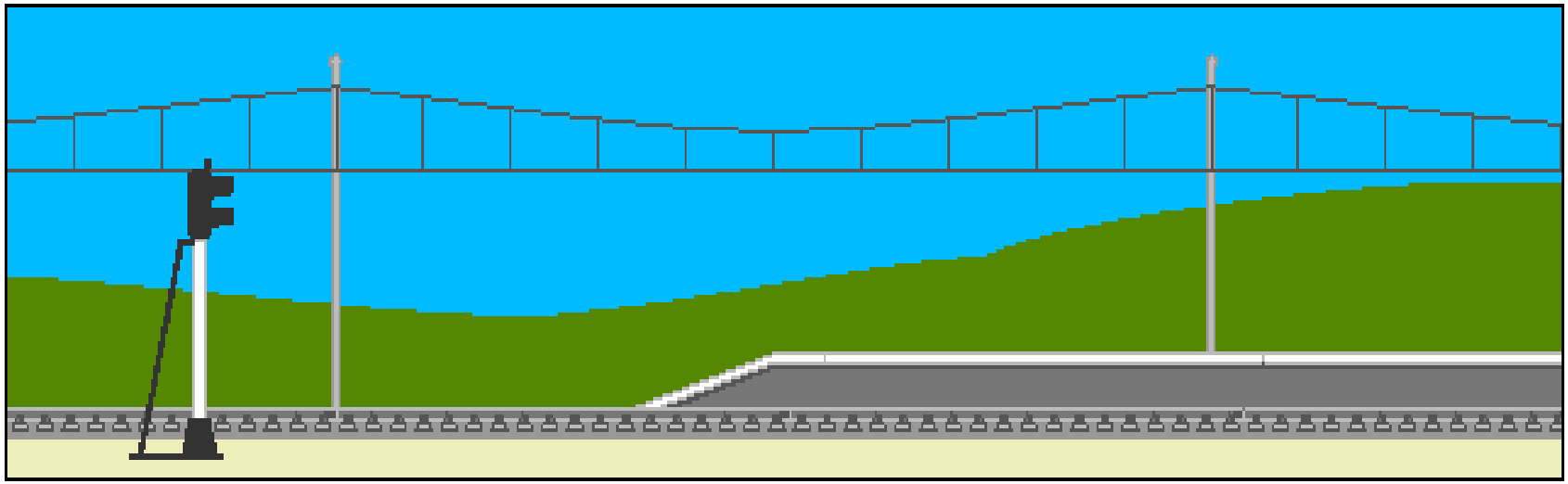
Indian Railways
Centre for Advanced Maintenance Technology

POWER SUPPLY ARRANGEMENTS

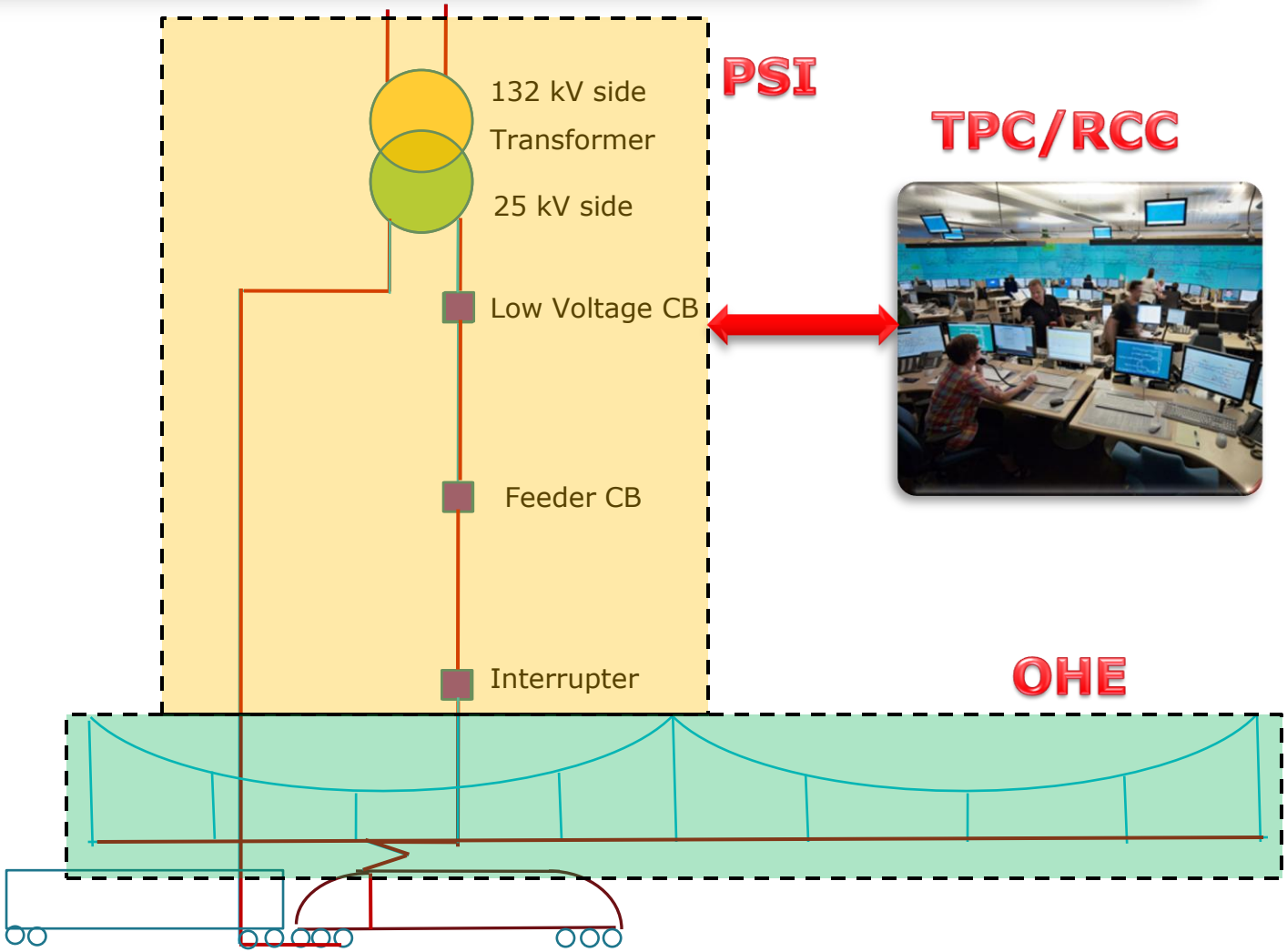
What is Traction Distribution?

For moving a train the energy is provided by the network called

TRD



Functioning of TrD System



25 kV, ac, 50 Hz single phase power supply for electric traction is derived from the grid system of State Electricity Boards through traction sub-stations located along the route of the electrified sections. The distance between adjacent sub-stations depends on intensity of traffic and load of trains.

At present there are broadly four different arrangements in existence as under :

1. The Supply Authorities supply power at 220/132 kV Extra High Voltage (EHV) at each Traction Sub-Station which is owned, installed, operated and maintained by the Railway.

2. The Railway receives 3-phase power supply from the Supply Authority at a single point near the grid substation, from where the Railway runs its own transmission lines providing its own Traction Sub-Stations.

3. All EHV and 25 kV equipment is owned, installed, operated, and maintained by the Supply Authority, except 25 kV feeder circuit breakers which are owned, installed, operated and maintained by the Railway.

4. All EHV and 25 kV equipment is owned, installed, operated and maintained by the Supply Authority but 25 kV feeder circuit breakers alone are operated on remote control by the Traction Power Controller (TPC).

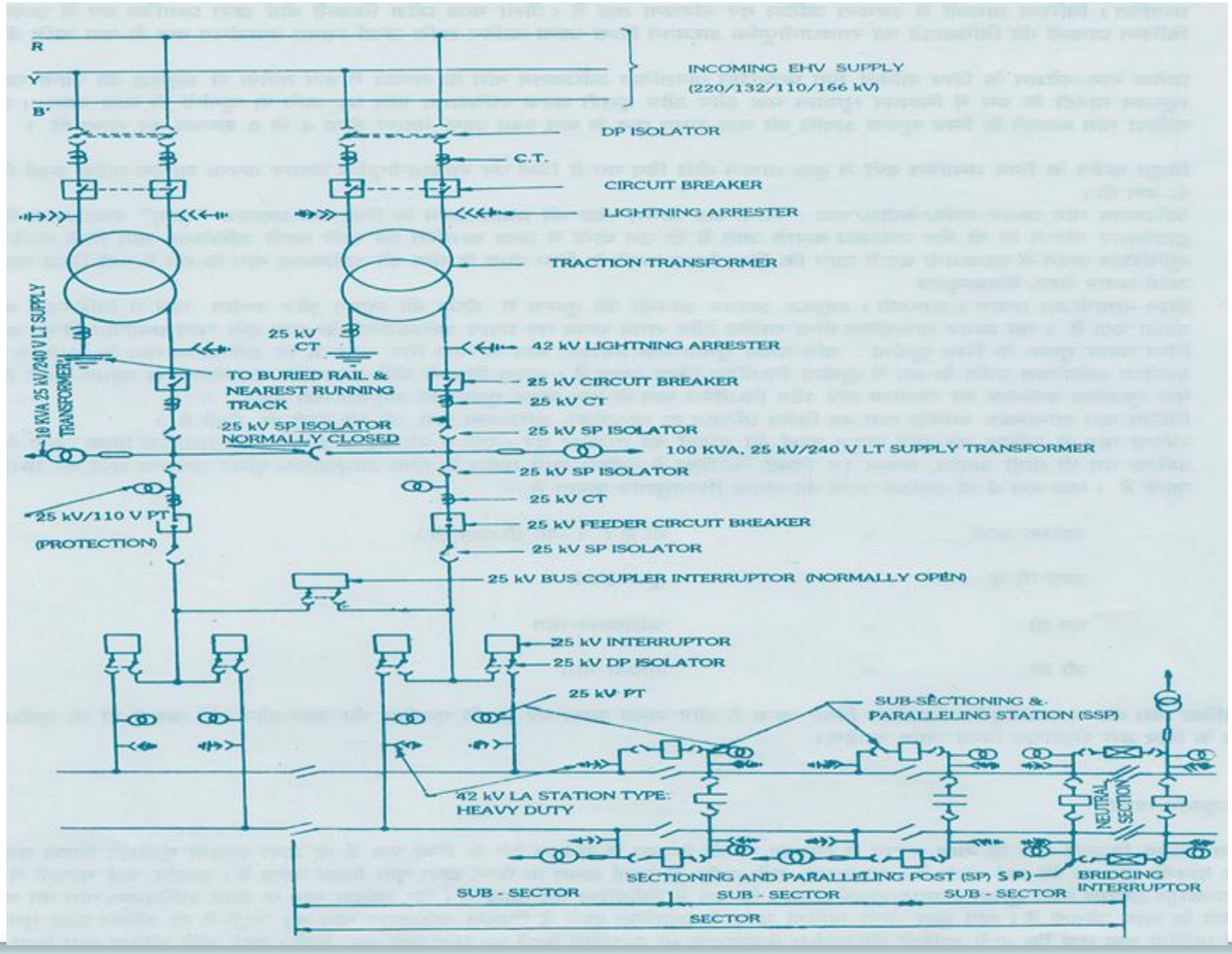
DUPLICATE SUPPLY

- To ensure continuity of supply under all conditions, the high voltage feed to the Traction Sub-Stations is invariably arranged either from two sources of power or by a double circuit transmission line, so that even if one source fails, the other remains in service.

VOLTAGE REGULATION

- The permissible variation of the bus bar voltage on the bus bars at the grid sub-station is +10% and -5% i.e., between 27,500 V. and 23,750 V. The tapping's on the transformers are on the secondary winding and are set to ensure that the voltage is maintained as high as possible but not exceeding 27.5 kV at the feeding post at any time.

Traction Power Supply Arrangement



25 kV Supply At Traction Sub-station

- On the secondary side, one transformer circuit breaker and one feeder circuit breaker are installed with associated double pole isolator, the bus bar connections being such that full flexibility of operation is assured.

- The traction sub-station is designed for remote operation.
- The facilities exist to change over from one feeder to the other by means of isolator/bus coupler.
- One end of the secondary winding of the transformer is solidly earthed at the sub-station and is connected to track/return feeder through buried rail.

FEEDING & SECTIONING ARRANGEMENTS

1. The generation and transmission systems of Supply Authorities are 3-phase systems. The single-phase traction load causes unbalance in the supply system.

2. To keep the unbalance on the 3-phase grid system within the permissible limits, power for ac single-phase traction is tapped off the grid system across the different phases at adjacent sub-stations in cyclic order.

3. Thus it becomes necessary to separate electrically the overhead equipment systems fed by adjacent substations. This is done by providing a 'Neutral Section' between two sub-stations on the overhead equipment to ensure that the two phases are not bridged by the pantographs of passing electric locomotives/EMUs.

4. The permissible voltage unbalance at the point of common coupling on the grid supply system should not exceed the following limits:

Voltage Unbalance	(%)
Instantaneous	5
2 hours	3
Continuous	2

5. To ensure rapid isolation of faults on the OHE and to facilitate maintenance work the OHE is sectioned at intervals of 10 to 15 km along the route. At each such point a 'switching station interrupters' are provided.

The shortest section of the OHE which can be isolated by opening interrupters alone is called a *'sub-sector'*. Each sub-sector is further sub-divided into smaller *'elementary sections'* by provision of off-load type manually operated isolator switches.

6. At some stations with large yards, alternative feeding arrangements are provided so that the power for feeding yards may be drawn from alternative routes. Normally the switch is locked in one position, being changed to the other when required after taking necessary precautions.

7. At electric loco running sheds and at watering stations manually operated interruptors and isolator with earthing heels are provided to enable switching off of the power supply locally and earthing the OHE to enable working on roofs of rolling-stock.

SWITCHING STATIONS

- Basically these are meant in normal times to parallel the overhead equipments and in emergencies to bifurcate and quickly isolate the faulty section through remote control operation.

- In addition the feeding post feeds the power into the overhead equipment sector wise and the sectioning post bifurcates the overhead equipment at the neutral section to avoid mix up of power fed from different phases (different substations).

- The sectioning post also helps in extending power supply in times of emergency like outage of one of the substations.

- The parallelism of overhead equipment helps to reduce the voltage drop by making use of all the overhead equipments to share the load.

All the switching Stations have:

i) interruptors to carry out the switching operations,

ii) potential transformers for line indication,

iii) auxiliary transformer for power supply at the switching station which is most often away from the station areas,

iv) lighting arrestor for the protection of each subsector of the overhead equipment.

Since the interruptors are meant to operate only under command there is no relay associated with switching station except the sectioning post.

FEEDING POST (FP)

★ Each feeder supplies the OHE on one side of the feeding post through interruptors controlling supply to the individual lines. Thus, for a two-track line, there will be four interruptors at each feeding post.

