INDIAN RAILWAYS INSTITUTE OF ELECTRICAL ENGINEERING NASIK ROAD

Brief on 2x25 KV OHE System

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Necessity of 2x25KV in IR in passenger services

Passenger Transport:

- The Indian Railway is 4th largest Railway network in the world (viz. USA,China, Russia, India)
- Passenger transport is calculated in PKM(Passenger KM)
- The India is 1st in population but China carries 1550 Billion PKM per annum where as India carries 1157 Billion PKM per annum. Therefore it is necessary to increase PKM in India to meet the passenger service demand.
- The PKM in India can be increased by running higher speed trains in the existing network and offloading freight operations from passenger routes. For this purpose Indian Railways have announced Mission Raftar in Rly budget in 2017-18. The main purpose of Mission Raftar is to increase **speed of passenger trains two times on the existing routes**. For this purpose, The ED level committee had recommended various measures. One of them is to increase throughput by changing 1x25 kV system to 2x25 kV system

Necessity of 2x25KV in IR in freight services

Freight Transport:

- The Indian Railway is 4th largest Railway network in the world (viz. USA,China, Russia, India)
- Goods transport is calculated in TKM(Tonnage KM)
- The India is 1st in population but China carries 4389 Billion TKM per annum where as India carries 1418 Billion TKM per annum. To make the country as Viksit Bharat it is necessary to increase TKM in India to meet the freight demand accordingly to reduce transportation costs at par with the developed countries.
- The TKM in India can be increased by introducing higher speed freight trains. For this purpose Indian Railways have launched **Mission 3000MT** to be achieved by 2027. Its main aim is to increase speed of freight trains and fast transportation of goods. This also can be done by enhancing power feeding in OHE using 2x25 kV system.

Mission 3000MT

1. A multidisciplinary committee was formed for planning various measures to meet future demand of freight loading of 3000MT per annum by 2027. The committee recommended various measures in the form of action plans for various departments of Indian Railways.
2. Recommended Action Plan for Mission- 3000MT :

- The conventional approach is incapable of achieving 3000 MT by 2027. Strong initiatives and robust inputs are warranted to address & overcome various constraints and challenges brought out in for realizing such ambitious target.
- Accordingly, a threefold strategy has been formulated to address following constraints: (i) Infrastructural constraints (ii) Rolling Stock constraints and (iii) Marketing, pricing, customer service and policy related issues:

Strategy for achieving above : (A)Network Expansion/Augmentation and Upgradation works to improve the carrying capacity of (3000MT +20%) (B)Commensurate Augmentation and Upgradation of Rolling Stock Fleet (Locos & Wagons) (C)Policy, Strategic and Customer-centric initiatives for inducing modal shift to Rail Above strategies (A), (B) & (C) have been translated into detailed action plan elaborated in various Annexures, as summarized below:

Detailed action plan for mission 3000 MT

1. To cater to the increased cargo:2000 nos High Horse Power Locomotives (9000 H.P. and 12,000 H.P.) are planned to be inducted over next 8/10 years.
2. With progressive adoption of automatic signaling to increase line capacity, the number of trains in every block section will increase manifold, which will necessitate additional electric power to feed additional trains.
3. In above scenario, present 1x25 KV OHE & associated power supply arrangement will become a bottleneck in rail operations on HDN/HUN routes.
4. Therefore, it is necessary to switch to modern traction system of 2x25 KV especially on HDN/HUN routes.
5. This technology has already been adopted on DFC routes and also being implemented on Delhi-Mumbai and Delhi-Howrah routes as part of Mission Raftar.
6. In this backdrop, following are recommended:- (i) Sanction of 2x25 KV traction system over select HDN & HUN routes progressively & ii) their phase wise implementation.
7. All future electrification works to be executed (NL, GC, DL/Tripling/Quadrupling) with 2x25 KV system.
8. In all sanctioned RE works where tenders have yet not been called, 2x25 KV traction system may be adopted.

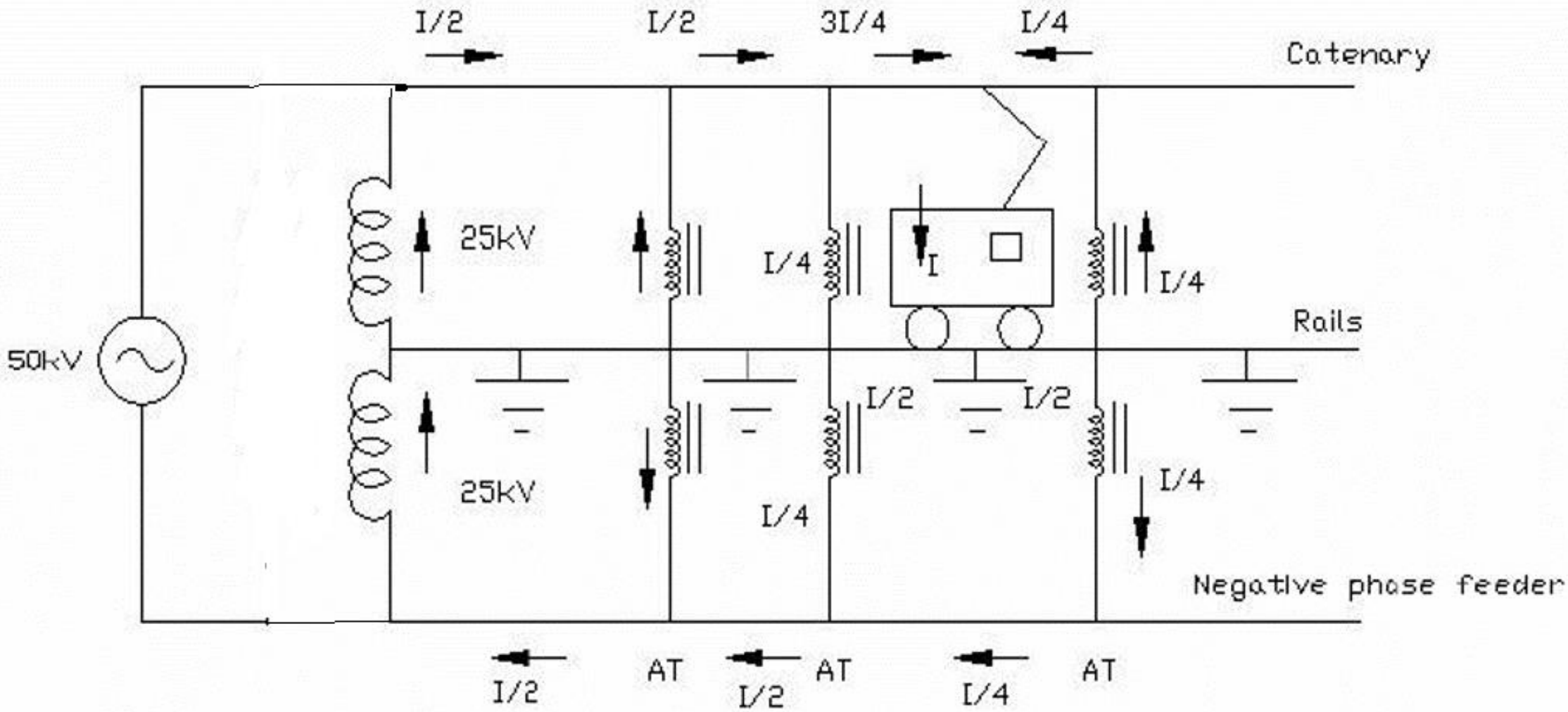
Limitations in the present system of 1x25KV to achieve higher speed of trains and also to meet mission 3000MT

- Limited power feeding
- Voltage drop at far end
- Unbalance in phases
- Electromagnetic interference
- Rail damage

Overcoming limitations of 1x25 kV by replacing it with 2x25 KV system :

1. By using higher voltage (50 KV)of transformer secondary and use of auto transformers but feeding the train at 25 KV only. The traction sub-station (TSS) will have transformers with secondary at 50 KV with intermediate tap. This tap will be connected to rail and ground performing the functions of neutral in the system. Center tap is solidly connected to ground thus one terminal is at +25 KV and another at -25 KV or we may say that the two supplies at a phase difference of 180 degree.
2. Feeder wire will run along the track and Auto Transformers will be installed at every 10 to 20 km for voltage regulation for OHE .
3. Less electric current on feeding circuit results in less voltage drop and energy loss, together with higher circuit voltage.
4. Extension of space between TSS.
5. Minimizing rail return currents.
6. Reducing of induced voltage on near by telecommunication circuits.

Principle of Operation of 2x25 KV System



Advantages of 2x25 KV System

1. The 2X25 KV AT feeding system is suitable to meet larger power supply needs with the Inherent advantage of less voltage drop in feeder circuit for a given spacing of traction substations. To meet the larger power supply requirements, 2X25 KV system is used
2. Power is generally obtained from 220 KV or 132 KV three phase networks from the power utility to reduce voltage unbalance on the transmission network. In the 2X25 KV TSS, the three-phase supply is utilized at the Traction Sub-station.
3. The 2X25 KV Auto Transformer (AT) system is having feeding voltage of 50 KV from the substation which is dropped to 25 KV by the AT installed at about 10 to 18 Km spacing along the track for supply to overhead equipment and rolling stocks.
4. Better voltage regulation even at higher load currents.

