash over mainly occur in the early morning in winter before sun rise and in the pre monsoon period, specially when monsoon are delayed. The pollutants provide a creepage path resulting into flash over of insulators and consequent tripping of the 25 KV and EHV circuit breakers. Pollution can be classified, broadly into the following categories.

1. Saline Pollution: caused by salt deposits in coastal areas. The adverse effect get magnified in foggy, humid and light rain conditions, resulting in series of flashovers.
2. Chemical and Industrial Pollution : Waste gases from industries – hydrochloric acid, sulphuric acid, hydrofluoric acid fumes etc. and minute particles of urea, cement etc. affect insulators of the electrified tracks in the vicinity of these industries.

These conditions not only effect the insulators, but also affect the steel parts including mast, which corrode rapidly and need frequent attention. Special steps are required to be taken throughout the year, suitably modifying the insulator cleaning schedules to ensure trouble free service.



Two Cantilever Arrangement for an Overlap
एक अतिव्यापन के लिए दो केन्टीलीवर व्यवस्था

1. Insulators

Although insulators supporting OHE are by the side of supporting masts, they are subject to settlement of carbon deposits, smoke pollution due to steam trains, oily deposits on account of diesel engine and cement or other industrial dust as mentioned earlier. If these deposits are not removed at regular intervals, they are liable to become hard and difficult to remove in course of time, and by reducing the insulation of the OHE greatly, lead finally to a flashover. Further, a dirty insulator of a section insulator can result in a dangerous potential in a section made dead.

The remedy lies in cleaning the insulators at regular intervals. Where there is no pollution, cleaning need be done only once a year or even at longer intervals. Where pollution is not appreciably high, the interval may be three months or longer depending upon the degree of pollution in the area. Generally in heavy industry areas more frequent cleaning of insulators may have to be done.

Cleaning is done by wiping the surface with a piece of dry cloth. A wet cloth may be necessary if the coating is hard. If the deposits are oily, petrol may be used for cleaning. If this too in ineffective where encrustation has become hard due to continued neglect, the coating may have to be removed by rubbing with a wet coir rope using a suitable detergent. After removing the deposits, the surface of the insulator should be washed well with water, wiped with dry cloth and polished until the normal glaze is restored.

The periodicity of cleaning of insulators in polluted locations should be laid down by local instructions. The affected section should be divided into various zones based on the degree and nature of pollution and periodicity of insulator cleaning fixed suitably. The cleaning will be required more frequently in

foggy weather compared to dry or rainy season. The periodicity may be reviewed based on effect of Special measure.

Other steps for reducing flashovers due to pollution _

a. Measurement of severity level of pollution:

   The severity level of pollution to be measured as per RDSO maintenance Instruction No.TI/MI/040 or latest so that adequate creepage distance insulators may be used.

b. Use of 1600 mm creepage distance Composite insulators:

   The composite insulator with 1600 mm creepage distance may be used where ESDD ≥ 0.3 mg/cm2 with approval of PCEE's as per directives issued by Railway Board vide letter No. 2002/EEM/161/21/ Vol. II dt 30.09.2020.

c. Handling of composite insulator:

   Since the composite insulators have silicon rubber as a component, they are much more flexible and fragile than the solid core porcelain insulators. Thus special care needs to be taken during their handling. In this regard, RDSO instruction no. TI/IN/0013, Rev-0 effective from Dec. 2005 be essentially followed.

2. OHE Structure and Fittings

Due to effluents discharged by the factories which are close to the railway tracks, the atmosphere gets surcharged due to presence of corrosive fumes in the effluents. Such cause corrosion of steel structures and OHE parts. In order to safeguard against this problem, remedial action as under should be taken.

a. Matter should be taken up with the factories and the Board of Control of Pollution of that area, they should ensure that the discharge of the factories is well within the limits laid down by the Board.

b. A special check at regular intervals should be conducted to see that the corrosion does not affect the performance of the components.

c. Chlorinated paints may be tried on the steel structures to off set the effect of pollution on the steel structures.

3. Contact Wire :

The silver brazed joints of jointed Contact wire do not fail suddenly. Initially the tip of the joint opens and the jointing surface is exposed to atmosphere. The joint gradually looses its strength due to displacement of silver with its oxides. Fast corrosion of silver brazed joints take place in the environment having SO2 gases with moisture and aerated aqueous NH3/ammonium salts. Hence following should be adopted in polluted zones, especially areas near drains

a. Check by inspection car once in three months in identified polluted areas/sections in which repeated failures have taken place. The identified open joints should be spliced immediately.

b. The jointed contact wire in the "identified polluted areas" shall be replaced with joint-less contact wire drawn out of continuous cast copper wire rods at the earliest opportunity on programmed basis.

   Joint-less contact wire drawn out of continuous cast copper wire rods have been used on IR. In polluted areas wherever splicing have been done, such locations be checked during schedule maintenance.

4. Catenary Wire:

In some of the divisions the corrosion of the catenary wire due to severe pollution has also been reported in the inner strands of catenary wire, leading to snapping of the catenary wire. This can be identified by formation of copper carbonate, a powdery blue- green compound insoluble in water.

20315 Clearances in Tunnels and Other Overline Structures.

If the OHE construction as well as the tunnels and over line structures are not modified subsequent to the electrification, the clearances provided at the time of erection will remain unaltered. It is, however, important to check the clearances during the annual maintenance, compare the values given in as erected and take corrective action as required. Bench marking of rail level should be done under critical OLS at the time of electrification and track level should not be altered thereafter. This shall be jointly checked by TRD & Engg. Officials once in year. This is Critical for Maintenance of Contact wire height.

20316 Regulating Equipment

(RDSO Spec No. TI/SPC/3 PHT ATD/0150 & TI /SPC/ 5 P ATD/0130)

1. There are three types of regulating equipment in use at present viz. 3 pulley type, 3 pulley type with 2400kgf tension and 5 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 chafing 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 type of equipment dimension 'X' (i.e. the distance between the 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 adjustment can be effected by using the adjusters provided. In the event of appreciable stretching of the contact and catenary wires, particularly a few months after installation, it will be necessary to cut small lengths of contact and catenary wires at the terminations to get correct alignment and adjustment.

2. Most of the points mentioned below are applicable to pulley type regulating equipment which is now standard:

2.1 MONTHLY CHECKS

2.1.1 Check for missing Balance Weights and if found missing, panto lower/raise caution or speed restriction for passing trains (in tension lengths involving turn outs, crossovers and overlaps) should be imposed by the concerned staff.

2.1.2 Check for free movement of ATD by slightly pushing up or pulling down the counter weights. If obstruction in movement of counterweights is observed and the counterweight do not come back to the position from where pushed / pulled measure the force required to move the counterweights with the help of spring balance. If the force is more than 10 kg, then take the following action:

   a. Check the parallelism of hex tie rod of antifalling device and if required, set it right.

   b. Check for bent/deformed/ missing guide tube and deformation of eye of base counterweight and deformation of counterweight eye rod, take corrective action to remove the defects. If the equipment is completely jammed, the equipment should be dismantled and bearings should be

replaced with only SKF 6305 – 2RS1 or NBC 6305-LLU.

2.2 Annual Checks:

2.2.1 Auto Tensioning Device:

1. Check visually whether all the pulleys are in same vertical plane, pulley block of the ATD is in alignment with the OHE and the bent arms of the pulley block are parallel to the pulley. If not, then check, center to center distance of holes of the bent arms of pulley/pulley block. If the holes do not match with each other, replace bent arms.
2. Check that eye & clevis is free to swivel, if not, file the back of clevis to obtain sufficient clearance between it and the edge of the anchor fitting, without seriously affecting the strength of the fitting.
3. Check the angle spacers over hex tie rod are free to move.
4. Check that the **hex pipe** of suitable length have been provided over hex tie rods as per the table given in ANNEXURE-A of RDSO Maintenance Instruction No.TI/MI/00029 (Rev-3).

2.2.2 STAINLESS STEEL WIRE ROPES:

1. Check thoroughly the condition of **stainless steel wire rope** through magnifying glass for loose wires/strands, broken wires/strands, rusting, pitting/corrosion and bird caging. If any of these defects is observed, the wire rope should be replaced immediately with new **lubricated wire rope**.
2. Lubricate the wire ropes at least once in a year with "BALMEROL ROPELUBE 1000".

2.2.3 ATD & WIRE ROPE COMBINED

1. Check that the stainless steel wire rope is centrally placed over the groove of the pulleys, if not, then release the tension on ATD and manually set the wire ropes centrally on the grooves.
2. Check for rusting / corrosion /deformation /breakage of all the components. If these are observed, then the defective components should be replaced.
3. Check for appreciable grazing of side walls of pulleys, by the wire rope . If appreciable grazing of side walls of pulleys is observed, then take the following action:
4. Straighten the side walls of pulley by a few mild blows with wooden mallet. If these can not be straightened, replace the pulley/pulleys.
5. Loosen or tighten the bolt connecting the bent arms to the clevis & eye to ensure that there is no grazing between & the section of wire rope carrying counterweight.
6. Check that the mast anchor fitting is correctly fitted so that its eye is in horizontal plane. If not, fit it correctly, by loosening the bolts connecting it to mast, set the anchor fitting right and tighten the bolts. If the deformation/ manufacturing defects on the mast anchor fitting are observed, it should be replaced.
7. Check if the pulley is tilted in vertical plane towards the bent arm right/left. If it is, then insert a beveled washer in between the clevis of eye & clevis and mast anchor fitting from bent arm right/left side, so that pulley becomes vertical.
8. Check **X-Y dimensions** and if required, adjust them according to adjustment charts as given in RDSO drawing no. TI/DRG/OHE/ATD/RDSO/00003/99/0.

2.3 CHECKS DURING POH

1. ATD should be taken out of service & dismantled carefully.
2. Check the pulley, bent arms & bearing housing for any change in dimension and if found deformed, it should be repaired/ replaced. The bearing should be replaced during each POH with a new

bearing of NBC 6305 LLU or SKF 6305 2RS1.

3. Ovality of SS wire rope should be checked at three places (near pulleys) 300 mm apart by measuring rope diameter at right angles. If ovality is found more than 0.51 mm, wire rope should be replaced with a new lubricated wire rope.
4. Special care should be taken while inserting the wire rope in SS wire rope end fitting, the strands of wire rope should not be open out, while reeling over the wedge piece.
5. Check thoroughly the condition of stainless steel wire rope through magnifying glass for loose wires/strands, broken wires/strands, rusting, pitting/corrosion and bird caging. If any of these defects is observed, the wire rope should be replaced immediately with new lubricated wire rope.
6. End reversal of wire rope should be done during POH.

Three Pulley Type ATD

20317 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. JE (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 breakdowns, 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 equipments to be carried in each carshould be issued by DEE(TRD). JE(OHE) should ensure that tools and equipment as per the approved list are always available in the car.
2. A monthly mechanical inspection of the bogies and running gear of each OHE Inspection car(Tower wagon) shall be done by a nominated supervisor of electrical department(Electric Loco Shed or diesel Loco shed or Electrical supervisor who has been trained to check all issues related to safe to run examination)/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 nominated supervisor of electrical department (Electric Loco Shed or diesel Loco shed or Electrical supervisor who has been trained to check all issues related to safe to run examination) /TXR responsible for monthly mechanical inspection will be nominated by PCEE/PCME respectively clearly laying down his duties .

The SSE/JE(TRD) in charge of the car will advise the nominated supervisor of electrical department(Electric Loco Shed or diesel Loco shed or Electrical supervisor who has been trained to check all issues related to safe to run examination)/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 h. in advance. SSE/JE(OHE) should ensure that this monthly advise is issued regularly and the car is offered for inspection and attended to every month. The nominated supervisor of electrical department(Electric Loco Shed or diesel Loco shed or Electrical supervisor who has been trained to check all issues related to safe to run examination)/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 6 years (72 months) or as per latest instructions of RDSO/ Railway Board in an EMU shop /Electric loco shed/Electric workshop/Diesel shed, as per RDSO's SMI No. TI/MI/0052 Rev.0 or latest revision for 4-wheeler tower wagon and SMI No. TI/MI/0043 Rev.2 or latest revision for 8-wheeler tower wagon.

3. The day to day maintenance of the diesel engines and driving gear of the car will be the responsibility of the JE(OHE) concerned. The OHE inspection car drivers 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 upon 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 spare OHE inspection cars may be provided as necessary.

   NOTE : RDSO L.No. TI/LKO/(OHE)/25/2020 O/o PED /TI/RDSO Dt. 07.05.2021(Rly.Bd. approval awaited)

20318 Salient Features of OHE Inspection Cars.

The salient features of the OHE inspection cars presently in use of 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 — 40Km/h
   - v. Transmission — Gear box system
   - vi. Brake system — Vacuum

2. a. Mark III 4 wheeler manufactured by Jamalpur workshop/E.Rly.
   - 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.

b. Mark IV 4 Wheeler tower wagon

i.	Diesel engine	285 HP
ii.	Axle load	16 Tonnes
iii.	Speed Potential	75 kmph
iv.	Transmission system	Hydrodynamic
v.	Brake system	Compressed air brakes

3. a. OHE Inspection Car – 8 wheeler(Diesel Hydraulic Tower Car) DHTC

i.	Diesel engine	Single 530 HP or twin 285 HP
ii.	Transmission	Voith's Hydraulic Transmission
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 60 t rising gradient while haulinga 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 kitchen ,storable space for tools,spares, and traction mast etc.	
xi.	Adjustable lifting and swivelling platform	
xii.	Observation dome	To watch pantograph and contact wire Interactionduring motion.

b. OHE inspection car – 8 wheeler Diesel Electric Tower Car (8-W DETC)

i.	Diesel engine	Twin 340 HP (i.e. 2x340 HP)
ii.	Transmission	Diesel Electric Transmission
iii.	Axle load	20.32 Tonnes
iv.	Pay load	12 Tonnes
v.	Speed potential	110 kmph on level tangent track.

OHE car is capable of running at a speed of 75 kmph with two loaded flat wagons weighing 120t (60 t each) at tangent track. It is capable of starting and hauling two wagons weighing 60teach (total 120t) on up gradient of 1 in 33.

vi.	Brake system	Compressed air brakes (panel mounted)
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.	Material cabin, storage space for tools, spares and traction mast etc.	
xi.	Adjustable Lifting and swiveling platform	
xii.	Observation dome	To watch pantograph and contact wire interaction during motion
xiii.	CCTV Camera	For viewing roof activity from both driving cabs
xvi.	Portable Genset cum welding machine	
xv.	Cabin heater	To keep driver cabin warm in winter season
xvi.	Battery charger (110 V DC)	for charging 110V Batteries, when need arises.

20319 Rules for Operation of OHE Inspection Car.

1. General

   a. Authorization:

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

   b. 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:

   c. Movement

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

2. Driving

   a. 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.

   b. 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.

   c. 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.

   d. 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. In such cases, Loco Inspectors, Loco Pilot having knowledge of the road of the section should accompany with the tower wagon.

3. Pantograph Operation.

   a. 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.

   b. The pantograph should normally be kept in the fully lowered position and clamped securely by means of the special clamp provided for the purposein 4-W OHE Inspection Car. This clamps to be provided by lock and key arrangement.No string, cord, etc. shall be used for this purpose.

   c. 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 Technician shall then go up on the roof and remove the clamps to release the pantographin 4-W OHE Inspection Car.

d. 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.

e. 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.

f. The Driver shall always stop the OHE Inspection Car ahead of all turn outs, cross overs, insulated overlaps and section insulators first and then proceed only after ensuring that the section ahead is dead and earthed. Banner flags shall then be removed for the purpose of admitting the OHE inspection car into the section ahead.

g. 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 Technician 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.

Note: The above instructions stipulated from (i) to (vi) are generally applicable for 4-wheeler tower wagons as pantograph provided with 4-wheeler tower Car is without foot insulators and actuating mechanism. However, in case of 8- wheeler tower car, pantograph is provided with foot insulators and its complete actuating mechanism, hence pantograph may be raised in OHE live section, hence earthing of pantograph is not required as it is insulated from OHE car body.

4. Operation of Lifting and Swiveling Platform

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

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

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

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

e. 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.

III MAINTENANCE SCHLEDULES FOR OHE

20320 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 Subordinate in charge of operation and maintenance of OHE and associated system, is indicated at Annexure 3.01.
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.

a. Deficiencies and short comings.

b. Lack of skill amongst staff.

c. Inadequacies in maintenance facilities

d. Constraints experienced

e. 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 in brief for various inspections is indicated at Annexure. 3.02

20321 General

1. 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 improve OHE reliability as well as safety of installations and staff.

   a. Thermo Vision Camera checks

   b. Current collection Tests

   c. Special checks

   d. Annual Maintenance and OHE Inspection Car Checks.

   e. Periodical Overhaul

   f. Re-tensioning of Unregulated OHE.

   g. Live line inspection of OHE by 8W OHE inspection car(Once in 06 months for normal routes and quarterly for suburban routes ; As per RlyBd L.No. 2020/EEM/161/1Vol-2 Dt. 21.09.2020)

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 installations. The periodicity may however, be modified by PCEE, 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 PCEE.

20322 Foot-Patrolling of OHE

1. The object of foot-patrolling is to made visual inspection of every part of OHE (including feeder line) so that any defect and abnormalities noticed are recorded and reported to the maintenance gangs for attention.
2. An experienced OHE Technician (accompanied by a Assistant if deemed 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. JE should foot patrol the entire section once in six months.

3. The Technician 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, Bolts and nuts for bonding, small chopper for clearing small bushes and creepers over the OHE mast, spring balance for pulling the Regulated Equipments for checking free movements.
4. The Technician on patrol duty should particularly look for the following –
   a. Chipped or damaged insulators.
   b. Displaced fittings and droppers
   c. Excessive sagging or hogging of contact wire
   d. Whether compensating 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 trees likely to infringe the OHE.
   i. Defective bonds and earth connections.
   j. Oil leakage if any from AT and drop out fuse position.
   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 Technician which endanger safety shall be reported forthwith to TPC through the nearest telephone/mobile. Full details should be given to enable the TPC to decide on the course of action to the taken and if required to regulate train movements in the affected section.
6. The Technician 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 (see para 20351) maintained for the purpose in the depot/sub depot. The roster of patrolling Technicians 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 Technician must report the defects on telephone/mobile 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 Technician will speak to TPC from every emergency telephone socket in route. Such calls from patrolling Technicians 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.

A proforma for Technician's Foot Patrol Report is given at Annexure3.03.

20323 Footplate Inspection of OHE

Inspection of OHE by foot plateis essential.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. Officers and senior subordinates shall travel by the cabs of locomotives and EMU trains as often as possible but atleast once a month to observe the general condition of OHE and to get a first hand knowledge of operating conditions.

20324 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 travelling 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. Alternatively, OLIVIR-G equipment can be fixed on locomotive focusing the pantograph and data of the sparking locations can be downloaded after the completion of inspection.

The current collection tests as above should be carried out by the depot-in-charge (SSE or JE) once in 6months over his entire section. The DEE (TRD)/ADEE (TRD) should accompany the depot-in-charge so as to cover his jurisdiction once a year.

The form in which a record is to be maintained is indicated in para 20349.

Revised Periodicity of Current Collection Tests (Rly Bd. Letter's no. 2013/Elect(G)/148/1 Dated 10.05.2019)

Current collection with OLIVER G	Periodicity of Current Collection to be Half- Yearly along with following. 1. Oliver –G Video should be seen on computer for checking the pantograph passes over turnout, crossover, IOL, UIOL. Its video based findings should also be necessarily recorded in appropriate registers and preventive maintenance done timely.

20325 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 that 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 by thermos-vision camera for 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 (see para 20351).

6. Feeders: Foot-patrolling of 25 kV feeders should be carried out every month. During this check, the Technician 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 -

a. Checking condition of insulators specially that of section -Insulators at major yards having mixed type of traction;

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

c. Remove bird nests on all portal structures and traction masts.

d. Condition of embankments with respect to stability of masts. Check soil erosion around the foundation in embankments and preventive steps shall be taken.

e. AT Rod gaps

f. Examine base of each structure to ensure that muffs permit drainage of water.

g. Check the condition and stability of structures situated along the track, which are higher than the height of contact wire in the electrified section.

h. Check the condition of the advertisement hoardings along the track and also on the over line structures in the electrified section for their stability.

i. Check the path way in the FOBs/ROBs for holes in the slabs above the OHE and if any found, they shall be suitably blocked.

j. Check the protective screens on the FOBs/ROBs for their condition and fixing arrangements.

k. Check and ensure condition of power line crossing conductors & structures and ensure the defects noticed during the joint check are attended.

l. Check the condition of lightning arrestors at TSS/Switching stations and ensure no moisture entry at the top and ensure good condition of connections on HT side and earth side. Ensure good condition of connections to leakage current monitor and surge arrestor wherever available.

m. Check the oil leakages in the power transformers, CTs, PTs, ATs and oil circuit breakers and arrest so as to avoid entry of moisture into the equipment. Replace silicagel in the breathers of vacuum CBs ,Interruptors, Power Transformers, and Auxiliary transformers.

n. Condition of earth screen and strung bus terminations at sub-stations should be checked.

o. Water falling as a jet on OHE from buildings, bridges should be checked and arrested, if any noticed.

p. Check gaskets of the all cubicles of switchgear of TSS and Switching post to arrest water/ moisture ingress. Check the functioning of heaters in the cubicles of all the equipment in the Traction Sub-stations and switching stations

q. Trimming / cutting of tree branches within 4m from OHE should be ensured as per detailed directives of the Railway/Railway Board so that reliability of traction power supply is not affected. Conduct Joint Tree survey by OHE and P.Way officials to identify vulnerable trees. Any tree or branches likely to fall on OHE should be cut / trimmed by Engg. Branch under the supervision of TRD to maintain safely clearance for smooth operation.

r. Ensure availability of structure bonds on all the Traction masts.

20326 Annual Maintenance and Checks by OHE Inspection Car

1. Maintenance Schedule of Cantilevers by OHE Inspection Car (Rly Bd. Letter's no. 2013/ Eect(G)/148/1 Dated 10.05.2019).

Single cantilever	IOH of single cantilever after every two year.
AOH of OHE with 02 or more cantilever, UIOL, IOL, T/O, X/O feeder Jumper, G-Jumper, Isolators, RRA etc.	Existing annual periodicity of OHE with 2 or more cantilever should be retained.
POH of OHE	POH of OHE after 8 years with 3 IOH in between after every 2 years. POH after every 6 years in coastal and saline area with 2 IOH in between after every 2 years.

a. 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.

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

i. Doubling the periodicity of maintenance in sidings. Periodicity of schedules to be double compare to that of the main line. However, insulator cleaning, foot- patrolling and tower car live line checking to be continued as per periodicity of main line .(As per RlyBd L.No. 2020/EEM/161/1Vol-2 Dt. 21.09.2020)

2. Masts, portals and cantilever supports:

a. Check rail level and setting distance against markings on the masts and entries in the Register. Variation above 3Omm in setting distance and 2Omm 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.

b. 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 aluminum paint.

c. Check all anchors for tightness of bolts, nuts and checknuts and pins, Lubricate all turn buckles/ adjusters and pulleys.

d. 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.

e. Check all bonds thoroughly. Defective bonds must be rectified and missing bonds provided,

f. Check and tighten all G.I.bolts and nuts.

g. 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'.

h. Examine register arm and all hooks and fittings for cracks. Check for cracks on steady arm tube also.

i. 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.

j. 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.

k. 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.

l. Ensure that the drain holes in the tubes are free and not clogged.

3. Contact and Catenary Wires:

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

b. Check condition of PG clamps and jumpers after opening the clamps and tighten properly.

4. Droppers:

a. Check droppers and tighten bolts wherever required.

b. Availability of U pin in contact clip.

c. Make droppers vertical.

d. Dropper should be changed if loops are worn out.

5. Turn outs

a. With OHE Inspection Car running on main line check up if pantograph glides smoothly under the loop line OHE.

b. With OHE Inspection Car running on loop line check up if pantograph glides smoothly under the main line OHE.

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

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

e. Check up cross contact bar, if any, for displacement and distortion. Check up for hit marks, if any.

f. Check up for hit marks if any.

g. Check up rail level and setting distance and track separation of the obligatory mast.

h. Check up for hard spots near rigid droppers, if any.

6. Section Insulators Assemblies:

a. Clean insulators and replace chipped or cracked insulators.

b. Check runners for flash-marks, hit marks and proper adjustment.

c. Check for excessive contact wire wear near anchor clamps.

d. Check the level of the assembly and adjust if necessary.

e. Tighten PG clamps of droppers and stiffeners.

7. Isolators:

a. Check number plates for cleanliness and security.

b. Check correctness of operation, alignment of contacts and arcing horns.

c. Check earth continuity where applicable.

d. Lubricate moving parts and locks.

e. Check interlocks where provided.

f. Check that the distance between male and female contacts in open position is 38Omm to 500 mm depending upon the type of isolator.

g. Wherever Earthing Heels are available with Isolator, ensure the smooth operation of its blade and clearance (minimum 320 mm) in Isolator closed condition.

(RDSO Spec TI/SPC/PSI/ISOLTR/0210)

8. Short Neutral Section Assemblies

Carry out all checks as indicated in para 20312.

a. Overlaps:

i. Check height and stagger of OHE In the overlap section.

ii. Check whether the normal minimum clearance of 500mm is available between the two OHEs in an insulated overlap and 200mm 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.

9. Contact Wire thickness:

Measure and record thickness of contact wire as detailed in para 20309.

10. 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 insulator type neutral section.

11. Overline, Structures/Tunnels

a. Check and record horizontal and vertical clearances and adjust OHE as required.

b. Check for any flash-marks on the under side of the bridge structures.

c. Check that the prescribed height of contact wire is available,

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

e. Check that smoke screens are properly secured and have adequate clearance from OHE. If not, get these attended to by Engineering Department.

f. In tunnels get necessary repairs done by Engineering Department.

g. Check rail level mark on sides of tunnels.

12. Level Crossings

a. Check height and gradient of contact wire.

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

c. Check the availability of danger board & public caution boards at height gauges, Staff caution boards and shock treatment board/Chart at gate lodge.

13. Regulating Equipment:

a. Check 'X' and 'Y' dimensions in the case of pulley type equipment against prescribed values for the temperature at the time of checking. Make use of turn-buckles to adjust as required.

b. Check that the compensating plate is vertical. If not, adjust as required.

c. Lubricate rope and other moving parts.

d. 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.

e. Check condition of stainless steel wire rope for any signs of corrosion and breakage of strands.

14. Bonds & Earthing Connection.

a. Check all bonds and replace defective or missing bonds. Paint all bonds.

b. Inspect earths and record earth resistance. Earths having resistance of over 10 ohm should be attended to.

15. Masts:

Check verticality of all masts with plumb-bob and take remedial action as required (see para 20305).

16. Sites affected by accidents:

Such sites should be specially checked and attended to. Porcelain insulators of the affected section should be thoroughly checked for any cracks/damage and to be replaced.

17. Feeder Lines:

a. Check guard wires at road crossings, if any.

b. Check earthing of towers.

c. Measure and record earthing resistance of towers.

d. Clean insulators and replace those which are cracked or chipped.

e. Check the jumper connections, strain clamps, PG clamps and bi-metallic strip.

18. PG clamps:

a. Check and clean oxide from surface.

b. Apply corrosion inhibiting compound.

c. Tighten to the prescribed torque.

19. Cleaning of Composite Insulators

A cleaning instruction no TI/IN/0040, Rev-0 has been issued vide RDSO letter no. TI/OHE/INSCOM/GEN dt 02.11.2019. As per this instruction following is to be done :-

a. General Instruction: For cleaning of 25 kV Composite Insulators fitted in polluted/heavily polluted area, following schedule shall be followed:

SN	Type of Insulator	Pollution level	Periodicity
1.	Stay Arm Insulator	Polluted Area/ Heavily Polluted	Once in a year
2.	Bracket Tube		
3.	9-Tonne		
4.	Sectioning		

b. Method:

i. Composite Insulator shall be cleaned with DRY SOFT COTTON CLOTH to remove the dust/pollution from insulator.

ii. No water, detergents, any solvents and abrasive material should be used for cleaning as use of such material leads to deterioration of electrical properties causing failure.

c. Precautions:

Please note that purpose of cleaning of Composite Insulator is only removal of dust/pollutants or any other deposition that adversely affects the electrical properties of Composite Insulators, hence care should be taken that during dry cleaning the insulator should not be rubbed excessively to make it bright.

20327 Integrated Blocks

The annual maintenance schedules 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, signal 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.

20328 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 retensioning done as required.

20329 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 part of the installation.

The tests to be done at the time of commissioning of new OHE have been detailed in Chapter IX. The work involved during 6/8-years (Vide Rly Bd. Letter's no. 2013/Eect(G)/148/1 Dated 10.05.2019.) 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 adjustments will have to be made or repairs done 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 of6/8years (Vide Rly Bd. Letter's no. 2013/Eect(G)/148/1 Dated 10.05.2019.). 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 work is achieved. All POH work should be done under the direct supervision of a supervisor not lower in rank than an JE/SSE.

To summarize, the object of POH is to make a thorough 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, thorough 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. POH OF cantilever assembly to be dispensed with , howevever , rusty cantilever must be replaced or painted depending on rusting. (As per RlyBd L.No. 2020/EEM/161/1Vol-2 Dt. 21.09.2020)

      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 isthe 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 clearances and adjust as per SED.

ii. 100 per cent OHE fittings in tunnels should be replaced with new or previously over-hauled fittings and the removed fittings taken to the Workshop for detailed examination.

f. Turn outs:

Check the position of the contact wires with respect to the track for compliance with 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:

i. 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 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 replaced. 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. 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(rope).

POH of ATD should be done after 8 years with AOH in between every year and after every 6 years in coastal and saline area with AOH every year (Rly Bd. Letter's no. 2013/Eect(G)/148/1 Dated 10.05.2019).

20330 Rehabilitation of OHE

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

20331 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 period 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, tape and binoculars. The main points to be noted while patrolling are as follows:

a. Structures:- Leaning 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; tilted stubs; cracks or breaks in chimney top; slippage oil stubs from encasing chimney concrete; uneven settlement of footings; disappearance of gravel blanket protection; backfill embankment and its covers (rip-rap or revelment); 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, earthwire and accessories and their attachment points on structures can only he 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/hail storms, quakes, snowfalls, forest fires, floods or heavy rains. Such inspection should be done after 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, it 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. Technician's ratchet,
k. Pull-lift device of adequate capacity,
l. Wire ropes, and
m. Spanners

IV. SAFETY RULES FOR OHE

20332 General

1. The following rules are supplementary to the General and Subsidiary Rules and the instructions contained in Volume 1.
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, tirfor,slings, D shackles and other load taking equipments etc. should be tested once in three months at least, in the presence of an JE, and record of such tests maintained in each depot.

20333 Documents to be kept with OHE Supervisors for Work on OHE

1. The JE (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 SSE/ JE (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.

20334 Permit to Work

Before commencing work on any part of the dead OHE or within 2m of live OHE, a permit-to-work shall be obtained from TPC or other authorized person as detailed in Chapter VI.

20335 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 in the Chapter VI shall be observed by all concerned to prevent accidental energization of the section under power block on account of electric train movements.

20336 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 1000 m intermediate earths shall be provided in such a manner as to ensure that the distance between earths does not exceed 1000 m.
4. Even when earthing is provided by isolator switches with earthing heels, additional temporary earths as above shall also be provided.

20337 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.

   For providing temporary earth on the OHE or other equipment after it has been made dead, only discharge/ earthing rod assembly specially designed for this purpose alone should be used. The cable shall be flexible and should have adequate cross-section of 40 sq.mm.

   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/earth wire of this mast 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 or to the mast 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.

1. First touch the top hook with Register arm tube for ensuring the OHE is in switched off condition. 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.
2. 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.
3. Repeat operations 4 and 5 for the second temporary earth on the other side of the working party.
4. After temporary earths have been fixed on the OHE on both sides of the work site, staff may proceed with the maintenance work.
5. 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 live equipment, the permit-to-work may be returned and supply restored.

20338 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 then 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 SSE/JE 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.

20339 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.

1. 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.
2. 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.

20340 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. All staff at work site shall wear safety shoes suitable for working with 25kV.

20341 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.

20342 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 it 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.

20343 Other Important Precautions to be taken while Carrying out Works on OHE

1. The useful cross section of a conductor shall not he reduced while making joints.
2. Any contact with conductors, which are not specifically earthed, is forbidden.
3. The strength of the anchoring rope should be not 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.

20344 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.

20345 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 25 kV 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 2m 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 aerial fuses.

20346 Deleted

20347 Isolators

Isolating Switches on the 25 kV 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 (see para 20600 & 20601).

20348 Petroleum Sidings

The following arrangements/precautions would be necessary: -

Arrangements

1. An equipotential link between the petroleum sidings installation earth 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 of neutral zones/sections in the contact wire similar to loco inspection pits.
4. The tracks must be provided with longitudinal bonds on both the rails as well as transverse bond (30 m 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.
5. 10 ohm earths must be connected to the petroleum siding on each side at the insulated joint.

Precautions

a. No oil tanker is permitted to stable under live OHE for inspection purpose.

b. Fuelling to be done by side filling arrangement only.

c. Pipe lines in the vicinity of the track should be properly earthed.

d. Minimum 2 m electrical clearance from live OHE of the adjacent track or only other structure nearby must be maintained.

e. 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.

V. FORMS AND REGISTERS

20349 Records to be Maintained

In Chapter VI 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 JE. This should be in proforma No. 03-1 appended.

   The form in which reports are to be submitted by the JE/SSE to ADEE (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 (para 20322) should be entered by the Technician in a Register to be maintained for the purpose by each Section Supervisor. The Register shall be generally as shown in proforma No. 03-2 appended.
3. Cantilever Assembly Maintenance Register as per proforma No. 03-3. This should be maintained by each depot/sub-depot.
4. Register of Contact Wire Thickness Measurements: This Register shall be maintained in proforma No. 03-4.
5. Register of Clearance under over line Structures as per proforma No. 03-5.
6. Register of Earth Resistance Measurement as per proforma No. 03-6.
7. Register of Current Collection Tests shall be maintained in proforma No. 03-7.
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, as per Proforma No. 03-10.

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, as per Proforma No. 03-11.
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, as per Proforma No. 03-12.
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., as per Proforma No. 03-13.
12. Register for Feeder Lines shall be maintained by concerned depots/sub-depots to indicate particulars of patrolling of 25 kV feeder lines and maintenance carried out on such feeder lines.
13. Register of Critical Implantation: The annual check of Implantation at critical locations (para-20306) shall be recorded in this Register as per Proform'a No. 03-8.
14. Register of Level Crossings: This should contain dates on which height of contact wire at Level Crossings as well as that of the height gauges at Level Crossings have been checked. See Proforma No. 03-14.
15. Register of Splices as referred to in para 20310 as per Proforma No. 03-15.
16. Register of OHE Break-downs: Each depot/sub-depot should maintain particulars of OHE break-downs occurring in its jurisdiction in Proform'a No. 03-9. For each break-down a page should be allotted. Reference to detailed reports submitted should also be given to facilitate investigations subsequently.
17. Register for Thermal Imaging of Electrical Junctions.
18. Register for PTFE Neutral section
19. Register for section insulator assembly
20. Register for power line crossings
21. Register for pantograph joint inspection
22. Register for maintenance of assets
23. Register for Tools and Plants checking
24. Register for Live line tower wagon checking

Registers may also be maintained for any other additional items in the proforma prescribed by PCEE.

The registers 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 registers are maintained up-to-date. Officers and Senior Supervisors during their inspections should scrutinize these registers and initial a few important entries.

Annexure 3.01
(Para 20301,2,4)
20320

SCHEDULE OF MONTHLY INSPECTIONS

SN	Nature of Inspection	SR.DEE	DEE	ADEE	SSE-In charge	SSE(Sectional)*	JE*
1.	Locomotive Cab	1	1	2	2	2	2
2.	OHE Inspection Car	1	2	3	4	4	6
3.	Foot patrolling	0	0	0	Entire section in year	Entire section in 6 month	Entire section in 3 month
4.	OHE Depot	1	2	4	4	-	-
5.	Station	1	1	2	4	4	4
6.	Night Inspection	-	1	1	2	2	2
7.	Office Inspection	1	1	1	1	-	-

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 checklists of items to be broadly covered are indicated at Annexure 3.02. Detailed maintenance schedules prescribed should also be kept in view.

iv. Quota of Inspections by HQ officers may be laid down by PCEE

Annexure 3.02
(Para 20302)

CHECK LIST FOR INSPECTIONS

1.0 OHE Depots & Subordinate Offices

a. OHE Depots
   1. Staff grievance register.
   2. Quarter register.
   3. Attendance registers.
   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 registers.
   2. Compliance of audit & account Inspection notes.
   3. Compliance of Officer's inspection notes.
   4. Test & Trial report.
   5. Latest drawings & specifications.
   6. Planning & progress of section works.

2.0 Station

a. SWR
   1. SWRs and its Appendix G with latest correction slips.
   2. Display of traction working diagram and its correctness at SM room & cabins.
   3. Traction KeyBoard 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.
   6. Availability of Hand Gloves for isolator operations and Power block collars.

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 & Plants.
   2. Working of TPC phones & emergency telephone sockets.
   3. History sheets of various equipments.

3.0 Cab Inspection

a. Condition of OHE
   1. Flashed/damaged insulators
   2. Displaced fittings & droppers
   3. Balance weight in reference to upper & lower limits marked on masts.
   4. Number plates, warning board for rusting & tightness.
   5. 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. Focusing of head lights & flasher light.
   2. 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. Observe any glow in the OHE connection with Equipment or jumpers at SSP, SP, Isolators.
   3. Other items as above.

4.0 deleted

5.0 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 500mm is available between the two OHEs in an insulated overlap and 200mmin 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 Crossing

1. Height & gradient of contact wire.

h. Regulating Equipment:

1. X-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.

Annexure 3.03

(Para 20321)

FOOT PATROL DIARY …….

DEPOT……..

JURISDICTION …….

NAME …….

	Items of Observation		Observations	
			Section Date	Section Date
FOUNDATIONS	1.	DAMAGED OR CRACKED		
	2.	SINKING OR TILTED		
	3.	WATER COLLECTION AROUND FOUNDATION		
	4.	SIDE EARTH FILLING REQUIRED.		
	5.	TOP OF FOUNDATION NOT CLEAR.		
OHE MASTS AND PORTALS	1.	MAST DEFLECTED TOWARDS TRACK.		
	2.	MAST DEFLECTED AWAY FROM TRACK.		
		Other than those already under observation & thus painted with yellow band.		
	3.	HIT MARK OR DAMAGE TO MAST.		
	4.	NUMBER PLATE MISSING		
	5.	NUMBER PLATE DAMAGED.		
	6.	HRL/IMP NOT PAINTED.		
ANCHOR	1.	NUT, CHECKNUT OR LOCK PLATE· PIN MISSING FROM ANCHOR BOLT.		
	2.	-DO - GUY ROD.		
	3.	ANCHOR BOLT RUSTING.		
BRACKET ASSEMBLY	1.	BRACKET INSULATOR DAMAGED.		
	2.	STAY INSULATOR DAMAGED .		
	3.	9-TONNE ANCHOR INSULATOR DAMAGED.		
	4.	ANY OTHER DEFECT NOTICED.		

	Items of Observation		Observations	
			Section Date	Section Date
SECTIONS INSULATOR	1.	ABNORMAL WEAR ON RUNNERS.		
	2.	CORE INSULATOR VERY DIRTY.		
	3.	CORE INSULATOR HAVING FLASH MARKS/DAMAGED.		
REGULATING EQUIPMENT	1.	'Y' DISTANCE IS ABNORMAL		
	2.	MOVEMENT OF B.W. NOT FREE.		
	3.	SS ROPE OVER-RIDING ON THE DRUM GROOVES.		
	4.	SS ROPE STRANDS FOUND CUT.		
	5.	WHETHER EQUALISING PLATE IS TILTED.		
AUX. TRANS FOR CLS SUPPLY	1.	DROP OUT FUSE FOUND FALLEN.		
	2.	SOUNDNESS OF EARTH CONNECTION.		
OHE SPAN	1.	SPAN DROPPERS ABNORMALLY OUT OF PLUMB.		
	2.	SPAN DROPPERS DAMAGED.		
	3.	ANY ABNORMALITY IN RESPECT OF JUMPERS.		
	4.	DAMAGE TO CATENARY STRANDS.		
	5.	EXCESSIVE SAGGING OR HOGGING OF CONTACT WIRE.		
ISOLATOR	1.	ISOLATOR NO. PLATE MISSING.		
	2.	ISOLATOR LOCK MISSING/ DAMAGED.		
	3.	ANY SIGNS OF SPARKING/ OVERHEATING		
RC & BT	1.	SUSPENSION INSULATOR DAMAGED.		
	2.	SOUNDNESS OF CONNECTION OF RC WITH RAILS.		
	3.	ANY OTHER DEFECTS NOTICED AT BOOSTER TRANSFORMER STATION		

	Items of Observation		Observations	
			Section Date	Section Date
GENERAL CHECKING	1.	DANGER AND CAUTION BOARDS		
	2.	HT. GAUGES AT LEVEL X-ING.		
	3.	EMERGENCY SOCKETS FOUND DAMAGED/ OUT OF ORDER.		
	4.	EARTHING OF OLS/PLA TFORM SHEDS ETC.		
	5.	BONDS FOUND DISCONNECTED/ MISSING.		
	6.	PROTECTIVE SCREENS ON FOB/ ROB.		
	7.	TREE BRANCHES NEAR OHE.		
	8.	BIRD NESTS AND PIECES OF STRAY WIRE.		
	9.	DEFECT IN TRANSFORMER SECONDARY NEUTRAL CONNECTION TO RAIL AT FP.		
	10.	SIGNS OF HEAVY SPARKING WHEN LOCO PASSES		
	11.	GENERAL CONDITIONS OF SWITCHING STATIONS ON ROUTE.		
	12.	MINOR DEFECTS RECTIFIED IF ANY DURING PATROLLING.		
	13.	MAJOR DEFECTS NOTICED		

Signature of Technician

Foot Patrolled

Date:

Signature of station masters/ Yard masters/ Cabin master with date and time

Checked by

SSE/JE/ELC (OHE)

Annexure 3.04

(Para 30348)

PROFORMA 03-1

..... RAILWAY

..... DIVISION

Date .....

1. Power Block in sub-sector/Elementary Section :
   Time asked Time received
   Time returned
   Remarks
2. Staff utilized
   Skilled Semi skilled Unskilled
3. Details of work carried out in Power block:

	Type of work	**Locations**	**Staff/ Supervisor**
3.1	Cleaning of Insulator- ST, BT & 9-T		
3.2	Section Insulator		
3.3	OHE checking and adjustment		
3.4	Height & stagger of contact wire		
3.5	Dia of contact wire measured		
3.6	Clearance checked at locations		
3.7	Insulated overlaps locations		
3.8	ATD locations		

4. General Report on OHE of section. Preventive actions suggested_____
5. Report on catenary / jumper damage in the section. Preventive actions suggested_____
6. Details of work carried out under Non-power block

	Type of work	**Locations**	**Staff/ Supervisor**
6.1	Muff cleaned		
6.2	Bond checking		
6.3	Rail level & Implantation checked		
6.4	Repainting of R/L and implantation		

7. Report of foundation/muff conditions, leaning of masts. Preventive actions suggested_____
8. Report on changes in RL/implantations. Preventive actions suggested_____
   Station_____ Sup. Signature_____
   Dated_____ Designation_____

PROFORMA 03-2

..... RAILWAY

..... DIVISION

Register for Foot Patrol Report

Section_____

SN	Location	Defect	Category (A or B)	Date	Noticed by	Supervisor remarks			Date attended
						Name/Sign	Date	Action proposed with PDC	

Category 'A'- means defect related to safety and train operaton

Category 'B'- All other excluding A

PROFORMA 03-3

..... RAILWAY

..... DIVISION

Tower wagon/ Cantilever Assembly Maintenance Register

KM_____ Section_____

SN	Location	Type of location	No. of cantilevers	Attention				Insu. Make batch			CW		Clearance	Condition of fittings	Staff/ Supervisor	Remarks
				Date of checking	Work done	Sch/ Unsch	Due Date.	9T	ST	BT	Ht.	St.				