FEEDING POST

FEEDING POST (FP)

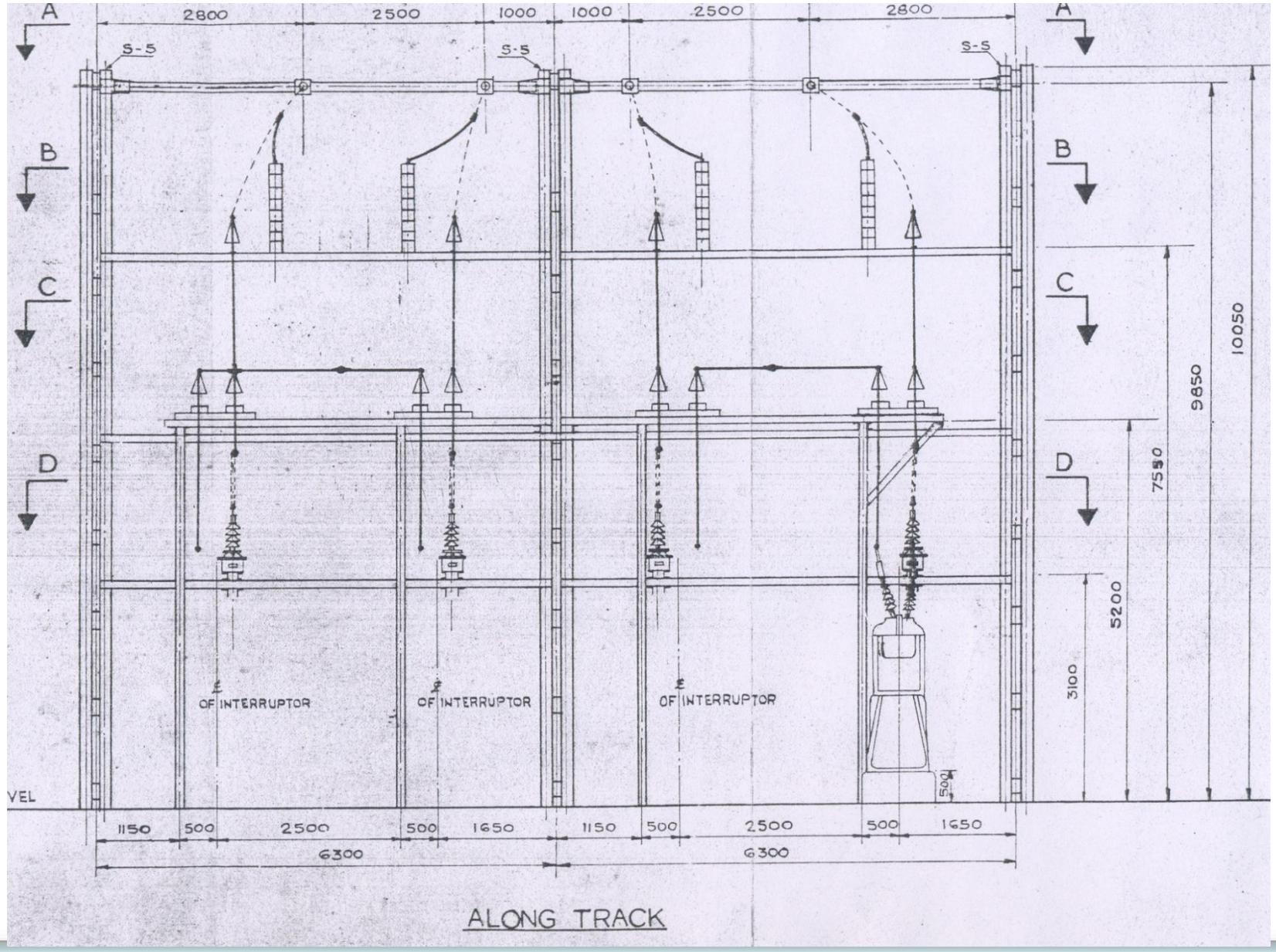
1. ***Lay out:*** As the name implies this post is meant to feed the power supply into the overhead equipment system drawn by feeders from the 220kV, 132kV, 110kV, 66kV/25kV, single phase traction substation.

   - For a double line section there will be a minimum of four interruptors. The typical Drg. No. ETI//PSI/006 issued by RDSO gives the layout details.

- As the interruptor will require periodical maintenance, arrangements are made for its total isolation by a double pole isolator. The two incoming feeders from the traction substation are kept separate at the feeding post. No common bus is provided.

- The lightning arrestors as usual are at the top at the entry point of the feeding post looking from the overhead equipment side.

Typical General Arrangement for Feeder Post (FP)



2. ***Potential Transformer:*** The potential transformer is located at a height of 3.1m on the OHE side of the double pole isolator.

The potential transformer is used only to indicate the condition of the overhead equipment i.e whether live or dead without relays. It is directly connected to the overhead equipment with one of the terminals of the potential transformer earthed.

3. ***Auxiliary Transformer:*** The auxiliary transformer also forms a part of the feeding post unless of course stable local supply is available.

The power supply from the auxiliary transformer is utilized for charging the batteries which feed power to operation of interruptors and remote control equipments. The power supply from the auxiliary transformer is also utilized for lighting.

4. ***General:*** The level for the feeding post is kept as the rail level of the nearest siding track, if any. Similarly the levels for the opposite gantries which carry the cross feeders is kept as the highest rail level of tracks falling in between. The foundation level is kept as the datum level. At the same time the finished ground level is kept at 200 mm below the datum level.

- The gantry masts are to be chosen depending on whether the overhead equipment carries a return conductor or not. With return conductor this mast has to be 12.4 m long and without return conductor 11.4m long mast is sufficient. The tensions in the cross feeder is reduced to 100 kgf at 4°C.

- Aluminium bus bars are used for power connections inside the feeding post. The minimum radius of bend for 36 mm aluminium bus bar is to be 200 mm. The inside area of the feeding post is spread with 20mm size stone chips to a depth of 100 mm and finished at ground level .

5. ***Cubicle:*** The remote control equipment are housed in a separate masonry cubicle of the size of a small room. The batteries with battery chargers are also provided in the room for operation of the interrupters and the remote control equipment.

6. ***Fencing:*** A fencing is provided all around to make the equipments inaccessible.

7. ***Return conductor:*** Feeding post is also the point where the return current to substation is collected from the rail and earth and transmitted to the substation. For this purpose, rail is buried along the tracks approximately one meter below ground level. Connections are taken from the buried rail to the running rail by means of Mild Steel flats (75 mm x 8 mm) two numbers for each track. These flats are given suitable protective coatings to prevent corrosion. The typical return current connection to buried rail arrangement is shown in RDSO's Drg. No. ETI/PSI/0212.

- The return conductor, which is insulated from the structure is connected to the buried rail on either side of the overlap in front of the feeding post.

- The general arrangement of connection of return conductor to track is given in RDSO's Drg.No. ETI/OHE/G/05306.

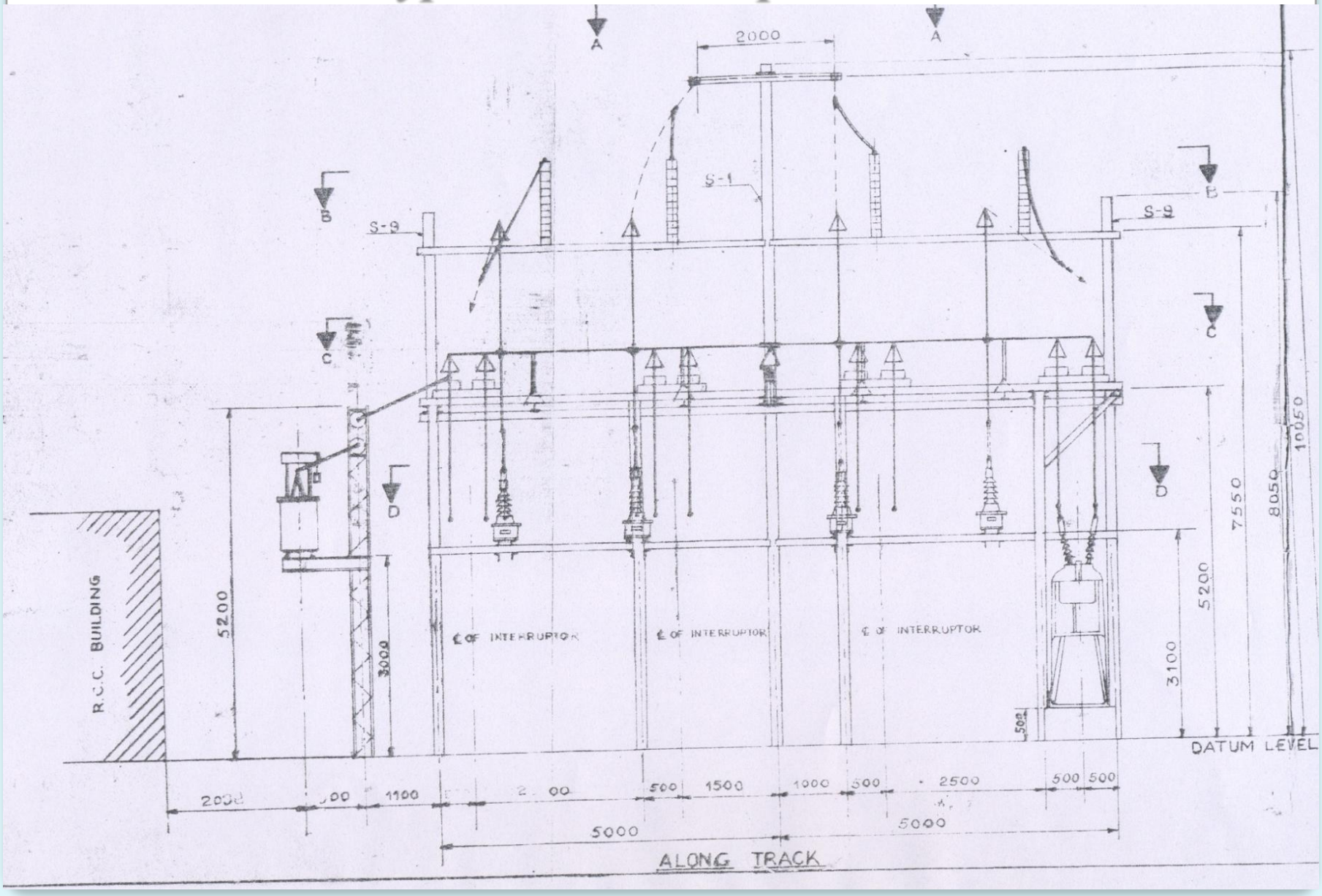
SECTIONING & PARALLELING POST (SP)

★ These posts are situated approximately midway between feeding posts marking the demarcating point of two zones fed from different phases from adjacent sub-stations. At these posts, a neutral section is provided to make it impossible for the pantograph of an electric locomotive or EMU train to bridge the different phases of 25 kV supply, while passing from the zone fed from one sub-station to the next one.

- A paralleling interrupter is provided at each 'SP' to parallel the OHE of the up and down tracks of a double track section, 'bridging interrupters' are also provided to permit one feeding post to feed beyond the sectioning post up to the next FP if its 25 kV supply is interrupted for some reasons. These bridging interrupters are normally kept open and should only be closed after taking special precautions.

- The layout of the SP is similar to the feeding post except that in SP there are no incoming feeders. The location of potential transformer, auxiliary transformer, lighting arrestors are all similar. Being the tail end of the feed from the sub-station the sectioning post is also to act as a paralleling post for the feeds on either side.

Typical Location plan SP



- At sectioning post a neutral section is provided to prevent bridging of feed on either side belonging to different phases. The general arrangement is given in RDSO's Drg. No. ETI/OHE/005.

- Bridging interrupters are provided at the sectioning post in case the feed has to be extended because of any difficulty at a sub-station.

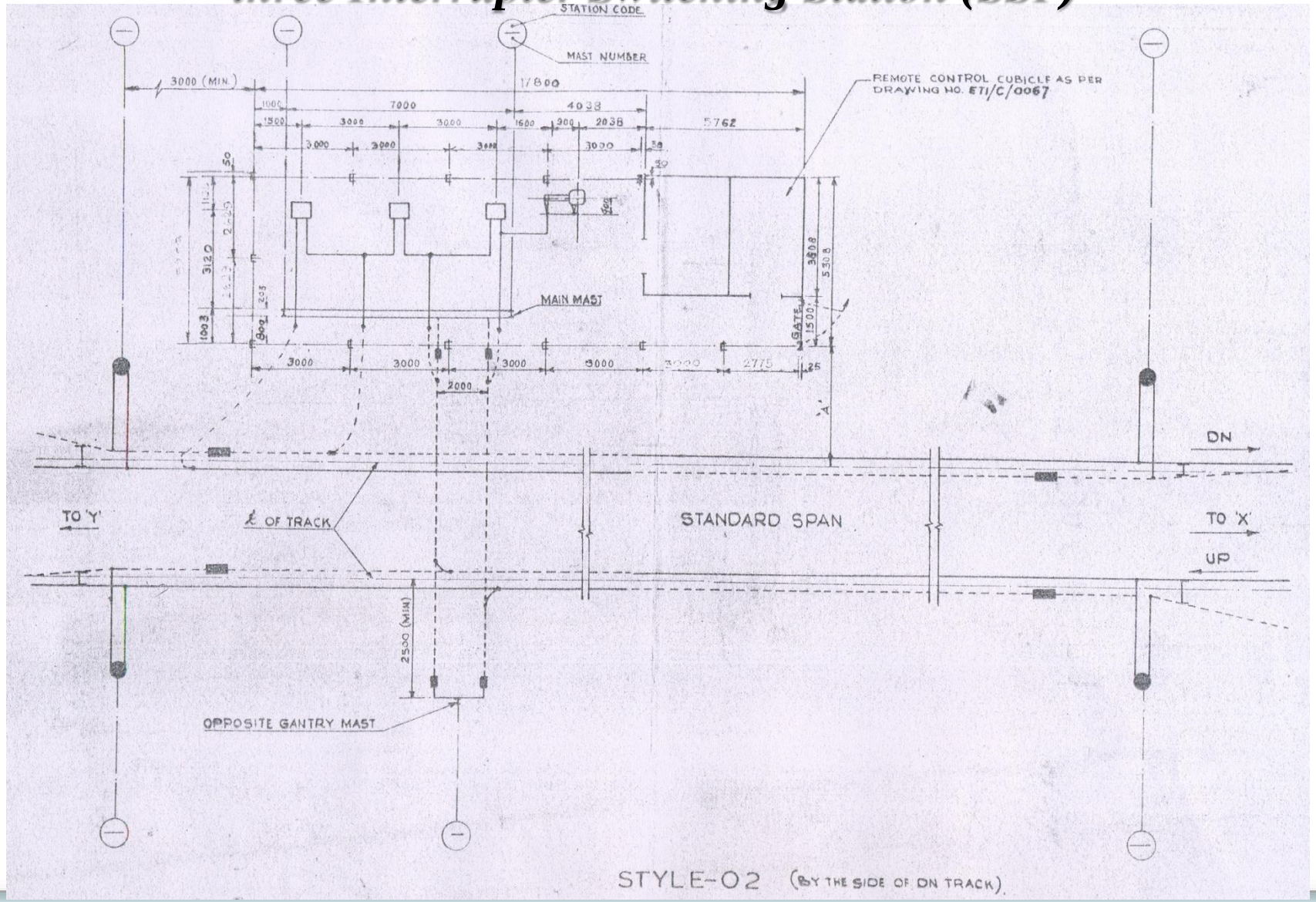
- At the sectioning post, the return conductor, if any is connected to the buried rail on either side of the neutral section.

