

CONCEPTS OF ELECTRIC TRACTION

Power Supply

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 at distances of 35 to 50 km apart. The distance between adjacent sub-stations may however be even less depending on intensity of traffic and load of trains.

Sectioning of OHE:-

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 interruptors' usually rated at 600A are provided. The shortest section of the OHE which can be isolated by opening interruptors 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.

At some stations with large yards, alternative feeding arrangements are provided so that the power for feeding and 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.

To meet requirements at electric loco running sheds, isolator with an earthing device in the 'off position' is provided. 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. There are several types of switching stations as detailed in the following paras.

Feeding Post (FP): It is a supply control post, where the incoming feeder link from grid substation are terminated.

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.

Sectioning and Paralleling Post (SP)

These posts are situated approximately midway between feeding posts marking the demarcating point of two zones fed from different phases a 'paralleling interrupter' is provided at each 'SP' to parallel the OHE of the up and down tracks of a double track section, 'bridging interruptors' are also provided to permit one feeding post to feed beyond the sectioning post upto the next FP if its 25 kV supply is interrupted for some reasons. These bridging interruptors are normally kept open and should only be closed after taking special precautions as detailed in these rules.

Sub-Sectioning and Paralleling Post (SSP)

One or more SSPs are provided between each FP and adjacent SP depending upon the distance between them. In a double track section, normally three interruptors are provided at each SSP i.e. two connecting the adjacent sub-sectors of up and down tracks.

Sub-Sectioning Post (SS)

These are provided only occasionally. They are similar to SSPs with provision for sectioning of the OHE but not paralleling.

Neutral Section: It is a short section of insulated and dead overhead equipment which separates the area fed by adjacent substation or feeding post.

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. Since the neutral section

remains 'dead', warning boards are provided in advance to warn and remind the Loco pilot of an approaching electric locomotive/EMU to open locomotive circuit breaker (DJ) before approaching the 'neutral section', to coast through it and then switch 'on' on the other side. Special care is taken in fixing the location of neutral sections, on level tangent tracks far away from signals, level crossing gates etc. to ensure that the train coasts through the neutral section at a sufficiently high speed, to obviate the possibility of its stopping and getting stuck within the neutral section.

Other Important Equipment at Switching Stations

Certain equipments 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 every sub-sector 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 signalling and operationally essential lighting installations. To ensure a fairly steady voltage, automatic voltage regulators are also provided where required.
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 and batteries and battery chargers required for the control of interruptors and other similar equipments.

OVERHEAD EQUIPMENT

Catenary and Contact Wires

1. The overhead equipment above the tracks comprises of the following: -
 - a) A stranded cadmium copper wire of about 65 mm² section or stranded aluminium alloy wire of about 116 mm² section for catenary.
 - b) A grooved hard drawn copper contact wire of 107 mm² cross-section (when new) supported from the catenary by means of droppers of 5 mm diameter spaced not more than 9 m apart.
2. The catenary and contact wire together have an equivalent copper section of 157 mm². 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.
3. 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 mm² section is provided.

Height of Contact Wire

The normal height of contact wire for regulated OHE is 5.60 m (with 10 cm pre-sag for 72 m span) above rail level. For unregulated OHE in areas with a temperature range of 4°C to 65°C, this figure is 5.75 m and in areas with a temperature range of 15°C to 65°C, it is 5.65 m. In certain cases, such as under over-line structures, the height may be as low as 4.65 m. For passing oversize consignments on such lines, special precautions have to be taken.

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. The catenary

system is normally supported on straight tracks at maximum intervals of 72 m by cantilever type arms fixed to galvanized broad flange or I section steel masts or fabricated steel structures. On curves the catenary is supported at closer intervals, the spans adopted depending upon the degree of curvature.

Stagger

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: The OHE conductors are terminated at intervals of about 1.5 km with an overlap, the conductor height being so adjusted that the pantograph glides from one conductor to the other smoothly.

There are two types of overlap spans as under:-

- a) Uninsulated 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.

- b) 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 interrupters or isolator except at neutral sections.

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.

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.