PROFORMA 03-4

..... RAILWAY

..... DIVISION

Record of Contact Wire Wear and splices

03-04 & 03-15 merged (ACS 13)

SN	Type of location (specify if stop signal/ hard spot location/ tunnel/ROB/ FOB/L.x gate or any other location	Location no.	At support		AT MID SPAN		Dt. Of provision of CW splice	Observation	No. of catenary strands out	Dt. Of prov. Of catenary splice	Staff/ Sup.	Remarks
			Thickness	Wear since last check	Thickness	Wear since last check						

PROFORMA 03-5

..... RAILWAY

..... DIVISION

Register for Features of overline structure

FOB/ROB..... Between Location.....

Station/Section.....

Line no..	Date	Span	Rail Level	Contact Wire Height at ends and midway	Clearance		Features Present						Sup/Staff	Remarks
					END1	END2	Crossing	Pipes	Protective screen	Caution Board	Earthing	Pr. ofFalseCat		

PROFORMA 03-6

..... RAILWAY

..... DIVISION

Register of Earth Resistance Measurements

Station..... Nearest Location.....

Earth Pit No.....

Sl.. No.	Date of Test	Resistance in Ohms	Over all Resistance	Initials of Supervisors	Remarks if any,

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Note - 1. Half page to be allotted for Each pit.
2. Earth test should be carried out on a dry day preferably in March/April once a year.

PROFORMA 03-7

..... RAILWAY

..... DIVISION

Record of current collection test

Date

Time

Done by

Train No.

From_____ To _____

Section

Location	Category			Corrective action	Dt. Of corrective action	Supervisor/Staff	Remarks
	Heavy	Medium	Light				

PROFORMA 03-8

..... RAILWAY

..... DIVISION

(03-8 & 03-13 merged)

Record of Implantation & Foundation (ACS 13)

Section _____

SN	Location no.	Date of check-ing	Founda-tion type	Type of soil	Implantation		Step distance	HRL mark height above RL	Amount of leaning at CW level		Amount of leaning at 1.85 m above HRL		Reason for leaning	Action taken	Supervi-sor/Staff	Remark
					As per SED	Actual			To-wards track	Away from track	To-wards traffic	Away from track				

Note: One page in the register to be allotted for each location

PROFORMA 03-9

..... RAILWAY

..... DIVISION

TRACTION DISTRIBUTION SECTION

Register of Break-downs/ Accidents involving OHE

1. Date of accident/break-down .....
2. Station .....
3. OHE Locations affected .....
4. Details of damages .....
5. Probable cause .....
6. Brief description and remedial action taken .....
7. Reference to detailed reports sent .....
8. Remarks, if any .....

Note: - One page in the register to be allotted for each case.

PROFORMA 03-10

..... RAILWAY

..... DIVISION

TRACTION DISTRIBUTION SECTION

Regulating Equipment

Location no. _____ Section:_____ Elementary section _____

Sl. No.	Date of Checking	Tension length m	Noted Value			Adjustment require		Date of Adjustment	Adjustment done			Temp oC	Final value		Whether greased	Whether replacement of ATD done with the overhauled one	Signature of SSE/ JE	Remarks
			Temp oC	X/ mm	Y mm	X/ mm	Y mm		By turn buckle	Wire cut			Xmm	Y mm				
										Catenary	Contact							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

(N.B.- One page to be allotted for each ATD location)

PROFORMA 03-11

..... RAILWAY

..... DIVISION

TRACTION DISTRIBUTION SECTION

Isolator Switches

Isolator Switch no. _____ Section/ Station:_____

SN	Location	Particular of isolator Switch	Elementary section connected	Date checked	Condition	Particulars of Work done, if any	Remarks
1	2	3	4	5	6	7	8

(NB Half page to be allotted for each switch)

Performa 03-12

..... RAILWAY

..... DIVISION

TRACTION DISTRIBUTION BRANCH
Turnout and Cross Overs

TURNOUT/CROSSOVER NO.---------- SECTION/STATION----------

S.N	Description		Std. value	Measured value			
1	Particulars of Turnout/ crossover(Givethe number i.e.1:8½ , 1:12etc.)		-	-	-	-	-
2	Section		-	-	-	-	-
3	Location No.		-	-	-	-	-
4	Date Checked		-	-	-	-	-
5	Type of Arrangement - Crossed type/Overlap type		-	-	-	-	-
6	Height of Contact Wire above rail level at support at Obligatory Structure	Main Line Contact Wire (mm), (H)					
		Turnout Contact Wire (mm)	H+50 *				
7	Turnout span (m)	54 (Max)					
8	Height of Contact Wire in Overlapping Zone	Mainline Contact Wire (mm) (H1)					
		Turnout Contact Wire (mm)	H 1+50 *				
9	Stagger of Contact Wire at Obligatory Structure	Mainline Contact wire (mm) Turnout Contact wire(mm)	200max. 300max.				
10	Sag of section insulator of Turnout/Crossover		Zero				
11	Movement of tower wagon from mainline to turnout a) Take off b) Point of take off (in m from O/S)		650 mmto 720 mm from centre line of pantograph ---				
12	Movement of tower wagon from turnout to mainline a)Take on b) Point of take on (in m from O/S)		650 mm to 720mm from centre line of pantograph ---				
13	Stagger of section insulator at turnout/crossover		+/- 100 mm				
14	Track separation at the location of section insulator (m) Runners towards the centre ofturnout Runners away fromthe centre of turnout		1.65 Min 1.45 Min				

15	Condition of ATD of turnout/mainline OHE		Free to move				
16	Length of pipe provided in hex tie rod of limiting device to bridge redundant length of hex tie rod.		As per SMI No. TI/MI/0035 Rev.1				
17	Setting distance (implantation) of obligatory structure (m)		3.0 Min				
18	Track separation at obligatory structure (mm)		150 to 700				
19	Distance of 'G' jumper from obligatory structure (m)		5.6				
20	Length of 'G' jumper. (m)		4.0				
21	Deviations from SEDs						
22	Adjustments done ,if any						
23	Remarks						
24	Name of supervisor and designation						
25	Signature of Supervisor						

* In case of overlap type arrangement.

(Proforma 03-13) merged with 3-08

(Proforma 03-14)

..... RAILWAY

..... DIVISION

TRACTION DISTRIBUTION SECTION

Level Crossing Gates

S.No.	Location of level X-ing	Line	Date of checking	Height of Contact wire	Condition of height gauge	Height of Height gauges from road level	Availability of 25 kV danger boards & Public caution boards at height gauge	Whether manned or un-manned,If manned Availability of staff warning board and electric shock treatment board at gate lodge	Remarks
1	2	3	4	5	6	7		8	9

(Half page for each level crossing)

(Proforma 03-15) merged with 3-04

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CHAPTER-4
REMOTE CONTROL EQUIPMENT

I. GENERAL

20400 Introduction

A Remote Control Centre (RCC) is set up near the Traffic Control Office on each Division having electric traction, to work in close liaison with the traffic control. The RCC includes the main control room, equipment room, Uninterrupted Power Supply (UPS) room, Remote Control laboratory and Battery Room and is the nerve center of the Traction Power Control.

Indian Railway is presently using Supervisory Control And Data Acquisition (SCADA) systems with Computer based equipment for Control and Data Acquisition of traction power supply system.

The SCADA equipment based on State of the art technology has come into use after 1980. Considering the fast growth and development of computer based equipment, newer types with enhanced capabilities and new makes are being introduced. Additional facilities at each new RCC is also natural as new features get incorporated. For complete details of SCADA system, the RDSO specification No. TI/SPC/RCC/SCADA/ 0130 (Rev.2) with A&C slip No.1 to 3 or latest may be referred.

II. SCADA EQUIPMENT

20401 General

The SCADA equipment at the RCC is called master Station while that of the controlled station is referred to as Remote Terminal Unit (RTU).

20402 Transmission Path

The communication setup for implementing high speed communication is achieved through use of Router with an inbuilt 2-port E1 interface card, LAN extender etc. In this arrangement one E1 which is provided between stations to station. For network redundancy, additional E1 is utilized to form an OFC ring from station to station.

20403 Master Station Equipment

RCC setup comprises of two server grade computers both in hot standby mode. Two Workstation-grade PCs in client server architecture is provided at RCC for every 15 RTUs to be integrated. E1 channels provided by S&T is used for communication between SCADA and RTUs. One E1 channel is used for maximum of 15 RTUs. RTUs communicates with RCC for transfer of events/alarms & measurands in addition to implementing telecommands. There is a provision of Energy Management Servers (EMS) in hot standby mode and 2 Workstation-Grade PCs. Separate web server is provided in RCC for accessing the SCADA/EMS data from any location through internet. Necessary fire wall is provided for keeping the system safe from intrusion of virus from outside world.

Configuration of Workstation-

i. Each operator workstation consists of two workstation-grade (not Desktop) PCs.

ii. One PC have provision for connecting four 42±1" signage display. By default, there is a provision of two (2) Displays; however the number may increase if the section is large enough. Each workstation grade PC is provided with a quad-output graphics display adapter.

iii. The second PC is provided with a single 42±1" signage and a second output for connecting to the projector.

iv. The SCADA software supports splitting of the SCADA graphics across the Displays.

A GPS receiver with antenna is provided to synchronize the timing of the servers with that of standard satellite timing. This ensure that all the date/time stampings of the reports generated by the SCADA system be accurate.

20404 Overall Screen Design &Real Time Display

The MMI (man machine interface) screen developed on WINDOWS generally comprises of Title bar, Menu bar, tool bars, status bars etc. for real time depiction & control of traction power system. This interface shall provide for all interactions between the operator and the SCADA system. It has also features for alerting the operator with audio/visual supports on occurrence of critical alarms and events. The audio alarms shall include play back of pre-recorded voice files in Wave or any other supported standard formats.

Full graphic, colored displays of controlled stations is provided by the software. The display includes ON/OFF status of all equipment, (such as feeder CB trip, ac and dc fail/low, RTU fail, communication fail, machine down etc.), alarms, measurands and names of the controlled stations.

It has facility for viewing display of full section, suitably condensed to fit screen size. This condensed picture is displayed on the MMI when required by the operator. This condensed diagram has fewer details as compared to the normal display.

If number of controlled stations is too large then the condensed picture for full section may be displayed on two or three pages.

Alarms for circuit breaker(s) tripping(s) is displayed on MMI screen in addition to flickering of circuit breaker symbol(s) till operator acknowledges the same. The telecommand points like CBs, Interrupters etc. are displayed with the distinct colour schemes & attributes.

20405 Alarm Processing and displays:

Alarms are generated as per configuration of the software i.e. whenever the state of the device is found to be in the abnormal condition or any measurand's set limit is violated. In the event of failure of RTU or any equipment at RCC such as Hostor MMI an equipment alarm appears.

The alarm list is of two kinds – current and historic.

The Current alarm list contain minimum 400 entries ordered chronologically. Acknowledgement status of an alarm is also indicated in the current alarm list.

Historical alarms list consist of alarms for the last one month.

20406 SCADA Software

1. SCADA software is capable of working on latest version of Microsoft WINDOWS operating system.
2. The software is compatible for working on IEC 60870-5-104companion standard protocols. It also supports multiple channels for communication to all RTUs.
3. The software fully supports file transfers for disturbance recording from protection relay between

RTU & RCC as defined by different IEC 60870-5-104 of standards. Protection relays supports IEC60870-5-103 protocol.

4. The Software is menu driven, GUI (graphic user interface) based and fully user configurable. It is possible to customize the software to specific need of mimic and tabular displays, representation of various equipment and devices.

20407 Test Procedure& Diagnostics

In general the software supports basic test procedure like-in-build test frames (TESTFR =act) as per 60870-5-104& basic standards of IEC 60870-5series. The only periodic poll from the Master is the General Interrogation, which may be at 15 minute interval. Apart from this, Master sent a TESTFR packet at every interval of 10-15 seconds, to check the healthiness of the RTU and Communication media.

RTU Diagnostics

The RTU is self-monitoring/diagnostic for fault conditions. This provides various details such as defective cards, host lines, device status, command supervision etc. The RTU generally supports the test procedures as per standard protocol IEC 60870-5-104.

RCC Diagnostics

SCADA application software has minimum following inherent features to check its own sub functions and reports status to the operator:

1. Online/standby /offline state of SCADA server/communication front ends.
2. State of all RTUs.
3. State of printers.
4. Connection status of all the operator workstation.
5. Communication as well as health status of energy meter and numerical relay.

20408 Historical Data Storage

The SCADA system is designed to cater for historical data storage of traction power supply system data for a period of 4 months. This includes:

1. All alarms/events / measurands of controlled stations and all system alarms.
2. Day wise storage of average feeder current and voltage during the day, maximum demand, maximum and minimum feeder voltage in the 25 kV side, total number of operations of feeder protective relays viz. OCR, DPR and WPC relays, CB tripping and maximum and minimum OHE voltage on both sides of the neutral section. A memory capacity of 40 MB is provided for this purpose in the hard disk, with provision for further expansion of the memory as required.

Backup of the data within 4 months is required to be taken due to limitation of memory.

20409 UPS and Batteries at RCC

On line UPS system of generally 2x5 kVA

Input:

3-Phase 415 +10% & -15% Volt AC, 50 ±3% Hz,

Output:

Stabilized 240 Volt AC, 50 Hz. rating along with the suitable batteries and associated equipment is used for RCC.

The UPS system operates in dual redundant hot standby mode where another generally 5 kVA UPS is provided with 100% redundancy to the system.

The malfunction of online UPS cause it to automatically isolate from the system and the other UPS take up the load without any interruption.

Each UPS is designed to operate as a true on-line, double conversion system where the UPS output is independent of input supply voltage & frequency variations.

Both the UPS unit share/connected to a single battery set. The voltage of each cell be 2 V and the bus voltage of Battery Bank is 110V or higher suitable to UPS.

The UPS is equipped with Cold start facility.

Battery:

Battery set of low maintenance lead acid batteries of sufficient AH capacity to cater the full RCC load for minimum 3 hours is provided.

20410 Remote Terminal Unit (RTU)

The Remote Terminal Unit (RTU) installed at TSS/SP/SSP/ATP to acquire data from power system devices i.e. CT/PT circuits, numerical relays and device status signals. RTU is also used for control of devices from Master station/RCC.

The RTU Hardware includes redundant CPU modules, it's associated digital input/output modules, alarm input modules, analogue input modules, watchdog, transducers, memory, interposing contactors, redundant power supply units and surge arresters and other items necessary for its proper functioning. In case of failure of CPU (Central Processing Unit) /PSU (Power Supply Unit) the redundant module takes care without interrupting the functionality of SCADA, and an alarm for the failed module is generated in the RCC and logged as event also.

20411 RTU FUNCTIONAL DETAILS

1. The RTU is designed for handling telecommands, telesignals and telemetered parameters. All the changes (one or more) in the status of the circuit breakers / interrupters /motor-operated isolators and alarms that may occur between consecutive polling is stored by the RTU until they are reported to the master stations along with their time of occurrence. More over a minimum of 400 events is stored in the RTU memory sequentially, in case of communication failure, for reporting to the master station. For TSS, minimum 1000 events is stored.
2. RTU uses IEC 60870-5-104 protocol for communication with RCC.
3. The CPU restores without any manual intervention after restoration of power failure or communication failure or internal fault.
4. The RTU have self-monitoring/diagnostic for fault conditions. This provides various details such as, defective I/O cards, hotlines, device status, command supervision etc.

20412 SCADA Equipment Capacity

The SCADA equipment is generally designed for the following typical capacity of tele commands, tele signals and telemetered parameters for a TSS, SSP, SP and ATP (Auto Transformer Post) of double

line section. The figures given below may vary depending on the layout of TSS, SP, SSP& ATP in a particular section, which could have single, double or more tracks.

Alarms/status monitored in SCADA for marking each alarm is uniformly applicable to 25kV or 2x25kV or Sub-urban as per DI/DO/AI requirements.

Minimum Input Output (IO) capacity required:

Sr. No.	Type of Input/output	Hardwired	From Relays/MFT Multi-Function Transducer)
1.	Tele signals (DI)	96	415
2.	Tele commands (DO)*	32	64
3.	Measurands (AI)	4	64

*These tele commands include both ON and OFF.

20413 Energy Management System (EMS):

A dedicated Energy Management System (EMS) is provided at the Remote Control Centre. EMS to record all energy parameters at HV /LV sides of all the FP/TSS locations in the section. EMS provides logging, storage and visualization functions for the data acquired from the different sites. Basic visualization functions, like graphs, tabular data is provided for EMS application.

Apart from EMS Main and Standby Server, there is a separate server for EMS Web Applications.

The EMS software shall be provide the following features–

1. Integration of data in 15 (configurable) minutes time block,
2. System should have the capability to generate energy data including frequency to facilitate demand requirement on day ahead, short time demand etc. based on average energy parameters of previous days / month it supports the following
   a. Data capture in 15 minutes interval against different demands portfolios (including frequency) such as base demand peak demand total demand and maximum demand.
   b. It supports demand aggregation over different periods (15 Minutes / Hourly / Daily / Monthly etc.
3. Real-time comparison between actual demand versus scheduled demand.
4. Comparison of any recorded parameter at different times in history.
5. The software is capable to provide a data tag for each TSS in identification of sub-division, division, Zonal Head Quarter, State and Region.
6. Based on Forecast, Projected schedule, drawl schedule and its revision as received from SLDC, the software generates report for variation of the same for analysis purpose and to improve forecasting and scheduling by SLDC.
7. The EMS should have the capability to import data from text/xml/Excel file for the purpose of analysing existing load profile for modelling the demand forecast system by SLDC.

20414 Special Features in SCADA Equipment

The following additional features are incorporated in the SCADA equipment:

1. Tripping of bridging interrupters on under voltage at SP in extended feed condition.
2. Inter lock release request facility for circuit breakers/interrupters control at boundary post
3. Control of shunt capacitor bank and monitoring of power factor.

4. Automatic localization of fault on OHE and isolation of faulty sub-sector.

SCADA systems on Indian Railways are being supplied by various manufacturers. Although the systems are different, the basicframework and features of the systems are similar. For details of operating instructions and maintenance, the operating technical manuals of the makers should be referred to.

III OPERATION AND MAINTENANCE OF RC EQUIPMENT

20415 Duties of SSE(RC)

He is the senior supervisor working under the control of DEE/AEE (TRD) and directly responsible for the proper operation and upkeep of the RC equipment, which are vital for the efficient operation of the electric traction system. He shall be thoroughly conversant with all the technical details of the equipment under his control. In particular, he shall perform the following duties.

1. Maintain the RC equipment at the RCC and the controlled stations in accordance with the prescribed schedules.
2. Keep close liaison with the S&T department as to the sound condition of the communication for RC operation.
3. Measures periodically the levels of voice frequency signals at controlled stations in case of quad cable and arrange with the S&T department for correction, when required, at their repeater stations.
4. Keep in constant touch with the TPC on shift duty and ensure prompt rectification of defects reported in the RC system.
5. Ensure proper maintenance of UPS/battery sets for uninterrupted operation of the RC equipment and the stand by generating set in the RCC.
6. Inspect the RC equipment at every controlled post once in two months.
7. Impart necessary training to the staff under him in the special techniques of maintenance of RC equipment as well as trouble shooting.
8. Ensure that the special instruments and tools provided for maintenance of the RC equipment are properly cared for.
9. Keep a watch on stocking of spare parts and other stores required for the RC equipment and Initiate timely action to recoup stocks.
10. Co-ordinate with SSE (PSI) and SSE (OHE) or territorial SSEs for manning the controlled posts in the event of persisting faults in the RC equipment's.
11. Submit prescribed periodical returns on RC equipment to AEE (TrD) and Sr. DEE (TrD).
12. Keep his superior officer fully informed of all important developments and seek their guidance when required.
13. Carry out such other duties as may be allotted by his superior officers.
14. Carry out minimum monthly inspections as per manufacturers recommendations.

20416 Operation of RC Equipment

The RCC is the nerve center of the traction system, from which full control over every switching operation on the entire electrified route is exercised. It should, therefore, be kept in perfect operating condition at all times. No one, other than an authorized official, shall at any time operate the equipment. The TPC shall, at every change of shift, carry out a lamp test and, once a day give a general check for all stations and thereby ensure that the indications on the mimic panel are In order. Any defects observed In operation shah immediately be reported to the SSE(RC) and the entry made in the log book of the time defect was reported and the time it was rectified. Any excessive delay in rectification

which militates against operation shall be brought to the notice of AEE(TRD). Depending upon the nature of the defect TPC shall take adequate precautions against mal-operation until the defect noticed is rectified.

Should RC equipment of a switching station fall completely, the failure shall be reported to AEE(TRD) and Sr. DEE (TrD) and arrangements made to man the switching station with trained personnel to carry out the switching operations, observing the precautions prescribed in the Chapter VIII 'Breakdowns'.

TPC shall once a day contact on telephone the Operators of each Grid sub-station from which traction power supply is obtained and ensure that the communication facilities are Intact.

20417 Investigation of Failures by SSE (RC)

As with any other equipment, every failure of RC equipment should be separately registered, investigated and rectified, making a brief note in the failure report of the action taken as well as classifying and finally pin-pointing the exact cause of the failure. The failures should be analyzed every month and any special steps required taken to overcome the trouble and prevent recurrence should be taken. A 'history sheet' showing the faults that have occurred on different items of equipment will assist in carrying out detailed investigation of recurring troubles in consultation with the Manufacturers of the equipment.

20418 Maintenance Schedule

The specific maintenance instructions issued by the respective suppliers of SRC/SCADA systems should be observed and changes to be made therein may be decided in consultation with the manufacturers. For the batteries used in the remote control center and the remote terminal units (RTUs), the instructions in Chapter II for fortnightly maintenance and quarterly maintenance shall be applicable.

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CHAPTER-5
OPERATION OF TRACTION POWER CONTROL

20500 Remote Control Centre

The Remote Control Centre (RCC) constitutes the 'heart' of the control system from where the switching operations over the electrified system are controlled by one single authority i.e., the Traction Power Controller.

20501 Manning of RCC

The RCC shall be manned throughout the 24 hours. There shall be shifts in each of which there will be at least one Traction Power Controller (TPC) who shall be in charge and, depending upon the workload, an Assistant Traction Power Controller (ATPC) to assist him. The CTPC will be directly responsible for the correctness of all-switching operations and entries in the LogBook. No person is permitted to operate the control switches except with the specific permission and knowledge of CTPC. No person shall be permitted to work as a TPC or ATPC, unless so authorized in writing by Sr.DEE (TrD).

20502 Knowledge of Rules

TPC (and ATPC where provided) shall be fully conversant at all times with the rules and regulations laid down by the Administration as well as with the details of the electrical distribution system. He shall keep all instructions issued from time to time as well as copies of documents like General and Subsidiary Rules, Station Working Rules etc. ready at hand. He shall keep all books and records up-to-date, posting all correction slips on the day of receipt in the appropriate document.

20503 Entry into RCC

No person is permitted to enter the TPC unless he has an authority for the purpose. The TPC and ATPC who are on duty shall not be disturbed or distracted.

20504 Shift Duty

No interchange of shift duty or variation of hours shall be permitted without the specific sanction of DEE/ADEE (TrD). In case of unavoidable circumstances the staff may make the necessary arrangement with other shift duty staff before approaching ADEE (TrD) for permission. No one shall leave his post of duty until he is relieved by an authorized person.

20505 Shift Duty Register

A shift Duty Register shall be maintained in which shall be noted every change of shift duty. Before handing over charge, the outgoing TPC shall record in the Shift Duty Register all points (shut downs, power blocks, defects in plant, any special instructions received, pending message, if any etc.) requiring the attention of the TPC who takes over. Before taking over of a shift duty, the TPC shall scrutinize all the entries recorded during the previous shift in the Shift Duty Register in the log book, study the entire mimic diagram in the presence of the previous shift TPC and clear all points of doubt, if any. He should then sign with time in the Shift Duty Register, thereby admitting having taken over correctly and assuming full responsibility from then onwards.

20506 Repair and Adjustment of RC Equipment

1. TPC shall not repair, adjust or any way interfere with any of the RC equipment at the RCC except for carrying out switching operations. Every defect shall be reported at once to the SSE (Remote Control) or the JE (Remote Control), who are responsible for the maintenance work.
2. No work may be commenced by any person on remote control or power supply equipment at the RCC or any controlled post without prior intimation to and approval of the TPC on duty, who shall record the event in the Log Book. At the end of the work, the TPC should test the equipment on remote control and satisfy himself that everything is in order.

20507 Switching Operations to be Deliberate

Since all circuit breakers and interruptors are operated through remote control, the TPC will have control over the switching operations over a wide area. The time required for each operation is of the order of only a few seconds. Every switching operation should, therefore, be carried out only after due thought and deliberation. Operation of several switches simultaneously should be avoided as far as possible as it may lead to wrong operations.

20508 Liaisons with Section Controller

While the Section Controller is directly in charge of all movements of trains, TPC is directly responsible for maintaining the power supply for all electrified tracks. For operation of the train services, it is necessary that the close liaison be maintained between the Section Controller and the TPC at all times. The particulars of communication facilities provided for this purpose have been described in Chapter ll of Vol l.

The TPC should also be in touch with the operators at the various Grid Substations.

20509 Prompt Attention to Telephone Calls

Either TPC or the ATPC shall attend promptly to all calls received on any of the telephones/Mobile Phonesat the RCC, priority however being given to emergency telephone and TPC telephone.

20510 Log Book

The Log Book is a primary minute-to-minute record of every switching operation carried out at the RCC, every interruptions to power supply, unusual or abnormal occurrences, messages received over the telephones, special instructions received from superior officers, defects reported in equipment and action taken to have them rectified as and when they occur, in chronological order.

20511 Movements of Maintenance Staff

It is also the duty of the TPC to keep a track of the movements of all maintenance staff of the Traction Distribution Branch so that in an emergency he is in a position to summon the nearest gang/person, as required. It is primarily the duty of the maintenance staff to keep the TPC informed of their movements - which shall be recorded in a "Register of staff movements."

20512 Checking of Time

The TPC shall check the correctness of the time on the clock at 1600 h of each day when time signal is received from the Traffic Control Office.

20513……..deleted

20514 Emergency Generator Set

A 415/24OV, ac, 50 Hz, 3 phase Diesel Engine Driven Generator Set is provided at each RCC for feeding of the essential loads in the event of failure of the mains supply. Each TPC and ATPC shall be fully conversant with the starting of the Generator Set. It shall be started and worked for an hour at least once a week if it has not been operated due to failure of mains supply.

20515 Duties of Chief Traction Power Controller

The Chief Traction Power Controller (CTPC) shall perform the following duties:-

1. Study of all failure reports of OHE, switching stations etc. daily specially in so far as they affect the operation of trains and submit connected periodical reports to ADEE (TrD). He shall maintain complete statistical data relating to operation of RC equipment and ensure that the schedules of maintenance are carried out regularly;
2. Scrutiny of traffic delays shown against the Traction Distribution Branch and liaison with the Chief Controller, as necessary, for ensuring the correctness of the records;
3. Maintenance of close contact with the Chief, Deputy and Section Controllers, TPC and ATPC, TLC, Sr.DEE (TrD) and ADEE (TrD) and study of all problems relating to train operations, as far as the Traction Distribution Branch is concerned, to seek solutions;
4. Scrutinize the Log Book and the Shift Duty Register once a day and ensure that they are properly maintained and actions necessary is taken,
5. In an emergency or disorganization be in direct touch with the Traffic Control Office and help in every way to restore and maintain the train services and take over operation of power control himself, if required;
6. Ensure that TPCs and ATPCs are adhering to the rules and instructions in force. Study all the rules in force and suggest amendments, modifications, corrections as may be found necessary in practice;
7. Co-ordinate the Weekly Power Block Programme of all traction staff and other departments and finalize it in consultation with the Traffic Department. Take steps to adhere to the agreed programme as far as practicable.
8. Compile periodical statistics from the data collected on SCADA system and as per instruction of Sr.DEE (TrD)including the analysis of failures on the SRC system, and submit them to Sr.DEE(TrD).
9. Report daily to the PCEE's office all matters as laid down by the PCEE.

20516 Duties of Traction Power Controller

He is the official in direct charge of the control of 25 kV power supply for electric traction and shall be fully acquainted with all the traction power supply Installations, and sectionalizing arrangements. There will be a TPC in each shift in the RCC and, depending upon the workload, he may be assisted by an ATPC. The essential duties of the TPC/ATPC are as under:

1. When taking over shift duty, he should acquaint himself with the prevailing position of the entire section including working of the RC equipment, condition of all transformers, circuit breakers, interrupters and isolators, sections under power block, any special Instructions to be carried out-movernents of important officials connected with the traction distribution system, position of the OHE Inspection Cars and break- down vehicles etc.;
2. Maintain continuous contact with the Power Supply Authorities;
3. Maintain continuous contact with the Traffic Section Controllers in regard to power supply affecting train movements, imposition of power blocks etc.;

4. In the event of power supply Interruptions or other failures, take prompt action in accordance with prescribed rules and local instructions for restoration of supply;
5. Imposition of and removal of power blocks as required, following the prescribed procedure and safety rules.
6. In the event of power supply failures, OHE break-downs, accidents etc. in the electrified section, advise promptly the concerned Foreman, ADEE, DEE/5r. DEE (and other officials in accordance with local Instructions), and keep them posted with all important developments;
7. Record in the Log Book, on prescribed proforma, full details of all switching operations carried out, power blocks imposed or refused (or delayed) and other occurrences in the distribution system;
8. Maintain the following registers and records in the proforma prescribed:-
   a. Shift Duty Register indicating points of importance including messages, movements of ODC involving power blocks and other details to be noted by following shifts.
   b. Record of standing instructions.
   c. Register of temporary instructions.
   d. Register of Staff Movements.
   e. Emergency Telephone Testing Register.
   f. Register of train delays due to failures of signal supply.
   g. Weather forecast register.
   h. CB tripping details register.
   i. HT failure registers.
   j. TSS-wise Energy Consumption registers.
   k. Live line tower wagon inspection register.
   l. Oliver G checking Progress registers.
   m. Tower wagon Monthly Mechanical checking and POH inspection registers.
   n. Daily maintenance progress cumulative register.
9. By 10 h each day submit the following reports to Sr. DEE/ DEE (TrD) and other officials as laid down in local instructions:-
   a. List of power blocks availed.
   b. Particulars of telecommunication failures.
   c. Particulars of RC failures
   d. Power Supply failures.
   e. Maximum demand and energy consumption at each traction sub-station.
   f. Condition of traction sub-station equipment
   g. All unusual occurrences, if any.

20517 Failure of Traction Power Supply

Failure of 25 kV ac, 50 Hz Signal phase power supply can be due to -

1. failure of equipment of Supply Authorities or
2. failure of railway equipment.

When the indications at the RCC are that failure of power supply is over the entire area fed by one sub-station, the cause and likely duration of failure should be ascertained immediately from the Operator of the Grid sub-station.

20518 Failures of Grid Supply

In the event of failure of Grid power supply at a sub-station, if the Operator at the Grid sub-station advises that he anticipates that the power supply may not be restored in less than 3 min, the TPC should immediately initiate emergency working extending the feed from the adjacent substation upto the failed sub-station, as a first step. He should inform the Sr DEE /DEE (TrD), ADEE (TrD) and Section Controller of this situation. He should also keep in continuous communication with the Grid sub-station, persue and restore supply to OHE as quickly as possible.

20519 Prolonged Power Supply Failures

1. If the power supply is anticipated to be restored after 10 minutes, as ascertained from the Operator at the Grid sub-station, or if he is unable to state when power supply is likely to be restored, TPC shall immediately proceed as follows:

   a. Advise the Deputy/Section Controller that emergency feeding arrangements are being introduced in the area fed by the particular sub-station. The Section Controller shall then inform the stations on either side of the concerned feeding post to issue caution orders to every electric loco and EMU driver entering the affected area to lower pantographs while passing the feeding post, specifying the structure number at which the Driver shall lower pantograph and the structure number on reaching which, he may raise it. The Section Controller shall also repeat the information to all loco sheds, both major and- minor, and to all train ordering stations. After this has been done the Section Controller shall confirm to the TPC that instructions for Issue of caution orders for lowering of pantographs have been issued and emergency feeding arrangements may be made. These instructions do not apply for locations where short neutral section assemblies have been provided opposite the feeding postor when one TSS supply is extended to the next TSS feeding zone.

   (The Loco Pilots of electric and EMU locomotives shall, however, continue to observe instructions regarding “Open DJ” and “Close DJ” at the neutral sections as usual).

   b. On receipt of the above information, TPC will open the two 25 kV feeder circuit breakers at the sub- station where supply is interrupted and put “Red Warning Caps”/”Device inhibited tags” on the corresponding control switches in the RCC.

   c. TPC will then close the bridging interruptors at the neutral Sections on either side.

   d. On restoration of supply from the grid sub-station, “Red Warning Caps”/”Device inhibited tags” shall not be removed and the feeder circuit breakers shad not be closed until the bridging interrupters have been opened first.

2. If emergency feeding is to be continued for long periods, temporary signals for lowering and raising of pantographs shall be provided.These instructions do not apply when one TSS supply is extended to the next TSS feeding zone.

20520 Faults on Railway Equipment and Lines

Any faults on OHE and 25 kV feeders lines will cause the corresponding feeder circuit breaker to trip, thus interrupting supply to the corresponding sector. When this happens TPC shall reclose it once immediately. If It trips again he shall keep the circuit breaker open and proceed to isolate the fault. Where auto reclosing feature is provided, the TPC should take action to isolate the fault after the auto-reclosure scheme locks out. After isolation of faulty section TPC shall release the auto reclosure lock-out.

20521 Lowering Pantographs of Defective Locos

Before concluding that the fault is on the the OHE and directing the OHE staff to proceed to the faulty section to rectify the fault, the TPC should first make sure that there is no defective locomotive or EMU in the faulty section, which could cause tripping of the feeder circuit breaker. If there is a locomotive in the faulty section he should arrange to have its pantograph lowered to ascertain if the fault is on the OHE or on the locomotive.

Loco Pilots and motormen should lower the pantographs of their units if they have reason to believe that a fault has developed causing tripping of 25 kV feeder circuit breaker at the sub-station as for example when 25 kV supply gets interrupted simultaneously with the tripping of the air blast circuit breaker on the rolling-stock. If this happens more than once, it is most probable that the 25 kV power supply interruption is due to fault on the loco. In such a case, the Driver should lower the pantograph and inform the TPC through emergency or other telephone of his observations and action taken by him so that TPC may take appropriate action. Whenever pantograph on the loco is defective, the TPC should ensure from the driver that the pantograph is properly tied down and secured, and does not come into contact with the OHE.

20522 Isolation of Faulty Section

1. Expeditious isolation of a faulty section is of the greatest importance. This can only be achieved if the TPCs are fully drilled in the correct method of fault localization. The method of fault localization which takes the least possible average time is the best. It is best to standardize the procedure with a “Control Card” for every circuit breaker and keep the card in a serial order so that, when a circuit breaker trips, the particular card can be picked out and the sequence of switching operations, as given in the card, carried out in the card till the faulty section is isolated and power restored to the other sections. Such control cards ensure correct sequence of operations irrespective of who is the TPC on shift duty.
2. Fig 5.01 is a typical control card for a double line section. The basic idea is to divide the section into sub- sections and find out whether the circuit breaker trips or not after reclosure. The full-line arrow shows the action to be taken if the circuit breaker holds and the dotted line arrow, if it does not. Following the arrows action has to be taken to open or close the interruptors and the feeder circuit breaker till the faulty section is identified.
3. Sr. DEE (TrD) should ensure that control cards similar to the above are carefully prepared and kept with TPC for every feeder circuit breaker. He should also ensure that all TPCs and ATPCs are fully familiar with the method of using the control cards. In the case of some SCADA systems, the fault localization and isolation sequence is automatic. TPC should carefully note the sequence and the section that is isolated. He should ensure that power supply is available on the rest of the OHE after a fault-tripping is noticed and try to minimize the length of the faulty section by directly opening of isolators manually.
4. While control card is generally drawn up after careful thought, yet, there could be reduction in average time taken to localise a fault by a change in the switching operations. This may be brought out by any official to the notice of Sr. DEE/TrD.
5. Control card for each Circuit breaker to be displayed.

20523 Faulty Section to be kept Isolated

1. On Single Line Sections

After the fault has been located, the faulty section shall be kept isolated by keeping open the concerned isolators. Feed to other elementary sections shall be restored by closing the concerned interruptors/isolators.

2. On other than Single Line Sections

After the faulty section has been located in accordance with para 20521, the faulty section as also the healthy sections on the adjacent lines over the same route as the faulty section, shall be kept isolated by keeping open the concerned interruptors. Feed to all other sections shall be restored by closing of other interruptors/isolators.

Further, the Section Controller shall be immediately informed by the TPC of the faulty and healthy sections. Feed to the healthy sections isolated shall be restored only on receipt of advice from the Section Controller of his having taken special precautions as per para 20523.

20524 Advice to Section Controller

1. Faulty Section

The Section Controller shall immediately be informed by the TPC to take all precautions as per Station Working Rules, as though the particular faulty section is under emergency power block and the JE or other traction official in the neighborhood shall be advised to check the faulty section. ADEE (TrD) and DEE (TrD) shall also be informed.

Only when the OHE staff are able to inspect and find out the nature of the fault, it will be possible for them to say how long it will take to rectify the fault and restore the power supply. The Section Controller shall decide whether single line working is to be introduced or not taking into account the following factors :

a. The traffic he has on hand,

b. The anticipated time by which the OHE maintenance staff can reach the site as ascertained from TPC.

2. Healthy section kept isolated (Para 20522)

On receipt of advise from TPC of temporary isolation of healthy section on line adjacent to a faulty section, the Section Controller shall immediately take necessary action for having caution orders issued to Loco Pilots of all trains due to enter any of the concerned block sections (with OHE temporarily isolated, though healthy) to watch out for possible obstruction arising due to an unusual occurrence on a track with faulty OHE and be prepared to stop.

In respect of the trains stranded in any of such concerned block sections, it will be possible to issue caution orders to their Loco Pilots only after they reach the next station. Separate instructions for Loco Pilots of such trains to proceed cautiously upto next station, in case of being detained in block section for no tension in OHE for more than 5 min, are contained in G & SR etc.

20525 Information to Traction Staff

All information regarding any unusual occurrence received from Station Masters etc. shall be given by the Section Controller to the TPC to assist him to quickly locate faults.

20526 Action to Rectify OHE Fault

1. The Section Controller shall give top priority for the movement of the maintenance staff (by train, OHE inspection Car or motor trolley) to reach the faulty section. It is the duty of all concerned to reach the break-down site either by rail or by road in the quickest possible time. They should carry with them a portable emergency telephone and mobile phone and keep in touch with TPC.
2. The TPC after locating the fault shall reduce the section under power block to the elementary section concerned by arranging either by trained station staff or TrD staff the opening of isolator

Switches. They shall, after inspecting the fault, inform TPC the time expected to be taken for rectifying the same. TPC shall pass on this information to the Section Controller.

3. The OHE staff shall then take a permit-to-work and proceed to rectify the fault duly observing the rules for the purpose.

20527 Emergency Telephone Working

If an Operator at a Grid sub-station is not able to speak to the adjacent Grid sub-station due to some fault or failure on their telecommunication system, the TPC shall arrange for the messages to be transmitted over the railway or other telephone, where practicable. Similarly, in case of fault or failure of telecommunication system on the railway, the Operator of the Grid sub-station shall arrange to transmit messages, if any from the TPC to any other sub-station through the Grid telecommunication system, on a reciprocal basis. Such messages should be passed only if they are very urgent and related to maintaining continuity or restoration of power supply.

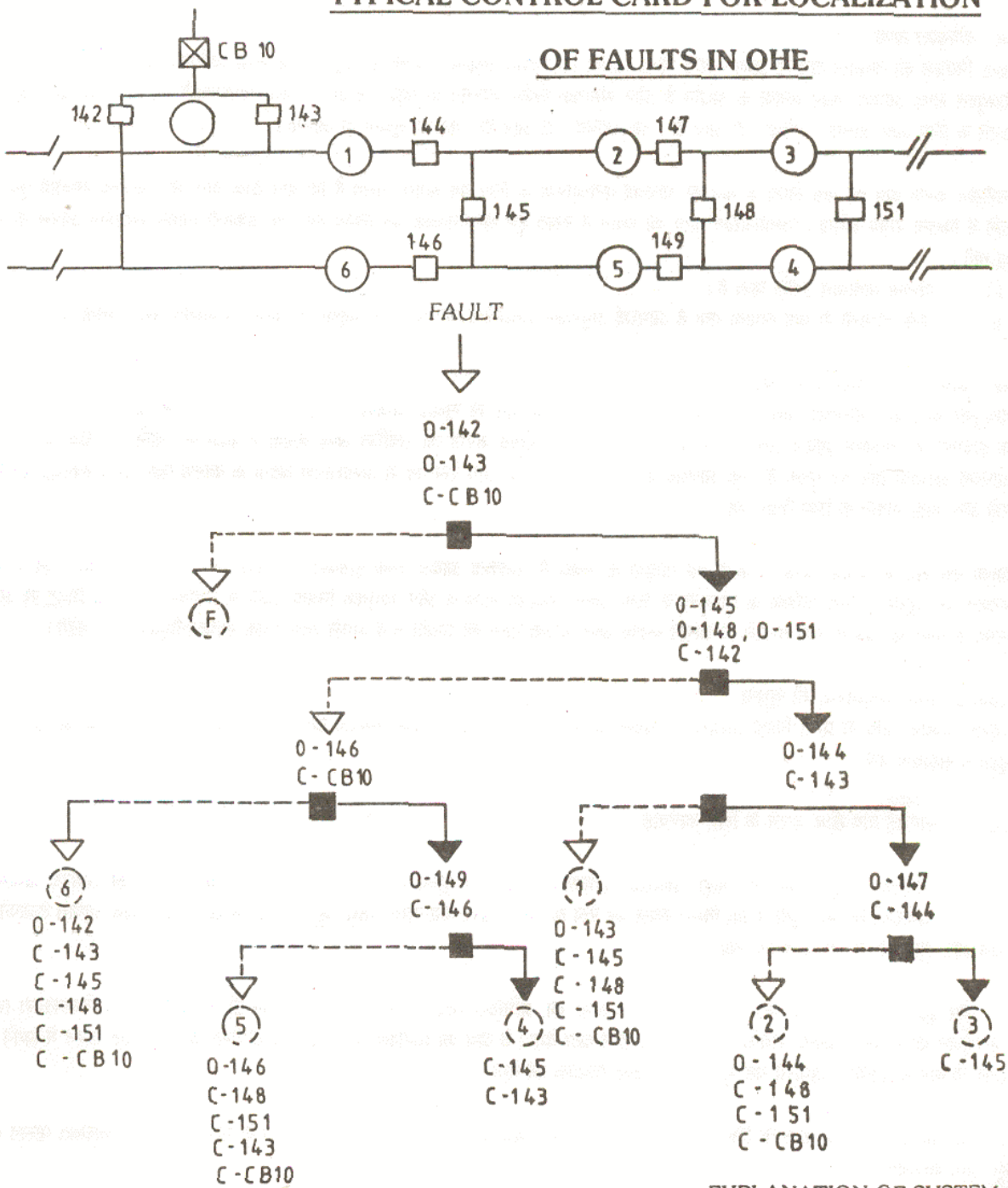
20528 Breakdowns and Emergencies

The TPC shall always be in a state of readiness to take quick and prompt action to tackle any breakdown or emergencies. He will keep liaison with not only the field officials at site who are engaged in restoration of affected section, but also the Head Quarter officials, giving details of the breakdown to the extent, they are known apart from, help from the neighbouring divisions or Head Quarters as the circumstances warrant. Mobile phone communication shall also be used by TPC to move TrD staffs to spot.