- Closing bridging interrupter when feed is available on either side from different substations can lead to a phase to phase fault. Hence as a protective measure a wrong phase coupling relay is included as a part of TSS equipment.

SUB-SECTIONING & PARALLELING POST

- This is the simplest of all posts as its purpose is only to sectionalize/ parallel the different sections of the overhead equipment. The general arrangement is given in RDSO's Drg.No. ETI/PSI/004.

Typical Location plan & Schematic Connection diagram for three Interrupter Switching Station (SSP)



- One or more SSPs are provided between each FP and adjacent SP depending upon the distance between them.

OTHER EQUIPMENT AT SWITCHING STATIONS

Certain equipment are installed at -various points to protect the lines, to monitor the availability of power supply and provide other facilities. These are generally as under:

1. Lightning arresters are provided to protect against voltage surges.

2. Auxiliary transformers are provided at all the posts and also at certain intermediate points to supply ac at 240 V, 50 Hz required for signaling and operationally essential lighting installations.

3. Potential transformers are provided at the various switching stations for monitoring supply to each sub-sector.

4. A small masonry cubicle is provided to accommodate remote control equipment, control panel, telephone, batteries and battery chargers required for the control of interrupters and other similar equipments.

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Indian Railways
Centre for Advanced Maintenance Technology

POWER SUPPLY FOR SIGNALLING

Phase II - Module No. STC-TrD-1

POWER SUPPLY FOR SIGNALLING

1. To ensure reliability of ac 240V, supply through 25 kV/240V auxiliary transformer by tapping 25 kV OHE is made available at following places :

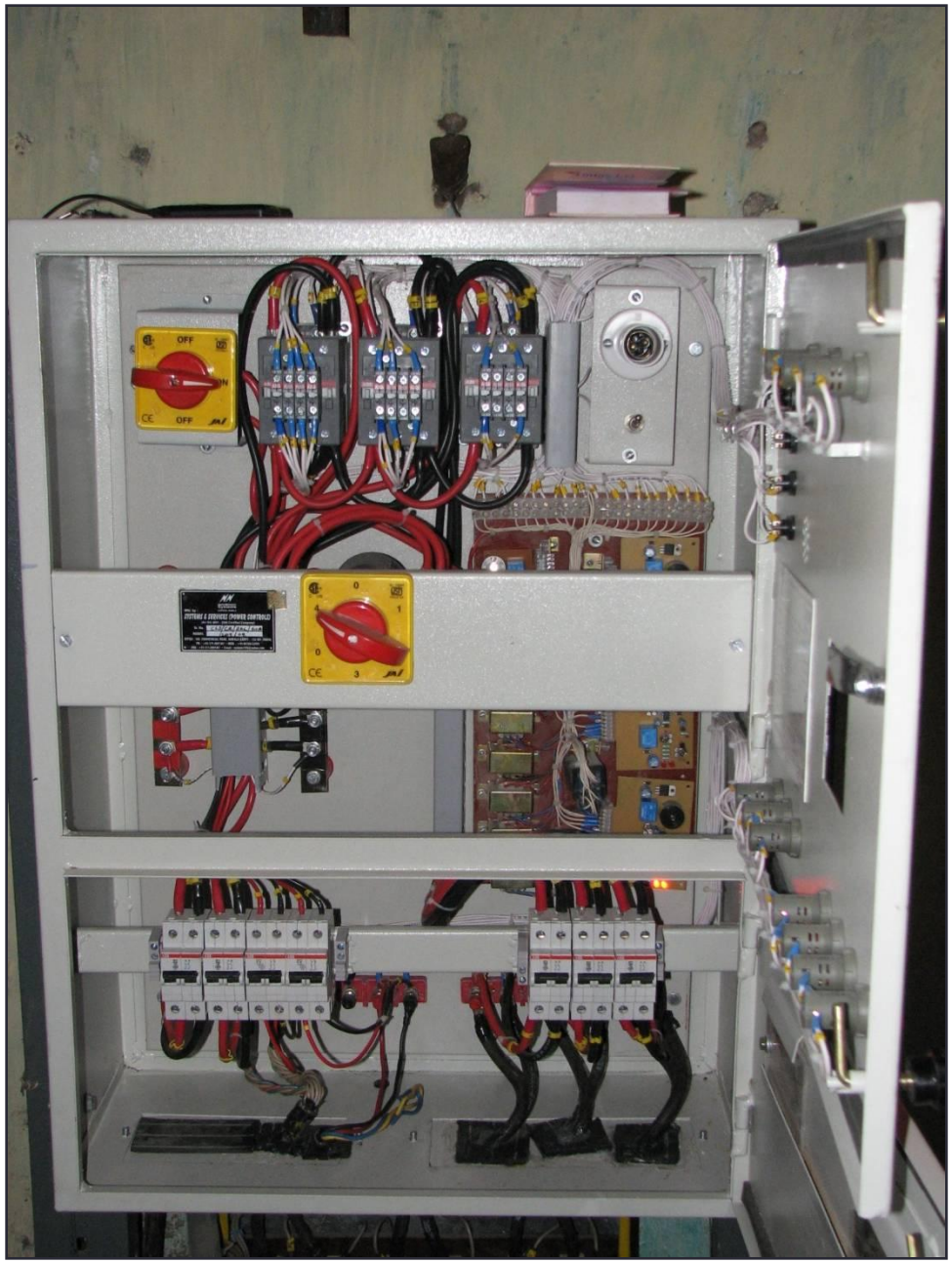
   (a) At each way side station for CLS.

   (b) Level crossings.

   (c) At IBH.

   (d) At all the power supply installations.

- ***Auxiliary Transformer***



CHANGE OVER PANEL TO SELECT THE SUPPLY FOR CLS FROM UP AT, DN AT OR LOCAL AUTOMATICALLY

2. In the event of power block on both the OHE sub-sectors from which the signal supply is derived, electric traffic would necessarily have to be suspended on the line. However, to cater for this condition and at large stations with considerable shunting movements, a stand-by diesel generator set may be installed by the S&T Department to meet emergencies, if considered essential.

VOLTAGE REGULATORS

- The fluctuating nature of traction load causes perceptible fluctuation on the ac 240 V supply affecting operation of signalling equipment. To overcome this, static type voltage regulators are provided by the S&T Department to limit voltage fluctuations to ± 5%.

“सोच से संभावनाओं तक का सफर हौसलों से होकर गुजरता है।”

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EXCELLENCE IN MAINTENANCE

Indian Railways

Centre for Advanced Maintenance Technology

REMOTE CONTROL

and

COMMUNICATION ARRANGEMENTS

Phase II - Module No. STC-TrD-1

REMOTE CONTROL CENTRE

REMOTE CONTROL

- The interruptors at the various switching stations as well as the feeder circuit breakers at the traction sub-stations are controlled from a Remote Control Centre (RCC) manned throughout the 24 hours of the day.

- During each shift there is one or more number of Traction Power Controllers (TPC), depending upon the work load.

- All switching operations on the system are thus under the control of one single person, namely TPC, who is responsible for maintaining continuity of power supply on all sections of the OHE.

- TPC also maintains continuous and close liaison with the Section Controllers in regard to train operations on electrified sections.

COMMUNICATION FACILITIES

- All aerial telecommunication lines running by the side of the tracks are replaced with under-ground cables/ microwave to overcome the interference caused by 25 kV single phase ac traction. The cables contain adequate number of pairs of conductors for the various types of Railway telecommunication circuits on ac traction.

- In an electrified section it is essential, in the interest of efficiency, to provide several independent telephone circuits to facilitate quick communication and to achieve necessary co-ordination between different branches of the Railway. In an emergency several alternative telephone channels will be available for communication should any one fail.

The various telephone circuits provided in electrified sections are :

1. Train Control/Section Control:

- This circuit is operated by the Section Controller and is used mainly for controlling train movements within his jurisdiction. It has connections with Signal Cabins, ASMs' Offices, Loco Sheds and Yard Masters' Offices.

2. *Dy. Control Telephone*

- This circuit is operated by the Deputy Controller and is used for directing traffic operations in general. It has connections with the important Station Masters' offices, Yard Masters' Offices, Loco Sheds and Signal Cabins.

3. Stock Control Telephone:

- This circuit is operated by the Stock Controller and is mainly used for keeping a continuous watch and to maintain control over the movements of wagons. It has connections with Yard Masters and important Station Masters' offices.

4. Traction Loco Control

- This is a circuit provided for ac traction and is operated by the Traction Loco Controller who is responsible for movements of electric locomotives and Electric Multiple Unit (EMU) stock. It has connections with Electric Loco Sheds, EMU Sheds, important Station Masters, Yard Masters, Divisional Officers such as Sr. DEE/DEE, AEE (RS), Sr DEE/DEE/AEE- (OP), Traffic Control Offices, Traction Foreman and important crew booking points.

5. *Traction Power Control*

- This is a special circuit on ac traction and is used by TPC for all communications in connection with power supply, switching operations and ‘permit-to-work'. It has connections with Station Masters' offices, cabins, Traction sub- stations, feeding posts, sectioning and sub-sectioning posts, traction maintenance depots, important Signal Cabins, Divisional Officers such as Sr. DEE (TrD), Sr. DEE/OP and Traffic Control Offices

6. Emergency Control Circuit

- This circuit is provided to facilitate the traction maintenance gangs and electric train crew to get in touch with TPC with the least possible delay in emergencies. This circuit is operated by TPC and is located in the RCC.

- Emergency telephone socket boxes are provided along the track at an interval of 0.75 to 1 km and also near the signal cabins, sub-sectioning and sectioning posts, insulated overlaps and feeding posts etc.

7. Hot Line Communication

- Hot line communication circuit should be provided between the HQ, divisional HQ traction loco controller and electric loco sheds. These would be provided in the HQ with CEE, CEE/Loco, Dy. CEE/RS, Sr. DEE/RS in the sheds and Sr. DEE/OP in the divisions.

8. *Walkie Talkie sets*

- Every maintenance depot of OHE should have adequate numbers of walkie-talkie sets to be available with them so that not only effective communication is available at site but also to increase the efficiency and productivity of the work during power blocks.

9. *Other Communication Facilities*

- An independent inter-communication 'circuit is also provided between the various Section Controllers and the Chief Controller for local communication between themselves.

जीवन हमें हमेशा
दूसरा मौका जरूर
देता है,
जिसे कल कहते हैं

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OVERHEAD EQUIPMENT

Phase II - Module No. STC-TrD-1


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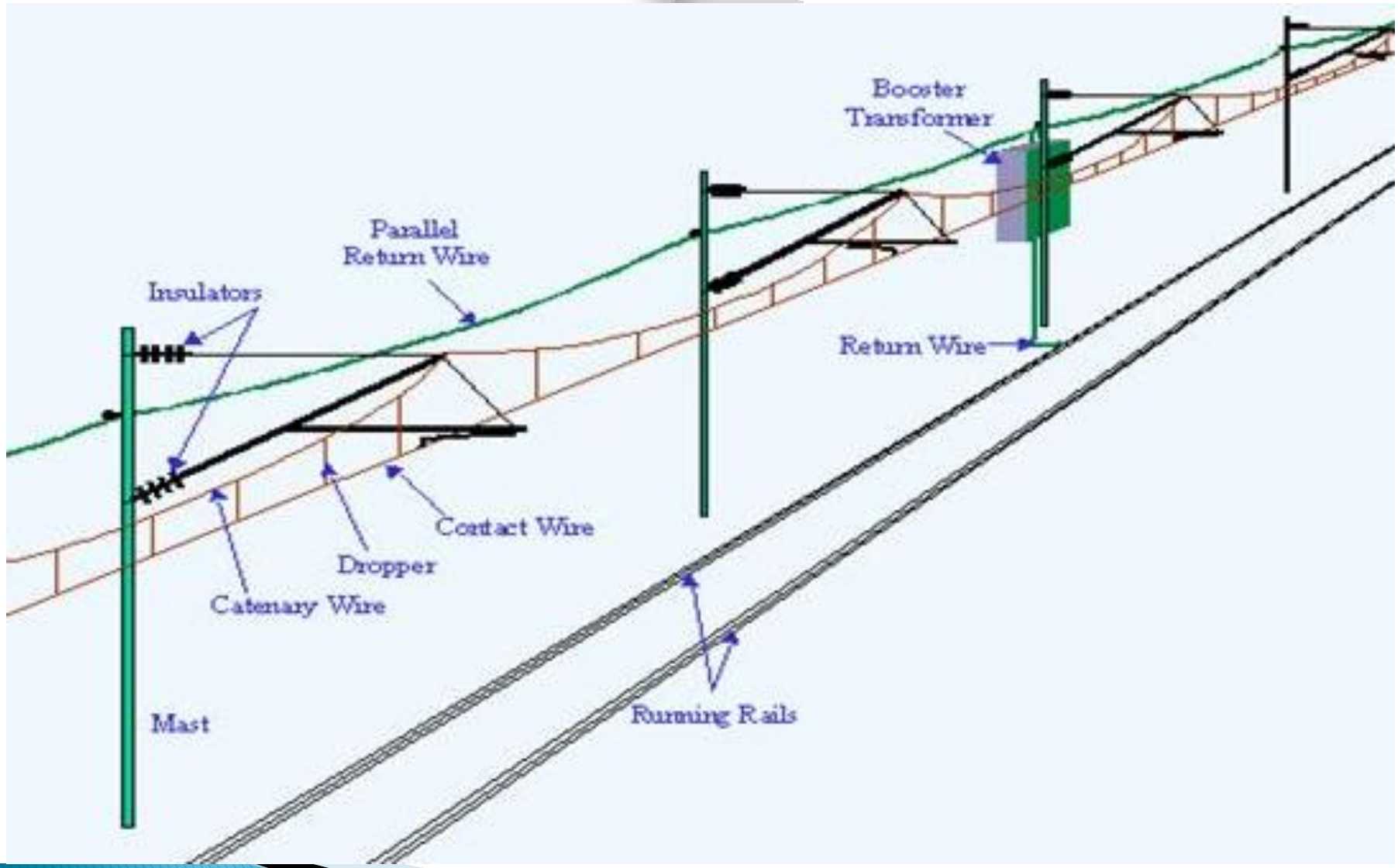
OVERHEAD EQUIPMENTS

- Masts and portals
- Cantilever Assembly
- Contact and Catenary Wire
- Dropper
- Bonds
- Auto tensioning device (ATD)
- Section Insulators
- Neutral Section Assembly

OVERHEAD SYSTEM



- Overhead Equipment (OHE) means the electrical conductors over the track together with their associated fittings, insulators and other attachments by means of which they are suspended and registered in position.

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

The overhead equipment above the tracks comprises of the following:-

a) A stranded cadmium copper wire of about 65sq.mm section or stranded aluminium alloy wire of about 116 sq.mm section for catenary.

b) A grooved hard drawn copper contact wire of 107 sq.mm cross-section (when new) supported from the catenary by means of droppers of 5 mm diameter spaced not more than 9 m apart.