Advantages contd..

5. Minimized rail currents resulting in reduction in rail potential rise. Return current through ground also reduces considerably.

6. In 2 X 25 KV system, the return current flows through the feeder wire. Since the direction of current in the feeder wire is opposite to the direction of current in the catenary wire, it minimizes the effect of the electromagnetic Interference in the proximity of the traction line.

7.Preferred solution across the globe to meet higher power requirement for Traction Purpose.

8.Provision of BEC with rail clamp eliminates the need for drilling holes in rails thus reducing chances of rail fracture

Countries Utilizing 2x25 KV system in operations

Sr.No.	Name of Country	System for
1	Australia	Adelaide Metro, Sydney Metro
2	Japan	Johoku, Joetsu & Hokuriku Shinkansen
3	China	China Rly, Beijing subway, Chengdu metro, Wenzhou Rail Transit
4	France	SNCF
5	Italy	New high speed rail network only
6	Belgium	National Railway at all high speed lines
7	UK	Demark Rail network

Power Feeding Arrangements for 2x25 KV System

There are two types of methods for obtaining 2x 25 kV output :

A. Scott connected Transformer

B. Open V connection of transformer

Power Feeding Arrangements for 2x25 KV System

A. 2X25 KV System with Scott Connection

- For double line sections, two Scott connected Transformers & four Auto- transformers are to be installed at TSS along with associated switchgear for Control & protection.

- The two windings of a Scott transformer i.e. Main and Teaser windings are of equal power rating and feed either side of the TSS independently. The supply of both the windings is at a phase difference of 90 degree and separated by neutral section provided near TSS. Out of two Scott transformers, only one is in operation and the other is on standby.

- Scott- connected transformer of 60/84/100 MVA (ONAN/ONAF/OFAF) is used to feed power to the traction system. Input supply of 220 KV or 132 KV, 3 phase, 50 Hz and two independent secondary winding for output at 50 KV.

- The feed of different phase is separated by neutral section provided near TSS. The Scott Connected Transformer in ONAN Mode shall feed the 30MVA Power to each side of the TSS.

- **Auto - transformers** are used at TSS, SP and SSP. The transformer winding of 50 KV with Centre tapped neutral with both the terminals of the Auto transformer winding connected to feeder and contact/Catenary wire. The neutral terminal of the ATs is connected to rail.

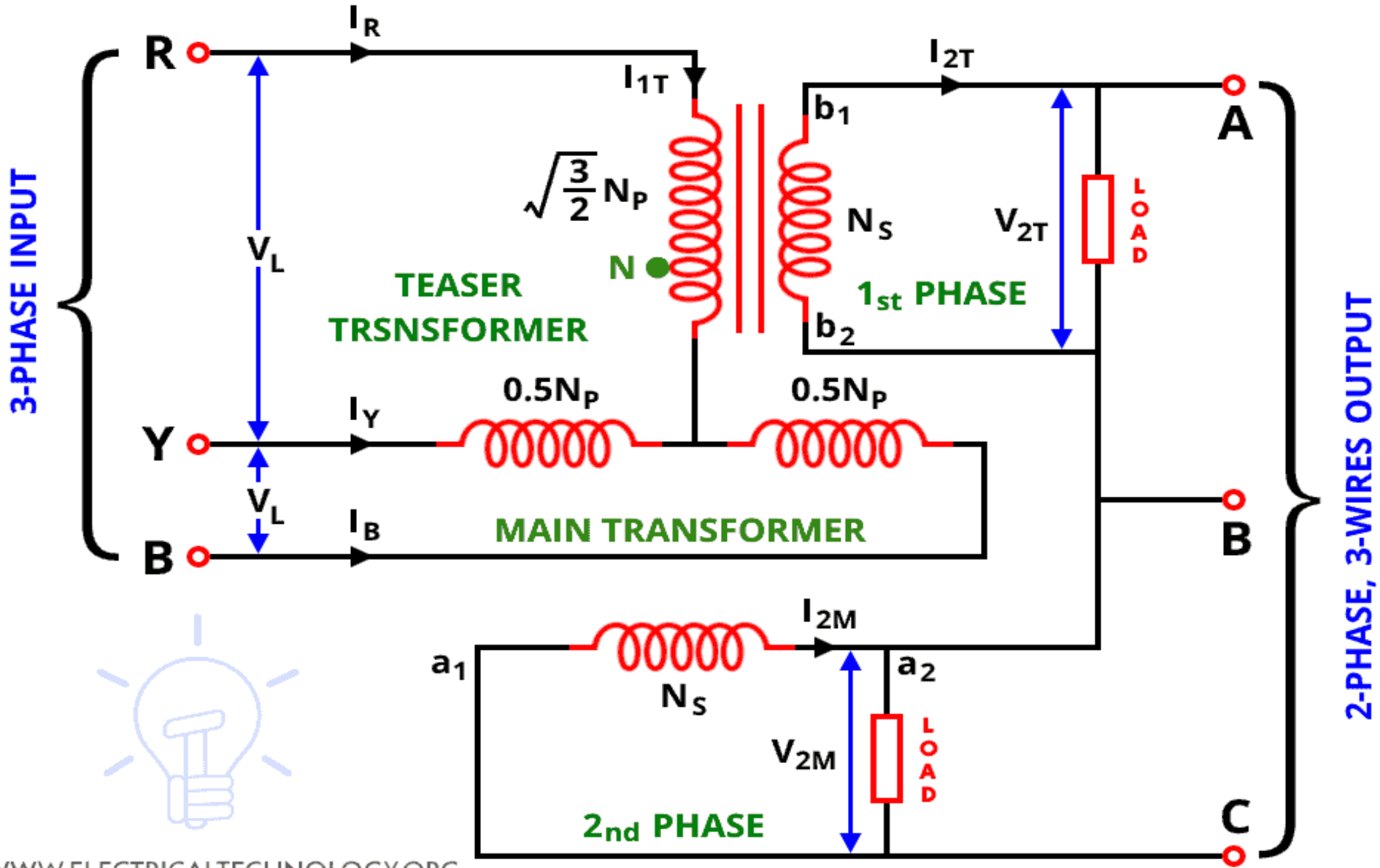
Scott connected scheme contd…

- Two adjacent ATs feeding on the network share train loads on the section between them and transfer the load current on 25 KV circuit to 50 KV circuit, consisting of contact wire and AT feeder. This reduces the voltage drop on feeding network remarkably.
- Furthermore, it minimizes the return current on the rail, which results in reducing induced voltage on nearby telecommunication lines.

Capacity of AT according to no.of lines in section :

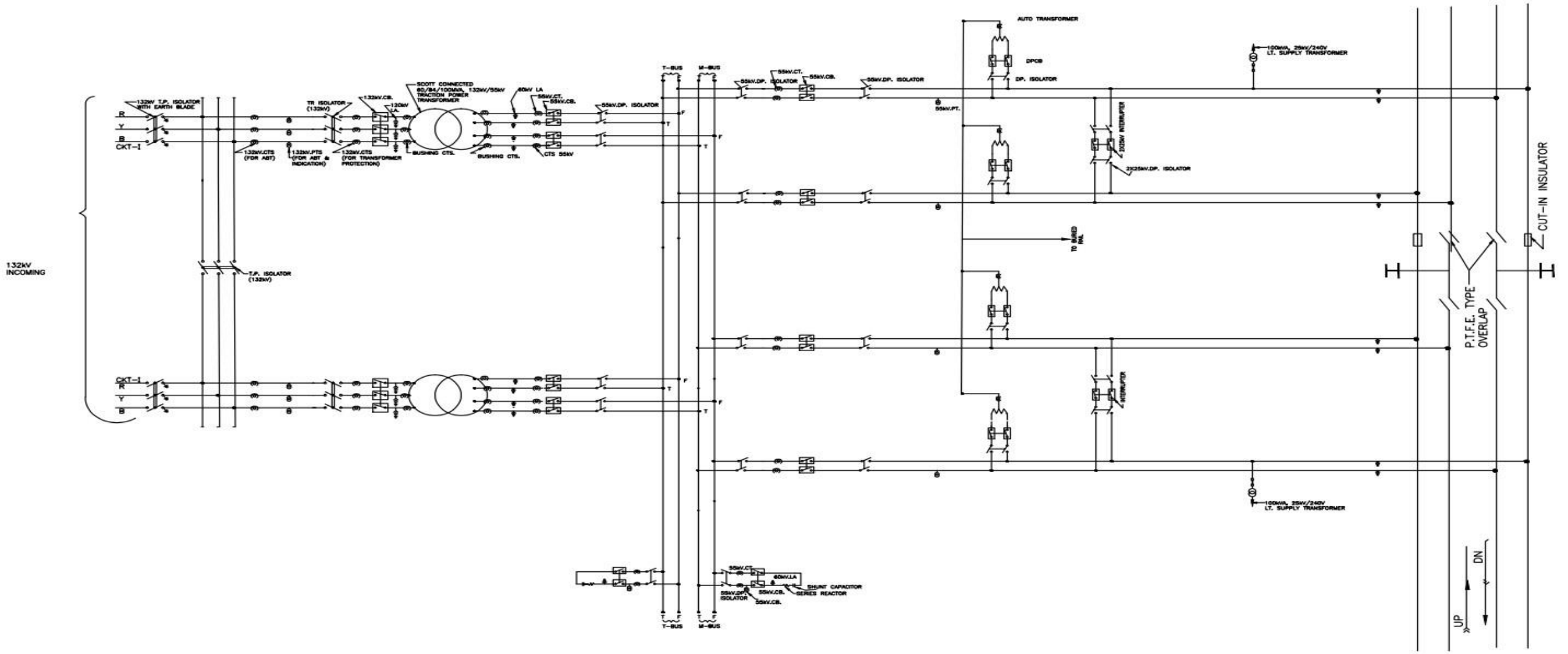
	2 line section	3 line section	4 line section
Capacity of AT used at TSS	12.3 MVA	12.3 MVA	12.3 MVA
Capacity of AT used at SSP/SP	8 MVA	16.5 MVA	16.5 MVA

