CHAPTER- 1

1. Foundation

1.1 Railway Administration-

Indian Railway is one of the largest organizations in the world. It is the largest enterprise, run by The Central Government. About 16 Lacks employees are there in this organization. Railway is under direct control of Railway- Board under Ministry of Railways- Government of India. The Minister of Railways is assisted by two State Ministers for Railways and is acknowledged by Chairman - Railway Board in all matters of railways. The Minister of Railway is answerable to Parliament in all matters of Railways

For efficient working & administration of Railways, it has divided into 16 Zonal Railways and each Zone is further divided into Divisions. Thus, Railway Administration has three tires viz.- Railway Board, Zonal Administration , Divisional Administration.

The Railway Board is chaired by Chairman Railway Board. He is the highest official of Railway. There are six Members in Railway Board to assist CRB in all matters concerning to their respective departments. The six Members are as follows-

Member Traffic
Member Personal
Member Engineering
Member Electrical
Member Mechanical
Finance Commissioner (Assists in Finance matters. He represents railways in Ministry of Finance and is answerable to Finance Minister)

Each Member is assisted by a separate Directorate which constitutes – Executive Director, Director, Joint Director, Additional Director, Assistant Director and other officials.

At Zonal level General Manager is the highest official and answerable to Railway Board in all matters of Zonal Railways. Additional General Manager & Sr. Assistant General Manager are also there to assist GM. Department wise Chief Officials are also there to assist GM in the matters pertaining to their respective departments. The sixteen Zonal Railways & their Head Quarters are as follows –

Sr.	Zone	Head Quarte
1.	Eastern Railway	Kolkata
2.	East-Central Railway	Hajipur
3.	East-Coast Railway	Bhubneshwar
4.	Western Railway	Churchgate (Mumbai)
5.	West Central railway	Jabalpur
6.	Northen Railway	New Delhi
7.	North-West Railway	Jaipur
8.	North-Central Railway	Allahabad
9.	North –Eastern Railway	Gorakhpur
10.	Southern Railway	Chennai

11.	South- East Railway	Garden Reach, Kolkata.
12.	South- Central Railway	Secunderabad.
13.	South- West Railway	Hubli.
14.	South- East Central Railway	Bilaspur.
15.	Central Railway Railway	CSTM Mumbai
16.	Northeast Frontier Railway	Gawhati

At divisional level, DRM (Divisional Railway Manager) is the highest official and is answerable to Zonal Management pertaining to all matter of Division. He is assisted by ADRM (Additional Divisional Railway Manager) and other branch officers known as Sr. Divisional officer. (Ex- Sr. DOM, Sr. DEE etc.). Sr. Divisional officers are responsible for their respective departments and are assisted by Divisional officer, Assistant Divisional officers and group three staff (Supervisors) .

Apart from Zonal & Divisional Railway the following Production units are also governed by Railway Board. The chief administrative officer of this production unit is General Manager.

1. Integral Coach factory - Perumbur – Tamilnadu.
2. Rail Coach Factory – Kapoorthala – Punjab.
3. Chitranjan Locomotive Works – Chitranjan – West Bengal .
4. Wheel and Axel plant - Bangalore – Karnataka.
5. Diesel Locomotive Works – Varanasi - Uttar Pradesh.
6. Diesel Loco Modernization Works – Ptiala - Punjab.

There are various repair shop and work shops are there which governed either by Divisional or Zonal administration. The official of Work-Shops, governed by Zonal Administration, is called as Chief Works Manager (CWM).

Divisions and Work Shops are separate and independent units, as far as administration is concerned and are under General Manager of the Zonal Railway.

1.2 Different Departments –

As per the various types of activities required to run the railway system , The Railway organization has been divided into the following departments –

1. Civil Engineering – Way (track) & Works.
2. Mechanical Engineering – Carriage & Wagon, Diesel Loco, Break down Staff.
3. Electrical Engineering – Train lighting & General Services, Traction Distribution, Electric loco. Electric Loco operation.
4. Signal & Telecommunication.
5. Traffic – Train operation, Safety.
6. Commercial – Selling of passenger tickets, freight charges, parcels, passenger amenities etc.

7. Accounts – Keeps account of railway earnings & expenditures
8. Stores – Purchasing materials required for working of Railway Organization, sell out scraped materials.
9. Personnel – Recruitment, Wages, Welfare, Promotion, Retirement of Railway employees.
10. Medical – Medical assistance (Hospital, Doctors, Medicines) to Railway Employees.
11. Security – RPF, GRP.
12. General Administration – Administrative set-up to look after railway organization as a whole.

1.3 Electrical Department

Railway Board –

1. Chairman Railway Board.(CRB)
2. Member Electrical.
3. Executive Director.
4. Director.
5. Joint Director
6. Assistant Director

Zonal Railway –

1. General Manager.(GM)
2. Additional General Manager.(AGM)
3. Chief Electrical Engineer(CEE)
4. Chief Electrical Services Engineer(CESE)
5. Chief Electrical Locomotive Engineer (CELE)
6. Chief Electrical Traction Engineer (CETE)
7. Chief Electrical Distribution Engineer (CEDE)
   Chief Electrical officers are assisted Dy. CEE, Senior Electrical Engineer (SEE) & Assistant Electrical Engineer (AEE).

Division –

1. Divisional Railway Manager(DRM)
2. Additional Divisional Railway Manager (ADRM)
3. Senior Divisional Electrical Engineer / Train Lighting & General Services (Sr.DEE/G)
4. Senior Divisional Electrical Engineer / Traction Distribution (SrDEE/TRD)
5. Senior Divisional Electrical Engineer / Traction Rolling Stock (Sr.DEE/TRS)
6. Senior Divisional Electrical Engineer / Traction Rolling Operation (Sr. DEE/TRO)
   Senior Divisional Electrical Engineers are assisted by Divisional Electrical Engineer (DEE) & Assistant Divisional Electrical Engineer (ADEE)

1.4 Activities in Electrical Department.

Electrical General Department has two sub departments – Train Lighting, OSM. The Train Lighting department looks after Light & Fan in carriages, air conditioning plant for AC coaches. OSM department looks after the electricity supply system of Service Buildings, Stations, Yards, Offices, Staff quarters & colony, electric motor pumps Air Conditioning Plants other than used in coaches, Diesel Electric Generators etc.

Traction Distribution Department may further be classified as – Over Head Equipment, Power Supply System, Remote Control & Traction Power Controller. The OHE sub-department looks after the over head conductor system made for pantographic current collection. PSI sub-department looks after Sub-Stations & Switching Stations made for traction power supply. Staff under remote control looks after the remote control system (SCADA) used for centralized control of Traction Power Supply System. The Traction Power Controller is one of the controllers who work at Divisional Control Room and He is responsible for availability of OHE and Power Supply, at all time, for normal train operation.

The Traction Rolling Stock department is responsible for scheduled maintenance, overhauling and repairs of Electric Locos.

The Traction Rolling Operation department looks after the management of Loco Crew (Drivers, Assistant Drivers), Locos. i.e duty roster of drivers, their routine medical check up , training etc., Power Plan of loco, trip inspection schedule, overhauling schedule etc.

1.5 Employee's Welfare Activity in Railway –

Railway Administration bears the responsibility to take care of the overall well being of his employees and their family. Therefore, Administration runs a number of welfare activities, so that, the employees and their family are maintaining a good social status. A few welfare activities are given below -

1. Railway Entertainment home.
2. Railway School.
3. Children camps.
4. Holyday Home.
5. T.B. sanitarium.
6. Canteen facility (catering)
7. Co-Operative Society.
8. Hostels.
9. Club.
10. Scholarship Etc.
11. Disaster Management help group etc.
12.

To make these programs effective and to ensure their affects, a separate welfare department has formed which works under administrative control of Personnel Department. On Zonal, Divisional & Workshop level, a personnel Officer is appointed to look after these activities. He is assisted by a good number of welfare inspectors. These welfare inspectors go to the employees and ask their problems, counsel them and short out their grievances.

2. Portable and Hand Tools

2.1 Name Size and usages of Portable and hand Tools-

Sr.	Name of Tools	Size	Usages
1.	Pliers , Nose Pliers, Side Cutting Pliers, Round Nose Pliers	15c.m., 20 .cm., 25c.m.	To hold wire, nuts etc., to cut wires.
2.	Screw Drivers	10,15,20,30,60 mm	To loose / tight screw
3.	Firmer chisel	15c.m., 2 to 5 c.m. width	For carpenter's work.
4.	Cold chisel	- do -	To cut metal sheets, pock wall etc.
5.	Hammer	250 gm to 7 kg	
6.	Mallet	--	
7.	File	Flat , Round, Triangular, half round	To make surface smooth, to rub the job into size etc.
8.	Drill Machine	Hand drill, Electric drill	To put the hole .
9.	Spanner	D spanner, Round , Adjustable, Box spanner, Wrinch	To loose / tight nut – blots , pipe threads etc.
10.	Centre Punch	-	To put point marking on the job.
11.	Tenon Saw	250- 400 mm.	To cut wood.
12.	Hack Saw	Fixed, Adjustable	To cut metals.
13.	Steel Foot	15,30 cm.	To measure straight length.
14.	Tri square	150, 300 mm	To put rectangle.
15.	Electrician knife	-	To cut cable insulation
16.	Soldering Iron	25,40,65,125 watts	To joint wire terminals ,to make connection,
17.	Standard Wire Gauge	-	To measure wire size.
18.	Micrometer	-	To measure diameter, thickness precisely .
19.	Wice	Pipe wice, bench wice, hand wice	To hold the job firmly.
20.	Tachometer		To measure RPM.

2.2 Crimping Tool –

To make wire or cable connections reliable, to get ease while making connections; it is good to use Lug on wire/ cable terminals. The Lug is firmly pressed on free end of wire / cable. To do this, a tool is used called Crimping tool and this act is called as crimping of Lug. Various types of crimping tools are available like-

1. Hand press Crimping Tool
2. Hand operated multi-utility tools.
3. Hand operated multi-utility with Die of various sizes.
4. Hand operated hydraulic pressure type.

Sizes of Die depend upon Lug & Cable size.

2.3 Torque Wrinch –

Nut –Bolts of various sizes are used in various types of Machines & Equipments. Some of them are very small and very big also. It is observed in day to day maintenance that some times nuts remain loose and some times tighten very hard; resulting in breakage of bolt. Some Machine parts are so peculiar that a slight variation in tightening of nut bolts from the design value; results in serious effects.

To avoid such types of failures, Torque wrinchs have been developed. These Wrinches are having facility to adjust the tightening force, such that, that the bolt gets tighten up to the set torque and after that the wrinch moves freely and the bolt escapes of being over or under tighten.

3. Measuring Tools –

Measuring tool means tools used for direct measurement of the quantities; like Scale, Caliper, Vernior Caliper, Micrometer etc.

3.1 Scale –

Scale is the simplest tool used for measurement of straight lengths. Scale is generally used for drawing and desk uses. For moderate and larger lengths flexible measuring tapes are used. As per its range it has markings of Meter, Centimeter, Millimeter, Inches etc.

3.2 Caliper –

It is a scale with special arrangements and used for measurement of inner diameter of spherical jobs.

3.3 Vernior Caliper –

It has two scales; one sliding on the other one. The sliding scale is called as vernior scale and the other as main scale or fixed scale. Vernior caliper is used for accurate measurement of very small dimensions. It can measure up to first place of decimal. It can be used for thickness, outer & inner diameter, depth etc,

3.4 Micrometer –

It is also used for small measurement. It can measure accurately up to second place of decimal. it is used for measurement of outer dia., thickness . It also has

two scale one called as main scale and the other one as circular scale. The circular scale turns on main scale as that of Nut on the Bolt.

While using Varnior or Micrometer , it should be checked for its error. Vernier scale should be locked with the securing screw prior to read it . The Micrometer should always be turn with the help of given ratchet and it should be locked in position with help of given liver, prior to read it.

3.5 Least Count –

It means the smallest count that can be measured accurately from the given measuring tool.

$$\text{Least Count of Vernier Calipers} = \frac{\text{Value of One mark of Main Scale}}{\text{Total numbers of marks on varnior scale}}$$

$$\text{Least Count of Micrometer} = \frac{\text{Value of one mark of Main Scale}}{\text{Total number of marks on circular scale}}$$

Final Reading = Main Scale Reading + Least Count (Varnior Scale OR Circular Scale Reading)

4. Calibration –

Calibration means to compare the reading of a measuring instrument with that of some higher standard meter or absolute meter. The measuring meters used in day to day work acquire some of the errors due to their inherent properties , physical conditions , handling etc.. Thus the measurements taken from such meters do not remain accurate. Therefore, calibration in a regular interval in necessary to maintain the reliability of the meter. Through the calibration, we try to ascertain the amount of error arisen in the meter so as to necessary adjustments may be done.

5. Accuracy –

It is very difficult to measure the true value of a quantity being measured by a measuring instrument. It is so, because of the errors in the instrument, human error etc..

Therefore, we have to compromise on the closest value of the measured values with respect to true value of the quantity being measured

Normally the accuracy of an instrument is given on the rating plate of the instrument. Accuracy of an instrument can be deduced at the time of its calibration.

6. Classification of Measuring Instruments –

As per use

1. Primary Instruments.- Used in laboratory
2. Secondary Instruments – Used in day to day work.

As per out put

1. Analogue- Pointer and Scale 2. Digital – Reading in digits.

As per nature of reading –

1. Indicating – indicates instantaneous value of the variable .
2. Recording – instantaneous values are recorded with respect to time (usually on chart, graph etc.) like speedometer
3. Integrating Type – indicates cumulative value, like energy meter etc.

6.1 Various Types of Meter -

As per the variable to be measured meters are of various types. Some of them are given below-

1. Volt Meter – It is used for measurement of voltage difference between any two points of a circuit. It is connected parallel to the points where voltage difference is to be measured. For identification it is marked with **V.**

2. Ammeter - It is used for measurement of current passing through a point in the circuit. It is connected in series. For identification it is marked with **A** .

Note :- Some of the Ammeter , Voltmeters etc are made for either Alternating Current & Voltage or for Direct Current & Voltage . Though some of them are such that they can work both in AC & DC system . This fact is encoded on the meter as symbol of AC & DC.

3. Megger - It is used for measurement of insulation resistance. Its scale has divisions in Megaohms (**MΩ**). On extreme left of the scale divisions infinite (∞) is marked and that of extreme right zero is marked. The standard rating of megger is - 500V, 1000V, 2500V,5000V ; since it generates so much of DC voltage when its handle is rotated at the said RPM.

$$1\ M\Omega = 1000000\ \Omega$$

4. Multimeter - It is the most commonly used meter. Some times it is called as AVO Meter ; because the general parameters of a electrical circuit like Voltage, Current & Resistance can be measured by this single meter. This is also used to check circuit continuity, advanced meters also have the facility to check capacitance, Diodes, signal level (**dB** – decibel) , etc. Multimeter is used only for low and medium voltage circuits.

5. Toung Tester – It is a type of Ammeter . It has a splitting jaw , opens and closes by the given handle. When a conductor is enclosed by its jaw, the meter reads the current flowing through the conductor. The specialty of this meter is that it requires no electrical connections as required by a ordinary Ammeter .

6. Tachometer – Used for measurement of RPM of moving shaft.

7. Personnel Safety -

7.1 Safety while handling Tools & Equipment -

1. Fine edge tools like Knife, Chisel, Screw-Driver etc. should not be kept in pockets without a suitable shield .
2. Pick or fetch a fine edge tool from its handle.
3. Do not hit the Chisel towards yourself while cutting a job.
4. Grip or handle of tools should be free from any type of oil, lubricant etc.
5. Appropriate tools of suitable capacity should be used.
6. While fetching a tool, it should not be thrown.
7. While working on heights, take care that tools should not fall.
8. Always use insulated tools while working on a electrical circuit.
9. Ensure that supply is cut-off and it will not be ON even accidentally, while working on a machine with moving parts.(Keep cut-outs of such machine with yourself)

7.2 Ladder , Helmet & Safety belts -

While working on heights always use ladder to reach safely at the work-place. Ensure that the ladder is secured by a man. Safety belt and helmet should invariably be used while working on height. They guards us from falling on ground . There are so many possibility of head injury ,so that , Helmet & Boots should be put –on while coming to work.

7.3 Earthing -

The outer body of every electrical equipment should be earthed. Earthing safe guards both the Man & Machine. Earthing means to connect the body electrically to the general mass of earth . The earthing provides the least resistance path to the leakage voltage to rush into the ground and thus the man becomes safe from the harmful effects of leakage voltage. Due to least resistance path the leakage voltage yields high line current and thus the protective equipments (Fuse, MCB etc) cut the supply to that machine.

7.4 Fuse / MCB -

Fuse / MCB are the basic protective equipments for safety of an electrical circuit or machine etc. Fuse element is a wire of some alloy metal (copper, tin ,led etc.) This element is placed suitably in porcelain casing. As per safe current rating ,its size (cross sectional area) vary in direct proportion. Beyond the rated current fuse element melts quickly and breaks the current flowing into the circuit. Basically fuses are of two type viz.- Rewire able , HRC (High rupturing capacity). HRC fuses have their element sealed in porcelain casing filled with some special powder which quenches the arc quickly as soon as it arises at the verge of melting of fuse element and thus isolates the circuits faster than rewire able fuse (Kit –Kate fuse).

Since it takes considerable time to replace the fuse , resulting down time of machine or circuit and also maintenance cost increases ; therefore , MCB is adopted as a better option . On fault current it simply trips like a Circuit Breaker which can be reset within no time. It is also available in a wide range.

7.5 General Safety Rules -

1. Never work on a machine or circuit with supply on .
2. Insulated tools should be used while working on electrical equipments.
3. While working on HV/EHV system, hand gloves, rubber mat should be used.
4. While removing plug-pin from socket, do not pull it from wire/cable.
5. While replacing fuse, switch off main switch.
6. Ensure proper earthing & use three pin plug.
7. Check out loose connection (a cause of sparking) and tight it ; avoid undue handling.
8. Availability of fire extinguisher (Sand/water bucket, chemical extinguisher) and knowledge of its proper use.
9. Do not loose your attention from your work.
10. Always use tested tools/equipment to their failure during the work.

7.6 Electrical Accident. -

If an electrical accident takes place the rescue operation may be divided into three stages viz.- Isolation , First Aid , All concern massage.

As a first step of rescue, either remove the victim from the place or remove the electricity from the place. In case of low voltage system the victim may be removed by some one who has made oneself protected from electricity by using dry wooden piece, bamboo or any such insulating thing. In case of high and extra high voltage system first of all supply should be switched off. In case of OHE or any where else, induced voltage is likely to be; the line should be earthed also.

When isolation is done , provide the necessary first aid in such a sequence

that the survival of the victim is on the top of the priority.

Send the victim to the Doctor. All concerned should be informed and also a note should be prepared highlighting the situation and cause of accident. This note shall be signed by those employees who are some how linked to the incident.

8. Safety in Electrified section -

The high voltage lines have two types of induction effects –

1. Electrostatic induction 2. Electromagnetic induction.

The high voltage lines behave like a capacitor and keep the static charges stored. The electromagnetic induction is due to the current flowing in the lines . In case of OHE electromagnetic induction effect is clearly evident. No work shall be done, in the vicinity of OHE; without considering the effects of induction .

The induction effect is in direct proportion to the proximity with OHE and to the parallelism with OHE.

To ensure the safety of employees in electrified section ,concept of safe working distance has been enforced. It means the safe working distance should not be fouled either directly or indirectly (Through any conducting part). Beyond the insulator each part of OHE is charged on working voltage and shall be treated as charged until grounded with the help of Two discharge rods(even earthing with one discharge rod is not safe). According to working voltage safe working distance is as under-

1. 1500 volt DC traction = 1mt.
2. 25 KV 1ph. AC traction = 2 mt.

Here are some of the warnings, to be taken care of, while working in electrified Sections –

8.1 Precaution while working on LT line – In electrified section, prior to work on LT line, the LT line should be earthed at both ends. The distance between two earths shall not be more than 1 KM. Each working party shall provide its own earthing.

8.2 Precaution while working on FOB, Platform Shed etc. – Such metallic structures in the vicinity of OHE , may have dangerous induced voltage . The work man should ensure proper earthing arrangement.

8.3 Over Head Water filling – In electrified section, if over head watering in coaches etc. is to be done , the supply of OHE shall be cut-off and both side earthing should be done by discharge rod. Care should be taken that no metallic article should enter into the Danger Zone of OHE.

8.4 Crane Working – The authorized employee shall be present at the site where crane working is to done in the electrified section.

8.5 Isolator operation – Isolator is a OFF load switch used for isolation of OHE. If care is not be observed, the operator may injured from electrical spark occurred on

isolator's contacts. The following are the rules regarding isolator operation-

1. Shall be opened in OFF load condition only.
2. Shall be operated by competent staff only.
3. Without applying handle lock operation shall not be treated as complete.
4. Isolator key shall be kept with Station Master and He shall maintain a register to record the key transactions.
5. Any unusual condition of Isolator shall be promptly reported.