CONTACT & CATENARY WIRE

❖ ***Contact wire –***

- Cross sectional area - 107 sq.mm.
- Diameter - 12.24 mm
- Normal tension – 1000 kg
- Breaking load – 3905 kg

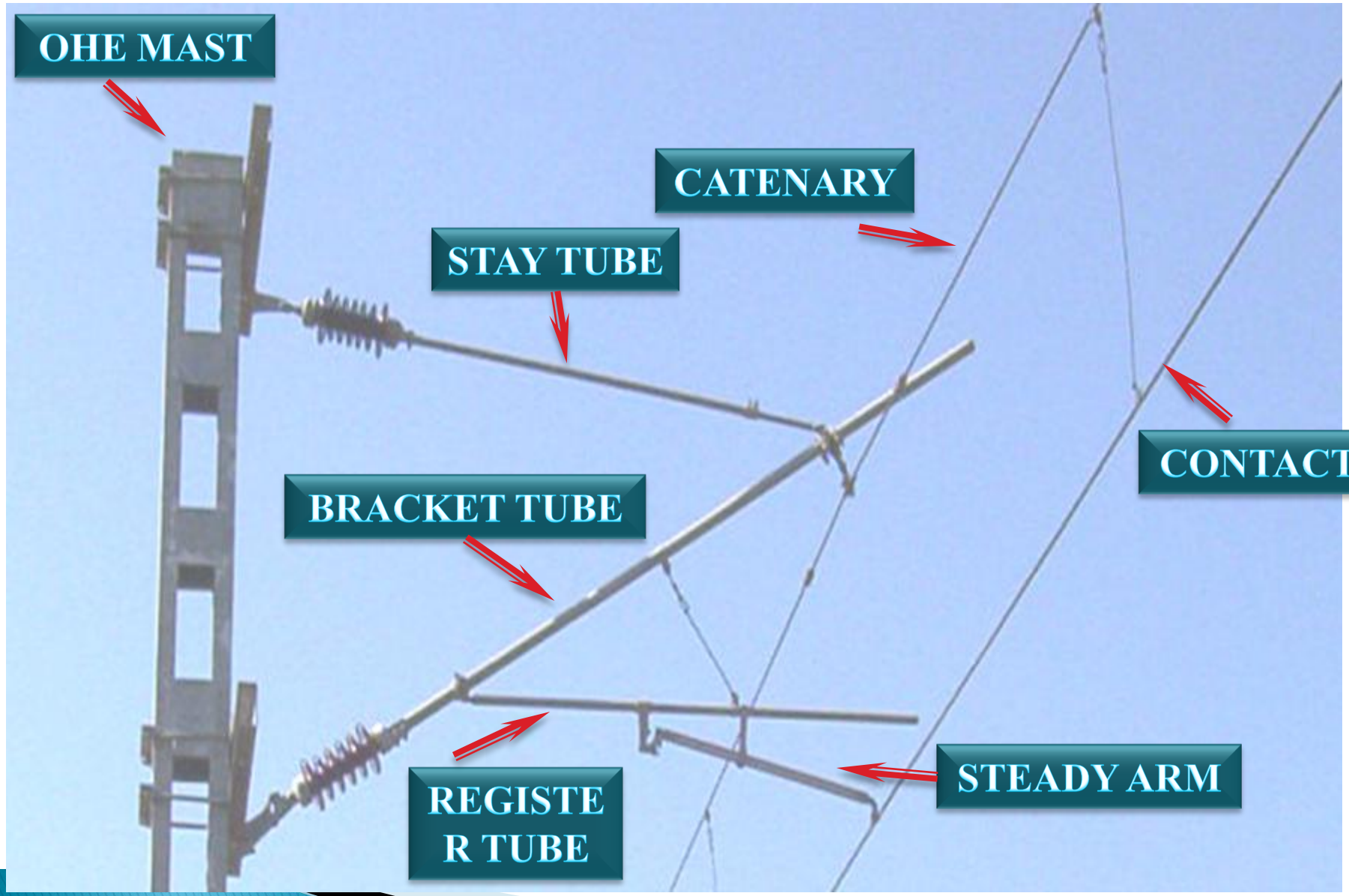
❖ *Catenary wire –*

- Cross sectional area - 65 sq.mm.
- Diameter – 10.50 mm
- Normal tension – 1000 kg
- Breaking load – 3920 kg

- The catenary and contact wire together have an equivalent copper section of 157 sq mm. The current normally permissible on a single track is 600 A approximately, because of equivalent cross-sectional area of OHE. This current limit is based on the temperature limit of 85°C in contact wire.

- For loop lines, sidings, yards and spur lines excluding the main running lines and first loop or lines taking off from main running line, tramway type OHE having only grooved hard drawn copper contact wire of 107 sq.mm section is provided.

CANTILEVER ASSEMBLY



CANTILEVER ASSEMBLY

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

It consists of the following structural members.

i) Stay arm

It comprises of dia. 28.4/33.7 mm (Small) size tube and an adjuster at the end to keep the bracket tube in position. It is insulated from mast by stay arm insulator.

ii) Bracket tube

It comprises of dia. 40/49 mm (large) or dia. 30/38 mm (standard) bracket tube and Insulated by bracket insulator. Catenary is supported from this member by catenary suspension bracket and catenary suspension clamp.

iii) Register Arm

It comprises of dia. 28.4 x 33.7 mm tube to register the contact wire in the desired position with the help of steady arm.

iv) Steady arm assembly

It is 32 x 31 mm BFB section made of aluminium-alloy to register the contact wire to the required stagger and to take the push up of contact wire. It is always in tension.

CROSSINGS

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

i) Power line crossing

An electrical overhead transmission or distribution line or underground cable placed across railway track(s) whether electrified or not for transmission of electrical energy.

ii) Crossing OHE

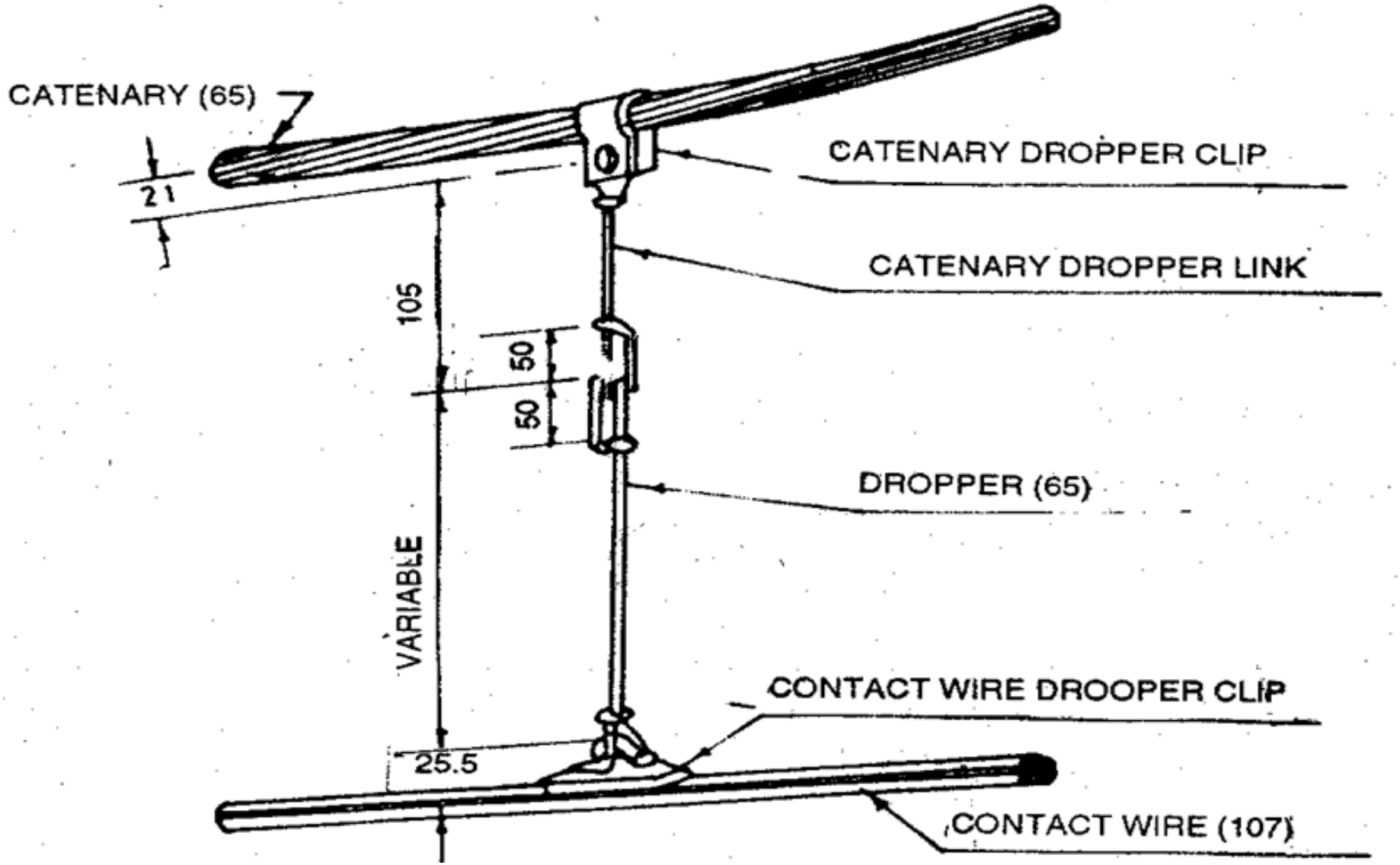
Crossing of two conductors of OHE crossing without physical contact.

DROPPER

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


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

❖ Catenary dropper Assembly



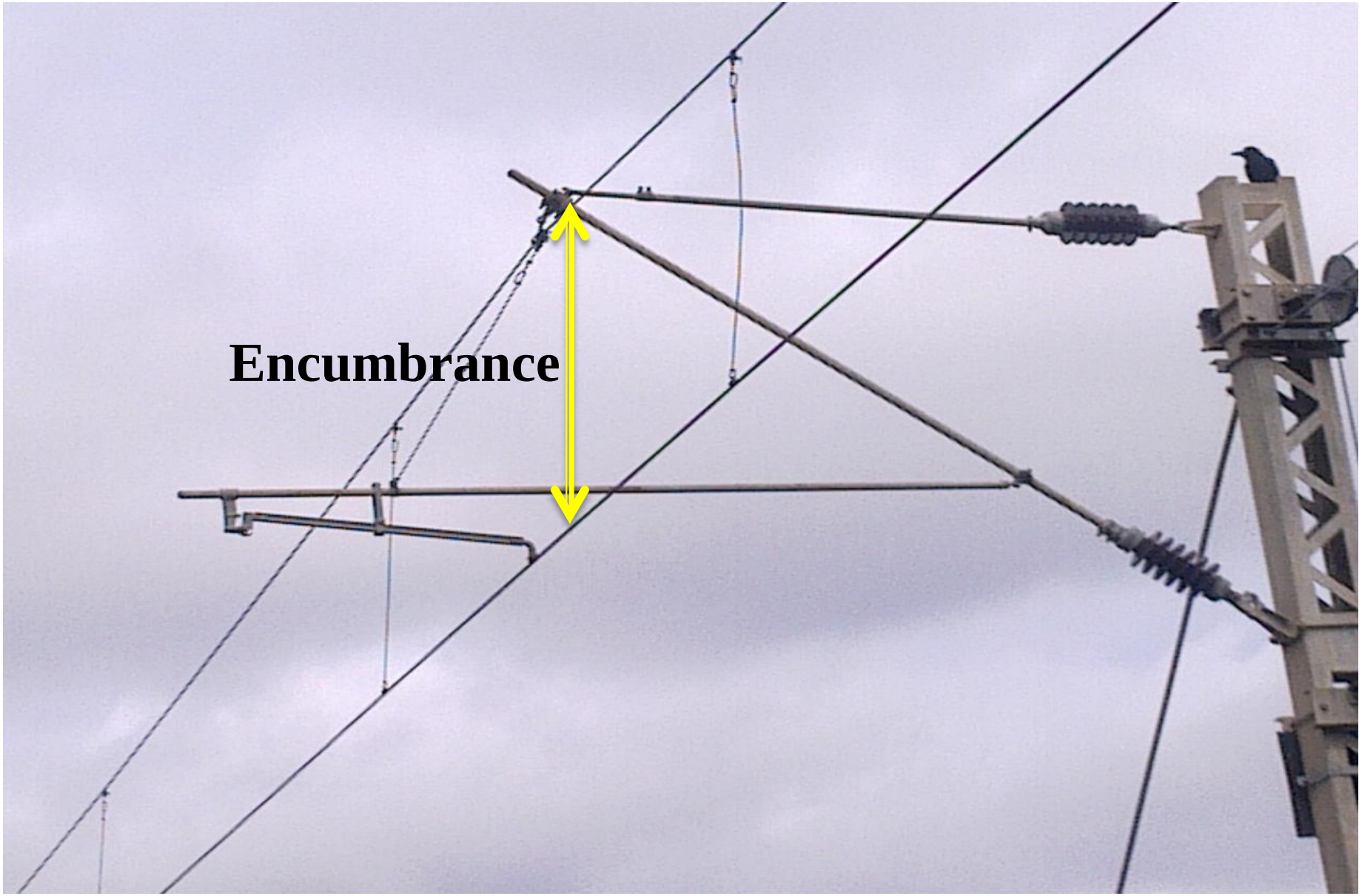
ELECTRICAL CLEARANCE

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

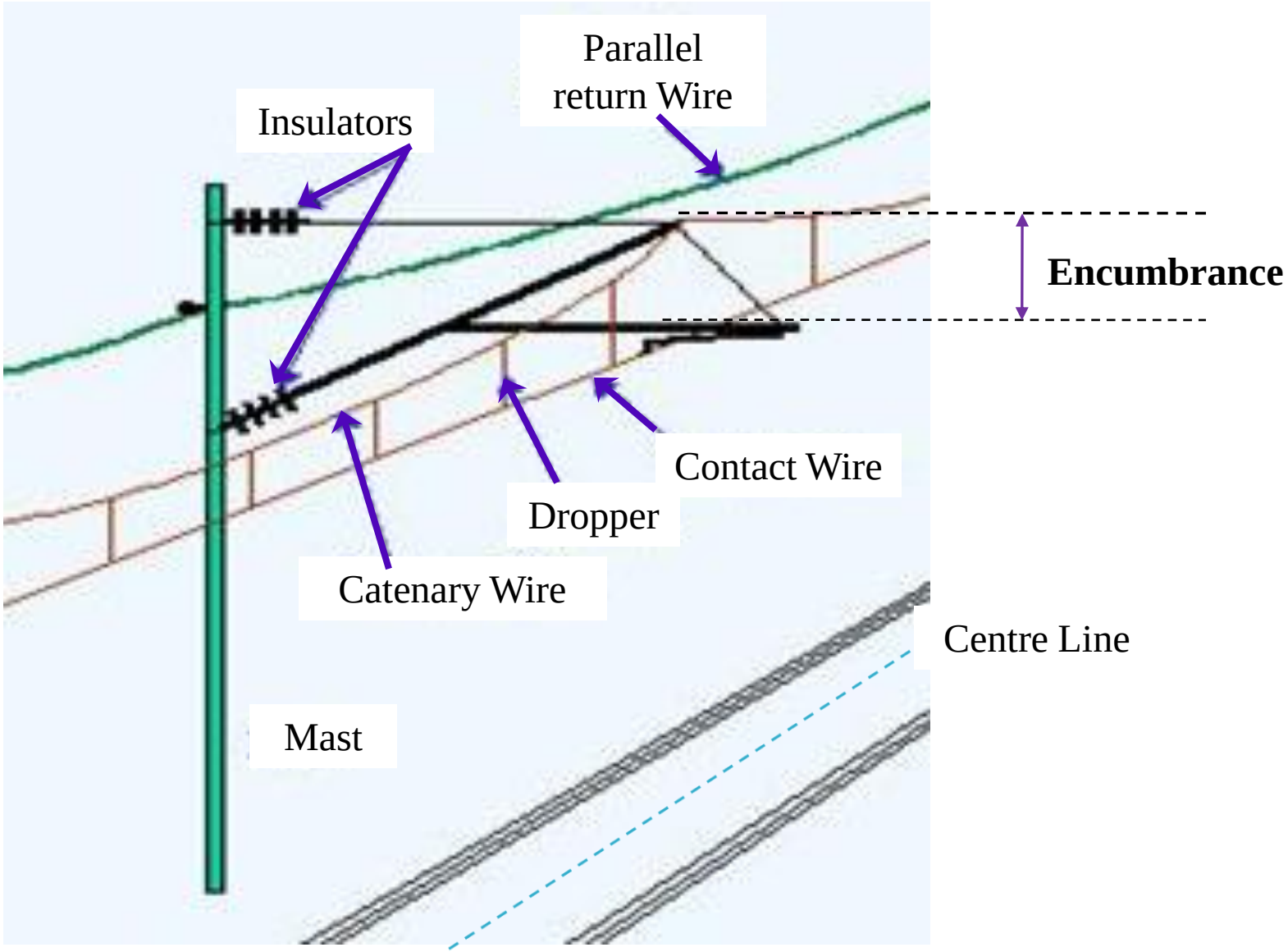
ENCUMBRANCE

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

- The encumbrance shall normally be 1.40 m.