Scott-T Transformer Connection



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132/2X25 KV TSS WITH SCOTT - T CONNECTION TRANSFORMERS (FOR DOUBLE LINE SECTION) WITH PARALLEL TO TRACK



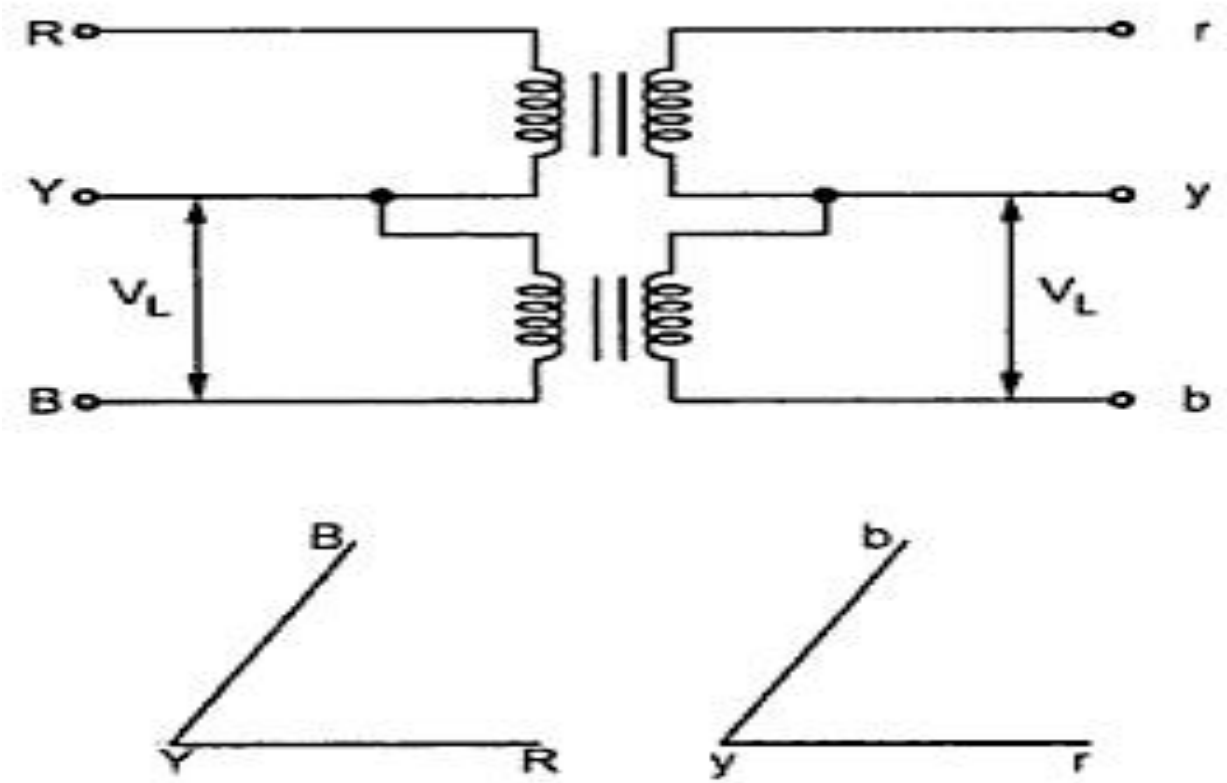
B. 2X25 KV System with V Connection

- In this scheme, three single phase transformers of 38/53/63 MVA (ONAN/ONAF/OFAF) are connected to different pairs of three phase of incoming supply forming an open delta connection on the primary side.
- Out of the three single phase transformers, first transformer feeds the OHE on one side of the TSS, second transformer (mid one) remains as standby and third transformer feeds the OHE on the other side of the TSS. The power supply on either side of TSS is at a phase difference of 120 degree and therefore separated by a neutral section provided near TSS.
- Each single-phase transformer has a voltage input of 220 KV or 132 KV, 50 Hz and two independent secondary windings, to be connected externally in such a manner (two inner terminals of these secondary windings are connected with each other and also connected to earth/Rail) so as to give an output voltage of 2X25 KV. The outer terminals of the windings are connected to Feeder wire and overhead contact/catenary wire respectively.
- Two transformers shall be in operation at a time and one shall be on standby. Hence in the V connected Scheme, each transformer in ONAN mode shall feed the 38 MVA Power in either side of the TSS.

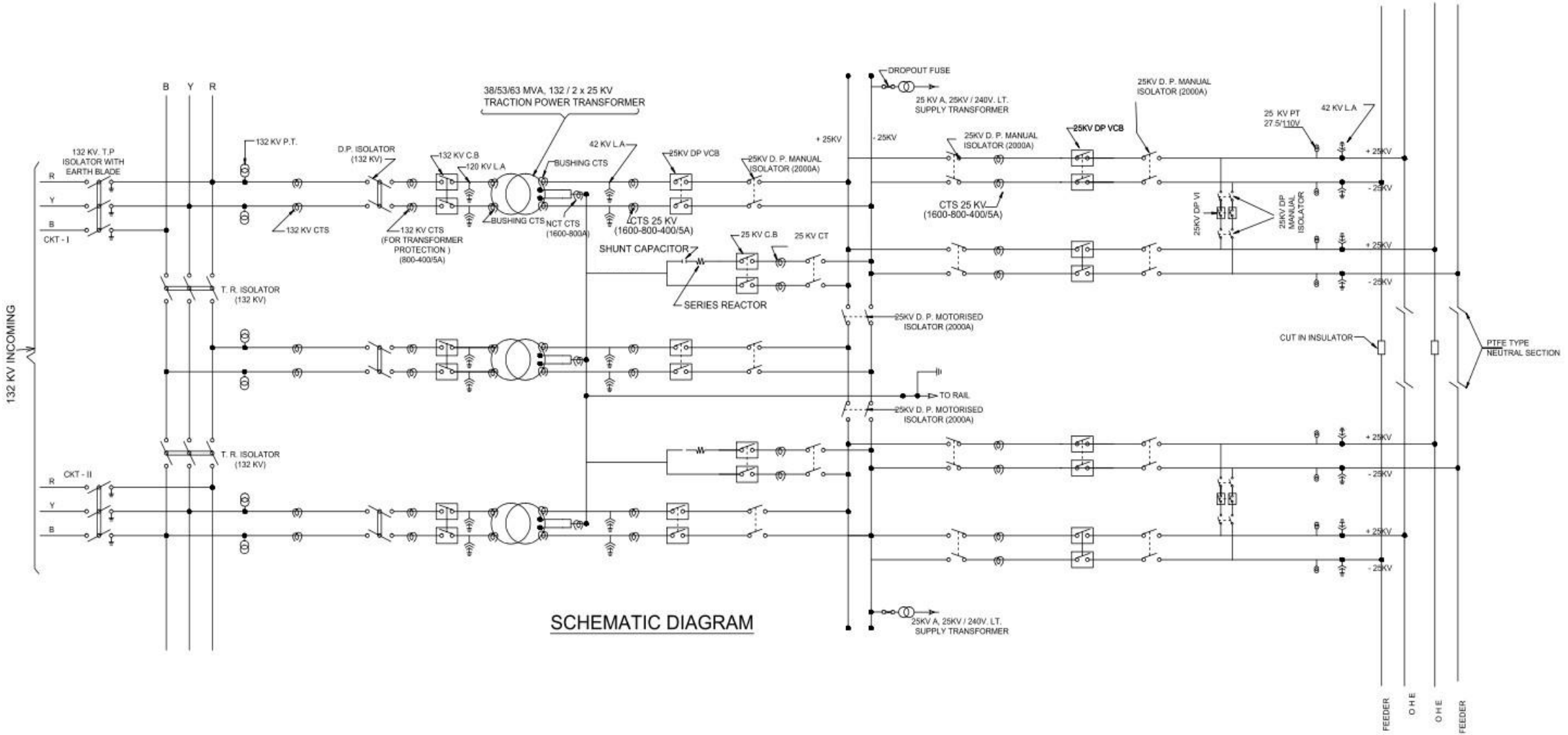
2X25 KV System with V Connection (continue..)