8.6 Bonding – All metallic structure shall be connected to rail so as to induced voltage developed in that structure may go to earth. Such connections are called as bond.

8.7 Temporary Jumper – The track acts as return path for traction current. If this path breaks, the voltage will appear at both the ends. Therefore, while rail is being replaced temporary jumper should be provided to make the continuity of return current.

8.8 Permit-to –work – To ensure safety in electrified section, permit –to –work methodology has been devised. In this method one competent employee, who has been authorized to control the electric supply, permits other competent employee to work on a given line/equipment by exchanging some type of token after being self satisfied that the line / equipment is safe to work upon. The line / equipment shall only be charged after cancellation or return of permit to work .

8.9 If fire occurs and the line/OHE/equipment is electrically live ; do not use water or water base fire extinguisher until the line/OHE/equipment becomes electrically safe .

9.0 Fire –

When any thing burns it emits heat, light and gases at very high temperature. These gases appear in the form of flame; all this happening is called as Fire. To sustain fire – Heat, Air and burning matter should be there. Out of these three factors, if any one is removed, the fire gets extinguished. As per the nature of the burning matter, fire is classified in four categories and accordingly Fire extinguisher too has classified. The suitability of fire extinguisher is clearly marked on its body as the class of fire extinguisher.

9.1 Classification of Fiers –

1. Type A –Fire involving combustible materials of organic nature, such as Wood, Paper, Rubber and many plastics etc. where the cooling effect of water is essential for extinction of fire.
2. Type B – Fire involving flammable liquids , petroleum products, or the like, where a blanketing effect is essential.
3. Type C – Fires involving flammable gases under pressure including liquefied gases, where it is necessary to inhibit the burning gases at fast rate with an inert gas, powder or vaporized liquid for extinguishment.
4. Type D – Fire involving combustible metals , such as magneshium, zinc, sodium ,potassium , when the burning metals are reactive to water containing agents, and

in certain cases carbon dioxide , halogenated hydrocarbons and ordinary dry powders. These fires require special media and techniques to extinguish.

9.2 Types of Fire Extinguisher-

1. Soda Acid type – class A fire.
2. Fome Type – class A & B fire.
3. Carbon dioxide type – class A, B, C, fire.
4. Dry chemical powder- according to situation, all types of fire.
5. Other methods – sand- bucket, fire brigade (call 101) etc.

During fire-fighting all care should be taken to minimize the losses by preventing the spread of fire, early extinction of fire. Ex-. In case fire caught in oil, it may spread in larger area if water get is used on that oil. Use of water in case of fire caught electric equipment may cause a bigger accident if the electric supply of that equipment is not cut-off.

10. First Aid –

10.1 Electric Shock-

1. Switch off supply, main switch.
2. Isolate the victim from electric supply.
3. Take care of the victim at open air ,check that breathing is there, conciseness, burns , bleeding etc.
4. Send to hospital for medical care.
5. If there is breathing problem, first of all apply artificial respiration and send for medical care.

10.2 – Cut & Wounds, Hits-

1. Apply bandage, clean the wound with anti –septic agent.
2. Try to stop bleeding.
3. Try to keep body part stable where bone is broken . Provide some type of support.
4. Solace the victim. Do needful as the situation warrants like provision Tea, water, try to keep body warm etc.
5. Send to Doctor without loosing time.

10.3 Burns –

1. At burn spot apply potato –water, Burnol , Coconut oil etc.
2. Make a liquid by mixing 10gm of eating –soda into half liter of water and apply this mixture on the burn spot with help of cotton.
3. Send to the doctor as quickly as possible.

11. Material Handling –

11.01 Types of Equipment used for material handling-

1. Manual equipment -

1.1 Carrier – Box tray, hand trolley etc.

1.2 Gravity used as slops.

1.3 Shovels, Wire Claw

2. Mechanical Equipment-

2.1 Crane (Electric Motor type, Manual hydraulic type) – for vertical lifting & horizontal displacement.

2.2 Fork Truck – vertical pick-up and displacement.

2.3 Conveyer Belt – From one fixed place to another fixed place.

2.4 Chain pulley block – vertical lifting.

2.5 Screw Jack, Hydraulic jack. Pulling & lifting devices etc.

2.6 Mass transportation means- truck, dumper, rope-way etc.

11.02 Precautions – Lifting devices should be used as per their capacity, Shifting devices should not be over loaded, Chain-Ropes should be regularly checked , while lifting secure the job properly, look-out for possible dangerous situation.

12. Cleanliness and Up keeping of working Environment-

1. Materials of different utilities, types should be placed at their specified place.

2. Nut, bolt, screws of different sizes should kept in different trays, buckets etc. such that they should mix one –another. It helps in proper assessment of quantity, no need to search.

3. Each stored item should be easily accessible, no need for search out , time saving, safety.

4. Clear demarcation of path way (normally with yellow paint), it reduces the possibility of accident, ease in working.

5. Long & heavy articles should not kept in vertical position, prevents accidents.

6. Week & Delicate items should be kept apart , prevents damages hence money saving.

7. Material sensitive to environment should be given due attention like cement bags be protected form moisture, Paint Can should be properly sealed, cables etc. Prevents damages , hence money saving.

8. Oil drum should be clearly indicated with name, tightly closed, secured from toppling and away form possibility of fire. Make provision for drainage.

9. Material sensitive to heat should be kept away from such possibility like electric bulbs etc.Prevents accidents.

10. Path way should be clean and free from lubricants, oil etc.

11. Scrape, Empties should be stored separately with proper categorization.

12. Use dust bins- improves cleanliness, a positive incentive to work .

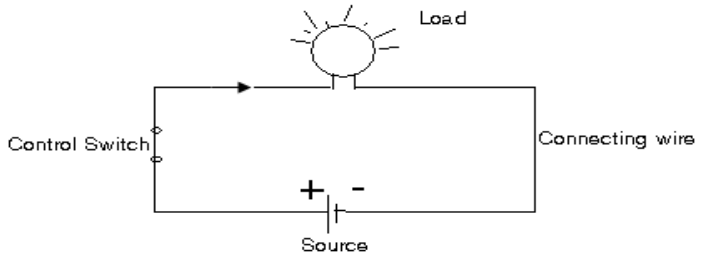
13. All care should be taken to prevent theft.

14. Proper Lighting and Ventilation prevents the possibility of hazards and helps in efficiency improvement.

CHAPTER -2
BASIC ELECTRICITY

1.0 Electricity is a form or type of energy. Without energy no work can be done. Basically electricity is said of two types viz-. Static electricity and Dynamic Electricity . Here we are going to learn about dynamic electricity.

2.0 Electric Circuit – The path made for flow of electric current is known as circuit. Basically there are four components of a circuit viz- Load, Source, connecting wires and control switch.



2.1 Types of Electrical Circuits –

1. Open Circuit – A circuit where the path of current is interrupted and there is no flow of current ; such a state of circuit is called as opened circuit.

2. Close Circuit – When there is closed continuous path for the flow of current; such state of circuit is called as closed circuit. In general close circuit means where current is flowing and open circuit means where No current is flowing.

3. Short Circuit – When a circuit gets completed without having a load or the load resistance is as low as zero; in such conditions current tends to rise very-very high and such state of circuit is called as short circuit.

2.2 Series Parallel Connection –

When there are more than one load or supply sources are connected; their connection is either called as Series Connection or Parallel Connection and the circuit thus formed is called as Series Circuit, Parallel Circuit, or Series-Parallel Circuit.

1. Series Circuit – Where there is only one path for current or in other words the same current flows through all loads ; the circuit is called as series connected circuit.

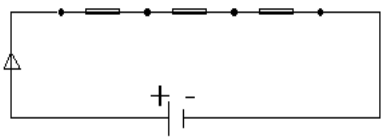
2. Parallel Circuit – Where there is more than one path for the current, the circuit is called as parallel connected circuit.

2.3 Comparison between series and parallel circuits-

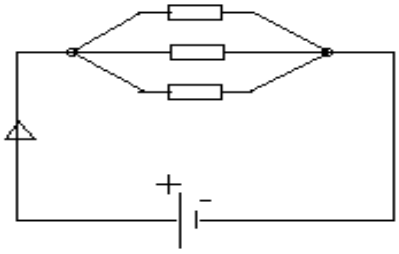
Sr	Series circuit	Parallel Circuit
1.	Single path for current flow	More than one path for current flow.

2.	Loads are connected like a string.	Loads are connected like a ladder.
3.	Voltage drop across different loads depends upon their individual resistances. i.e V= v1+v2+v3+…	All connected loads gets same voltage .i.e. V=v1=v2=v3=…..
4.	Same current flows through all the loads, i.e. I = i1=i2=i3=……	Current in each branch depends upon branch resistance, i.e. I = i1+i2+i3+…..
5.	Resistance increases if connected in series , i.e. R = r1+r2+r3+….	Total resistance becomes lesser than the smallest resistance connected in parallel connection , i.e. $R = \frac{r1.\ r2.\ r3}{r1.r2 + r2.r3 + r1.r3}$

Series Circuit –



Parallel Circuit -



3.0 Current –

The rate of flow of electrons in a conductor is called as current. Its unit of measurement is Ampere (A or Amp). It is measured by Ammeter. Ammeter is connected in series to the load that's current is to be measured. Other units are – mili Ampere (mA), Kilo Ampere (KA). Etc.

1000 mili Ampere = 1 Ampere.
1000 Ampere = 1 Kilo Ampere.

Current is the effect of Voltage. Without voltage difference there is no current.

4.0 Voltage –

Voltage is the electrical pressure which causes current in electrical circuit. Its unit of measurement is Volt (V) and measured by Volt –meter. Volt-meter is connected between those two points that's voltage difference is to be measured. In other words volt-meter is connected in parallel to that load where across voltage drop is to be measured. The other units are – mili Volt (mV), Kilo Volt (KV) etc.

1000 mili volt = 1 Volt
1000 Volt = 1 Kilo Volt

For practical purposes Electromotive Force (EMF) and Voltage may be taken as synonymous, though there is little difference.

5.0 Direct Current (DC) / Alternating Current (AC) –

Direct current means current that's magnitude and direction remains unchanged with respect to time. It is the effect of Direct Voltage. Ex- out-put of DC generator, Battery (pure DC), Out put of rectifier circuit, etc. DC source of supply will be marked (+ Positive) and (- Negative)

Alternating Current means that's magnitude and direction continuously changes with respect to time. In one direction its magnitude rises from zero to maximum and reduces to zero and again rises from zero to max, but in opposite direction, and max to zero. Such alternating quality is denoted as cycles per second (or frequency). Ex.- out put of Alternator (or AC generator). AC sources of supply will be marked (P- phase) and (N – neutral).In our country alternating current of 50 cycles per second (or 50Hz) is being used.

6.0 Resistance –

Resistance is the property of the material by virtue of which it opposes the flow of current .Although it is the inherent property of materials, but it is greatly influenced by dimensions also. Resistance of a conductor is represented by this formula –

$$R = p\frac{l}{a}$$

Where-

R- Resistance, p – resistivity , l – length of conductor, a- cross sectional area of conductor.

The formula states that conductor made-up from high resistyvity material will have more resistance and vice-versa. The resistance is directly proportional to length and inversely proportional to cross-sectional area.

The unit of resistance is Ohm (Ω). It is measured by Ohm-meter, multi-meter, Contact resistance meter, Megger (for insulation resistance), Earth tester (for earth pit

resistance.) Other multiple units of Ohm are – KΩ (Kilo-ohm), MΩ (Mega-Ohm), GΩ (Giga-Ohm).

The effect of resistance is voltage drop & rise in temperature.

7.0 Work –

The displacement of a body in the direction of applied force is called as work.

$$\text{Work} = \text{Force} \times \text{Displacement}$$

The units of Work are – Foot- Pond, Kilogram-Meter etc.
Ex. – If a 10kg weight is lifted by 10 meters then work done is 10x10 = 100 kg-mt.

8.0 Power –

The rate of doing work is called as power .In other words Work done per second is power.

$$\text{Power} = \frac{\text{Force} \times \text{Displacement}}{\text{Time}}$$

8.1 Horse Power – It is unit of mechanical power. Engine Capacity, Motor Capacity etc. are represented in HP.

1 HP = 550 foot-ponds per seconds.
1 HP = 33000 foot-ponds per minutes.
1 HP = 75 Kg-mt per second.

8.2 Electrical Power – The unit of electrical power is Watt. It is measured by Watt meter.

Watt = Voltage x Current (for DC circuits)
Watt = Voltage x Current x Power Factor (for AC circuits)
The other units are KW (kilo-watt) MW (mega-watt)

8.3 Relation –

$$1\text{HP} = 746 \text{ watt}$$

8.4 Power Factor

It is the ratio of Actual Power to Aperant Power. Actual Power means power actually used .Its unit is Watt. Aperant Power means power taken from source. Its unit is Votlt –Amper . Therefore,

$$\text{Power Factor} = \frac{\text{Watt}}{\text{Votl-Amper}}$$

The values of PF vary from 0 to 1.
9.0 Ohm's Law –

In a closed circuit the current is directly proportional to applied voltage and inversely proportional to circuit resistance while physical condition of the circuit is kept constant.

In other words; in a closed circuit the ratio of voltage and current is always constant. This constant is numerically equal to the resistance of the circuit provided physical condition of the circuit is kept constant.

Generally physical condition means temperature, connections, and wire size etc.. The mathematical representation of this law is –

$$R = \frac{V}{I}$$

Other Derivatives of this mathematical expression are –

$$I = \frac{V}{R} \qquad V = I \times R$$

10.0 Magnetism & Electromagnets –

Iron and a few similar metals can acquire the property to attract similar metals; such metals are called as Magnets and their vary property is called as magnetism. Ex- Iron, Nickle, Cobalt etc.. The general properties of magnets are as under –

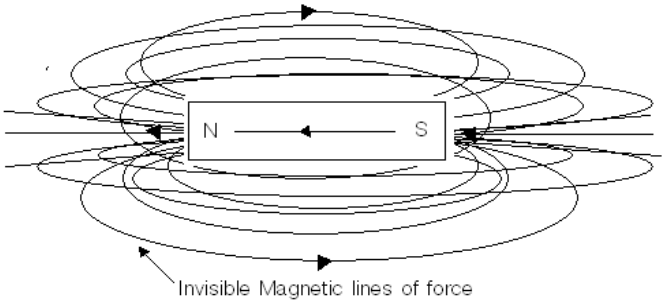
1. A magnet has two poles (practically power points of the magnet) known as South Pole and North Pole.
2. A freely suspended magnet always rests in North-South direction of earth.
3. If a magnet is broken into pieces; every piece will have North- South poles; regardless of the size of piece.
4. Similar poles repel and opposite poles attract each other.
5. Invisible lines of force emerge from North Pole enveloping the magnet converges into the South Pole. These lines of forces are called as Magnetic lines of forces.
6. The magnetic property of a magnet vanishes if it is heated up to a certain temperature.

The magnets naturally available in earth are called as Natural Magnet or Permanent Magnets. We can also make an ordinary piece of iron as magnet. When sufficient number of turns of a wire is coiled over the piece of iron and an electric current is made to run through the coils; the ordinary piece of iron becomes a magnet. It exhibits magnetism until the current in coils is stopped. Such a magnet is called as Electromagnet. Electromagnets are invariable part of various electrical equipments, electrical machines, meters etc. like – Motor, Generator, Transformer, Analogue Measuring Meters etc.

10.01 Magnetic Field –

The area surrounding the magnet where its effects can be seen is called as magnetic field of the magnet. This area directly depends upon magnetic power of the magnet.

10.02 Magnetic Lines of Forces.



10.04 Magneto motive Force (MMF)-

The power required to establish magnetic lines of force is known as Magneto motive force.

10.05 Ampere-Turn –

It is the unit of MMF. When electromagnet is made its magnetic strength is numerically equal to the product of Number of turns in the coil and the current flown through.

Ampere-Turn = Number turns in coil x Current flowing through the coil.

Up to a certain limit magnetic strength is directly proportional to Ampere-turn, but after that magnetic strength does not increase irrespective of increase in ampere-turn.

11.0 Cell –

Cell is an arrangement which converts chemical energy into electrical energy.

11.01 Battery –

The series or parallel or serie-parallel combination of two or more cells is called as battery.

11.02 Types of Cell –

1. Primary Cell- The cell which can be used once, e.i. recharging is not possible is called as primary cell. The cell becomes ready for out-put as soon as its ingredients are put together. Being used to give supply, its ingredients become useless and recharging is not possible. To use it next time, fresh ingredients (chemicals) has to be provided.

2. Secondary Cell – The cell which can be recharged, after being discharged and thus can be used repeatedly without replacing its ingredient chemicals, is called as secondary cell.

Putting the ingredient chemicals together, the cell does not become ready for use. First it has to be connected with a DC supply source that its positive terminal is connected with positive terminal of supply source and Negative with Negative terminal. Now current is established through the cell and it initiates chemical reaction in side the cell. The electrical energy is now being stored in the cell. This action is called as charging of cell. After being charged, the cell is disconnected from supply source and now is ready for use. When this cell is used by connecting some load/circuit between its terminals, it starts giving supply into the load /circuit. This action is called as discharging of cell. After being discharged, it can again be recharged by applying charging process and the

cycle of charging and recharging may go on. In this cycle of charging and discharging there is no need of replacement of active material of the cell.

There are some parameters to identify the cells as charged or discharged.

11.03 Types of Secondary Cell –

1. Lead –Acid Cell.
2. Alkaline Cell.
    - i – Nickel-Iron Cell.
    - ii- Nickel –Cadmium Cell.

11.04 Comparison between Lead-Acid & Nickel-Iron Cell

Serial	Particular	Lead-Acid Cell	Nickel-Iron
1.	Container	Hard rubber/ Ebonite	Nickel plated iron.
2.	Positive Plate	Lead Oxide (PbO2)	Nickel Hydroxide Ni(OH)4
3.	Negative Plate	Pure Lead (Pb)	Iron (Fe)
4.	Electrolyte	Distilled water and Sulphuric Acid[H2SO4], generally ratio is 1:4	21% solution of Caustic Potash [KOH]
5.	Separator	Rubber or PVC	Rubber or PVC
6.	Maximum Voltage	2.2 volt per cell	1.4 volt per cell
7.	Specific Gravity(SPG) when fully charged	Approx. 1.220	1.220 constant
8.	Storage Condition	If kept discharged for long time it becomes useless	Can be used after long discharged spell.
9.	Weight	Heavy	Light
10.	Discharge Capacity	Heavy currents may be drawn.	Heavy current may not be drawn.
11.	Mechanical Strength	Weak	Strong
12.	Gassing	Harmful gassing while charging	No gassing.
13.	Capacity	High	Low
14.	Cost	Low	High
15.	Maintenance	High	Low

12.0 Principle of Motor & Generator –

Electric Motor is a machine which converts electrical energy into mechanical energy, while Electrical Generator is a machine which converts mechanical energy into electrical energy. In practical terminology the word Generator implies DC Generator. AC generators are well known as Alternators.

Principle of Electric Motors- When a current caring conductor is placed in a magnetic field, a force acts upon the conductor.

Principle of generator – When a conductor cuts the magnetic lines of force, an EMF is generated across the conductor. In other words, if there is relative motion between conductor and magnetic lines of forces in normal direction to the direction of magnetic lines of force, an EMF will be generated across the conductor.

SOLVED EXAMPELS

1. Find the total resistance between points A and B in fig.-1.

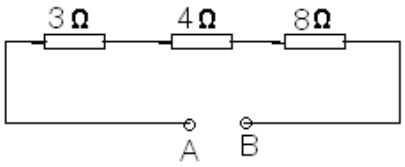


fig.-1

⇨ Let the total resistance between terminal A & B is R . Let 3Ω = r1, 4Ω = r2, 8Ω = r3.

As per fig-1, all the three resistances are connected in series connection. We know that in case of series connection the formula for total resistance is –

$$R = r1 + r2 + r3 + \ldots\ldots.$$

Therefore R (A-B) = 3Ω +4Ω +8Ω = 15Ω – Ans.