20529 Obstruction of Track - Protective Steps to be taken by TPC

On being informed by the Section Controller/Station Master of any accident/incident likely to obstruct one or more tracks or OHE in a multitrack section, necessitating immediate suspension of movement of trains and being told by Section Controller to switch off power, the TPC shall immediately switch off power supply to the OHE of the affected track as also that of the adjacent tracks over the length of the track affected. The power supply shall be restored only after it is confirmed to the TPC that the track and OHE are clear of any obstruction and movement of electric trains is safe.

TYPICAL CONTROL CARD FOR LOCALIZATION OF FAULTS IN OHE



EXPLANATION OF SYSTEM :-

FEEDER	F
OPEN (7 SEC)	O
CLOSE (15SEC)	C
C B. HOLDING	———
C B. TRIPPED	— — — —
FAULT LOCATED	◌

AV. TIME 136 SEC.			F	6	5	4	1	2	3	AVERAGE
FAULTY SECTION TOTAL OPERATIONS	O	2	7	8	7	7	8	7	$6\frac{4}{7}$
	C	1	8	8	6	7	7	5	6

FIG. 5.01

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CHAPTER-6
POWER BLOCKS AND PERMITS-TO-WORK

20600 Operation of Isolator Switches

1. Before considering the procedure for obtaining power blocks, attention isdrawn to the precautions to be taken in opening an isolator switch. Manually operated isolator switches are provided at different points on the main line to sectionalize the OHE into elementary sections and at large yards to isolate different elementary sections for maintenance of the OHE.
2. The operating handle of every isolator switch shall always be kept locked either in the open or closed position. Any loss or damage of a padlock or key shall be reported immediately to the OHE Section JE, SSE (OHE) and TPC.
3. An isolator switch is not meant for breaking a current, but only to break a circuit when no current is passing through it. If an attempt is made to open a switch when it is actually carrying current, severe arcing will occur at the switch contacts and may result in serious consequences including danger to the operator. An isolator switch shall not be opened when current is passing through it. It may be opened when there is no train in the sub sector in double/multiple line sections.
4. Isolator switches on the main line may only be opened provided the corresponding sub-sector is first made dead by TPC. The person operating the isolator switch shall not open it, unless specifically asked to do so by TPC by a clear message supported by a private number or after receipt of a separate permit-to-work for the section which includes the elementary sections on either the isolator switch. TPC shall ensure that the sub-sector is dead before he orders opening of an Isolator switch in it.
5. Isolator switches, however, can be closed by a duly authorised person even if the adjacent lnterruptors are closed (i.e. on load) provided the closure is made swiftly in one motion. It is imperative that once the fixed and moving contacts have met, the contacts are not separated. -

20601 Isolators in Yards and Sheds

1. Isolator switches provided for isolating sidings and yards and also to feed OHE inside running sheds, may be opened provided the official concerned makes it certain that -
2. the entire section is visible; and
3. There is no locomotive with raised pantograph in the section.

If is not possible to get an assurance of these conditions, the principles of para 20600-4 shall be followed.

20602 Maintenance Blocks

There are generally two types of blocks required for maintenance work on electric traction Installations:

1. Traffic Block: Where a line is blocked against movement of vehicles whether steam, electric or diesel locomotive hauled. This will be required whenever heavy repair have to be carried out. A traffic block will be granted by the Section Controller in consultation with the TPC.
2. Power Block: Where a section of line is blocked against movement of electric locomotive hauled vehicles or EMUs only i.e., a section where 25 kV electric supply to the OHE is switched off and the section made dead. Power block will be required whenever light repairs to or maintenance of

the OHE has to be carried out and the nature of the work is such that traffic block is not necessary. Power blocks are granted by TPC in consultation with the Section Controller. Whenever a power block is granted by TPC, movement of vehicles hauled by other than electric power, i.e., steam or diesel may be permitted, provided a caution order is issued as per General and Subsidiary Rules drawing the attention of the Driver to the fact that the OHE staff are working at the kilometerage specified and he should exercise caution when passing over the section and obey signals displayed at the place of work.

20603 Power Blocks

1. Power blocks are of three different types:
   a. Emergency power block,
   b. Pre-arranged power block,
   c. Locally arranged power block.

Power blocks on the OHE of "Secondary lines" i.e. siding, yards, sheds, etc. arranged by the Station Master, Yard Master, Shed Foreman or Engine Examiner concerned locally come under category (c).

2. In all cases of power block TPC shall put red warning caps on control switches corresponding to interruptors which are kept open for isolating the section. Similarly, warning boards shall be fixed on all manually operated switches opened locally for isolating the section. This shall be done by the operator who opens the switches. These red warning caps and warning boards can be removed only when cancelling the power block. In case SCADA system is in operation instructions issued for the operation of the system shall be followed.

20604 Emergency Power Block

An "Emergency Power Block" shall be arranged by the TPC and25 kV supply to the OHE affected shall be switched off by him immediately on receipt of an advice of any break-down of the OHE or injury to persons or damage to property particularly in the following cases:

1. The whole or part of the OHE or a feeder or a cable falling down and or persons or animals or falling trees or vehicles coming in contact with or likely to come in contact with live equipment;
2. A damaged catenary or contact wire fouling the vehicle gauge;
3. A damaged electric locomotive getting damaged to rectify which the Driver requires the permit-to-work;
4. Derailment or any other traffic accident on the electrified lines, where cutting off of 25 kV power supply is considered necessary by TPC or the Section Controller, in the interest of safety.

20605 Reporting Abnormalities in OHE

It is the duty of every railway official to report immediately any abnormalities on the OHE such as are mentioned in para 20604 or of tracks, masts/ structures or pantographs of locomotives as may adversely affect safety of trains movements, to the TPC either directly or through any Station Master, Section Controller or through the nearest available telephone. If the damage is heavy or the moving dimensions are infringed he should take steps to protect the lines in accordance with General and Subsidiary Rules.

20606 Request for Emergency Power Block

1. The person who gives the first Information of break-down on the OHE shall invariably give all essential information such as his name, designation, kilometerage where the abnormality has been

noticed, its nature and place from where he is reporting. He should leave the place only with the permission of the TPC.

2. The reason for asking for an emergency power block should be brief and to the point, but explicit. Much time and trouble can be saved if the first information given is clear and unambiguous, to enable the TPC to decide upon the course of action to be taken.

20607 Action to be taken by TPC

On receiving the information the TPC shall immediately arrange to switch off power supply to the section affected (the details of defects being obtained after the supply is switched off). He shall at the same time advise the Section Controller on duty the section made dead by him. The Section Controller in turn should arrange with the Station Masters concerned to take protective measures in accordance with "Station Working Rules".

20608 Precautions after Emergency Power Block is Imposed

Once an emergency power block is imposed, no work on the affected lines shall be commenced until an authorized OHE official arrives at site and earths the OHE at two points or more as per rules. Power supply to the section concerned shall not be restored by TPC until the authorized official at the site issue a message supported by private number.

20609 Identification of Sectors, Sub-Sectors and Elementary Sections

1. It is vitally important for every Railway official who has occasion to ask for Power block to know the correct method of identifying and describing any section of the OHE where shutdown is required. He should have with him the upto-date Station Working Rule Diagram/Sectioning diagram for the section, showing all relevant particulars such as station names, position of all isolators, interruptors, circuit breakers, "up" and "down" tracks, cross-over section insulators, sectors, sub-sectors and elementary section numbers.

Sectors: These are described by referring to a section of OHE of a track which can be energized by closing a feeder circuit breaker at the substation/ feeding post. It covers the section between sub-station/feeding post and adjacent neutral sections.

Sub-sectors: These are described by the names of two limiting switching stations in the order in which the train moves and adding the name of the track, e.g., Sub-sector Kendposi-Tabu Dn.

Elementary Sections: are referred to by four/five digit numbers. The sections are numbered serially in the direction of power supply i.e., from the feeding post/substation towards the neutral section or the terminal point. At each feeding post/sub-station a new series of numbers starts. The first two/three digits represent the interrupter controlling feed to the section and the last two digits the serial number of the elementary section. Up line elementary sections have progressively odd numbers and Down line elementary sections have progressively even numbers. e.g., elementary section 0202 means the first elementary section from the feeding post/sub-station on the down line, fed by interrupter 02.

Whenever there is a doubt in the description, the person asking for power block shall state clearly the track and OHE structure numbers between which work is to be done.

20610 Telephone Messages

All messages relating to shut-down and restoration of power supply, permits-to-work, etc. issued over the telephone shall invariably be supported by exchange of Private Numbers. The procedure to be followed is as detailed below -

1. Every official who has to exchange such messages shall maintain a Private Number book. As each message is sent, the Private Number used should be scored out in the Private Number sheet, initialled and dated. The message number should also be recorded. Every Private Number book and permit-to- work form is an important document and should be carefully preserved for a period of one year unless required for a longer period in connection with an inquiry or investigation.
2. Every message shall start with the Private Number of the sender and end with the Private Number of the person who has received it.
3. Messages should be brief and to the point. They shall be written out in full before they are sent. The description of the section on which power block is required should be unambiguous as detailed in para 20609. All messages regarding permits-to-work shall be in the standard form.
4. The same person who asks for and obtains a power block should also cancel it before power supply is restored. The persons exchanging the private numbers should identify themselves by name over the telephone.
5. The correctness of every massage shall be confirmed by the person who has received it by repeating it. Each message shall be recorded by the sender as well as by the receiver in message books maintained for the purpose.
6. To avoid confusion, use words “Open” and “Close” shall be used instead of phonetically similar words such as “Switch Off”, “Switch On”. Whenever necessary words may have to be spelt out (e.g.,1 (one) 4 (four) and not fourteen), B for Bombay, C for Calcutta and so on.

20611 Procedure for Obtaining Traffic or Power Blocks and Permits-to-work

Officials in the electrified area who require prearranged traffic blocks, power blocks or permits-to-work in the danger zone of traction equipment, or who require OHE and or bonding staff to be present at site for scheduled maintenance works, shall deliver at the office of Sr DEE (TrD) not later than 10 hours on the first working day of the week statements in the prescribed form showing-

1. the nature of the work and the date on which it is to be performed;
2. by whom the work isto be carried out
3. location of the work and the section of the lines to be blocked;
4. The trains between which the block is required; and
5. Whether the track will be available for steam or diesel traffic.

2. The requirements of all departments will be co-ordinated in the office of Sr.DEE (TrD) and a consolidated statement forwarded to the Senior Divisional Operating Manager concerned, by 12 hours on every Wednesday, for inclusion in the weekly programme of traffic and power blocks.
3. Works of an urgent nature shall be attended to by obtaining emergency blocks and permits-to-work from TPC.
4. A weekly programme of work involving traffic blocks, power blocks and permits-to-work shall be prepared in the office of Sr. DOM and dispatched to all concerned (TPC, TLC, Loco Sheds, Station Masters/Yard Masters concerned and Traffic Controller in addition to the departmental officials who asked for the blocks).
5. Most of the traction sub-stations have two sets of traction power transformers and associated switch gear. Maintenance of equipment of the traction sub-station, therefore, does not necessitate total shut down of 25 kV supply at each sub-station. Whenever any maintenance or breakdown is to be attended in the traction sub-station, the permit to work should be obtained by the supervisor incharge from the TPC and after completing the work, the permit to work should be returned by the Supervisor incharge to the TPC. Similarly at the switching stations normally the alternative feed is

available to the concerned sub-sector and therefore, does not necessitate the power block but only a permit to work should be obtained from the TPC and after completion of the work, the same should be rerturned to the TPC. In case of attending to the gantry of a switching station, complete block of the switching station is required for which power block has to be taken from the TPC.

20612 Pre-arranged Power Block

After a prearranged power block has been agreed to be granted and an advice to this effect circulated to all the concerned, the following gives the detailed procedure to be adopted by the Section Controller and the TPC for granting the power block. Assume that power block is required on the Up line between station..... and..... on Elementary Section No. ..... at 10-00 hours after the passage of a specified Up train (say 'X'): -

1. On the scheduled day about two hours before the block period, i.e., at about 8.00 hours, TPC will obtain confirmation from the Section Controller concerned that the trains are running to time and power block will be available as, scheduled, after the Train No. 'X' Up has passed station at about 10-00 hrs.
2. The TPC will pass on information to the JE of the maintenance gang that the power block, as already arranged, will be available in time.
3. The maintenance gang should arrange to leave the depot in time with all materials and tools so as to be ready at site at about 9.30 hrs. The OHE staff (in charge of the work) on arrival at site should immediately contact the TPC and inform him of their arrival.
   Any person detailed to open an isolator switch for switching off power supply shall also report to TPC of his arrival at site at the required location.
   The maintenance gang should carry at least two portable telephone sets and the necessary earthing pole assembly along with them while proceeding to do maintenance work on the OHE.
4. The TPC should maintain continuous contact with the OHE staff at site.
5. As soon 'X' Up clears the Up track between . ..... and ..... Section Controller should inform Station Master on duty at all stations concerned to arrange for "longitudinal" and "cross" protection as laid down in Station Working Rules (see paras 20621 to 20626).
6. The Station Master shall ensure that the protection as specified in the Station Working Rules iscarried out and confirm it to the Section Controller with exchange of Private Numbers.
7. The Section Controller on receipt of assurances from the concerned Station Masters will advise TPC that the power block may be given.
8. If the power block message is given by TPC in the prescribed printed form the Section Controller will sign the same and send it to the TPC; if it is given over the telephone, the Section Controller will grant the power block through a message with exchange of Private Numbers.
9. On receipt of the above message TPC will open the interruptors concerned and issue messages to the field staff for operation of the required isolators. On receipt of the confirmatory message that the isolators have been opened, TPC will close the interruptors restoring power supply to all parts, except over the particular elementary section where work has to be done. He will then issue a permit-to-work message in the prescribed form to the authorized person in charge of the maintenance gang.
10. After obtaining permit to work, the authorized person may use a flag signal (Yellow flag) to direct the nominated staff to discharge and earth the OHE at two or more points.
11. The maintenance gang will start the work after taking necessary safety precautions to protect themselves, viz., by earthing, display of banner flags etc. as detailed in General and Subsidiary Rules.

Note: On sections with automatic signalling, the signals may be at danger due to earthing of OHE with the rails during the period of the power block. The Station Master shall issue necessary authority as per rules for steam, and diesel trains when these are permitted to be moved over the section under power block.

20613 Restoration of Supply After a Permit-to-work is Returned

On completion of the work, the person who received the permit-to-work shall ensure that -

1. all men and materials have been withdrawn from the electrical equipment and its vicinity,
2. all earths provided for the protection of the working parties have been removed; and
3. all staff, who have been deputed to work, are warned that the power supply is to be restored.

He should then inform TPC by a message, supported by Private Number, that the work, for which the permit- to-work was issued, has been completed, the men and materials have been withdrawn from the specified section, the earths have been removed and power supply may be restored to the section. This shall constitute cancellation of the permit-to-work previously obtained.

20614 Work by other than Authorized Persons

1. If work is to be carried out on or adjacent to any part of the electrical equipment by other than 'authorized' persons such work shall not commence until the person in-charge of the work isin possession of a written permit-to-work in the prescribed form issued to him by an 'authorized' person.

   Such permits-to-work in the prescribed form shall only be issued an 'authorized' person of the Electric Traction Branch not below the rank of a Senior Technician.
2. The permit-to-work shall first be taken from TPC by an 'authorized' person who shall earth the electrical equipment specified and hand over a permit-to-work card to the person in-charge of the work getting an acknowledgment on the other copy. A duplicate copy of every permit-to-work card shall be retained in the personal possession of the 'authorized' person who issued it.
3. On completion of the work and when all men and materials have been withdrawn from the electric equipment and its vicinity, the person in-charge of the working party shall cancel his permit-to-work card and return it to the 'authorized' person who issued it. The 'authorized' person shall in turn issue a message to TPC to cancel permit-to-work as detailed in para 20613.

20615 Local Cancellation of Permit-to-Work When Telephones are Interrupted

If telephone communication with TPC is interrupted when a permit to work is to be cancelled, the authorized person to whom the permit-to-work was issued shall arrange locally for restoring the normal (live) conditions on the equipment specified in the permit-to-work and for cancelling the power block, if possible. Before this is done the authorized person should satisfy himself that no other party has been given a permit-to-work for the same section.

20616 Multiple Working Parties

1. Whenever work has to be carried out by more than one working party, within a sub-sector or an elementary section, the permit -to-work shall be issued by the TPC only to one authorized person who alone shall be responsiblefor all work on the portion of electrical equipment specified in the permit-to-work. Other party or parties may work on the same portion of electrical equipment only with the permission of this authorized person. The authorized person shall cancel the permit-to-work only when he has satisfied himself that all working parties who have been permitted by him to work in the section covered by the permit-to-work have withdrawn their men and materials and have removed the earths from the electrical equipment on which they had worked. In the event of telephone communication being interrupted, the person responsible shall take action as provided in para 20615 above for cancellation of the power block.

2. Where the two parties are working far from each other, the party who has to work for a longer period shall take the permit-to-work and then permit the other party to start his work by a message supported by a Private Number. The second party shall inform the party from whom he got the permit-to-work of completion of work and removal of earths and withdrawal of men and material by a message supported by Private Number.

20617 Entries in the Log Book

The number of each permit-to-work issued must be entered in the log book by TPC together with the particulars and time when the equipment is made dead and re-energized after completion for the work, as per information received on telephone from the 'authorized' person concerned.

20618 Work Inside Loco Shed or Car Shed

For work to be done Inside the loco sheds or car sheds, the application for permit-to-work must he made to the SSE, JE or Charge-man (RS) who shall arrange for the issue of the permit- to-work after getting the switch of the inspection bay or the feeders opened. No intimation to TPC is necessary. The permit-to-work must be received for cancellation from the person in-charge of the work by the SSE, JE or JE (RS) before the switches are closed.

20619 Local Block

Power supply for sidings which do not affect movements of trains on the main lines, for loop lines and reception and despatch yards, is controlled by manually operated isolators. Keys for these isolators are usually in the custody of the Stationmaster concerned. Power blocks on such sidings can be arranged when required by an authorized official subject to the following:

1. The Station Master, Cabin Assistant Station Master, and others responsible for the movement of traffic, should take measures detailed in para 20621, 20622 and 20625.
2. TPC shall be informed before and after the shut-down is effected.
3. Isolators may only be opened after due precautions prescribed in para 20600, 20622 and 20625.
4. Earthing of equipment and issue of permit-to-work isdone as prescribed in these rules.
5. Local power blocks shall be recorded in form ETR-4 prescribed for the purpose.

20620 Protective Measures for Power Blocks

It Is essential that every Railway official concerned with the movement of trains on the electrified section, have a thorough understanding of the precautions to be taken to ensure safety of staff working on the OHE under power blocks. The reasons for the precautions and the nature of the precautions are therefore given at some length in the following para graphs.

The protective measures are -

1. Longitudinal Protection: To stop movement of electric rolling-stock running on the same track on which a section has been made dead and power block has been granted.
2. Transverse or Cross Protection: To stop movement of electric rolling-stock running into a section, which has been made dead, from another track or from a siding through cross-overs.

20621 Longitudinal Protection

1. At all points where interrupters or isolator switches are provided the overhead lines are sectioned and insulated (air gap) overlap span is provided. The arrangement adopted is shown in Fig. 6.01. The OHE from the direction 'X' is anchored on mast D while that from direction 'Y' is anchored

on mast 'A'. The two systems are held apart by steady arms from masts 'B' and 'C' and are kept insulated from each other, there being sufficient air gap between them. The two contact wires are, however, running parallel to each other at about the same level between OHE masts 'B' and 'C'. When a locomotive passes form 'B' to 'C', the pantograph will normally be in contact with and receive power from both the contact wires but when passing either between 'A' and 'B' or between 'C' and 'D', it will be in contact with only one contact wire. Since the isolator switch provided is normally in closed position, it connects the two OHE together and, therefore, they are both energized at the same voltage

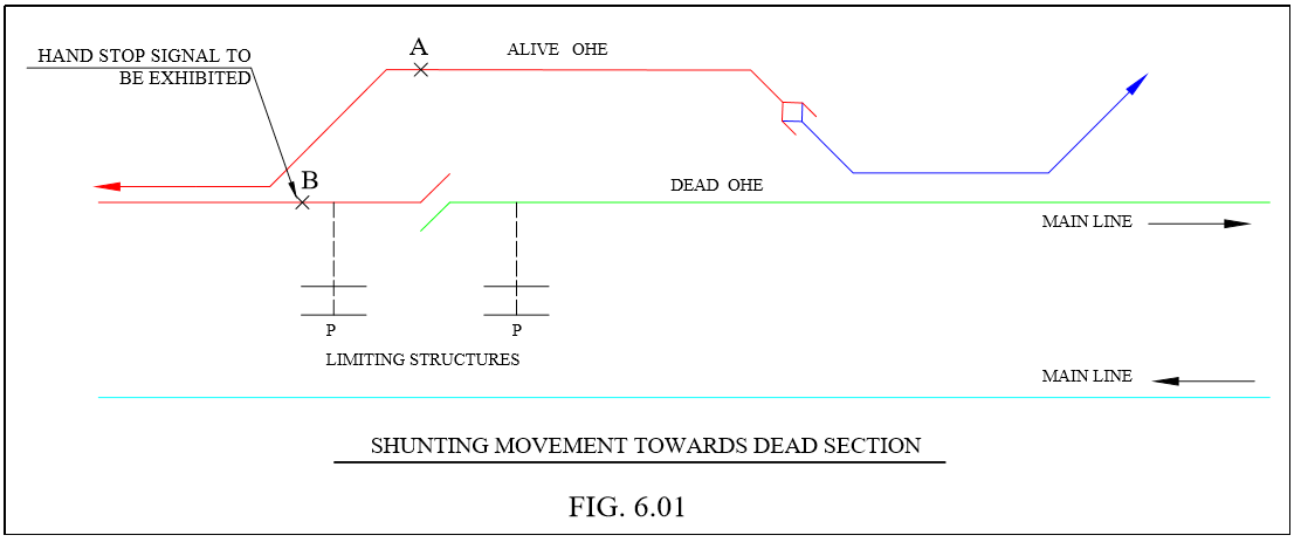

FIG. 6.01

2. If a power block has taken on Section 'Y' and the isolator switch is in open position, it will be seen that the OHE from direction 'Y' (dotted lines) is dead and earthed whereas that from direction 'X' is live at a potential of 25 kV. The pantograph of electric rolling-stock while passing between OHE masts 'B' and 'C will short circuit the live and dead contact wires. Such a movement will on danger the life of staff who may be working on the dead OHE section 'Y', apart from producing destructive arcing resulting in severe damage to the pantograph and the contact wire.
3. To avert such disastrous effects, under no circumstances should electric rolling-stock be admitted into the insulated overlap separating the dead section on which a power block has been taken from live sections.

20622 Transverse or Cross Protection

1. Section insulators have been provided on crossovers to separate and insulate different sections of OHE from each other, e.g., the up track from the Down track, the main line from the siding yard, OHE inside a loco maintenance shed from the yard lines.
2. A section insulator, comprises of a strain insulator, with two runners connected to one of contact wires as shown in Fig. 3.02 (Chapter lll). The runners are at the same height as the contact with the other side, and also shaped so as to allow a smooth passage of the pantograph underneath. It will be seen from Fig. 3.02 that the two runners overlap with the contact wire on the other side for a short distance to ensure that there is no Interruption of the current drawn by the locomotive as it passes under the section insulator.
3. Electric rolling-stock with raised pantograph should, therefore, never be allowed to pass below a section insulator if a power block has been given on one of the tracks, as the pantograph will momentarily connect the live OHE with the dead OHE, while bridging the runners and contact wire. This again energizes the dead section and endangers lives of those who are working on it.

4. In view of its extreme importance the rule is again repeated: Under no circumstances should electric rolling- stock be passed below an insulated overlap span or a section insulator which separates a dead section on which a power block has been granted, from the live section.

20623 Procedure for Arranging Longitudinal and Transverse Protection

1. Before a power block is granted the Section Controller should advise the Station Master, Yard Masters and Cabin Assistant Station Masters concerned to protect the dead sections, both longitudinally and transversely. It is only when all the Station Masters and Cabin Assistant Station Masters concerned have confirmed that this has been done, the Section Controller can advise TPC agreeing to the grant of power block. The Station Master, Yard Master and Cabin Assistant Station Master concerned will continue to maintain protection till the power block is cancelled by the Section Controller.
2. The Section Controller will in turn permit removal of protection only after the power block is cancelled by TPC.

20624 Station Working Rules for Longitudinal and Transverse Protection

1. In view of the large number of possible movements which may accidentally energize a dead section under a power block, the various protective measures to be taken by each Station Master, Cabin Assistant Station Master and Yard Master when power block is granted for the various sectors, sub-sectors or elementary sections should be catalogued in the Station Working Rules for each station. It is the duty of every Station Master, Yard Master and Assistant Yard Master to be thoroughly familiar with these instructions so as to be able to carry out efficiently and quickly the protective measures prescribed.
2. The Station Working Rules should contain-
   a. rules to be generally observed byall stations;
   b. a chart giving exactly what precautions have to be taken for granting power blocks on each sector, sub-sector or elementary section; and
   c. a drawing showing the wired and unwired tracks as well as the sectionalizing arrangements including the position of signals and points referred to in the chart mentioned above.

This drawing is the only valid document to be referred to for the purpose of granting power block. No modification of the installation shall be done without its first being incorporated in the above drawing.

3. In case of large stations, a copy of Station Working Rules may be issued to each cabin.
4. Every Station Master/Yard Master/Asstt. Station master shall be trained for the purpose and be fully conversant with all the local switches/isolators/cross-overs and special instructions applicable to the equipment provided the station and as laid down in the Station Working Rules to enable him to operate isolators under instructions from TPC.

20625 Protection of Dead Section

The protection of a dead section is achieved by the following means:

1. In the normal running direction, movements of trains are generally controlled by signals. Protection is obtained by placing a “Red Warning Collar” on the signal lever controlling the concerned signals, painted with inscription “Beware - No Voltage”.
2. If the points and signals are locally operated, they should be locked and the keys controlling the lever or lever frames should be kept with the Station Master on duty. When the signal cabin or lever frames are controlled electrically by a Station Master or a Cabin Assistant Station Master, the Station Master or Cabin Assistant on duty shall place the warning collars on the relevant slides of electric slide instruments or on the relevant keys of electric transmitters or interlocked key boxes.

This action must be taken by the Cabin Assistant may be, in respect of each and every movement completion, confirmation should be given to the power block to be issued by the TPC.

Station Master or the Station Master, as the case prescribed in the Station Working Rules and after Section Controller to enable him to agree for the

In a large yard several warning collars may be required. Sufficient number of warning collars should be kept in each station/cabin. The exact number provided should be indicated in the corresponding Station Working Rules.

3. Once a warning collar is placed on the signal lever, it shall not be removed except after exchange of messages with private member.

20626 Shunting Movement Towards Dead Section

1. In cases where no signal exists for controlling the entry of an electric Train into the dead section, the Station Master should arrange a hand stop signal to be exhibited at the point upto which alone the electric locomotive is allowed to proceed.

If it is necessary for an electric locomotive to carry on shunting movement towards the dead section, the red warning collar placed on a lever may be removed to permit the movement, provided that a hand stop signal as above is exhibited and the Loco pilot is specifically instructed not to move the loco beyond the point.

2. An example of this operation is given In Fig. 6.02. As per para 20625 the lever controlling the signals should have “red warning collars” placed on them to give protection to the dead section. However, If It Is essential to carry out a shunting operation with an electric locomotive situated at point ‘A’ on the loop line to move lnto the main through the turn-out, this may be permitted provided that the shunting movement is carried out only upto limiting mast ‘P’, short of the overlap span, where a hand signal is to be exhibited to prevent all movements beyond the point ‘P’.
3. Train or shunting movements by other than electric locomotives, I.e., by steam or diesel locos, may be permitted to enter the dead section, provided that the Station Master ensures by personal inspection that the Train formation does not include an electric locomotives or OHE Inspection Car or EMU with pantograph raised. The 11 red warning collars” may be permitted to be removed to allow such movements.

20627 Movement of Other than Electric Trains

Goods or Passenger trains hauled by other than electric locomotives may be allowed to pass through the dead section subject to the following conditions :-

1. This has not been prohibited specifically in the power block message.
2. Steam or diesel engine or trains hauled by such engines shall be brought to a stand at the station preceding the station/section at which power block is granted and the Station Master or this station shall satisfy himself by personal inspection that there is no electric locomotive in the train in question.

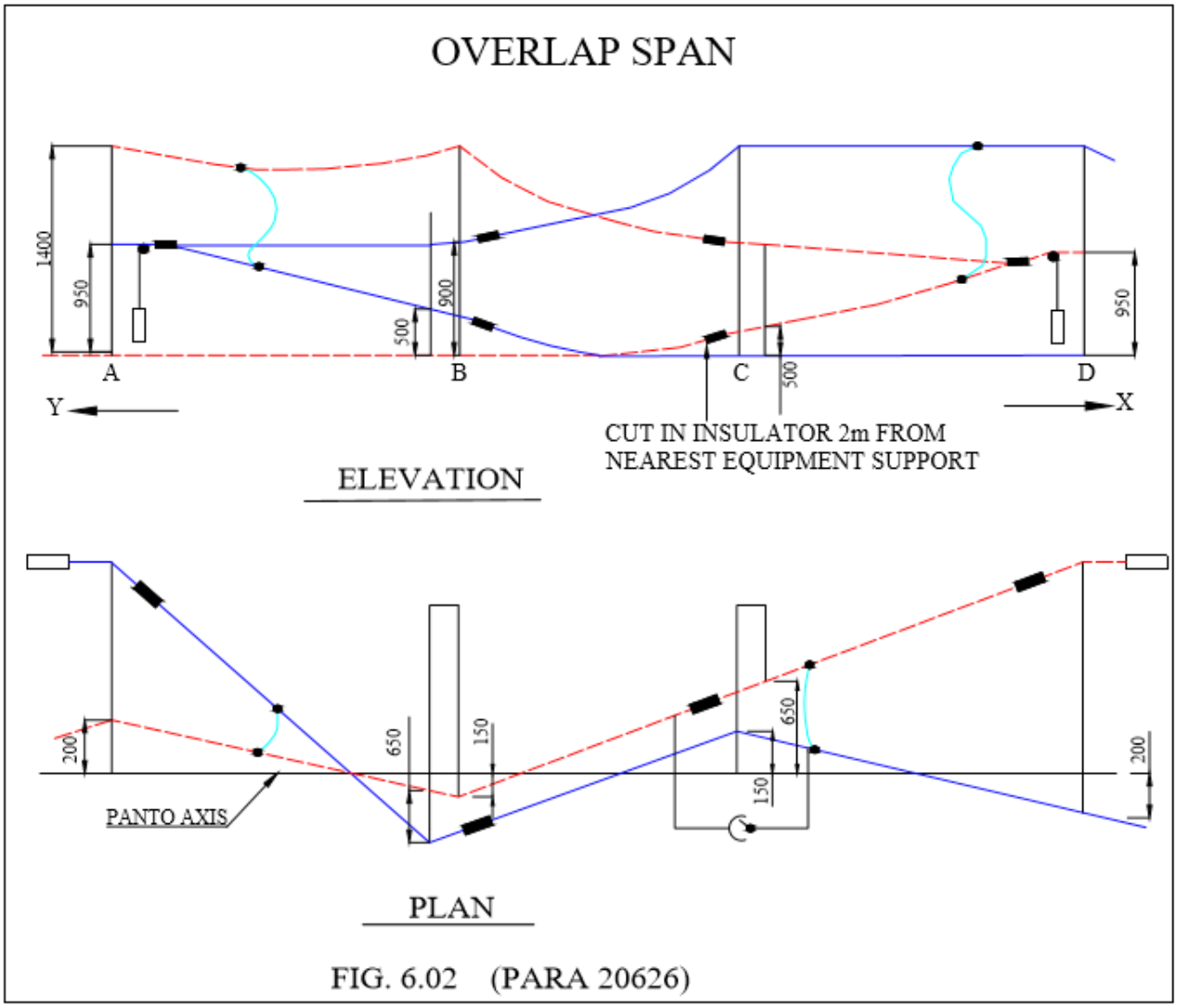

FIG. 6.02 (PARA 20626)

3. He shall also give a Caution Order to the Driver of such engine or train warning him of the power block ahead and instructing him to watch for hand signals and observe them.

4. No Station Master shall give line clear or lower signals for a train to run over a section under power block unless he has received an assurance (supported by Private Number) from the Station Master of the preceding station that there is no electric locomotive or Inspection Car with pantograph raised in the train.

5. Whenever a " red warning collar" has been removed for permitting a movement as per paras 20626 and this para, it shall be replaced back on the signal control lever immediately after the movement is completed.

   For purposes of the above rule the term "Electric Rolling -Stock" does not include electric rolling-stock hauled 'dead' as a vehicle or OHE Inspection Car with its pantograph removed or securely locked down.

20628 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 acknowledgment of the receiving party on a carbon copy. When they are located far apart, the messages can be exchanged on phone, the receiver recording the message on an identical form and repeating it for confirmation.

FormETR.2 Thishas3parts and is used for exchange of messages 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 invariable be made out in duplicate and sent to the other party obtaining acknowledgment 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 acknowledgment on the carbon copy.

An message exchange over telephone should be supported with exchange of Private Numbers.

Form ETR. 1
Part A.
RAILWAY

POWER BLOCK MESSAGE FOR BLOCKING OF LINES FOR ELECTRIC TRACTION PURPOSES

Serial No.

Date .....
Time Hr ..... Mts .....

From,
Traction Power Controller

To,
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 block is likely to last for ... Hr. Mts ...

Private No. .....

Sent by .....

Received by .....

(Name) ..... (Name)

*Score out whichever is not applicable.

Form ETR. 1

Part B

..... RAILWAY

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 .....

Particulars of line/s Reasons

....

....

Private No .....

Sent by .....

(Name)

Received by .....

(Name)

*Score out whichever is not applicable

Form ETR-1

Part-C

..... RAILWAY

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)

Your No..... of.....(date)

The following line/s have been made alive and the block imposed on these line/s may be cancelled:-

Private No .....

Sent by .....

(Name)

Received by .....

(Name)

Form ETR-2

Part-A.

..... RAILWAY

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 isolation
.....	.....
....	.....
.....	.....

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,

.....

at.....

To,

Traction power controller,

at.....

Your No. .....of .....

Local earths have been applied at the following points:-

.....Line earthed at structured Nos. .....

.....Line earthed at structured Nos. .....

.....Line earthed at structured Nos. .....

The following permit to work have been issued on the authority and I am responsible for the permit to work:-

(1).....(2).....(3).....

'Permit to work'.....

Nos..... ....

Date of issue ....

Time of issue ....

Dept. Issued to ....

Person in-charge ofwork ....

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, ...

.....

at .....

To,

Traction Power Controller

at.....

My No. ..... of.....

I hereby declare that the work on or near electrical equipment/s which has/have been isolated has been completed. All men and materials have been withdrawn and the men have been warned that it is no longer safe to work on or adjacent to electrical equipments. All Permits-to-work issued by me have been withdrawn and cancelled. All local 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 the following electrical equipment which is dead, isolated from all 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 ..... at ..... Hr ..... Mts . ..... on ..... (date).

Signature .....

(of the authorized person)

Name .....

Designation .....

Date ..... Hr ..... Mts.....

Fnorm 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 foil of this Permit to work, I fully understand the portion of electrical equipment which is dead, isolated and earthed 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,

.....

at.....

To,

.....

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

..... RAILWAY

PERMIT-TO-WORK ON OR NEAR AC TRACTION ELECTRICAL EQUIPMENT

Serial No. Date.....

From,

.....

at.....

To,

.....

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,

Name ....

Designation .....

To,

*Station Master/Yard Master

.....

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 from ..... hour until further advice

The block is likely to, last for .....Hrs.. .....Mts ...

Signature .....

Copy to:- (1) Traction Power Controller Section Controller

(c) Section Controller

Form ETR-4

Part B

.....RAILWAY

LOCAL BLOCK

Serial No. Date.....

ACKNOWLEDGEMENT

Received Massage No.....from..... .....

At.....Hr.....Mts.....

.....

Signature of the 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 ....

My 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 Section Controller.

(2) Section Controller

*****

CHAPTER-7
SIGNALLING & TELECOMMNICATION AND PERMANENT WAY INSTALLATIONS IN ELECTRIFIED SECTIONS

20700 Introduction

The important points concerning the signalling, telecommunication and permanent way installations in electrified sections can be grouped as follow:

I. Signals and associated equipments

II. Telecommunication facilities for ac traction

III. Power supply for S&T installations

IV. Permanent way installations

Various aspects for the general information of electrical staff are covered in this chapter. The rules are covered in the Indian Railways Telecom Manual for the S&T staff and in the Indian Railway Permanent Way Manual for the civil engineering staff.

The safety rules applicable to the staff of S&T and civil engineering departments are given in Chapter IV, Vol. 1 of this Manual.

I. SIGNALS AND ASSOCIATED EQUIPMENT

20701 Effects of 25 kV Traction on S&T Equipment

Any circuit in the vicinity of OHE for 25 kV ac 50 Hz signal phase traction system 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 currents and voltages to develop in metallic items parallel to the track. The items include the rails, traction return conductor where provided, cable sheath and S&T circuits. The voltages that occur in the metallic items appear as potential gradients. The value of induced voltage depends on various factors such as:

1. length of parallelism between the cable and electrified track
2. soil conductivity
3. Screening efficiency of cable sheath where existing
4. return current through the rails and return conductor where provided.
5. mutual inductance between catenary and cable conductors
6. current carried by the OHE.

Appropriate precautions to overcome the effects of the induced voltage , therfore, have to be taken by S & T department.

Other aspects where S&T equipment is affected are:

a. OHE masts and fittings may come in the way of visibility of signals to some extent and may come in the way of signal.

b. Restrictions in the path of traction currents on section provided with track circuits.

20702 Types of Signals

In the double line electrified sections, the signalling system shall generally be the colour light signal (CLS) type. But the semaphore signals may be maintained on single line sections (Main or branch) which are taken up for Railway Electrification.

20703 Locations of Signals

1. Signals are so located as to afford maximum visibility to Loco Pilots and the signal structures have to be clear of the moving dimensions. In electrified sections, however, the signals should have the required electrical clearance of at least 2m from the live conductor. Detailed instructions on the location of signals have been issued by the S&T Deptt.
2. Where a signal post or its fittings have to be located within 2 m of live OHE, a screen of wire mesh of approved design solidly connected with the structural work shall be provided between the signal post and the OHE for protection of staff. Provision of such a screen is mandatory where non-technical staff like lamp-man are required to climb up signal posts. The protection screen is not necessary when only the technical personnel, such as inspectors and maintainers of the S&T Deptt. are authorised to work on the signals. When a screen is not provided for any reasons, a caution board of approved design shall be provided on the signal post on the side facing the ladder at a height of 3 m above the rail level to caution such staff.
3. Technical personnel shall exercise particular care to protect themselves while working on signal posts not provided with protective screens. If there is any likelihood of any part of their tools or equipment coming within 2 m of live equipment, they shall take a power block as detailed in Chapter VI. The same precautions are also required in the vicinity of return conductors, which should be treated as live.
4. To ensure maximum visibility of signals to the Loco Pilots, signal Posts should be located on the side opposite to that of traction masts as for as possible. Where this is not possible as in double line sections and station yards, the following steps are taken to achieve maximum visibility from the Loco Pilot's normal position in the driving cab.
    a. The distance between the signal post and traction mast shall be as large as possible. In case the traction mast is located in front of the signal post, the distance between the traction mast and signal post should preferably not be less than 30 metres.
    b. Layout plan (LOP) showing placement of traction mast and signal shall be approved by PCSTE (or his authorised representative) with concerned Electrical officer.
    c. PCSTEs/PCEEs are empowered to give dispensation for reduction in the distance for placing mast in front of the signal post on tangent/curve track from 30m upto a suitable distance (Ref. Fig. A1.10) after ensuring proper visibility of signal as per provisions of ACTM & SEM.
    d. In addition, it is desirable that no traction mast located in rear of the signal post at a distance less than 10meters. PCSTEs/PCEEs are empowered to give dispensation for reduction in the distance for placing mast in rear of signal post from 10m to a suitable distance.
5. The signal post should be sufficiently high so as to be seen clearly.
6. For deciding setting of mast near signals, para 20.5 of Appendix 1 may be referred to.
7. On curved tracks or in areas where other obstructions such as buildings, trees, etc. exist the site is individually examined for deciding the most appropriate location of the signal.
8. In all cases a "Signal Siting Committee" which includes a representative of the Electrical Department should be constituted to examine the visibility of the signal before finally deciding its location and height.

20704 Insulation of Wires and Point Rods

Normally wires and point rods would be eliminated in the signalling system in ac electrified section. However, where these exist, the wire transmission as well as point rods in ac electrified areas are subject to induced voltage which could reach high values when an OHE fault occurs. This induced voltage or rail voltage is transmitted through the wires and point rods to the lever frame. Insulators are therefore, provided on the wires and point rods for insulating them from rail potentials and induced voltages, in accordance with detailed instructions on the subject laid down in Chapter XXII of Indian Railway Signal Engineering Manual issued by S&T Department.

20705 Earthing of S&T Equipment

Earthing of the following equipment is essential on sections electrified with 25 kV ac 50 Hz single phase system the earthing being done in accordance with prescribed instructions.

1. Signal posts provided with protective wire-mesh screens.
2. The lever frames and other metallic parts of the cabin in contact with, the lever frame, (This includes rail stagings wherever they are used. Where the electrical conductivity of the joints of the rail staging is doubtful the members are to be bonded at the joints.)
3. Metallic sheaths wherever applicable and armouring of all underground cables. The earthing of the sheath and armouring of main cables at either end is a matter of paramount importance because unless the cables are earthed properly at both ends it will not be possible to obtain the screening effect of the cable from induced voltages.
4. Block instruments working on earth return through the respective block filters.
5. All telecommunication equipment.
6. The surge arresters provided in block filters as well as those provided for telecommunication equipment in switching stations.

The telecommunication equipment may be connected to the same earth as the lever frames. Surge arresters may be connected to the earth for the cable sheath. In all other cases separate earths shall be provided. The resistance of an earth shall not exceed 10 ohms.