- Auto- transformers are used at SP and SSP. The transformer winding is 50 KV with Centre tapped neutral with both the terminals of the winding connected to AT feeder and the contact wire. The neutral terminals of the ATs are connected to rail.
- Two adjacent ATs feeding on the network share train loads on the section between them and transfer the load current on 25 KV circuit to 50 KV circuit, consisting of contact & catenary wire and AT feeder. This reduces the voltage drop on the feeding network remarkably. Furthermore, it minimizes the return current on the rail, which results in reducing the induced voltage on nearby telecommunication lines.
- Auto transformers are not used at the TSS. However, these have been provided at SP/SSP of **16.5 MVA capacities**. Moreover, no independent AT post has been proposed.

‘V’ Connection of Transformer



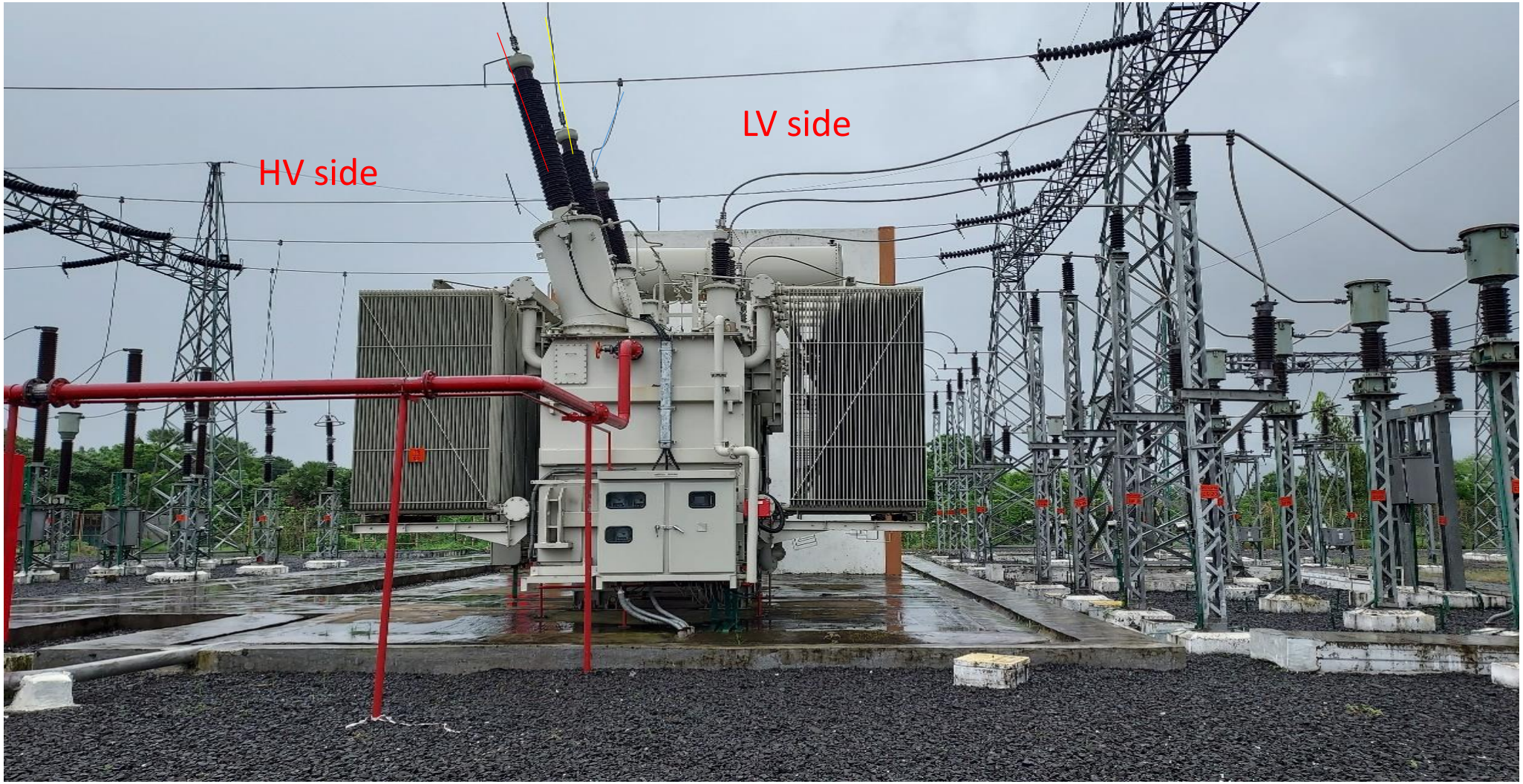
132/2X25 KV TSS WITH ‘V’ CONNECTION TRANSFORMERS (FOR DOUBLE LINE SECTION) WITH PARALLEL TO TRACK



Biruni TSS at EDFC using V Connected Transformers



Scott- Transformer



Comparison between Scott connected and V Connected Transformers

- The Voltage Unbalance in Scott Connected Transformer Scheme is least and therefore the Railways should preferably provide Scott Connected Transformer wherever the voltage unbalance problem is seen . The problem of unbalancing has been raised by few power utilities and therefore Scott or V connected arrangement should be chosen judiciously after coordinating with the power utilities.
- Scott Connected Transformer is more complex and costlier than the V connected Transformer .
- Since, no AT is to be used at the TSS of V connected scheme; it is simpler than Scott Connected scheme.
- Considering the complexities involved of the unbalancing , space constraints and other site problems, the Scott connected or V connected arrangement may be chosen by the Zonal Railways after coordinating with the power utilities and with the approval of PCEEs (RDSO spec…)

Comparison of Scott Vs V connection

s.n	Scott Connection	V connection
1	Two Transformers (64 MVA each)	Three transformers (
2	There are 2 secondary windings in each Transformer as Main & Teaser winding. One side of TSS is fed by M phase to OHE (+25 KV) & Feeder (-25KV) and other side by T phase (OHE (+25 KV) & Feeder (-25KV))	One transformer feeds OHE (+25 KV) & Feeder (-25KV) on one side of TSS and other transformer feeds OHE (+25 KV) & Feeder (-25KV)on otherside of TSS
3	3 Phase incoming supply required	3 Phase incoming supply required
4	One transformer is standby	One middle transformer is standby
5	This system is used for higher power requirement with good voltage balance	This system is used for higher power requirement with inferior voltage balance

Spacing comparison between TSS in Scott and V type arrangement vs no.of lines in section

Type of connection	2 line section	3 line section	4 line section
Scott	60-70 KM	50-60 KM	40 -50 KM
V connection	60-70 km	50-60 KM	40 -50 KM

Analysis of Scott vs V connected transformer

A. Costing

s.No	Type of transformer	Cost
1	Scott connected	Rs.11 cr
2	V connected	Rs. 6 cr
3	Auto transformer	Rs.1.25 cr

Analysis of Scott vs V connected transformer

B. Details of Scott and V connected TSS available in Katni-APR-BSPR section.

s.no	Location of TSS	Type of connection	No. of transformers	Make	Capacity
1	NRZB	Scott	02	GEC	54 MVA each
2	APR	Scott	02+01*	KONKAR	54 MVA each
3	UKR	V	03	TELK	21.6 MVA each
4	BSPR	V	02	TELK	21.6 MVA each

Analysis of Scott vs V connected transformer

C. Failure details of Transformers

s.no	Location of Transformer /Make	Type of Transformer	Nature of failure	Reason	Cost of repair
1	APR (Konkar)	Scott	1 no. winding burnt (in year 1995)	Due to earth fault in OHE	Replaced with GEC make Under warranty repair
2	APR (Konkar)	Scott	Winding burnt (in 2001)	Differential with PRD trip	Rs. 98 lakhs approx.
3	APR (GEC)	Scott	11 no's bushing busted and uprooted (in 2005)	Due to suspected impulse	Rs. 98 lakhs approx
4	APR (Konkar)	Scott	245KV HV bushing (L-2) busted	As per DGA report, arcing occurred inside the transformer as H2 &	Under Repair

Analysis of Scott vs V connected transformer

D. Maintenance cost per Year (Ref : LOA of SECR , Dt: 05.06.24)

s.No	Type of Transformer	Cost of maintenance per year	cost of maintenance for total Transformers	Grand total of cost per TSS
1. A	Scott connected	Rs.94,800/-	Rs.1,89,000/-(for 02 T/F's)	Rs.2,24,360/-
1.B	Auto transformer	Rs.8840/-	Rs.35,360/-	
2.	V connected	Rs.24,000/-	Rs.72,000/- (considering 3 T/F's at TSS)	Rs.72,000/-

- Difference in maintenance cost per TSS/year between Scott and V Transformers =Rs.1,52,360 .
- Cost of Maintenance of Scott connected TSS = 3 times of V connected TSS

Interlocking arrangement in Scott connected TSS

- The Closing of the LVCB on the secondary side of Traction Transformer (i.e. 50 KV, SF-6 CB) shall be possible only when any one of the Circuit Breaker of associated Autotransformer at TSS is in closed condition.
- The automatic opening of the LVCB on the secondary side of Traction Transformer (i.e. 50 KV,SF-6 CB) shall happen as soon as all the Circuit Breakers of the associated Autotransformers at the Traction Sub Station are opened.
- The closing of coupling motorised isolator between Main Bus and Teaser Bus should be possible only when all the LVCBs of the Transformer are open. This coupling isolator has been provided for the feed extension in case of failure of TSS.
- To ensure above, necessary interlock shall be provided.