2. Find the total resistance between points A and B in fig.-2

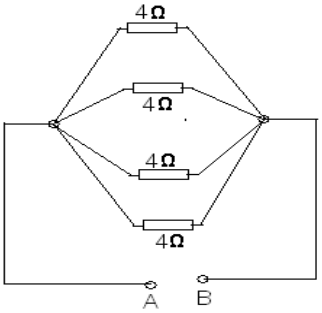


fig-2

⇨All the four resistances of 4 ohms each are connected in parallel connection. The equivalent resistance R for parallel connection is given by the following expression

$$R = \frac{r1 \cdot r2 \cdot r3 \cdot r4}{r2 \cdot r3 \cdot r4 + r1 \cdot r3 \cdot r4 + r1 \cdot r2 \cdot r4 + r1 \cdot r2 \cdot r3}$$

Putting the value of r1,r2,r3 and r4 in the above expression and solving it –

R=

4.4.4.4

CHAPTER – 3

DRAWING & CIRCUIT DIAGRAME

1.0 Introduction-

Drawing is said to be the Engineer's Language. The vocal description of an object will always be inferior to what a picture or drawing depicts about the object. The importance of drawing can well under stood when it is required to state about some thing that has not been seen before. Thus drawing is a tool of Engineers to make their ideas visible, ease in explaining the facts & situation, ease in assessments etc..

2.0 Types –

Machine drawing, Electrical Drawing, Maps, Lay outs etc. In machine drawing shape, size, dimension etc are all impotent. Any deviation will make the efforts useless. In electrical drawing, symbols are used. Here connections are important; shape, size etc. have no significance.

3.0 Lettering –

Various information given on the Drawing is called as Lettering, like – Title of the drawing, dimensions, and notes etc. Generally vertical or inclined writing is used. Lettering is done in two types of writing- Single Stroke, Gothic letter.

3.1 Single Stroke letter –

Single stoke letter means to write in single move of pencil. Single stroke lettering is used where thin and small letters are required. Normally Capital Letters are used. The various sizes of letters are as follows-

1. Title, Drawing No. - 6,8,10 and 12 mm height.
2. Sub-title – 3, 4, 5 and 6 mm height.
3. Material's name, dimensions, notes- 2, 3, 4, 5 mm height.

Ex-

A Q L P R U 1 5 9 6 2 vertical letters

A Q L P R U 1 5 9 6 2 inclined letters (70º)

3.2 Gothic Letter -

Thicker than single stroke letters are called as Gothic letters. Such type of lettering is used for main heading of the drawing. The thickness of such letters should be 1/5 to 1/10 of its height. The ratio of height to width should be 5:4. (Except A, K, M, W where the ratio is 1:1). The letters C, D, G, O, and Q should be in round shape when written in vertical style and in oval shape when written in inclined style.

Ex.-

A B C D 1 6 7 9 (vertical)

A B C D 1 6 7 9 (inclined)

4.0 Size of drawing –

4.1 Full size drawing-

Drawing made in actual dimension of the object, i.e. the length of 5 cm will be drawn as 5 cm on drawing sheet.

4.2 Enlarge size drawing –

The size of drawing (dimensions) will be greater than the actual size (dimensions) of the object.

4.3 Reduced size drawing –

The size of drawing (dimensions) will be smaller than the actual size (dimensions) of the object.

4.4 Scale of drawing –

To make Enlarge or Reduced drawing , some scale has to be chosen . Ex 50mt= 5cm. The ratio of dimension on drawing sheet to actual dimension is call as Representation Factor.

$$\text{Representation Factor} = \frac{\text{Dimension on drawing}}{\text{Actual dimension}}$$

4.5 Plan –

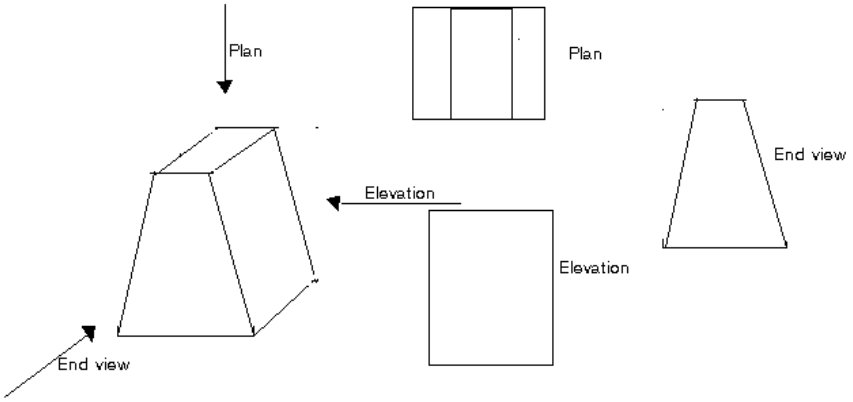
The drawing made by viewing the object form its top. The direction of observation shall be normal to the top surface. The depicts about length and width of the object, but no information about depth.

4.6 Elevation –

The drawing made by viewing the object from its front. The direction of observation shall be normal to the front surface. The Elevation depicts about length and height, but no information about width.

4.7 End view –

The drawing made by viewing the object from its one of the sides (right or left). The direction shall normal to the surface. The end view depicts about width and height but no information about length. Some times it is also called as side elevation.



5.0 Drawing Materials & Equipments.

5.1 Drawing Board –

It is a rectangular board of thickness 25 mm, made up from soft seasoned wood. Its top surface is leveled and smooth. On its left edge, a thin strip of ebony is attached such that, that the T-square may slide on it. Drawing boards are available in the following sizes-

1. B-0 = 1250x900 mm.
2. B-1 = 900x600 mm.
3. B-2 = 650x500 mm.
4. B-3 = 500x350 mm.

5.2 Drawing Paper –

It is specially made thick and smooth paper; available in following sizes-

1. A 0 = 841x1189 mm.
2. A 1 = 594x841 mm.
3. A 2 = 420x594 mm.
4. A 3 = 297x420 mm.
5. A 4 = 210x297 mm.
6. A 5 = 147x210 mm.

5.3 Drawing Pencil –

Drawing pencils are of various types according to dark and light writing. It is identified by its grade code which shall be printed on it. Ex.- HB, H, 2H, 2B,3H etc. . H stands for Hard and B stands for Soft. Soft lead pencil will write darker.

5.4 Drawing Clip/Pin –

It is used to fix drawing paper on drawing board.

5.5 Sand Paper –

To sharpen the pencil lead.

5.6 T- square –

It is made of hard, smooth wooden strip. Its shape is like alphabet T ,so the name is. It is used to draw horizontal parallel lines, with the help of set- squares inclined parallel lines etc.

5.7 Set – Squares –

It is a triangle of suitable size, made up of plastic and other such materials. It is a set of two right-angle triangles ; one with 45^{o} angles and other with 30- 60^{o} angles . It is used to draw inclined lines at any angle, inclined parallel lines etc..

5.8 Protractor –

It is a half circled, transparent strip of suitable size. It has markings of angle from 0 to 180^{o}. It used to read angle, to draw angle etc.

5.9 Compass –

It is made up of metals and hard plastic. It is used to draw circles , sector of circle etc. It has two leg one long and other short. The long leg is pointed and the short leg has the arrangement to grip the pencil.

5.10 Divider –

It has two pointed legs of equal length; made up from metal or hard plastic. It is used for transfer of small lengths from one section of drawing to the other section.

5.11 Scale –

It is a measuring tool for measurement of length on drawing sheet. Generally it has markings of Centimeter, Millimeter, Inch and its divisions. Generally available to measure up to 30CM.

5.12 Minidrafter –

It is drawing equipment. It is a combination of Scale, T- square, Set-squares and Protractor. It is very useful, handy, light and time saving equipment.

6.0 Technique of taking copies of Drawing -

The draftsman makes drawings on some special paper known as trashing paper. This drawing is called as Main Drawing or Original Sheet of drawing. For practical usages several true copies are made. There are some techniques to make the true copy; which are as follows-

1. Fero -Print- White lines on blue background.
2. Ammonia – Print – Blue lines on white background.
3. Xerox Print – Black lines on white background.

7.0 Symbols used in electrical drawings-

CHAPTER – 4
Basic Property of Electrical Materials

1.0 Electrical Materials –

Materials used for electrical systems/ equipment/machines etc. are called as electrical material. All available materials can be classified according to the electrical properties.

1.1 Classification of electrical materials -

1. Conducting material.
2. Insulating material.
3. Semiconductor Material.
4. Magnetic material.

1.2 Conducting Material –

Materials that can pass electric current are called as conducting material. The property of materials by virtue of which it allows current to pass through is called as conductivity. It is opposite to resistance. According to their conductivity conducting materials are classified as –

1. High Conductivity Material 2. Low Conductivity Material.

1.2.1 High Conductivity Material –

Material that has least resistance is called as High conductivity material. Ex. Copper, Alluminium , Silver etc. High conductivity materials are used for wires, cables, winding etc.

1.2.2 Low conductivity Material –

Materials that have high resistivity are called as Low conductivity materials. Ex.- Iron and its alloy, Tungsten , Nicrome and other compound metals. The Low conductivity/high resistivity metals are used to make load resistance, heating elements, filaments etc.

1.2.3 Desired properties of conducting materials –

1. Low temperature co-efficient of resistance (i.e. increase in resistance per degree increase in temperature. Resistance of all metals increases with increase in temperature and decreases with decrease in temperature.)
2. Mechanically strong and flexible, can be machined, ductile, can be drawn into wires.
3. High temperature conductivity, sufficient mechanical strength on high temperatures.

1.3 Insulating Material –

The materials that do not allow electricity to pass through are called as insulating material. They have very very high resistivity . Practically no current can pass through up

to certain voltage. Beyond that higher limit a sudden break down takes and heavy current passes in the form of flash. Such insulating material is useless.

Insulating materials are used to make Insulation/Insulators for Electrical equipments and they prevent leakage of current. The failure of insulation means failure of equipment.

Ex.- Cotton, Paper, Wood, Plastics, Rubber, Warnish, Paint, Insulating oils, Air, SF6 gas, Asbestos , Mica, Bakelite etc..

It is to note that insulating properties of insulating materials is adversely affected by the following factors i.e. – Temperature, Moisture, Dirt-Dust and impurities and in some cases from Sun-light also .

1.3.1 Desired Properties of Insulating material –

1. High resistivity.
2. Sufficient mechanical strength.
3. Should not be hygroscopic.
4. Heat conductivity should be high.

1.4 Semi Conducting Materials –

The resistivity of such materials lie between conducting and insulating materials. Their conductivity increases with increase of temperature. Up to a certain voltage they behave like a good insulating material and beyond that they behave like a good conductor. They are used to make electronic circuit components like- Diode, Trangisters, SCR etc. Ex . of semi-conducting materials are – Silicon , Germanium etc.

1.5 Magnetic Materials-

Materials that acquire magnetic properties are called as magnetic materials. Magnetic materials are used to make Electromagnets which is used in almost all types of electrical equipments/ Machines ect.

When same magneto-motive force is applied on specimens of a number of matters, they acquire different magnetism. The property of matters to acquire magnetism is called as Permeability.

According to permeability matters are classified as follows-

1. Fero-magnetic materials – Very high permeability. Ex. - Iron, Cobalt, Nickle .
2. Para-magnetic materials – Low permeability. Ex- Alluminium, Platinum.
3. Dia- magnetic materials – Very poor permeability. Ex.- Silver, Copper etc.

Materials which have high permeability and low Iron loss should be used to make magnetic core of electrical equipment/machine.

When a specimen is magnetized and demagnetized repeatedly, it becomes hot. This is called as iron loss. When an electromagnet is energized by alternating current, then due to nature of AC current the electromagnet becomes magnetize- demagnetize as per AC current wave and becomes hot.

2.0 Self life and Thermal Ageing of Insulating Materials –

Self life of a material may be understood as the useful life of material under normal working conditions. Careful handling improves the useful life where as rough

handling reduces it. Useful life means that, that the material retains the desired quality for that period. In case of electrical machines, its useful life depends upon the success of insulation. If due to any reason insulation fails, its results in failure of machine. As we know that most of the insulating materials are sensitive to moisture, temperature, dirt and dust .Out of these factors moisture & temperature affects most adversely. The deterioration of insulation can be checked by performing some of the tests like – BDV, Insulation Resistance, and Polarization Index etc.

The effect of temperature and thermal fatigue is evident as charring, reduced flexibility of insulation, brittleness, discoloring etc. Insulating materials are classified as per their thermal endurance limit. (i.e. temperature bearing capacity)

Sr.No.	Class	Max. temperature ^oC	Materials.
1.	Y	90	Cotton, Silk, Paper, Wood, Cellulose, Fiber etc.
2.	A	105	The materials of class Y impregnated with natural resins, cellulose, insulating oil, laminated wood, varnished paper etc.
3.	E	120	Synthetic resin enamels , cotton and paper laminates with formaldehyde bonding etc.
4.	B	130	Mica, Glass, Fiber, Asbestos etc. with suitable bonding substances, built-up mica glass fiber and asbestos laminates.
5.	F	155	The material of class B with more thermally resistant bonding materials.
6.	H	180	Glass fiber and asbestos materials, and built up mica, with appropriate silicon resins.
7.	C	>180	Mica, ceramics, glass, quartz and asbestos without binders or with silicon resins or superior thermal stability.

3.0 Baking Cycle -

As per the requirements of the machines, the windings and coils are applied with varnish and dried at a suitable high temperature. It results in insulation & hardening of winding. In the course of usage, the winding absorbs moisture from atmosphere and its insulating property deteriorates. Under such condition winding is again applied with varnish which called as baking cycle. In general baking cycle is as under-

1. Clean the winding.
2. Heat up the winding up to 100 ºC approx. for some time so that winding becomes free from moisture.
3. Keep the winding dip into varnish for some time so that it may absorb varnish.
4. Bring out the winding from varnish bath and allow the extra varnish to get away.
5. Dry the winding at approx. 100 ºC for some time so that varnish gets dry and hard.

Improvement in winding can be checked by IR test.

4.0 Source of Insulating Materials.-

1. Fibrous Material – Asbestos, Wood, Paper, Hard-Board, Silk, Cotton, Adhesive Tape, Empire Cloth.
2. Mineral Product – Mica, Marble, Slate, Mineral Oil etc.
3. Ceramic Product – Glass, Quartz, Silica, Porcelain etc.
4. Rubber And Byproduct – Vulcanized India rubber (VIR), Ebonite, Gutta-percha etc.
5. Waxes & Compound – Paraffin wax, Bitumen compound, etc.
6. Synthetic Resins – Plastic, Bakelite, PVC, Polythen, varnish, enamels etc..

5.0 Desired Properties of Electrical Engineering Materials -

1. High Conductivity, High Resistance & Low Dielectric Loss .
2. Low weight.
3. High thermal conductivity and viscosity.
4. Non inflammable, fire retardant.
5. Passive to oil, liquid, acid & base substances etc.
6. Non hygroscopic, inert to chemicals commonly present in soil and other metals.
7. Mechanically strong, non fragile.
8. Capable to work at high temperatures.
9. Easley available, low cost.
10. Sufficient flexibility.

6.0 Choice of material-

Points that shall be given the due consideration, while selecting the material for a given situation; are as follows

1. Material should meet the required qualities – voltage rating, current rating, dielectric strength etc.
2. Which type of material is easely available.
3. The selected material should meet the maximum requirements out of the requirements, the situation demands.
4. An economic comparison should be done between various materials in different situations.
5. Ease in production should be considered.
6. Durability and Reliability.
7. Material cost should be low to reduce the overall cost of the product.
8. Various quality standards like electrical, mechanical, chemical etc should be confirmed.

CHAPTER -5

Name , Size , Location of Important Parts of OHE

1. Support Structure -

Support structure is meant for hanging the OHE above rail level with the help of cantilever. There are two types of support structure namely Mast & Portal.

MAST

These are the types of mast –

1. BFB. (Broad Flange Beam)
2. RSJ. (Rolled Steel Joist)
3. Fabricated mast – a) K-series b) B-series.
4. Cement Concrete mast.
5. TTC (Two Track , Three Track mast)

BFB Mast –

Size - 6"×6" (152mm×152mm) to 16"×16" (406mm×406mm)
Length - 9.30 mt , 9.50 mt.
Weight – 30.4 kg per mt. for size 6"×6".
Use – Good for bending moments but weak for twisting moments. Single cantilever, Umbrella type location.
Type - As per hole schedule-
i)- BFB/A – Normal, Single Cantilever, Without return conductor.
ii)- BFB/B – Normal with return conductor.
iii)- BFB/C – Normal with return conductor at reduced height.

RSJ Mast –

Size - 6"×8" (152mm× 203mm)
Length - 9.30 mt , 9.50 mt.
Weight - 53.3 kg/mt.
Use - Suitable for all types of location
Type - RSJ/ A,B,C,E,H

K-Series Mast

Size – K-100, K-125, K-150 (up to K-250mm at an interval of 25mm).
K series mast is formed by welding of two channels through plates to look like alphabet K. Welding side dimension is fixed at 300mm while channel width is variable like 100mm,125mm,150mm. etc.
Length – 9.30mt, 9.50mt
Weight- Per meter weight varies according to the size.
Use- Suitable for all type of location.

B- Series Mast

Size – B-100, B-125, B-150 (up to B-250mm at an interval of 25mm).
B series mast is formed by welding of two channels through batten plates of different sizes along the length of mast. Welding side dimension is fixed at 300mm while channel width is variable like 100mm,125mm,150mm.etc.
Length – 9.30mt, 9.50mt
Weight- Per meter weight varies according to the size.
Use- Suitable for all type of location.

Cement Concrete Mast – It is seen as answer to save cost of steel structures. It has some Inherent draw backs like complete demolition of mast in case of break –downs, costly pre stressed steel ingots are required, separate earth wire is requited etc.

TTC Mast-

Use- To support two or three track OHE where sufficient implantation is not available for individual masts, at turn outs to maintain OHE profile etc.

Construction- main parts are as follows-

1. Up right- size 225×300 mm , length 12.21 mt.
2. Boom- 5 or 8 mt. length.
3. Tie rod- of 20 mm Ø one or two No. with adjuster.
4. Drop arm- D type

Special Structure-

These are basically RSJ mast of different lengths. These are said as R type mast like- R-14, R-15, R-16, R-17. These are used as gantry mast, mast for Booster Transformer etc.R-14 mast is 10.00 mt. long, rest are 12.4 mt. long.

PORTAL

Where separate mast for each line is not possible due to less implantation , portal structure are used to support OHE of more than one track. Portal are used for yard and sidings.

Main parts of a portal-

1.Up-right – 2 No.
2. End peace- 2 No.
3. Center peace – 1 No.
4. Knee bracing- 2 No.
5. Cover Angle – 8 No.

The distance between inner surface of both the up right of a portal is known as Clear span of the Portal.
Types of portal and their particulars-

Sr. No.	Type	Suitable for No of tracks	Clear Span Mt	Up-right Size mm	Angle Size mm	Lasing rod dia. mm	Height Mt.	Remark
1	N	4	20	450×450	62.5x62.5x6.25	16	10.50	
2	O	6	30	550x550	76x76x9.5	16	10.65	
3	R	8	40	600x600	80x80x8	20	10.66	
4.	P	6	30	300x300	300x90 channel 2 No. welded with brace plate		10.61	
5	G			400x250	400x100 channel 2 No. welded with brace plate	6.35x6.35 brace plate		
6	Spl BFB	It is special arrangement adopted according to the site condition. Its up right is made by welding two BFB mast.						

2. CANTELEVER

Cantilever or Bracket Assembly is an arrangement, required for suspension of OHE over track level, at a particular height. It is a swiveling type arrangement, composed of various small components. Each component can be individually replaced with the new one, incase of failure/ break down. The main parts of a bracket assembly are as under-

Sr. No	Name of component	Material
1.	Stay tube mast fitting	Galvanized malleable cast iron
2.	Bracket tube mast fitting	-do-
3.	Stay tube insulator	Porcelain
4.	Stay tube	G.I. cold drawn steel
5.	Stay tube adjuster	G.I.
6.	Adjuster sleeve	Alluminium Bronze
7.	Catenary Suspension bracket	-do-
8.	Catenary Suspension clamp	-do-
9.	Bracket Insulator	Porcelain

10	Bracket Tube	Cold drawn steel
11.	Resister arm dropper	Electrolytic copper
12.	Resister arm hook	Alluminium Bronze.
13.	25mm Resister Arm	Cold Drawn Steel
14.	Resister Arm dropper clip	Copper
15.	Steady Arm hook	Alluminium Bronze.
16.	Steady Arm	Alluminium Alloy.
17.	Anti Wind clamp	-do-
18.	Steady Arm Swivel	Galvenized Steel
19	Swivel Clip	Alluminium Bronze.

Definitions :-

1. Implantation – The horizontal distance between track center and mast is called as implantation. It is also called as Setting Distance.

   Various values of implantation is as under-

   I. Minimum cum normal value (Mast) – 2.50 mt.
   II. Minimum with CEE's permission – 2.36 mt.
   III. Minimum Portal Up-right – 3.00 mt.
   IV. Minimum Platform – 4.75 mt.
   V. Minimum Main Line In side Curve – 2.90 mt.
   VI. Minimum Main Line Out side Curve – 2.50 mt.
   VII. Minimum First Mast before Signal – 3.05 mt.
   VIII. Minimum Gantry Mast - 4.30 mt.