20706 Signaling & Telecommunication Cables

The main S & T cable in ac electrified sections are usually of the PVC insulated, screened and armoured type to IRS Specification No., S-35. These cables are laid in accordance with instructions issued by the S & T Department. Instructions which are likely to affect traction installations are given below

1. The cable is laid so that it is not less than 1 m from the nearest edge of the traction mast foundation provided that the depth of the cable does not exceed 0.5 m. When the cable is laid at a depth greater than 0.5 m a minimum distance of 3 m shall be maintained between the cable and the nearest edge of the traction mast foundation. If it is difficult to maintain these distances the cable shall be laid in concrete pipes for distance of 3m on either side from the mast. When so laid the distance between the cable and foundation may be reduced to 0.5m. These precautions are necessary to avoid damage to the cable in the event of the failure of an overhead insulator.
2. In the vicinity of traction substations and feeding posts, the cable shall be laid at least 1 m away from any metallic parts of the OHE and other equipment at the sub-station/ feeding post as well as from the substation earthing system. In addition, the cables shall be laid in concrete pipes for a length of 300m on either side of the feeding post. As far as possible the cable shall be laid on the side of the track opposite to the feeding post.
3. In the vicinity of switching stations, the cable shall be laid in the ground at least 1 m away from any

metallic structure of the switching station and at least 5m away from the station earthing system. The distance of 5 m can be reduced to 1 m provided the cable are laid in concrete pipes.

4. Where an independent earth is provided for an OHE mast/ structure i.e., where the mast is connected to a separate earth instead of being connected to the rail, the cables shall he laid at least one metre away from the earth.
5. Where there are traction masts/structures along the cable route, the cable shall be laid in the trench which should be as far as possible but not less than 5.50 m from the centre of the track.
6. Where cables have to cross the track, concrete or GI pipes must be used for the crossing. The use of GI pipes or a form of metallic pipes is prohibited within a distance of 300m from the feeding post. Similarly galvanized iron metallic pipes are prohibited in close proximity to switching station earths or traction masts.

20707 Block Instruments and Block Circuits

On replacement of overhead communication lines with cables, block instruments working with overhead lines with earth return are transferred to special PVC insulated quads in the underground cables. Special protective devices are provided at both ends of block circuits for protection of the instruments as well as the operating staff.

20708 Track Circuits

Any of the following types of track circuits may be used on ac electrified sections :-

1. dc single rail track circuits.
2. ac track circuits working at a frequency other than 50 Hz so as to be unaffected by the latter.
3. Voice frequency and other forms of electronic track circuits.

The track circuits of (ii) and (iii) above may be either the double rail type or the single rail type.

20709 Bonding in Track Circuited Zones

The track bonding for the passage of traction current requires modifications in the track circuited zones. Appendix ll may be referred to in this regard.

20710 Signalling and Inter-locking Circuits

In view of the high level of electromagnetic and electrostatic induction in overhead lines, all overhead lines used for signalling and inter locking circuits in ac electrified sections have been replaced by underground cables. The replaced lines, if not dismantled before energization of the OHE, shall be cut into sections and earthed at several places.

The length of a circuit in a cable shall be such that the induced voltage in the circuit does not exceed 120 volts (corresponding to a parallelism of 3.5 km). If for any reason parallelism of a circuit exceeds 3. 5 km, a relay is inserted in the circuit so that the physical continuity of the cable is broken and the parallelism of each portion is reduced to less than 3.5 km. If the parallelism in excess of 3.5 km is due to feeding two circuits from a common battery or power supply source, separate batteries are provided to feed the circuit on each side so as to limit the parallelism to less than 3.5 km.

II. TELECOMMUNICATION FACILITIES FOR AC TRACTION

20711 Telecommunication Circuits

The telecommunication facilities provided in electrified sections have been detailed in Chapter II of Volume

On ac electrified sections all overhead telecommunication lines running parallel to the track have to be replaced by underground cables. When the induced voltage in the cable is expected to exceed 60 volts; way station and subscriber's equipment, exchanges are protected from the induced voltage by providing isolating transformers. When transformers are provided it will not be possible to transfer dc. circuits suchas CB and auto telephones, dc telegraph circuits etc. , into the cable.

The attenuation of speech in an overhead line of 56.S kg per km copper is approximately 0.039 dB per km whereas the attenuation in an underground long distance cable is approximately 0.22 db per km. The telecommunication circuits are therefore subject to about five times the attenuation when transferred to underground cables and consequently repeaters are required for these circuits at intervals of about 50 to 60 km for satisfactory working. Where the cables are laid by the DOT all repeaters and isolating transformers are provided by them.

20712 Principles of Tapping

Traction Power centre, Traction loco Control and emergency telephone circuits are specifically installed for electric traction. Control regarding utilization of these circuits rests with the Principal Chief Electrical Engineer. All tappings of these circuits will, therefore, be provided with the specific approval of PCEE. Adequate capacities on all these circuits shall be provided taking into account future requirements. Usually the following tappings are provided:

1. Traction Power Control Circuit
   a. Traction Power Control of the adjoining Remote Control Centres,
   b. All switching stations,
   c. All railway traction sub-stations,
   d. All grid sub-stations,
   e. Central repair shop,
   f. All OHE, PSI and RC maintenance depots,
   g. Offices of all Station Masters/ ASMS,
   h. Offices of Yard Master who control movement of trains,
   i. Offices and residences of Traction Distribution officers,
   j. Residences of SSE, SSE/JE of OHE, PSI, Substation, RC maintenance depots.

2. Traction Loco Control Circuit,
   a. All electric loco sheds,
   b. All electric loco stabling sidings,
   c. Offices of Station Masters of originating, and junction stations,
   d. Offices of Yard Masters of large yards,
   e. Office of SSE (RS) and JE (RS),
   f. Offices and residences of Rolling Stock officers,
   g. Residences of SSE(RS), SSE(RS), SSE and JE provided their residences are more than 500rn from their offices and no other telephone facilities exist at their residences.

3. Emergency Control Circuit
   a. At regular intervals along side the track not exceeding 1 km of running track.
   b. At all traction sub-stations, switching stations, and maintenance depots.
   c. Near booster transformer locations and Isolator switches provided for isolation of OHE.

If the distance between two successive emergency telephone sockets determined as above is less than 100 m, only one socket shall be provided, at such locations.

However, in large yards having more than four tracks which are likely to be occupied most of the time, an additional emergency socket may be provided on the opposite side of the yard near an isolator provided for isolation of traction OHE.

Where the transverse distance between two tracks involves walking of more than 300 m, separate tapping shall be provided for each individual track. If not already done, this circuit should also be extended to the TLC to enable him to guide loco/EMU crew in the event of failures enroute.

4. Railway's local telephone
   a. Remote Control Centre,
   b. Traction Loco Controller,
   c. Traction Power Controller,
   d. Offices and residences of all officers of Traction Distribution and Rolling Stock - operation and maintenance
   e. Offices and residence of SSE & SSE(RS) and CTFR & TFR,
   f. Office and residence of SSE and JE of OHE, PSI and RC maintenance depots,
   g. Office and residence of ELC of sub-depot,
   h. SEB's Grid Substation, if feasible.

5. P & T Telephones
   a. Remote Control Center,
   b. All Traction sub-stations,
   c. Offices and residences of SR.DEE & DEE(TrD), SR.DEE & DEE(RS), SR.DEE & DEE(RSO), ADEE(TrD), ADEE(RS) and ADEE(RSO).

20713 Power Supply Arrangement

(The Power Supply arrangement for signaling and telecommunication installations in 25KV AC Areas will be as per Joint Circular of ED/RE & ED/Signal Railway Board circulated vide Railway Board letter No. 82/RE/250/1 dated 13.09.2002.)

III. PERMANENT WAY INSTALLATIONS

20714 Major Track Maintenance Works

1. An authorized OHE staff should invariably be present, when relaying work or any major work on rack is carried out in order to ensure the following points:
   a. Power block is correctly taken and permit to work is issued;
   b. The structure bonds, track bonds, cross bonds, longitudinal rail bonds etc. are not disturbed and if disconnected for the work, they are reconnected properly when the work is completed;

c. The return feeder connections to the rails at the feeding posts are proper and not disturbed;

d. The setting distance of the structure is not affected during slewing;

e. The track level is not raised beyond the permissible limits during the work;

f. Excavation or digging near a mast foundation is done in such a manner that the foundation isnot exposed;

g. The clearance particularly at overline structure is maintained to the required standards;

h. Precautions for the safety of staff working under the OHE are taken correctly;

The Engineering officials in charge of such major work shall ensure that intimation to their counterparts for OHE maintenance work is given with adequate notice.

20715 New Sections to be Electrified

Engineering staff working in section being electrified should be specially trained and instructed in regard to working in electrified sections well in time (Para 20971).

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CHAPTER-8
BREAKDOWNS

I. GENERAL

20800 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 specifically 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.

20801 Types of Breakdowns

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

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

20802 Breakdown Gangs

Accidents and breakdowns involving traction installations and electric rolling-stock should normally be attended 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 electrified suburban sections, however, 'breakdown gangs' of adequate strength may he located at selected points to deal promptly with OHE failures, particularly during the hours of peak traffic.

20803 Emergency Stores and Breakdown Equipment

1. For each OHE depot/sub-depot, the actual quantity of OHE stores like 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 kilometres 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 Inspection 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 the primary responsibility of the supervisor in-charge of the OHE depot/

sub-depot to ensure that all breakdown 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. A list of tools & plants and Spares to be kept at OHE Inspection Cars, wiring trains, breakdown lorries and BD coaches are to be prepared by Sr.DEE/TRD based on the local requirement. Periodical review to be done by ADEE/DEE/Sr.DEE/TRD regarding the availability of the same.

3. The SSE (PSI) and SSE (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.

20804 Record of Staff Movements

TPC should, even when everything is normal, keep a continuous record of the movements of maintenance gangs so that he can contact the gangs immediately whenever required to attend to any emergency. All senior supervisors and officers of the Traction Distribution Branch should also keep the TPC informed of their movements. These instructions also apply to off-duty hours for officers, senior supervisors and key personnel.

20805 Summoning of 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.In view of the mobile communication available now, a list of all TRD staff with their mobile phone number shall be maintained depot wise and can be made use of during any emergency.

II. SUB-STATION AND SWITCHING STATION BREAK-DOWNS

20806 Traction Transformer Breakdowns

Breakdown 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.

20807 Repair of Traction Transformer

For repair of Traction Transformer, refer Guiding Notes on Maintenance (Para 20215, 20216) of CHAPTER II of this Volume.

20808 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-wiree 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 oxyacetylene flame cutting equipment.
4. Portable floodlights 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-phage, 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 to drive the motors. The mobile van would also be useful to flood-light an area such as when there is an extensive OHE breakdown.

20809 Breakdown of Circuit Breakers, Interruptors

If a circuit breaker or interrupter requires major repairs, it should be brought to the PSl maintenance depot after replacing it by a spare one.

20810 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 Interrupter 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.

III. BREAKDOWNS OF REMOTE CONTROL EQUIPMENT

20811 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. SSE (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 ADEE (TRD) as competent with their mobile phone numbers.
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 telephones 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 authorised 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.

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

20812 Restoration of Remote Control

SSE (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.

20813 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 it self breakdown all circuits through it may be in operative in such cases, essential messages may be passed through P & T telephones, Railway local telephones network, Railway wireless network or microwave network, cellular network ,satellite communication etc. 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.

IV. OHE BREAKDOWNS

20814 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.

20815 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

20816 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.

20817 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 may be restored to the healthy sections and normal train operation resumed.

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.

20818 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.

20819 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 railway 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 along side 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.

20820 Officers and supervisors to Proceed to Site

On receipt of information about an OHE breakdown the JE(OHE), SSE(OHE),DEE/ADEE(TrD) shall proceed by quickest available means to the scene of accident. The Sr. DEE (TrD) should also proceed to the site if 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.

20821 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 ADEE(TrD) or Sr.DEE/DEE (TrD) of the Division concerned. The Officers who receive such requests from neighboring divisions should treat the matter as of utmost importance and render all possible assistance.

20822 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.

20823 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 equipment 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.

20824 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 arranges 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 Annexure 8.01 and 8.02.

20825 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.

20826 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 effecting 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.

20827 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.

20828 Wiring Train

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.

20829 Interference with OHE During Restoration

In clearing the line for 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 conducive to good current collection. Also introduction of such splices is liable to delay restoration of normal electric services.

20830 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.8.01.

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 issuspended with the help of special fittings made of MS

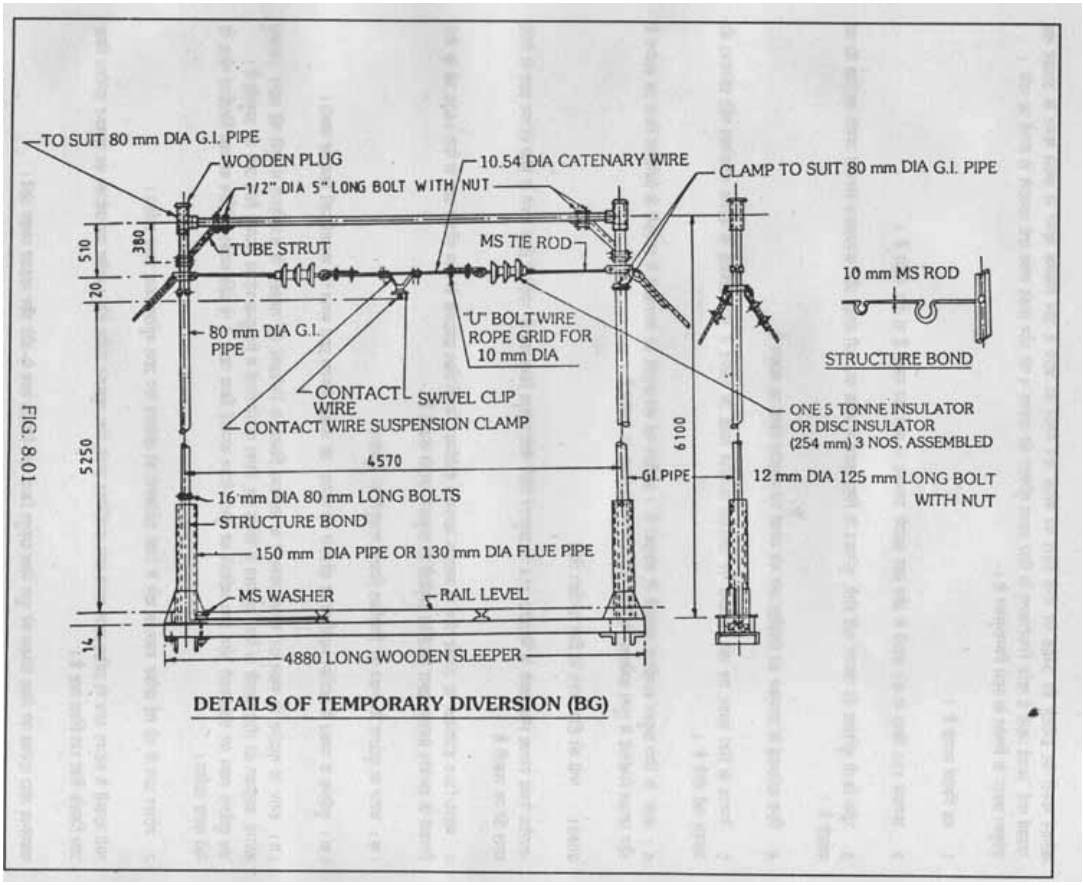
flats form the catenary wire stretched between the two uprights of the structure and insulated by two 9-tonne insulators as shown in the figure.

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 80mm diameter and 150mm 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 structure 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 on 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.



DETAILS OF TEMPORARY DIVERSION (BG)

Para 20830(a) Temporary Speed Restrictions

The instructions regarding speed restriction in electrified sections are beingnotified under GR-17.09. The temporary speed restrictions shall be imposed by Electrical (TrD) Deptt, as per GR-4.09 wherein a caution order shall be handed over to driver at the stopping station immediately short of the place where such precautions are necessary. While imposing temporary speed restrictions, the following guidelines shall generally be followed: -

1. Whenever temporary mast is provided, speed restriction of about 15-40 kmph isimposed depending upon the site conditions. Then the new mast is provided, the foundation of which takes about 5/6 days for curing and after that only OHE is shifted to the new mast. Total time taken in this process is about 10 days from the date-of imposition of speed restriction depending upon the availability of blocks.
2. Whenever mast gets bent due to accidents etc. same is straightened using tirfor. Speed restriction of about 30-60 kmph is imposed depending upon site conditions/stagger profile. Bent is removed during next 3-4 days depending upon the availability of blocks.
3. Whenever there is extensive damage to OHE due to Panto entanglement etc. but not affecting the masts, OHE is attended by using temporary droppers etc. and speed restrictions of about 30-60 kmph is imposed depending upon site conditions and restoration of sectional speed takes about 4 days depending upon the extent of damage and block availability.

20831 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 drew 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.

20832 Log of Events and Reporting of Breakdowns

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 PCEE and PCOM a detailed report covering every major breakdown of OHE or other traction installations giving all essential information including-
   a. nature of break-downs and lines affected with detailed sketch;
   b. chronological account of action taken to effect repairs and restore traffic;
   c. repercussions on traffic and rough estimated cost for repairing the damage;
   d. cause of breakdown and staff responsible, if any;
   e. 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.

20833 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.

20834 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.

V. ROAD VEHICLES

20835 Use of Road Vehicles during Emergencies

Road vehicles like motor trucks and jeeps available with maintenance officials should be maintained in proper condition at all times, as they are liable to be called for use in attending to breakdowns or emergencies. The essential rules for operation of road vehicles are given in the following paras.

20836 Driver's Duties

1. No person shall drive a vehicle belonging to the railway unless he has a proper license and is duly authorized. No vehicle shall be driven on a public road unless the necessary tax has been paid to the Licensing Authority for the area as prescribed by the Motor Vehicles Act.
2. Every Driver of a vehicle shall familiarize himself and comply with the traffic laws prevailing in the area, where he operates. He shall be liable to disciplinary action for any willful violation thereof.
3. Before operating any vehicle the Driver shall make sure that it is in a proper operating condition as follows
   a. Test brakes, steering gear, clutch, horn and lights.
   b. See that the tyres are in good condition and properly inflated.

c. Check emergency equipment e.g., first aid kit jack and tools.

d. Ensure that requisite quantities of petrol, lubricating oil and water are available in the vehicle.

Loco Pilots shall test the head and the tail lights before undertaking night driving. They shall not undertake driving until these are in order.

4. If any major defect is noticed during a journey, it shall be reported to the SSE concerned immediately, and the vehicle shall not be operated until the defect has been set right.

5. Before filling the petrol tank the engine shall be shut off. The hose nozzle shall be kept in contact with the tank to avoid static sparks.

   While filling petrol tanks of the vehicles, smoking and use of open flames shall not be permitted near the vehicle.

6. 'Left-hand-drive' vehicles shall have these words written and displayed conspicuously at the back.

7. All loaded trucks, carrying loads projecting beyond the rear end of the body shall carry red flags of approved type and size when driving during day-time and red lights placed at extreme ends of the loads or trailers at night.

8. Drivers shall not drive vehicles while in a drunken state.

20837 Operation of Road Vehicles

1. When loading or unloading vehicles, the emergency parking brakes shall be applied and the wheels blocked.
2. Equipment, materials and tools carried on vehicles shall be properly secured and arranged so as not to obstruct the view of the Driver or to interfere with his giving traffic signals.
3. The vehicle shall be operated within prescribed speed limits. The speed shall be reasonably reduced, where necessary, due to bad weather, poor visibility, heavy traffic and the conditions of the road and the Driver.
4. Drivers shall keep at a safe distance from vehicles in front. They shall not attempt to overtake any vehicle unless they can see far enough to be sure of passing safely and until the horn signal given for this purpose has been accepted by the Driver of the vehicle in front.
5. Drivers shall not attempt to pass other vehicles on curves, grades, street intersections or such other places where the view is not clear.
6. No motor vehicle shall be driven past school buses that are taking in or putting down children.
7. Drivers shall, at night, dim lights when meeting other vehicles. When blinded by glaring headlights they shall slow down and, if necessary, stop until the vehicle has crossed.
8. When fire department vehicles, ambulances or police patrols are heard or observed approaching from any direction, vehicles shall be stopped at a safe place until these vehicles have passed.
9. When proceeding down a grade the clutch shall not be disengaged. The engine shall be throttled.
10. When approaching railway crossings and road intersections, Drivers shall slow down speed and be prepared to stop.
11. On slippery roads, Drivers, shall operate at a much lower speed and keep a safe distance from vehicles in front to enable them to make a stop within safe limits, leaving the vehicle in gear and applying the brakes until speed has been retarded sufficiently to engage the clutch without danger of skidding.

12. Drivers shall anticipate the intentions of other Drivers and pedestrians and shall themselves give clear signals of their intentions regarding stopping or turning. They shall make allowance for lack of skill or improper attitude on the part of other Drivers, pedestrians, children and animals. They shall not frighten or annoy them by hooting too frequently.
13. When moving a vehicle in reverse direction make sure that the rear is clear and free. Under poor visibility or an hilly or congested roads, driver shall employ a signal-man.
14. Horns shall be used only when necessary. Use of horn just near the object is dangerous and shall be avoided.
15. Doors, tall gates, or parts of load of a vehicle shall not be kept dangling when the vehicle is in motion.
16. The number of persons riding with the Driver shall not exceed the number of seats actually provided.

20838 Precautions when Transporting Heavy Materials

1. Drivers of trucks carrying heavy structures or long ladders equipped with booms shall not drive with such equipment in an elevated or partially elevated position.
2. Proper precautions shall be taken at all times to prevent contact with overhead lines, trees or structures.
3. In transporting material, particular care shall be exercised to see that material shall not shift or fall from the vehicle.
4. Where poles or the long sections of material projecting beyond the vehicle are to be transported along public roads, a red flag in day-time or a red light at night shall be fastened to the end of the projection.

20839 Transportation of Personnel

1. The number of employees carried in vehicles shall not exceed the prescribed limit and they shall be provided with proper sitting arrangements.
2. Persons who are not employed in the railway shall not be allowed to use the vehicles unless specifically permitted.
3. A person shall not put any part of his body outside the vehicles and shall not sit or stand on the rung-board or other outside projections of the vehicle when in motion to avoid injury from other vehicles.
4. Employees shall not enter or leave the vehicle when it is in motion.
5. Employees shall not ride on a load of poles or other material carried on vehicles in a dangerous way.
6. Vehicles fully loaded with personnel shall not be started or stopped suddenly with a jerk, except under emergency conditions.

20840 Parking

1. Vehicles should be parked on the correct side close to kerb of the road so as not to interfere with traffic. Vehicles shall not be parked on bridges, road curves, culverts and Intersections.
2. When parking on a grade, the vehicle shall be in gear, hand-brakes, applied wheels turned towards the kerb. Bricks or stones shall be placed in the wheel path on the down grade side so that the vehicle cannot accidentally roll down.
3. When parking along a highway at night, parking lights shall be left on, but dimmed. If any repair work is to be done, flares shall be set at opposite ends so as to be visible from a distance of at least 150m to warn other Drivers in advance.
4. When parking on the highway near another vehicle on the opposite side of the road, sufficient clearance shall be kept between the two vehicles.

5. Before leaving a parked vehicle, Drivers shall take with them the ignition keyto prevent theft or unauthorized starting of the vehicle.
6. Before changing tires or making any other repairs along a highway, the Drivers shall pull off the vehicle to the side of the road at a safe distance from the running traffic.
7. When leaving or entering a parked vehicle, kerb side doors alone shall be used. If the doors open on roadside, look back and make sure that no vehicle is approaching from the rear.
8. Before starting a parked vehicle, the Driver shall observe the front and the rear to ensure that there are no persons or objects in the way.

20841 Maintenance of Road Vehicles

1. Road vehicles are costly and should be driven carefully and maintained efficiently. The SSE shall inspect every vehicle under his control at least once a fortnight, and arrange to have the defects noticed rectified promptly.
2. Every emergency vehicle shall also be inspected by an ADEE once a month and by the DEE once in six months and the observations made recorded in a register.
3. Each vehicle shall be equipped with an approved set of tools and first aid kit and the Driver shall be trained in their use.
4. A first aid blanket shall be carried on every truck and the Driver shall be trained to use it as an improvised stretcher.
5. When vehicles are jacked up for working underneath, sufficient number of wooden blocks shall be put below to protect men underneath, should the jack fail. Goggles shall be worn to prevent dust getting into eyes.

20842 Procedure in Traffic Accidents

1. Accidents which may appear trivial often result in claims for personal injury or damage to property. A Driver shall, therefore, always be courteous and helpful.
2. Drivers shall not get involved in an argument as to who was responsible for the accident but endeavor to get all the facts in the case.
3. The following instructions shall be observed by Drivers should an accident occur: -
   a. Stop the vehicle and pull over to the kerb if no other vehicle is involved. The vehicle should not be disturbed should there be a fatal accident, as police may make note of the evidence. Protect the rear and front so as to divert the traffic.
   b. If any one is injured, render first aid; send for the Doctor and ambulance, if necessary. Render every assistance.
   c. Do not leave the scene of accident without stopping to identify yourself.
   d. When requested, give your name and address and show your Driver's License to the other party.
   e. Secure name, address and license number of the other Driver, vehicle license number and names and addresses of the vehicle owner, witnesses and the insurance company.
   f. Unless some police officer is available at the scene of accident, notify police station having jurisdiction in the territory.
   g. Sketch the location showing position of vehicles or pedestrians involved and any special condition such as obstructions, parked cars, skid marks.
   h. Try to get the names and addresses of any eye witness and if possible get their statements.
   i. Record date, time of day, weather and road conditions and any other information which you may consider useful.
   j. Submit a detailed report to the superior.

Annexure 8.01

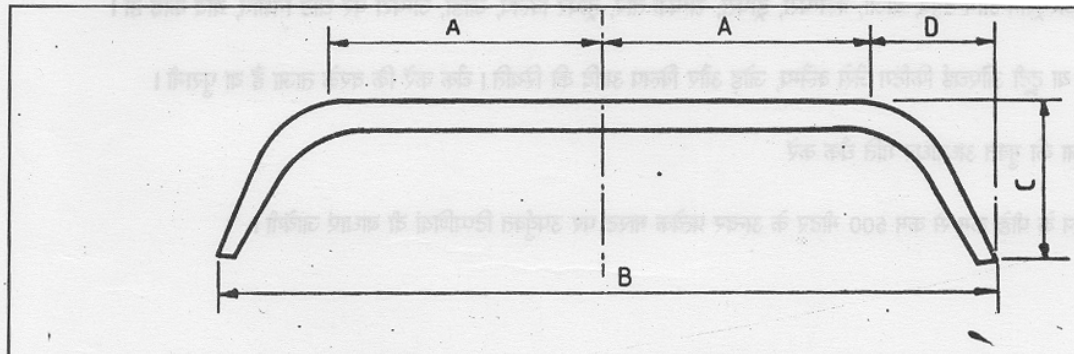
PANTO ENTANGLEMENTS : ITEMS TO BE CHECKED ON PANTOGRAPH

1. Check that the pantograph wearing strips are properly-fastened with the panto pan and there are no loose fastners 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 while 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.



PANTO TYPE	A	B	C	D
AM -12	520	1800	300	380
AM -18	632	2032	306	384

FIG. 8.02

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. 8.02.

7. Check the broken or cracked fittings of the pantograph and see whether the cracks are old or fresh.

Annexure 8.02

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 R.L.
3. Height of contact wire of turn-out/cross-over above R.L.
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/crossover contact wire.
8. Position of Registration tube and register arm dropper clip.
9. Track separation at obligatory point.
10. Position at which horn of 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, splices, jumpers, if any.
13. Condition of cracked or broken OHE fittings such as clamps, splices and clips etc. Check whether the cracks are fresh or old.
14. Check free vertical movement of the steady arm.

Above observations will be made on every mast within at least 500 m in the rear of the location of entanglement.

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CHAPTER-9
PREPARATION FOR COMMSSIONING

20900 Introduction

Prior to commissioning new Railway Electrification, schemes, detailed preparation work is a necessary pre- requisite. While instructions are issued separately in technical manuals of various equipments, salient points in respect of the following major heads are outlined in this chapter.

I Traction sub-stations

II Transmission lines and 25 kV feeders

III Protective equipment

IV Switching Stations

V Remote Control equipment

VI Overhead equipment

VIIGeneral

This chapter is devoted to the technical aspects of work which call for attention during inspections, tests and trials before energization. Chapter X deals with procedures in connection with energization and commissioning and putting the assets into beneficial use.

20901 Reference to Rules and Statutory Rules

The safety of travelling public, railway staff and property shall be ensured by strict compliance with the rules laid down

1. Indian Electricity Act 1910 (latest revision),
2. Indian Electricity Rules (latest edition),
3. Indian Railway Act (as amended from time to time),
4. General Rules for Indian Railways and associated Subsidiary Rules prescribed by Zonal Railways,
5. Indian Railways' Schedule of Dimensions,
6. The Rules for Opening of a Railway or Section of a Railway for Public Carriage of Passengers, 1935 (as amended from time to time),
7. Bonding and Earthing Code, Code for Earthing for Traction Installations and Regulations for Power line Crossings,
8. Relevant IS or IRS specifications and code of practices for various equipment.

During the preparations for commissioning, the provisions of all these rules shall be kept in view.

Wherever extracts and Appendix etc. of the rules have been included from these rules in the ACTM, the figures and contents would automatically get amended with dates of amendments.

Methods/procedures indicated in the manual are only for guidance and may be modified as per latest methods/standards prescribed by RDSO/approved by PCEE.

20902 Pre-Commissioning Inspections

1. Pre-commissioning inspections and tests cover two distinct parts, viz.
   a. Detailed inspection at the level of the HODand Senior Subordinates, and
   b. General inspection at the level of the Divisional Officers.

These two inspections are primary Inspections covering all the installations and are independent of any inspections which may be carried out by Administrative officers.

2. Officers and staff of various sections (Departments) in the Division should associate themselves with the field work during construction, acquaint themselves with the Installations, satisfy themselves about high standards and quality of work and get the defects noticed rectified then and there, while work is in progress.
3. The departmental agencies executing the work in the construction organization shall also keep constant liaison with their counterparts in the open line, who will be responsible for the maintenance of assets created by the construction unit.

20903 Defect and Deficiency Lists

When the work is declared as having been completed and ready for Inspection, the field officers and Senior subordinates of the open line, along with their counterparts of the construction unit and representative of contractors, if any, will carry out joint checks. The checks should be thorough and cover every part of the installation. In making these checks the latest drawings should only be used (superseded versions can be misleading and should be positively avoided).

All defects noticed during such joint checks should be rectified before the sections are taken over by the open line maintenance organization. The defects will be categorized in three types and jointly signed lists be prepared accordingly:

Category A - Defects concerning vital safety items and serious shortcomings, which must be rectified before even test charge.

Category B - Defects , not affecting safety though their rectification before commissioning is essential for trouble free working of electric train service.

Category C – Minor defects, which need not hold up commissioning and can be rectified after commissioning in a reasonable time.

During the preparatory period, these lists should be constantly reviewed jointly and progress of rectification to be done by construction organization be watched.

I. TRACTION SUB-STATIONS

20904 Planning of Power Supply

1. Sub-stations play a vital role in electric traction and, therefore, the need for considerable care during erection and commissioning cannot be over-emphasized. A high standard of workmanship is essential and the pre- commissioning tests should be systematically carried out by competent staff, using dependable and calibrated instruments.
2. When a long stretch of section of the railway is sanctioned for electrification, detailed planning of section by section energizing be undertaken and commissioning for commercial operation of electric traction over appropriate sections with partial change of traction be decided. Keeping in view the fact that 100% traffic cannot be switched over till a viable section of the Railway is completed, the order in which the sub-stations should be brought on line should be decided by

PCEE in consultation with RE and operating branch. This decision should take into account the reliability of supply for the energized section, the tariff structure and the commitments in regard to contract demand and minimum guarantee to supply authorities.

3. The supply authorities may then be advised the dates by which power supply will be needed at the various sub-stations. Agreements may be entered into at appropriate time to make sure that the supply authorities do not delay the work on their part and have adequate time to complete the construction of their works for connecting the substation to the grid.
4. The phasing diagram, deciding which phases of SEB's transmission lines will be connected at different sub- stations should be finalized in consultation with supply authorities for the entire section of the Zonal Railway planned for electrification, keeping in view power supply on adjacent railway systems. The connection of the substations to the transmission lines should be in cyclic order so that the load due to electric traction on the grid system is well balanced and remain within the permissible limits of unbalance.
5. The power supply to traction substation is connected through transmission line, which often cross the track. The application for the 'Track Crossing' should therefore be processed well in advance through Sr. DEE (G), to avoid delays in the supply connection.

20905 Commissioning of Traction Transformers

During the preparation for commissioning of transformers at traction sub-stations in addition to manufacturer's instructions, the following steps shall be taken:

1. Drying out of transformer shall be undertaken as per the procedure laid down. (Refer para 20208)
2. Tap-changing mechanism shall be checked for being in perfect operating condition, both electrically and mechanically. Ratio test should also be done in this procedure. (Refer para 20206)
3. Transformer bushings should be paid special attention to ensure that the manufacturer seal is intact and the bushings are in excellent condition. The Insulation Resistance of the bushing should be around 10,000 Mega Ohm.
4. All gaskets should be properly compressed and tight fitted. No leakage of oil should be visible from valves, pipe joints, gauge glass, radiators or any other parts of transformer. The welded joints should also be checked for for seepage if any.
5. For a sub-station with more than one transformer, they should preferably be identical. The polarity on both should be checked.
6. The oil filled in transformer should be fully de-aerated to avoid false operation of Buchholz relay.
7. The Buchholz relay should be erected as per instructions of the makers and tested for correct operation.
8. All accessories like silica gel breather vent pipe, explosion vent diaphragm, circulating oil pump and special cooling equipment, if any should be checked.
9. In addition to Buchholz relay, (Refer para 20214) other protective devices provided for the protection of transformer (Refer para 20212, 20213) should be examined and checked carefully and tested after erection at site.
10. Earthing of transformers and its neutral terminal shall be done in accordance with the "Code of Practice for Earthing of Power Supply Installations" (Appendix III).

20906 Precautions During Commissioning of Traction Transformer

While working on traction transformers, the following special precautions should be taken by all the staff:

1. It is very important that any one working on a transformer with any of its covers open should remove all loose articles from his clothing such as pens, pencils, watches, money, smoking articles, tools particularly if they are oily, as they are liable to slip and fall into the transformer in the course of work. The number of men working on top should be restricted to the minimum. If tools have to be used they should be fastened by lengths of strings to the workers' wrists or to the tank rim.
2. Moisture lowers the dielectric strength of oil, and hence every possible precaution should be taken to prevent its entry. Sweat on hands and face should be wiped off frequently by a dry cloth and tools should be kept clean and dry, especially when coming in contact with oil. Another source of entry of moisture into the tank is by condensation. If a transformer is at a lower temperature than its surroundings, condense will form on the exposed surfaces. Transformer should, therefore, be at or above the ambient temperature before being opened for work at any time.

If any cleaning or wiping is necessary, this should be done with clean, dry oil using soft, non-fluffy cloth, and never by using cotton waste.

20907 Tests on Transformer Windings

1. Insulation resistance readings should be recorded with a 2500 V or 5000 V megger. The following are the minimum permitted values at an ambient temperature of 30 degree centigrade. Temperature has a material influence on insulation resistance, and therefore the test should not be conducted when oil is hot.

2000 Mega Ohm between EHV winding and earth.

400 Mega Ohm between 25 kV winding and earth.

2500 Meg Ohm between EHV and 25 kV windings.

2. Test on insulation: The test consists of applying dc high voltage (2500 V or 5000 V, with the help of a megger, continuously between winding and earth, and noting the insulation resistance at the end of 10 sec, 60 sec and 600 sec. To maintain constant voltage, a motor-driven megger is preferable. The polarization ratios R60/R10 and R600/R60 should not be less than 1.4 and 1.2 respectively. (R10, R60, R600 are the Insulation Resistance values after 10 sec, 60 sec and 600 sec respectively).
3. Phasing out test: This is comparatively easy, as single phase transformers alone are provided at traction sub station; if both the transformers install at a sub station are of identical manufacture the terminal connections will be identical. Nevertheless, the correctness of polarity should be checked applying 400 V across the primaries in an identical manner and measuring the relative voltage between the two secondaries of transformers after connecting one terminal of one secondary with the corresponding terminal of the other.
4. Oil test: The tests on transformer oil should be done in accordance with IS-1866 for oil in use (See Annexure 2.03 Chapter 11).

20908 Circuit Breakers and Interruptors

The installation of circuit breakers and interruptors should be carefully done as per Instruction Manual of makers and as per maintenance instruction no. TI/MI/0054 or latest. The following special checks may be made.

Check, first of all, if the circuit breaker mounting is quite vertical and the base firmly secured. Examine the operating mechanism in the weatherproof housing for cleanliness, free movement of rollers, bearings and sliding surfaces, which should be very lightly oiled. Open and close the breaker several times to check that everything is working smoothly. Make sure that all pins, locking plates and split-pins are in place.

On the electrical side, examine the condition of the wiring, its insulation resistance and tightness of the terminal screws. Check if the opening and closing solenoid or motor when electrically operated does operate satisfactorily with battery voltage 20 per cent less and 10 per cent more than the rated voltage. Check also the manual operation and record the operating time for closing and opening. Examine whether the heater in the equipment cabinet is in working order. Observe if the auxiliary contacts are clean and good and the terminal block well secured.

Select a few circuit breakers at random to inspect the interior of the arc-extinction chamber to make sure that the main circuit breaker contacts are in excellent condition and their alignment good, but taking care not to contaminate the parts. The parts handled should be washed thoroughly well with good transformer oil and put back and oil level restored.

Examine particularly if there is any strain on the circuit breaker porcelain housing because of misalignment orrigidity of the connection from its terminals to the busbars. Usually this is made through flexible connectors; nevertheless, it is wise to check the position of the connecting leads when the bolts are loosened. Make sure also that the metal-to-metal contact is perfect at the terminal connections. Any imperfection here will result in overheating of the terminal which may even lead to eventual fracture of the housing itself. It is best to measure the contact resistance by “Ductor” or similar low-resistance-reading instrument.

Finally, check the general condition of the equipment, finish and weather-proof-ness of the cabinet and whether it is Insect-proof, whether fuses are intact, and if the operation counter, where provided, works properly and if the metal supports and frame are well earthed.

20909 Isolators

Examine the insulators carefully for any surface cracks and make sure if the surface is clean. Check operation of isolator manually to see ifthe movement is free and smooth, and if the switch blades are fully open or fully closed when the handle is locked at the top or bottom position. Examine the contacts and check if the spring pressureis adequate and blades make full contact. Check terminal connections, preferably the a “Ductor”, examine whether the interlocking between the circuit breaker and its associated Isolator functions properly and the isolator frame is solidly connected to earth by two independent connections. For interlocking scheme for EHV and 25 kV CBs & isolators, reference may be made to RDSO Drawing(ETI/PSI/5212).

20910 Current and Potential Transformers

Check and record the insulation resistance of primary and secondary to earth and between primary and secondary. Check oil level in PT if it is not of the sealed type as also its dielectric strength. Top up the oil drawn for test. Make sure that the terminal connections are well made preferably recording the contact resistance of CT connections by a “Ductor”. The frames of the PT and CT should be well earthed by two independent connections to earth.

20911 Lightning Arrestors

Pre commissioning tests of the Lightening arrestors is to be conducted as per the maintenance instruction no. TI/MI/0041 Rev.01 (or latest).

20912 Shielding and Earthing

Check whether the whole of the sub-station area is well protected against atmospheric surges by screening conductors strung between substation structures and solidly connected to the earth system in accordance with the approved drawing.

Check visually whether the metallic casing of every sub-station equipment and the neutral terminals of the power – transformers are solidly connected to the sub-station earthing grid,and confirm that the "Code for Earthing Power Supply Installations" Appendix lll is complied with in all respects.

20913 Busbars and Insulators

A careful inspection should be, made of every insulator supporting a busbar to detect any minute cracks on the surface; paint marks or dust should be removed and the surface gloss restored.

Time spent in checking the current carrying joints on busbars and terminal connections will pay ample dividends. The contact surface should be clean, smooth and without any irregularities and burrs, so that when they are tightened the area of contact is large. The pressure should also be adequate. Particular care should be taken when joints are made between two dissimilar metals like aluminium and copper. Special bimetallic fittings should be used in such cases to prevent electrolytic corrosion. Connections should be such as to produce no strain on the equipment.

20914 Clearances

The minimum clearances in mm in air for live equipment shall be as under

		25 KV	66kV	100kV	132kV	220 kV
1.	Between phases	-	630	900	1300	2400
2.	Between one phase and earth for rigid connection	500	630	900	1300	2100
3.	Between any points where man may be required to stand to the nearest					
a)	unsecured conductor in air (mm)	3000	3500	3500	4000	5000
b)	secured condition in air (mm)	2000	-	-	-	-
4.	Min. height of busbar	3800	4600	4600	4600	5500

20915 Auxiliary Power Supply for Traction Substations & Control Room

Whenever possible, a 3 phase, 415 / 240 V, 50 Hz supply upto 100 kVA is obtained to meet the power demands for erection and commissioning of the substation. The LT control board should also have matching capacity. An auxiliary transformer of 100 kVA, 1 -phase 25 kV / 240 V is provided to cater to the substation and control load. The station transformer should also be subjected to detailed inspection and check as for the main transformer.

The control room building shall be neat, well ventilated and provided with a strong door. The control panel should have sufficient space all round to provide working space to carry out the necessary tests.

20916 Batteries & Battery Charger

The Battery room should be particularly well ventilated, protected, dust-free and dry. The battery room floor and walls upto a height of 2 m should be painted with anti-sulphuric acid paint. The batteries themselves should be well supported on teakwood stands, painted with anti-sulphuric acid paint and resting on porcelain insulators to prevent leakage. Examine the log book for the period during which the battery was given its first charge and make sure that the manufacturer's instructions have been adhered to as regards the rate of charge and the number of charge and discharge cycles. Make sure there is no possibility of the battery gases reaching the equipment room. Observe the condition of the

battery plates. Take specific gravity of all the cells and voltage across each cell on load. Check if all the inter-cell connectors are tight and well vaseline. Check finally if the battery fuses are of the correct capacity and there is no possibility of battery supply failure. Make sure that the alarm bell goes off if the supply is interrupted for any reason to the control panels.

The battery charger should be inspected to make sure that its capacity for normal and boost charge as well as trickle charge is sufficient and that it complies with the technical specifications, that the meters provided are indicating properly and it is complete with necessary fuses and indicating lamps. The metal casing should have two independent earths.

20917 General

Inspect the substation area to make sure that it has good drainage, that it has good all-weather road as well as rail access, that the whole area is well fenced-in with lockable gates wide enough to permit entry of a motor truck. Ensure that baffle wall in between traction power transformer and suitable oil drainage arrangement with an oil soak pit has been made in accordance with IE Rule 64 (2). The numbering of transformers, isolators, circuit breakers, Incoming transmission lines and outgoing 25 kV feeder lines should be checked to see if it has been correctly done, and does correspond with the numbering scheme on the control panels at the sub-station control room, and also on the mimic diagram board at the RCC. Fire extinguishers and fire-buckets filled with sand shall be kept ready at hand. Station name-board, Danger and Caution boards, Protected Area board etc. shall be well displayed.

20918 General Inspection of Substations and Commissioning

After defects observed during detailed inspection have all been rectified, the Sr. DEE (TrD) of the open line and the Dy. CEE(PSI) of RE organization shall carry out a general inspection of every part of the sub-station along with the Contractors representative. Considering that these are high voltage installations, the inspection should be thorough. As many spot checks as possible should be conducted to ascertain the condition of the equipment and the care taken during erection. Particular attention should be paid to the safety aspects like clearances, operation of protective relays and functioning of the trip circuits and earthing. The statutory regulations such as the Indian Electricity Act and Rules should be strictly complied with and the inspecting officers shall each personally satisfy himself by tests and measurements that the installations are fit in every way to be energized and then issue a joint certificate to that effect.