Interlocking arrangement in V connected TSS

- In this scheme the middle Traction transformer is to be used in either direction in case of failure of any one of the outer transformer. Therefore necessary interlock is to be provided between Motorized Coupling Isolator and LV Circuit Breaker in order to avoid wrong phase coupling as well as to ensure off load operation of the motorized isolator.
- There is off load circuit tap changer on primary side of the transformer with 6 tap positions (including principal tap) for voltage adjustment. Therefore, the tap changer should be operated only when both the primary and secondary circuit breakers are in open condition.

Power Factor Improvement

Railway Board vide letter no. 2008/RE/170/1 dated 12.06.2012 (Annexure-3) has already communicated that “it has been decided that Railways/CORE/MRVC/RVNL etc. should provide only fixed type capacitor bank in all new & existing 25 KV & 2X25 KV TSSs for the time.” Thus, it is proposed to provide only conventional fixed type Capacitor Bank & Reactors in the 2X25 KV TSSs.

Earthing & Bonding

- AEC (Aerial Earth Conductor) & BEC (Buried Earth Conductor) are provided to contain touch and step potential of the Track.
- AEC – ACSR, Raccoon conductor of Size : 6/1/4.09 mm, Dia. 12.24 mm (92 mm2)
- BEC - Galvanized steel -19 strands –Dia.20 mm (238 mm^2), buried 300 mm underground, ~1m from mast foundation (opposite to track)
- Every OHE mast/portal , feeder mast has to be connected by same conductor to BEC by Tee and Lug connectors as per Drg.no. TI/DRG/OHE/TC/RDSO/00001/20/0
- UP BEC-UP Mast-UP Rail-DN Rail-DN Mast-DN BEC cross-bonding by 50mm x6 mm MS/ GS flat every 450m
- At platform, BEC can run on platform coping and on bridges, in a covered trench

Inter track bond /Earth connected at 450 m



Mast connected to BEC



Earthing of Centre point in Auto Transformer



Modifications plan for 2x25KV - OHE

SN	Details	IR 1x25	IR 2x25
1	Foundations	As per FBM codes & soil bearing pressure, size of foundation may be decided by prescribed chart by RDSO.	As per FBM codes & soil bearing pressure, size of foundation may be decided by prescribed chart by RDSO.
2	Mast	B-series mast of B-150, B-175, B-200,B-250 & O, N, R type portals	B-series mast of B-175, B-200, B-225,B-250 & O, N, R type portals
3	Setting Distance	Minimum 2.80 m	Minimum 2.80 m
4	Span	As per wind pressure zone defined by RDSO	
5	Tension length	1500 m (Max)	1500 m (Max)
6	Height of contact wire	5.5m	5.5m

Modification plan for 2x25KV-OHE (contd.)

SN	Details	IR 1x25	IR 2x25
7	Cantilever	Stay arm- dia 28.4/33.7 mm, tube Register arm-dia 28.4/33.7 mm tube Bracket tube- 40/49 mm dia tube. steady arm-32x31 mm BFB section of Al-alloy	
8	OHE wire	65 Sq.mm Catenary wire (CU-Mg) & 107 Sq.mm Contact wire (HDGC-Cu-Cd) with 2000 kgf (1000kgf each) tension.	i)For modification of existing 1x25 KV system ,65 Sq.mm Catenary wire (CU-Mg/Cu-Cd) & 107 Sq.mm Contact wire (HDGC-Cu-Cd) with 2400 kgf (1200kgf each) tension. ii) 125 Sq.mm Catenary wire (CU-Mg/Cu-Cd) & 150 Sq.mm Contact wire with 3000Kgf (1500 kgf on each) tension.
9	Dropper	Link dropper (non- current carrying) 5 mm copper wire with one loop to support contact wire with various dropper schedule used.	Current carrying “A“ dropper as per RDSO“s spec. or one C Jumper (in span jumper) in every span should be provided & Rigid droppers to be removed.

Modification plan for 2x25KV-OHE(contd.)

SN	Details	IR 1x25	IR 2x25
10	Regulating equipment.	Pulley type ATD (3:1 ratio) for 2000 kgf in both Cat. & Cont. wire. (1000 Kgf each)	Pulley type ATD (3:1 ratio) for 2400 kgf in both Cat. & Cont. wire. (1200 Kgf each)
11	Feeder	Not Applicable.	1. Additional feeder of 234 sq. mm (AAAC material) for existing OHE runs along with OHE with negative polarity. 2. Additional feeder of 288 sq.mm with cat/cont. of 125/150 sq.mm.
12	Jumper wire	105 Sq. mm copper flexible G-jumper for continuity of OHE.	160 Sq. mm copper flexible G-jumper for continuity of OHE as per specification no. ETI/OHE/3(2/94) with the approval of PCEE.
13	Pre-sag	100 mm	50 mm (for 160 kmph)

Modification plan for 2x25KV-OHE (contd.)

SN	Details	IR 1x25	IR 2x25
14	Earthing & Bonding	Rail & structure bond at every mast (72 m). System as per IS 3043 By M.S. flat of size 40 x 6 mm & 50 x 6 mm.	AEC of 92 sq.mm for each OHE structure continuity & BEC of 240 sq.mm will be buried to earth by 300 mm along the track individually. Structure to rail bond connectivity every 450 m (max). Each metallic part/ structure in vicinity of OHE shall be connected with return rail by the means of metallic strip and by providing separate earth pit.
15	Span	As per wind pressure zone defined by RDSO	As per wind pressure zone defined by RDSO
16	Tension length	1500 m (Max)	1500 m (Max)
17	Contact wire gradient & Relative Gradient	3 mm/m & 1.5 m on main line	2 mm/m & 1mm/m on main line

Modification plan for 2x25 kV –PSI

sn	Details of item	1 x 25 KV	2 x 25 KV SCOTT	2 x 25 KV V connected
1	Incoming power supply	2 phase, 66/132/220 KV	3 phase, 132/220 KV	3 phase, 132/220 KV
2	Transformer capacity	21.6/30 MVA (ONAN/ONAF)	60/84/100 MVA (ONAN/ONAF/OFAF)	38/53/63 (ONAN/ONAF/OFAF)
3	No.of transformers	2 (1 standby)	2 (1 standby)	3 (1 standby-middle one)
4	Auto Transformer capacity at TSS and Qty a. For 2 line section b. For 3 & 4 line section	---	a.12.3 MVA , 04 no's b.12.3 MVA , 04 nos	---
5	Auto Transformer capacity at SP/SSP a. For 2 line section	----	a.8 MVA, 02 no's	a. 16.5 MVA 02 no's

Modification plan for 2x25 kV –PSI (contd.)

Sn	Details of item	1 x 25 KV	2 x 25 KV SCOTT	2 x 25 KV V connected
7	Spacing of TSS a. 2 line section b. 3 line section c. 4 line section	35-50 km	a.60-70 km b. 50-60 km c. 40-50 km	a.60-70 km b. 50-60 km c. 40-50 km
8	Power factor improvement	Fixed type capacitor bank 220 KVAr/ 8 KV each	2 no.'s 4 MVA , 50 KV capacitor bank. 1 for Teaser winding and 1 for main winding	2 no.'s 4 MVA , 25 KV capacitor bank. 1 each for working transformer
9	Battery a. TSS b. SP/SSP	a.110V , 200 AH b. 110V 40 AH	a. 110V 250 AH b. 110V 150 AH	a. 110V 250 AH b. 110V 150 AH

Modification plan for 2x25 kV -PSI

Sn	Details of item	1 x 25 KV	2 x 25 KV SCOTT	2 x 25 KV V connected
10	Earthing at SP/SSP	With existing guidelines	Design should be for 12KA fault level for 3 sec duration as per ETI/PSI/120(2/91)	
11	BusBar and conductors in TSS	existing	Earth wire 19/2.5 mm Primary side conductor : 28.62 mm ACSR Zebra conductor Secondary side : 50 mm Dia Aluminium busbar & 36 mm Dia AAAC Bersismis conductor	Earth wire 19/2.5 mm Primary side conductor : 28.62 mm ACSR Zebra conductor Secondary side : 50 mm Dia Aluminium busbar & 38.25 mm Dia AAC Bull conductor

Protection for TSS and OHE

I. Protection system at TSS:

A. Protection for traction transformers

B. Protection of OHE

C. Protection of HT capacitor & series reactor

D. Protection of Auto Transformer

II. Protection at SSP, SP & AT Posts:

A. Traction Transformer protection

The following protection functions provided for the protection of traction transformers:

1. Differential protection.

2. IDMT over current protection on HV & LV sides.

3. Over load protection on HV & LV sides.

4.Earth fault protection on HV & LV sides.