   Implantation less than 2.50mt is said as Critical implantation and a record of such location is maintained to keep a close watch on it.

2. Encumbrance :- The vertical Distance between Catenary and Contact wire is called as Encumbrance . Minimum 15 cm.(Mid Span), Normal/ Maximum 1.4 mt. (Cantilever).

3. Step Distance. :- The distance between rail level and top of the foundation is called as Step distance. For yard lines, value is 20 to 40 cm. for main line 40to 60 cm. .

4. Stagger :- The horizontal distance between track center and contact wire, measured on contact plane is called as stagger. Its normal cum maximum value is
   Straight Track - ± 200 mm.
   Curved Track - ± 300 mm.

5. Contact Height :- The vertical distance between rail level and contact wire is called as contact height or OHE height.
   The height parameters are as under-
   1. Minimum Height for Un regulated OHE -
      - For temperature range 4ºC to 65ºC - 5.75mt.
      - For temperature range 15ºC to 65ºC- 5.65mt.

2. Minimum height of regulated OHE in normal conditions- 5.50mt.
3. Minimum height at support with 10 cm pre sag. - 5.60mt.
4. Minimum height under over line structure permitting C class ODC. 4.92mt.
5. Minimum height at level crossing gate .- 5.50mt.
6. Minimum height where C class ODC will not be permitted- 4.80mt.
7. Minimum height in loco shed - 5.80mt.

6. Steady clearance – The vertical distance between contact wire and resistance arm is called steady clearance.It should not be less than 250mm. With BFB Steady arm not less than 300mm.

3. CATENARY, CONTACT & DROPPER –

Contact Wire- As the name indicates, the pantograph remains in contact of this wire and receive electrical supply. It looks like copper rod and it has groove through out of its length on both the lateral surfaces enabling suspension through dropper contact clip and at the same time smooth passage of pantograph. Some other details are as follows-

1- Material :- Hard Drawn copper (2% iron , 98% copper).
2- Diameter :- 12.24 mm (new)
3- Cross Sectional Area :- 107 Sq mm(new).
4- Condemn Dia. :- 8.25 mm (for main line), 8.00mm(for yard).
5- Normal load :- 1000 kg, 1250 kg.
6- Breaking load :- 3905 kg.
7- Weight :- 0.952 kg/mt.

Catenary Wire - It is stranded conductor. When this wire is suspended at support structures by suspension clamp & bracket of cantilever assembly , it acquires the catenary shape hence named as catenary wire. It takes part in current conduction and also bears the load of contact wire through in- span droppers of different lengths. Thus the contact wire remains approximately smooth and parallel to the rail.

For spark less current collection, the pantograph shall always remain in contact of contact wire at all speed. It requires some flexibility in OHE such that the pantograph and OHE may simultaneously oscillate according to the track level variations. This is achieved, up a large extent, by providing some sag in OHE, called as Pre-Sag of OHE. The value of pre-sag is 50mm &100 mm in old & new electrifications respectively.

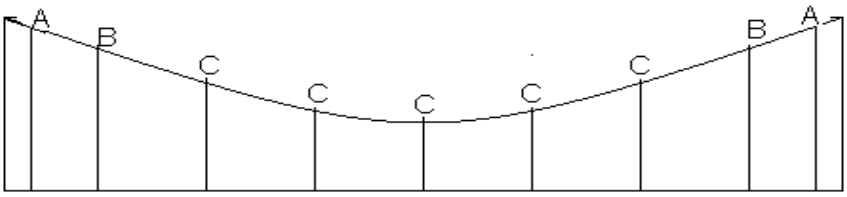
Some particulars of catenary wire are as follows -

1. Material – Cadmium copper.
2. No. of strands – 19
3. Dia. of each strand - 2.10 mm
4. Over all Dia. –10.50 mm
5. Cross Section – 64.84 Sq. mm = 65 sq mm
6. Normal load – 1000 kg.
7. Breaking load – 3920 kg.
8. Weight – 0.597 kg / mt.

Dropper – Dropper means arrangement made up of wire and used for suspension & support of OHE components. Usually, it is made by 5 or 7mm dia, single strand copper conductor. According to application it is classified as -

1. In span dropper
2. Resister Arm Dropper
3. Raise resister arm dropper
4. Adjustable dropper
5. Rigid dropper
6. Head span & Cross span dropper.

1. In span-Dropper – It is made up of semi hard drawn copper wire of 5 mm dia. It transfers the load of contact wire to catenary wire . Within a span ,its length and distance varies according to its position form support in such a way that the contact wire remains approximately in horizontal level. It has two parts, interlinked through loops, to work as shock absorber against the upwards thrust made by the pantograph.
The upper part is fixed length of 105mm. The lower part length is variable.
The first dropper, placed always at 2.25mt from support is called as A dropper. The second dropper, placed at 6.75mt from A dropper is called as B dropper. Rest all droppers are called as C droppers and placed always at 9.00mt from B and next C dropper. Thus for a 72 mt span dropper arrangement is as below-



2. Resister Arm Dropper – It is used for keeping resister arm dropper in horizontal position. In cantilevers with minus stagger it supports resister arm dropper from bracket tube and that for plus stagger, supports from suspension clamp. It is made up of 7mm or 5mm dia. semi hard drawn copper, now a days only 5 mm dia wire is being used. It is also in two parts, the upper part is 120mm long and the lower part is of variable length.

3. Raised Resister Arm Dropper-
Semi hard drawn copper wire , 5mm or 7mmdia, to support raise resister arm dropper. Unlike resister arm dropper ,it is in single piece.

4. Adjustable Dropper -
Semi hard drawn copper wire , 5 mm dia. It is in two parts, interlinked through loop. Both the parts over lapping each other and tighten by two PG clams (6171). Thus its length can be adjusted and so the name adjustable dropper. Used is section insulator assembly for level adjustment.

5. Rigid Dropper – It is made up of contact wire piece. Its length depends upon location, where it is to be used. It is used for maintaining encumbrance, usually at turn outs. Its usual location is at 50mm from cantilever.

6. Head span & Cross span dropper. – These are used in Head Span Structure. Head Span structures are like portal structure as far as purpose is concerned, but now a days these are not in use. In DC traction, it can still be seen.

4. INSULATORS-

Material – Porcelain.

General Construction –

Solid core porcelain with all around sheds(petikote). G.I. cap on both the ends for fittings arrangement . Cork flat ring and silica or cement mixture is used for fixing of GI cap on porcelain core. The over all length varies with type of Insulator.

All type of porcelain insulator deteriorates due to ageing, dirt, dust and exposure to heat like spark, flash etc.

Creepage Distance –

The distance between metal caps, measured on porcelain surface is called creepage distance of insulator.

All around shed on solid core is made to increase the creepage distance. It prevents the formation of continuous leakage current path from dirt, dust and rain water etc.

In polluted zone, long creepage distance (1050mm, 1080mm) insulators should be used.

Creepage distance also varies according to the service voltage.

Hybrid Insulator –

Core – solid porcelain , Shed – Hard rubber, Fitting Arrangement – GI caps

Types of Insulator – as per use and location -

1. Stay Tube Insulator – used between mast fitting and stay tube . Its length is 525mm.
2. Bracket Tube Insulator – Used between mast fitting and bracket tube. There two No. of U bolts for holding of bracket tube. Its length is 500mm.
3. 9 ton Insulator – Its design tension is 9 ton and hence the name 9 tone insulator . It is used for anchoring of OHE and as cut –in –insulator in over laps and section insulator assembly. Its length is 542mm .
4. Disk Insulator – It is used for suspension of RC wire. It can be used as insulator string by joining one with another. Its height is 145mm while disk dia is 255mm.
5. Solid Core Insulator – its length is 500mm . Both of its end cap has special arrangement for attachment of contact ending cone and cross beam.
6. Pedestal Insulator – Its height is 420mm. It is used for support of Bus –Bar, jumper, it is also a component of Isolator assembly. Its design is such that it can vertically bolted with gantry structure , channels, portal etc and hence the name called as pedestal insulator.
7. Tie Rod insulator – It is a special insulator used between moving contact and operating mechanism of Isolator.
8. Bushing Insulator – It is hollow and theoretically used for bringing out the connection lead from earthed housings. Practically a bushing has complex construction and its shape –design etc are dependent on some other factors.

9. Pin Insulator – Some time back ,pin insulators were being used in TRD for DO fuse assembly. Now it has been replaced by pedestal insulators. Basically, it was a bigger size of that, which is still in use for over head telephone lines.

5. SECTION INSULATOR-

Section insulator is a sectioning arrangement of OHE. Sectioning arrangements part the OHE in different electrical sections and at the same time provides smooth passage to pantograph.

There are three types of sectioning arrangement in OHE to sectionalize OHE in different electrical sections, namely – Section Insulator, Insulated Over lap and Neutral section.

The impotent point about section insulator and insulated over lap, which makes the difference between them and neutral section is that , that when the pantograph passes through them both the electrical sections becomes electrically short, though for a moment.

The main parts of Section Insulator are-

1. Solid core section insulator
2. 9 ton cut in insulator
3. Copper runner
4. Cross Beam
5. Adjustable Dropper
6. Catenary dropper clip & dropper link
7. Catenary ending cone
8. Contact ending Clamp
9. Parallel Clamp for double contact wire
10. Section insulator Saddle pin.

Section insulator is used in cross-over OHE for keeping UP & DN side electrically independent, for making of elementary section, making of neutral section for loco sheds, siding etc. Normally it is not used in main line OHE since due to its weight it causes sag in OHE . In case of tram-way type OHE ,it is erected on catilever.

6. NEUTRAL SECTION-

What is Neutral Section-?

Neutral Section is the portion of OHE, that is kept dead and electric engine passes this section by its own momentum. Electric engine receives no electric power supply from this portion of OHE.

Why Neutral Section-

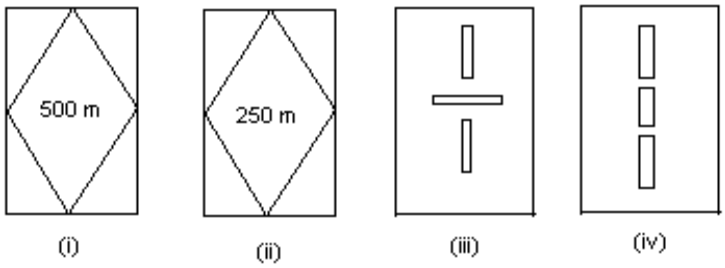
In consecutive TSS, the power supply is received from State Electricity board's three phase supply net work in a cyclic combination of two phases. Therefore, the resulting single phase 25 kv supply also have the phase difference. That is why, the neutral section is a must at mid of two TSS. In short, Neutral section is required to keep phase isolation in OHE. Since there is no question of phase difference in DC supply, hence no need of NS in DC OHE.

Neutral section is compulsory corresponding to SP. More over it is made corresponding to TSS for flexibility in supply system, in yards and loco shed for the sake of safety.

Types of Neutral Section -

1. Conventional or Over lap type – 41 mt.
2. Section Insulator type Neutral Section – 5mt. , 12-14 mt.
3. PTFE Type (Poly Tetra Floro Ethylene) –
   9.40mt, 5.136 mt, 3.74mt. (short PTFE neutral section)

Caution Boards for Neutral Section –



1. 500 mt board – 500 mt prior to neutral section, warns loco pilot that NS is there.
2. 250 mt. board- 250 mt prior to neutral section .
3. DJ open board – just before NS, on mast, loco pilot should open DJ
4. DJ close board – just after NS, on mast, loco pilot should close DJ and normal traction.
   At DJ open board ,the driver shall open the DJ without fail other wise the OHE gets damaged due to sparking between panto and OHE.

PTFE Type Neutral Section – To get rid of load stalling with over lap type NS and possibility of panto entanglement with section insulator type neutral section, the PTFE Neutral Section (Phase Break) is a solution.

The basic idea of this neutral section is to insert PTFE rod insulator in catenary & contact wire and to break electrical continuity. The shape-size of rod insulator is designed in such a way that it provides sufficient creepage distance and smooth passage (without mechanical hindrance) to pantograph.

Normally PTFE neutral section is provided at cantilever . Two rod insulators are connected in series with the help of small contact wire piece in between. This contact wire is connected to earth through earthing jumper. Some other provisions for arresting of electrical sparking is also made, which vary model to model.

The main parts of PTFE neutral section (3.74mt.) is as under-

1. Ceramic beaded rod insulator = 2 No
2. Contact Wire splice = 3 No.

3. Arching horn assembly = 2 No.
4. Parallel Groove clamp = 2 No.
5. Contact Wire clamp and dropper = 2 No.
6. Glass fiber tension insulator = 2 No
7. Messenger end clamp = 4 No
8. Tube to messenger clamp = 2 No
9. Anti torsion spring dropper = 2 No
10. Arc catcher assembly = 1 No.
11. Earth jumper end attachment = 1 No
12. Adjustable dropper = 4 No.
13. Swivel clamp = 1 No
14. Swivel clip for 25mm dia. tube = 1 No

7. ISOLATOR –

1. Isolator is OFF load hand operated switch ie it shall not be used for current chopping or it shall not be operated when current is flowing through it.
2. Isolator is used for isolation of Elementary Section and Power supply equipment.
3. Isolator is a mechanical device therefore its handle lock shall invariably be locked after each operation; otherwise it may operate due to its own weight. It is also necessary for safety of OHE.
4. The handle lock keys are kept in Key-Box in custody of Station Master. Any damage to handle lock or lock-open condition shall be reported to Station Master/ TPC.
5. Since isolator is a simple lever arrangement, therefore correct /complete operation shall be visually confirmed.
6. Each isolator has a number preceded by SM or SS. SM stands for main line isolator and SS stands for yard /sidings. The number of SS is also the number of yard- elementary section that supply is controlled by the SS. For example – elementary section (yard) X-42 shall be controlled by SS/42 , ie elementary section X-42 shall be isolated from rest of the OHE by opening of SS/42.
7. Types-
    i. Single Pole – one fixed one moving contact.
    ii. Single Pole with Earthing heel- one fixed, two moving contacts inter locked.
    iii. Double Pole – Four fixed ,two moving contact.
    iv. Bipolar Isolator- Two fixed, two moving contact.
    Normally the term pole stands for Phase. Double Isolator and Bipolar Isolators are used in switching stations. Earthing Heel isolator earths the section besides isolation.
8. The main parts of a single pole isolator is as under-
    i. Isolator mounting channel.
    ii. Solid core pedestal insulators
    iii. Tie rod insulator
    iv. Fixed & Moving contact.
    v. Arching horns
    vi. Operating lever mechanism.
    vii. Operating pipe & handle with inbuilt lock.

viii. Flexible jumper.

9. Some Important particulars regarding isolator used in 25KV is as under-
   i. The gap between fixed and moving contact when isolator is in open condition shall be 500mm
   ii. Arcing contacts shall leave contact after complete separation of main contact and while closing it come in contact prior to main contact.
   iii. The isolator –mast shall be earthed through separate earth pit (10Ω max) and bonded to rail in two distinct places.
   iv. Current Rating – 800/ 1250 Amp.

8. REGULATING EQUIPMENT / AUTO TENSIONING DEVICE

In unregulated OHE where tension lengths are fixed anchored, the sag and tension of OHE vary with temperature. When temperature increases sag increases and excessive tension arises in case the temperature go below the average.
The solution came as regulating equipment, which automatically adjusts the temperature dependent length variation of OHE. Hence the profile and tension of OHE remains unaffected from temperature variation.
The Regulating Equipment/ Auto Tensioning Device is Simple Machine working on principle of Pulley Block and is required to make 2000kg pull on OHE side.
The OHE anchored through regulating equipment is known as regulated OHE. The center point of tension length of regulated OHE is made fixed by anticreep arrangement.
The important particulars of ATD (Winch type & 3 Pulley type) are tabulated as under-

Sr. No.	Particulars	Winch Type	3 Pulley Type	
			Old	Modified
1.	Mechanical Advantage	1:5	1:3	1:3
2	Number of Pulley	2	3	3
3.	Value of Balance Weight (Simple Catenary OHE)Kg	400	665	665
4.	Value of Balance Weight (tramway OHE) Kg.	250	415	415
5.	X- value at 35 ºC ,mm	1250	1050	1300
6.	Y – value at 35 ºC, mm	2500	2300	2300
7.	Length of SS rope Mt.	10.50/10.80	7.50	8.00
8.	Length of Hex tie rod , mm			

X- value – The center to center distance between fixed pulley and moving pulley. It means the distance available for moving pulley to move, when OHE expands. The mean temperature considered is 35ºC.
Y- value – The distance between top of muff and bottom of counter weight.
Standard values of counter weights = 40 kg, 20 kg , 10 kg, 5 kg.

Main Parts of Winch Type Regulating Equipment-

1. Drum (big pulley)
2. Small pulley
3. 9 ton adjuster
4. Double Strap
5. 9 ton insulator
6. Compensating plate.
7. 5 ton adjuster
8. SS rope
9. Balance weight
10. Anchor Fitting
11. Guy Rod
12. Antifalling Device
13. Double eye distance rod
14. Clevis top fitting.

9. POWER LINE CROSSING –

Power Line Crossing means crossing of electrical conductors, being used for transmission and distribution of electrical power, across the railway track either by Over Head Conductor (in air) or by under ground cables.
The technical parameters of Power Line Crossings are governed by Power Line Crossing Regulation, made under Indian Electricity Rules. Some the important points about power line crossing are as under-

1. Power line crossing up to voltage 33kv shall, preferably be under ground.
2. Power line crossing above 33kv shall be over head.
3. Cable used for power line crossing shall be armored, the armor shall be connected to separately made earth –pit.
4. The distance between cable crossing and mast foundation/switching stations foundation etc. should not be less than 5 mt.
5. Cable Crossing shall be made through steel pipe/ cement concrete pipe, lay at one meter depth from rail level. The pipe shall be in slant surface to prohibit water logging in side the pipe.
6. Cable crossing shall be demarked through Cable Route Indicator.
7. Power line over head crossing shall cross the track in the middle of span length, in case of electrified railway track. Span means distance between consecutive support structures of OHE.
8. Power line over head crossing shall preferably be at right angles to the track , in case of electrified railway track. The maximum crossing angle shall be 30^{0} from normal to the railway track.
9. The support Towers for Power line over head crossing shall be at a distance that is equal to Tower Height plus 6mt. from the nearest railway track.
10. Power line over head crossing shall not pass over the railway's station building/switching station/sub-station/booster transformer etc.
11. Power line over head crossing-span shall be 80% of normal spans.
12. Power line over head crossing up to 33 kv shall be along with guard wires and the clearance between guard wire and OHE shall not be less than 2mt.

13. Power line over head crossing above 33kv, which are protected by high speed circuit breakers, guard wire is not required.
14. Over head power line support structures shall be equipped with Warning boards, anticlimbing device and shall be connected to separately made earth pit with earth resistance not more than 10Ω.
15. Clearance between rail level and the lowest surface of Power line over head crossing conductors shall be as under-

i.	1. Up to 11kv	- by under ground cable.
ii.	Above 11kv ,up to 66kv	- 14.10mt.
iii.	Above 66kv, up to 132kv	- 14.60mt
iv.	Above 132kv, up to 220kv	- 15.40mt
v.	Above 220kv,up to 400kv	- 17.90mt
vi.	Above 400kv, up to 500kv	- 19.30mt
vii.	Above 500kv, up to 800kv	- 23.40mt

10. STANDARD, NON-STANDARD SPAN

The distance between consecutive support structures used for suspension of OHE of the same track /tension length is known as span.
Span length depends upon various factors like expected maximum wind pressure in the territory, curvature, sag, droppering etc.
Considering such affecting parameters and ease in working, various restrictions and standardizations regarding span lengths have been made
Span lengths which are multiple of 4.5 meters are called as standard span and rest are called as non-standard span. Non-standard spans are adopted where standard spans are not possible like – on curvatures, bridge mast, breakdown sites etc. Some of the important parameters are as under-

1. Maximum span – 72mt.
2. Minimum span – 27mt. , 22.5mt in exceptional cases.
3. Difference of two consecutive span lengths shall not be more than 18mt.

11. REGULATED & UNREGULATED OHE –

Sr	Un regulated OHE	Regulated OHE
1.	OHE with both end fix anchor	OHE with both end balance weight anchor
2.	Maximum tension length 2000mt	1500mt/1600mt
3.	Anticreep not required	Anticreep required .
4.	OHE stretched at 3000 kg	2000kg.
5.	Minimum height at support in normal condition- 5.65mt/5.75mt	5.60mt
6.	Anchor height from rail level- 6.95mt	6.75mt.

12. OVER LAP –

Definition – Over lap is the method of joining of two tension lengths without affecting the value of their individual tension length as well as providing smooth passage to pantograph.

In overlapping zone the pantograph should at least be in touch of both the contact wire for 2(minimum value) to 9mts. To get these criteria , formation of over lap may be done in three span or four spans.