Encumbrance

Concept of Encumbrance



Reduced Encumbrance

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

Span under over-line structure (m)	*Recommended encumbrances for span under over-line structure (m)*	*Largest permissible adjacent spans (m)*
63	0.9	67.5
58.5	0.9	67.5
54	0.75	67.5#
49.5	0.6	63
45	0.6	63
40.5	0.5	58.5
36	0.4	54*
31.5	0.4	49.5
27	0.3	45

- # Applicable where the encumbrance cannot be increased to 1 40 m in a single span from the value given in column 2. The normal encumbrance o(1.40 in should be provided in subsequent spans. In such cases, the encumbrance may be adjusted in such a way that the lowest point of the catenary does not fall between first dropper and the support.

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

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

Minimum Encumbrance

- Normally, the axial distance between the catenary and the contact wire at the minimum dropper should not be less than 150 mm. smaller droppers may be adopted in exceptional cases.

- If the shortest dropper is loop type and more than 150 mm, no speed restriction is called for. But if the dropper Is without loop or of rigid type or less than 150 mm, the overhead equipment is deemed suitable upto 90km/h speed.

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

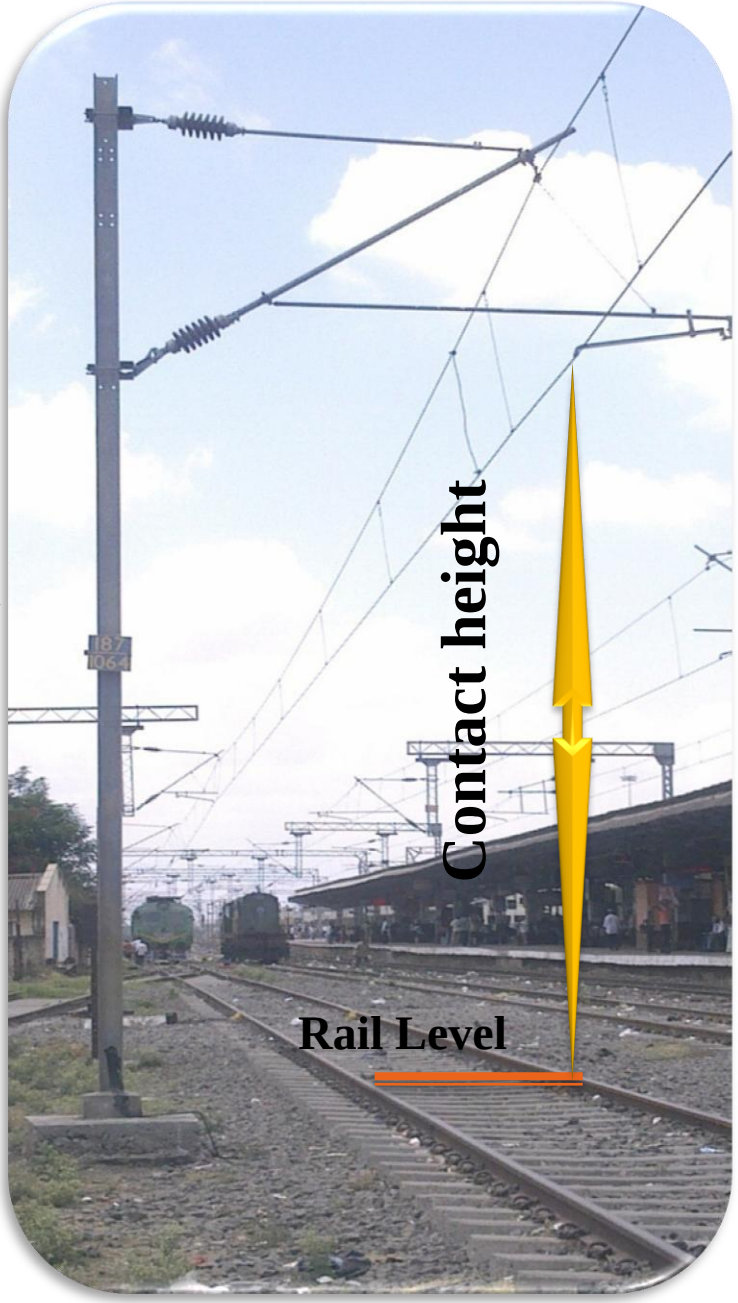
A conductor connecting

(a) a substation with a feeding post, or

(b) a feeding post with the OHE.

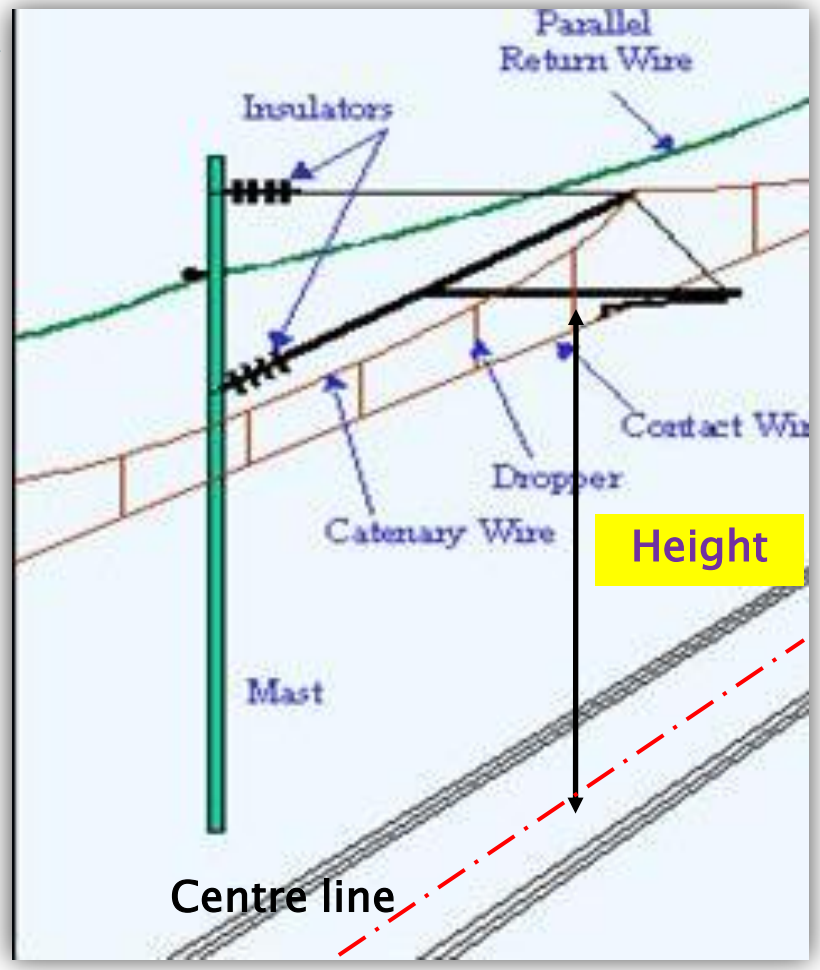
Height of Contact Wire

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



Height of Contact Wire

- Normal : 5.60M (above rail level)
- Minimum : 4.80m
- Maximum : 5.80m
- On level crossing : 5.50m (Provision of height guage at LC gates)



JUMPER

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

MAST

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

MECHANICAL INDEPENDENCE OF OHE STRUCTURES

- By providing independent structures for supporting the OHE of each track, complete mechanical independence of each OHE is secured. Any irregularity or damage or maladjustment of the OHE of one track will not, therefore, affect the performance of the other.

FELXIBLE HEAD-SPAN AND RIGHT PORTALS

- In large yards, where difficulty is experienced in locating individual supporting structures between the tracks, a cross catenary wire system called flexible head-span is provided to maintain two or more catenaries and their contact wires at the appropriate heights and locations. Where the OHE has to be regulated, rigid portal structures are used.

NEUTRAL SECTION

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

OVER LINE STRUCTURE

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

PANTOGRAPH

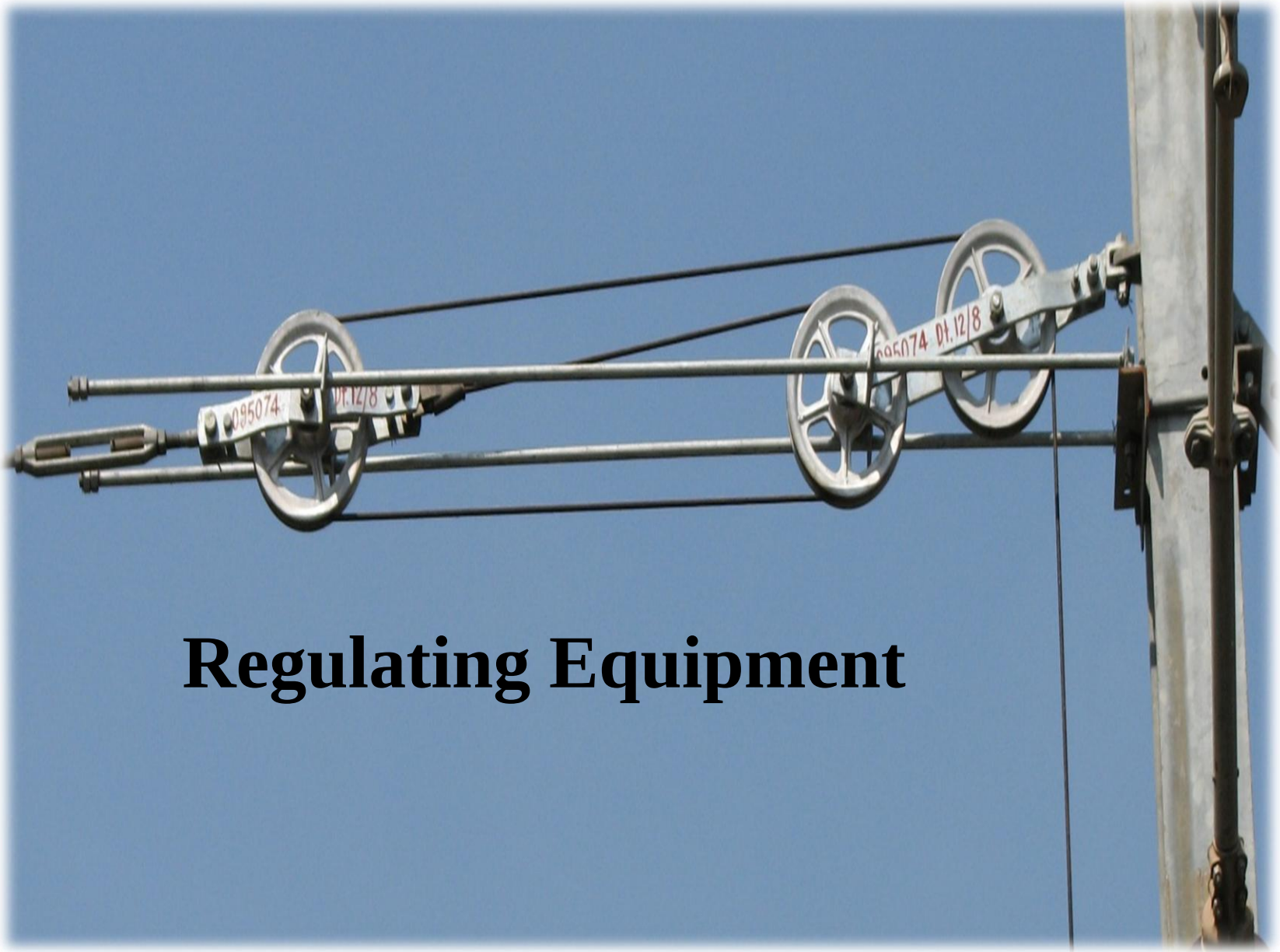
- A collapsible device mounted on and insulated from the roof of an electric engine or motor coach for collecting current from the overhead equipment.