5. Instantaneous over-current protection on receiving side.

6.Phase-failure relay (only applicable for center point of secondary winding of traction transformer earthed) -to detect a malfunction of a LV circuit breaker.

7. Auxiliary relays for transformer faults i.e., Buchholz, excessive winding and oil temperature trip and alarm, pressure relief device trip and low-oil level alarm

Main Transformer protection relay



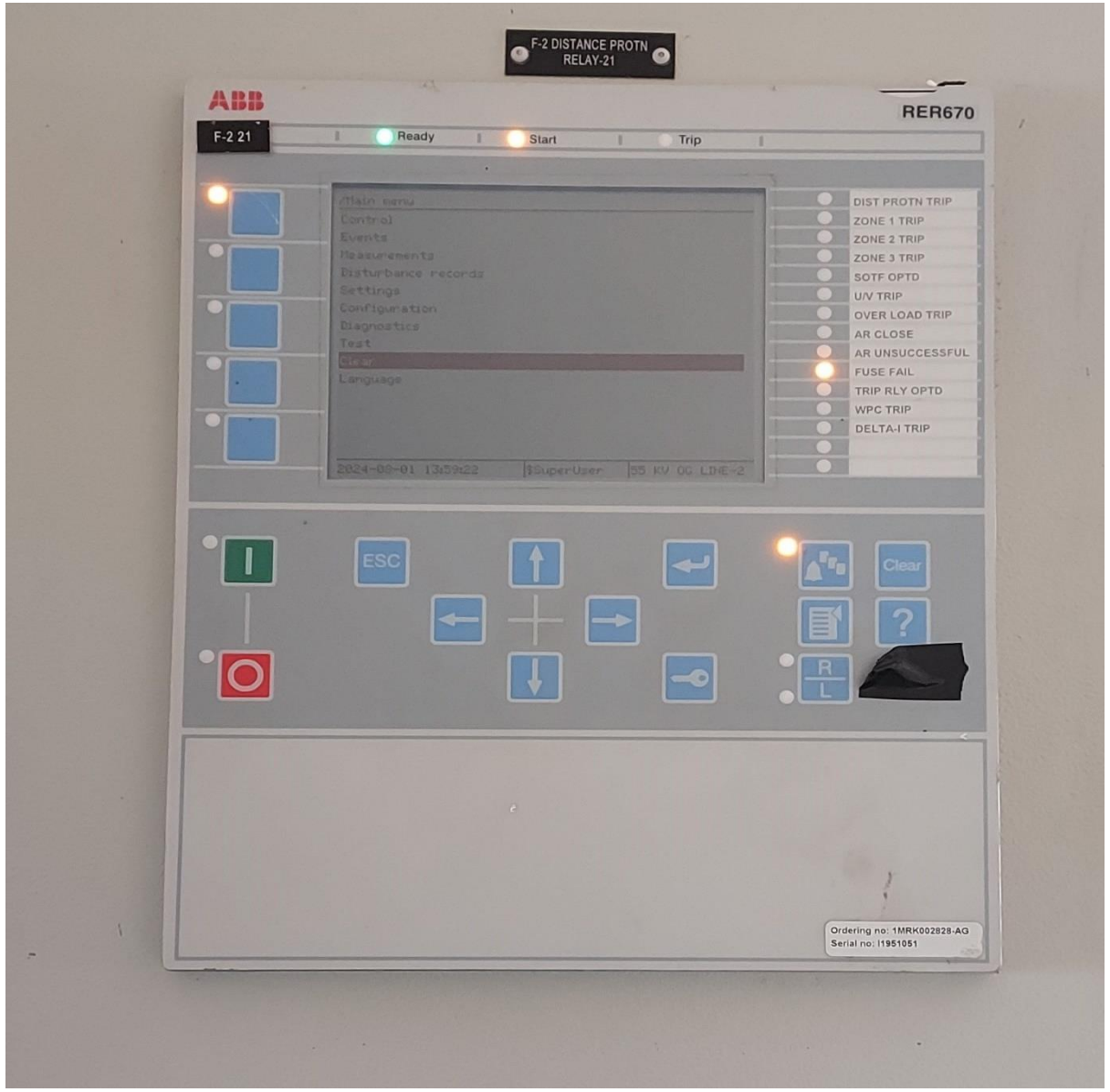


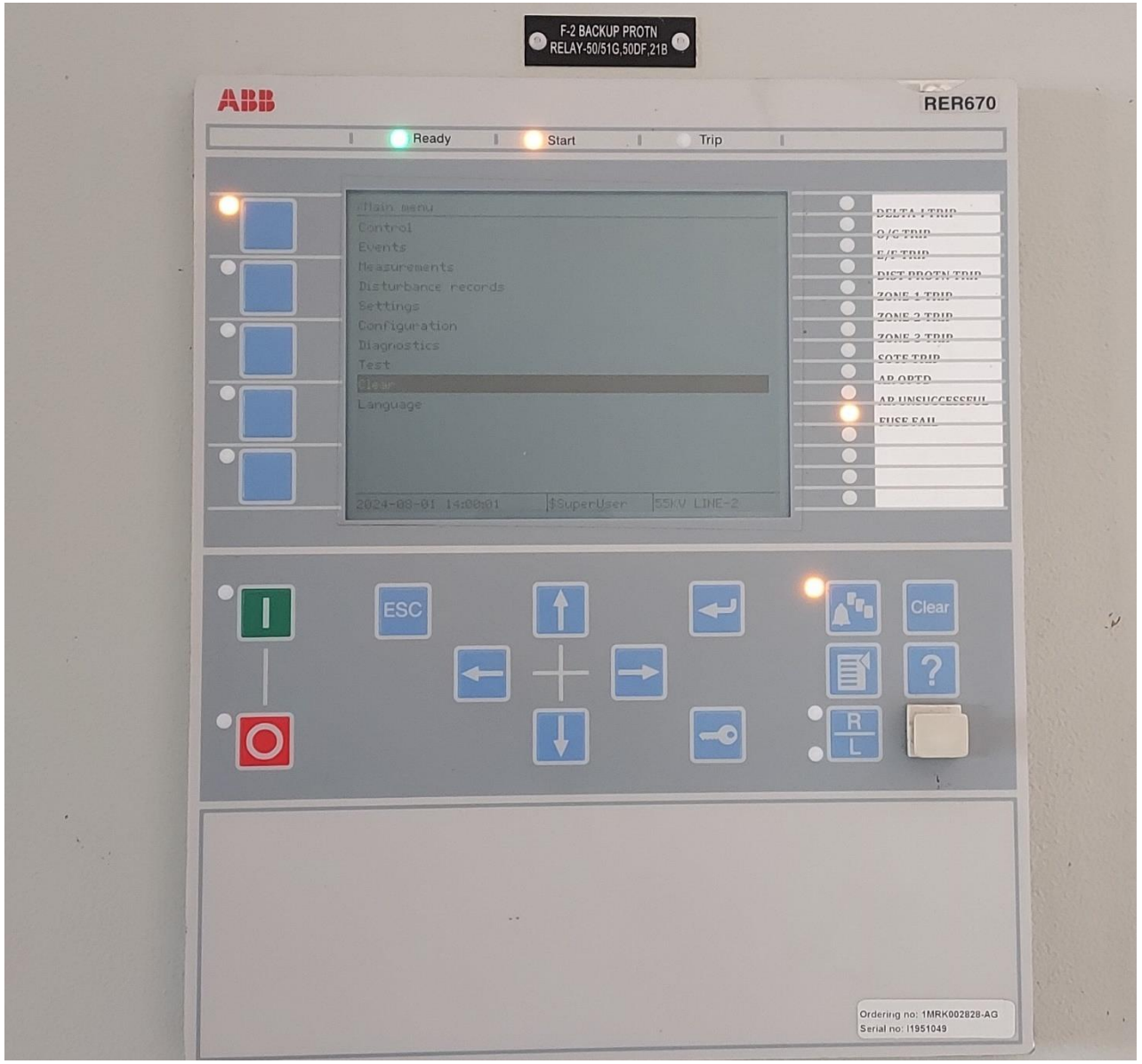
B. OHE protection

The following functions provided for the protection of OHE:

1. 3-Zone distance protection (with a polygon protection characteristic)
2. Delta-I type high resistive fault protection
3. Instantaneous over-current protection with single stage definite time over current element.
4. Under-voltage relay to prevent closing of Feeder CB under extended feed condition
5. PT fuse failure protection
6. 2-shot Auto Reclose function