Type :-

1. Un insulated – The over lap where there is permanent electrical continuity between both the OHE .
2. Insulated. – The over lap where there is any switch or switching station connected between both the OHE. This is used as sectioning arrangement.

Comparison :-

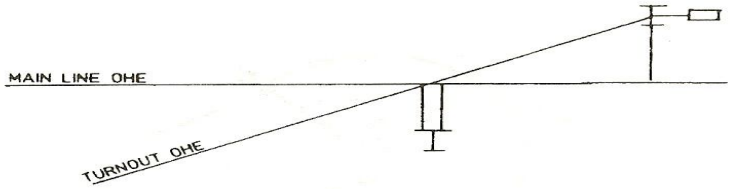
Sr. No.	Un-Insulated	Insulated
1.	Used for continuity, made at regular interval along the OHE	Used for sectioning , made corresponding to TSS,SSP, Isolator , BT location.
2.	Permanent Continuity by G jumper (5.6mt from support)	Continuity through switch (Isolator,BM)
3.	Cut in insulator is not required	Cut in insulator is inserted both in contact and catenary wire (2.5mt from support)
4.	F jumper not required	F jumper in OOR OHE is required.
5.	Clearance between parallel OHE 200mm	500mm
6.	No restriction for half tension length	Half tension length should not exceed 600mt.
7.	Bend Steady Arm is not required	In four span over lap Bend Steady arm is required to maintain clearance at central location.

13. TURN OUT :-

The OHE arrangements at turn out location are as under-

1. Cross type - used in yards , fit for speed not exceeding 100KMPH.
2. Over lap type – most suitable arrangement , used on main line.
3. Knuckle type- used in yards.

a) Overlap type equipments



b) Cross type equipments

c) Knuckle type equipments

Fig. 2.18 Types of OHE at Turn-outs

Obligatory Mast – Provision of a mast is obligatory at that point where Turn-out OHE & Main Line OHE get apart and run separately is called Obligatory mast.

Track Separation – The distance between Main Line track and Turn Out Track is called as Track Separation.

CHAPTER -6
OHE Maintenance

1. Maintenance Schedule of OHE –

Maintenance schedule of OHE is as follows-

1.	Foot patrolling	Every ten days.
2.	Push trolley Inspection	Every month by section supervisor.
3.	Current Collection Test	With in 3 to 6 month by AEE/SSE With in a year by Sr.DEE.
4.	Special Check	As per requirement.
5.	AOH & TW checking	Once in a year.
6.	Periodic Over Haul (POH)	After 4 years
7.	Re tensioning	Of unregulated OHE after 2 years.

There is some modification in maintenance schedule as –

a. AOH of single cantilever – after 18 months.
b. POH recommended after 4½ year and that of ATD will continue after 4 years.

2 Section foot patrolling _

Foot Patrolling shall be done by Linesman. The Linesman shall check the OHE visually as per the check list. The Linesman should keep the following items while on section foot patrolling- spanner set, emergency telephone, detonator, red hand flag, a few nut-bolt for structure bond & massage book.

CHECK LIST –FOOT PATROLLING

A. Foundation-

1. Crack or Damaged.
2. Water collection.
3. Leaning mast
4. Damaged Number plate.

B. Anchor-

1. Nut, Check Nut, Missing lock plate pin from anchor bolt.
2. Nut, Check Nut, Missing lock plate pin from guy rod.
3. Rusty Anchor bolt.

C. Bracket Assembly-

1. Damaged Bracket Insulator
2. Damaged Stay Insulator
3. Damaged 9 ton Insulator
4. Any other defect.

D. Section Insulator-

1. Abnormal wear of runners.
2. Dirty solid core insulator.
3. Damaged solid core insulator.
4. Any other abnormality.

E. Regulating Equipment –

1. Check Guide tube, Cleat angle fitting.

2. Check Balance weight eye, observe that the balance weight moves on application of 10kg of force and attains its previous position.
3. Check for alignment of Pulley and mast anchor fitting.
4. Check for over riding of SS rope on pulley collar, Bird caging, broken strands, grazing of pulley collar and SS rope.
5. Check for tilting equalizing plate.
6. Check for twist in OOR contact wire.
7. Check for abnormal Y value according to the temperature.

F. Auxiliary Transformer for CLS supply –

1. Check D.O. fuse OK/ hanging.
2. Check proper earth connection.
3. Check for Oil leakage.
4. Any other abnormality.

G. OHE span –

1. Check in span droppers for damage, out of plumb, Abnormality of Jumpers.
2. Check catenary strands broken, abnormal sag in contact wire.

H. Isolator –

1. Check for damaged pedestal insulator.
2. Check for damaged /missing/open handle lock.
3. Any abnormality of bond and earth connection.
4. Check for sign of over heating / sparking.

I. General Check -

1. Danger / Caution Board.
2. Height gauge at Level crossing.
3. Station Sheds earthing.
4. Damaged emergency sockets.
5. Damaged / Missing Bonds.
6. Protective Screen at FOB /ROB.
7. Check for Tree cutting /Tree trimming .
8. Check the switching stations for any abnormality from out side.
9. Bird nests and hanging stray wires on mast & portals.
10. Open bond connections corresponding to FP/TSS and observe spark while a train passes.

Linesman shall note down minor works done during the patrolling and defects noticed in the following proforma so as to systematic and prompt corrective action may be taken.

Patrolling Section --------- Kilometer -------

Sr. No	Loc No.	Line	Abnormality	Category A,B	Date Abnormality Noticed	Supervisor's Remark			Date corrective action taken
						Name signature	Date	Recommended Corrective action	

Category A – Abnormality related to train operation and safety.
Category B – Abnormality other than A.

3. CURRENT COLLECTION TEST –

The purpose of this test is to find out locations of OHE where spark happens between pantograph & contact wire while loco is in motion. It has observed that at spark locations the wear rate of contact wire is comparatively high.

Earlier, this test was done by placing mirror on rear wind penal such that the image of panto is seen from rear loco cabin. The observer call out spark / flash / heavy flash etc. and the other person note down corresponding mast location. Later on , according to this test report , the OHE maintenance gang checks the location and rectify the same.

Abnormalities of OHE responsible for sparks are – Kink, Hard spots, Dropper position, mal adjustment of over lap OHE etc..

Now a days current collection test is done by a computerized spark detection system, known as Oliver-G. This system is comprised of a computer, video camera, focus and GPS antenna. The system can easily be fitted on Loco. The picture of spark corresponding to mast is accurately stored

Current Collection Test Resister (03-07 A, As per ACTM)

Sr	Date-Current Collection								

4. SPECIL- CHECK:-

Some of the OHE components that are liable to fail and affect system reliability, are frequently checked and maintained. The frequency of maintenance may vary as per the conditions.

1. Insulators- Insulator cleaning in polluted zone – monthly, quarterly or half yearly.
2. Section Insulator – SI in cross-over OHE, Loco shed etc. – Quarterly, half yearly.
3. Isolator's earthing specially in goods shed, yards and other earth pits also.
4. Bi- metallic clamps for tightness/heating – quarterly.
5. Foot patrolling of feeder lines.
6. Bridge mast and OHE.
7. Special drive for removal bird nests in breeding seasion.
8. Pre Monsoon checking- insulator cleaning in general, tree-trimming, cable checking, naked foundation etc.
9. **Thermography –** Thermo vision camera is recently introduced in TRD organization. This camera senses the thermal radiation (not the light radiation) of the object and produces the colored image of the object. The colour and its shed depends upon the temperature. Thus by observing the thermal image of the object , unusual temperature rise can easily be noticed . This method of inspection for electrical equipments, jumper and bus bar connections etc. , is emerging as fool proof method. By using this method regularly faults can be detected well before the failure happens.

5. ANNUAL OVERHAULLING & TOWER WAGON CHECKING-

Under this schedule of maintenance, the OHE checked and maintained by Tower Wagon. The object of this schedule is to check all the parts and components of OHE for their good working condition and to impart requisite maintenance. Also important parameters of OHE like- height, stagger, implantation etc are corrected and recorded into prescribed formats.

The prescribed check sheets for various parts of OHE are as follows-

CHECK SHEET FOR MAST

Location Number-------Type of mast------Type of location---Section

Sr	Item checked	Standard Value	Observation
1.	Mast condition	Free from rust/corrosion	
2.	Foundation	1. Free from crack/damages. 2. No water logging. 3. No naked foundation. 4. Free from ballast heap.	
3.	Compare implantation with SED (tolerance 30mm)		
4.	Leaning Mast	Mast should be Normal Up to 3cm- Keep under observation. More than 3cm – immediate action.	
5.	Condition of markings painted on mast (rail level, height, implantation, emergency phone socket)	Should be in good condition.	
6.	Number plate	Available & OK	
7.	Structure Bond	Should available / Nut-bolt OK /	

		condition OK/ paint if required.	
8.	Guy rod mast anchor fitting	Snap head pin ,washer & split pin should be available.	
9.	Guy rod condition	OK	
10.	Guy rod strap nut, washer & pin	Nut should be tight with washer & split pin.	
11.	Foundation (as per Sr.2)		

LEANING MAST:-

Deflection at 1.85mt from rail level is checked by Plum Bob and The same is multiplied by 3 to find the deflection at contact plane. If deflection at contact plane comes 15cm or more, immediate corrective action shall be taken. Normally mast is supported by suitable means, if leans out side the track or other wise suitable filling are done by digging the foundation. For identification of leaning mast, a 5 cm wide yellow band is painted on the mast at a height 1.85mt form rail level.

Mast foundation maintenance record (as per ACTM Prof. No 03-08)

SN	Loc. No	Loc. Type	Dt. Of check	Condition/ Type of Foundation	Soil type	Implantation		Step Distance	HRL Mark height above rail level	Leaning at CH		Leaning at 1.85mt		REASON	Action taken
						SED	Actual			Towards track	Away track	Towards track	Away track		

BRACKET MAINTENANCE CHECK LIST

Location: Elementary Section: Line:
Structure type: Date:

SN	Item to be checked	Standard	Observation
1.	Tightness of mast fitting nut -bolt	All tight	
2.	Bracket Insulator/ Stay Insulator -Cleanliness/ Damaged/ Cracked	Clean/No damage& crack	
3.	Note make and batch of Bracket/Stay insulator.		
4.	Tightness of Bracket insulator U clamp nuts/ availability of check nuts	All tight/ avilable	
5.	Check suspension fitting & tightness of nut	OK	
6.	Check Stay tube cross nut bolt fitting with insulator	Ok	
7.	Check Sleeve & Adjuster- tightness of Nut/check Nut	OK	
8.	Check 9 ton insulator – Cleanliness/ Damage/Crack/ make & batch	OK	
9.	Check Resister Arm hook clamp nut-bolt tightness and crack.	OK	
10.	Resister Arm dropper /fitting/availability of split pin	OK	
11.	Horizontality of resister arm	Horizontal	
12.	Steady Clearance- i) Tubular Steady Arm ii) BFB steady arm with Drop bracket clamp.	i) 250mm, ii) 300mm	

CANTILEVER ASSEMBLY MAINTENANCE RESISTER (Pro.03-03 as per ACTM)

SN	Loc	Line	Type of Loc.	No. of C/L	Attention				Insu.Make Batch			Contac. Wire		Clearance	Fitting Cond.	Staff/ Supe.	Remark
					Dt. Of Check	Work done	Sche. Un Sche	Due Dt.	9T	ST	BT	Ht	Stg.				

OHE MAINTENANCE CHECK-SHEET

SN	Item to be checked	Observation	Action
1.	Catenary Wire	Strands broken	To be spliced.
2.	Contact wire	Condemning dia./ kink/ Crack	Remove kink / splice.

3.	Splice	Check as per splice check sheet	-
4.	In-Span droppers	- Catenary dropper clip/nut -worn out loops -Contact dropper clip U pin - Mutual distance / tension/loose (100mm tolerance in position)	- - replace dropper - replace U pin if required. - No dropper should be over tension. Do needful.
5.	C jumper	- Missing jumper - jumper in tension - strands broken - Check portion under PG clamps For heating/spark/broken strands.	- provide it. - adjust position - replace it - Do need full/ replace.
6.	Sag	-	In case of unregulated OHE retensioning shall be done.
7.	Bridle Wire	- It should not be loose - tightness of PG clamp - dropper position	- Do needful.
8.	Anticreep wire	- tightness of suspension clamp - strands broken - mast anchor fitting - 9 ton insulator.	{- correct as the position warrants

Note – The contact wire dia should be taken at the same point every time . 20mm prior to cantilever swivel clip , a identification mark with white paint shall be painted , in this regard . Catenary wire splice is a must in case 20% strands (3 strands) are found broken.

Proforma No.03-04 (As per ACTM)

RECORD OF CONTACT WIRE WEAR AND SPLICE

SN	Type of Loc.	Loc. No.	At support		At mid span		Dt. of provision of CW splice	Obser-vation	No. of catenary strands out	Dt. of Provision of Catenary Splice	Thermograph testing			Staff/ Supe-visor	Remark
			Dia.	Wear since last check	Dia.	Wear since last check					Testing Date	Obser-vation	Recti-fication		

Proforma No. 03-14 (As per ACTM)

REGISTER FOR LEVEL CROSSING GAUGES

SN	Loc. Of Level crossing	Gate No.	Line	Date of checking	Height Of Contact	Condition of Height	Level Of Road	Condition Of bond	Manned/ Un-manned	Remark

					wire	guage	Below Rail level			

The contact height at level crossing gate should not be less than 5.50mt . The height of Height-Guage from road level shall be 4.67mt.

CHECK SHEET FOR INSULATORS

Location No.--------- Type of Insulator---------- Make/Batch---------- Erection Date-------

SN	Item to be checked	Observation	Remark
1.	Cleanliness	Surface should be clean & bright	Do the needful
2.	Flash/ Crack	Yes- No	Replace
3.	Shed broken	No/one/two/more	Replace at once if more than two
4.	Weather location is in Stone pelting area	-Protective screen required/Available	Provision of hybrid insulators
5.	Creepage of metal cap.	Yes- No	If yes replace

§ Insulators shall be load tested prior to erection on line and only OK insulators shall be used . Prohibited make/batch insulators shall not be used .

Proforma 03-12

MAINTENANCE & MEASUREMENTS OF TURNOUT/ CROSSOVER

SN	Description	Std.Value	2008-09	
			Measured	Adjusted

	Ref.- RDSO's TI/MI0028 Rev.02		value	value
1.	Particulars of turnout/crossover - 1:8½ , 1:12			
2.	Section			
3.	Location No.			
4.	Date checked			
5.	Type of Arrangement(crossed/overlap)			
6.	Turn out span	54 mts.		
7.	Length of redundant pipe	As per chart		
8.	Track separation at obligatory structure(mm)	500-700 mm if not available permissible up to 150mm		
9.	Implantation of obligatory structure	3.0 mt.		
10.	Distance of "G" jumper from obligatory structure	5.6 mts towards over lap		
11.	Length of "G" jumper.	4.00 mts.		
12.	Height of contact wire above rail level at obligatory structure.	ML- H T/O- H+50		
13.	Height of contact wire towards turnout up to 10mts.	ML- H T/O- H+50		
14.	Stagger of contact wire at obligatory structure.	ML- 200 max T/O – 300 max		
15.	Sag of section insulator of Turn out/ cross over	Zero		
16.	Movement of tower wagon from main line to turn out(650-720)	a) Take on b)Take off		
17.	Movement of tower wagon from turn out to main line (650-720)	a) Take on b)Take off		
18.	Stagger of section insulator at cross over/turn out	+/- 100 mm		
19.	Track separation at the location 1. Runners towards the center of turn out- 2. Runners away from center of turn out-	1. Min1.65 mts 2. Min 1.45 mts.		
20.	Condition of ATD of turn out /mainline	Free to move		
21.	While running T/wagon on main line observation of turn out contact wire	Not to touch the panto pan.		
22	Observation of obligatory location	RT Horizontal Bracket Plumbed Dip 25-30 cm.		
23.	Remark if any			
Name & Signature of Supervisor				

CHECK SHEET FOR CONTACT SPLICE

{CEE/CSTM memo No.-L.574.TRD.Technical Instruction/ Circular 42(CEE-TD. Technical circular No.01/2007) dated 22.05.2007}

SN	Item to be checked	Remark
1.	Date of splice	
2.	Date of inspection	
3.	In between location of splice	
4.	Up line / Dn line	
5.	Check the dia of contact wire on each side of splice.	
6.	Check for yellow identification mark	
7.	Check the availability of droppers on each side of splice	
8.	Check for tightness of splice nut bolt & slippage of contact wire.	
9.	Check for crack in splice	
10.	Any other observation	

Note – Catenary splice shall be checked for tightness & open strands.

CHECK SHEET FOR INSULATED CATENARY WIRE

{CEE/CSTM memo No.-L.574.TRD.Technical Instruction/ Circular 42(CEE-TD. Technical circular No.01/2007) dated 22.05.2007}

SN	Items to be checked	Remark
1.	Check Catenary splice – No thread should be visible after tightening.	
2.	Ensure that on either side of splice no strand is broken.	
3.	No. crack on splice body .	
4.	Check & record the projection of insulated catenary wire on either side of Over Line Structure(FOB/ROB/Bridge). This projection should not be less than 2mts.	
5.	Check and record the vertical clearance between Insulated Ctenary Wire and Over Line Structure . This should not be less than 250 mm.	
6.	Open the catenary clip of dropper and check- 1.	

PTFE (Aurther Flury) Neutral Section Monthly Maintenance Check Sheet.

{CEE/CSTM memo No.-L.574.TRD.Technical Instruction/ Circular 42(CEE-TD. Technical circular No.01/2007) dated 22.05.2007}

Sr No	Item to be checked	Standard	Observation
1.	Tightness of all nut -bolts	Completely tight	
2.	Tightness of PG clamp & earthing jumper	-do-	
3.	Check contact end splice a. end first b. end second		
4.	Check adjustable dropper & split pins a. end first b. end second	Should be available & tight	
5.	Diameter of rod insulator 1. a. end first b. end second 2. a. end first b. end second.		
6.	Clean PTFE rod insulator with soap-water		
7.	Check stagger at PTFE bracket	Should be zero.	
8.	Check wear of rod insulator.(Rod insulator can be turned in five positions)	If wear is 2mm or more, turn it by two marks.	
9.	Check level of rod insulator	Should be zero.	
10.	Check runners for abnormal wear.		
11.	Check catenary ending cone a. end first b. end second.		

PTFE Monthly maintenance record (Proforma No 03-17 as per ACTM)

Section ---------- Location ---------- Type----------

SN	Date of inspection	Stagger of PTFE	Heighr of PTFE	Imp. at PTFE	Stagger before 3 location			Vertical clearance		Horizontal clearance				Condi-tion of bids	Any grease collection	Action taken	Sign. of Super-visor
										END1		END2					
					1	2	3	END1	END2	L	R	L	R				

Proforma 03-06 (As per ACTM)

Register of Earth Resistance Measurements

Station/Section------- Earth pit No.------- Provided for-------

SN	Date	Resistance	Overall	Condition of earth	EPR	Initial of	Remarks

	of test	in ohms	Resistance	pit & intactness of bonding	meter No. & make	supervisor	if any

CHECHK SHEET FOR LEVEL CROSSING GATE INSPECTION

{CEE/CSTM memo No.-L.574.TRD.Technical Instruction/ Circular 42(CEE-TD. Technical circular No.01/2007) dated 22.05.2007}

SN	Item to be checked	Remarks.
1.	Availability of structure bond at both side of level crossing up to 500m. & bond painting.	Yes /No
2.	Availability of inter track bond	Yes /No
3.	Availability of earthing of barrier / lever	Yes /No
4.	Availability of inter panel connector (GI wire) and earthing of fencing penal.	Yes/ No
5.	1. Earth Resistance 2. Painted earth pit resistance and date of measurement. 3. Availability of earth pit box with cover.	-- Ω Yes/ No Yes/ No
6.	Marking of 4mt with yellow paint on Up-right of Height guage.	Yes/ No
7.	Height of Height-Gauge - Up line / Dn line (mt)	----- / ----
8.	Height of contact wire at level crossing – Up line / Dn line (mt)	---- /----
9.	Availability and condition of DANGER caution board.	
10.	Condition of Muff on both sides of crossing up to 500 mt.	
11.	Availability and condition of Public Caution Board at Crossing Cabin.	
12.	If CLS Panel is there- 1. In coming supply indication-Availability(UP / DN / Local) 2. CLS load is on- UP-AT / DN- AT / Local supply 3. Voltage(AC) - ---------- volt 4. Is there any unauthorized connection - Yes/ No 5. Maximum Instantaneous Load (Motor operated Barrier) ----- Amp. B. Condition of Auxiliary Transformer – 1. Oil level in conservator tank - Ok / low 2. Oil leakage from – 1.1,1.2,2.2,2.1, drain valve - Yes / No 3. Tap Position ----- 4. Voltage (LV- Box) ---------- Volt AC 5. Condition and Rating of Fuse. 6. Condition of 63 Amp cut-out. – Normal/ Over Hot/ Correct rating. 7. Earth resistance value & date of measurement –Marked/Notmarked 8. Availability of duplicate earthing – Available / Not Available. 9. At Caution Board – Available / Not Available. 10. At Number Plate – Available /Not Available.	