An application should thereafter be submitted to the PCEE and the Electrical Inspector to the Railway seeking his permission for the commissioning of the sub-station, provided power supply will be made available by the supply authority and testing of protective relays has been completed. After his sanction is received and the precautions and procedures detailed in Chapter X are complied with the substation may be commissioned.

For the first three days after commissioning, the substation equipment shall be kept under careful observation by a senior and experienced supervisory official. Thereafter daily inspection should be continued for the first fortnight. Immediately after energization the correct operation of every protective relay shall be checked. The substation should be taken over on RC.

II. EHV TRANSMISSION LINES AND 25 kV FEEDERS LINES

20919 Detailed Inspection of Transmission Lines

As soon as a section of transmission line between two substations is declared by the Contractor as ready for inspection, detailed inspection shall be carried out by the AEE (TrD) and his staff together with their counterparts on the construction organization and contractors' representatives and a joint note prepared

of the observation made and tests conducted. An defects, whether major or minor, shall be arranged to be rectified immediately so that there may be no delay in energizing the transmission lines.

20920 Compliance with Rules and Approved

The work shall strictly comply with Indian Electricity Act and Indian Electricity Rules, the Contract Specifications and approved including sag-tension charts, particularly in respect to clearances between ground (and other structures) to live conductors.

20921 Visual Inspection

This will cover every mast location and crossing across railway tracks, roads etc., special attention being paid to workmanship, completeness of installations and cleanliness of insulators. The tightness of bolts and nuts in structural steel work and fittings shall be checked. If galvanizing of steelwork has been damaged anywhere, the part affected shall be properly protected by painting with cold galvanizing paint to the satisfaction of the railway. Muffing for each of the tower footings should be checked to make sure that it extends from well below the ground level to at least 380 mm above the ground in irrigated fields, 230 mm above ground level in dry location and 150 mm above the maximum water level in water-logged areas.

Joints in transmission line conductors shall be not less than 15 m from the tower. There shall be no joints in tension lengths of less than 3 spans, nor any in spans over rivers, railway tracks or roads. A few jumper connections between line conductors shall be opened at random to check whether the contact surfaces are good and joint compound has been applied. At the same time, the tightness of all PG clamps should be checked.

20922 Clearances and Sag

The minimum clearances shall be in accordance with I. E. Rules and Indian Standards. In case of 132 kV lines under maximum temperature condition, in still air, the minimum clearances are indicated below.

1.	Open route	6.1m
2.	At all roads and accessible places	6.1m
3.	Between nearest live conductor and any part of any fences, wall, building or other structure on which a man may stand, or against which a ladder may be placed.	4.6m
4.	Between the nearest live conductor and the Earth.	.1m
5.	Between the nearest live conductor and any tree or hedge in the vicinity.	4.6m
6.	Minimum spacing between conductors	
	Vertical	3.9m
	Horizontal	6.8 m

The minimum clearance between live parts and earthed tower or cross arm members for 132 KV shall be

1.	Single Suspension strings in still air and when deflected by wind by 30 degree from the vertical.	1370mm

2. Single Suspension strings in still air and when deflected by wind by 60 degree from the vertical.	1070mm
3. Strain strings at strain towers	1530mm
4. Jumper connections at strain towers when deflected by wind upto 10 degree from the vertical.	1530mm

The height of the lowest part of conductor shall be checked and recorded -

1. At mid-spans at typical locations on the open route.
2. Above railway tracks, roads, building and public places.

Minimum clearance of live parts shall be checked for each of tower at typical locations and recorded. Sag of the earth wires and conductors shall also be checked at selected spans and recorded.

20923 Earthing

Every tower is individually earthed by connecting one of its legs to one or more earth electrodes near by, through a galvanized steel flat 40 mm x 6 mm so that the earth resistance is not more than 10 Ohm before the overhead earth conductor is bonded to the structure. Examine whether the steel flat is properly bolted to the stub-angle iron and well protected below the ground up to the earth electrode.

20924 Insulators and Insulation Resistance

Suspension and strain insulators shall be inspected as closely as possible for any chippings or cracks, for cleanliness, and preface of arcing horns at the line end of each suspension string above the conductor, at both ends of each tension string, and at both ends of each insulator string up to a distance of 1.6 km from the sub- station.

The number of 255 mm dia porcelain discs shall normally be 9 for suspension strings and 10 for tension strings for 132 kV supply. To provide graded insulation, the number of discs will be reduced by one, namely 8 for suspension string and 9 for tension strings upto a distance of 1.6 km from the sub-station.

Duplicate suspension/tension strings shall be provided for all road crossings. For railway crossings, anchor type towers shall be provided on the two sides with duplicate tension insulators, the whole crossing, being in conformity with the 'Regulations for Power Line Crossing of Railway Tracks' (Appendix IV)

Insulation resistance for each power conductor shall be measured and recorded from sub-station to sub-station, using a 2500 V or 5000 V megger. It shall be not less than 100 Mega Ohm.

20925 Continuity Test

Continuity of each conductor shall be measured from, substation to substation using a megger continuity tester and the results recorded.

20926 Accessories

During detailed inspection, it should be verified whether every tower is fitted with an anticlimbing device and enamelled number plates. In addition circular enamelled discs coloured red, yellow and blue are to be provided on terminal towers to indicate the phases. Danger boards should also exist on the transmission line towers where they are near roads or other public places.

20927 General inspection and Energization

After defects noticed during detailed inspection are rectified, Sr. DEE/DEE(TrD) of the open line together with his counterpart on the construction organization and Contractors' representative shall carry out general inspection to make sure that the installationis in good order. During this inspection, the inspection party will carry out as many spot checks as possible to confirm that the detailed inspection has been properly carried out earlier. On the basis of their personal observations, a joint certificate will be issued by the inspecting officers and contractors' representative, confirming that the installation is fit in every respect for energization.

Wide publicity should be given to warn the public that the lines will be energized and of the accompanying danger to any trespassers. After getting sanctioned of the PCEE and Electrical Inspector to the Railway, and clearance certificate from all concerned in a manner similar to the procedure for energizing OHE described in chapter X, the transmission line may be energized provided the sub-station and the connected protective gear have already been tested and commissioned.

20928 25 kV Feeders

Detailed and general inspection of 25 kV feeder lines should be carried out on the same lines as described for the transmission lines and the OHE. Here too, each tower is individually earthed by a separate electrode, in addition to being connected together through the overhead earthing conductor. The clearances to road and rail crossings should be checked with respect to approved plans, duplicate insulators being provided in eachcase. No earthed structure, other than the earthed supporting structure of the 25 kV feeder lines shall be nearer than 2 m from the live OHE.

Tower footing resistance, insulation resistance of both phase and return conductors and through continuity should all be checked and recorded. If the substation is already energized, the 25 kV feeder lines can also be energized on lines similar to procedure described for the transmission lines and the OHE after taking all precautions for safety of equipment and staff working on contiguous sections.

III. PROTECTIVE EQUIPMIENT

20929 Testing of Protective Relays

Before any traction installation is commissioned, the proper operating of every protective- relay should be ensured so that it can be fully dependent upon in all circumstances. This is done in three stages –

1. Checking the relay in the laboratory prior to installation.
2. Checking after installation and before the substation is commissioned.
3. Confirmatory test after energization and before introduction of commercial services.

In carrying out the tests, the Manufacturers' instruction manuals should be studied. The commissioning engineer should be well acquainted with the principles of operation, constructional features and the traction load conditions, so that the relays may be correctly set.

20930 Inspection of Setting of Relays and Calibration of Meters

Electromechanical Protective relays are usually received well packed in separate cases. After opening the case, the relay should be carefully removed, examined for any external damage and taken into the Relay Testing Laboratory. Before removing the cover, remove all traces of dust from the case and the cover. Check the name-plate particulars to see if they are correct. Check carefully the delicate relay movement and make sure if it isquite free mechanically, and all parts are clean and connections tight, taking care not to disturb the settings. See whether the flag operating and reset mechanism is functioning well. Examine the cleanliness and wipe of contacts.

The performance of the relay for different settings should then be checked using standard relay testing equipment, making such adjustments as may be found necessary. A detailed record of the test set up and the calibration curves should be entered in a register as a permanent record. The plug settings are then correctly made to cater for the expected load conditions.

Where relays have both current and potential coils, as in directional and MHO relays particular check should be made to see whether the internal connections of the two sets of coils are correct. If the polarity of one with respect to the other is not right, the relay will fail to operate on a fault, which should, of course, never be permitted to occur.

If everything is alright, the relay cover may he put back, after checking the interior once again and wiping all dust on the cover. It is recommended that the date of calibration should be painted on the case for ready reference. A test certificate should be issued to the field officer for record.

If latest Numerical Relays are being used then follow the instruction manual supplied by the relay manufacturer for pre commissioning test and storage requirement.

Simultaneously, maximum demand and energy meters should also be got calibrated and sealed in consultation with the Supply Authority.

20931 Protective Devices at Sub-stations

(Ref RDSO Spec TI/SPC/PSI/PROTCT/6071)

The following protective and indicating devices are provided for each traction transformer :

1. Numeric integrated transformer Differential protection relay.
2. Numeric integrated transformer protection relay (HV/LV) comprises of:
   a. Instantaneous Over Current Protection.
   b. IDMT Over current protection.
   c. Definite Time Over Current Protection.
   d. Restricted Earth Fault Protection
3. Buchholz relay with alarm and trip contacts.
4. Winding temperature protection with alarm and trip contacts.
5. Oil temperature protection with alarm and trip contacts.
6. Protection against low oil level.

In addition, a low oil level indicator is provided on the conservator tank. Local Indicators are provided on the transformer tank for excessive oil and winding temperatures, whereas a common indication only is provided on the control panel at the RCC for excessive winding and oil temperatures as well as Buchholz relay.

The following further protective relays are provided for each feeder circuit breakers :

1. Feeder protection module comprising of Over current , Distance Protection Relay, Wrong phase coupling, PTFF, Auto recloser protections.
2. Delta I relay

Proper functioning of each of these relays and the contact mechanism of each should be checked individually. At the same time, the correct operation of the following annunciations and the associated cancelling buttons and flag indications should also be checked :

1. EHV transformer circuit breaker auto-trip.

2. Buchholz alarm
3. Buchholz trip
4. Winding temperature alarm
5. Winding temperature trip
6. Oil temperature alarm
7. Oil temperature trip
8. Low oil trip
9. 25 kV transformer circuit breaker trip.
10. 25 kV feeder circuit breaker trip
11. Transformer circuit breaker inter-trip
12. 230 V ac failure
13. 110 V dc low voltage
14. 24 V dc low voltage

Check should be made of all indicating instruments on the control panel to see if the movements are free and the readings are correct. Test plugs where provided for checking relay operation should be examined if they fit properly. Indicating lamps should be functioning properly, but a switch should be provided to cut them out when the station is unattended.

Check should also be made for proper functioning of device provided for tripping CBs in the event of 110 V dc supply failure.

20932 Control Circuits and Wiring

After installation of all equipment and completion of control cable connections, a detailed check of the wiring should be conducted verifying the colour, code and identification tags and markings on the terminal strips on the equipment and the control panels with respect to the approved wiring diagram. Insulation and continuity tests should also be taken and values recorded.

A word of caution is necessary here. The detailed diagrams of control circuit and wiring of control panel supplied by the Manufacturers should not merely be taken on trust, but subjected to careful scrutiny as to their correctness. Errors do occur in drawings and if they are not detected at the very early stage itself, they may cause a great deal of confusion and trouble later. The best method of detecting errors in detailed wiring diagram isto prepare a simplified schematic or functional diagram so that the circuit arrangements becomes quite clear and obvious. It will then be known what exactly to do for any test, what links to close or open and what connections to make or break. To restore the connections back to normal after the tests have been successfully completed, a detailed diary should be kept of every change or alteration made for purpose of test. If any modifications are required to correct the errors discovered, the Manufacturer should be advised immediately and his confirmation obtained. When the work is completed, overall operation may be checked by manually closing the relay contacts and finding out whether the appropriate device has operated or not.

20933 Fuses

Control circuit fuses shall be-of correct rating. If the-trip battery circuit fuse is under-rated, it is liable to deteriorate due to excessive heating and fail ultimately, which could indeed be dangerous. To guard against this possibility, alarms are sometimes provided to draw the attention of the operator in the event of fuse failure. In ac traction, failure of battery fuse is automatically relayed to the RCC but the TPC cannot replace the fuse by RC, someone has to go and replace it which may take considerable time.

In view of this, fuses in the control circuit may err by being slightly over-sized but should never be under-sized. For the same reason all connections in the trip circuit should be well made and the fixing screws kept tight, but not over-tight which may cause excessive pinching of the connecting lead and may eventually cause a breakage.

20934 Insulation and Lead Burden Measurement

Insulation resistance to earth should be measured. Any connection to earth and wiring made deliberately such as earthing links on current and voltage transformers and on dc supply should be removed before the test; care being taken to put them back as soon as the test is over. Measure and record the insulation resistance of the following circuits –

1. Current transformer secondary circuit.
2. Potential transformer secondary circuit.
3. DC trip circuit wiring.

When measuring the insulation resistance to earth of an individual circuit all other circuits should be normal i.e. earth links closed to ensure that the insulation is satisfactory both to earth and all circuits.

Lead burden should also be measured between current transformer and the relays to ensure that the burden imposed on the CT is within its capacity. This test will reveal if there is any poor contact in the secondary circuit of the CT or if the distance between the transformer and the control panel is too long. With a CT rated at 5A, lead resistance is particularly important.

20935 Current Transformer Ratio and Polarity Test

Every CT should be individually tested to verify whether the polarity markings on the primary and secondary terminals are correct, using the set up shown in Fig. 9.01.

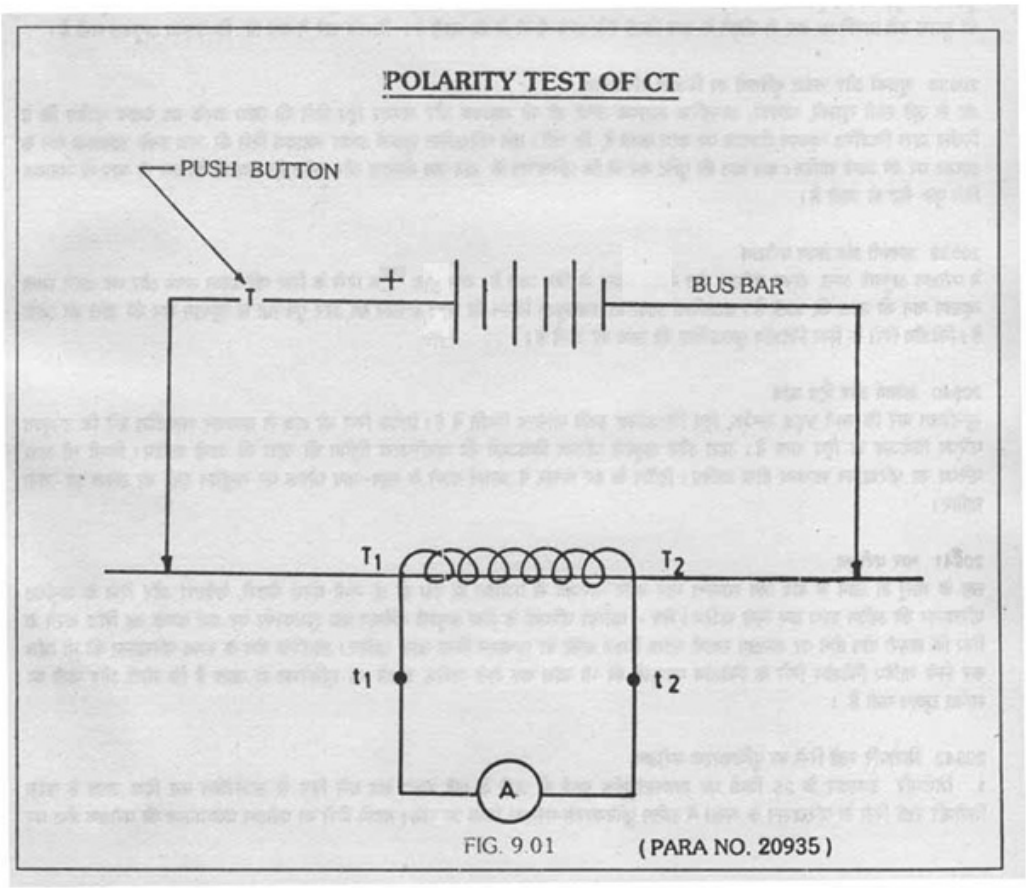

FIG. 9.01 (PARA NO. 20935)

'A' should be a moving coil centre –zero type low range ammeter . A 6 V storage battery may be used to energized the primary winding through a single pole push-button switch. On closing the push button, the dc ammeter should show a positive flick, and on opening a negative flick.

20936 Primary Injection Test

This check is carried out with a "primary injection set", which is usually arranged for connection to the 240 V supply means and furnishes heavy current at a low voltage. Provision usually exists to connect the secondary windings of the test set either in series or in parallel to get the necessary output. A 10 kVA test set usually permits currents up to 1000 A to be obtained with four secondary windings in parallel and upto 250 A at a higher voltage with the windings in series. When dealing with very large currents, it is essential that the connecting leads and area of contact and contact pressure should be adequate enough otherwise, higher values of current will not flow.

The merit of primary injection test is that it gives an overall check on the correctness of the entire circuitry.

20937 Voltage Transformer Ratio and Polarity Check

Polarity of the potential transformer could also be checked using the same method described for current transformer testing. In this case, however, care should be taken to connect the battery supply to the primary winding with the moving coil ammeter connected to the secondary winding.

The ratio check can be made when the 25 KV busbars are first made alive. The PT secondary voltage is then compared with that of another PT known to have the correct ratio, after connecting it to the primary bars.

20938 Electrical Operation of Indicators and Associated Devices

All shunt connected indicator, annunciators, internal auxiliary elements, DC auxiliary and master trip relays, should be checked for operation at the minimum voltage stipulated by the Manufacturer. Series-operated indicators or auxiliary relays should be checked at their pick-up values. Confirm that auxiliary relays reset when voltage and current supply is removed after operation.

20939 Secondary Injection Test

For Electromechanical type Relays-These tests are done with a secondary injection test set. Normally, operating time and minimum closing value are checked for induction relays. For instantaneous attracted armature type relays, the minimum closing and resetting value are checked. For directional relays, directional characteristics are checked.

For Numerical type Relays- The Relay Test kit suitable for testing numerical relays having parallelogram characteristics should be used for secondary injection for testing and calibration of numerical relays.

20940 Alarm and Trip Check

Ensure that all fuses, links, trip latches etc. are in normal position. By operating each relays manually, verified if the appropriate circuit breaker trips. Inter-tripping of primary and secondary circuit breakers should also be checked. There should be no normal-operation of any other circuit. In every case of tripping, the appropriate flag indication should take place on annunciator, accompanied by operation of the alarm.

20941 Load Test

After the section is commissioned, a final check should be made of the proper operation of all voltmeters, ammeters and relays when normal load currents are flowing through the circuits. For differential circuits, spill currents should be measured to prove that protection will be stable under external faults, by shorting the secondary terminal on one current transformer; operation under an internal fault should also be checked. The directional features of directional relays should also be checked. This ensures that the relative polarity of CT and PT is correct.

20942 Confirmatory test of OHE Protective Relays

1. A short time after OHE has been successfully charged at 25 kV, it is de-energized to conduct final confirmatory test on the operation of OHE protective relays. Although relays would necessarily have been tested on the test bench at the laboratory and subsequently in the field after erection, a final confirmatory field test is essential before declaring the section as fit for commercial operation to ensure that in the event of a fault the relays do trip.
2. The Numerical Feeder protection relays should all be set for instantaneous operation as mentioned earlier. In all, the following three tests are necessary and in each case all the feeder circuit breakers and their associated relays should be tested one after another:
   a. A direct fault on the busbars of the feeding post to test operation of the over-current relays.
   b. A fault at the farthest end of a single line section under emergency feed conditions to check the operation of distance protection relay (numerical integrated feeder protection module) and also the under-voltage relay at the sectioning post.
   c. Closing the bridging interruptor at sectioning post to check the operation of wrong phase coupling relay.
3. Test (a) can be conducted as soon as the substation and feeding posts are commissioned, without waiting for the energization of the OHE. In carrying out Tests (b) and (c) one must provide and be prepared for the very remote contingency of the distance relay failing to trip the circuit breaker when it is closed on the fault, due to polarity of the potential coil of the distance relay not being correct in relation to that of the current coil. Before starting the test, trip circuit operation should be checked by manual closing of the relay contacts. A responsible official should remove the MHO relay cover and be ready to close the relay contacts manually and trip the circuit breaker, should it fail to do so automatically when the circuit breaker is closed on the fault. Should this happen, the connecting leads either of the potential coil or the current coil on the MHO relay should be reversed and the test repeated.
4. For carrying out the short circuit tests, care should be taken to earth the line by a solid flexible, jumper connection (105 mm2) to an earthed structure. A thin wire such as 14 SWG should never be used for connection to earth, under the mistaken impression that the fuse would blow out and not jeopardize system stability, should the 25 kV circuit breaker fail to trip. It should be remembered that the circuit breaker is designed to clear the fault whereas the improvised fuse is not. When it blows on account of heavy short circuit current, the flash over caused by it can damage the galvanizing of the mast and perhaps shatter any insulator nearby.
5. A point to be ensured in particular is that none of the relays at the grid substation trips during any of these short circuit tests. This can be ensured earlier by proper co-ordination of relay settings at the traction sub-station. Normally, the feeder circuit breaker trips out within about 250 mili-seconds from the occurrence of short circuit and HV transformer CB trips on IDMT within about 500 milli-seconds. The Supply Authorities should be requested to set their relays allowing a time lag of 0.5 seconds to ensure that the substation circuit breaker does not trip for faults on the railway traction system.

6. It is quite possible that in these short circuit tests, more than one relay associated with the feeder circuit breaker may operate; for example, the impedance distance relay in addition to the over-current relay, even for a fault close to the sub- station. This is quite in order, since this automatically gives back up protection. A note should be made as to which flag/LED indications have operated to ascertain which of the protective relays have operated during each test.
7. When testing the wrong phase coupling relay, the relay at one substation alone operate and not at both ends, as may be expected. This, however, does not matter at all. Nevertheless, if it is required to check the other relay, the relay which has operated may be blocked and the performance of the other relay tested by a second test.
8. The operation of the under-voltage relay at the sectioning post for a fault at the farthest end under emergency feed conditions can be checked by posting someone at the sectioning post. The test could however be postponed by a few days and conducted after introduction of commercial services.
9. Since these confirmatory tests are to be conducted after successful energization of the OHE and before introduction of commercial operation, it is essential to complete the tests in the shortest possible time. However, being the most severe tests these should not be repeated too often. This can be ensured by organizing the work properly by posting testing parties at the right places and controlling all operations through the TPC and by RC.

IV. SWITCHING STATIONS & AUXILIARY TRANSFORMER STATIONS

20943 Power Supply

Power supply for all switching stations is arranged through the 10 kVA, 25 kV/240V auxiliary transformers connected to UP and DN line in double line section. If an ac 240 V supply nearby is available from the supply authority, a service connection should be taken from the source as well.

A 24 hour record of voltage should be taken and the tap switch of the auxiliary transformers correctly set.

20944 Installation of Equipment

The installation of every item of equipment like interruptors, isolators, busbars, lightning arresters and wiring from equipment to the control panel in the switching stations cubicle, 72/110 V and 24 V batteries and, battery chargers etc. should be checked, keeping the points referred to in paras 20915 to 20918 in mind, except for the following minor variations.

1. Interrupters are installed for controlling supplies to the sub-sectors. The remarks made under para 20908 are equally applicable, except that no relays are associated with them.
2. Potential transformers for catenary supply indication are mounted on the switching station gantry.
3. 25 kV lightning arrestors are also installed on the gantry.

20945 Clearances

Check whether the following minimum clearances for 25 kV do exist:

1. Height of any live conductors from ground level — 3m
2. Distance between any live part(25kV) and earthed part or part likely to be earthed — 500mm

(In special circumstances and with the approval of the design office this can be 450mm.)

3. Between any live part (3kV) and earthed part such as return conductor or return feeder — 150mm

No live part may project beyond the fenced enclosure except at a height of 6.1m or more. This should be particularly checked to guard against the possibility of danger to any member of the public who may walk by the side of the switching station with an umbrella or a long pole.

Check and ensure that the distance from the centre of the nearest track to the face of the switching station gantry is not less than 3.5 m.

20946 Auxiliary Transformers

These should be inspected and tested in accordance with the procedure earlier stipulated under "substation" – Part I above.

The mounting of these transformers should be checked to ensure proper fitment and conformity with schedule of dimensions and electrical clearances.

20947 General

Verify whether the erection of fencing is neat and all parts are given a good finish with paint, the gate is provided with a good lock and anti-climbing devices are satisfactory. The area inside the switching station should be leveled at least 10 cm above the surrounding area. Good drainage must be provided so that there may be no possibility of water logging at any time.

To facilitate unloading and loading of heavy materials transported by trolley or OHE inspection car, a suitable loading platform should be provided from which a path-way should be available upto the gate. Wherever possible a jeepable road approach should also be provided from the nearest public road.

When the switching station is at the foot of or at the top of a steep embankment, suitable foot steps should be provided leading upto the gate.

20948 Interlocking

Verify whether the double-pole isolator associated with every interruptor is equipped with an interlock and it is functioning properly. It should not be possible to open or close the isolator unless the interruptor is locked in the open position. It should also not be possible to operate the interruptor either manually or by RC, unless the isolator is locked in the open or closed position. To ensure this, the interlocking device should consist of a lock combined with an electrical contactor on the operating mechanism of the interruptor to make or break the RC circuit and a lock for the isolator operating mechanism, with a common captive interlock key for the two locks.

20949 Feeding Posts

At locations where the traction substation is close to the tracks, the feeding post may be a part of the substation; if, however, it is far away, the feeding post close to the tracks will receive 25 kV supply from the traction substation, with 25 kV feeder circuit breakers located at the substation end.

In either case, the neutral conductor (also called the negative or return conductor) of the feeder line should be solidly connected to the track rails, in addition to being earthed at the traction transformer end. This connection to the rails is vitally important for the proper and safe working of the traction system and it should under no circumstances be broken. To ensure this, the neutral conductor is connected to the rails by eight independent galvanized steel stranded (7/16) cables for a double track section with two conductors for each rail. The ends of stranded cables are brazed or welded on to suitable shoes which are riveted to the rail webs.

Examine all the connections and make sure that the cables are well bonded to the rails with sufficient length left free for flexibility. The down-lead from the terminal tower should be well protected mechanically to prevent its being cut and stolen.

20950 Number Plates and Boards

Check the numbering of the interruptors, isolators, PTs and then jumper connections to the OHE to see if they do correspond to the numbering scheme on the control panel in the switching station equipment room, the mimic diagram board at the RCC and the sub-sector numbers.

Check also if the following boards and fittings are provided at each switching station :

1. Switching station name board,
2. ”Danger boards” to caution public,
3. “Protected place” board prohibiting unauthorized entry,
4. Fire-buckets and fire extinguisher inside the equipment room.
5. First aid box and “Rules for Resuscitation from Electric Shock” board(In trilingual) inside the equipment room.
6. 25 kV Power supply arrangement board.

Essential caution boards and number plates should be painted with fluorescent paint so as to be brightly visible in light at night.

20951 Earthing and Bonding

The structural steel work as well as the neutral conductor of auxiliary transformer, and the metal case of every electrical equipment shall be connected by two independent connection to earth in accordance with the “ Code for Earthing Traction Power Supply Installation” vide Appendix III. According to this code, HT and LT earths should be provided separately, but interconnected together by a link. It is equally important to check that the structure supporting the busbars are solidly connected by two independent connections to the non- track circuited rail with single rail track circuit or to the mid point of the impedance bonds where both rails are used for track circuiting.

During detailed inspection, the resistance of each electrode should be measured and recorded by a megger earth tester so that the combined resistance of the HT earthing system is 2 Ohm, or less and of the LT earth 10 Ohm or less, when not connected to the rails.

V. REMOTE CONTROL EQUIPMENT

20952 Importance of Remote Control

Remote Control Center is the nerve center of the traction system, from where full control over every switching operation on the entire electrified route is exercised, its efficient operation is, therefore, of prime importance for successful working of the system. It is desirable to complete all tests and trials on the RC equipment at the RCC and at the switching stations and to make them fully functional before energization of OHE. To achieve this, tests and trials should start about a month earlier, by which time the following item of work should be ready.

1. Derivative cables from the main telecommunication trunk cable should be led and terminated inside the equipment room in RCC, substations and each of the switching stations. Care should be taken to ensure that the metal sheathing of the derivative cable is terminated short of the cable terminating box and kept insulated from earth inside the equipment room and surge arrestors are provided for each terminal.
2. Repeater stations should be fully functioning.
3. All control phones in RCC and TPC telephones in sub-stations and switching stations be installed and commissioned.

4. The air conditioning of the RCC should be complete before the erection of the RC equipment starts.
5. RC equipment should be ready and wired up at RCC controlled posts.
6. Batteries and battery charger along with power supply and charging arrangements should be ready.

20953 Manning of Substations and switching posts

When RC equipment is first brought into operation, it will take about 6 months before teething troubles are overcome and equipment stabilizes for trouble free service. During this time, it is necessary to man the substations and switching stations to operate the interruptors manually and give reports to TPC when required. This situation also arises for longer period if the RCC is not ready before energization.

The switching station attendants should be given adequate training in their duties and should normally be available from about a month before the date of commissioning. It is usually possible to introduce commercial service on limited scale, before commissioning of RC equipment.

20954 Level Measurements

Signal levels should be measured and recorded both at the sending and receiving ends at the control center as well as at every substation and switching station. These measurements are of two kinds:

1. Individual levels of every frequency on the 'send' channel. These are measured by a vacuum-tube voltmeter (VTVM) /Transistorized voltmeter (TVM) with its selector switch in "high" Impedance position at the oscillator output terminals. These should be about - 16 dB.
2. On the receive side, the levels are taken with VTVM in the "high" - impedance position, at the detector input terminals: this should be between-17 and - 25 dBm.
3. Composite levels taken between the terminals of the tele-command and tele-signal cable pairs with a VTVM with selector switch in the "high" impedance position. Readings may also be taken at the input and output terminals of the repeater station and plotted on a graph sheet.
4. Measurements should be taken of the levels of every channel on send and receive pairs at the control centre using the Selective Level Meter. The levels for the send-channels should not be lower than - 22 dBm. and for the receive channels - 22 to - 30 dBm.
5. After final adjustment of the levels, a note should be made of the values of the attenuation pads included in all the circuits and kept as a permanent record for purposes of comparison and reference.

It may be noted that the line impedance of the send and receive circuits is 1120 Ohm whereas that of the amplifier output only 150 Ohm. A matching transformer is therefore provided between the two. When measurements are taken, care is required to keep the selector switch of the VTVM in the "high" position, as long as the circuits are through, but if the output level is to be measured with the line or equipment disconnected the switch shall be kept at the 150 Ohm or 1120 Ohm position as necessary to achieve matching.

Another point to be kept in mind is that although the individual level of a single channel is say -22 dBm, the level indicated on the line is much higher if measured with VTVM because of the presence of a large number of frequencies each of which has a level of - 22 dBm. Thus the correct reading of - 22 dBm is indicated when a Selective Level Meter is used with frequency range switch in the "frequency" position; but the same meter would indicate perhaps + 5 dBm if there are say 12 channels and the frequency range switch is kept in the "flat" position. Distinction should therefore be made between the individual channel levels and composite level, where all frequencies are present.

20955 Detailed Inspection of RC Equipment

Detailed program of erection of equipment, sequence of preliminary tests to be carried out at the RCC

and controlled stations, shall be furnished by the contractor to enable the Railway staff to carry out stage inspections and testing of individual panels, equipment cabinets and control units at the master station and Remote Terminal units.

When contractor reports completion of erection, commissioning and all adjustments and testing work and notifies that the installations are ready, detailed inspection shall be carried out by ADEE (TrD) and open line staff along with their counterparts on construction organization and representative of the contractor. The defects noticed shall be rectified immediately.

Contractor shall also furnish a detailed test program for the final testing of the RC equipment for the approval of the Railway Engineers. These tests will be done jointly by open line officers, RE officers and the contractors' representative. The test program shall cover the proving tests for all the parameters and facilities provided for the operation of RC equipment in the specification. The tests at site after Installation and commissioning shall constitute the acceptance tests, which will be carried out after the detailed Inspection and rectification of defects is completed. Thorough checking of all switching operations, correct operation of all alarm, indications and annunciation facilities, tele-signallng and tele-metering arrangements, mimic diagram displays, VDU displays, data –logging and data storage, diagnostic facilities etc. shall be done from both control stands of the master station as well as from the remote terminal units. Operating time for various operation shall also be checked and recorded.

All these tests carried out jointly shall be recorded so as to establish, authentic initial record of the performance of the equipment to ensure that the RC equipment is complete and trouble free.

20956 Interlocking of the Bridging Interruptor

Interlocks in the RC equipment for the bridging interruptor at the sectioning post provide for the following:

1. When catenary supply is available on both sides of the interruptor, the interruptor should not close.
2. When supply is available only on one side, the interruptor can be closed.
3. When supply is not available on both sides of the interruptor the interruptor can be closed but should trip immediately

This is achieved by utilizing 100 or 110 V ac supply from potential transformers provided for this purpose at the sectioning post.

Provision is also made for the bridging interruptor to trip if the catenary voltage drops too low. This setting is adjustable between 15kV and 19kV and should be set at 19kV.

The above interlocks should be thoroughly checked when commissioning RC equipment at sectioning posts.

20957 General Inspection by Divisional Officers

After defects noticed during the detailed inspection as above have been rectified, the Sr.DEE/DEE(TrD) of the open line together with the counterpart on the construction organization and Contractors representative's shall carry out general inspection of the entire installation to make sure that it is in good working condition. During the inspection verification of as many tele-command and tele-signals operations as possible shall be carried out from the control centre. Inspection of the installation at every sub-station as many posts as possible shall also be carried out. Level and frequency measurements should be taken at random at a few points to compare the result obtain with those recorded during the detailed inspection.

The divisional officers will issue a joint certificate if they are fully satisfied with their observations and tests, that the RC installations are fully fit for commissioning. Thereafter, the RC may be put into regular services and its operation closely watched by manning the switching stations and sub-stations as mentioned earlier. Detailed record of every failure shall be maintained by TPC and the maintenance official. Each of these failure should be gone into fully to ascertain the cause of failure, which incidentally would give the staff excellent opportunity to get familiar with the circuitry and fault finding procedure.

VI. OVERHEAD EQUIPMENT

20958 Detailed Joint Inspection of OHE

The importance of OHE arises from the fact that it is extensive, with a very large number of insulators, fittings and component parts, failure of any one of which may result in dislocation of traction services for appreciable periods until the defect is rectified. The adjustment work is particularly important at cross-over and over-lap spans since any wide departures from the standards laid down could cause entanglement of the pantograph with the OHE, with serious repercussions. The need for a very thorough detailed inspection of every part of the installation, post by post can't, therefore, be over-stragged.

When the OHE contractor reports completion of all adjustment work, detailed inspection will be carried out by the ADEE(TrD) and staff of the open line with their counterparts on the construction organization and representatives of the Contractor, using an OHE inspection car, flat-topped wagon of wiring train, or ladders as may be convenient.

20959 Compliance with Latest

The OHE shall be strictly in compliance with the latest approved General Supply Diagram, Sectioning Diagram, Layout Plan and Structure Erection, particularly in regard to

1. run of conductors; stagger and height;
2 disposition of brackets and clearances;
3. correctness of jumper connections, especially at switching stations;
4. numbering of interruptors, circuit breakers and isolators in relation to the elementary sections, sub-sectors or sectors controlled.

20960 Infringements

None of the wayside or over-line structures shall cause infringement of the Schedule of Dimensions. Every such infringement shall be individually recorded and action taken immediately either to have them removed or, where this is not possible, to obtain sanction from the Commissioner of Railway Safety.

20961 Important Point to be Checked

The following points shall be checked during the detailed inspection:

1. Cantilever Assemblies: Every cantilever assembly shall be adjusted strictly in accordance with the approved structure erection , especially in regard to the positioning of stay arm, bracket tube and register arm. The projection of bracket tube and register arm and the allowance in the stay arm shall be sufficient for slewing of tracks. Normally this allowance is 15 cm to 20 cm from the centre line of catenary suspension bracket to end of bracket tube and 20 cm (min.) for register arms. All nuts should be tightened and locking plates provided with split pins or check nuts. Make sure that all temporary earths provided by Contractor's men during construction work have been removed.

2. Anchoring Points: The movement of counter-weights shall be free and not obstructed in any way. Flexible steel ropes shall move freely and centrally with respect to the pulley sheaves and not rub against any member. The distance between the pulley centres and the height of counterweight above the muff level, shall be as per the chart in relation to the prevailing ambient temperature. Anti-creeps shall be properly tensioned and positioned.
3. Overlap Spans: Adjustments at insulated and uninsulated overlap spans, turn-outs, crossovers and section insulator assembly shall be correct not only in respect of the run of conductors and jumper connections, but also the height of contact wire. The separation between different OHE and displacement of cantilevers at insulated overlaps should be adequate.
4. Insulators : Insulators shall be perfectly clean. Should the surface be polluted by dust, it should be cleaned and gloss restored. All insulators on out-of-run wires should be so located that they do not foul but are well away from the zone swept by the pantographs: The runners of section insulators should be so located as to be beyond the zone of sweep of pantographs running on adjacent tracks. There should be no undue sag due to the section insulators, the runners should be level and not be tilted to one side so that the pantograph may pass smoothly.
5. Height of Contact Wire: This shall be checked at every structure and at mid-span for regulated OHE. A pre- determined sag in the contact wire of 50 mm or 100 mm at mid-span on a 72 m span for 50 or 100 mm presag compensated OHE respectively should exist on the open routes. Height of contact wire at level crossings shall not be less than 5.50 m.
6. Stagger : Stagger in tangent track shall be to the left and to the right at the alternate bracket, not exceeding 200 mm on either side of the centre line of the track, except where otherwise specified in Structure Erection Drawings. Stagger for in-running OHE shall not be more than 300 mm at the mast/structure on the outside of curves except in case of overlap spans and also at the turn-outs. Stagger of contact wire at mid-span in transition portion of the curves shall be within 200 mm.
7. Gradient of Contact Wire : On both side of overline structures, tunnels and level crossings, the gradient of contact wire shall be in accordance with the approved profile.
8. Clearances: The live metallic caps of insulators on out of run wires shall be at at least 2 m away from adjacent earthed mast/structure (other than the OHE structure). The distance of these insulators shall be 3 m from the bracket supporting the OHE in case of insulated overlaps. Clearance of 2 m shall normally exist from nearest point of two adjacent elementary sections except at the section insulators. Where clearance of 2 m is not available, it shall be not less than the minimum long duration electric clearance of 320 mm. Whenever the OHEs of two elementary sections cross one another, necessary cut in insulators shall be provided.
9. Bonding : Every mast/structure supporting OHE as well as platform structures, foot over bridges etc. shall be properly bonded to the rails and earthed in accordance with the Bonding and Earthing code (Appendix II)
10. Telephone or Power Crossings : Keep a close watch for any overhead telephone crossings over the OHE, which may not have been removed by oversight. Immediate steps should be taken to have these removed. High voltage transmission line crossings across the tracks shall be checked against the approved plan authorizing the crossing, particularly the clearance between the OHE and the guard wires, duly recording the results individually. If the crossing is not in accordance with the approved plan, the Supply Authority should be contacted immediately and the infringements should either be removed or necessary relaxation be obtained from PCEE and Electrical Inspector to the Railway.
11. RDSO's limits & tolerances in erection with respect to structure erection drawings parameters in new Electrification works issued vide TI/MI/0049 should be followed.

20962 Notices to be Displayed – Caution Boards and Number Plates

During the detailed inspection, special attention shall be paid to verify whether the following notices have actually been displayed at the various locations indicated below:-

1. 'Treatment for electric shock' boards, (in trilingual) giving instructions for treatment of electric shock in English, Hindi and the regional language, at all railway stations (ASMs or SMs Offices) signalling cabins, SSE(P. Way) ,JE(P. Way) and SSE(Works) offices and depots, Signal Inspectors' offices and depots. OHE Maintenance depots, OHE inspection car sheds, substations, switching station cubicles, loco sheds etc.

   It should be noted that standard printed charts for 'Treatment for electric shock' are meant for voltages upto 1100 Volts. A person in contact with higher voltages should be isolated only after 'switching off power'.
2. General 'Caution Notices' regarding danger of high voltage traction wires for public at various entrances to railway station and for staff at prominent places at each station, particularly on stanchions or pillars supporting platform roof.
3. "25 KV Cautions Boards" (in trilingual) shall be affixed on to the screens erected on foot over and road over bridges.
4. 'Danger' boards on level crossing height gauges.
5. 'Engine Stop' boards, at termination of OHE in the sections to be energized.
6. "Caution-Unwired Turn out" boards ahead of all unwired turn-outs or crossovers taking off from wired tracks.
7. "Warning" boards for neutral sections.
8. Boards for "Switching on" and "Switching off" of power at neutral sections. Four boards are required for each track as detailed in Chapter II, Vol.I.
9. "Danger" boards to be installed on OHE near watering stations, if any.
10. "25 kV Caution" boards at sub-stations and switching stations.
11. "Caution" notices on all diesel, electric and steam locos which work on the energized section, including those owned by private parties.
12. "Caution" boards at such signal posts where protective screening cannot be provided for signal and telecommunication staff.

20963 Recording of Defects and Rectifications

During the detailed inspection, defects and deficiency lists as indicated in para 20903 shall be jointly prepared.

As soon as the defects are rectified, the open line officers should be advised and suitable remarks made against each item of the list. The open line officer and his staff, if deemed necessary, re-check the Installation, to ensure rectification of defects. -

20964 General Inspection of the OHE by Divisional Officers

After all major defects observed during detailed inspection have been rectified Sr. DEE/DEE (TrD) of the open line and Dy. CEE(OHE) of the construction organization shall carry out a "General Inspection" of the entire section proposed for energization, along with the Contractor's representative. For this purpose, an OHE inspection car fitted with pantograph shall be used and run at a speed not exceeding 8 km/h observing all safety precautions laid down, such as earthing the OHE. The pantograph may be used to measure height and stagger of contact wire, which should be test checked at least at two locations per track km.

The object of this "General Inspection" is to make sure that the OHE and connected installations are in good order and are fit for energization. During this inspection, the whole installation shall be inspected visually observing, in particular, the following details and looking for any thing unusual or abnormal in the installation :

1. Cantilever assemblies, positioning of fittings, stagger of contact wire, lift of the steady arm in curves where the radial pull of contact wire tends to move the steady arm upwards, kinks or twists in contact wire, infringement of section insulators and conductors in overlap spans or any deformity suffered anywhere. Any loose wires hanging anywhere or other obstructions shall be observed, and any abnormality removed or rectified immediately.
2. Clearances to live metal parts of insulators on out-of-run wires should be atleast 2 m from the adjacent structures (other than OHE).

During this inspection, spot checks shall be conducted at as many places as possible to verify whether the detailed inspection by the senior subordinates has been thorough, to confirm that the defects noticed earlier have been rectified and to make sure that the installations are in excellent order and suitable for energization subject to final pre-commissioning tests.