OHE protection- Relay





C. Auto Transformer Protection Relay



- Differential Relay
- Bucholzz Relay
- Oil temp indicator with Alarm and Trip contacts
- Winding temperature indicator with Alarm and Trip contacts
- Pressure relief device
- Low oil level Alarms

II. Protection at SP/SSP

1. AT differential Protection Relay

2. Voltage operated auxiliary relays for Transformer faults. ie. Buchholz, PRD, Winding Temp. & Oil Temp.

Induction of New Technology in OHE construction –

1.Mobile Rail based Auger for cylindrical foundations



- Used 1st time in India for cylindrical foundation of OHE mast(In DFCCIL)
- Can dig circular foundation with minimum manpower
- Self propelled and can run on Soil, Ballast, Rail

2.Mechanical mast Grabber for OHE mast erection



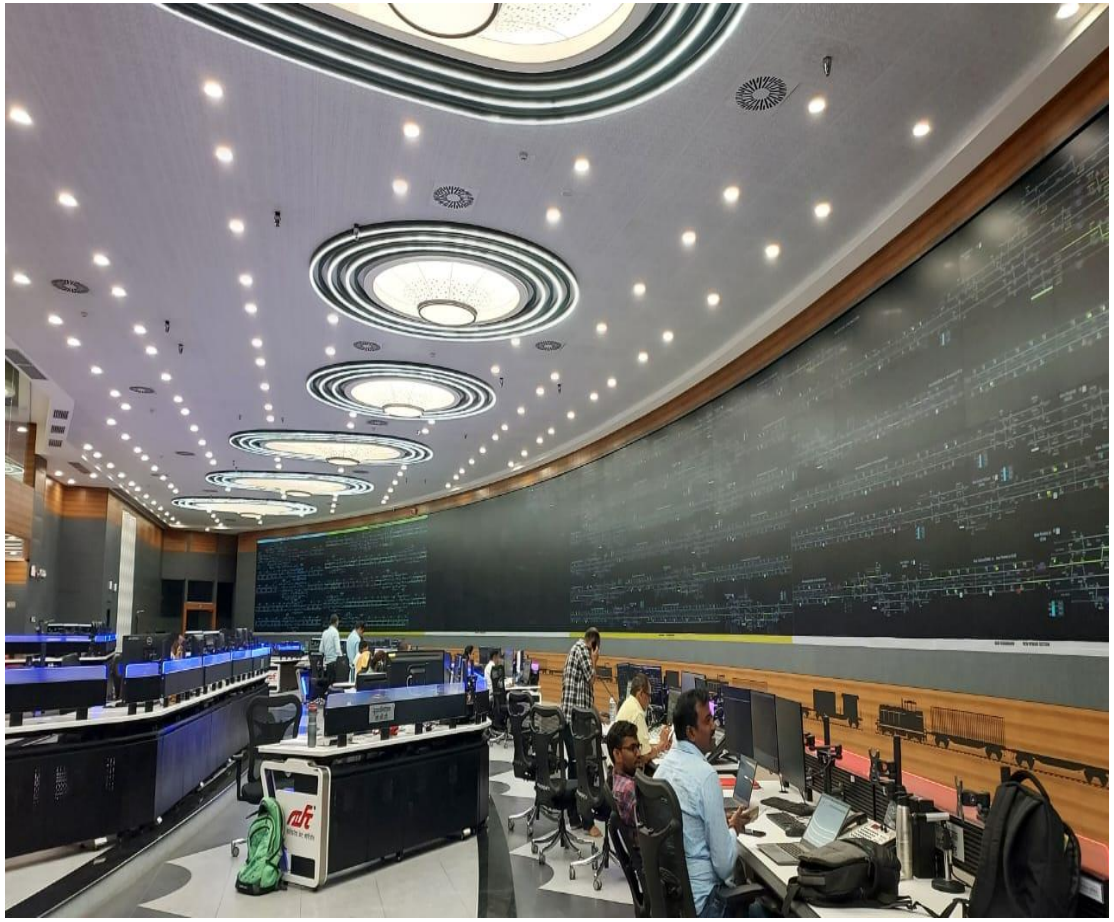
- Rail cum Road vehicle
- Used in DFCCIL
- Contains hydraulic crane
- Grabber for lifting the mast
- Work fast with less manpower

3.Automatic Wiring train



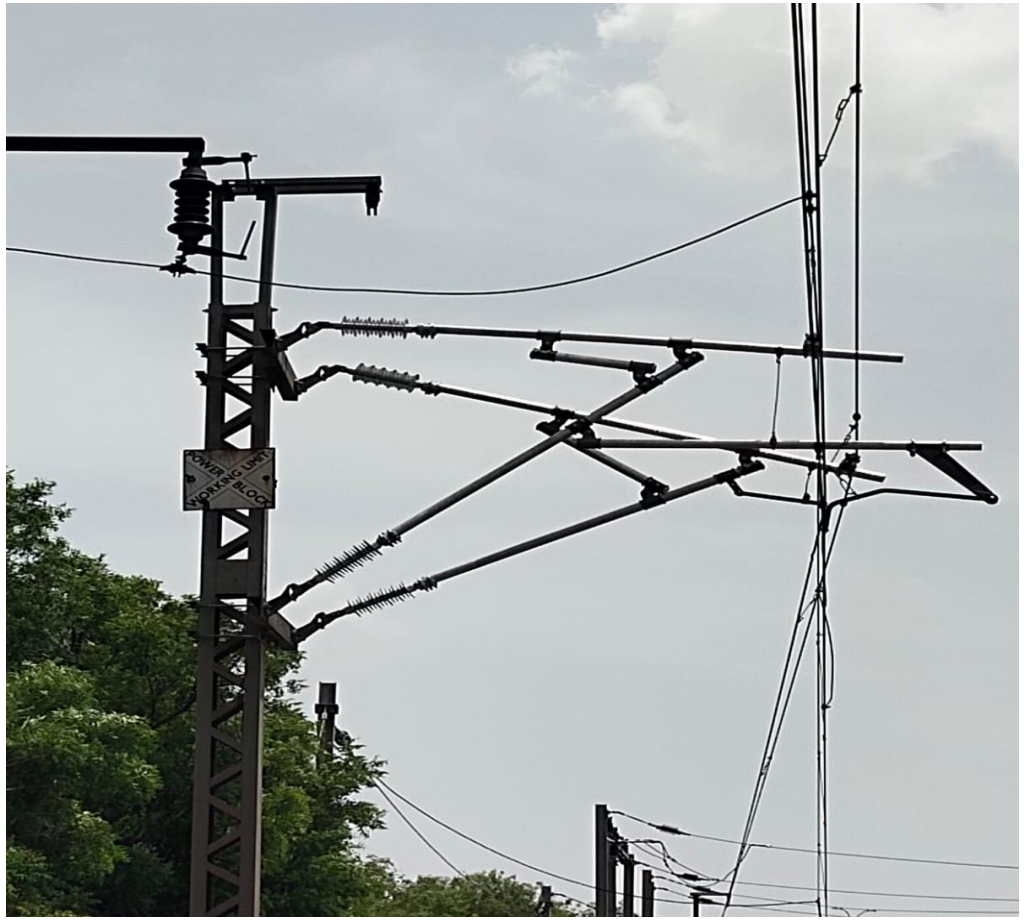
- Auto tensioning and simultaneous contact & catenary wiring.
- Used by DFCCIL
- Wiring possible in both directions
- Average OHE wiring of 6km/day is possible

4.Operation Control Centre- DFCCIL at ADI



- Live centralised operation of all trains
- Centralised control and operations of SCADA system
- Centralised health monitoring of S&T equipment
- Control and command center in disaster management.

6.Modular cantilever system(MCS) for OHE- Used at DFCCIL



- Structural integrity validated for severe static & dynamic loading conditions, designed for High tension OHE lines for high speed trains
- Corrosion resistant, long service life
- Suitable for various positions- pushoff, pulloff, anti-creep, overlap etc..

7.Regulating equipment(ATD) in 2x 25 KV- Used by Eastern DFCCIL



- 3 pulley type higher tension with counter weight eye-rod i.e., with 1200 Kgf tension

Indications in SCADA For TSS

❖Transformer protection indications

- Differential trip
- Oil temperature high alarm
- Low oil level alarm
- Buchholz alarm
- WTI (Winding Temperature Indication) High Trip Main
- WTI (Winding Temperature Indication) High trip Teaser
- Overcurrent (OC) trip Indication
- Earth fault (E/F) trip Indication
- LV side
- Main OC trip indication
- Teaser OC trip indication
- Main REF (Restricted Earth Fault)
- Teaser REF (Restricted Earth Fault)
- **Signal remains green for the concerned indication if healthy, when alarm/trip occurs it turns Red**

Indications in TPC/SCADA



Indications in SCADA for feeder protection

- Feeder side (For faults in OHE and (-)25 KV Feeder)
  - Distance protection zone trip
  - SOTF (switch on the fault) Trip
  - Under voltage trip
  - Thermal overload trip
  - Auto reclose (AR)
  - Auto reclose (AR) unsuccessful
  - Fuse failure
  - WPC (wrong phase connection) Trip
  - Delta I trip (For High Resistive Faults)

Signal remains green for the concerned indication if healthy, when alarm/trip occurs it turns Red

Principle of Nitrogen Injection fire protection system

- Nitrogen injection fire protection system designed for oil filled transformers shall prevent tank explosion and the fire during internal faults resulting in an arc, where tank explosion will normally take few seconds after arc generation and also extinguish the external oil fires on transformer top cover due to tank explosion and/or external failures like busing fires, OLTC fires and fire from surrounding equipment's.
- The system shall drain a pre-determined quantity of oil from the tank top through outlet valve to reduce the tank pressure and inject nitrogen gas at high pressure from the lower side of the tank through inlet valves to create stirring action and deduce the temperature of top oil surface below flash point to extinguish the fire.
- Conservator tank oil shall be isolated during busing bursting, tank explosion and oil fire to prevent aggravation of fire.
- Transformer isolation shall be an essential pre-condition for activating the system.