GANTRY MAINTENANCE CHECK-SHEET (Feeder Wire)

{CEE/CSTM memo No.-L.574.TRD.Technical Instruction/ Circular 42(CEE-TD. Technical circular No.01/2007) dated 22.05.2007}

SN	Item to be Checked	Remark

.1	Following Items to be check In cross feeder- a) Snap head pin ring & flat washers availability as per schedule and bolt U-bolts nut with check nut . and there tightness.	
1.1	a) support clevises b) 9- Tone adjuster c) Double strap with snap head pin wiser and spit pin d) Strain clamp position	
2 2.1	At the anchors mast location feeder wire s proper fitting Such as wiser nut check nut , pins etc. and there tightness. a) support clevises b) b) double strap set with snap head pin and split pin c) 9-Tone adjuster d) Strain clamp position	
2.2	Availability of Gay rod and there tightness	
2.3	Insulator cleaning .if found any damage /crack /flash/PC Broken condition replace with new tested OK insulator.	
3	Check the Running feeder and ensure the following- 1. Availability and tightness of washer, split-pin and snap head pin of Clevis, double strap and suspension. 2. Availability of Aluminum ferule in feeder suspension. 3. Cleaning of insulator & replacement if cracked or flashed. 4. Availability & tightness of nuts for 'U' bolts of suspension.	
4.	Check for correctness of Feeder- Mast- Earth- Wire (if it is there)	
5.	Check tightness of Super Mast Cross Arm nut-bolts.	
6.	Open PG clamps and check the bi-metallic clamp for oxidation marks. If it is there ,replace the same.	
7.	Check for availability of anti-falling jumper between- Feeder & OHE jumper, Cross feeder and running feeder jumper, Cross feeder & OHE.	
8.	Check the feeder wire for broken –strands and splice if required. Use Binocular for checking.	
9.	Material of feeder wire – Copper / Aluminum.	

CHECK SHEET FOR TUNNELS

{CEE/CSTM memo No.-L.574.TRD.Technical Instruction/ Circular 42(CEE-TD. Technical circular No.01/2007) dated 22.05.2007}

SN	Item to be Checked	Remarks

1.	i- Locations of Critical Electrical Clearance. ii- Clearance at such locations in mm.	
2.	i- Locations of Minimum contact wire height. ii- Contact wire height at such locations.	
3.	i- Locations of minimum contact wire dia. (Max. wear) ii- Contact wire dia. at such locations.	
4.	Condition of Auxiliary Transformer- i- Oil level in conservator tank. ii- Oil leakage from -1.1,1.2,2.2,2.1, drain valve, tap changer. iii- Tap position. iv- AC voltage in low voltage box. v- Condition of Drop out fuse. vi- Condition of 63Amp cut-out in low voltage box. vii- Earth resistance, date of inspection, condition of earth pit, marking of earth value, marking of action taken in case earth resistance found high. viii- Duplicate earthing of AT . ix- AT caution board. x- AT number plate. xi- Condition /Availability of Anti climbing device. xii- Condition of Silica Gel in breather.	
5.	i- Condition of insulators in side tunnel (Clean/dirty/flashed/chiped) ii- Application of Silicon Grease.	
6.	i- Earth strip should run through out the tunnel length and brackets supported on the tunnel wall should be firmly connected with earth strip. ii- Earth strip should be painted. iii- On each end of the tunnel ,earth pit should be available and it should be Properly checked. iv- Earth resistance and date of measurement should be marked on . v- Action taken to reduce the earth pit resistance.	
7.	Availability of insulated catenary wire at entry and exit of the tunnel.	
8.	Availability of structure bond on each side of the tunnel up to 500m.	
9.	Availability of inter track bond.	

Proforma No 03-05(As per ACTM)

REGISTER FOR FEATURES OF OVERLINE STRUCTURE

Loc	Type of Loc	Line	Date	Span in mts	Ht. bet. rail to bottom of OLS	Contact wire height in mts.	Clearance in cm.		Feature Present						Sup. / Staff Name & Signature	Remark
							END1	END 2	Crossing	Pipes	Protective screen	Caution Board	Earthing	Pr. of Ins. Cat./ double CW		

CHECK SHEET FOR GUIRDER BRIDGE

{CEE/CSTM memo No.-L.574.TRD.Technical Instruction/ Circular 42(CEE-TD. Technical circular No.01/2007) dated 22.05.2007}

Section ---------- Date ----------

SN	Item to be Checked		Remark		
1.	Location				
2.	Type of Bridge				
3.	Whether Insulated catenary is provided or not.				
4.	Inter guarder continuity bond.				
5.	Inter track bond.				
6.	Check Rail Continuity bond.				
7.	Earth pit resistance.				
8.	Contact Height at bridge location.				
9.	Description of bridge	Location			
		Type of Mast			
10.	Condition of foundation, grouting angle & fittings of each bridge mast.				
11.	Condition of additional arrangement on bridge piers for erection of mast.				
12.	Marking of implantation, rail level on bridge mast.				
13.	Bonding of bridge mast.				

CHECK SHEET FOR OVER LAP

Section ----------
No. Span – Three / Four
Date:- ----------

Type of Over lap – Insulated / Un Insulated,
Location No ----------

SN	Item to be checked	Observation	Remark
		Insulated Over Lap	
1.	Location	Place- TSS/SSP/ Elementary Section	
2.	Cantilever (IR/OR)		Check as per cantilever check sheet.
3.	Clearance	500mm between parallel OHE	
4.	Encumbrance	Intermediate location- IR – 1400mm, OR – 400mm Central Location IR- 750/1400mm	
5.	Up lift of OR OHE	500 mm	
6.	Cut in insulator	-Cut in insulator should be 2 mt away form cantilever, both of Catenary & Contact Wire. - Insulators should be clean. - Shed Broken.	
7.	F jumper	- Distance from support. - Broken strands - excessive tension - Condition of PG clamp.	
8.	Feeder Large jumper/ Isolator jumper	PG clamp/ excessive tension/ broken strands	
9.	Push arm for OR OHE	- Plumb / Deplumed - Condition of contact wire in push arm.	
10.	Caution board	Availability /Condition of Power Block working limit board.	
		Un- Insulated Over lap	
11.	Clearance	Between parallel OHE- 200mm	
12.	G jumper	4mt long/ with 8 PG clamp/ stands OK/ not in tension / No mark of heating & sparking	Inner surface of PG clamp should checked for heating marks.
13.	Stagger	Should not be more than 300mm for IR OHE	

Note: - While negotiating over lap, the pantograph should remain in contact with both contact wires of over lap for 2 to 9 mts. In this course jerk in OHE or panto should not be observed. For maintenance of over lap, power block on each side of over lap should be taken. For replacement of G jumper, first connect new jumper then disconnect the old one.

Proforma 03-15 (As per ACTM)

OVER LAP (Insulated / Un-Insulated) MAINTENANCE RECORD REGISTER

SN	Date	Overlap Type & span	Clearance Between Two OHE (500mm) (200mm)	Length of Parallelism (2 to 9 mt)	Jumper Condition	Condition of RRA clamp	Thermograph of jumper & PG clamp	Signature

CHECK SHEET FOR REGULATING EQUIPMENT(Wich Type)

(As per CAMTECH book let)

SN	Item to be checked	Observation	Remark
1.	Balance Weight movement(by spring balance)	1. Moves on force less than 10kg 2. Moves on force more than 10 kg	1. OK 2. Requires attension
2.	Mast fitting eye & clevise movement.	1. Free movement 2. Friction	1. OK , 2.Rectify by filing observing strength of clevise.
3.	Pulley Drum	1. Helical grooves having knife edge. 2. Helical grooves are damaged , may cause rope over riding. 3. SS rope over riding. 4. Balance weight end of SS rope rubbing with drum collar. 5. Grease if shield bearing not used. 6. Check the bent-arm-right for Correct shape.	1. Replace drum. 2. Replace drum. 3. Rectify / replace drum. 4.1 Rectify by tempering Collar with mallet. 4.2 Use taper washer , as per situation.
4.	SS rope	Broken strands, Rust , Bird Caging.	
5.	Small pulley	1. Having free movement. 2. SS rope rubbing 3. Grease if shield bearing not used.	
6.	Anti falling device	1.No rubbing between angle spacer and tie rod. 2. Tie rod nut –bolt are tight and split pin is there.	
7.	9 tone insulator	Check as per insulator check sheet.	
8.	Compensating plate	1. It should be vertical. 2. Snap head pin, washer & split pin should be available.	
9.	9 tone / 5 tone adjuster.	1. Check –nut should be tight. 2. Adjuster should be half open. 3. Split pin should be available.	

10.	Ending Cone	1. Catenary ending cone should be tight. 2.Check contact wire for groove 3. Availability of washer & split pin snap head pin	
11.	Guide tube	1.Mast angle fitting should be OK 2.Guid tube should be straight. 3.No rubbing between balance weight eye& guide tube.	
12.	Z-Y value	Measure and Tally with temperature /tension length chart	Do needful.

CHECK SHEET FOR REGULATING EQUIPMENT(THREE PULLY TYPE)
(As per CHAMTECH Booklet)

SN	Item to be checked	Observation	Remark
1.	Mast fitting eye& clevise	1. Free movement 2. Friction	1. OK , 2.Rectify by filing observing strength of clevise.
2.	Bent Arm	Should be parallel to axis of eye& clevise.	Check hole of bent arm.
3.	Pulley Block	Should be in alignment with OHE.	Bent arm holes may not match 1. File the holes slightly 2. Replace bent arm.
4.	Movement of pulley block	While balance weight is pushed-up the pulley should move smoothly & the B/W should return to its original position	1.There may be rubbing in Guide tube, antifalling device. 2.Bearing may be defective-Grease it or replace.
5.	SS rope	Broken strand, Rust, Bird Caging , deformation etc.	Do needful / replace.
6.	Pulley Block	Rubbing of rope with pulley collar , Position of rope in pulley groove.	1.Position the rope in pulley groove by removing the load from ATD. 2..1 Rectify deformation of pulley collar by mallet/ replace pulley. 2.2 Rubbing in bolts joining eye, clevise & bent arm. 2.3 Horizontality of mast fitting, tight nut bolt.
7.	Anti Falling Device	1.Rubbing between tie rod and angle spacer. 2.Tightness of nut, availability of slit pin.	Rectify angle spacer/Straiten tie rod.

8.	Guide tube	1.Mast angle fitting –OK 2.Guide tube should be straight. 3.No rubbing between guide tube and B/W eye.	
9.	X-Y value	Measure and Tally with temperature /tension length chart	Do needful.

Note. – 1. Temperature marking on mast should be done.

2. Muff cleaning. Travel of balance weight should not be blocked, like heap of ballast.
3. Balance weight should come to the original position after pushing –up or pulling down. B/W should be pulled or pushed behind the mast.

PROFORMA 03-10

Maintenance of Winch/3:1 Ratio type ATD as per TI/MI0018 rev.3 & TI/MI0029 rev.3

Type of RE :- ---------- Location No.------ Section --------- Provided for---------

Date of Inspection	Clevis & Eye- Type(Al,Bz,forged steel) , Manufacturer, Date of Installation			
	Check	Observation	Remedial Action	Remark
	i- Visual Examination ii- Alignment of clevis with fixed pulley iii- Movement of clevis & eye.			
	Mast Anchor fitting- Type(Al,Bz,forged steel) , Manufacturer, Date of Installation			
	i-Check deformation of fitting ii-Check whether eye of fitting is in horizontal plane.			
	Counter Weight - Type , Manufacturer, Date of Installation			
	i- Check for missing counter weight ii- Check deformation of eye of the base of counter weight.			
	Guide tube- Manufacturer, Date of Installation			
	i- Check for bent/deformated/ missing guide tube.			
	Drum & wheel disc (for winch type only)- Manufacturer, Date of Installation			
	i- Visual examination of wear of drum with GO not GO gauge & wheel disc. ii- Visual examination of wear of bent arms on both side. iii- Grazing of side walls of drum/wheel disc with wire rope. iv- Alignment of drum with OHE. v- Gap between drum and wheel disc.			
	Pulley Block- (for 3 pulley type) - Manufacturer, Date of Installation			
	i- Visual examination of wear of pulley, bent arms. ii- Movement of axel. iii- Grazing of side walls of pulley with wire rope. vi- Alignment of pulley block of ATD with OHE and bent arms.			
	SS wire rope- Make, Batch and date of Installation			
	-Condition of SS rope -Position of SS rope over pulley groove -Date of lubrication -Measurement of Y,Z dimension as per chart of ATD. -Status of inner and outer strands of wire -Ovality of SS rope over radially moving portion			

	Hex tie rod- Manufacturer, Date of Installation			
	i- Visual examination for rusting /corrosion/deformation/breakage ii- Parallelism of hex tie rod iii – Length of hex tie rod iv – Movement of angle spacer over hex tie rod.			
	Bearing – Bearing No., Manufacturer, Date of Installation			
	Condition of felt and grease seal.			
	Fastners - Manufacturer, Date of Installation			
	Looseness of fastners			
Name & signature of Supervisor.				

CHECK BEFORE REUSE OF SS WIRE ROPE (As per TI/MI-29, Rev-2)

{CEE/CSTM memo No.-L.574.TRD.Technical Instruction/ Circular 42(CEE-TD. Technical circular No.01/2007) dated 22.05.2007}

SN	Item to be Checked	Remark
1.	Date of check	
2.	Make /Batch details	
3.	Length of SS rope.	
4.	Checking with magnifying glass 1. Loose strands 2. Broken strands 3. Rust 4. Pit/ Corrosion 5. Bird caging.	
5.	Check the presence of magnetism in rope with the help of a magnet.- Magnetism should be absent.	
6.	Check the Ovality over radially moving portion of SS rope at 3 points , mutually 300mm apart. If Ovality is more than 0.51mm, the rope should not be used.	Diameter- A B C
7.	If the rope fails in those tests, mentioned in Sr.4,5,6 ,the rope should be condemned.	Declared condemned / reuse
8.	Mark with red paint if declared condemned . If it is to be reused mark with yellow paint. The marking shall be made on balance weight end.	
9.	Name / Signature./Designation.	

X-Y adjustment of ATD

1. X-Y value should be checked as per chart showing relation among temperature, half tension length and X-Y value. Slit variations can be adjusted from 9 ton adjuster.
2. If variations are more it can not be adjusted from adjusters. In this case wire cutting is evident.

3. For wire cutting , ATD shall be released from OHE tension , using come-along clamp, sling, tirfor & other necessary tools. As per X-Y chart ,portion of contact and catenary wire shall be cut and load of OHE shall be transferred to ATD.

Power Line Crossing -

1. No work shall be undertaken by the Owner over Power line Crossing , without obtaining the consent in writing from the Railway.
2. The crossing shall always be maintained in a state of good repair so as to reduce hazards to life and property. The crossing shall be jointly inspected by The Railway and Owner of crossing at an interval not exceeding 12 months. The defects noticed/ pointed out by Railway shall be promptly attended by the Owner.
3. Possible defects- Broken strands of crossing conductor, broken insulator, rusty tower, tree & vegetation, earthing, water logging etc.
4. All defects/failures like snapping of conductors in the crossing span , braking of insulator string in the over head line crossingor any defect that is likely to be affect the safe movement of the railway traffic or the safety of the railway property or personnel shall be reported forthwith by the Owner to the station master on duty at the railway station on both side of the crossing .

CHECK SHEET FOR SECTION INSULATOR.

Location No.----------

SN	Item to be checked	Observation	Remark
1.	9 ton cut in insulator	Check for – Cleanliness, damaged petticoat, crack, flash., Make & Batch. - Tightness of catenary ending cone. - Availability of washer and split pin in snap head pin.	Replace if any defect noticed
2.	Section Insulator	– Cleanliness, damaged petticoat, crack, flash., Make & Batch.	
3.	Copper Runner	- Check for excessive wear , hit mark. - Clearance between contact wire & copper runner on trailing side. - Clearance between section insulator and copper runner.	- check the level of SI with sprit level.
4.	Contact Splice	- General check of splice. - Hit mark and abnormal wear of contact wire.	- check the level of solid core section insulator with sprit level.
5.	Adjustable Dropper	- Loop wear - Excessive tension	

		- Catenary /contact clip - PG clamp	
6.	Stiffener	- Availability - Tightness of PG clamp.	
7.	Encumbrance	- 450mm (min)	
8.	Stagger	- Zero (desired) - ±100 mm (max.)	
9.	Track separation (in case of turn out location)	- Facing end 1.45 mt (min) - Trailing end 1.65 mt(min)	

Proforma 03-16

SECTION INSULATOR MAINTENANCE RECORD RESISTER

Date	Stagger (zero OR ±100mm max.)	Sag (zero)	Condition of Insulator	Condition of runner	Leveling	Condition of anchor clamp	Condition of dropper & stiffener	Remark

Proforma-03-11

Isolator Maintenance Record Resister (As per ACTM)

1. Isolator No 2. Make & Batch 3. Location
4. Line 5. Elementry Section 6. Station
7. Integral Lock key No. 8. Pad lock key No.

SN	ITEM TO BE CHECKED	STANDARD VALUE	OBSERVATION			
1.	Clenliness of Number plate	Cleaned				
2.	Securing of Number plate	Secured				
3.	Check for free movement	Free				
4.	Check for alignment	Ok				
5.	Check arcing horn	Ok				
6.	Check earth continuity	Available				
7.	Lubricate moving parts check condition of brass bushes & their split pins					
8.	Check male/female contact for flash marks & burrs	No mark				
9.	Apply petroleum jelly to male/female contact in open condition.					
10	Check distance between male and female contact in open condition.	500 mm				
11.	Check terminal lug for- 1. Rusting. 2. Melting 3. Flashing 4. Strand damages 5. Soldering failure etc.	 - No rust - No melting - No flashing - No damages - Properly Soldered.				
12	Check for proper soldering of jumper.					
13.	Check handle pipe near sleeve for rustiness.	No rust				
14.	Check for anti falling jumper provision.	Provided				
15.	Check tie rod insulator and pedestal insulator for crack / flash.	No flash/crack.				
16.	Infrared (Thermography) testing – Jumper & lugs					
	Date					
	Name & Signature of technician					
	Signature of Supervisor					

6. PERIODIAL OVERHAULING -

The aim of POH is to recondition and restore the installation in the condition it was when it was first commissioned. The POH should be through and cover every part of the installation. Through inspection of OHE should be done and worn-our part should be replaced by those which have been reconditioned earlier in the maintenance depots and kept ready. The parts removed are sent to the maintenance depot for dismantling, through examination, re-conditioning if possible and re-assembly for use again as required.

The POH is done at an interval of 4 years . In addition to the items detailed under annual maintenance , the following items should be attended during POH –

(a) Mast ,Portal and Cantilever :-

1. At least one complete cantilever assembly per kilometer should be removed and taken to the workshop for dismantling and detailed examination of various components after through cleaning. This test check would reveal the extent to which other cantilever assemblies have to be examined.
2. All regulating equipment should be replaced by previously overhauled ones and the removed equipment should be sent to the work shop for overhaul.
3. Check the position of cantilever with reference to temperature and its distance from anti creep center, the resister arm and steady arm should be in plane of bracket.
4. Check the cantilever for compliance with the “as erected” SEDs.

(b) Catenary & Contact wire :-

1. Dismantle all jumper connections , clean the surface clip and clamps etc. with suitable means like fine emery paper. Check the conductors for over heating , broken strands etc. Replace the clamps, clips & jumper as the condition warrants. Splice the catenary wire if more than 20% strands are broken.
2. Remove the kinks if noticed.

(c) Insulated and Uninsulated Overlaps :-

1. Check the position of contact wire with respect to tracks to comply with SED’s.
2. 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 drawing.

(e) Tunnels :-

1. Check the height and gradient of the contact wire and adjust as perSED.
2. 100 per cent OHE fittings in tunnels should be replaced with new or previously over-hauled fittings and the removed fittings taken to the work shop for detailed examination.

(f) Turn Outs :-

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

(g) Over head Cross Feeders , Return conductors and 25 KV feeders :-

1. Examine wires for frayed strands , overheating , pinching or corrosion ,especially at suspension clamps and PG clamps , tighten junctions sleeves .
2. While tightening PG clamps ensure that all joints are properly cotes with Vaseline.
3. Check tension in wires and adjust if necessary .
4. Other over head wires such as by pass feeders and earth wires should be inspected .The Insulator attachments should be dismantled, over-hauled and put back in position . The insulator should be cleaned at the same time.