20965 Lapping and Polishing of OHE

After the OHE is ready in all respect, lapping and polishing of contact wire be undertaken to remove all dirt collected on the contact face with the pantograph. For this purposes an electric loco pantograph raised and hauled by a diesel loco may be use at a speed of 15 to 20kmph during the first run and not more than 40 kmph in subsequent runs. Alternatively, an OHE inspection car may be used. It is an advantage if before lapping by pantograph under side of contact wire is manually cleaned by rubbing and wiping with a wet cloth and detergent and finally wipe with clean cloth. Normally 3 to 4 runs for lapping and polishing may be done.

When lapping and polishing is in progress suitable safety precautions to block the section and earthing of the line as per rules, should be taken and work is supervised at a level not less than SSE.

20966 Procedure for Final Test of OHE

After the OHE is declared as fit for energization and all construction staff have been withdrawn from the field, insulation and continuity test shall be conducted jointly by officers of the construction organization and the open line with assistance of senior subordinates. This should be done at least a day in advance of energization. This tests should be conducted for every elementary section. The following preliminary action shall be taken to prepare the circuit for the test.

To carry out the test in a systematic manner, a detailed programme of work should be prepare. A senior, experienced official should be nominated for controlling the movements of all working parties each of whom will be given a copy of the programme with specific instructions as to the sequence of switching operations to be carried out. This preliminary action should be taken atleast a week in advance of the date fixed for the test.

On the day of test, interruptors and circuit breakers at all switching stations shall be taken on 'local' control and RC put out of operation. All interruptors and double-pole switches are then opened and locked in the open position' Danger-Men Working' boards should be attached to the operating handle of each 25 kV isolator at feeding post. All potential and auxiliary transformers at switching stations should be temporarily disconnected from the bus bars. All other isolating switches in the various yards and other locations provided for isolation of elementary section also be plays in the "off" position. When all these operation are completed a confirmatory message shall be sent to the TPC.

The test shall be controlled by one senior official who shall continuously remain at the RCC and direct all operations as required. Basically, these tests comprise-

1. Measurement of insulation resistance of every elementary section with respect to earth.
2. Checking electrical independence and insulation resistance between adjacent elementary section and also adjacent sub-sectors.
3. Checking electrical continuity of every sub-sectors.

The test shall be carried out by one party with the assistance of two or more field parties as required. The control party alone will carry with it all test instruments and take measurements. The field parties will merely carry out instructions given. They should have with them necessary jumper connection and earthing poles for earthing the equipment when directed to do so. The field parties are forbidden to carry out any operations on their own. As the different working parties will be working at different locations, independent from one another, they should carry with them portable telephones through which they will remain in continuous contact with TPC through emergency telephones circuit. In case the emergency telephone circuit is not available alternative arrangements shall be made by S&T Department for telephone communication.

Along with the control party carrying out the tests, the Contractors shall attach a work party who will accompany the control party from location to location and rectify any defects which may come to light during the tests.

20967 Insulation Tests

Starting from the feeding post, the control party will measure and record the insulation resistance of every elementary section to earth by a 2500 V megger, after arranging with the out-field parties to (i) isolate the elementary section concerned and (ii) earth adjacent elementary sections. This test will show -

1. the insulation level of every elementary section; and
2. the electrical independence of the elementary section, from adjacent elementary sections.

If the tests for all elementary sections at that location are satisfactory, the control party may proceed to the next elementary section and carry out similar tests. When all elementary sections at a particular station have been tested, the control party will move to the next station, directing the field parties to do likewise and carry out the tests on each elementary section at that station as before until every elementary section in the sector has been tested.

During the course of construction work, erection staff usually provide temporary earths, using a short piece of binding wire on the OHE at certain locations to safeguard themselves, but after the work is completed these temporary earths may not have been removed by oversight. Such temporary earths on the OHE will give misleading readings during the final insulation test and cause annoyance. To prevent this, Contractors should be particularly instructed earlier to remove all such temporary earths.

Guide Lines for Minimum Permissible Insulation Resistance

It is very difficult to lay down any specific rules in regard to the minimum permissible values, as they depend upon a number of factors, which should he taken into account when fixing the value in any given case. Some of these factors are mentioned below.

1. Voltage rating has an important bearing on the minimum value necessary, before switching on supply. Obviously, the higher the voltage rating, the greater should be the insulation resistance.
2. Condition of Equipment : The insulation resistance for new equipment should necessarily be much more than for the same equipment after a few years of service. Similarly, the value required (after

an equipment has been overhauled, cleaned, dried out) before being turned out of the repair shop should be appropriately higher than when the same equipment was in service before being brought into the shops. A unit which is lying idle for some time may show a comparatively low megger reading merely because of absorption of moisture and yet its insulation may be good and it would work satisfactorily when put into service; the absorbed moisture would soon be driven out when it is loaded up and the insulation resistance would automatically improve.

3. Type of equipment : It is a fundamental fact that the larger the number of leakage paths, the lower would the insulation value tend to be. Assuming that the voltage rating and the type of insulation provided for two armatures are identical, it is obvious that the one with a commutator will have a lower value of insulation resistance, than one with mere slip rings.

For the same reason, the insulation resistance of 25 kV OHE tends to be quite low, Assuming that each support insulator has a value of 500 Mega Ohms, an elementary section may have 50 of them in parallel, bringing down the overall value to 10 Mega ohms. Smoke pollution will greatly diminish this too. A single badly polluted section insulator may easily bring down the value to half a Mega ohm or less. While one would not dream of switching on supply to a 3.3 kV transformer showing so low a reading- 25 kV supply is commonly switched on to the OHE even in such cases since the accumulated dust and smoke particles, which are responsible for the low value of resistance, soon get burnt out, and the insulation resistance usually improves greatly after energization.

4. Size of plant :Some of the formulae commonly used are

Large AC motors : $\frac{V}{1000 + (kW/100)}$ at 750C

Large DC motors $\frac{V}{1000 + kW}$ at 75 0 C

Having referred to the various factors which should be taken into account in fixing the minimum value of insulation resistance, a few thumb rules are given below for guidance: -

Insulation resistance in mega ohms to earth at room temperature (40 0 C)

1. Internal wiring	50/number of outlets
2. Power equipment in general	2Mega /kV desirable 1Mega ohm/kV minimum
3. Transformer windings	400V-2Mega ohm,11kV-50Mega ohm 25kV-200Mega ohm.,132kV-2000Mega ohm.
4. Circuit -Breakers	-do- -do-

5. OHE-Elementary Section	New installation -25Mega ohm. desirable On sections having steam traction And several section insulators. -1Mega ohm. (These, however, would need to be cleaned to improve IR)
6. Traction Motors	1 Mega Ohm for motors upto 750 V And3Mega Ohm for motors of higher voltage (at 75 0 C)

20968 Continuity Tests

When insulation tests are completed for all the elementary sections, the control party may proceed in the reverse direction towards the feeding posts carrying out continuity tests as described below -

In this test, the various control switches which might have been opened out earlier should be put back to their final positions as indicated in the Station Working Rules, as in normal operation. Any temporary earths provided for earthing adjacent sections shall be removed. When this is done, the various elementary sections are automatically joined up electrically and each sub-sector is made through. The continuity test is then conducted by a low reading ohm-meter by measuring the resistance of each sub-sector from the feeding post and with each sub-sector earthed at the farthest point towards the neutral section. The through continuity of every sub-sector shall be checked individually. It is important to note that a megger insulation tester is unsuitable for measuring continuity as it may read zero even when the resistance is as high as 1000 ohms.

If the tests show up any defects on the line, they should be rectified at once. Sometimes, it may be found that although the insulation resistance is all right, there is no through continuity on some sub-sectors. The most probable cause for this is a disconnected jumper connection at an overlap span. This should also be immediately traced and rectified.

20969 Divisional Officers' Joint Certificate

The test results shall be recorded and signed by Sr. DEE Open line and Construction and forwarded to PCEE, along- with other papers for sanctioning energization in his capacity as Electrical Inspector.

VII. GENERAL ARRANGEMENTS

20970 Preparation for Operating Electrified Services

While the engineers are busy carrying out tests and trials of electric equipment to get everything ready by the target date fixed for commissioning, several steps have to be taken by the Operating Department to be ready to operate the electrified services when the section is commissioned. The DOM of the open line and the DOM of the construction organization shall both be jointly responsible for the following:

1. The Rules and Regulations concerning operation, namely General and Subsidiary Rules, Revised Station Working Rules to come into operation after introduction of electric traction, relevant Chapters of this Manual shall be handed over to every Station Master on the section to be electrified. In addition It is essential that the implications of these rules and procedures should not only be explained to the concerned staff, but they should be examined verbally to make sure that they do understand them and further, their assurance in writing to that effect should be obtained.

The training of Station Masters, Section Controllers, Cabin staff and other categories in the special rules and procedures applicable to 25 kV traction is best arranged at a short orientation course for the purpose in the Zonal Training School.

2. (a) At every station on the electrified section, a large scale Sectioning Diagram, should be exhibited, with the different elementary sections painted in distinguishing colours to help better understanding, also showing location of isolating switches, wired and unwired lines etc. The meaning of these should be explained to the concerned staff.

   (b) A complete sectioning diagram of the OHE for the relevant section should also be exhibited in the office of the Section Controller in a similar manner. These diagram shall be kept up dated by OHE supervisors, marking the changes made from time to time.

3. Sufficient number of 'Yellow Warning Collars' should be supplied to each of the signal cabins; the cabin staff should be instructed regarding their purpose. They should also be told that no electric train or EMU should ever be permitted to enter an unwired line or a section for which power block has been taken. That they understand the new procedures should be confirmed by them in writing.
4. Station Masters and Section Controllers should also be fully conversant with the system of power blocks and the need for longitudinal and cross protection on electrified lines, and the precautions to be taken by them in regard to train movements especially oversize consignments.
5. Station Masters/ Assistant station master/pointsman should be issued with competency certificates, after giving practical training, to enable them to operate specific isolators under instructions of Traction Power Controller (TPC).
6. First Aid boxes and charts showing resuscitation of persons who have suffered electric shock should be kept at every station. As many persons as possible should be trained in the correct method of rendering artificial respiration, preferably by a doctor.
7. The extreme danger of any one coming near line OHE should be fully explained and widely publicized amongst all staff and members of the public. No one should be permitted to ride on roofs of coaches and locomotives.
8. The rules for watering of carriages should be distributed to all TXR and station staff concerned and the procedure fully explained and assurance obtained from them in writing.
9. On all steam and diesel engines which may enter the electrified section, 'Caution' legends shall be painted on the side panels. Steam engine Loco Pilots and the Firemen should be particularly warned that they should under no circumstances climb up the coal stack on the tender or wield the long steel rake so as to come any where near the OHE and never direct jets of water on the coal in the tenders or towards the traction wires. Experience has shown that In spite of such warnings, many an unfortunate loco Driver or Fireman have suffered electrocution: by force of habit they climb up the coal heap for loco for some work, forgetting the presence of OHE in a newly electrified section. Loco Pilots and Firemen should be repeatedly warned of the danger of death due to such carelessness.
10. Traffic staff should be advised of the provision of emergency telephone sockets and their locations, and instructed in the correct way of plugging in these telephones into the sockets.

After the two DOMs have toured the area and assured themselves that all the above preparatory steps have been implemented, they shall render a certificate to the effect that the section can be opened for public carriage of passengers under electric traction without endangering the safety of the travelling public or of the employees of the railway.

20971 Preparation by the Engineering Department

The Divisional Engineer of the open line and his counterpart on the construction organization shall also warn engineering staff in regard to the precautions to be taken by them while working on electrified sections. The SSE(P.Way) and the maintenance gangs should be particularly advised that the alignment of the track with respect to the OHE structures should be strictly preserved and maintained. Their attention should be drawn to the instructions contained in Chapter II Part 'J' of IR Permanent Way Manual for taking the necessary steps to educate the Permanent Way staff and to equip them with the accessories.

20972 Preparation by the S&T Department

Introduction of ac 25 kV traction involves a considerable amount of work to be done by the S&T Department, to modify the existing circuits, shifting of signals, introduction of colour light signals and laying of appreciable lengths of signal cables apart from providing telecommunication facilities required for electric traction. The precautions to be taken in testing and commissioning the S&T equipment, which should precede electrification, are the responsibility of the S&T Department and is, therefore, not dealt with here.

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CHAPTER-10
COMMISSIONING OF ELECTRIC TRACTION

21000 General

When electric traction is to be introduced for the first time or extended to new section on a Railway, considerable additional responsibility devolves, particularly on the electrical deptt. To discharge these responsibilities, it is essential to have a clear programme of action to be taken in the final stages of completion to ensure that:

1. the works carried out departmentally and by contractors are of high standards.
2. the organization for running the services will be ready by the time the sections are commissioned;
3. as and when installations are energized on 25 kV, they are taken over promptly and operated efficiently.

21001 Preparation by Open Line

The intention of having electrification works carried out by a separate organisation within the Railway is to relieve the PCEE of the Open Line of the burden of detailed design, supervision and execution of works, departmentally or through contractor. It is however, essential for PCEE of the Open Line to keep himself in touch with the developments and progress of works, so that he may take timely action for taking over the installation on commissioning. He will have to arrange every other thing.

1. creation of an organization, with sufficient number of trained personnel, to take over the operation and maintenance of the electrified section from the date of Commissioning;
2. recruitment and training ofoperating and maintenance staff;
3. close association of Open Line Officers and staff during the final stages of erection and adjustment work to enable them to study the details of installations;
4. carrying out of detailed inspection of the works by Assistant Officers and senior subordinates followed by general inspection by Senior Officers for getting all defects rectified;
5. final tests and trials with rolling-stock;
6. Administrative Officers' inspection and sanction to the energization of substations, switching stations and OHE by Electrical inspector;
7. final Inspection of OHE and installations by CRS, commissioning and putting into commercial service and;
8. post-commissioning work, operation and maintenance.

21002 Organization for Inspection and Taking Over

The PCEE of the open line railway shall set up the organization on the following line:

1. Create all the posts of officers and staff in accordance with the norms and fill up at least 6 months in advance two post of JAG Officers viz. Sr. DEE/TrD and Sr. DEE/RS along with requisite site staff and supervisors.
2. when electrification is introduced for the first time on the zonal railway, a nucleus set up at the headquarters office should also be created.

3. organize a Training School at least one year in advance/ for the training of maintenance, operation and running staff to man the services.
4. Recruit maintenance and operating staff and train them to man the services, arrange for selection of running staff from steam and diesel cadre and start their conversion training courses at least a year prior to the date of energization, so as to position adequate number of Loco Pilots, assistant Loco Pilots and supervisors in time to take over the services.
5. Position the Inspectorial cadre to ensure compliance with the requirements laid down in para 20970 station bystation and to train along with Sr. DSO all the Operating Deptt. staff.
6. Augment the organizational set up 3 months in advance of the date of commissioning posting additional officer and staff to ensure detailed joint checks and rectification of defects in time.
7. Expedite the completion of facilities for setting up OHE and PSI depots and workshop facilities built by the construction unit and arrange to equip the emergency vans, OHE Inspection Cars and other maintenance vehicles to undertake the maintenance and operation.
8. If a loco-shed is part of the RE project, some officers and staff should be posted at least 6 months before the locos are received so that they can set up the shed facilities jointly withthe construction unit, arrange for jigs, fixtures, and other special tools, take over the major plant and machinery such as cranes for light and heavy lifting bays etc. and get themselves organized for the maintenance and operation of the rolling stock.

Having nucleus setup of key officers is an important step which enables establishing a good rapport with, and making full use of the resources of the construction organisation in creating full facilities for the open line maintenance. Opportunity to select right type of men with skill for different jobs from a number of sources viz. direct recruitment, other open line units and sheds, contractor's skilled labour etc. can be taken by the officers if they are in position in good time. This enables the change of traction from the very first day of energization on trial basis and increase it to a very significant level immediately after CRS's inspection and sanction for carriage of passenger traffic.

21003 Duties of Senior Divisional Electrical Engineer (TrD)

1. Assisted by his DEE/ADEE(TrD) he will follow up with the Construction Organization to ensure that the following works are ready well in advance of the date of commissioning:-
   a. Accommodation for the new Sr.DEE(TrD)'s Office together with necessary furniture, office equipment etc.
   b. Central Repair Shops, PSI and maintenance Depots, and Sub-depots with necessary road and rail facilities.
   c. Full stock of spare parts, tools and plant, testing equipment, lifting tackle, emergency vans, motor trolleys, push trolleys, jeeps, motor trucks etc. required for operation and maintenance.
   d. Installation of emergency power plant at the RCC.
2. He will make a detailed study of tariff for power supply and get acquainted with officers of the power supply authorities.
3. He will arrange for creation and timely filling up of all posts required for operation and maintenance.
4. He will arrange for screening and conversion training of staff expected to be rendered surplus due to electrification and recruitment and initial training of the balance requirement of staff.

21004 Duties for Senior Divisional Electrical Engineer (RS)

1. Assisted by his DEE/ADEE(RS) he will follow up with the Construction Organization to ensure that the following works are ready well in advance of the date of commissioning:
   a. Additional accommodation for the new Sr.DEE(RS)'s Office together with necessary furniture, office equipment etc.
   b. Electric loco/EMU shed and out-station maintenance depots with all facilities like travelling crane, pits for inspection, power supply, plug sockets, lighting, storage racks etc.
   c. Installation of the full complement of machinery, tools and plant and testing equipment at all repair and maintenance depots.
   d. Full stock of spare parts and arrangements for stocking them for recurring consumption.
2. He will also arrange for sanction for necessary posts for operation and maintenance of rolling-stock.
3. He will arrange for screening and conversion training of Steam/Diesel Loco Pilots through all phases including their basic theoretical and practical training in electric rolling-stock, their learning the road and rules for operation of electric stock.
4. He will arrange for preparation of loco link diagrams and Loco Pilots' rosters as well as Trouble-shooting Directory for different types of rolling stock.
5. He will arrange for screening and conversion training of maintenance staff rendered surplus due to electrification and also recruitment and initial training of balance requirements of staff.

21005 Responsibility of Construction Organization

The Construction Organization is responsible for the execution and completion of works and testing, commissioning and handing over all installations in proper working condition to PCEE of the Open Line and in particular to ensure that-

1. the design of all installation is in accordance with approved standards and where any departure from accepted norms becomes necessary approval of Railway Board/ RDSO/ CRS/ Electrical Inspector is obtained;
2. progressing of works is done to comply with the target dates fixed by the Railway Board and all works executed are to a high standard;
3. procurement of all special stores, transport vehicles including OHE inspection cars for maintenance, tools and plant, machinery and testing instruments and their handing over to the Open Line in two stages the minimum required before tests and trials followed by the balance immediately after installation and commissioning in done (refer Appendix VI);
4. the PCEE informed of all developments and in consultationwith him the programme and date for commissioning of installations is fixed;
5. copies of all approved specifications, contract documents and important letters are furnished to the PCEE. Sufficient number of copies of allspecifications and manufacturer's instruction booklets should be sent to the Divisional Officers concerned so that they may be distributed to the maintenance Staff. "Asmade drawings" or tracings incorporating all modifications during construction, countersigned bythe Engineers of the Contractor and construction organization are handed overto PCEE of the Open Line for safe and permanent custody;
6. Exercising necessary coordination with the Supply Authorities to ensure that power supply will be made available and with the Department of Telecommunication and/or service providers e.g BSNL etc so that all the works will be complete and completion reports given well in advance for enabling energisation of the lines. In event of any delay in the completion of telecom protective works &

receipt of Completion Certificate, to modified proforma 10.09 of ACTM Vol.II (Part - I), Railway Board's permission may be obtained in proforma 10.19.

7. Complying with all the formalities connected with the energization of all sections in accordance with the rules laid down.

21006 Commissioning of Traction Substations

1. Energization of traction substations is the first step towards commissioning of electric traction on a new section of a Railway. This can be done subject to-
   a. Power Supply Authorities being ready to give power supply;
   b. detailed inspection of the substations, protective equipment and connected RC equipment having been completed and test being quite satisfactory;
   c. full communication facilities being available;
   d. permission for energization of the substation having been received from PCEE and Electrical Inspector to the Railway.
2. Normally all sub-stations should be commissioned well before the date fixed for energization of OHE for commercial traffic use.
3. On the appointed day,necessary clearance certificates should be obtained from the Contractors, Dy.CEE(PSI), Officers of the Supply Authority andothers who were working at the substation during the construction period, that their staff have been withdrawn and the substation may be energized. The 25kV feeder isolators at the sub- station and feeding post ends should be opened and locked and the 25 kV feeder conductors solidly earthed by duplicate earths. Readings of the tariff metering equipment should be recorded and the meters jointly sealed by the Open Line Sr.DEE/ DEE and the Officers of the Supply Authority. After final meggering of the whole installation, all circuit breakers and isolators are kept in the open position and the 'remote/local' switch put in the 'local' position.

Power supply may then be switched on step by step to the transformers and busbars and the indications on the control panel checked. Subject to everything being in order, operation of the various control-gear can be checked, followed by tripping of circuit breakers by manually closing the contacts of the protective relays. Finally, overall confirmatory test may be conducted of the correct tripping of circuit breakers when close against dead-short circuits on the 25 kV busbar. This test will also confirm ifthe settings of the grid sub-station relays are properly co-ordinated with the settings of the traction substation relays so that the grid substation CB's do not trip for a fault on the 25 kV installations.

4. The two transformers may then be kept energized continuously. An experienced supervisory official should be deputed to keep a close watch on the equipment for the first three days, followed by a detailed inspection after a week and then after fortnight.

Should a circuit breaker trip during the period, the cause should be carefully investigated. The annunciator panel should be checked to ascertain which of the relays have operated. Occasionally the Buchholz relay may operate. A probable cause for this when a transformer is energized for the first time is that air bubbles which may have been entrapped between the windings when oil is filled into the transformer tank, may get released when the transformer gets warmed up and may operate the Buchholz. However, a careful check is still necessary to ascertain the cause of every tripping.

5. 25 kV power supply may he extended up to the feeding posts if all work on 25 kV feeders and the feeding posts has been completed in all respects, after taking the usual safety precautions.

21007 Notification for energisation:- (ACS 17, ACS 21 & ACS 22)

1. A notification indicating the intention to energize completed section/s of OHE, a month in advance of the approximate date on which the line is expected to be energized, will have to be issued to the following:-
   a. The Press.
   b. The CRS and PCEE and Electrical Inspector.
   c. General Manager, Principal Chief Operating Manager, Chief Engineer/Construction, Principal Chief Commercial Manager, Principal Chief Mechanical Engineer, Principal Chief Signal and Telecommunication Engineer, Principal Chief Security Officer and Divisional Railway Managers concerned.
   d. Power Supply Authorities.
   e. Department of Telecommunication.
   f. Field Officers of Railway Electrification.
   g. OHE Contractors.
   h. Government Railway Police.

The notification shall be issued in the proforma 10-01 appended.

2. Notification regarding level crossing Gates:

At least a month in advance of the energization of a section, a notification in the proforma 10-02 appended shall be issued by the concerned Railway for the safety of public and vehicles using level crossings. This notification shall be published in local papers and also in the Gazettes of Railways and State Govt.

3. Notification for particular section to be energized:

At least a fortnight in advance of the probable date of energization, a notification in the proforma 10-01 shall be issued by the field unit of RE construction, notifying all concerned of the energization of the relevant portion of the section.

21008 Sanction of Electrical Inspector to the Railway (EIG sanction) & OHE energisation

1. Application shall be submitted at least a fortnight before energization to PCEE and Electrical Inspector to the Railway for the following:-
   a Formal approval, if not already received to the design and layout of all high voltage equipment including traction sub-stations, transmission lines,25 kV feeders, switching stations etc.
   b. Approval for energization of HT installations mentioned above including OHE.
   c. Prior approval of PCEE to be obtained for the use of composite insulators before erection.
   d. Prior approval of EIG to be obtained for OHE clearance study under critical over line structures where CRS/RB condonation is required.
   e. Approval of EIG for any power line crossings in the section.

2. Documents required for ElG's sanction:
   The following documents shall accompany the application for ElG's sanction.
   a. Copies for Press cuttings of the Public notification as mentioned in para21007,
   b. Certificate regarding OHE (proforma 10-03).

c. Certificate regarding bonding and earthing (proforma 10-04).
d. Certificate of open line officers about knowledge of their staff regarding safety procedures and precautionary measures to be observed, issue of station working rules, obtaining assurance of the staff about their knowledge of rules applicable to a.c traction and countersigned by DRM (Proforma 10-05).
e. Copies of insulation resistance test results of OHE.
f. Insulation resistance test results for auxiliary transformers.
g. Test results for equipment in switching stations and sub stations and their safety certificates, if earlier sanction for energising these has not been obtained separately.
h. Completion Certificate for protective works from Deptt. Of Telecommunication/Telecom service provider e.g. BSNL, etc. In the event of DOT's delay in the issuance of the Completion Certificate to modified proforma 10.09 of ACTM Vol.II (Part-I), Railway Board's permission may be obtained in proforma 10-19.
i. Any other data, test results and certificates required by the Electrical Inspector.

The sanction of the Electrical inspector may be issued in the proforma 10-07.

3. Wherever it is necessary to check the satisfactory completion of work, EIG after satisfying himself may authorize temporary energisation of the overhead equipment for undertaking OHE proving runs, testing of protective relays and other measures to ensure safety.

4. Publicity

Wide publicity through the Press and posters given earlier would keep the public fully informed about the proposal to electrify the lines and warned to danger of live OHE. All diesel and steam engine Loco Pilots should also be advised by respective supervisors that they should, under no circumstances, climb over engines or ladders when they are under the OHE, as they will endanger their lives by coming close to the live OHE. Train watering staff should also be cautioned by their supervisors so that they may not inadvertently climb on the carriages, by old habit.

5. Energization of OHE

On the appointed day and hour, all concerned will assemble either at a feeding post or at the RCC assuming it has already been commissioned. The entire energisation operation shall be carried out under one Senior Electrical Officer who will be nominated for the purpose. He will first collect the following Clearance Certificates:

a. Certificate from contractors working on OHE, switching stations, RC and also from other agencies whose staff were engaged on construction works, to the effect that their men have been withdrawn from work, that they have been warned that installations would be energized and that no work be done thereafter without obtaining a permit to work.
b. Joint Certificate by the RE and open line Sr.DEEs stating that they have withdrawn their staff and warned them as above and that the installation has been jointly inspected and is fit for energisation and also that due precautions have been taken to protect contiguous sections where men may be working.
c. Certificate issued by S&T officers that their work has been completed and the OHE can be charged at 25 kV ac.
d. Certificate of the PCEE and Electrical Inspector of the Railway permitting energisation.
e. Certificate of completion of protective works from DOT/Telecom service provider e.g. BSNL etc. for energisation of OHE provided further that no such clearance shall be necessary in

cases of additions and alterations to traction installation on existing electrified routes where PCEE and EIG is satisfied that the amount and nature of traction energy transmitted in the system as a whole, will remain unaltered, provided further that in the event of DOT's delay in the issuance of the Completion Certificate, as per modified proforma 10.09 of ACTM Vol. II (Part—I),Railway Board's permission may be obtained in proforma 10.19.

The Senior Electrical Officer in-charge of the energization program will supervise the detailed sequence of operation to switch on25kV supply progressively, step by step, starting with 25kV feeders from the sub-station to the feeding post, busbars of the feeding post, followed by one sub-sector after another until the whole section is energized. It is best to start by keeping all circuit breakers and interruptors in the open position so that one after the other they may be switched on according to a prearranged program. The merit of this procedure is that a faulty subsector, if any, is immediately identified. Alternatively, the whole section covered by a sub-station may be energized at one go. Should the feeder circuit breaker trip, it will be necessary to identify the faulty sub-sector and arrange for its rectification. Before commencing energisation, certain essential staff should be kept ready at strategic locations enroute to rectify any faults which may be detected.

A short time after the energisation of OHE confirmatory tests for proper operation of the protective relays as per para 20931 shall be carried out.

21009 Introduction of services on Electric Traction:

Prior to introduction of services with Electric Traction on any section following certificates and documents are prerequisite and must be submitted to the Sanctioning Authority:

1. General safety certificate of works, signed by field level SAG/SG/JAG Officer directly incharge of the Railway Electrification works.
2. Safety Certificate for electrical works, signed by field level Electrical officer of SAG/SG/JAG rank from the organization undertaking the electrification works and counter signed by PCEE (Open Line) in acceptance thereof.
3. Safety Certificate in respect of electric rolling stock signed by PCEE,PCME, PCOM, PCE&PCSTE of the Open Line Railway.
4. Certificate issued by divisional officers and countersigned by DRM as per Proforma 10.05
5. Copies of Station Working Rules which have been distributed to the various Station Masters.
6. List of Questions and answers as per Profoma 10-27 FORM – XV (Railway Board letter No. 2014/ CEDO/ORI/0/02 dated 28.01.2015.

1. CRS Sanction:-

Sanction is required from the CRS in respect of —

Introduction of electric traction for passenger services on any railway orsection of a railway.

2. Introduction of Electric traction in yard lines/loop lines/ sidings

a. For new as well as existing Yard Lines/ Loop Lines/ sidings, sanction for energisation of traction installations shall be obtained from EIG & section opened for goods traffic on electric traction.
b. In consideration of the application for sanction, for introduction of passenger traffic, CRS may at his discretion decide not to inspect the section prior to according the sanction.

3. Procedure for introduction of goods traffic on electric traction

A line once energized should not be left remunerative longer than is absolutely necessary. The Principal

Chief Electrical Engineer/ Manager in charge of the electrification should fix the date of commencement of goods operation on electric traction in consultation with the General Manager of the connected open line administration.

The General Manager may, if necessary, arrange to have inspection of the electrified line by responsible officers of the traffic, civil, electrical and S&T departments so that they may satisfy themselves that adequate facilities will be provided before commencement of goods operations on electric traction.

The GM shall satisfy himself that the minimum required maintenance infrastructure for sustaining goods operations safely and reliably is in place before according his approval.

21010 Inspection by CRS for the Introduction of Passenger Services on Electric Traction:

1. The inspection of the entire section will be carried out by CRS alongwith PCEE or his HODs, Chief Project Director(CPD)/RE alongwith the concerned Divisional Officers.
2. During this inspection CRS will particularly examine the safety and operational aspects, inspect the rule books, register in possession of staff and test the knowledge of the staff such as engineering gangs, substation staff, transportation staff at stations, cabin etc.

21011 Sanction of CRS for introduction of passenger services on Electric Traction:

Subject to the inspection being satisfactory, an "all concerned message" may be issued by the CRS communicating his sanction for the introduction of passenger services under electric traction.

After the receipt of CRS's sanction, passenger services may be commenced immediately.

21012 Anti-theft Energization

To over come the problem of copper wire thefts, it may sometimes be necessary to charge the conductors at 2.2 kV. Guidelines for such charging of OHE are given in the Appendix Vllto this Volume.

21013 Responsibility for Maintenance and Provisional Acceptance Certificate

1. When a long sections is under Electrification, shorter sub-sections are often energized as an anti-theft measure. Till such time commercial services are not introduced after CRS's inspection and sanction, the OHE and other power supply and switching installations shall be maintained by the construction organisation.
2. With the energization of the OHE and CRS's sanction and introduction of commercial services, all electrical equipment including sub-stations and all other connected equipment are deemed as having been taken over the Open Line of the Railway and thereafter the responsibility for operation and maintenance shall devolve on the Divisional Officers concerned.

However, in order to ensure that all works are completed by the construction organization, a specific "Handing Over" procedure may be evolved by openline PCEE, PCSTE &PCE to bring out left over work if any; to be completed even after introduction of commercial services. The construction organization shall have such work completed in a reasonable period.

3. A letter of "provisional acceptance" shall then be issued by the head of the Construction Organization to the various Contractors in respect of the equipment erected and handed over by them. Should the test results for any particular equipment or installation be unsatisfactory, an extension may be given to the Contractor to have the defects set right and to hand over the installation in good condition. When this has been done, a separate letter of acceptance shall be issued in respect of such equipment. The provisional acceptance certificate shall be jointly signed by the concerned Dy.

CEE of the Railway Electrification Organization and Sr. DEE (TrD) and Contractor's authorized representative.

21014 Contractor's Responsibility During Guarantee Period

1. This is defined by the terms of the contract. Normally, the Contractor of a "supply and erection" contract guarantees the satisfactory operation of all equipment and installations for a period of twelve months from the date of issue of "provisional acceptance certificate". The contractor provides the services of an experienced Engineer to maintain liaison with Officers of the Open Line and the Construction Organization and help in rectification of defects observed and investigation of serious breakdowns of equipment, and advise on the maintenance procedures. The contractor is expected to bear the cost of all modifications, additions and substitutions which may be considered necessary due to faulty materials, design or workmanship of the installations for which he is responsible.
2. Most of the heavy equipment for sub-stations, switching stations etc. are usually obtained from different manufacturers against a "Supply Contract". In such cases, the usual guarantee clause provides for suppliers responsibility for a period of 12 months from the date of commissioning or 18 months from the date of supply-whichever is earlier. A clear record should, therefore, be maintained of the dates of receipt of the equipment and the dates of energization of each equipment so that the period of responsibility of the Contractor is clearly defined.
3. It is essential for the Electrical Officers and Supervisors concerned to make a careful study of the contract documents so that appropriate action may be taken as circumstances dictate. In regard to the defects noticed during the guarantee period the procedure to be followed for reporting and investigation are described in the next para.

21015 Failure of Equipment After Commissioning and During the Guarantee Period

Although during this period the equipment is operated and maintained by the Open Line Railway Engineers, the procedure described below should invariably be followed to ensure that defects noticed during the guarantee period are rectified by Manufacturers under the Guarantee Clause.

1. Instructions issued by the manufacturers for operation and maintenance should be strictly followed by the Railway. If any modification is required, approval of the Manufacturers should first be obtained. The standard Guarantee Clause provides that the equipment shall be free from defects in material and workmanship during manufacture. The liability of the supplier in this respect is normally limited to the supply and installation of replacement parts, free of charge, and repair of defective parts noticed during normal usage of the equipment as also those, attributed to faulty design of the equipment. If the equipment becomes irreparable the supplier will have to replace the same in its entirety.
2. It is essential that any defect noticed is brought to the attention of the supplier without delay. A clear record of defects and deficiencies noticed shall he entered in a register by the Open Line Officer and the date of intimation to supplier recorded against each item.
3. When an equipment fails, the Sr.DEE shall first make an inspection of the equipment on the spot with the least possible delay along-with the representative of the Contractor. The presence of the Manufacturer's or Contractor's representative is essential and should be ensured during the joint inspection to avoid disputes later on. The defective equipment shall not be dismantled or disturbed except with the approval of, or in the presence of, the representative of the supplier, to avoid obliteration of any important evidence which could help in investigation of the defect. After the inspection, a joint report shall be prepared recording the relevant data such as-
   a. Full particulars of the equipment - date received and date commissioned.
   b. Full circumstances in which failure occurred.

c. Observations and tests made.
d. Probable cause that could lead to the failure.
e. Recommendations, long term and short term, for preventing such failures in future.

4. Should there be repeated failures of the same type, the cause of failure should be investigated intensively, taking all connected factors into account such as switching operations carried out, maintenance work done etc. These factors should be statistically analyzed. A report on the failure of the equipment should be sent promptly to the supplier of the equipment endorsing a copy to the COS, Inspection Agency, PCEE and RDSO.
5. In the case of works contracts, too, the same procedure should be followed.
6. According to the provision of the contract, in the event of design defects, the contractor's liability is not only limited to repair/replacement of the components/equipments affected; but also to all other components in similar situation/ condition even though they may not have failed in service, have to be replaced or modified by the supplier. This aspect needs careful study by the Sr.DEEs.

21016 History Sheet

Maintenance of a History sheet for each major equipment is very important as this will give a connected account of all failures of the equipment and particulars of repairs carried out and will be of great help in investigating recurring failures.

21017 Final Acceptance Certificate

Immediately after the completion of the guarantee period, a final acceptance certificate' shall be jointly signed by the Sr. DEE of the concerned Railway and Contractor's representative and countersigned by the head of the construction Organisation and issued to the Contractor, provided that the terms of the Guarantee Clause have been fulfilled. With the issue of the final acceptance Certificates, the responsibility of the Contractor or Supplier ceases, but their advice may still be sought where it may be considered necessary.

21018 Standard Forms

Typical forms for issue of notifications and certificates mentioned below are appended at the end of this chapter.

SN	Particulars	Proforma
1.	Public Notification regarding energisation	10-01
2.	Public Notification regarding level crossing	10-02
3.	Joint Certificate regarding OHE by Sr. DEE(TrD) & Dy. CEE(OHE)/RE	10-03
4.	Certificate regarding bonding and earthing	10-04
5.	Joint certificate by Divisional Officers countersigned by DRM regarding safety procedure, etc.	10-05
6.	Certificate by DRM regarding safety measures	10-06Proforma deleted since necessary items are included in revised proforma (10-05)
7.	Sanction of PCEE and Electrical Inspector for energisation	10-07
8.	Certificate by S&T Department	10-08
9.	Certificate in respect of completion of works from DOT	10-09
10.	Clearance Certificate for 25 KV feeder line	10-10
11.	Clearance Certificate for OHE	10-11
12.	Clearance Certificate for Switching Station	10-12
13.	Completion certificate for booster transformer Station.	10-13Proforma deleted

SN	Particulars	Proforma
14.	Clearance Certificate for DOT and works	10-14 Proforma deleted and its contents included in proforma (10-08)
15.	Clearance Certificate by OHE Contractor	10-15
16.	Clearance Certificate by Switching Station Contractor	10-16
17.	Clearance Certificate by Remote Control Equipment Contractor	10-17

For Introduction of Electric Traction :

1. 25kV ac charging of section for Railway electrification work for existing lines / New lines / Gauge conversion lines / Doubling / Multiple lines & Energisation of any High Tension installation in this regard shall be done with the approval of Electrical Inspector to Govt. Of India (EIG) as laid down in Indian Electricity Act 2003.
2. The competent authority to grant sanction to open the section with electric traction for above mentioned work shall be PCEE of Zonal Railway with no further delegation.

Proforma 10-1

INDIAN RAILWAYS

"PUBLIC NOTIFICATION"

Notice is hereby given to all users of Railway lines and premises situated on the completed section of the under- noted section of the ..... Railway that the 25000 Volt, 50 Hz., ac overhead traction wires will be energized on or after the date specified against the section. On and from the same date the overhead traction line shall be treated as live at all times and no unauthorized person shall approach or work in the proximity of the said overhead line.

Section Date

1

2.

3.

4.

Chief Project Director

Railway Electrification

(To be published in all the leading Newspapers and local Railway Gazette in English, Hindi and local language for one day at least a week before the date of commissioning. Also notices to be pasted at all Railway Stations and Offices to give wide publicity).

Copy forwarded for information to:-

1. The Secretary (Railway Electrification), Railway Board, New Delhi.
2. The Commissioner of Railway Safety.
3. The Principal Chief Electrical Engineer and Electrical Inspector.
4. All other Heads of Departments.
5. The Divisional Railway Managers of the Railway and contiguous Divisions.

6. The General Manager (DOT) Railway Electrification Project,
7. The PostmasterGeneral,
8. The Chief Engineer, State Electricity Board.
9. The Superintendent, Government Railway Police.
10. All officers of Construction Organisation.
11. Contractors engaged in the project.

Place: Chief Project Director

Date Railway Electrification

Proforma 10-02

INDIAN RAILWAY

INTRODUCTION OF ac 25 kV TRACTION

"WARNING TO ROAD USERS"

It is notified for information of the Public that in connection with introduction of 25 kV ac electric traction over the section ..... of the ..... Railway, height gauges have been erected at all the level crossings with clear height 4.78 m above road level with a view to prevent loads of excessive height from coming into contact or dangerous proximity to live traction wire (contact wire), which shall be at a height of minimum 5.5m above the rail level at level crossings.

Public are hereby notified to observe the height specified above for the purpose of loading vehicles and to see that the loads carried in road vehicles do not infringe the height gauges under any circumstances.

The dangers of a load of excessive height are as follows: -

i. Danger to the height gauge and consequent obstruction to the road as well as the railway line.
ii. Danger to the materials or equipment carried or the vehicle itself.
iii. Danger of fire and risk of life due to contact with or dangerous proximity to the conductors.

No.

Date Chief Project Director

Railway Electrification

(To be given wide publicity through the press and posters well in advance of erection of height gauges).

Proforma 10-03

CERTIFICATE REGARDING OHE

Certified that the OHE in the above mentioned section has been erected as per approved and standard specifications and there are no infringements to the Schedule of Dimensions (including the Rules applicable for 25 kV ac traction) except when approval of Railway Board/competent authority has been obtained. The OHE has been inspected and found to comply with the above requirements.

Sr. DEE (TRD) Dy. CEE(OHE), RE

Place:

Date

Proforma 10-04

CERTIFICATE REGARDING BONDINGAND EARTHING

Certified that bonding and earthing of the section have been carried out as per the "Bonding Code" and as per approved drawings.

Dy.CSTE(Signalling) Sr. DEE (TrD) Dy.CEE(OHE), RE

Proforma 10-05

CERTIFICATE REGARDING SAFETY PROCEDURES AND PRECAUTIOINARY MEASURES FOR STAFF

Description of section to be electrified:

.....

It is hereby certified that :

1. Each station and cabin in the electrified sections Between _____ and _____have been supplied with a copy each of General and subsidiary Rules and special working rules for 25 kV a.c. electric traction.
2. All staff including running and maintenance staff have been made fully conversant with the safety procedures and precautionary measures laid down in the General and subsidiary rules and special working rules for 25 kV a.c. electric traction and the manual for a.c traction maintenance and operation to be observed while working in the electrified section.

3. Necessary instructions in connection with safety procedures and precautionary measures to be observed while working in a section provided with 25 kV a.c. traction system have been issued to all categories of staff including running and maintenance staff of the various departments working in and required to work in the electrified section.
4. The assurance of all the sectional running and maintenance staff in regard to their having adequate knowledge of safety procedures and precautionary measures to beobserved while working in 25 kV a.c. electric traction system has been obtained from them individually.

Sr. DOM	Sr.DSO/DSO	Sr.DEN	Sr.DME
Sr. DSTE	Sr.DEE (G)	Sr.DEE (TRD)	

Countersigned

Divisional Railway Manager

_____Division

_____Railway

Proforma 10-06 (Deleted vide correction slip 3)

Proforma 10-07

.....Railway

To,

Chief Project Director
Railway Electrification

Sub: Sanction for energization of overhead equipment, switching stations. booster transformer stations etc. on the Section. .....

Sanction is hereby accorded to energize progressively the completed works for 25 kV feeder lines from traction Sub-stations to feeding posts, switching stations, booster transformer stations and auxiliary transformer stations, as and when each section is completed arid jointly inspected, measured IR value and certified by Sr.DEE(TrD)/ ..... and DY.CEE (Construction).

Principal Chief Electrical Engineer

and Electrical Inspector,

..... Railway.

Proforma 10-8

Chief Project Director
Railway Electrification

Reg : Energisation of OHE in the section ----------Signalling &Telecommunication (S & T) works.