RETURN CONDUCTOR

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

REGULATING EQUIPMENT

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



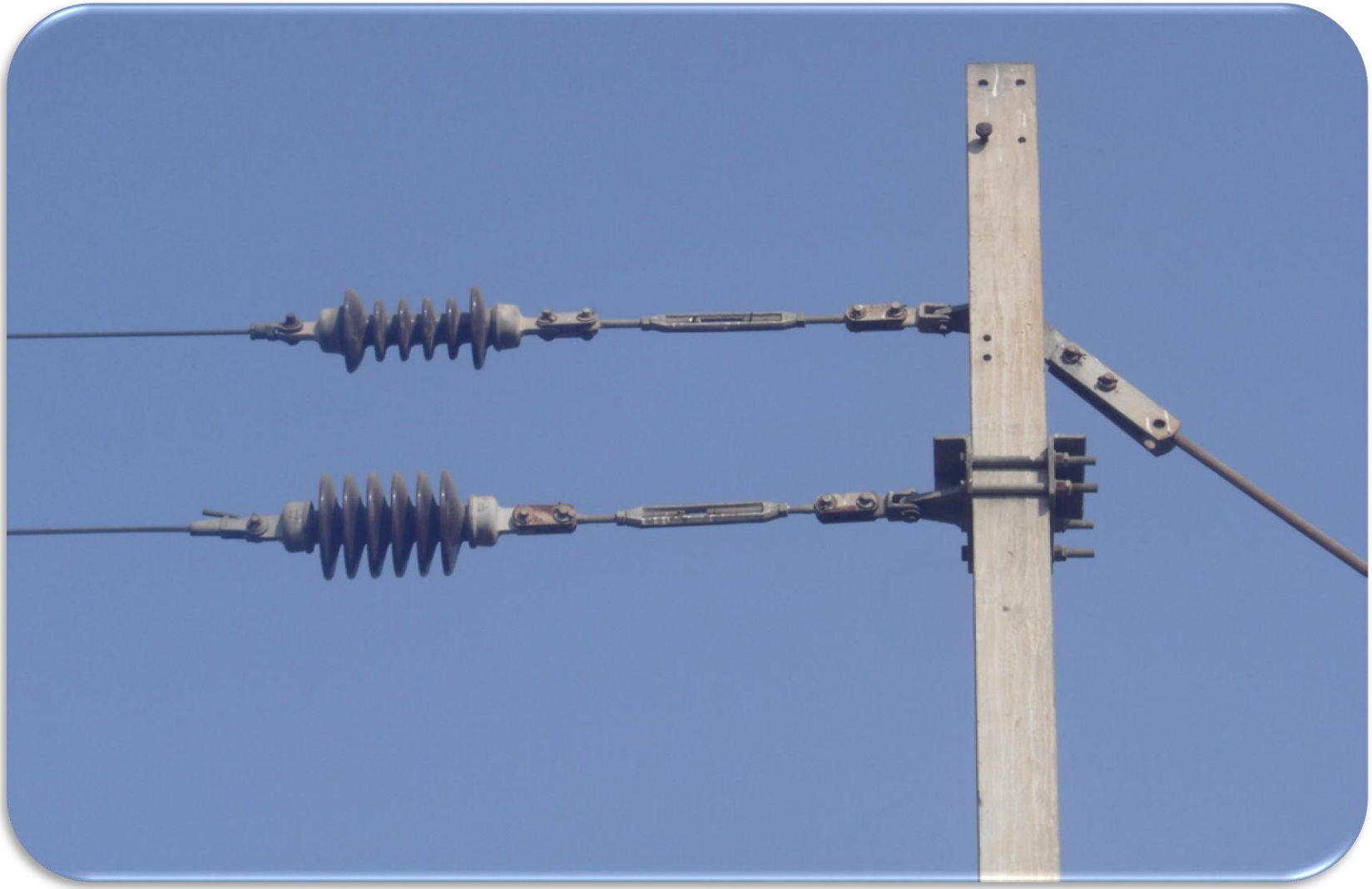
Regulating Equipment

REGULATED AND UNREGULATED OHE

- OHE with automatic tensioning called 'regulated OHE' is generally provided for all main lines, but for large isolated yard and unimportant lines, automatic tensioning is dispensed with in the interest of economy and only unregulated OHE is used.

Regulated Type OHE

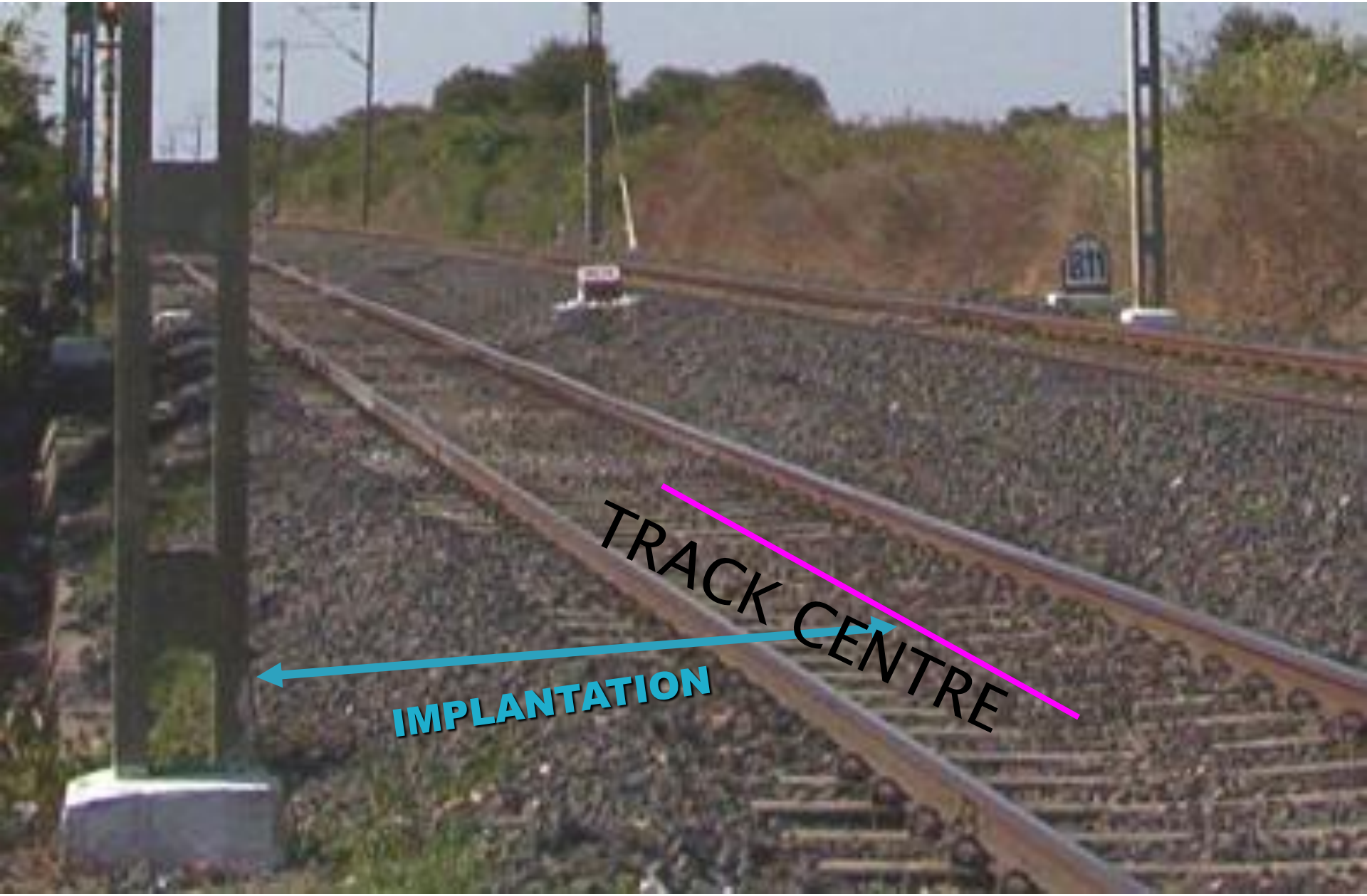
Un Regulated Type OHE



SETTING DISTANCE

(Implantation)

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


TRACK CENTRE
IMPLANTATION

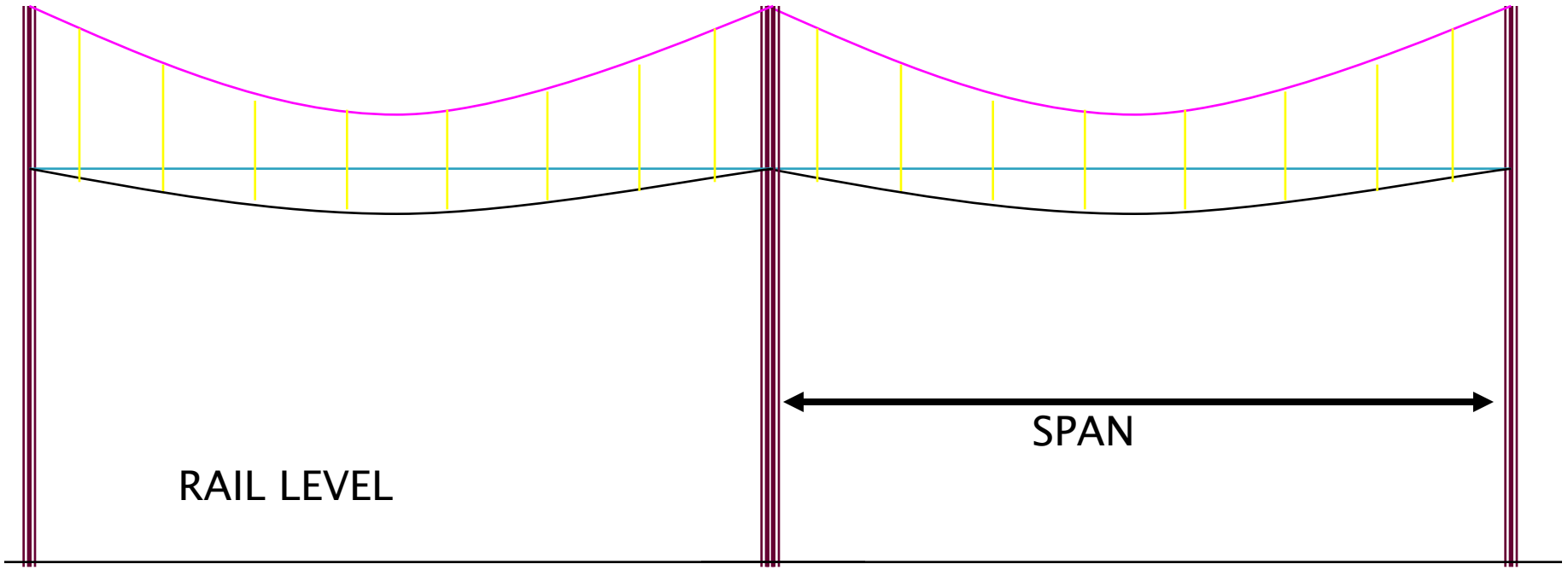
SUSPENSION DISTANCE

- The horizontal distance from the centre of the eye of catenary suspension bracket to the face of the mast for a single cantilever assembly or to the face of cross arm channel in case of multiple cantilever assembly.

SPAN LENGTH

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

- Length of span is governed by curvature, blow off etc.


SPAN
RAIL LEVEL

SPAN OF SUPPORTING MAST/ STRUCTURES

- The span normally used for supporting the OHE from masts/structure using the cantilever type bracket assembly varies from maximum 72 m on straight track to 27 m on curved track, the spans depending upon the degree of curvature.

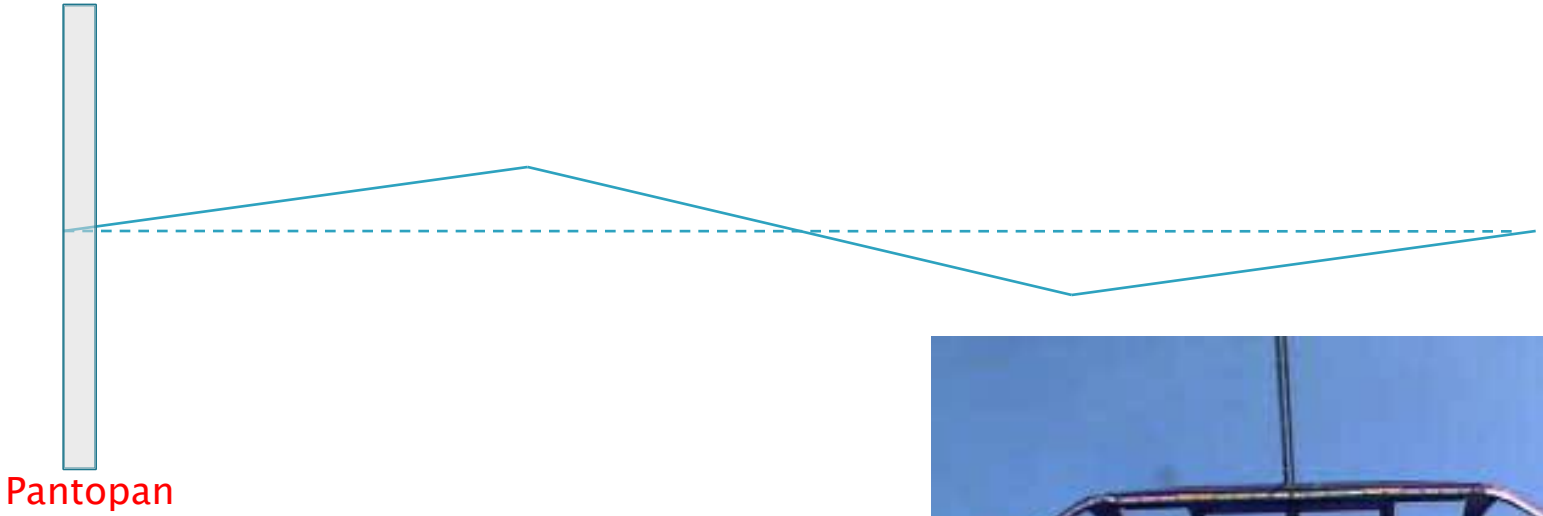
STAGGER

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

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

Concept of Stagger

Deflection of contact wire from centre of track on both sides



± 200 mm on straight track

± 300 mm on curves

- The contact wire is staggered so that as the pantograph glides along, the contact wire sweeps across the current collecting strips of the pantograph upto a distance of 200 mm on either side of the centre line on straight runs and 300 mm on one side on curves. This ensures a uniform wear of the current collecting strips of the pantographs.

OVERLAPS

- An arrangement of overhead equipment over a track where two sets of traction conductors are run parallel to each other for short distance over span(s) providing a smooth passage for the pantograph of an electric rolling stock

- There are two types of overlap spans as under :

  a. Un-insulated overlap

  b. Insulated overlap

Two types of overlap spans

Un-insulated Overlap

- **Un-insulated overlap** spans where the distance of separation between two contact wires is 200 mm and the two conductors are permanently connected together electrically by suitable jumpers.

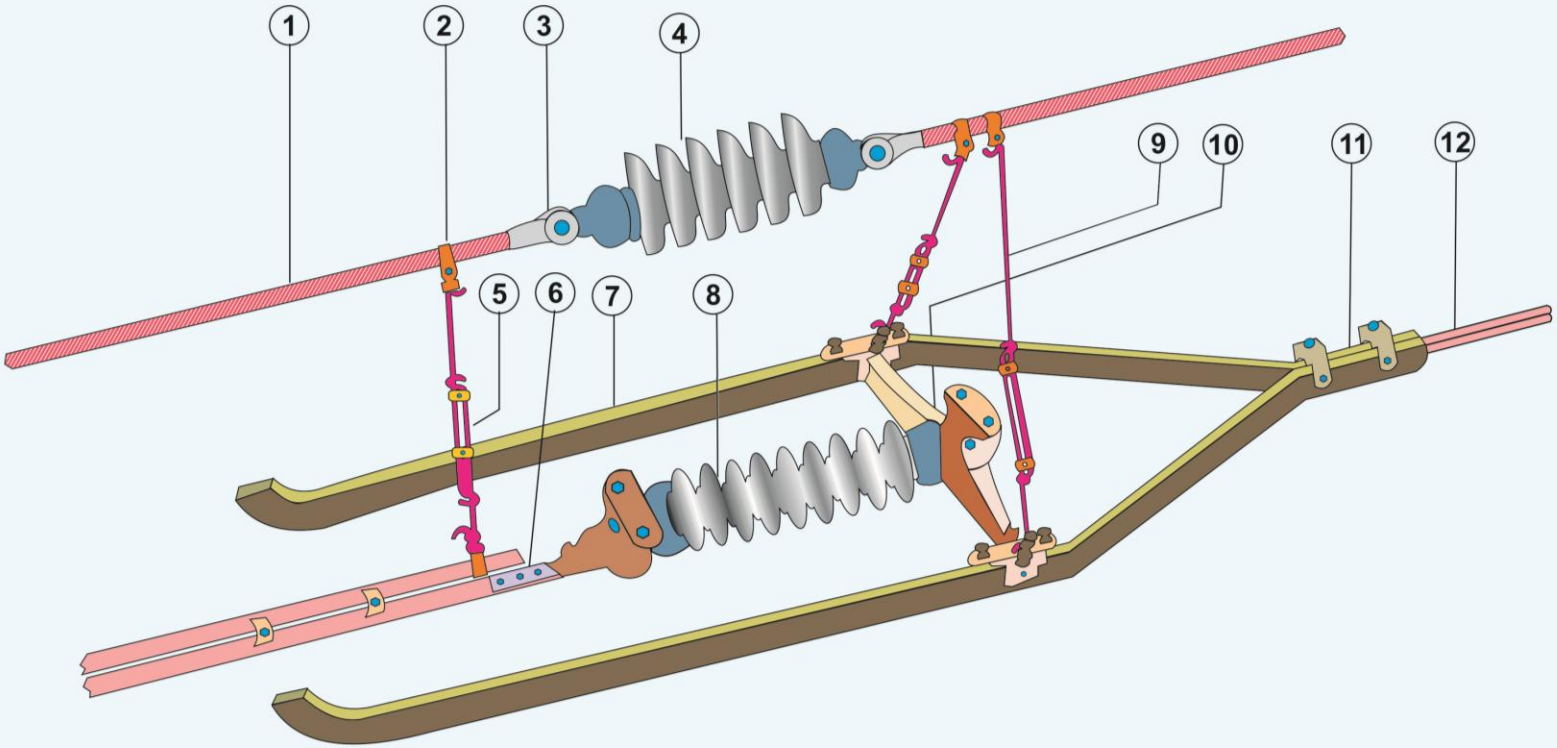
Insulated Overlap

- **Insulated overlaps** where the two OHE systems are kept apart at a distance of 500 mm. Normally the electrical discontinuity at insulated overlaps is bridged by interruptors or isolator except at neutral sections.