7. RE-TENSIONING OF UNREGILATED OHE :-

The re-tensioning of unregulated OHE in accordance with the tension, temperature chart should be done ordinarily at the end of 6 month from the date of erecting and again at the end of 12 months . There after the tension should be checked up once in two years and re-tensioning done as required.

CHECK SHEET CANTILEVER POH

{CEE/CSTM memo No.-L.574.TRD.Technical Instruction/ Circular 42(CEE-TD. Technical circular No.01/2007) dated 22.05.2007}

POH Section : From Km To Km
Date Removal of Cantilever Location

SN	Item to be checked	Standard	Observation
1.	Stay Tube-		
	a-Corrosion	a- No corrosion	a-
	b-Physical Condition	b- No bend/crack	b-
	c-Fixing Hole	c- No deformation	c-
2	Bracket tube-		
	a-Corrosion	a- No corrosion	a-
	b-Physical Condition	b- No bend/crack	b-
	c-Fixing Hole	c- No deformation	c-
3	Resister Arm-		
	a-Corrosion	a- No corrosion	a-
	b-Physical Condition	b- No bend/crack	b-
	c-Fixing Hole	c- No deformation	c-
4	Steady Arm-		
	a-Corrosion	a- No corrosion	a-
	b-Physical Condition	b- No bend/crack	b-
	c-Fixing Hole	c- No deformation	c-
5	Mast Attachment-		
	a-Corrosion	a- No corrosion	a-
	b-Physical Condition	b- No bend/crack	b-
	c-Fixing Hole	c- No deformation	c-

6	Catenary Suspension Bracket- a-Corrosion b-Physical Condition c-Fixing Hole	 a- No corrosion b- No bend/crack c- No deformation	 a- b- c-
7	Suspension Clamp- a-Corrosion b-Physical Condition c-Fixing Hole	 a- No corrosion b- No bend/crack c- No deformation	 a- b- c-
8	Mast Bracket Fitting a-Corrosion b-Physical Condition c-Fixing Hole	 a- No corrosion b- No bend/crack c- No deformation	 a- b- c-
9	Resister Arm Hook- a-Corrosion b-Physical Condition c-Fixing Hole	 a- No corrosion b- No bend/crack c- No deformation	 a- b- c-
10	Drop Bracket Clamp- a-Corrosion b-Physical Condition c-Fixing Hole	 a- No corrosion b- No bend/crack c- No deformation	 a- b- c-
11.	End Clamp- a-Corrosion b-Physical Condition c-Fixing Hole	 a- No corrosion b- No bend/crack c- No deformation	 a- b- c-
12.	Stay Insulator a- Physical Condition b- Chipped / Cracked c- Cleanliness	 a- No cementation b- No crack / Chipping c- Clean.	 a- b- c-
13.	Bracket Insulator a- Physical Condition b- Chipped / Cracked c- Cleanliness	 a- No cementation b- No crack / Chipping c- Clean.	 a- b- c-
14.	Anti Wind Clamp a- Physical Condition	 a- No Bend	 a-
15.	Resister Arm Dropper Assembly a- Physical Condition	 a- No Crack	 a-
16.	38mm arm dropper assembly a- Physical condition	 a- No Crack	 a-

SE (TD) SSE(TD) AEE(TD)

8. **TI/MI** -

TI/MI is the letter published by RDSO. Under this letter head Special Maintenance Instructions (SMI) for Traction Installations are issued. RDSO regularly reviews the performance of Traction Installations and as per the findings of their investigations and other collected statistics ,they issue necessary guide lines to Railways so as to Zero Failure target may be achieved & Reliability of the Installations may be improved.

1. TI/MI- 0001 (Rev. 0) – Failure of 25 KV pedestal insulator-

Solid core pedestal insulator should be used. Pedestal insulators are weak against turning or twisting forces, therefore, in their uses alignment should be ensured. Ex- Isolator Assembly, Support for rigid bus-bars etc.

2. TI/MI- 0007 (Rev. 0) – Use of Disk Insulators -

Earlier it was approved to use Disk Insulators in place of 9 tone insulators. The result were not satisfactory and the instructions approving use of Disk Insulator in place of 9 tone insulator has been withdrawn.

3. TI/MI- 0008 (Rev. 0) – Double eye distance rod. -

At balance weight anchor locations , double eye distance rod should be used between 9 ton insulator and ATD, so that ,when temperature will increase the 9 ton insulator shall not come in contact with anti falling device; otherwise insulator may get damaged.

4. TI/MI- 0009 (Rev. 0) – Arrangement of Copper Cross Feeder (Drawing) -

Arrangement drawings for the use of copper cross feeder in place of aluminum cross feeder at switching stations has issued under drawing No.-

1. ETI/OHE/G/05121 sheet 1&2 , 5122 sheet 1&2
2. ETI/OHE/P/1130, 6830-1 REV. D

5. TI/MI- 0011 – Testing of 25KV solid core insulators -

Solid core insulators should be tested at their manufacturing site on 60% of their design loads so that faulty insulators may be sorted out.

6. TI/MI- 0018 – Winch type ATD -

It is observed that big drum of Winch type ATD tilts , causes rubbing of SS rope with drum wall and further SS rope gets damaged. Instructions are issued to use beveled spacer between mast fitting and clevice eye to avoid tilting of drum . SS rope dia. 8.5mm , gap between drum walls- 10.5mm

7. TI/MI- 0028- Check sheet for Turn-Out Maintenance. -

Details are given in Maintenance of Turn –Out, Cross Over.

8. TI/MI – 0027 – Contact Wire -

It states that contact wire should be manufactured containing 0.1% Silver and its wear rate should be observed. It is expected that the wear rate of such contact wire shall be low.

9. TI/MI – 0034 – Investigation of Contact wire failure cases -

It has observed that most of the contact wire parting cases occurred at RRA clamp. The Cause concluded is formation of crack and groove on the contact wire surface from RRA clamp edge. Instructions are issued to check the contact wire inside the RRA clamp, PG clamp & Ending Cones etc. where, there is possibility of formation of crack & groove on the contact wire. In case OR cantilever is out of plumb, hammering should not be done on RRA clamp to plumb the cantilever.

10. TI/MI – 0035 – Provision of Sleeve in Anti Falling Device -

It states that GI sleeve of about 20mm dia should be provided in anti falling device of ATD such that, in case of SS rope failure travel of moving pulley assembly may not yield excessive sag in OHE as well as when temperature goes down travel of moving pulley should not be restricted so that the OHE may be prohibited from excessive tension.

11. TI/MI- 0036 – Provision of Insulated Catenary -

It states that insulated catenary wire piece should be spliced in OHE under Over Line Structures, so that if continuous row of water falls from OLS to OHE it may not cause the short circuit and securing the catenary wire from parting.

12. TI/MI -0037 -

It states that contact wire may part due to opening of silver brazed joints. The silver brazed joints are sensitive to pollutions. It is, therefore, recommended that such contact wire should be identified through ultrasonic testing and should be replaced by Continuous cast copper contact wire. PG clamps of G jumper should be replaced during POH . The released PG clamps may be re used if restored in good working condition. Contact Ending Cone should be visually inspected during First POH., in second POH (8 years) should be replaced. It may be reused if restored in good working condition . Catenary ending cone shall also be replaced in second POH but should not be reused.

13. TI/IN -002 (Rev. 0) –

It concludes that Thyristor Controlled Automatic Switched Capacitor Bank is the best solution to counter power factor problem of Traction Load at TSS. Earlier used fixed capacitor banks in FP and TSS affects adversely to Power Factor in case they remain connected to bus bar during light load or No load on FP/TSS. The problem also gets multiplied and becomes bigger due to the type of energy meter used and the method adopted for calculation of overall Power Factor of the month for billing purpose.

14. TI/IN – 005 (Rev. 2) , TI/IN-0007(Rev-0) -

RDSO has adopted a statistical method to analyze the insulator failure cases and using this method they declare the make and batch of a particular type of insulator as failure prone. Insulators of failure prone make/batch should be replaced as soon as possible. The method to declare any Make & Batch as failure prone may be stated , in summary, as – if the reason of insulator failure is clear and known ,and is some thing else than material failure ,then no investigation is required. If the failure incidence is first for a certain make & batch of insulator and the reason concluded for the failure is material failure then insulators of that make and batch should be kept on watch. Again, with in one year of the incident, another insulator of the vary make & batch fails due to material failure ,then at least 5 insulators of that make and batch should be taken out from near about locations and should be tested .

15. TI/IN – 008 (Rev. -0) –

It states that Copper Cross Feeder Wire (37/2.25mm , 150sqmm) should be used in place of Aluminum Cross Feeder Wire (19/3.99mm). Aluminum conductors are liable to fail due to pollution and bi-metallic action. Cross Feeder Wires should not be spliced.

16. TI/IN -009 (Rev.-0) -

It states the procedure to be followed to splice the Aluminum Cross Feeder Wires that are yet to be replaced with Copper Cross Feeders and are parallel to the running OHE .

9. Maintenance Tools -

The following list of Tools /Tackles are used in traction organization –

1.Tirfor-1.5.2.5.3.0,5.0 Tone.
2. Pull-Lift – ¾, 3 tone.
3. Dropper making Jig and Wire straightener for 5 , 7 mm dropper wire.
4. Come Along Clamps for – Contact Wire, Catenary Wire, Aluminum SPIDER conductor, Earth wire (19/2.5mm) Galvanized steel.
5. Rail jumper with clamp at both ends.
6. Earthing Discharge Rod.
7. Aluminum straight Ladder – 8mt with hook at top, 11mt extensible.
8. Drilling Machine (25mm).
9. Bench Grinder (Double end) Pedestal Motor Driven (203mm) disc.
10. Hydraulic Compressor for return conductor splicing.
11. Portable Diesel Generator set (3KVA, 240V, and 1Ph).
12. Flood Light fitting with 500 Watt Lamps.
13. First Aid Box, Stretcher.
14. Portable Fire Extinguisher (DCP, Foam type) , Fire Buckets.
15. Contact Wire Cutter(36") , Dropper Wire Cutter (12") .
16. "D" shackles set of one each (1" , 3/4" , 5/8" , 1/2").
17. Single Sleeve Pulley block 3 1/2" x ½ Groove Steel, Groove Fiber for Contact & Catenary.
18. Single Sleeve Pulley Block 6"x 1" Groove Steel.
19. Contact Wire twist-cum-bender 6" .
20. Steel Sling with eye each end 19mm dia.(1m , 2m , 3m , 4m , 10m).
21. Copper Hammer 2 Kg.
22. Micro Meter, Vernier Callipers.
23. Metric Tape 2m,15m, 30m.
24. Bench Vice 6".
25. Dynamometer (3500Kg x 20Kg) 300 mm dia.
26. Earth Tester.
27. Binoculars.
28. Field Telephone.
29. Black smith hammer 10Kg, 12Kg.
30. Bond Press.
31. Portable hand drill 12.5mm.
32. Spanner Set. (DE, Ring).
33. Screw Driver 6" , 8" , 12" , 16 "
34. Insulated Cutting Plier , Nose Plier, Adjustable Plier Wrench, Pipe Wrench(8", 12")
35. Hacksaw frame Adjustable.
36. Plumb Bob .
37. Sprit Level.
38. Detonator Box, Hand Flag set, Banner Flag.
39. Blow Lamp.
40. Grease Gun.
41. Thermometers.
42. Crow bars, Pick Axe.

11. POWER BLOCK & PRECAUTIONS -

1. Power Block – To switch off power supply of any section of OHE and the section is blocked against movement of electric locomotive haul vehicle or EMUs only is called as power block.

2. Traffic Block – Where a line is blocked against movement of vehicles whether steam, Electric or diesel locomotive hauled is called as Traffic block.

3. Power Block & Permit To Work (PTW) - As we know that to switch off power supply of OHE is called as Power Block ; but Power Block is not the Authorization to work on OHE.
Before commencement of work on OHE or in the vicinity of OHE, it is compulsory to have permit to work from TPC. Getting PTW , OHE can be earthed and then after work can be done on OHE.

4. Types of Power Block –
    1. Prearranged Power Block.
    2. Local Power Block.
    3. Emergency Power Block .

    Prearrange Power Blocks are those power blocks whose Day , Time, Duration ,Section etc are mutually decided by the Traffic and TRD or any concerned departments. Normally one week before the Power Block Programme is finalized for the next week as per the block demanded and the traffic expected. Final Programme is informed to all concerned staff.
    Normally pre arranged block is operated on main line and so prior sanction of Section Controller is a must.

    Station Master can sanction Power Block on the lines of their yard and sidings, excluding main running lines; such power blocks are called as Local Power Block. Prior sanction of Section Controller is not required. But any work related to OHE or can affect directly or indirectly to OHE shall prior be reported to TPC.

    In case of any unusual occurred or is likely to be occurred, a railway man is supposed to inform about the incident to TPC and ask the TPC to switch OFF the Power Supply of OHE. TPC will immediately switch OFF the supply of both the effected and the healthy section, parallel to the effected section and will inform to SCOR in writing about the unusual noticed/reported and subsequently supply switched OFF to the section. Receiving such written massage, the SCOR will enquire about the incident and its effects. Being assured that the parallel healthy section is safe for

traffic, the SCOR will inform to TPC, in writing, that the OHE of healthy section may be charged; the TPC will charge the OHE of the healthy section & the effected or the faulty section will be treated as under Power Block. Such Power Blocks, operated in emergency situations are called as Emergency Power Block. The Staff who sought for the emergency power block is required neither to work at the site nor to permit any body else to work at that site until the OHE of the site is made safe by providing discharge rods on the OHE.

5. Sectioning Of OHE

OHE is sectionalized in small electrical sections so that easy control of power supply as well as maintenance and restoration work can be done without affecting traffic adversely. These electrical sections are called as –

1. Sector .
2. Sub Sector .
3. Elementry Section .

The boundary of these electrical sections are defined with the help sectioning arrangements viz.- Insulated Over Lap, Section Insulator & Neutral Section. The section of OHE between TSS and SP is called as sector . The Sector is further divided into Sub-sectors by placing SSP in between TSS and SP.

The elementary section is the smallest section of OHE that can be made dead and isolated from rest of the OHE. The supply of an elementary section is normally controlled by hand operated OFF LOAD Isolator switch. Every elementary section has a unique identification number. Elementary sections are mutually shown in contrast colors in sectioning diagram. Normally the elementary section of main line OHE has 4 or 5 digit identification number ; wherein first 2 or 3 digit stands for the number of interrupter which controls the supply of that Sub-sector in which the vary elementary section is falling and the remaining digits stands for serial number of the vary elementary section , counted from the interrupter. Identification of UP & DN line is done by sorting the elementary section serial number in EVEN and ODD numbers. That is, all elementary sections with last digit as even will be on one side and that of as odd on the other side.

Elementary sections of yard have identification number prefaced with X . The number after X indicates the number of that isolator (SS) which controls the supply of that elementary section.

6. Power Block Protection -

Protection of a section under power block is the combined effort exercised by Section Controller, Traction Power Controller, Concerned Station Master and the working gang who is availing power block.

The section controller makes marking of power block section on the train control chart and advice the station master to apply power block protection. The massage is supported by the exchange of private number.

The TPC hand over the PTW to working party under a pre defined standard power block massage. This massage must be supported with the exchange of private

number, massage-book number, date, time and name. TPC should also do some thing (like marking on Mimic Board) for his remembrance that so-and-so section is under power block. He shall also note down the particulars of handed over PTW in Power Block Register.

The ASM is required to apply Longitudinal Protection and Transverse Protection. The protection prohibiting the movement of trains of the same line on which the power block is under force is called as Longitudinal Protection. The protection prohibiting the movement of trains of other lines is called as transverse protection. Ex- Prohibition of UP or DN train via cross-over in the power block section enforced on opposite line. The Longitudinal & Transverse Protection can be effected with help of Station Working Rules. In Electrified section , SWR is also supplied by the TRD department. It states the switching operations required to be done , its sequence and condition of points and signals in case of power block on each elementary section , sun sector and sector connected with that station . It also contains the sectioning diagram of OHE, pertaining to that station .

The working gang is required to apply electrical protection by earthing the OHE through discharge rods and also to apply track protection.

TRACK PROTECTION -

Straight Track:-

1. Red Banner Flag, 600 mt. before work place.
2. 1200 mt. before the work place, 3 Detonators, 10-10 mts apart should be placed on track in cross arrangement.
3. One person should be deputed ,with red hand flag, at 45 mts before the detonators.
4. One person should be deputed , with red hand flag, at 30 mts before the work place.

Curved Track:-

1. One person should be deputed, with red hand flag, at 30 mts before the work
   Place.
2. Red Banner Flag, 600 mt. before work place.
3. 800 mt. before the Banner Flag , 3 Detonators, 10-10 mts apart should be placed on track in cross arrangement.
4. One person should be deputed, with red hand flag, at 45 mts before the detonators.
5. One person with red hand flag should be deputed in between the banner flag & detonators.

7. General Precaution while working in 25 KV AC electrified section / OHE:-

1. Knowledge of action taken while electrical accident.
2. Availability of First Aid Box at work place/ suitable location.
3. Tools & Plants should be tested as per schedule.
4. Sectioning diagram of the section should be available.
5. Observe the fellow employee that they are following the safety rules.

6. Before commencement of work on OHE , ensure the availability of Permit to work and earthing of OHE at appropriate locations.
7. Discharge rods should be provided by each gang independently, irrespective of their working section.
8. The distance between two discharge rods should be less than 1000 mt.
9. Neutral section should be treated as live OHE, unless it is earthed by discharge rods.
10. While working on Isolator, its terminals should be shorted by a jumper.
11. Use helmet and safety belt while working on OHE/Gantry.
12. Be care full for proximity of ladder and live OHE.
13. Use cotton or jute rope with ladder, ensure good condition of rope.
14. Metal measuring tape should not be used in electrified section.
15. Ladder should not be rest on contact wire.
16. Not more than one work man should climb on ladder.
17. The ladder should not be used for transportation of tools-tackles or material.
18. Tools and spare parts should not be exchanged by throwing it. Always use rope or any safe method.
19. While splicing conductors, their cross section / strands should not be impaired.
20. The size and strength of anchoring rope(sling, rope of tirfor , pulley-block etc) should be greater than the load, being tackled by them.
21. To switch off 25 kv supply is not the safe condition to work on OHE unless it is earthed by discharge rods on both the sides of the work place. In case of T/O, X/O etc. , ensure that the work man always remains between two discharge rods
22. Take care of bonds for its connection, shape and condition. It should not be damaged or disturbed.
23. Maintain **working clearance** of **two meters** from live OHE.
24. While operating isolator , ensure that the operation of isolator has completed. There is possibility that the link between operating rod and mechanism is broken.
25. Check discharge rod before its use, that clamps are OK and cable (40 sqmm) is in good condition (- no broken strands, no cut on cable insulation , soldering OK ,etc). Ensure that structure bond is available with mast otherwise earth clamp of discharge rod should be clamped on traction rail (Not S&T rail) . Line should be tested at RT tube before grounding it.

8. Precaution while working with Tower Wagon-

1. The Tower Wagon shall be operated only by an authorized railway employee. The authorized employee shall have competency certificate in this regard.
2. Employees working on tower wagon should be acquainted of rules made for operation of a tower wagon i.e. rules of train operation.
3. When a tower wagon is on work its speed should not be more than 8kmph.

4. Before rising of pantograph of tower wagon, ensure availability of PTW, OHE has tested and earthed by discharge rod, panto earthing isolator, mounted on tower wagon, has closed and locked.
5. Pantograph of tower wagon is secured manually after lowering it. Such a manual work should be done after ascertaining that, that the tower wagon is standing under a dead & earthed OHE, panto earthing isolator is in closed and locked condition. To open and lock the earthing isolator , ensure that the man has came down from TW roof after securing the pantograph in lowered condition and no other man left on the roof of tower wagon.
6. Work plate form on the roof of tower wagon shall only be moved while tower wagon is in stand still condition. The speed of tower wagon should not be more than 5 kmph if its work plate-form is in raised condition.
7. To cross any insulated over lap, turn out, cross over or section insulator, neutral section (That is boundary of elementary sections) ensure that the next section is in deenrgized condition.
8. Tower Wagon pantograph should not be raised until OHE is made dead and earthed.
9. Banner flag should be placed on suitable location so that the tower wagon may not enter into a live section.
10. The discharge rods shall be removed from OHE, after completion of work, lowering and securing of pantograph and all work men has come down from roof of tower wagon.

12. COMPETANCY CERTIFICATE:

Competency Certificate authorizes a employee to do a some specific work. No employee shall work in electrified section without having proper competency certificate. Competency certificate is issued by a competent authority (SSE, AEE, DEE etc) after evaluating the competency of the employee through examination /practical demonstration etc.

The following competency certificates are issued to the employees working in traction distribution department.