1. All modifications to mechanical and electrical signalling have been carried out to make the installations suitable for introduction of 25 kV a.c. traction. The overhead signalling circuits have been transferred to underground cables.
2. Colour light signals as well as new signals have been installed at _____ stations and the mechanical semaphore signals have been re-sited without infringing the schedule of dimensions except where approval of Railway Board/competent authority has been obtained so as to afford necessary visibility to the locomotive crews.
3. The existing block and token instruments have been modified to suit the introduction of 25 kV a.c. traction.
4. All telecommunication installations and circuits have been modified to make them suitable for introduction of 25 kV a.c. traction. The traction Loco Control, Traction Power Control and Emergency Control circuits have been introduced with emergency telephone sockets alongside the track as per approved plans.
5. The tools as prescribed by the Principal Chief Signal & Telecommunication Engineer of the Railway have been issued to the S & T staff working in the above section.
6. All S & T staff have been warned that the above section would be charged at 25 kV a.c. immediately. No work on or within 2 metre of the live OHE would be carried out hereafter without obtaining power block from an authorised official of the Sr. DEE/TRD.
7. All safety procedures and precautionary measures necessary have been taken in accordance with the 'Manual for a.c. Traction Maintenance and Operation' and
8. The above section may be energised at25 kV a.c.

Dy. CSTE/RE

Proforma- 10-09

COMPLETION CERTIFICATE

Chief Project Director,
Railway Electrification

SUB: Energisation of overhead equipment in the section --------

The DOT has completed all its works including protective works required in connection with electrification of the above section at 25 kV ac 50 Hz and has no objection to the Railway energizing the OHE at 25 kV a.c.

For General Manager
(Electrification Circle)

Proforma 10-10

CLEARANCE CERTIFICATE FOR ENERGIZATION ON 25 kV

1. 25 kV Feeder Lines

1. Detailed description of installation to be energized:

25 kV double circuit feeder line from... substation to..... feeding station near the tracks.

2. It ishereby certified that:
   a. The above installation has been jointly checked tested for completeness, electrical clearances, insulation resistance, earthing etc. and found in order. Test results are separately submitted.
   b. The works have been completed in accordance with approved and complies in all respects with the requirements of the "Manual of ac Traction Maintenance and Operation", Indian Electricity Rules and special instructions on the subject.
   c. All our staff have been withdrawn and warned that the line will be charged at 2.5 kV ac immediately. Clearance Certificate to the same effect have been obtained from all the Contractors working on the above section. No work on the above section will be taken up hereafter without obtaining a power block from an official authorized by Sr. DEE (TrD).
   d. All other safety precautions necessary have been taken.

3. The 25 kV feeders referred to above are now clear and fit for energization and may be energized at 25 kV ac.

4. Forwarded to CEE(RE).

....

Sr. DEE (TrD) DY.CEE (OHE)RE

PLACE.

Date.

Proforma 10-11

CLEARANCE CERTIFICATE FOR ENERGIZATION ON 25 kV

2. Overhead Equipment

1. Detailed description of overhead equipment to be energized:

2. It is hereby certified that:
   a. The above overhead equipment has been jointly checked for completeness, electrical clearances and tested for insulation and continuity, electrical independence of different elementary sections as also bonding and earthing etc. and found to be in order.
   b. The work has been completed in accordance with the latest approved generally supply diagram and sectioning diagrams etc. and complies in all respects with the requirements of "Manual of ac Traction Maintenance and Operation" and Indian Electricity Rules.

c. All our staff have been withdrawn and warned that the line will be charged at 25 kV ac immediately. Clearance Certificates to the same effect have been obtained from all the Contractors working on the above section. No work on the above section will be taken up hereafter without obtaining a power block from an official authorized by SR.DEE (TrD).

d. All safety precautions necessary have been taken. In accordance with "Manual for ac Traction Maintenance and Operation" Sections viz ..... have also been adjusted, checked and made ready for energization. Solid earths have also been provided on contiguous sections viz. at structures Nos ..... Isolating switches Nos ..... and interruptors Nos ..... have been opened and kept locked in the open position.

3. The overhead equipment referred to above is now clear and fit for energization and may be energized at 25 kV ac.

4. Forwarded to CEE(RE).

.....
Sr. DEE (TrD)
PLACE .....
Date .....

.....
Dy.CEE(OHE),RE

Proforma 10-12

CLEARANCE CERTIFICATE FOR ENERGIZATION ON 25 kV

3. Switching Stations

1. Detailed description of switching stations to be energized:
   a. The above switching stations have been jointly checked and tested for completeness, correct electrical connections including cross-feeder connections, electrical clearances, insulation resistance, earthing and bonding etc. and found to be in order. Test reports are separately submitted.
   b. The works have been completed in accordance with approved drawings and complies in all respects with the requirements of the "Manual for ac Traction Maintenance and Operation", Indian Electricity Rules and special instructions on the subject.
   c. All our staff have been withdrawn and warned that the line will be charged at 25 kV ac immediately. Clearance Certificate to the same effect have been obtained from all the Contractors working on the above section. No work on the above section will be taken up hereafter without obtaining a power block from an official authorized by Sr. DEE (TrD).
   d. All other safety precautions necessary have been taken.
2. The switching stations referred to above arenow clear and fit for energization on 25 kV ac.
3. Forwarded to CEE(RE).

.....
Sr. DEE (TrD)

.....
Dy.CEE(PSI),RE

PLACE. .....
Date.....

Proforma 10-14

(Proforma deleted and its contents included in proforma (10-08) via ACS-3)

CLEARANCE CERTIFICATE FOR ENERGIZATION ON 25 kV

5. DOT and S&T WORKS

1. Description of section for which clearance is given:
2. It is hereby certified that:-
   a. Clearance has been obtained from the DOT, Electrification Circle that the overhead equipment, switching and booster transformer stations on the above section may be energized at 25 kV. ac.
   b. All S & T works have been completed in accordance with approved and instructions, and complies in all respects with requirements of "Manual for ac Traction Maintenance and Operation" and special instructions.
   c. All our staff have been warned that the above section would be charged on 25 kV ac immediately. No work on or within 2 m of the line OHE would be parried out hereafter without obtaining a power block from an official authorized by SR.DEE (TrD).
   d. All safety precautions necessary have been taken, in accordance with "Manual for ac Traction Maintenance and Operation".
3. The sections referred to above may now be energized on 25 kV ac.

.....

Dy.CSTE(Sig.

.....

DY.CSTE (Tele)

PLACE.....

Date.....

Proforma 10-15

The DY.CEE (OHE) .

..... Electrification Project

.....

Sub: Clearance Certificate byContractor for energization on 25 kVac in Section..

Dear Sir,

1. It is hereby certified that all our work on the above section has been completed.
2. It is hereby certified that all our staff have been withdrawn and warned that the above section would be energized on ..... and that no one may henceforth carry out any work on the above section without obtaining a permit-to-work from an official authorized by SR.DEE (TrD).
3. Adequate precautions will also be taken by our staff when working in areas contiguous to the section electrified on ac 25 kV system or on parallel lines.
4. The dead overhead sections contiguous and adjacent to the electrified sections have been and will be

kept solidly earthed. The installations onthe above section are now ready and safe for energization. They may nowbe charged at 25 kV ac, 50 Hz, supply.

Yours faithfully,

for M/s .....

Contractor for OHE.

Proforma 10-16

To

Dy.CEE(PSI),

.....Electrification Project,

.....

Dear Sir,

Sub: Clearance Certificate for energization of Switching Stations in Section .....

It is certified that all physical works have been completed on the following FPs, SPs, & SSPs and that these switching stations are fit to be charged with 25 kV ac single-phase, 50 Hz., electrical energy on and from .....

All men, materials and earths have been removed from the switching stations and the OHE.

FP at.....

SP at.....

SSP at.....

Yours faithfully,

for M/s .....

Contractor for Switching Stations

Proforma 10-17

To

DY.CEE (PSI),

..... Electrification Project,

.....

Dear Sir,

Sub: Clearance Certificate for the commissioning of Remote Control Equipment in the Section.

It is certified that all works in regard to the Remote Control Equipment installed by us for the section..... have been completed and that they are fit for commissioning.

All men and materials have been removed from the site of the equipment and from the vicinity of the switching stations.

Yours faithfully,

Date

for M/s ..... Contractor for Remote Control Equipment.

Profarma 10-19

FORM XV - I, XVI & XVII

(See rule 5(3-42,43 & 59), 5(4), 5(5) and Chapter VII of the Railways Opening for Public Carriage of Passengers Rules, 2000)

GENERAL SAFETY CERTIFICATE

(As per sub Para 2(a) or Para 21009 of ACTM)

Description of Work:

SECTION	CHAINAGE	
	FROM	TO

We do hereby certify that in the work mentioned above: -

1. There is no infringement to the schedule of dimensions due to OHE/signal structures (or the sanction of Railway Board regarding infringement of schedule of dimensions due to OHE/Signalling structures has been obtained, as the case may be).

Infringement of maximum and minimum dimensions (Form XVII) Rule 5(5).

SN	Location (Divn, section and Kms.)	Name of structures which infringe	Prescribed maximum and minimum dimensions	Existing actual dimensions	Amount of infringement	Particulars of sanctions to infringement and Remarks

2. All the works have been carried out in accordance with the standard drawings,designs and specifications.
3. Masts/structures are such as per prescribed norms.
4. The signalling/interlocking/block signalling has been carried out in accordance withsignaling and interlocking plan and the requirement laid down in the manuals orinstructions for the installation and maintenance of signalling, interlocking and block signaling apparatus have been fully complied with.
5. The work has been carried out in accordance with the provisions of the AC TractionManual.

We hereby certify that the section has been carefully inspected and tested. It is also certifiedthat the above work has been properly completed and is in good working order. The workcan be opened for

public carriage of passengers and goods traffic without endangering thesafety of the traveling public or of the employees of the Railways.

	CEE (Const.)	CSTE (Const)
OR	Dy. CEE/RE	Dy. CSTE/RE

Countersigned by CPD OR CEE (lncharge of Project)

Proforma-10-20

Form XV-2

(See rule 5(3)(59) and Chapter VIII of the Railways Opening for Public Carriage of Passengers Rules, 2000)

CERTIFICATE FOR ELECTRICAL WORKS

(As per sub Para 2(b) of Para 21009 of ACTM)

SECTION	CHAINAGE	
	FROM	TO

It is certified that: -

1. Adequate arrangements have been made to warn the public regarding the dangers ofcoming in contact with live overhead equipment within the Railway premises.
2. The design of steel structures of overhead equipment complies with the IndianElectricity Rules. The wind pressure of ……. has been adopted for the sectionand wind pressure of…… has been adopted at Bridges.
3. Bonding of rails by means of mild steel flats has been done at various locationswhere public or Railway Staff come frequently in contact with the rails. Trackbonding is done in accordance with the "Code for Bonding & Earthing" as laid downin the ACTM.
4. All the traction structures and other structures to which the OHE is attached are alsobonded to the rails in accordance with the "Code for Bonding & Earthing" referred toabove.
5. The overhead lines and underground cables crossing the railway tracks are inaccordance with the "Regulations for Electrical crossings of Railway Track" andthe crossing plans as approved by Railways' Principal Chief Electrical Engineer who is alsothe Electrical Inspector for such installations.
6. There are no Railway structures carrying 25 KV live conductor outside the Railways'premises in the above section.

7. The height gauges have been provided, so that no part of any road vehicle or its loadcomes in contact with live overhead equipment and have adequate clearances oneither side of Railway premises at level crossings.
8. The height gauges are provided with Danger Boards and clearance above road level maintained as per ACTM.
9. No unauthorized cables/wires are crossing the Railway tracks.

CPDORCEE
(lncharge of Project)

Principal Chief Electrical Engineer,
Open Line Railway

Proforma-10-21

---------- RAILWAY

JOINT SAFETY CERTIFICATE NO.SLC/BG/01/2004

Certified that it is safe to run …… Class of locomotive, single or coupled, having maximum axle load …… atthe maximum speed and on the section given in the table below. The maximum permissible speed as certified by RDSO is given injuxtaposition.

SN	Class of locomotives & Drawing Nos.	Section		K.M.		Existing permissible speed of the section (KMPH)	Proposed permissible speed (KMPH)	Maximum permissible speed certified by RDSO in (KMPH)	Speed restriction (permanent & temporary)	Reason for Speed restriction	Remarks
		From	To	From	To						
1	2	3	4	5	6	7	8	9	10	11	12

Principal Chief Signal & Telecom Engg.Railway
Principal Chief Mechanical EngineerRailway

Principal Chief Operating Manager Railway
Principal Chief Electrical Engineer Railway

Principle Chief Engineer Railway

Proforma-10-22

FORM X

(See rule 5(1)(j) of the Railways Opening for Public Carriage of Passengers Rules, 2000)

BRIEF PARTICULARS OF TRACTION INSTALLATION
(Sample)

Section:	Tundla-Delhi	North Central Railway
Length:	292RKM	Gauge 1676 mm

1. Total track kms electrified section - 650
2. Brief particulars of traction system: -

The type of Over head Equipment installed on main line of the section is of the simple polygonal type with swiveling brackets having tensions in the conductors regulated automatically. The tension in the catenary and contact wire is kept as 1000 kgf each. The contact wire has been given a pre sag of 103 mm for a span of 72 m (suitably reduced for smaller spans). On secondary lines and yards, the Over Head Equipment is of fixed type and unregulated. The contact wire is grooved hard drawn copper with 107 sq. mm cross section supported by means of copper droppers from catenary which is stranded (1982.10 mm) with 65 sq. mm cross section made up of cadmium copper having 80% conductivity. The maximum wind pressure for design of masts and foundation has been taken …….kg/sqm. Maximum span adopted on main lines is 63 m. The Over Head Equipment has been designed for a maximum speed of 160 km/h.

The power supply is taken from UPSEB at a single point viz. Aligarh from where railways run their own transmission lines, for feeding the Sub Stations located at Hathras, Khurja and Sahibabad. At each of the sub stations two power transformers 12.5 MVA, 132/25KV are installed, one of them acting as standby. Standard arrangement of having neutral of normal/short PTFE type have been provided at the sectioning post between two substations for separation of phases. For sectioning and isolating facilities, sub sectioning and paralleling posts have been provided. All the switching operations at power supply stations are remote controlled from a single remote control center located at Tundla. The RCC/SCADA system has been provided by …… (Manufacturer) and is of ..... Type (Microprocessor/PC based). The same will be commissioned by …… (Target date, if not commissioned at the time of making application to CRS).

CPD or CEE (Incharge of Project) OR Chief Electrical Engineer/Const, Open Line Railway

Proforma-10-23

FORM XI

(See rule 5(1)(k) of the Railways Opening for Public Carriage of Passengers Rules, 2000)

POWER SUPPLY INSTALLATION ABSTRACT

SECTION: RAILWAY

LENGTH: ……. KM GAUGE: ……mm

SN	Type of Switching Stations	Total Nos	Location and Nearest railway Stations	Remarks
1	2	3	4	5
1	Traction substation and feeding stations			
2	Sectioning and paralleling station			
3	Sub-sectioning and paralleling stations			
4	Sub-sectioning stations			
5	Booster transformer stations		(List to be attached)	
6	LT Supply transformer stations		(List to be attached)	

CPD or CEE (Incharge of Project) OR Chief Electrical Engineer/Const, Open Line Railway

Proforma-10-24

FORM- XII

(See rule 5(1)(1) of the Railways Opening for Public Carriage of Passengers Rules, 2000)

MAINTENANCE DEPOT ABSTRACT

SECTION: RAILWAY

LENGTH: ……. KM GAUGE: ……mm

SN	Location	Name of the nearest Railway stations and distance there from	No. of OHE maintenance car (tower wagon) and emergency road vehicles provided	Remarks
1	2	3	4	5

CPD or CEE (Incharge of Project) OR Chief Electrical Engineer/Const, Open Line Railway

Proforma-10-25

FORM XIII

(see rule 5(1)(m) of the Railways Opening for Public Carriage of Passengers Rules, 2000)

RESTRICTED OHE CLEARANCE ABSTRACT

SECTION: RAILWAY

LENGTH: ……. KM GAUGE: ……mm

1. Overline Structure

SN	Location of Over line Structure	Type of Structure	Clearance from R.L. to Bottom of Structure	Height of contact wire below the structure	Whether Catenary is anchored or Freely Running Below/Above the Structure	Minimum static Clearance between 25 KV Live Parts & Earth	Remarks
1	2	3	4	5	6	7	8

2. Location of OHE where specified (2.0 m) working clearance are not available

SN	Location	Type of nearest earthed part	Actual distance between live part and earth	Remarks
1	2	3	4	5

CPD or CEE (Incharge of Project) OR Chief Electrical Engineer/Const, Open Line Railway

Proforma-10-26

FORM XIV

(See rule 5(1)(n) of the Railways Opening for Public Carriage of Passengers Rules, 2000)

ELECTRICAL CROSSING OVER ELECTRIFIED TRACKS ABSTRACT

SECTION: RAILWAY

LENGTH: ……. KM GAUGE: ……mm

SN	Location	Brief Tech. Particulars including Voltage	Owned by	Whether with guards or w/o guards	Whether clearance as per regulation for Electrical crossing available	Remarks
1	2	3	4	5	6	7

CPD or CEE (Incharge of Project) OR Chief Electrical Engineer/Const, Open Line Railway

*****

21100 2x25 kV Auto-Transformer Feed System

BRIEF DESCRIPTION OF THE 2 X 25 kV SYSTEMS.

The incoming power supply scheme is similar to 25 kV simple feed system. Power supply for ac traction is obtained from the nearest grid sub-station of the Power Supply Authority. For this purpose duplicate feeders, generally at 132 kV or 22OkV, comprising only two phases are provided from the grid sub-station to traction substation.

The loads, however, are 2-3 times higher compared to 25 kV system and therefore Wood-bridge/V-connected transformers are provided in the traction substations to bring down the unbalance within acceptable limits. It is possible to absorb such unbalances without exceeding the permissible limits if the grid system capacity is adequate.

In 2x25 kV system, power is fed from the TSS at 50 kV and utilization is achieved at 25 kV by providing Auto-transformers of adequate capacity and by providing one additional conductor normally referred as feeder wire (similar to the return conductor in BT/RC system). Centre point of the Auto Transformer is connected to the earth/Rail. This arrangement facilitates +25 kV Voltage between OHE and rail and -25 kV voltage between earth/Rail and the Feeder Wire.

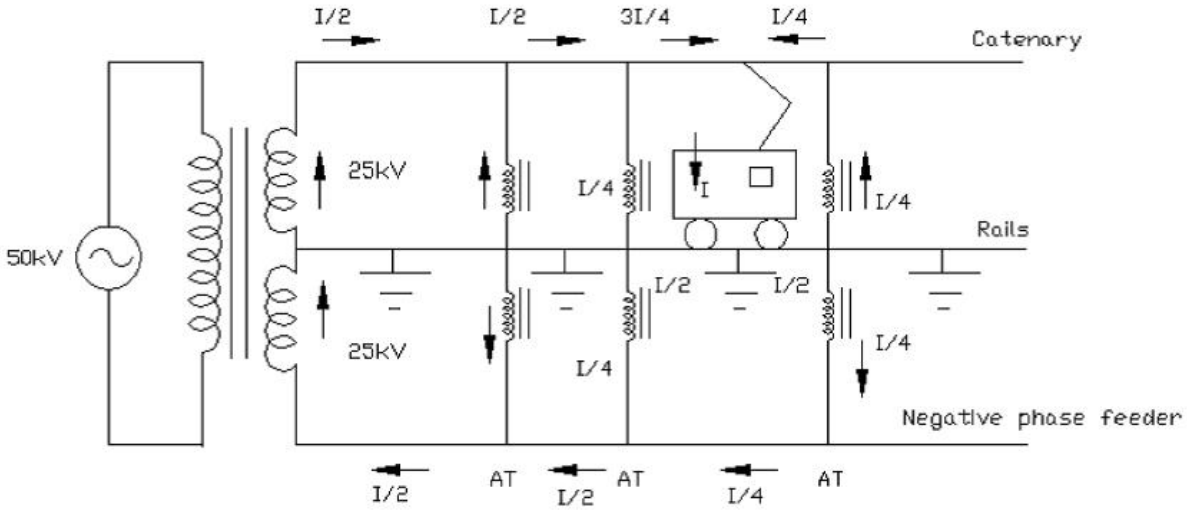


Figure:1

Advantage of 2X25kV system:-

1. The 2X25 kV AT feeding system is suitable to meet larger power supply needs with the inherent advantage of less voltage drop in feeder circuit for a given spacing of traction substations. To meet the larger power supply requirements, 2X25kV system is used in various countries including DFCCIL in India.

2. Power is generally obtained from 220 kV or 132 kV three phase networks from the power utility to reduce voltage unbalance on the transmission network. In the 2X25kV TSS, the three phase supply is utilized at the Traction Sub-station.
3. The 2X25 kV Auto Transformer (AT) system is having feeding voltage of 50 kV from the substation which is dropped to 25 kV by the AT installed at about 10 to 18 Km spacing along the track for supply to overhead equipment and rolling stocks. A pilot project for this system was provided in Bina-Katni Section. The design of the system was done with the help of Japanese Consultants.
4. Better voltage regulation even at higher load currents.
5. Minimized rail currents resulting in reduction in rail potential rise. Return current through ground also reduces considerably.
6. In 2X25kV system, the return current flows through the feeder wire. Since the direction of current in the feeder wire is opposite to the direction of current in the catenary wire, it minimizes the effect of the electromagnetic Interference in the proximity of the traction line.
7. Preferred solution across the globe to meet higher power requirement for Traction Purpose.

Schemes proposed for 2X25kV System along with various Transformers

Scott Connected Transformer Scheme:

1. In this scheme two Scott connected Transformers & four Auto-transformers are to be installed at a TSS along with associated switchgear for Control & protection. The two windings of a Scott transformer i.e. Main and Teaser windings are of equal power rating and feed either side of the TSS independently. The supply of both the windings is at a phase difference of 90 degree and separated by neutral section provided near TSS. Out of two Scott transformers, only one is in operation and the other is on standby.

2. Scott Connected Transformer:

Scott- connected transformer of 60/84/100 MVA (ONAN/ONAF/OFAF) is used to feed power to the traction system. It has a voltage input of 220kV or 132kV, 3 phase, 50 Hz and two independent secondary winding for output at 50 kV. The Transformer has two secondary windings, known as the main winding and teaser winding. The two windings are identical in voltage and current rating but are in phase difference of 90 degree. These two windings of equal power rating i.e. Main & Teaser windings, feed power on either side of the TSS. The feed of different phase is separated by neutral section provided near TSS. The Scott Connected Transformer in ONAN Mode shall feed the 30MVA Power to each side of the TSS.

2x25 kV AUTO TRANSFORMER FEED SYSTEM TRACTION SUBSTATION

(SCOTT CONNECTION TYPE)

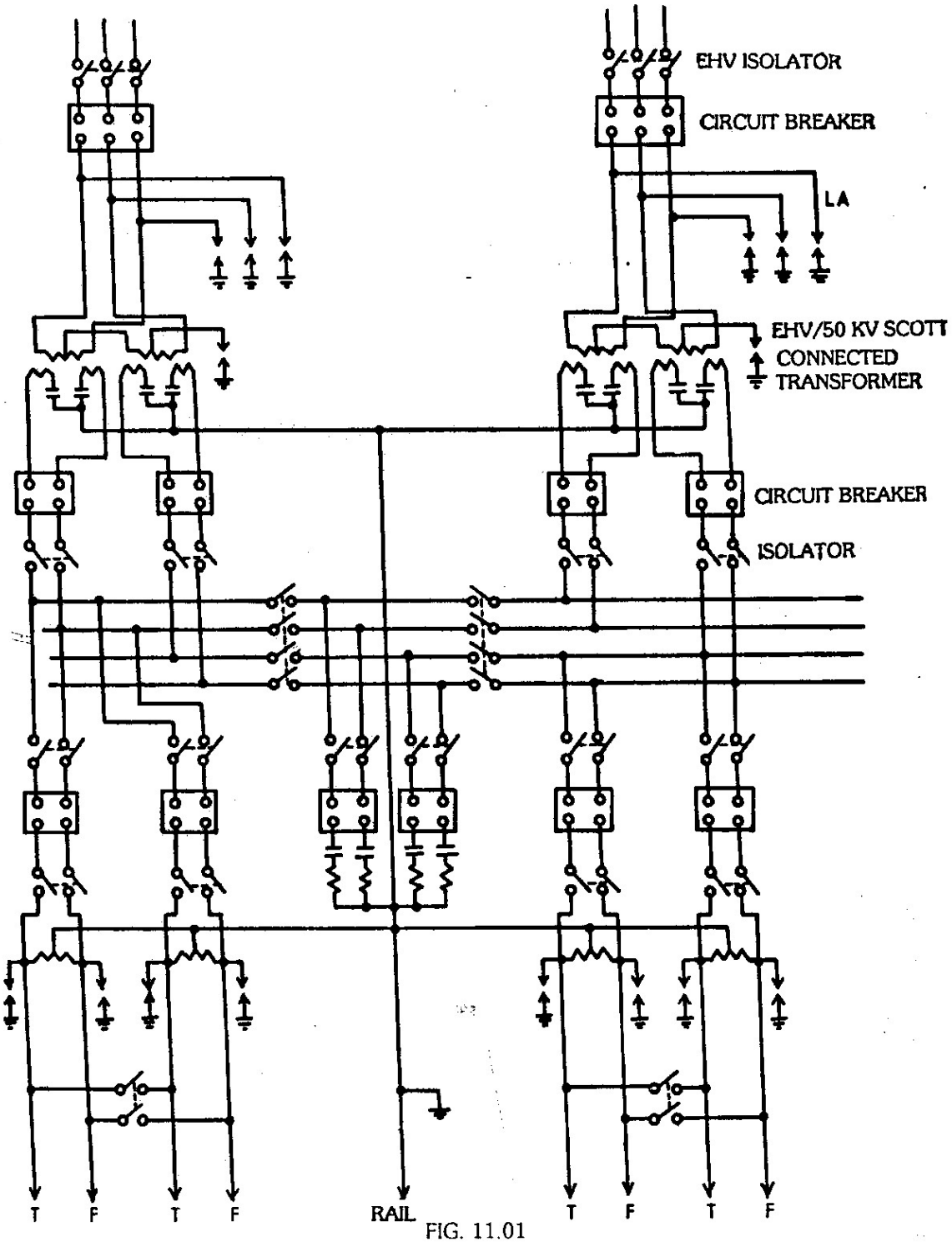


FIG. 11.01

3. Auto Transformers:

Auto- transformers are used at TSS, SP and SSP. The transformer winding of 50kV with Centre tapped neutral with both the terminals of the Autotransformer winding connected to feeder and contact / Catenary wire. The neutral terminal of the ATs is connected to rail.

Two adjacent ATs feeding on the network share train loads on the section between them and transfer the load current on 25 kV circuit to 50 kV circuit, consisting of contact wire and AT feeder. This reduces the voltage drop on feeding network remarkably. Furthermore, it minimizes the return current on the rail, which results in reducing induced voltage on nearby telecommunication lines.

In the Scott connected arrangement for 2 Line section, 12.3 MVA Auto transformers are to be installed at the TSS and 8MVA Auto transformers to be used at the SP & SSP, as adopted by DFCCIL in Western Corridor. Further, the Scott connected arrangement for 3 Line and 4 line sections have been provided with 12.3 MVA auto transformers at TSS and 16.5 MVA auto transformers at SP/SSP. Moreover, no independent AT post has been proposed in any scheme.

4. V Connected Transformer Scheme:

In this scheme, three single phase transformers are connected to different pairs of three phase of incoming supply forming an open delta connection on the primary side. Out of the three single phase transformers, first transformer feeds the OHE on one side of the TSS, second transformer (mid one) remains as standby and third transformer feeds the OHE on the other side of the TSS. The power supply on either side of TSS is at a phase difference of 120 degree and therefore separated by a neutral section provided near TSS.

5. V- Connected Transformer:

In the above arrangement, three 38/53/63 MVA (ONAN/ONAF/OFAF) Transformers are provided at TSS along with associated switchgear for Control and Protection. Each single phase transformer has a voltage input of 220kV or 132kV, 50 Hz and two independent secondary windings, to be connected externally in such a manner (two inner terminals of these secondary windings are connected with each other and also connected to earth/Rail) so as to give an output voltage of 2X25kV. The outer terminals of the windings are connected to Feeder wire and overhead contact/catenary wire respectively. Two transformers shall be in operation at a time and one shall be on standby. In the V connected Scheme, each transformer in ONAN mode shall feed the 38MVA Power in either side of the TSS.

6. Auto Transformers:

i. Auto- transformers are used at SP and SSP. The transformer winding is 50 kV with Centre tapped neutral with both the terminals of the winding connected to AT feeder and the contact wire. The neutral terminals of the ATs are connected to rail.

ii. Two adjacent ATs feeding on the network share train loads on the section between them and transfer the load current on 25 kV circuit to 50 kV circuit, consisting of contact & catenary wire and AT feeder. This reduces the voltage drop on the feeding network remarkably. Furthermore, it minimizes the return current on the rail, which results in reducing the induced voltage on nearby telecommunication lines.

iii. Auto transformers are not used at the TSS. However, these have been provided at SP/SSP of 16.5 MVA capacities. Moreover, no independent AT post has been proposed.

7. Scott connected vs V Connected Scheme

i. Considering the three phase utilization equally in the Scott Connected scheme, it is better in reducing the unbalancing at point of common coupling with the utility as compared to V-Connected scheme. The point of common coupling is already defined in the clause no. 2.2 of RDSO Instruction no. TI/IN/0019 (09/09).

ii. The Voltage Unbalance in Scott Connected Transformer Scheme is least and therefore the Railways should preferably provide Scott Connected Transformer wherever the voltage unbalance problem is seen. The detailed study regarding this is available in clause no. 2.1.13 of Chapter 1, Part-II in Volume-1 of Treatise on Electric Traction Distribution, which can be readily referred (page no. 125 of Volume-1).The problem of unbalancing has been raised by few power utilities and therefore Scott or V connected arrangement should be chosen judiciously after coordinating with the power utilities.

iii. Scott Connected Transformer is more complex and costlier than the V connected Transformer but Scott connected Transformer effectively checks the voltage unbalance.

iv. Initially, in Bina-Katni Section of IR, the Scott Connected Transformers were imported; however, Transformers for V connected scheme were supplied by an Indian Manufacturer.

v. The maintenance/Overhauling of the Scott Connected Transformer is more complex in comparison to Single Phase Transformer. V connected scheme is economical in comparison to Scott Connected scheme.

vi. Since, no AT is to be used at the TSS of V connected scheme; it is simpler than Scott Connected scheme.

8. Utilisation of Scheme:

Considering the complexities involved of the unbalancing (as deliberated under Para 4.3 above), space constraints and other site problems, the Scott connected or V connected arrangement may be chosen by the Zonal Railways after coordinating with the power utilities and with the approval of PCEEs.

9. Spacing of the TSS & Switching post (SP/SSP):

Two-line section – Considering the load requirement of 0.5MVA/TKM in ONAN mode on the main line section, the spacing of TSS in Scott connected scheme of 60-70 Km is suggested. In the proposed V connected scheme, the transmission of full power from the transformer is not at 50 kV and therefore the spacing of the TSS in V connected scheme for 2 Line system has been kept same as in Scott connected scheme i.e. 60-70 KM with power requirement of around 0.6MVA/TKM in ONAN mode.

Three line sections – In the 3 Line section, the loading in MVA/TKM basis will be less than the 2 line system as all the three lines will not be fully loaded at a time. Therefore, the load requirement of around 0.4 MVA/TKM in ONAN Mode for 3 Line section has been considered and accordingly the spacing of TSS in Scott connected scheme is suggested as 50-60 KM. In the proposed V connected scheme for 3 line, the transmission of full power from the transformer is not at 50 kV and therefore the spacing of the TSS in V connected scheme for 3 Line system has been kept same as in Scott connected scheme i.e. 50-60 KM with power requirement of around 0.5 MVA/TKM in ONAN mode.

Four line section– In the 4 Line section, the loading in MVA/TKM basis will be less than the 3 line system as all the four lines will not be fully loaded at a time. Therefore, the load requirement of less than 0.4 MVA/TKM in ONAN Mode for 4 Line section has been considered and accordingly the spacing of TSS in Scott connected scheme is suggested as 40-50 KM. In the proposed V connected scheme for 4 line, the transmission of full power from the transformer is not at 50 kV and therefore the

spacing of the TSS in V connected scheme for 4 Line system has been kept same as in Scott connected scheme i.e. 40-50 KM with a power requirement of around 0.5 MVA/TKM in ONAN mode.

The sectioning and paralleling post (SP) is to be constructed at approx. midway between consecutive TSS and SSP may be constructed at approx. midway between TSS & SP.

The transformer is provided with ONAF/OFAF mode to meet the power requirement under feed extension condition and to account for the margin of 10 KM given in the spacing.

Wherever the Traction Sub Station feeds a mix of 2 line- 3 line sections, 3 line-4 line sections etc., the spacing and location selection of the Traction Sub Station may be decided by considering the above power requirement in ONAN mode on TKM basis as per the scheme adopted. In such cases, the power requirement on each side of Traction Sub Station may be done separately and accordingly the TSS and SP to be located in terms of spacing. The SSP may be provided at approximately mid of TSS and SP.

10. Operational Philosophy

The spacing of the Traction Sub Station has been proposed in the above Para considering the ONAN ratings of the Traction Power transformers and considering the load requirement of normal operation.

In the case of feed extension from a particular Traction Sub Station due to failure of the adjacent Traction Sub Station, the Transformer of the healthy TSSs may be utilized on the ONAF/OFAF mode and it will be possible to take the full load of the failed Traction Sub Station.

In Scott connected scheme, there are two double pole feeder circuit breakers for either side of the Traction Sub Station. One Circuit Breaker feeds the OHE with/without interrupters and another is kept redundant for each side of the Traction Sub Station.

In V connected scheme, the secondary voltages of the traction transformers are out of phase by 120O from each other and therefore it is required to understand the operation. The standby transformer provided in the middle can feed in either direction through the motorized coupling isolator provided on the bus, in case of failure of any of the outer transformer. Also, there are two double pole feeder circuit breakers for either side of the Traction Sub Station. One Circuit Breaker feeds the OHE with/without interrupters and another is kept redundant for each side of the Traction Sub Station.

SP and SSP for 2 Line systems have been proposed separately for Scott connected arrangement and V connected arrangement. The SP/SSP for 2 Line V connected arrangement is of common Bus type. The SP/SSP for 3 lines and 4 Lines section have been proposed of common bus type and may be used with both kind of feeding arrangement i.e. Scott connected or V connected arrangement.

In Common Bus type of SP & SSP, the fault on common Bus may hamper the train operation. Therefore, the Bypass Motorised Isolator (for off-load sectioning or off-load feed extension) has been provided to continue the train operation even in fault at common Bus. Further, the common Bus type SP/SSP may be used as a boundary post for interfacing 2Line/3Line/4Line sections of 2X25 kV sections with each other.

11. Interlocking

a. Scott Connected TSS
   i. The Closing of the LVCB on the secondary side of Traction Transformer (i.e. 50kV, SF6CB) shall be possible only when any one of the Circuit Breaker of associated Autotransformer at TSS is in closed condition.
   ii. The automatic opening of the LVCB on the secondary side of Traction Transformer (i.e. 50kV, SF6CB) shall happen as soon as all the Circuit Breakers of the associated Autotransformers at the Traction Sub Station are opened.

iii. The closing of coupling motorised isolator between Main Bus and Teaser Bus should be possible only when all the LVCBs of the Transformer are open. This coupling isolator has been provided for the feed extension in case of failure of TSS.
iv. To ensure above, necessary interlock shall be provided.

b. V Connected TSS

In this scheme the middle Traction transformer is to be used in either direction in case of failure of any one of the outer transformer. Therefore necessary interlock is to be provided between Motorised Coupling Isolator and LV Circuit Breaker in order to avoid wrong phase coupling as well as to ensure off load operation of the Motorised isolator.

There is off load circuit tap changer on primary side of the transformer with 6 tap positions (including principal tap) for voltage adjustment. Therefore, the tap changer should be operated only when both the primary and secondary circuit breakers are in open condition.

12. Three Phase connectivity to TSS:-

Railways to work out for new 3 phase, transmission line or extending/upgrading the existing transmission line on 3 phase to new location for connecting different TSS on these routes considering the economics of building this transmission line. In case the new Line is constructed, the line should support the capacity of transformer and adequate redundancy. To meet the power requirement with adequate redundancy, the provision of double circuit Transmission line may be considered. As per the CEA notification, dated 20.08.2010 Chapter IV, Part-A, Para 41 (3), table 7, In case of 66kV Voltage Level, The transformation capacity of any single sub-station for meeting loads shall not normally exceed 75MVA. In view of this limitation, if 66kV incoming supply is there, only ONAN Mode Transformer i.e. 60MVA Scott Connected or 38X2= 76MVA, V connected can be used. To address the huge power requirement for future load, it is suggested to not to take feed from the utility at 66 kV. Therefore, it is suggested to use 220kV or 132kV incoming Voltage only.

Interface of 25kV system with 2X25kV system and extension of feed from 25kV system to 2X25kV System and vice versa:

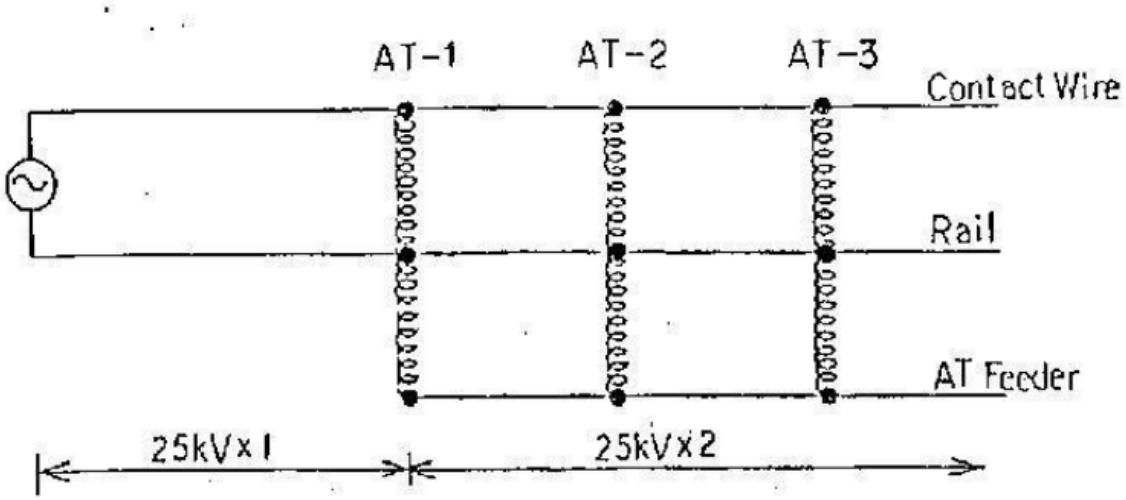
The SP may be proposed as an interface between subject two systems as the SP have been provided with adequate AT capacity to cater the feed extension. However, the overloading of the Autotransformer/ Autotransformers installed at SP shall determine the extent of feed extension.

Extension of feed between 2 x25 kV system and 1x 25 kV system

General Principle

Generally speaking, extension of feed from 1x 25 kV section to 2x 25 k V section and vice versa is possible with following remarks concerning capacity of AT at the boundary of both systems.

a. Extension of feed from 1x 25 k V section to 2x 25 kV section.



In this case, AT-1 at boundary of both systems is burdened with all the train loads which are located at right side of AT -2 and nearly half of the train loads between AT-1 and AT-2 Therefore, overload of AT-1 shall be observed.

21101 OHE Recording-cum-Test Car

1. For satisfactory current collection, the geometry of the overhead equipment is required to be maintained within very stringent limits. Presently monitoring of various parameters of overhead equipment like height, stagger, wear of contact wire, condition at the cross-overs and overlaps, is being done manually which could introduce errors in measurement due to individual's judgment. Moreover, it is time consuming. For the very high reliability of operation expected of electric traction system, mechanized monitoring of various parameters is essential.
2. Due to increasing demand for freight and passenger traffic, trailing loads and speed of trains are being increased gradually. Heavier freight trains hauled by one or two consists of locomotives will draw heavy currents from the substation. For meeting the requirement of increasing passenger traffic, trains with higher speeds are being introduced. In view of these developments, it is necessary to ascertain potential of the existing OHE and pantograph contact system for effecting requisite improvement and developing newer designs to achieve satisfactory current collection at higher speeds and heavier loads.
3. For achieving these objectives, efforts are on to develop an Overhead Equipment Recording cum Test Car. This car will be used to measure and record various parameters of OHE and pantograph both under static and dynamic conditions. The proposed car will be of trailer type, suitable for running at speeds of 160 km/h with potential to run up to 200 km/h. The car shall be hauled by locomotive or attached to a train. The car will be provided with on-board computer based data acquisition and processing system. The facility for video recording of arcs generated due to interruption in current drawn by locomotive as a result of loss of contact between pantograph and the OHE is also proposed to be provided.
4. The various parameters proposed to be monitored are:

Measurements on pantograph:

a. acrodynamic upward force of the pantograph;
b. contact force between pantograph and contact wire;
c. vertical and horizontal movement of pantograph;
d. quality of current collection- loss of contact;

Measurements on OHE:

a. height of contact wire ;
b. stagger of the contact wire;
c. gradient of the contact wire;
d. detection of hard spots;
e. checking of crossovers and turn-outs;
f. body vertical acceleration;
g. body lateral acceleration;
h. quality of current collection - loss of contact.

21102 Rail-cum-Road Vehicle

Such a vehicle is suitable for propulsion both on the road as well as on the track. Two sets of wheels are provided for this purpose. This vehicle is provided with an extendible swivelling platform. The vehicle can be driven on road to the level crossing nearest to the work site and taken there on the track.

21103 Transportable Self Propelled Trolley

This is a self propelled trolley which can be transported by a truck to a point accessible through road, close to the work site, for carrying out work on OHE. The trolley is provided with extendible swivelling platform.

21104 Microprocessor Based Numerical Integrated Feeder Protection Module

1. For the distance protection of the overhead equipment, the relay which was in use is the electromechanical type. The relay is prone to trip on normal over loads because of its inadequate discrimination between load current and the fault current when the fault is at the farther end causing undesirable tripping of the feeder circuit breaker. This problem will be more acute in the future due to the further increase in traffic anticipated and the increase in the traction power transformer capacity at TSS.

2. To overcome the above problem, the integrated microprocessor based numerical 25 kV feeder protection module comprising of Polygonal characteristic distance protection, Wrong Phase Coupling (WPC), 2 stage (Stage 1 instantaneous & Stage 2 Definite time) Over Current Relay (OCR) , Potential Transformer Fuse Failure (PTFF) Alarm and Trip, Auto Reclosure Relay, CB Trip Circuit Supervision Relay, Breaker backup (LBB) has been developed for Railway traction application. For its full utilization in controlling / monitoring of protection system, the module is capable of communicating with the RTU based on standard IEC 60870-5-103 protocol for transfer of information stored in relays to the RTU.

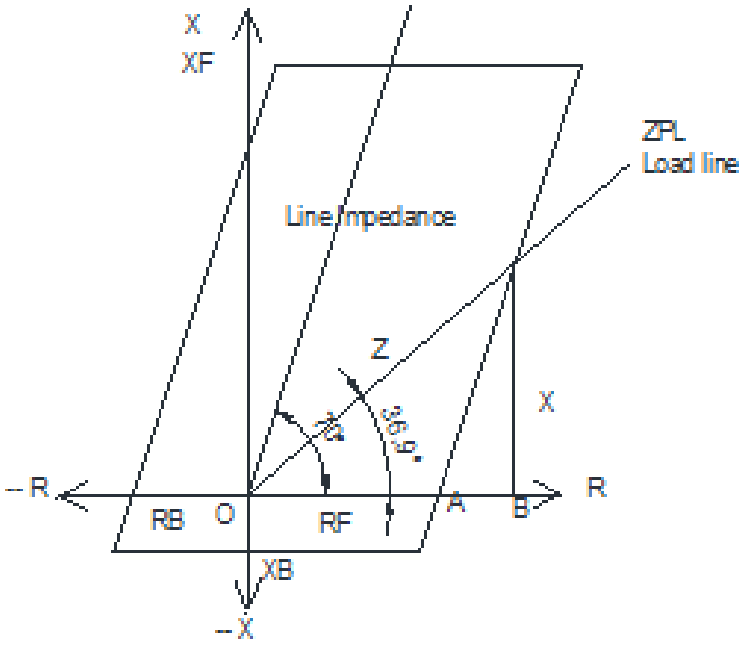
3. Concept of Numerical Relay: The numerical relay comprises of the following components.
   a Central Processing Unit
   b. Memory (RAM & ROM)
   c. ADC (Analog to Digital Converter)
   d. IO modules (Input/output Modules)
   e. Communication module (RS 232/485/Ethernet)

The numerical relay measures electric parameters (V, I) and convert them into digital data with the help of ADC which undergoes mathematical and logical analysis based on the program stored in the memory and to take action on tripping if fault occurs in the power system.