SECTION INSULATOR

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

STANDARD SECTION INSULATOR ASSEMBLY



1. Catenary Wire
2. Catenary Clip
3. Catenary Ending Clamp
4. 9 Tonne Insulator
5. PG Clamp 6170
6. Trailing Grip
7. Runner
8. Core Insulator
9. Adjustable Dropper
10. Cross Beam
11. Facing Grip
12. Contact Wire

Section Insulator Assembly

- Section insulators are provided to insulate the OHE of one elementary section from the OHE of the adjacent elementary section such as at cross-overs.

- When the pantograph of a locomotive passes from one track to another along a cross-over/turnout, current collection changes from one OHE to other and therefore the runners of the section insulators overlap with contact wire so that there is no arcing.

- On double line sections with runners trailing, the section insulator assembly using porcelain insulators are fit for speeds upto 120 km/h provided it is installed between the first one-tenth and one - third of the span. In case the runners of the section insulator assembly are in the facing direction or it is not installed within the first one third of the span, the speed should be restricted to 80 km/h.

SUPPLY CONTROL POST

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

a) Feeding Post (FP)

- It is a supply post where the incoming 25 kV feeder lines from substation are terminated, and connected to the overhead equipment through interrupters.

b) Sectioning and Paralleling Post (SP)

- It is a supply control post situated mid-way between two feeding points at the neutral section and provided with bridging and paralleling interrupters.

c) Sub-sectioning and Paralleling Post (SSP)

- It is a supply control post where sectioning and paralleling interrupters are provided.

d) Sub-sectioning Post (SSP) (for single line section):

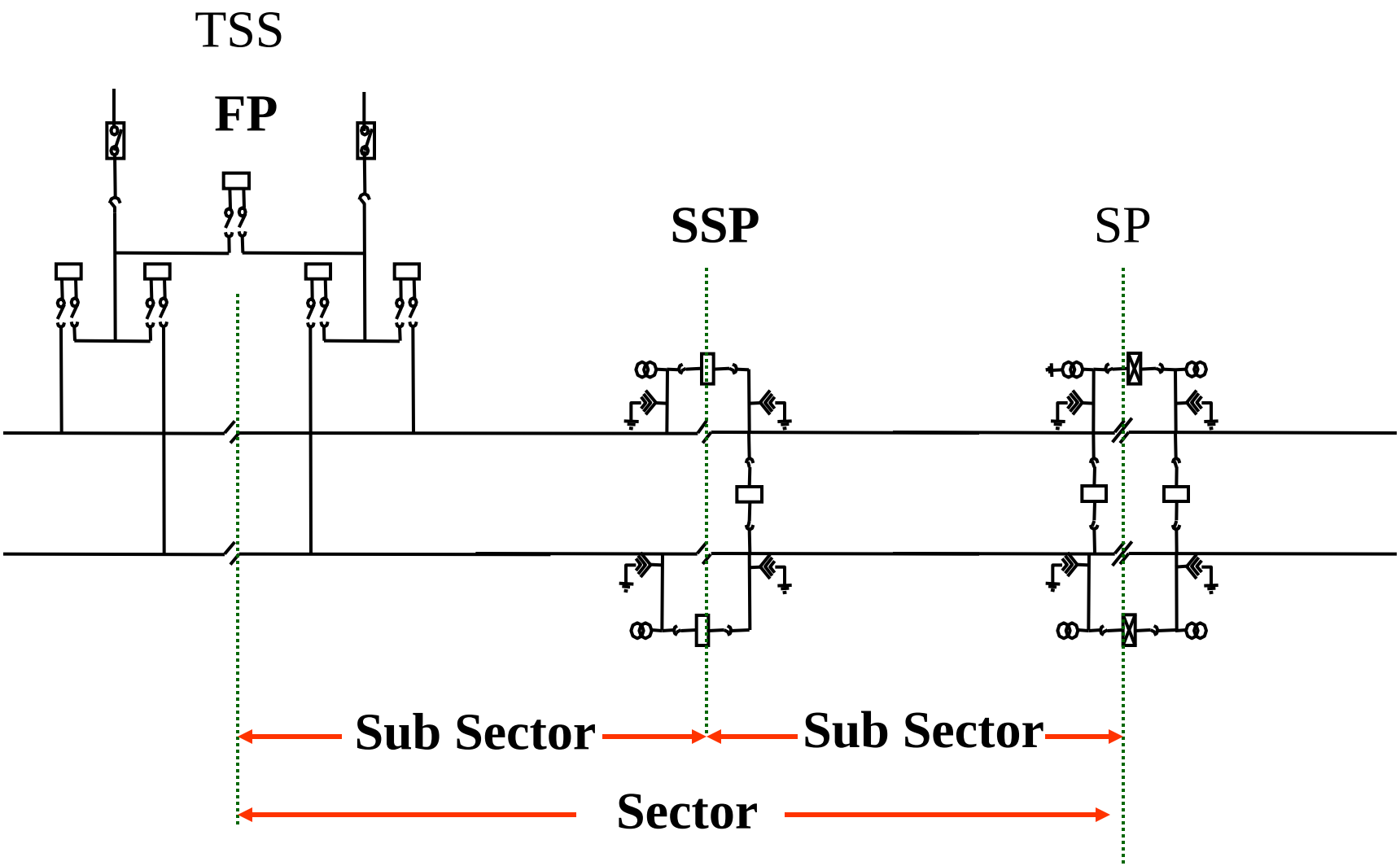
- It is a supply control post where a sectioning interrupter is provided.

SECTOR

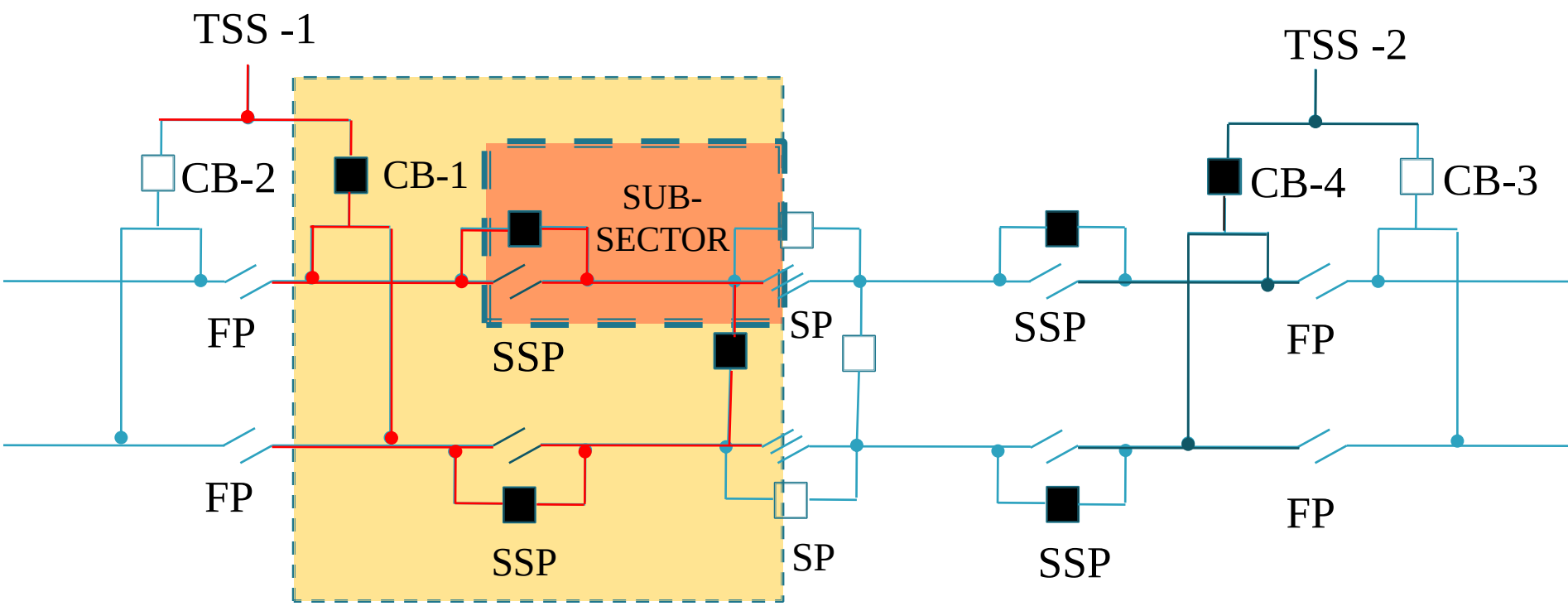
A section of Overhead equipment of a track which can be energized by closing a feeder circuit breaker at the substation.

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

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


TSS
FP
SSP
SP
Sub Sector
Sub Sector
Sector

Concept Of Sector And Subsector



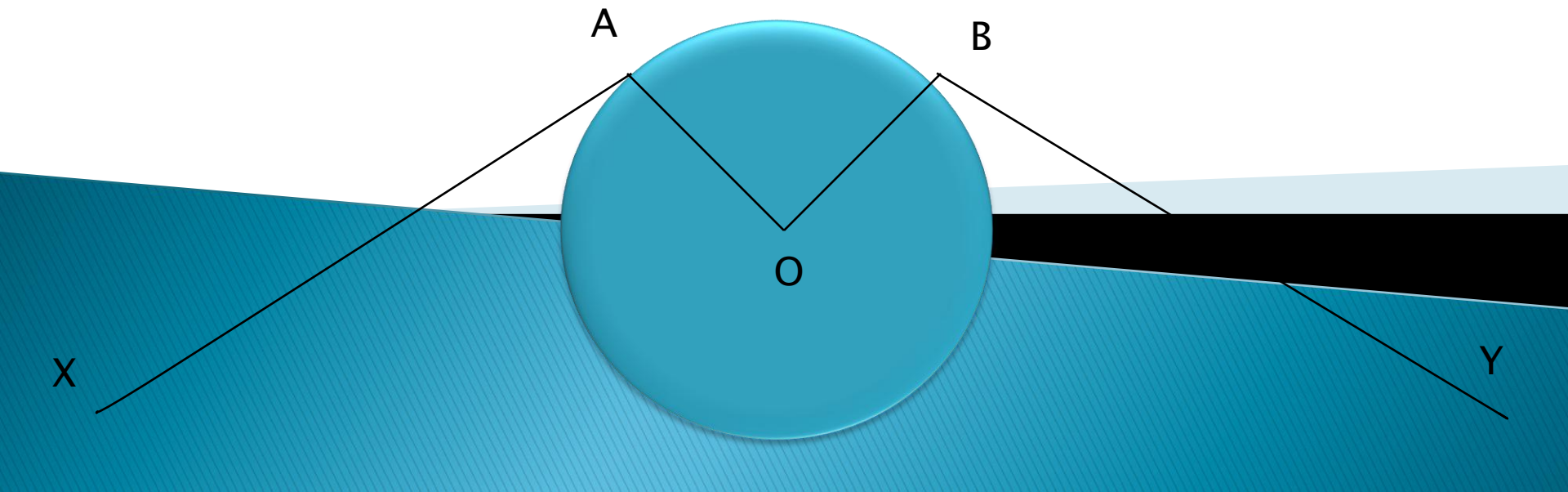
Sector OHE charged by closing CB is called sector.

Sub Sector OHE charged by closing interrupter is called sub sector.

DEGREE OF CURVATURE

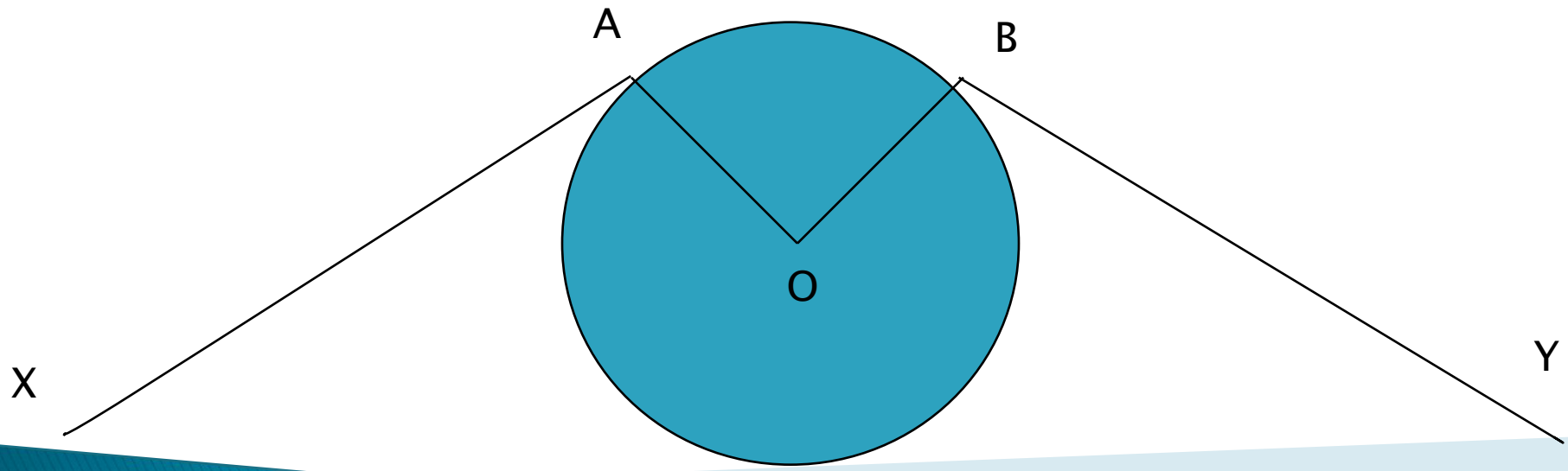
- It is the angle subtended by the portion of curve at the centre of circle drawn through that portion of curve under consideration.