SR	Category of Certificate	Designation of Staff	To be issued by
1.	TR-1	Khalasi	SSE after oral test
2.	TR-2	OHE linesman	AEE/TRD after oral test
3.	TR-3	OHE Supervisor	DEE/TRD after written and oral test
4.	TR-4	TW Driver	DEE/TRD after written and oral test
5.	TR-5	PSI Fitter	AEE/TRD after oral test
6.	TR-6	PSI Supervisor	DEE/TRD after written and oral test
7.	TR-7	Supervisor/Artisan –Relay &	AEE/DEE(TRD) after written ,oral

		Instruments	test and practical test.
8.	TR-8	Skilled Artisan -RC	AEE/TRD
9.	TR-9	Supervisor - RC	DEE/TRD after written and oral test

1. TR-1 - It authorizes to work as an unskilled Khalasi in the OHE/PSI section to assist skilled staff and supervisors in maintenance, repair and installation work. It does NOT authorize to work independently on any OHE line or Power Supply installation.

2. TR-2 - It authorizes OHE Linesman to -
    1. Take power block from TPC for 25KV OHE/66/132/220 KV transmission lines and underground cables;
    2. effect shut down in yards and sidings by operating isolator switches;
    3. operate switching stations on local control under instructions from TPC;
    4. carry out repair , installation and maintenance work on 25KV OHE; duly observing the prescribed rules.

    It does not authorize Linesman to –
    1. issue permits –to –work;
    2. bring into operation any new installation.
3. TR-5 - It authorizes PSI artisan to -
    1. Work as a fitter in the installation maintenance and repair of TSS, switching stations, BT,AT etc.
    2. effect shut down on 25KV equipment under instructions of TPC;
    3. Take power block from TPC for working on 25 KV equipment;
    4. operate equipment at TSS and at witching stations under instructions from TPC, duly observing the prescribed rules.

    It dose not authorizes to –
    1. issue permits-to-work;
    2. effect shut down or take power block for extra high voltage(EHV) installations.
    3. bring into operation any new installation

13. BONDING & EARTHING

BONDING –

Bond is an electrical connection which connects rail to rail or any metallic structure to rail. The purpose of bond is provide easy path to traction return current and neutralize the induced voltage generated in the metallic structure.

Material – Mild steel

Size Normal – 40x6 mm, & should not be less than 200 sq.mm.

Type –

1.Rail Bond – connects rail to rail across fishplate.

2. Inter Rail Bond – connects both the rails of a track.
3. Inter Track Bond- connects two tracks.
4. Structure Bond – Connects metallic structure to rail, like mast , girder, FOB, level crossing gate etc.
5. Z Bond- connects traction rail to traction rail in track circuited area.

Bond Maintenance –

1. Open the bond nut-bolt, clean the surface from rust/corrosion, apply petroleum jelly and re-tight the nut bolts.
2. Replace damaged/ broken bonds , replace missing nut-bolts.
3. Check the shape and keep below the rail level.
4. Apply black paint.
5. Correct the insulation between S&T rail and traction rail.

.<u>EARTHING</u> –

Earthing means to make a effective electrical connection with general mass of earth. In Electrical system earthing is essential for safety of both the man & machine. Besides, it is also necessary for proper working of electrical power system . In this regard earthing is classified as –

1. System earthing –like neutral earthing, LA connection etc.
2. Equipment earthing – earthing of non-electrical metallic portion of electrical equipment like outer cover.

For earthing , the object/equipmet is connected with the general mass of the Earth. A earth pit is made by making a pit (dia.- 30cm, depth- 3or3.5 mts) and putting in earth electrode. The electrode is a GI pipe, 40mm dia and 4mts long, systematically perforated. This electrode is connected to the equipment, being earthed, through a earth wire or strip.
The following actions are desired for a proper up keeping of earth pit-

1. Keep the surrounding of earth pit clean; ensure good condition of earth Kundee. Earth resistance value, date of measurement should be painted with black paint.
2. Ensure good condition nut –bolt joint between earth electrode and earth wire. Do needful conditioning- tightening, rust cleaning etc.
3. Damaged or broken earth wire/strip should be replaced.
4. Measure earth resistance with earth tester. If desired value is not getting ,do the needful –
    I. Pour some water in the earth pit.
    II. Dig out earth electrode and check for rust, corrosion etc.
    III. Putting in earth electrode, fill the pit with alternate layer of common salt and charcoal and finally cover the pit with soil. Put some water to moist the pit .

IV. More earth pits may also be connected to get the desired value.

5. Some of the standard earth pit resistances are – 0.5 Ω for TSS, 2.0Ω for Switching Stations. 10 Ω for single earth pit.

Note – Earth pit resistance is always the maximum permissible value.

CHAPTER –7

ERCTION TESTING COMMISSIONING OF OHE

1. MAST-

Points to be considered while erecting a mast/portal -

- A Suitability of the type of foundation &mast according to the type of location.
- A Check the mast for any type of abnormality like deformation, corrosion etc.
- A Grouting angle should be fixed properly. Ensure that at least 1350mm mast – length is buried into the foundation.
- A Tie the mast with rope and pulling-lifting devise. Lift-up the free end of the mast and put the grouting angle end of the mast into the foundation simultaneously. Take care for proximity of mast to the live OHE wire.
- A Reverse deflection about 5 to 8 cm should be ensured.
- A Making the mast stand up into the foundation with grouting angle, fill it with the cement-concrete mixture and ensure proper filling of the mixture by ramming it.
- A Grouting angle should remain fixed to its position till the cement-concrete mixture sets.
- A Muff should be made after removal of grouting angle.
- A Ratio of cement, sand and concrete should be 1:3:6 and 1:2:4 for Foundation and muff respectively.

2. PORTAL-

1. Suitability of the type of foundation & portal according to the type of location.
2. Check the Portal for any type of abnormality like deformation, corrosion etc.
3. Portal shall be erected with the help of a crane. After complete assembly of the portal it shall be lifted up by the crane and stand up into the foundation. Suitably supported and secured in its position by grouting angle and other means, the foundation is filled with the mixture of cement concrete (1:2:4). Alternatively, one of the up-rights is erected and grouted. The second up-right is also erected but not grouted. Now the boom is lifted up with the help of crane, assembled with both the up right and properly supported & secured in its position. Next the grouting of second up-right is done.

Note :- Support shall not be removed until the concrete sets completely.
Power Block and earthing of the nearby OHE should be done.

3. INSULATOR-

All type of insulator shall be checked for cleanliness, damaged shed, cracks and load testing prior to installation. Location wise Make and Batch of insulator should be recorded. Insulators of banned or failure prone Make shall not be used though that passes the load test.

Design of test jig has been stated in TI/MI-24. Test load of different types insulator is given below-

Sr No	Type of Insulator	Design load	Test load

1.	Bracket Insulator	7000 Kg	4900Kg
2.	Stay insulator	7000Kg	4900Kg
3.	9 Ton insulator	9900kg	6930Kg
4.	Pedestal insulator	6000Kg	4200Kg

4. CANTILEVER-

Different parameters of Bracket Assembly (Cantilever) are as follows-

1. Size of Bracket Tube- 30/38mm (Standard), 40/49 (large).
2. Stay tube – 28.4/33.7 mm.
3. Resister arm- 28.4/33.7 mm.
4. BFB Steady arm- 32x31 mm.
5. Distance between top & bottom fitting- 1900 mm /2000 mm.
6. Steady clearance- 300 mm /250 mm.
7. Bracket tube projection – 200 mm.
8. Resister arm projection – 200 mm.
9. Encumbrance – 1400 mm (Normal) , 300 mm (min.)
10. Stay tubes adjuster- ± 90 mm.

Cantilever is made by assembling different tubes and fittings. These tubes are cut to the size ,which depends on the implantation of the location & encumbrance required to be maintained . To assemble a cantilever, it is required that tubes of proper length are available and hook- clamps are tighten at proper point on the tubes. From this point of view, four dimensions of a cantilever known as A, B, C, and D are stated . The meaning of these are-

A- Distance between mast stay fitting and eye of catenary suspension Bracket hook.

B- Distance between vertical swivel axis and eye of catenary suspension Bracket hook.

C- Distance between vertical swivel axis and resister arm hook(eye).

D- Horizontal distance between resister arm hook(eye) and Catenary suspension axis.

First of all top fitting and bottom fitting is fixed at the proper point on the mast, maintaining proper gap in between. Stay insulator and bracket insulator are attached with their fittings, using rope pulley block. Cantilever tubes , cut to the size according to the location implantation are also lifted with the help of rope pulley block and attached with insulator. All nut-bolts and fittings are tighten properly and this assembled cantilever is fastened with mast , untill the OHE is suspended on it.

Usually tools required are – ladder, rope pulley block, spanners (24/27,17/19,21/23), measuring tape etc.

5. OHE- (OVER HEAD EQUIPMENT) – To erect OHE, first of all on the first anchor mast , the ATD is fixed and locked with Y value corresponding to the 35 °C. A temporary grooved pulley of 30cm dia. is also fixed on the mast. A wire with Catenary & Contact ending cone , attached on its end, is fixed on this grooved pulley with the help of U clamps. To run catenary wire between both the anchor locations, the pulley-hook assembly is suspended on Suspension Bracket Fittings of each mast between these anchor locations. The Catenary wire is attached with the ending cone of Temporary Grooved-pulley . Now catenary wire is stretched over the pulley- hook assembly by releasing the catenary wire from reel –wagon. In this way the catenary wire is stretched up to another anchor location where the wire is anchored through dynamometer and maintaining a tension of 1000 kgf. The Catenary wire is left in that state for about 48 hrs. so that its tension may equalize over all the spans. While stretching the catenary wire all care should be taken for preventing bird –caging and other types of abnormality.

Droppers are attached as per the dropper schedule. Pulley or wire loop is attached to the free end of the droppers.

Now contact wire is stretched between both the anchor locations in same way as the catenary wire was stretched . The contact wire is supported through pulley or wire loop attached with the dropper free end . Tension in contact wire should be 1500 kgf. to maintain the sag. Prior to stretching of contact wire the catenary wire is lifted from pulley-hook assembly and tighten into suspension brackets.

Now the Contact and Catenary wire is attached with the temporary pulley arrangement of the second anchor mast releasing the Dynamometers and left for some time in that state .

Now Temporary pulley arrangement is also released by attaching the catenary- contact wire with ATD after securing the ant creep center by tightening the ant creep wire with catenary wire in double suspension clamp.

Now the ATD is on load and after some time when considerable creepage in catenary and contact wire is not expected , the droppers are attached with contact wire. Final adjustment through height and stagger chart will be done.

6. Regulating Equipment –

The following tools and equipment is required for erection of regulating equipment – Come along clamp with common plate for catenary and contact wires, D-shackle, Wire ciling (1 No of 5 mt length, 2 No of one mt length), Pulling and lifting device (3 ton and 1.5 ton capacity) , rope pulley block, small rope peaces , ladder , tool box (spanner set hammer, plier , thermometer, measuring tape, hack-saw), contact wire bender & twister, discharge rod etc.

The following parts shall be checked for their good & proper state- S.S. rope and its length according to the type of ATD, Groove and collar of pulley for damage and sharp edge, Bearings, bend arm & Straight-arm, ending cone, antifalling device, etc..

After parts inspection the ATD will be assembled. In case of Winch type ATD, the SS rope shall be marked at 4.5 mt from an end. Both the end of SS rope shall be entered in joint- hole of big drum in such a way that the 4.5 mt. Long end of SS rope comes out from the hole made on helical grooves of big drum and the other end comes out from hole made between drum collars. The SS rope is made fixed by fixing thimble in the joint- hole of big drum . The 4.5 mt. Long side of SS rope is fixed in the ending cone, by thimble, after turning the SS rope over small pulley. This ending cone is on the straight arm . The other end of SS rope is tuned 5 times, in anti-clock direction, over the big drum and is fixed in balance-weight-ending –con using thimble.

For erection of ATD, the balance weight is lifted upto a height , depending on ambient temperature , by ciling and ¾ ton pullin & lifting device. The tension of OHE is balanced through ciling (about 5 mt. Length) and 3 ton pulling & lifting device. The assembled ATD is lifted by rope- pulley block. The clevise is fixed between bent- arm & Straight-arm through GI nut-bolt. The clevise along with angle plate of antifalling device is fixed with mast anchor fitting through GI nut & bolt. The double eye distance rod is attached with small pulley, maintaining their alignment. The free end of SS rope is attached with single eye distance rod of balance weight through double- strap and pins. Now load on cilling and pulling & lifting device shall be released. The following points shall be taken care of -

1. The adjusters shall be half open and their check –nuts are tighten.
2. Split pin are there in studs.
3. Bearings used shall be sealed type and in good condition, otherwise are well greased.
4. X-Y values are as per temperature chart.
5. Compensating plate is vertical.
6. There is no grasing between pulley and SS rope.

7. Section Insulator-

The following tools-tackles are required for erection of Section Insulator – 3/2 ton pulling & lifting devise , 2 No. come along clamp for catenary and contact wire each, hammer, spanner set (30/32 D spanner, 17/19 ratchet, 24/27), catenary ending cone

with snap head pin and split pin, plare, measuring tape, insulation tape, binding wire, hack-saw, load tested 9 ton insulator etc.

First of all location shall be decided as per the general guide lines for erection of section insulator. The expected center point of the section insulator shall be marked on catenary & contact wire by insulation tape. On catenary wire two markings shall be made on both side of marked center point of SI at 30 cm each. Thus the distance between outer markings will be 60 cm. Two come along clamps shall be fixed at suitable location on catenary wire and load taken by 3/2 ton pulling and lifting device. The above marked 60 cm portion becomes loose and that portion shall cut out from catenary wire . Catenary ending cones are joined to the fresh free end of catenary wire and tested 9 ton insulator is inserted. Now load is released.

Now after preparing section insulator assembly , two markings are made on contact wire. First marking at 1.325 mt from marked center point of SI in facing end direction and second marking at 0.375 mt in trailing end side. The assembled section insulator is lifted up hanged at its proper position through binding wire that its load goes to catenary wire. Now Adjustable dropper are provided. Like wise catenary wire contact wire load is taken and marked portion of contact wire is cut out , free ends of contact wire is tighten in the SI ending clamps. Load is released and level of section insulator is adjusted through sprit level, adjustable dropper, saddle pin , and runner adjusters.

The following points shall be given due consideration while erecting section insulator.

1. Encumbrance at section insulator shall not be less than 450mm.
2. The clearance between contact wire and free end of copper runner shall not be less than 230mm.
3. In turn out location the track separation shall not be less than 1.45mt with facing end towards the center of turn out and that of trailing end towards the center of turn out, 1.65 mt. These distances shall be measured at the ends of section insulator.
4. Stagger – desired " 0", max. ± 100mm.
5. For loop lines, it shall be close to the first mast of loop line. In case of main line, it shall be erected between 2 to 10mt, in trailing direction as per the direction of traffic.
6. 3 to 4 cm over lapping between contact wire and runner shall be ensured by checking its level through sprit level.
7. On both sides of section insulator , contact wire pieces (called stiffner) of length 2 mt each shall be provided on contact wire by PG clamps to give stiffness to the contact wire. In span dropper is provided between stiffner and catenary wire.
8. The final adjustment shall be done by tower wagon.

8. ISOLATOR-

1. Secure the Isolator mounting channel on mast.

2. Fix the pedestal insulators on the mounting channel.
3. Fix the Fixed Contact and Moving Contact (along with tie rod insulator) on pedestal insulators.
4. Joint the Tie Rod insulator with link mechanism.
5. Fix the operating handle at suitable height on the mast.
6. Join the operating handle and link mechanism with operating rod.

During the erection of an isolator the following points should be considered-

1. Insulator shall be checked for any type of damage.
2. In open state of isolator, the clearance between fixed and moving contact should not be less than 500mm.
3. The mast should be connected to a separate earth pit, that earth resistance should not be more than 10 Ω.
4. With isolator closed and handle locked, the moving contact should full in contact with fixed contact.
5. Isolator operation should not be hard. Check operating rod guides.
6. Isolator jumpers (i.e. between isolator terminal and OHE) should neither be stretched nor loose. Sufficient earth (not ground) clearance should be maintained with jumper.

9. EIG Sanction-

Chief Electrical Engineer is the Administrative Head of Electrical department and is responsible for efficient working of the department. He is answerable to General Manager regarding all the matters of Electrical Department.

As per section 36(1) of Indian Electricity Act 1910, The CEE shall also discharge the duties Electrical Inspector to Government
in connection with all transmission lines on Railways, 25KV feeder lines, Sub-Stations & Switching Stations either in railway premises or out side, but under Railway's control.

Working as Electrical Inspector to Government, he is responsible for the followings –

1. Scrutiny and approval of the layout and design for sub-stations, OHE and other installations for compliance with the Indian Electricity Act and Rules.
2. Approval for the energization of the installations.
3. Statutory inspection of the installations periodically under rule 46 of Indian Electricity Rules.
4. Inspection of the completed installations, either personally or by deputing his officers, for compliance with the safety requirements.
5. Investigation of electrical accidents and issuing directives to prevent their recurrence.

The following documents are sent with the application to EIG, seeking approval to Energization (OHE, Sub-Station).

1. Cuttings of leading New Papers as proof of Public Announcement.

2. Certificate regarding OHE.
3. Certificate regarding precaution and safety instruction.
4. Certificate from DRM regarding safety precautions.
5. Insulation Resistance test certificate of OHE.
6. Insulation resistance test certificate of AT & BT.
7. Test result certificate of equipment in TSS & switching station.
8. No objection certificate from DOT.
9. Any other certificate asked by EIG.

10. Test Procedure of OHE.-

Before commissioning of OHE various inspection at various stages are done which can be seen as-

- Inspection by supervisor & AEE.
- General Inspection by Divisional Engineer.

Irregularities noticed (& rectified accordingly) are classified as-

A- Irregularities important regarding safety & accident.
B- Irregularities not important for safety but their rectification is must.
C- Irregularities of very ordinary nature and for their rectification commissioning should not be delayed. These can be rectified after commissioning also.

Joint Inspection of OHE -

A joint inspection is done by AEE/TD, Supervisor & Representative of contractor. Inspection is done as per drawing. Height, Stagger, Clearances, Cantilever,CB,BM,Isolator, infringement to standard moving dimension etc. are checked. Important points of inspection are as follows-

-Removal of temporary earth connection & cantilever.
- Free movement of ATD.
-200mm & 500mm clearance in overlaps.
- Easy movement of Isolator ,500mm clearance between fixed and moving contact.
- Insulators for any damage.
- 100 mm pre sag, broken strands of catenary wire.
- Height at level crossing gate should not be less than 5.50mt.
- Stagger on tangent and curved track 200&300mm respectively.
- Gradient of OHE on main line and yard line should not be more than 3mm/mt & 10mm/mt respectively.
- Checking of Bonding and earthing. Earth pit resistance should not be more than 10Ω.
- Horizontal & Vertical clearance between OHE and nearby structure.

Caution Boards Displayed –

- Shock treatment chart and First Aid Box should be available in all offices, Stations, Depots, Sub-Station & Switching Stations of Electrified section.
- General Caution Board & Danger Board at all Station office,FOB,ROB.

- Protective Screen at FOB, ROB.
- Danger board at level crossing gate.
- Electric Engine Stop board, Caution Un-wired turn out, Neutral section board, Gradient Board, Watering limit board General Caution board should be at their proper location.

General Inspection of OHE –

Attending all defects in OHE and Other associated items as per their necessity, a General inspection of the system is done by SrDEE/TD, Dy.CEE & Representative of Contractor. Generally this is done by Tower Wagon. The purpose of this inspection is to conclude the condition of OHE as suitable for charging.

Final Inspection of OHE –

After General Inspection of the OHE preparation for insulation resistance test and continuity test is done. This test is done in the presence of Officers of Open line . Insulation Resistance of each elementary section with respect to elementary sections of either sides is checked by isolating the elementary section from elementary sections of either sides . The elementary sections of either sides are connected to earth. All isolators CB, BM are kepet opened and locked, AT are disconnected.

Continuity between elementary sections and sub-sectors is checked by Ductor. The insulation resistance of the a elementary section should not be less than 25 MΩ.

11 Precautions while working on 25KV AC OHE-

1. Maintain 2 mt working clearance from 25KV live equipment.
2. Ensure Permit to Work from TPC before commencement of work.
3. Ensure discharge rod on both side of work spot.
4. Steel tape should not be used.
5. Distance between two-discharge rods should not be more than 1KM.
6. Ladder should be raised from mast side. One man will hold it with hand and other will pull it with rope.
7. Slipy or wet foot-ware should not be used while climbing on ladder.
8. Use safety belt and helmet.
9. Don’t throw the tools, handle it through rope.
10. Don’t operate Isolator ON-Load.
11. Don’t Use water in case of fire of live equipment.
12. Ensure proper track protection .

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