As the numerical relay is communicable the fault data stored in the relay can be transferred to RCC through SCADA and the analysis of retrieved data is possible.

4. The integrated microprocessor based numerical 25 kV feeder protection module comprising of Polygonal characteristic distance protection, Wrong Phase Coupling (WPC), 2 stage (Stage 1 instantaneous & Stage 2 Definite time) Over Current Relay (OCR) , Potential Transformer Fuse Failure (PTFF) Alarm and Trip, Auto Reclosure Relay, CB Trip Circuit Supervision Relay, Breaker backup (LBB) has been developed for Railway traction application. For its full utilization in controlling / monitoring of protection system, the module is capable of communicating with the RTU based on standard IEC 60870-5-103 protocol for transfer of information stored in relays to the RTU. To avoid malfunction of relay due to load encroachment, the load impedance area of the polygonal shall be settable for non-tripping in case the impedance falls in this area. For other details the specification no. TI/SPC/PSI/PROTCT/5070(Rev.-1) or latest and relay manual may be referred.

Parallelogram characteristic distance protection element



21105 Composite Insulators

The conventional porcelain insulators have poor impact withstand capability. The sheds of such insulators are easily broken due to acts of vandalism. Also, conventional porcelain insulators have a limitation of creepage distance i.e. 1050 mm and glazed surface of porcelain also does not have good hydrophobic property. These limitations can be overcome with the use of Silicone composite insulators. The composite insulator comprises a 'boron free, ECR grade glass fiber reinforced plastic (FRP) rod' and injection moulded sheds of High Temperature Vulcanising (HTV) Silicone rubber. The metal end fittings are usually crimped to the core prior to moulding of Sheds & Sheath to prevent ingress of moisture and direct tracking along the length of the core. Such insulators have excellent impact withstand capability and excellent Hydrophobic & anti- tracking properties".

21106 Automatic Phase Switching Section (in place of Neutral Section) and Numerical Control Logic Relay: DELETED

Automatic Phase Switching Section (APSS) has been developed for 25 kV Single Phase 50 Hz AC Traction Power Supply System of Indian Railway to facilitate automatic changeover of supply coming

from different phases as soon as the Electric Loco/EMU negotiates the IOLs meant for phase separation without affecting the status of loco/EMU circuit breaker (DJ). No neutral section is required in APSS for separation of different phase supply at SP and hence, Loco Pilot can run the train at desired speed without any hassle and stress and worrying about DJ ON/OFF Boards giving instructions for opening and closing of electric loco/circuit breaker (DJ) which were required in case of neutral section. Three insulated overlaps along with CBs, CTs & PTs at SP (or any desired location) associated with Automatic Phase Switching Section (APSS) has to be provided. Circuit Breaker rated for APSS operation will be provided as per RDSO specification No TI/SPC/PSI/LVCBIN/0120 with latest amendments.

For details the specification no. TI/SPC/PSI/NCLR/0190 and manual of associated relay provided by the manufacturer of the Numerical Control Logic Relay (NCLR) may be referred.

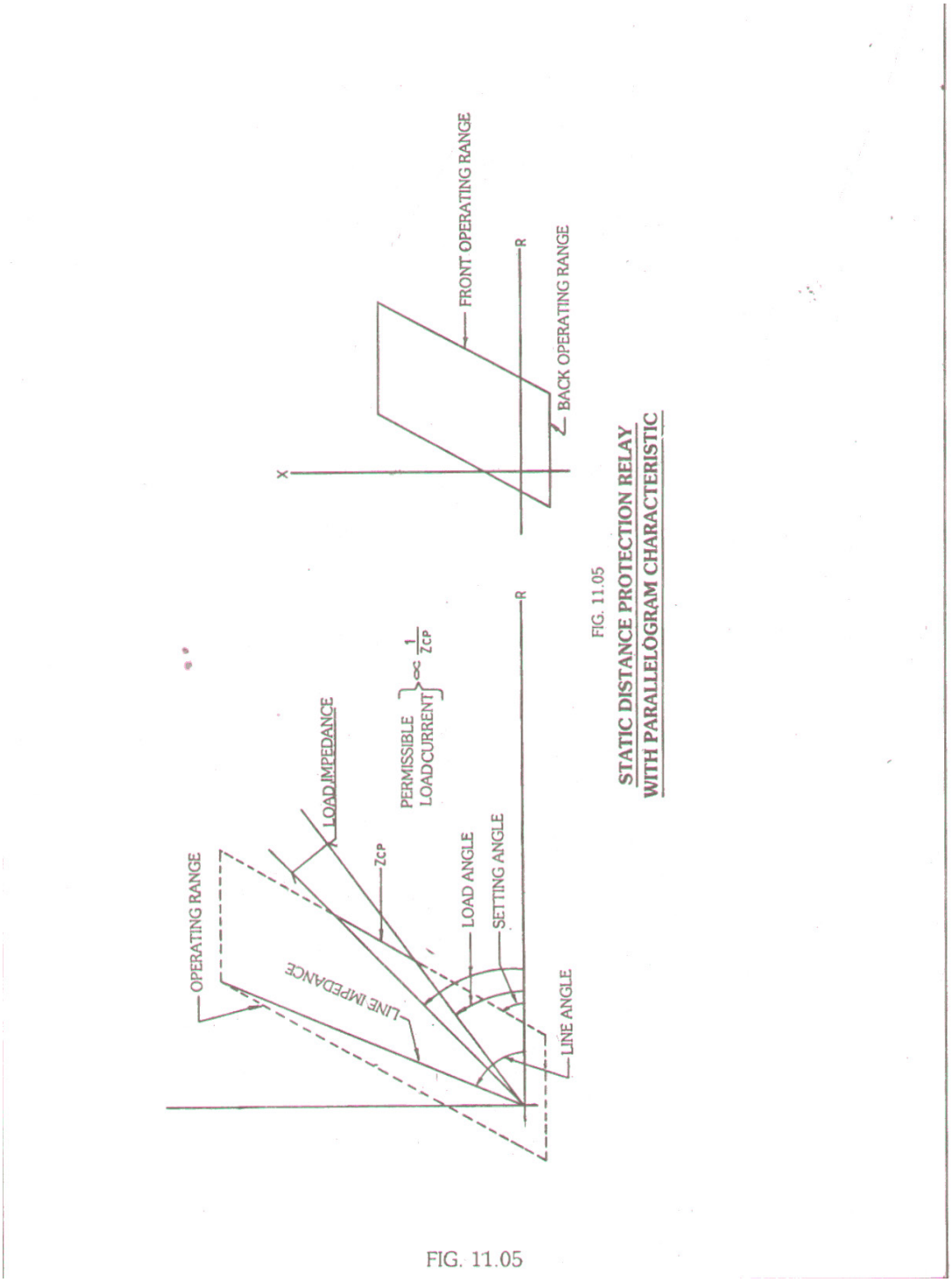


FIG. 11.05
STATIC DISTANCE PROTECTION RELAY
WITH PARALLELOGRAM CHARACTERISTIC

FIG. 11.05

21107 HIGH RISE OHE

1. RDSO Design Document No. TI/DESIGNS/OHE/2014/00001(Rev-1) for 'Overhead Equipment for Running Double Stack Container Under Electrified Route' may be referred (Authority: Railway Board letter No. 2014/RE/161/19 dated 14.09.2017.
2. OHE PARAMETER FOR HIGH RISE OHE

Height of Double Stack Container	:	6809 mm & 7100 mm
Height of Contact Wire at Support from Rail Level	:	7570 mm
Height of Contact Wire at mid Span from Rail Level	:	7520 mm
Height of Catenary Wire at Support from Rail level	:	8970 mm
Presag at mid spa	:	50 mm
Maximum Span length	:	To be decided as per New wind zone as per Table 4.13(i) & 4.13(iii) of Design Document (54 metres for wind load 155 kg/Sq. m)
Maximum Stagger at Tangent Track	:	+150 mm
Maximum Stagger at Curves	:	+250 mm
Standard Encumbrance	:	1.400 metres
Dropper Schedule to be followed	:	1.400/1.400 metres Encumbrance Generally. (Based on Site conditions other prescribed standard Encumbrance may be followed)
Mast Length	:	11.4 metres
Minimum Implantation	:	2.8 metres
Tension in Catenary Wire	:	1000 kgf
Tension in Contact Wire	:	1000 kgf

Maximum Tension Length	:	1.5 km
Catenary Wire	:	65 Sq. mm
Contact Wire	:	107 Sq.mm

MERGING WITH EXISTING OHE

For Mainline OHE (Height of Contact Wire at support)	:	5.80 metres
For High Rise OHE (Height of Contact Wire at support)	:	7.57 metres
Difference	:	1.77 metres

The High Rise OHE shall be merged with Conventional OHE

with the Contact wire gradient of @ 10mm/metre . With restricted speed contact wire gradient may be adopted as per EN 50119.

3. OTHER DETAILS:

Type of Auto Tensioning Devices	:	Three Pulley modified Groove Auto Tensioning Device as per RDSO Specification No. TI/ SPC /OHE/ ATD /0060 Rev. 1 with A & C Slip No. 1 - For total OHE Tension of 2000 kgf
Stainless Steel Wire Rope	:	As per RDSO Specification No. TI/SPC/OHE/WR/1060 with A & C Slip No. 1 to 4
Anchor Height	:	As per RDSO Drawing No. TI/DRG/ OHE/GUYHR/ RDSO/ 00001/13/0 (Sheet 1 to 4)
Distance of bottom of Counter Weight Assembly from top of muff	:	2300 mm at 35o C
X-Y Adjustment Chart	:	As per RDSO Drawing No. TI/DRG/ OHE/ATD/ RDSO/ 00003/99/0 - Three Pulley ATD
Guide Tube	:	As per RDSO Drawing No. ETI/OHE/ G/01505

Schedule of Dimensions for 25 KV Electric Traction with High Rise OHE:

Minimum Height of Overhead Structure above rail level for a distance of 1600mm on either side of centre of Track shall be as under:

(Reference: ACS 21 of IRSOD(BG) Revised 2004)

1. Light Overhead Structure such as Foot Over Bridges: 8430mm

2. Heavy Overhead Structures, such as Road Over Bridges and Flyovers: 8050mm
3. Heavy Overhead Structures, Such as Road Over Bridges and Flyovers, if any turnout or crossover is located under that heavy overhead structure or within 40meters from its nearest face: 8430mm

Note:

1. Necessary provision shall be made in overhead structure and overhead equipment to permit an extra allowance for raising of track in future to cater for modern track structure in the form of increased ballast cushion of 350mm, larger sleeper depth of 230mm and heavier rail section of 200mm including 10m thick rubber pad by using longer traction overhead mast, if necessary.
2. In case of restricted height of existing overhead structures, minimum height of overhead structure for a distance of 1600mm on either side of centre of track for provision of high rise OHE as per note (iii) below, to permit operation of double stack container having height as 6809mm shall be as under:
   a. Light Overhead Structure such as Foot Over Bridges: 7568 mm
   b. Heavy Overhead Structures, such as Road Over Bridges and Flyovers: 7468mm
   c. Heavy Overhead Structures, Such as Road Over Bridges and Flyovers, if any turnout or crossover is located under that heavy overhead structure or within 40meters from its nearest face: 7568mm

   For these minimum restricted heights, catenary wire shall be terminated outside overhead structure (Road Over Bridges & Flyovers/Foot Over Bridges)
3. In case of restricted height of existing overhead structures, bridges and tunnels the minimum height of underside of the contact wire from rail level can be reduced to 7166mm. In such cases a special study shall be made before 25kV AC traction is introduced as explained below:

(a)	Height of Rolling stock	6809mm
(b)	Short duration electrical clearance	200mm
(c)	Additional electrical clearance for oscillation of contact wire (For OHE span length of 49.5m or below)	50mm
(d)	Allowance for track upgradation/maintenance	50mm
(e)	Rise in rolling stock height under dynamic condition	57mm
	Minimum Height of contact wire	7166mm

4. Extra vertical clearance shall be provided on curves as under:

   Extra vertical clearance (mm) = Width of MMD(mm)X Super elevation (mm)/Dynamic Gauge(mm)

   This extra vertical clearance on curve should be with respect to inner rail of curve.

5. Clearances for Power Line Crossings including Telephone Line Crossings of Railway Tracks:

SN	Overhead crossing voltage	Minimum clearance from Rail Level		Minimum clearance between highest traction conductor and lowest transmission line crossing conductor
		Existing power line crossing for existing Non-electrified line	New power line crossing or crossing planned for alteration	
(1)	(2)	(3)	(4)	(5)
1	Upto & including 11 kV	By underground cable		
2	Above 11 kV& upto 33 kV	10860	16660	2440
3	Above 33 kV& upto 66 kV	11160	16960	2440
4	Above 66 kV& upto 132 kV	11760	17560	3050
5	Above 132 kV& upto 220 kV	12660	18460	4580
6	Above 220 kV& upto 400 kV	14460	20260	5490
7	Above 400 kV& upto 500 kV	15360	21160	7940
8	Above 500 kV& upto 800KV	18060	23860	7940

Note:

i. All height/clearances are in mm and under maximum sag condition

ii. If the crossing is provided with a guarding, a minimum clearance of 2000mm shall be maintained between bottom of guard wire and heighest traction conductor

iii. Power line crossing in yards & station area shall be avoided.

iv. For any electrification work of existing line: doubling/gauge conversion along with electrification, existing crossings can continue, if dimensions are as per Column (5) above, even if dimensions of Col (3) are not satisfied i.e. for electrification works Col(3) is not applicable

6. DRAWINGS APPLICABLE FOR HIGH RISE OHE:

The following Standard RDSO Drawings pertain to High Rise OHE.

Sl. No.	Description	Drawing No.
(i)	Employment Schedule for OHE Mast (11.4 metre) Wind Pressure 178 kgf/ m2 for High Rise OHE.	TI/DRG/CIV/ES/00001/13/0 (Sheet – 1)
(ii)	Employment Schedule for OHE Mast (11.4 metre) Wind Pressure 155 kgf/ m2 for High Rise OHE.	TI/DRG/CIV/ES/00001/13/0 (Sheet – 2)
(iii)	Employment Schedule for OHE Mast (11.4 metre) Wind Pressure 136 kgf/ m2 for High Rise OHE.	TI/DRG/CIV/ES/00001/13/0 (Sheet – 3)
(iv)	Employment Schedule for OHE Mast (11.4 metre) Wind Pressure 105 kgf/ m2 for High Rise OHE.	TI/DRG/CIV/ES/00001/ 13/0 (Sheet – 4)
(v)	Employment Schedule for OHE Mast (11.4 metre) Wind Pressure 73 kgf/ m2 for High Rise OHE.	TI/DRG/CIV/ES/00001/ 13/0 (Sheet – 5)
(vi)	Volume Charts & Equivalent Charts of Foundations(Side Bearing, Side Gravity & WBC) for High Rise OHE	TI/DRG/CIV/FND/00001/13/0 (Sheet - 1)
(vii)	Volume Charts & Equivalent Charts of Foundations(NG Type) for High Rise OHE	TI/DRG/CIV/FND/00001/13/0 (Sheet – 2)
(viii)	Volume Charts & Equivalent Charts of Foundations for Dry Black Cotton Soil(NBC Type, 3.0 metre Depth)for High Rise OHE	TI/DRG/CIV/FND/00001/13/0 (Sheet – 3)
(ix)	Volume Charts & Equivalent Charts of New Pure Gravity Foundations(500 mm exposed) for High Rise OHE	TI/DRG/CIV/FND/00001/13/0 (Sheet – 4)
(x)	Volume Charts & Equivalent Charts of Foundations for Dry Black Cotton Soil(NBC Type, 2.5 metre Depth)for High Rise OHE	TI/DRG/CIV/FND/00001/13/0 (Sheet – 5)
(xi)	Schedule of Anchor Blocks for B G Tracks for High Rise OHE	TI/DRG/OHE/ GUYHR/00001/14/0 (Sheet - 1)
(xii)	Schedule of Anchor Blocks for B G Track for Black Cotton Soil for High Rise OHE	TI/DRG/OHE/ GUYHR/00001/14/0 (Sheet - 2)
(xiii)	Guy Rod Φ 25 mm for High Rise OHE	TI/DRG/OHE/ GUYHR/00001/14/0 (Sheet - 3)
(xiv)	Anchor arrangement with Dwarf Mast For Conventional & High Rise OHE	ETI/OHE/HR/G/01402
(xv)	11.4 m long Standard Traction Mast (Fabricated with Batten Plates “B” Series) for High Rise OHE	TI/DRG/CIV/B-Mast/ 00001 /13/0
(xvi)	Standard Plan Height Gauge for level crossing (For clear span up to 7.3 meter) Details of structure and foundation for High Rise OHE (7.52 mtr at mid span at LC gate)	TI/DRG/CIV/H Gauge-HR/ RDSO/00001/20/0
(xvii)	Standard Plan Height Gauge for level crossing (For clear span above 7.3 mtr upto 12.2 meter) Details of structure and foundation for High Rise OHE (7.52 mtr at mid span at LC gate)	TI/DRG/CIV/H Gauge-HR/ RDSO/00002/20/0

(xvi)	BFB Type Portal	TI/DRG/CIV/BFB-PORTAL/ 00001 /13/0 (Sheet 1 & 2)
(xvi)	N Type Portal	TI/DRG/CIV/N-PORTAL/00001 /13 /0 (Sheet 1 & 2)
(xviii)	P Type Portal	TI/DRG/CIV/P-PORTAL/00001 /13/0 (Sheet 1 & 2)
(xix)	O Type Portal	TI/DRG/CIV/O-PORTAL/00001 /13/0 (Sheet 1 & 2)
(xx)	G Type Portal	TI/DRG/CIV/G-PORTAL/00001 /13/0
(xxi)	R Type Portal	TI/DRG/CIV/R-PORTAL/00001 /13/0 (Sheet 1 & 2)
(xxii)	TTC Mast	TI/DRG/CIV/TTC/00001/13/0 (Sheet 1 to 2)
(xxii))	Dropper Schedule for High Rise OHE(Encumbrance 1400mm/1400mm)	TI/DRG/OHE/DROP/00001/10/1
(xxiv)	Dropper Schedule for High Rise OHE(Encumbrance 1400mm/900mm)	TI/DRG/OHE/DROP/00002/10/1
(xxv)	Dropper Schedule for High Rise OHE(Encumbrance 1400mm/750mm)	TI/DRG/OHE/DROP/00003/10/1
(xxvi)	Auxiliary Transformer for High Rise OHE	TI/OHE/HR/AT/G/05522 (Sheet 1 to 2)
(xxvii)	Standard arrangement of Drop arm for supporting Cantilever on the boom of portals and two track cantilever for Normal as well as High Rise OHE.	ETI/C/HR/0076

7. SALIENT TECHNICAL FEATURES OF HIGH REACH PANTOGRAPH:

(Already used for trial)

(Specification No. RDSO/2007/EL/SPEC/0054, Rev. '1' with Latest Addendum & corrigendum Slip for high rise Pantograph)

MAIN FEATURES

i)	Operating Voltage	:	a) Nominal - 25 kV, 50 Hz
			b) Max. (Cont.) - 27.5 kV.
			c) Short time Max. - 30 kV. for 10 Seconds.
ii)	Rated current	:	600 Amps. (Minimum)
iii)	Mounting	:	4 Supports (Indian Railways existing arrangement of four support 807 mm along the length of loco x 1160 mm along the width of loco, shall be preferred.)
iv)	Maximum Extension	:	At least 3.5 meters from the locked down height
v)	Working Range	:	0.15 meters to 3.3 meters (for satisfactory current collection)
vi)	Maximum Weight	:	180 kg. Approx. (Without Insulators)
vii)	Static Up-thrust	:	7 ± 0.4 kgf.

viii)	Maximum Speed	:	140 kmph.
ix)	Width of Pantograph Pan		2032 mm + 5 mm
x)	Overall length (Including Shunt)	:	2000 mm. (In folded condition) From rear Panto mounting Foot Insulator
xi)	Total forces	:	As low as possible (the value to be furnished by the Tenderer)
xii)	Wearing Strip material	:	Metallised Carbon Strips as per RDSO's Specification No. RDSO/2009/ EL /SPEC /0097 ,Rev.'0'
xiii)	Maximum Folded height above mounting insulator	:	295 ± 5 mm. [So as to be within existing Maximum Moving Dimension (MMD) of Electric Loco]
xiv)	Compressed Air Supply	:	The compressed Air supply in the loco may vary between 5.5 kg/cm2 and 11 kg/cm2 depending upon the type of Stock, Compressor operation etc. Pantograph shall start lowering if the Air pressure drops below 4.5 kg/cm2.
xv)	Raising time for the Pantograph to reach an extension of about 3.5 meters in 6 to 15 seconds.		
xvi)	Lowering time for the Pantograph to fold on its stops from 3.5 meters – less than or equal to 15 seconds. Break from the Contact wire should be rapid and controlled throughout the remaining lowering operation. Folding on to the stops should be without any jerk.		
xvii)	The resistance of Pantograph between carrier i.e. from Contact Strip and Power take off point on the base frame shall not exceed 10 milli-ohms.		
xviii)	Adequate lowering effort and retaining force in the lowered condition shall be ensured to lower and retain the Pantograph in the lowered position without undue vibrations at speeds up to 140 kmph.		

21108 Copper Magnesium Catenary wire

Presently, Cadmium Copper Stranded Catenary wire is being used in Indian Railways. Copper-cadmium has a good combination of properties but is no longer accepted in most applications as a conductor alloy, on account of the toxicity hazard and risk of respiratory disease associated with cadmium, both in initial manufacturing and later in recycling. In service, copper-cadmium poses no threat to health.

Hence, RDSO has developed Copper Magnesium Stranded catenary wire, with properties similar to copper cadmium catenary wire so that existing copper cadmium catenary wire can be replaced with non-hazardous alloy without compromising electrical and mechanical properties. Copper Magnesium has good resistance in natural and industrial atmosphere (maritime air too). Prototype testing has been conducted and field trial is to be done.

CHEMICAL COMPOSITION

Element	**%ppm**
Cu+Ag	Remaining
Mg	0.1% - 0.7%
Bi	< 10 ppm
Pb	<5 ppm
P	<50 ppm
Oxygen	<20 ppm

PROPERTIES OF STANDARD MAGENESIUM COPPER (Cu-Mg) STRANDED CONDUCTOR

Nominal equivalent Area of Hard Drawn Copper	No. of strands and diameter 0f Wire	Approx. overall Diameter	Weight Per Km.			Resistance per km at 20°C corrected to Standard Weight		Minimum breaking load of Conductor	Calculated area of Magnesium Copper.
			Std	Max	Min	Std	Max		
mm2	mm2	mm	Kg	Kg	Kg	Ohm	Ohm	Kgf	mm2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
19.84	7/2.10	6.3	217.60	221.76	213.58	0.8958	0.9132	1432.7	24.05
53.50	19/2.10	10.5	594.40	605.78	583.41	0.3322	0.3387	3915.9	64.85
103.62	37/2.10	14.7	1163.52	1185.79	1142.01	0.1717	0.1750	7625.7	125.60

21109 Spring type ATD

Spring type Auto Tensioning Device can be used at locations having space constraint for providing Counter Weights like tunnel, viaduct , bridges etc.

Spring ATD is full maintenance-free system with the anticipated service life more than 30 years. It's installation and operation are easier than pulley type regulating equipment. It also minimizes the human/material resources for maintenance due to Lower weight & Small size. It provides safeguard against accidents due to no hanging counter weight as pulley type regulating equipment. Prototype testing has been completed and field trial is to be done.

Spring ATD can be used for higher tension and high speed.

21110 Open Access- Optimization of Traction Power Procurement Cost

Indian Railways (IR), along with national highways and ports, is the backbone of India's transport infrastructure. The reach and access of its services are expanding with continuous improvement through its committed team of about 1.3 million employees and use of cutting-edge technologies. Ministry of Railways has been relentlessly working on multiple fronts to speed up growth of Indian Railways and improve its financial health. IR consumed over 19.91 billion units of electrical energy for its traction applications during 2018-19 which is about 1.3% of total electrical energy generated in the country. The energy bill paid for consuming this energy was about □11,960 cr. Indian Railways have been very conscious about saving energy and accordingly consistently been working towards controlling its energy bill on traction side by adopting multi-pronged strategies including procuring energy from open market.

Earlier IR has been procuring electricity as an ordinary consumer for its traction applications despite being the single largest user of energy in the country. Accordingly, it has been paying higher tariffs for energy duly taking the burden of distribution losses, cross subsidy and other surcharges of Power Distribution Companies (DISCOMs). The Electricity Act 2003 conferred Deemed Licensee status on IR being Central Government department due to its involvement in transmission &distribution of energy from the time electricity came to India. Accordingly, IR had been working to get this provision of Electricity Act operational; however it didn't come through for quite some time due to various factors.

Ministry of Railways took up this task with fresh impetus and subsequently a strategy was drawn. In line with this, Indian Railway approached Central Electricity Regulatory Commission (CERC) for issue of necessary guidelines to all State Transmission Utilities (STUs) and State Load Dispatch Centers (SLDCs) to facilitate Open Access to Indian Railways on existing transmission network as Deemed Licensee. This was made to enable Indian Railways to procure energy from any generating unit, including captive generating plants, traders, or through power exchange up to the interconnection point of railway network in terms of specific provisions of Railway Act.

In its historic judgment on 5th Nov.'15, CERC in Petition No. 197/MP/2015 ordered that:

"Indian Railways is an authorized entity under the Railways Act to undertake transmission and distribution activities in connection with the working of the railways, independent of its status under the Electricity Act. Indian Railways is a deemed Licensee under third proviso to Section 14 of the Electricity Act and no separate declaration to that effect is required from the Appropriate Commission. All concerned RLDCs, State Transmission Utilities and SLDCs are directed to facilitate long term access and medium term access in terms of Connectivity Regulations from the generating stations or other sources to the facilities and network of Indian Railways."

Finally, IR's vision of drawing electrical energy as deemed licensee was realized on 26th Nov.'15 when it started drawing about 200 MW power on Central Railway from Ratnagiri Gas Power Pvt. Ltd. {RGPPL - Gas based power plant} in Maharashtra. This was for the first time that IR had drawn energy under open access as a distribution licensee using state distribution network. IR contracted about 540 MW from RGPPL for consumption in the states of Maharashtra, Gujarat, M.P., and Jharkhand for meeting its electric traction power requirement. The flow of power in all these four States was completed by 22nd Jan.'16. Further, IR also contracted 50 MW through open tender for taking on its own transmission network for Dadri to Kanpur which started flowing from 1st Dec.'15.

The salient features of CERC/SERC regulations regarding open access are as under.

Eligibility for Open access:

1. Application for open access should be made in prescribed format.

2. Valid Power Purchase agreement between Generator/Trader and Power Procurer.
3. Applicable fees as prescribed by respective regulatory authority shall be paid by open access applicant.
4. All fees and charges applicable shall be paid as decides by respective regulatory authority.
5. No resale of Energy allowed in open access.
6. Distribution Franchisee not eligible for Open access.
7. No surcharge or cross-subsidy to captive generation plant for carrying the electricity to the destination of his own use.

A Consumer having Contract Demand of 1 MW and above with a Distribution License shall be eligible for Open Access for obtaining supply of electricity from one or more

a. Generating Plants or Stations, including Captive Generating Plants;
b. Trading Licensees
c. Power Exchanges
d. Other Distribution Licensees
e. Any other sources, or a combination thereof and all collectively called 'Sources':

Provided that, for the purpose of unit conversion from MVA to MW, the unity power factor shall be considered;

Completion of Works

1. Where the grant of Open Access is agreed to but requires the completion of works relating to extension or augmentation of lines, transformers, metering arrangements, etc., or the commissioning of new Sub-Stations, the Distribution Licensee shall complete such works within the time limits specified in the Regulations of the Commission governing Standards of Performance.

Meter Reading

1. The final meter reading of the Consumer shall be taken by the Distribution Licensee from the date of commencement of Open Access: in presence of representatives of consumer and distribution licensee.

Settlement of Dues

1. A Consumer applying for Open Access to the Distribution System shall settle all dues of the Distribution Licensee prior to applying for Open Access:

Open Access Agreement

1. An Open Access Agreement shall be entered into upon grant of Medium or Long Term Open Access in the format prescribed.

Categories of Open Access

The application procedure, application fee and the time frame for processing applications for Open Access shall depend on the inter-se location of drawl and injection points, i.e. on whether

1. Both are within the same Distribution System;
2. Both are within the State but in different Distribution Systems;
3. Both are in different States.

Duration of Open Access

Open Access Category	Duration
Long-term Open Access (LTOA)	Exceeding twelve years but not exceeding twenty-five years
Medium-term Open Access (MTOA)	Exceeding three months but not exceeding three years
Short-term Open Access (STOA)	Not exceeding one month
Day ahead open access	With in 24 hrs.

The procedure for Inter-State Open Access shall be as per the Central Commission's Regulations whereas for Intra-State Open Acess shall be as per respective state commissions regulations.

APPLICABLE CHARGES:

1. The bill will be raised on the Open Access Generator / Open Access consumer The bill will include the following charges:
   a. Wheeling Charges / Transmission Charges, as may be applicable;
   b. Cross Subsidy Surcharge, as may be applicable;
   c. Additional Surcharge on the Charges of Wheeling;
   d. Standby Charges;
   e.Voltage Surcharge, as may be applicable;
   f. System Operating Charges& Market operating charges
   g. Charges in case of over or under drawl with reference to the scheduled power. from the grid.
   h. Any other charge or other sum recoverable.

Metering and Communication

All Open Access Consumers and Generating Stations shall install Special Energy Meters ('SEM's):

Railways have unveiled Mission 41K on the occasion of "Roundtable discussion with Stakeholders" on 17th January 2017 at Ministry of Railways. According to Mission 41K, it is estimated that on account of Open Access, in the period from 2015 to 2025 a cumulative saving of about ₹ 41,000 cr. shall be achieved in electric traction bill. Due to power procurement under open access IR has achieved a saving of over ₹ 12,500 crores in traction bills from 2015 to 2019-20.

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CHAPTER-12
TRAINING AND COMPETENCY CERTIFICATES

I. TRAINING

21200 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.

21201 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 isalso necessary to establish sufficiently in advance suitable training schools with the facilities for imparting the training by qualified instructors.

21202 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 as 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.

21203 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 (Degree and Diploma holders)
   b. Traction Power Controllers and Asstt. Traction Power Controllers;
   c. Skilled and semi-skilled artisan staff for maintenance of OHE, PSI and RC equipment;
   d. Initial Training for Group D,
   e. Any other category as approved by PCEE.
2. The period of initial training for typical categories is given below, this may be modified by PCEE in accordance with local requirements :
   a. Directly recruited supervisors (Degree and Diploma Holders)-
      i. OHE 52 weeks
      ii. PSI 52 weeks

iii. Remote Control 52 weeks
iv. TPCs/ATPCS 52 weeks

b. Promotee JEs 13 weeks

c. Skilled artisans for maintenance-
   i. Direct recruits(ITI/Non ITI) 26/78 weeks
   ii. To be absorbed from Diesel/Steam or Electric general services 30 weeks

d. Group D: 12 days

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.

21204 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.
3. Promotional Training syllabi and Duration should be as given in theRailway Board letter no E(MPP)2019/3/44 dt 27.1.20.

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 the 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 moral as a whole.

21205 Refresher Courses

1. In accordance with extant instructions current on the subject, refresher courses should be arrangedonce in 3 years for supervisors and 5 years for technicians. This is obligatory for those categories of staff dealing with "safety of train operation or having daily contact with the public". The following is an illustrative list of traction distribution staff coming with in the scope of these instructions.
   a. Traction Power Controllers
   b. Asstt. Traction Power Controllers

c. Supervisors of OHE
d. OHE Inspection Car Drivers
e. technicians 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 PCEE to suit local conditions. The duration for typical categories is given below for guidance :

a. Supervisors	12 days
b. Artisan Staff	12 days
c. OHE Inspection Car Drivers	6 days

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 Technicians 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 breakdowns/accidents.
7. During refresher courses, it willbe 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.

21206 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 utilized 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 equipment.

c. Circuit diagrams, sectioning diagrams, etc. illuminated and arranged to show the sequence of operations.
d. Samples ofdamaged 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.

4. Model OHE in OHE depots to be provided by RE during initial electrification. At existing major OHE depots, divisions to provide model OHE for training of staff.

21207 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 working. In exceptional cases when such training cannot be arranged conveniently in the Zonal Schools, PCEE 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.

21208 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.

21209 Examination at the End of Training

All trainees 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 PCEE, The examination should have a practical bias.

21210 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.

21211 Syllabi

Syllabi for the various training courses should be as given in the Railway Board letter no E(MPP)2019/3/44 dt 27.1.20.

1. OHE Technician (Initial Training) - Duration: 26/156 (ITI/Non ITI) weeks.
   a. Theoretical:

As given in the" Railway Board letter no E(MPP)2019/3/44 dt 27.1.20.

   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 of height.
      b. Practicing the use of various tools, tackles and gadgets used in OHE work.
      c. Practicing 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.

II. COMPETENCY CERTIFICATES

21212 Authorized Person

An "authorized person" is one who is duly authorized to perform specific duties pertaining to his Employment, the authorization being made by the competent authority empowered for the purpose by the Railway Administration.

21213 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:

Designation of staff	Category of certificate	To be issued by
A. OHE SECTION		
1. Khalasi	TR-1	JE or SSE after oral test
2. Technician	TR-2	ADEE(TRD) after oral test.
3. Supervisor	TR-3	DEE(TRD) after written and oral test.
4. OHE Inspection Car Driver	TR-4	DEE(TrD) after written and oral test.
B. PSI SECTION		
5. Assistant	TR-1	JE or SSE after oral test
6. Technician	TR-5	ADEE(TRD) after oral test.
7. Supervisor	TR-6	DEE(TRD) after written and oral test.
8. Artisans/Supervisors for Protective	TR-7	ADEE/DEE(TrD) after written, oral and practical test.

Relays and Instruments

C. REMOTE CONTROL

9. Technician	TR-8	ADEE(TrD).
10. Supervisor	TR-9	DEE(TRD) after written and oral test.
11. Station staff	TR-10	DEE(TRD)/ADEE(TRD) after practical training ,Oral test and assurance .
12. P Way Staff	TR-11	DEE(TRD)/ADEE(TRD) after practical training ,Oral test and assurance .

21214 Period of Training

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

21215 OHE Inspection Car Driver

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

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.

An oral and practical test by SSE(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.

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.

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).

Prescribed medical examination.

21216 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 JE or SSE 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 the 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 SSE and ADEE and an entry made of such checks in the Register of Certificates (para 21217). Station staff should be issued competency certificate no- 10 after practical training , oral test and assurance signed by staff. The Validity of all the competency certificates will be 5 years.

21217 Register of Certificates

A register of Competency Certificates issued shall be maintained in the office of every supervisory official, as per proforma given in Annexure 12.01, showing the names and designations of staff under him who have been Issued with the Certificates.

21218 Service Record

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

21219 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.

Annexure 12.01

Proforma Register of Competency Certificates

Name	Designation	Certificate No	Date of test and issue	Name of the official who conducted the test	Station where the employee is posted at present	Date of periodical check	Remarks

..... RAILWAY

. ELECTRICAL DEPARTMENT

CERTIFICATE OF COMPETENCY No. TR-1

(For unskilled Class IV staff)

No.....

Shri ..... S/o shri ..... is authorized to work as an unskilled Assistant in the OHE/PSI section to assist skilled staff and supervisors in maintenance, repair and installation work. The safety rules pertaining to his work have been personally explained to him by me.

*He is NOT authorized to work independently on any OHE line or Power Supply installation except in the presence of and under the direct supervision of an authorized person.

*However a Literate Khalasi having minimum three years of working experience is authorized to operate isolator under instruction of TPC following all extant procedure/rule issued in this regard.

Date.....

.....

SSE/JE

*Strike out item not applicable.

A fresh certificate should be issued when he is transferred to a new section after the safety rules pertaining to the new section are explained to him.

. ..... RAILWAY

ELECTRICAL DEPARTMENT

CERTIFICATE OF COMPETENCY No.TR-2

(For OHE Technician)

No. .....

Shri ..... S/o Shri..... has been examined for his knowledge of rules and is authorized to work as Technician grade .....in the electrified section from ..... to .....

He is authorized to*-

a. Take power block from TPC for 25 kV OHE/66/132/220 kV transmission lines and underground cables
b. effect shut down in yards and sidings by operating isolator switches;
c. operate switching stations on local control under instructions from TPC;
d. carry out repair, installation and maintenance work on 25 kV OHE; duly observing the prescribed rules.

He is.NOT authorized to-

a. issue 'permits-to-work'; and
b. bring into operation any new installation.

Date .....

.....

ADEE(TRD)

'Strike. out item not applicable.

..... RAILWAY

ELECTRICAL DEPARTMENT

CERTIFICATE OF COMPETENCY No. TR-3

(For OHE Supervisor)

No. .....

Shri ..... has been examined for his knowledge of rules and is authorized to work as a Supervisor on the installation, maintenance and repairs of 25 kV OHE and 66/132/220 kV Transmission lines and underground cables. He is authorized to.

a. issue permits-to-work ; and
b. bring into operation new installations after they have been inspected by an officer, duly observing the prescribed rules.

Date .....

.....

DEE(TRD)

..... RAILWAY

ELECTRICAL DEPARTMENT

CERTIFICATE OF COMPETENCY No. TR-4

(For OHE Inspection Car Drivers)

No. .....

Shri ..... is authorized to drive an OHE Inspection Car in the section between ..... and ..... duly observing the safety rules and standing instructions. His written declaration* dated ..... that he isfamiliar with the road signals in the above section has been noted in issuing this certificate.

He is further authorized to carry out routine maintenance of the OHE Inspection Car in accordance with the prescribed schedules.

Date ....

.....

DEE(TRD)

*This declaration must be countersigned by Driving Inspector and personally scrutinized by the Officer before issue of this certificate. The Driving Inspector before countersigning the declaration, shall orally examine the employee for his knowledge of the road.

.....RAILWAY

ELECTRICAL DEPARTMENT

CERTIFICATE OF COMPETENCY No. TR-5

(For Skilled PSI staff)

No. .....

Shri ..... has been examined for his knowledge of rules and is authorized to work as a Technician in the installation, maintenance and repair of Traction Power Supply installations at sub-stations, switching stations and auxiliary transformer stations. He is authorized to -

1. effect shut down on 25 kV equipment under instructions of TPC;

2. take power block from TPC for working, on 25 kV equipment;

3. operate equipment at traction sub-stations and switching stations under instructions from TPC, duly observing the prescribed rules.

He is NOT authorized to-

1. issue permits-to-work;
2. effect shut downs or take power block for extra high voltage (EHV)installations and
3. bring into operation any new installation,

.....

ADEE(TRD)

……..... RAILWAY

ELECTRICAL DEPARTMENT

CERTIFICATE OF COMPETENCY No. TR-6

(For Supervisors of PSI)

No.....

Shri ..... has been examined for his knowledge of rules and is authorized to work as a Supervisor on the installation, maintenance and repair of 25kV and extra high voltage (EHV) Traction Power Supply Installations at sub-stations, switching stations and booster transformer stations. In addition to items covered by Certificate No.TR-5, he is authorized to -

1. issue permits-to-work on 25 kV and extra high voltage ((EHV)equipment;

2. bring into operation new 25 kV and extra high voltage installations after they have been inspected by an Officer, duly observing the prescribed rules.

Date .....

.....

DEE(TrD)

..... RAILWAY

ELECTRICAL DEPARTMENT

CERTIFICATE OF COMPETENCY No. TR-7

(For staff dealing with Protective Relays and Instruments)

No.....

Shri .....(Designation) has been examined for his knowledge of rules as well as his skill pertaining to the maintenance, testing and repair of protective relays and associated circuits and instruments in traction substations and switching stations and is authorized to*-

1. work as a skilled artisan to perform the above type of work;

2. supervise the above works.

He is authorized to bring into operation new installations only after they have been inspected by an Officer.

Date. .....

.....

DEE(TrD)/ADEE(TrD)

*Strike out item not applicable.

..... RAILWAY

ELECTRICAL DEPARTMENT

CERTIFICATE OF COMPETENCY NO.TR-8

(For Skilled staff of Remote Control)

No.....

Shri ..... has been examined for his knowledge of rules and is authorised to work as a skilled Fitter in the installation, maintenance and repair of Remote Control equipment*/ FMVFT equipment at Remote Control Centre and controlled posts.

He is NOT authorized to work on any 240 V medium or higher voltage equipment.

Date. .....

.....

ADEE(TRD)

*Strike out item not applicable.

.....RAILWAY

ELECTRICAL DEPARTMENT

CERTIFICATE OF COMPETENCY No. TR-9

(For Supervisors of Remote Control)

No.....

Shri ..... has been examined for his knowledge of rules and is authorized to work as a Supervisor in the installation, maintenance and repair and testing of Remote Control equipment including FMVFT equipment.

He is authorized to bring being into operation new installations only after they have been inspected by an Officer.

Date.....

.....

DEE(TRD)

.....RAILWAY

ELECTRICAL DEPARTMENT

CERTIFICATE OF COMPETENCY No.TR- 10

(For Station Master/Yard Master/Asstt. Station master/Pointsman)

No. .....

Shri ..... S/o Shri.....Designation……. has been trained, examined and found fit for his knowledge of rules and special Instructions applicable to the equipment provided the station as laid down in the Station Working Rules to enable him to operate isolator switches under instructions from TPC in the 25 kV OHE electrified section during emergencies with exchange of private number and initial.

Date .....

.....

DEE(TRD)/ADEE(TRD)

PROFORMA OF

ASSURANCE

Necessary training for operation of isolator switches has been given to me with necessary operating instructions.

I can operate the switch during emergencies on receiving message from ON duty TPC.

Date .....

Signature

Name & Designation

Station Seal

.....RAILWAY

ELECTRICAL DEPARTMENT

CERTIFICATE OF COMPETENCY No.TR- 11

(For Permanent way staff)

No. .....

Shri ..... S/o Shri.....Designation……. has been trained, examined and found fit for his knowledge of Subsidiary rules for 25 kV ac traction issued by PCEE and PCOM and Permanent Way Safety Rules issued by Principal Chief Engineer as supplement to Part "J" Chapter II of Indian Railway Permanent Way Manual and ACTM (special Instructions applicable for Changing the Rails in 25 kV Electrified Section).

At the time of dismantling / replacing track from the site, Shri ..... is authorized to provide continuity jumpers as per instructions given in ACTM in addition to other instructions for the precautions to be observed by permanent way staff.

Date .....

.....

DEE(TRD)/ADEE(TRD)

*****