Nitrogen Injection fire protection system



CONCLUSION

- Though the 2x25 KV System looks some complex at this juncture but considering the requirement of the increasing traffic and exclusive advantages of the system, it is the need of the hour. What is needed is to implement the system in phased and organized manner to the current routes. It has already been decided as policy that all new routes/work will be only of 2x25 KV . For existing routes priority wise and phase wise implementation is being done. Some PSI equipment which were being imported have been started to manufacture indigenously now. Further more manufacturers to be developed and process to be expedited. More emphasis is to be given for incoming transmission line work either by coordination with local power supplying authorities and/or developing transmission line execution agency inside.
- Knowledge imparting is one of the crucial aspect which is being addressed by giving training at each level of the stakeholders. It is essential to remove the blockage of minds in which new system is seen as complex and manpower prefers to work in existing system.
- The things are going on planned manner at each work front and it is sure that coming days will be technologically golden era for Indian Railways after implementation of Mission 3000MT.

THANKS

AEC Wire run through Suspension clamp and Termination





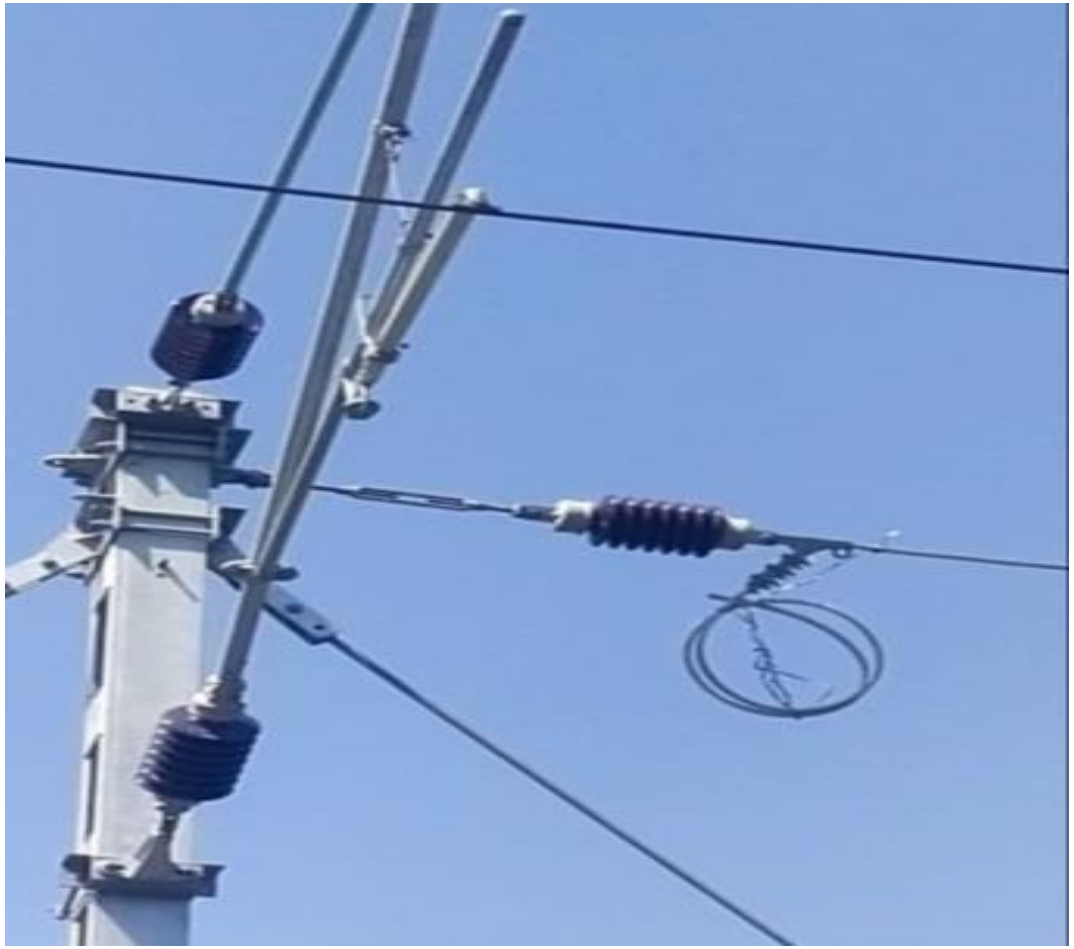
Provision of BEC for mast with Lug & T Connector





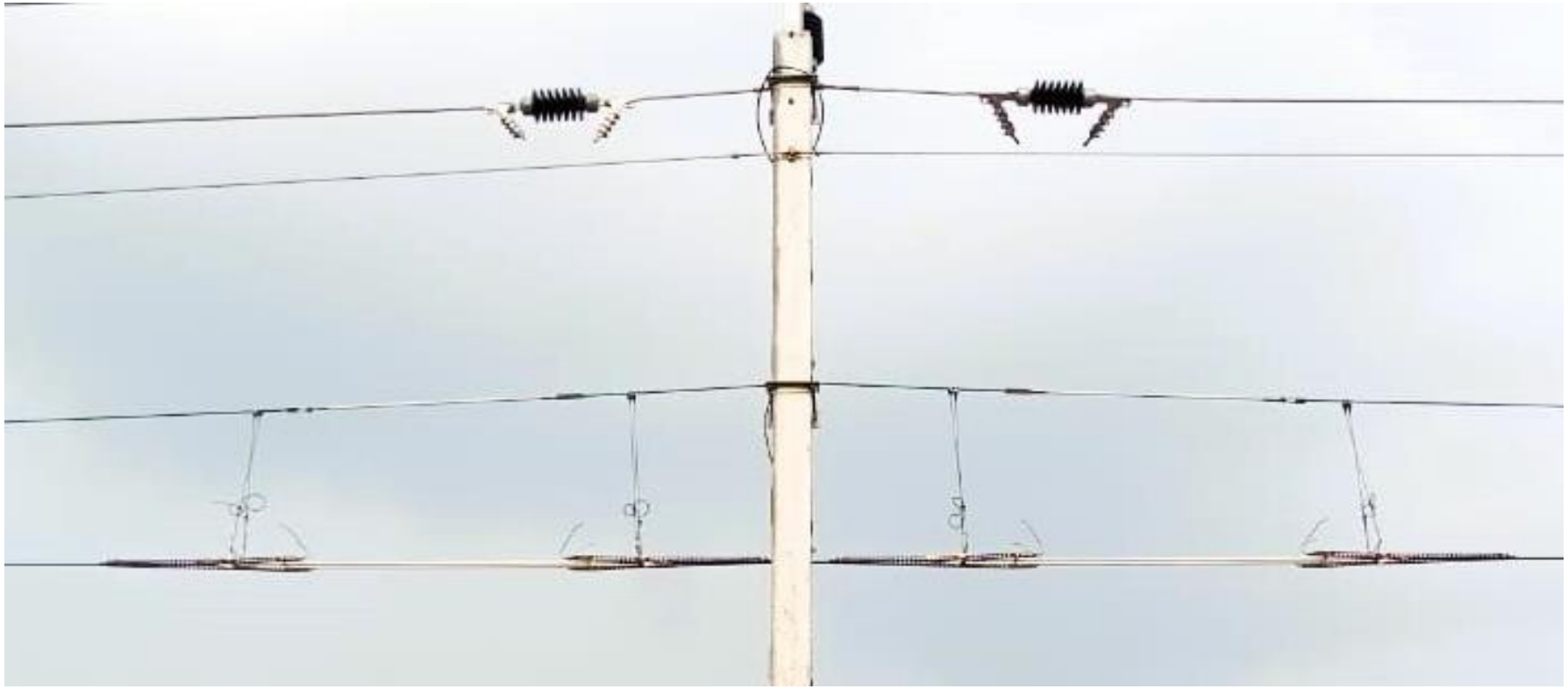


Feeder Wire termination





Feeder wire Termination at Neutral Section



TSS – Panchali



Auto transformer Mid point Earthing



Incoming Bay of TSS