- Let ‘AB’ be the portion of curve X-A-B-Y. If circle is drawn through the curve AB, than the angle AOB, which the curve makes at the centre ‘O’ is known as “Degree of curvature”.



ONE DEGREE CURVE

- When a curve of 30m (100ft.) length makes an angle of 1deg. At the centre of curve, it is called1 deg. Curve.



VERSINE

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

$$\text{Versine} \quad V = L^2/8R$$

Where L-length of curve
& R-radius of curve.

SUPPER ELEVATION

- Super elevation is defined as the rise of one side of track to counteract centrifugal force developed during the motion of a body on a curved track. It is the difference of levels of rail in the horizontal plane.

- In curves the outer rail will be raised above the level of inner rail to counteract the centrifugal force developed by the moving bogie of train. Super elevation is required to be taken into account in define of OHE as it affects.

Super elevation (d) is given by

$$d = \frac{GV^2}{gR}$$

Where g = 9.81 m/sec2. and V is speed in kmph,

G is gauge of track = 1.676 m & R is radius .

Then $d = 13.18 \times V^2/R.$

BLOW -OFF

- "Blow –off " is the displacement of conductor from its original position due to wind pressure. Of all the factors which influence the stagger of the contact wire.

- Blow–off effect due to wind blowing across the track is the most predominating, specially so in large spans. The value of blow-off is found to be as high as 450mm for 72m span with a wind pressure of 88kg/sqm.

The actual value can be determined from the formula for sag as given below.

$$\text{Blow-off } (d_w) = 1.05 \frac{We+Wq}{8(Tc+tq)} L^2$$

Where :

We- is wind load per unit length of contact wire.

Wq- is wind load per unit length of catenary wire,

Tc- is the tension in contact wire,

Tq- is the tension in catenary wire and,

L - is the span length.

1.05- is the constant,as the wind load on droppers & jumpers is assumed 5% of wind load on contact & catenary wires.

- As the wind acting on the conductor slips away hence only 2/3 of the projected area is considered for wind loading.

- Therefore, Wind load on a conductor

  = 2/3 X projected area of conductor X wind pressure.

MAXIMUM SPEED

- The OHE with maximum span of 72 m and with pre-sag of that span of 100 mm and with tension of 1000 kgf in contact and catenary wire is designed for a speed potential of up to 160 km/h. The existing system is generally fit for 140 km/h with AM-12 pantographs now in use on ac locomotives.

WIND PRESSURE

Wind Load

- Wind pressures for design of all masts and determination of spans are based on IS:875-1964 - "Code of Practice for Structural Safety of Buildings - Loading Standards". vide an amendment issued in 1971 to this specification, wind pressures for structures of height less than 30 m were reduced by 25%.

- Accordingly, the standard wind pressures adopted are as follows for all new works for different zones as indicated in the specification:

i) Green zone (light) - 75 kg/m^2

ii) Yellow zone (medium) - 112.50 kg/m^2

iii) Red zone (heavy) - 150 kg/m^2

Loading calculation

- For working out the wind loading the total projected area for the rolled sections. 150% of the projected area for fabricated structures, and 2/3 rd of the projected area for conductors and other circular member is taken into account.

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

a) at 35° C temperature and full wind pressure.

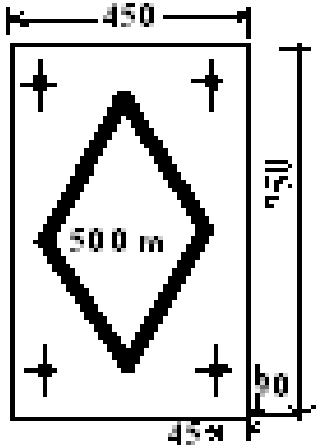
b) at 4° C temperature and 20% of the governing wind pressure.

जब दिमाग कमजोर होता है,
परिस्थितियाँ समस्या बन जाती है
जब दिमाग स्थिर होता है,
परिस्थितियाँ चुनौती बन जाती है
जब दिमाग मजबूत होता है,
परिस्थितियाँ अवसर बन जाती है

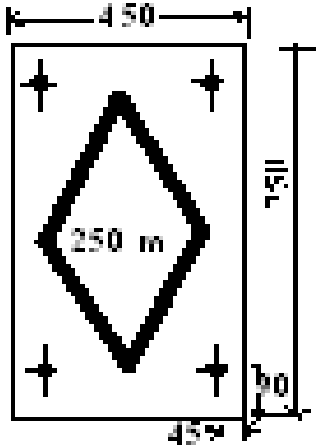
Indian Railways
Centre for Advanced Maintenance Technology

SPECIAL WARNING SIGNALS

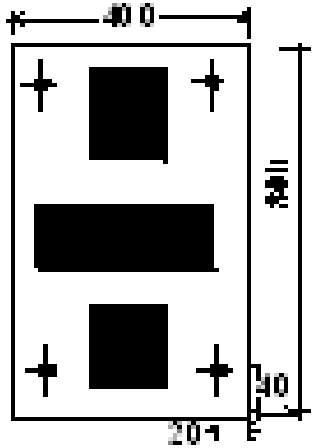
WARNING BOARDS



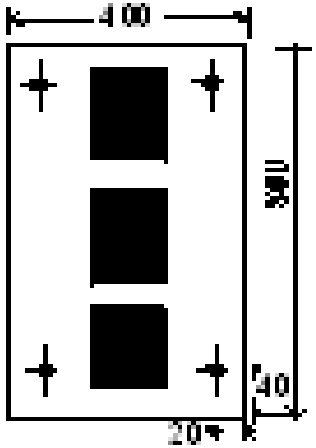
(1) DISTANCE BOARD



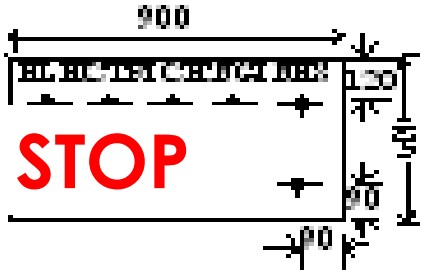
(2) DISTANCE BOARD



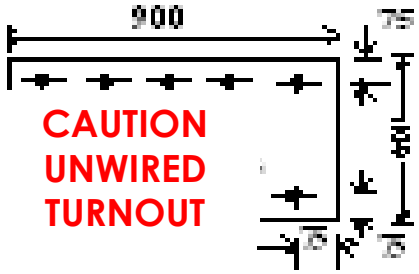
(3) SWITCH OFF SUPPLY



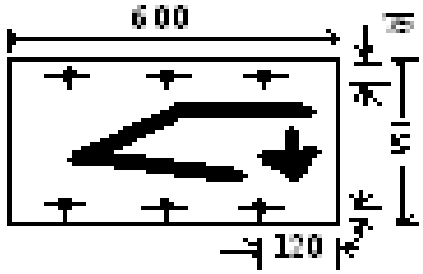
(4) SWITCH ON SUPPLY



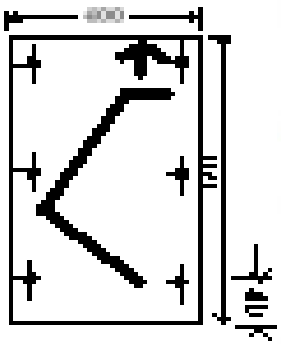
(5) STOP BOARD



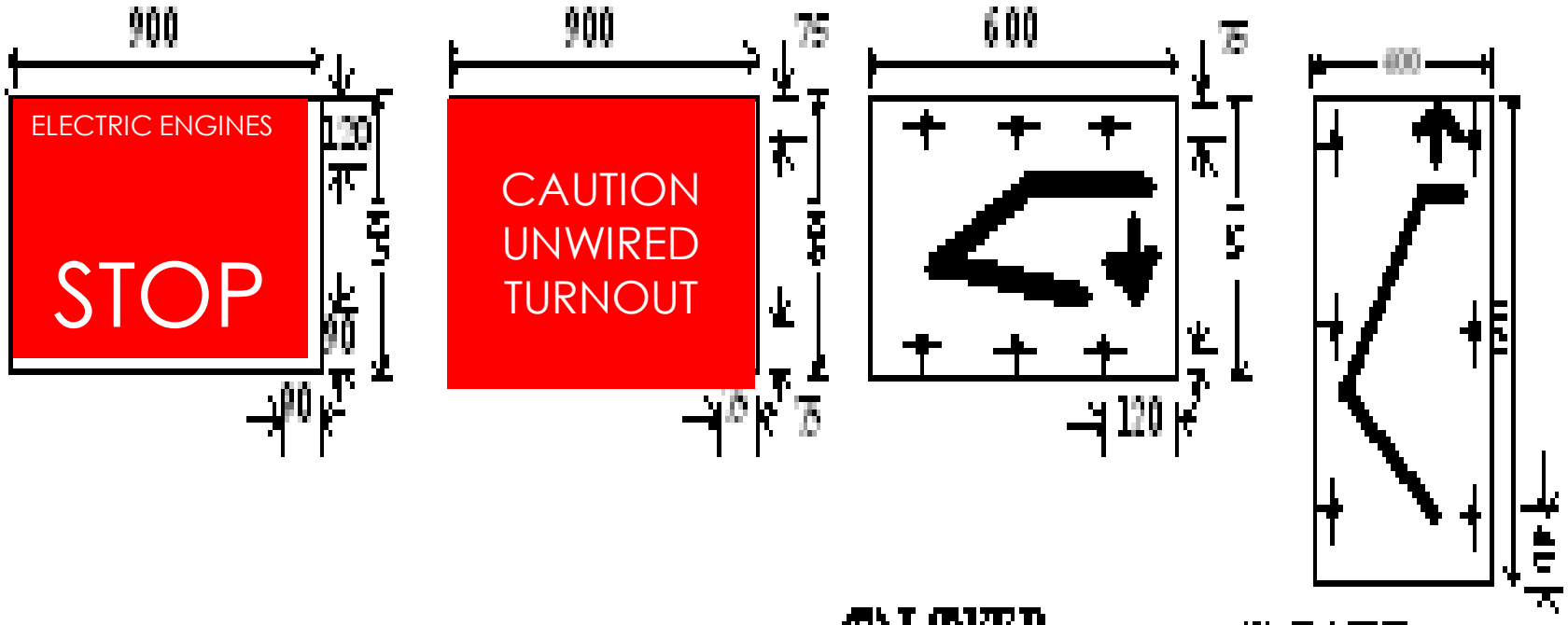
(6) CAUTION BOARD



(7) LOWER PANTOGRAPH



(8) RAISE PANTOGRAPH



(5) STOP BOARD

(6) CAUTION BOARD

(7) LOWER PANTOGRAPH

(8) RAISE PANTOGRAPH

1. Signal Marking The End Of Catenary

- Certain loops and sidings at a station may not be wired.
- An electric locomotive should not be taken into an unwired track as its pantographs and the OHE may get damaged and it will require a diesel or steam engine to pull the electric locomotive out of the unwired track.


CAUTION
UN WIRED
TURN OUTS
सावधान बिना तार के विशाखन


ELECTRIC ENGINES
STOP
विदयुत इंजनों का रोक - स्थ

- Caution boards are provided for warning the Drivers of the unwired tracks taking off from wired tracks.

- In addition special Indication boards are provided where the OHE ends on a track.

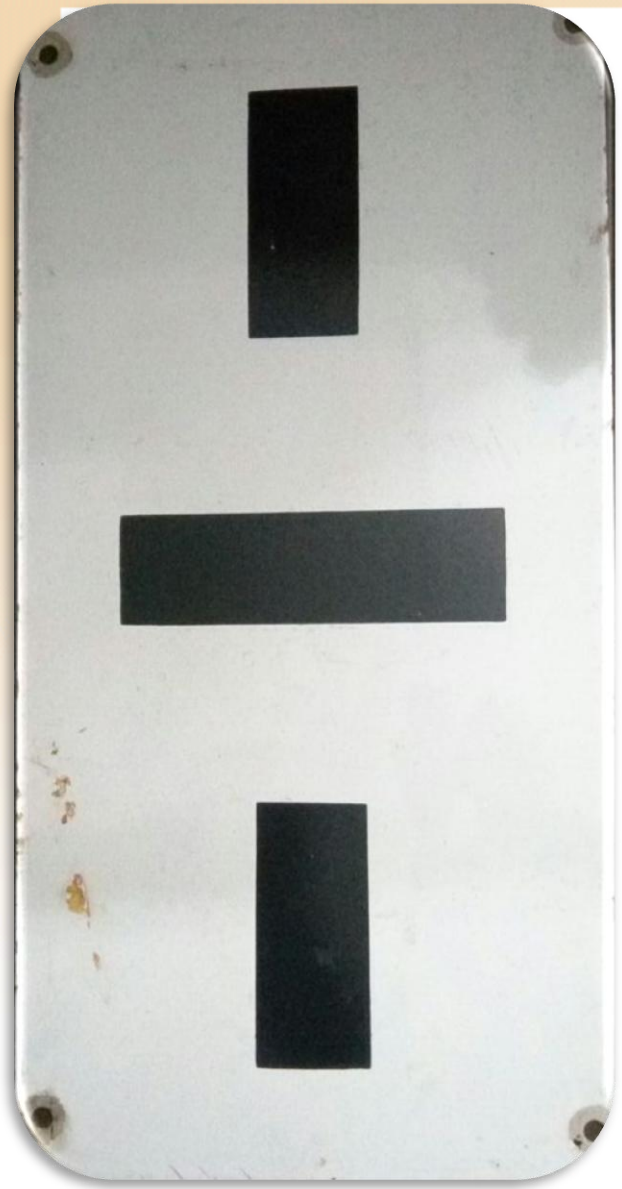
2. WARNING SIGNALS FOR NEUTRAL SECTIONS

- To indicate to the Driver that he is approaching a neutral section and should be in readiness to open DJ, two warning boards are fixed 500 m and 250 m ahead of the neutral section.

- The point where DJ is to be opened is indicated by a signal. Indication that the neutral section has been passed and DJ may be switched on again is given by another signal.

PROVIDED 500m AHEAD of NEUTRAL SECTION

PROVIDED 250m AHEAD of NEUTRAL SECTION



PROVIDED 250m(min.) AHEAD of NEUTRAL SECTION

3. TEMPORARY SIGNALS

- Occasionally it becomes necessary to lower the pantograph on certain sections when OHE is not properly adjusted so as to avoid damage to the pantographs.

- In such cases temporary warning boards are placed ahead of the section, facing the direction from which locomotives normally approach for this purpose.

- On reaching such a warning board, the Driver shall open DJ and lower pantograph/s of his electric locomotive/s.
- He may raise the pantographs after passing the section and reaching the signal provided for the purpose.

PROVIDED AT ANCHOR LOCATION OF INSULATED OVERLAP

CAUTION NOTICE PROVIDED TO WARN PUBLIC AT STATION, FOB,ROB,

DANGER CAUTION AT LEVEL CROSSINGS

जितना कठिन संघर्ष
होगा जीत उतनी ही
शानदार होगी .....